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# 1. Welcome!

Welcome to FluidSIM !

Thank you for purchasing the FluidSIM Pneumatics training software. This handbook functions both as an introduction to FluidSIM and as a reference manual outlining the possibilities, concepts, and operation of the software package. This handbook, however, is not intended to help in defining special aspects of pneumatics. Concerns of this nature can be found in the Festo Didactic GmbH & Co. KG textbook series.

Users of this software are encouraged to contribute tips, criticism, and suggestions for improvement of the program via email at

[info@fluidsim.com](mailto:info@fluidsim.com)

[did@de.festo.com](mailto:did@de.festo.com)

Moreover, the newest updates can be found at our Internet site at

[www.fluidsim.com](http://www.fluidsim.com)

[www.festo-didactic.com](http://www.festo-didactic.com)

August 2007 The Authors

## 1. Welcome!

### 1.1

#### **About FluidSIM**

FluidSIM Pneumatics is a teaching tool for simulating pneumatics basics and runs using Microsoft Windows®. It can be used in combination with the Festo Didactic GmbH & Co. KG training hardware, but also independently. FluidSIM was developed as a joint venture between the University of Paderborn, Festo Didactic GmbH & Co. KG, and Art Systems Software GmbH, Paderborn.

A major feature of FluidSIM is its close connection with CAD functionality and simulation. FluidSIM allows DIN-compliant drawing of electro-pneumatic circuit diagrams and can perform realistic simulations of the drawing based on physical models of the components. Simply stated, this eliminates the gap between the drawing of a circuit diagram and the simulation of the related pneumatic system.

The CAD functionality of FluidSIM has been specially tailored for fluidics. For example, *while drawing*, the program will check whether or not certain connections between components are permissible.

Another feature of FluidSIM results from its well thought-out didactic concept: FluidSIM supports learning, educating, and visualizing pneumatic knowledge. Pneumatic components are explained with textual descriptions, figures, and animations that illustrate underlying working principles; exercises and educational films mediate knowledge about both important circuits and the usage of pneumatic components.

The development of FluidSIM included special emphasis on both an intuitive and easy-to-learn user interface. The user will quickly learn to draw and simulate electro-pneumatic circuit diagrams.

## 1. Welcome!

### 1.2

#### Layout of the Handbook

The Handbook from FluidSIM has been divided into two parts. The first part serves as a user's guide, and the second part functions as a reference book. The user's guide contains chapters that introduce the user to FluidSIM. By following the chapters in order, the user will understand how to operate FluidSIM. The reference part contains a complete listing of the FluidSIM functions, the component library, the didactics material, and the FluidSIM messages.

#### User's Guide

Chapter 2 describes the computer requirements for FluidSIM, the installation process, and the meaning of the supplied files.

Chapter 3 contains small examples of circuit diagrams, showing how they can be simulated and how new circuit diagrams can be created.

Chapter 4 introduces advanced concepts of FluidSIM. Examples include the linking of pneumatic and electric components, the possible settings for simulation, and the testing of a circuit diagram.

Chapter 5 shows additional educational concepts. In particular, FluidSIM enables a user to pop-up a component's technical description, to start animations, or to play a film with related information.

Chapter 6 describes special functions of FluidSIM including how to print and export circuit diagrams, along with the rearrangement of the component library.

Chapter 8 deals specifically with help for questions concerning the use of FluidSIM. It also includes tips for the advanced user.

#### Reference

Appendix A contains a complete listing of FluidSIM menus and is intended to be used as a quick reference for all FluidSIM functions.

Appendix B contains the library of all FluidSIM components.

## 1. Welcome!

Appendix C contains the component illustrations, the animations, the exercises, and the educational films.

Appendix D contains a listing of messages that may occur while using FluidSIM along with a brief explanation for each.

### 1.3 Conventions

User instructions are indented and marked with the  arrow; important passages begin with the  symbol.

The symbols found on the FluidSIM toolbar are represented in this manual with the appropriate icon; menu entries are shown ; function keys are represented with their appropriate key symbol. For example  is the icon used to start a simulation;  indicates the “Open...” entry under the “File” menu;  stands for function key “9”.

In this manual the term “clicking” with a mouse means using the left mouse button. It is explicitly stated when the right button is to be used.

Values for quantities calculated and displayed in FluidSIM are expressed in the following units:

Quantity	Unit of measure
Pressure (p)	bar, MPa, psi
Flow (q)	l/min, gal/min, g/s
Velocity (v)	m/s
Force (F)	N, kN
Opening level (%)	-
Voltage (U)	V
Current (I)	A

## 2. Getting Started

This Chapter describes how FluidSIM is installed on your computer.

### 2.1

#### Technical Requirements

You need a computer with a Pentium processor or higher that runs using Microsoft Windows95<sup>®</sup>, Microsoft Windows98<sup>®</sup>, Microsoft WindowsME<sup>®</sup>, Microsoft WindowsNT<sup>®</sup>, Microsoft Windows2000<sup>®</sup> or Microsoft WindowsXP<sup>®</sup>.

If you intend to draw simple circuit diagrams or to simulate the existing circuit diagrams, 128 MB RAM is adequate. However, minimum 256 MB RAM is recommended to simulate complex circuit diagrams.

In order to play the educational films, you will need a CD-ROM drive that runs at double speed along with hardware for sound.

### 2.2

#### Installation

Having purchased the full version of FluidSIM, you received two CD-ROMs and possibly a license connector. One CD-ROM contains both full version and student version of FluidSIM. The other provides educational films providing the Video-CD format that may also be viewed on common DVD-players.

The installation procedure is described in the following sections.

The full version of FluidSIM is available in two versions: A version that supports the automatic [online activation](#) and the license connector version.

## 2. Getting Started

### 2.2.1

#### Installation and Online Activation

For the online activation you will need a computer with internet access. During the installation you will be prompted to activate FluidSIM. There are three ways of doing so:

- **Automatic Online Activation**  
This variant requires Internet access from the computer where FluidSIM is to be activated and realizes a completely automated procedure.
- **Indirect Activation**  
In this variant an activation dialog box is opened that shows an Internet address (url) and your individual license ID. With this information you can generate your individual activation key at an arbitrary computer with Internet access. Then, the activation key has to be entered in the activation dialog box of the installation PC.
- **Call Festo to receive your individual activation key**  
If you don't have Internet access or if the Internet activation fails, you can call a service employee at weekday office hours who will provide you with your activation code. Please note: The displayed phone number in Germany is available at European office times only. Depending on the geographical position of your site, you will find different telephone numbers for the software activation on the shipping box.

#### Import Online Activation Notes

During the activation of FluidSIM several features of your PC and the product ID are used to generate an individual activation key. This string is valid for your PC only. I.e., if your PC is substantially modified or if you want to use another PC, your FluidSIM license has to be transferred to the new hardware. Such a transfer requires the deactivation of the license of the original PC, which is accomplished by uninstalling FluidSIM. The respective uninstallation program can be found in the menu Start under "Deinstallation" or in the control panel under "Software".

If a deactivation of FluidSIM is not possible because of technical problems, as an exception your license can be transferred without deactivation.

## 2. Getting Started



Note that a license transfer without a preceding deactivation is possible only a few times. Also note that if your license has been transferred to another PC, it cannot be re-activated for the initial PC without deactivating it before.

### 2.2.2 Installation with license connector

Depending on the license model (single-position systems or network), the license connector is needed only during the *Installation* of FluidSIM or must be attached to the so-called *license server*.

The network license connector defines how many instances of FluidSIM can be running at the same time in the network. If you attempt to start more instances than the allowed number, an error message is displayed. If the license server is down or if the license connector has been removed from the system, all circuits that are already open and modified can be saved before FluidSIM terminates. If the license server is up again FluidSIM starts as usual.



Details for a network installation of FluidSIM is given in an addendum of the FluidSIM package and can also be found as pdf-file “net\_inst.pdf” in the “Doc”-Folder of the installation CD.

### FluidSIM Full Version: Installation from CD

**If your software needs a license connector, connect the key not until you are requested by the installation program.**

→ Switch on your PC and login with administrator permissions.

→ Insert the CD.

Usually the installation program starts automatically. Please start it manually if it doesn't:

→ Click **Run...** in the Start Menu.

A dialog box opens.

## 2. Getting Started

→ Enter the following string in the space provided: `d:\setup.exe`. Then click “OK”.

If your CD-ROM drive is configured differently, then be sure to use the appropriate letter in place of `d`.

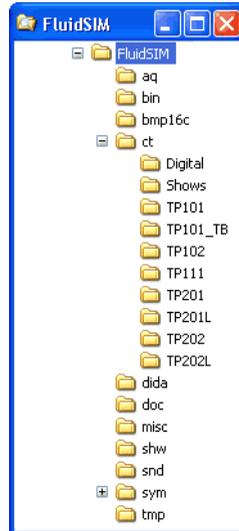
After a few seconds the startup screen of the installation program appears. Here you can choose whether to install the student version or the full version of FluidSIM. When installing the full version, please select the appropriate license connector (single-position systems or network). If you got a FluidSIM version for online activation no license connector is necessary but only your individual product ID is required, which is printed on the back of the CD cover. Note that the student version does neither require a license connector nor a product ID.

→ Follow the directions as they appear on the screen. If you are unsure how to answer or are unsure of a question, simply click “Next →”.

## 2. Getting Started

### 2.3 Supplied Files

The directory structure of FluidSIM is demonstrated in the following figure.



In case you installed FluidSIM for several users, you should not make any changes to the installation directory. New files and changes of the existing circuits, symbols and didactic material should be performed in the directory `MyDocuments`.

The directory `ct` contains the supplied circuits for FluidSIM. This is also the default directory in which all new circuits diagrams are saved. In its subdirectories the following circuit diagrams have been included:

`digital`: Circuits including sample circuits regarding digital technology.

`shows`: Circuits that can be opened as a bitmap via the [Didactics](#) menu (see section 5).

`tp101`: Circuits in the workbook "Pneumatics Basic Level TP 101".

## 2. Getting Started

tp101\_1b: Circuits in the textbook “Pneumatics Basic Level TP 101”.

tp102: Circuits in the workbook “Pneumatics Advanced Level TP 102”.

tp111: Circuits in the workbook “Closed-loop Pneumatics Basic Level TP 111”.

tp201: Circuits in the workbook “Electropneumatics Basic Level TP 201”.

tp2011: Circuits in the workbook “Electropneumatics Basic Level TP 201”, where the activating logic is implemented using digital technology instead of electrical components.

tp202: Circuits in the workbook “Electropneumatics Advanced Level TP 202”.

tp2021: Circuits in the workbook “Electropneumatics Advanced Level TP 202”, where the activating logic is implemented using digital technology instead of electrical components.

### 2.4

#### **De-installation of a Single-Position License**

The following steps are necessary to de-install FluidSIM from your computer.

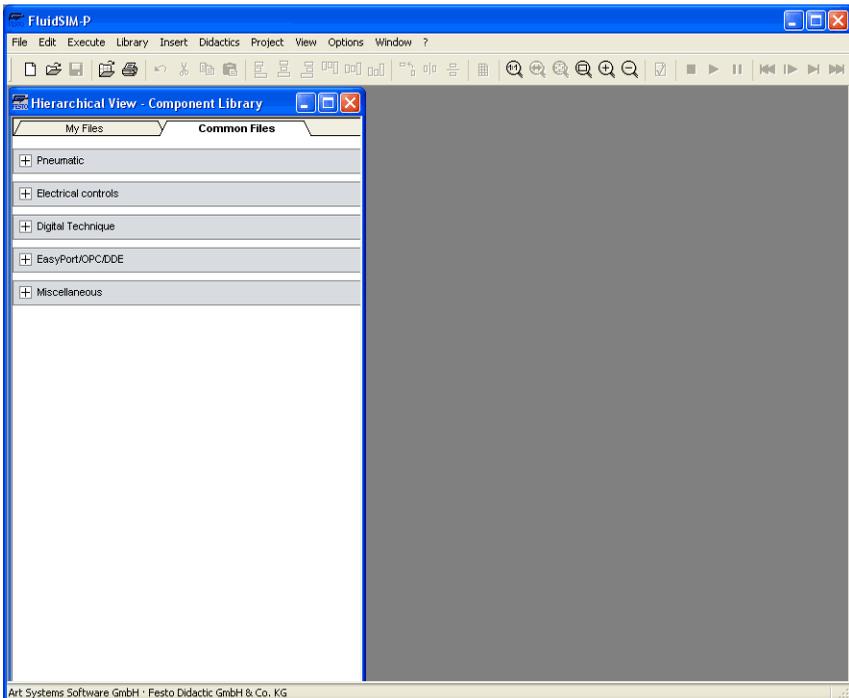
- Click on the program icon RemoveFluidSIM-P in the Start Menu ProgramFiles/FestoDidactic. If the program icon cannot be found, start the program unwise.exe in the bin-subdirectory of the FluidSIM directory.

### 3. Introduction to Simulating and Creating Circuits

The following chapter is set up in the form of a tutorial to introduce the user to important FluidSIM functions. At the end the user should be comfortable designing and simulating circuit diagrams.

→ Start FluidSIM via the Start Menu under ProgramFiles/  
FestoDidactic.

After a few seconds the main window from FluidSIM should appear on your screen:



### 3. Introduction to Simulating and Creating Circuits

The left-hand side shows the component library of FluidSIM in its hierarchical view; it contains pneumatic, electrical and digital components for the designing new circuit diagrams. Using the menu bar at the top of the window, you may access all functions provided for designing and simulating circuit diagrams. The toolbar below allows convenient access to frequently used menu functions.

The toolbar contains the following ten groups of functions:

1.  creating new circuit diagrams, previewing a circuit diagram, opening and saving circuit diagrams
2.  printing the contents of the window, for example circuit diagrams and component photos
3.  editing circuit diagrams
4.  alignment of components
5.  rotate and mirror
6.  using a grid
7.  zooming in and zooming out of circuit diagrams, component pictures, and other windows
8.  superficial circuit checking
9.  simulating circuit diagrams, directing animation (basic level)
10.  simulating circuit diagrams, directing animation (additional functions)



Only a certain number of the above listed functions will apply to a specific circuit diagram. FluidSIM recognizes which functions apply according to the contents of the window, component functions and context (circuit diagram design, animation, circuit diagram simulation, etc.), and disables the operations on the toolbar that do not apply.

In many new Microsoft Windows® programs “context menus” are available. A **context menu** appears when the user clicks the *right* button on the mouse within the program window. In FluidSIM, context menus apply to the contents and situations in the window; the context menus contain a useful subset of functions from the main menu bar.

Located at the bottom of the window is a status bar that displays information on the current calculations and activities during the operation of FluidSIM. In Edit Mode, FluidSIM displays the designation of the component found under the mouse cursor.

Buttons, scrollbars, and the menu bar in FluidSIM operate in the same way as in most other programs that utilize Microsoft Windows®.

### 3. Introduction to Simulating and Creating Circuits

#### 3.1 Simulating Existing Circuit Diagrams

Included with the FluidSIM installation disks are a number of working circuit diagrams.

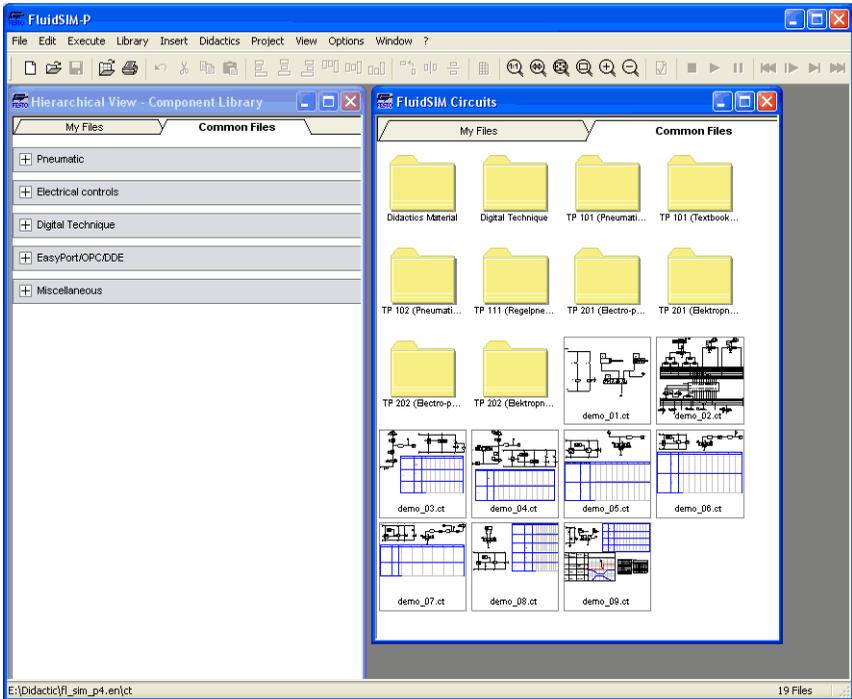
Among others, these are circuit diagrams as part of the learning material and will be discussed in the following workbooks “Pneumatics Basic Level TP 101” und “Electropneumatics Basic Level TP 201” (see section 2.3).

These circuit diagrams can be opened and simulated with FluidSIM as follows:

→ Click on  or choose **Circuit Preview** in the **File** menu.

### 3. Introduction to Simulating and Creating Circuits

Preview windows containing overviews of existing circuit diagrams should appear:



A preview window displays the circuit diagrams of a specific directory in alphabetical order accompanied by a miniature representation. The name of the current directory is shown in the title bar of the preview window; the files of the FluidSIM circuit diagrams contain the extension ct.

### 3. Introduction to Simulating and Creating Circuits

By double clicking a directory icon you go down to the respective subdirectory.



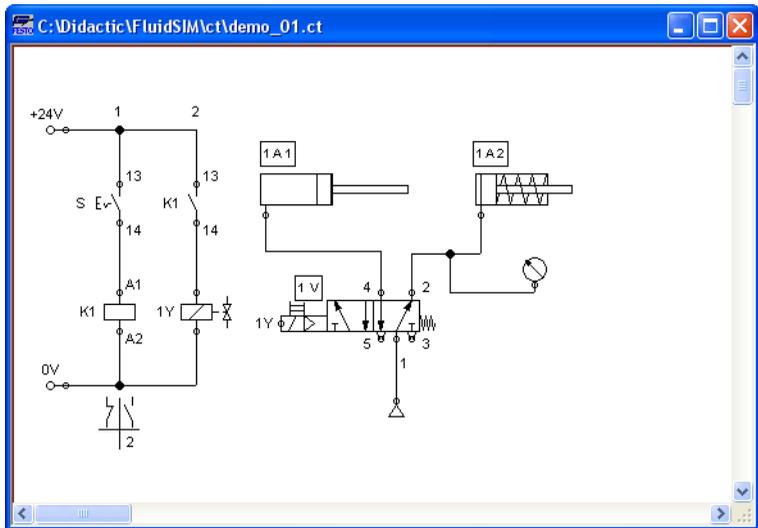
In the `ct` subdirectory of the `f1_sim_p` installation additional subdirectories for diagrams can be created. These subdirectories are automatically found by FluidSIM, and extra directory icons are created for them.

→ Open the circuit diagram `demo1.ct` by double clicking on its miniature representation.

Circuit diagrams can also be opened using the File Selector dialog box. By clicking on  or choosing `Open...` under the `File` menu, the File Selector dialog box will appear, in which a circuit diagram can be opened by double clicking on its filename.

### 3. Introduction to Simulating and Creating Circuits

In either case the circuit diagram is opened and displayed in a new window:



→ Click on  or on **Execute Start**, or press the key **F9**.

FluidSIM switches to the *simulation mode* and starts the simulation of the circuit diagram. When in the simulation mode, the mouse cursor changes to a hand .

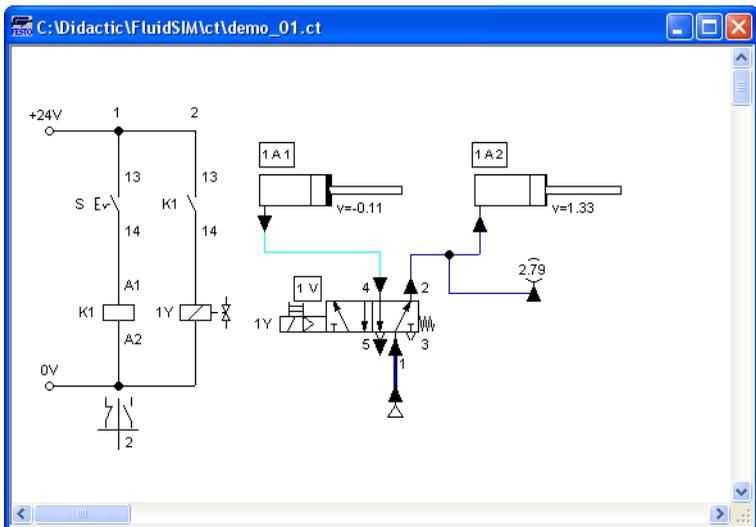
During the simulation FluidSIM first calculates all electrical parameters. pressure is calculated.

This step is followed by formulating a model of the pneumatic circuit and, based on this model, a continuous distribution for pressure and volumetric flow rate for the circuit.

### 3. Introduction to Simulating and Creating Circuits

Formulating models is demanding. Depending on a circuit's complexity and the computer's power, a circuit's simulation may take considerable time. Likewise, the real-time completion of the following dynamic simulation cannot always be guaranteed. The percentage of real-time achieved is shown in FluidSIM in the status bar at the lower edge of the main window.

As soon as the results are available, the connection lines will be shown in color and the cylinders extend:



The colors of the connection lines have the following meaning:

Color	Meaning
Dark blue	Pneumatic line under pressure
Light blue	Pneumatic line without pressure
Light red	Electrical line, current flowing

You can define your own mapping between colors and state values under [Options Simulation...](#). The varying thicknesses of the *dark blue* connection lines correspond to the pressure as related to the maximum pressure. FluidSIM distinguishes between two thicknesses of line:

Thickness	Meaning
	Pressure less than maximum
	Maximum pressure

The exact numeric values for pressures, flow rates, voltages, and currents are displayed on the attached measuring instruments. Section 4.7 describes how you may go about getting values for all or only selected variables on the circuit diagram, even when measuring instruments are not present.



Simulation in FluidSIM is based on physical models whose components match those components found in the Festo Didactic GmbH & Co. KG equipment set. Therefore, calculated values should closely match measured values. When comparing results, please acknowledge the fact that in practice, measurements can be subject to large fluctuations. The reasons for differences range from component tolerances, different hose lengths to air temperature.

The calculation of variables forms the basis for an exact, *real-time proportional* animation of the cylinder.

**Real-time-proportionality** guarantees the following property: If in reality a cylinder moves twice as fast as another one, the relationship between these two components is shown in the animation. In other words, the real-time relationship remains unaltered.

Manually operated valves and switches, found in the circuit diagram, can be switched by clicking on them with the mouse:

→ Move the mouse cursor to the left switch.

The mouse cursor becomes a hand with index finger  and indicates that the switch may be flipped.

→ Click on the switch.

When you click on a manually operated switch, its real behavior is simulated. In this example the clicked switch becomes closed and recalculation begins automatically. Following the calculation, the new pressure and flow values are indicated and the cylinders retract to their starting position.



The switching of a component is only possible when a simulation is running () or when a simulation has been set to pause ()

In the event that you would like to simulate another circuit diagram, it is not necessary to close the open one. FluidSIM allows you to have several circuits open at one time. Furthermore, FluidSIM is able to simulate multiple circuits simultaneously.

→ Click on  or [Execute Stop](#) to switch the current circuit from Simulation Mode to Edit Mode.



By switching a circuit from Simulation Mode to Edit Mode, all components will automatically be set back to their “normal status”. In particular, switches are set to their original position, valves switch to their normal position, cylinder pistons are set to their *previous* position, and all values calculated are deleted.



By clicking on  (alternative: [Execute Pause](#) or [F8](#)) you can switch from Edit Mode to Simulation Mode without starting the simulation. This feature is useful, if components shall be set *before* the simulation is started.

#### 3.2 The Different Simulation Modes

In addition to the functions of the preceding section (, , ), there exist also the following additional functions:

-  reset and restart of the simulation
-  simulation in single step mode
-  simulation to a certain point where a state change happens

#### Reset and Restart of the Simulation

By clicking on  or under [Execute Reset](#), an already running simulation or paused simulation can be reset. Immediately following this, the simulation will be restarted.

#### Single Step Mode

During single step mode, the simulation will stop after a small step. More exactly, by clicking on  or [Execute Single Step](#), the simulation will begin for just a short time period (approximately 0.01 - 0.1 seconds in the real system); the system then pauses ().



A running simulation can, at any time, be set into single step mode. It is then possible to focus on key moments during the simulation.

#### Simulation to a State Change

By clicking on  or under [Execute Simulate until State Change](#) the simulation begins and runs up until a certain point where a state change happens; the simulation then pauses (). The following situations describe the point at which the simulation pauses:

1. a cylinder's piston moves at a stop
2. a valve switches or is operated

### 3. Introduction to Simulating and Creating Circuits

3. a relay switches
4. a switch is operated

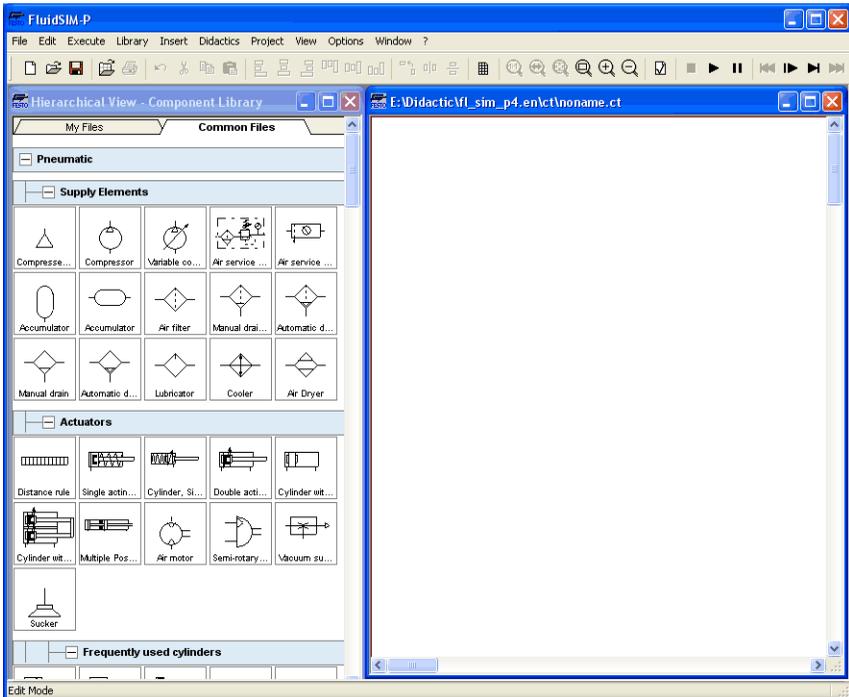
It is possible to switch from a running simulation into this state change mode.

#### **3.3 Creating new Circuit Diagrams**

This section contains an introduction to creating and simulating circuit diagrams using FluidSIM.

### 3. Introduction to Simulating and Creating Circuits

→ Create an empty drawing area by clicking on  or under **File** **New** to open a new window:



Circuit diagrams can only be created or altered in the Edit Mode. The Edit Mode is indicated with the following mouse cursor .

Each and every newly opened drawing area automatically contains a name, with which it can be saved. This name is found in the title bar of the new window.

### 3. Introduction to Simulating and Creating Circuits

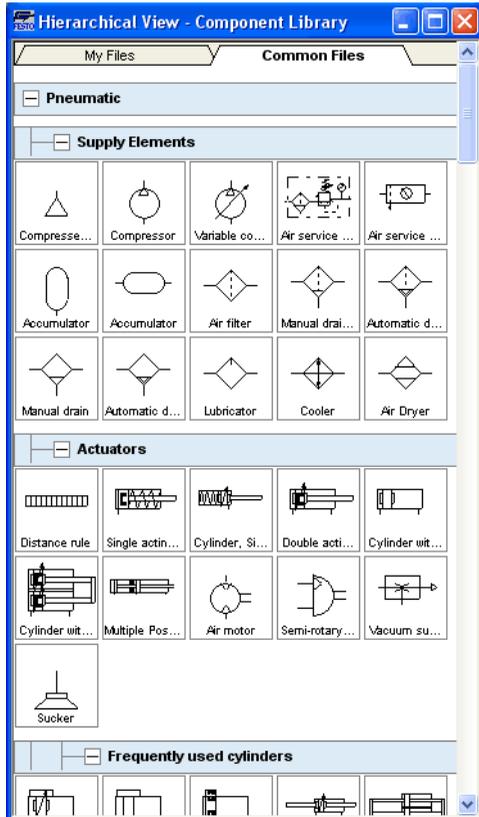
While in basic mode, you will see the available component groups in the hierarchical view of the component library. To list the components of a group, you may list off the group by clicking it. For a better overview you may also hide non-required elements and subgroups by once more clicking and hence closing the hierarchy. Component groups may often contain further subgroups that may also be listed off or closed.

To list off a group including all of its subgroups, you may hold the Shift-Key while clicking. This will reduce your efforts to list off each subgroup. You may similarly use the Shift-Key to close all subgroups of a superordinate group.

.....→ press the Shift-Key, hold it and click "Pneumatic".

### 3. Introduction to Simulating and Creating Circuits

The entire group of pneumatic components will be listed off. Using the scrollbars, you may browse through the component library to the left and right or up and down.



Using the mouse and “drag-and-drop” you may drag components from the component library to the drawing area:

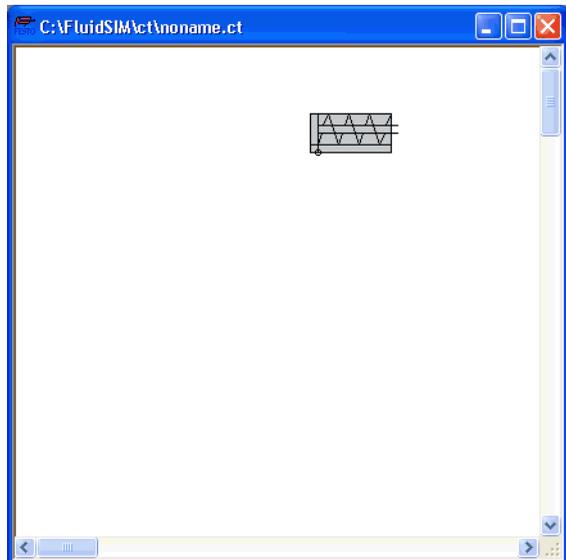
### 3. Introduction to Simulating and Creating Circuits

→ Move the mouse cursor to a component in the library, more specifically to the cylinder.

→ Press the left mouse button. While continuing to hold down the button, move the cursor.

The cylinder is then *highlighted* (selected) and the mouse cursor changes to a four way directional cross  $\text{⤵}$ . The component's outline moves with the mouse cursor.

→ Move the cursor to the drawing area and release the button on the mouse. This action places the cylinder in the drawing area:



### 3. Introduction to Simulating and Creating Circuits

In this way it is possible to “drag” each component from the component library and place it in the desired position in the drawing area. In the same way it is possible to rearrange components already in the drawing area.

→ Drag the cylinder to the bottom right hand corner.



In order to simplify the creation of circuit diagrams, the components automatically snap to grid in the drawing area.

→ Try to move the cylinder onto a non-permissible area, for example outside the window.

Outside a permissible area the mouse cursor changes to the prohibited sign ; the component cannot be dropped.

→ Drag a second cylinder onto the drawing area and notice that the second cylinder is now highlighted.

→ Highlight, say, select the first cylinder by clicking on it.

→ Delete the cylinder by clicking on  (cut) or under [Edit Delete](#) or by pressing the  key.

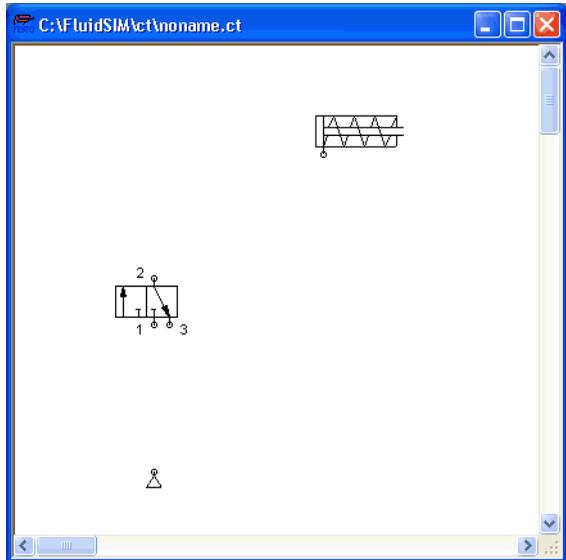


The commands in the [Edit](#) menu correspond only to the selected components.

→ Drag onto the drawing area a configurable 3/n-way valve and a compressed air supply.

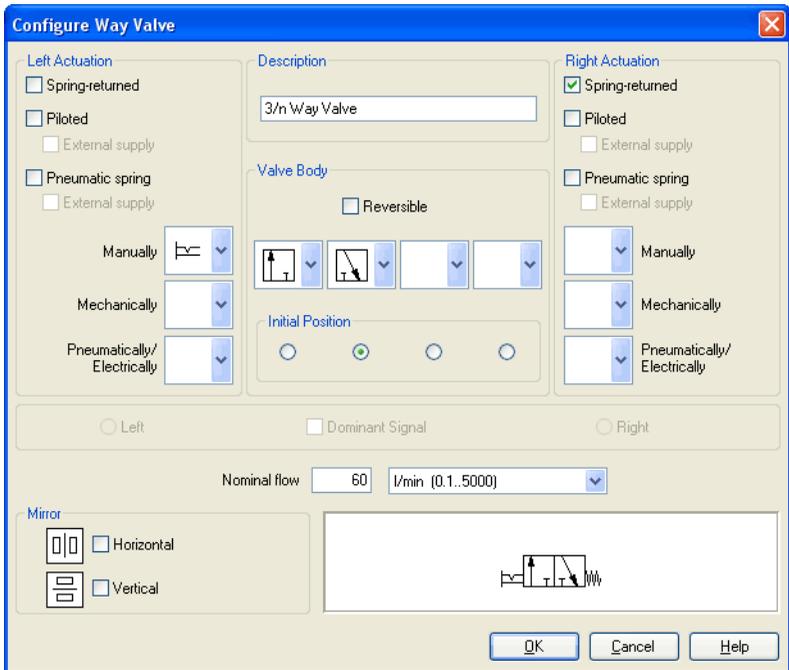
### 3. Introduction to Simulating and Creating Circuits

→ Arrange the components in the following manner:



### 3. Introduction to Simulating and Creating Circuits

Double click the valve to assign an operation mode to it. A dialog box appears:



Description of the dialog box:

- “Left/Right Actuation”

For both sides the actuation modes of the valve can be defined individually; it can be one or more of the categories “Manually”, “Mechanically”, or “Pneumatically/Electrically”. An operation mode is set by clicking on the down-arrow at the right-hand side of the list and selecting a symbol. If for a category no operation mode is desired, simply choose the blank symbol from the list. Moreover, for each side of the valve the attributes “Spring-returned” and “Piloted” can be set.

- “Description”

Enter here a name for the valve. This name is used in the [state diagram](#) and in the [parts list](#).

- “Valve Body”

A configurable valve has at most four positions. For each of the positions a valve body element can be chosen individually. Such an element is set by clicking on the down-arrow at the right-hand side of the list and selecting a symbol. If for a position no element is desired, simply choose the blank symbol from the list. The valve may be marked “Reversible” to indicate that there is no particular direction of flow.

- “Initial Position”

This button defines the valve’s initial position (sometimes also called normal position or neutral position), which is the position without having any operation applied to the valve. Note that this setting is only exploited if it physically does not contradict a spring-returned setting, possibly defined above.

- “Dominant Signal”

A “Dominant signal” on the left or right-hand side defines the overriding signal, in case the valve is addressed from both sides simultaneously.

- “Standard Nominal Flow Rate”

This is where you define the standard nominal flow rate of the valve.

→ Choose from the left-hand side in the topmost list a manual operation with snap in, and select the “Spring-returned” option in the right field. Close the dialog box via OK.

### 3. Introduction to Simulating and Creating Circuits

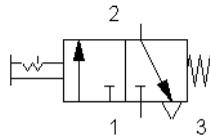
Since the connection “3” of the valve serves as air discharge, an exhaust should be assigned to it.

→ Double click the connection “3”.

A dialog box opens in which a *terminator* can be chosen by clicking on the down-arrow at the right-hand side of the list and selecting a symbol.

→ Select the third symbol (the simple exhaust) and close the dialog.

Now the valve should look as follows:



→ Move the mouse cursor over the left cylinder *connection* .

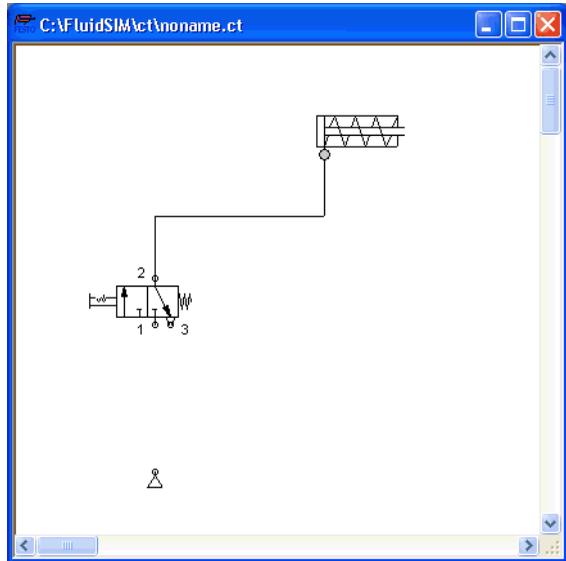
In Edit Mode, the mouse cursor changes to a cross-wires pointer , when it is above a component *connection* .

→ Press the left mouse button while the mouse cursor is above the cylinder connection. Move the mouse cursor and notice how the cross-wires pointer gains arrows .

→ Keep pressing the mouse button, and move the cross-wires pointer  to the upper valve connection. Notice how the arrows on the cross-wires pointer turn inward .

→ Release the mouse button.

Immediately a line appears between the two chosen connections:



FluidSIM automatically draws a line between the two chosen connections. The mouse cursor changes to the prohibited sign  when it is not possible to draw a line between two connections.

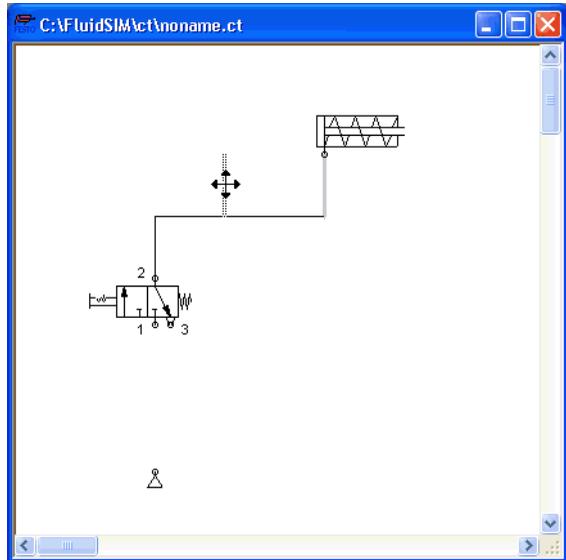
→ Move the mouse cursor to a line.

In the Edit Mode, the mouse cursor changes to a line-selection symbol , when it is positioned over a line.

→ Press the left mouse button and move the line-selection symbol to the left. Release the mouse button.

### 3. Introduction to Simulating and Creating Circuits

Immediately, the line is redrawn:

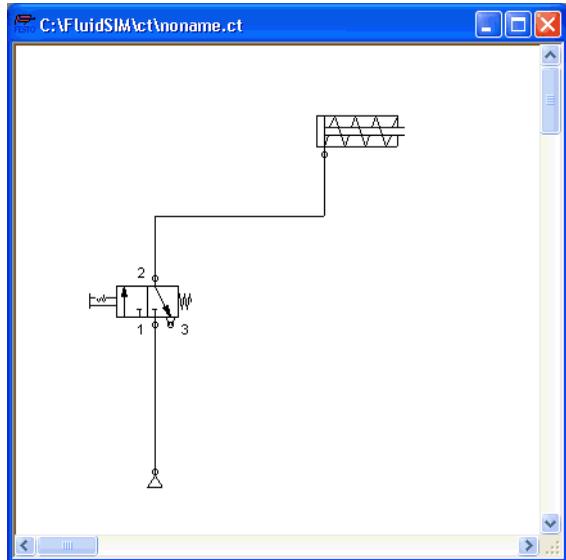


In the Edit Mode the components and lines can be selected, moved, or deleted by clicking on **Edit Delete** or by pressing the **Del** key.

→ Connect the remaining components.

### 3. Introduction to Simulating and Creating Circuits

The circuit diagram should look somewhat like the following one:

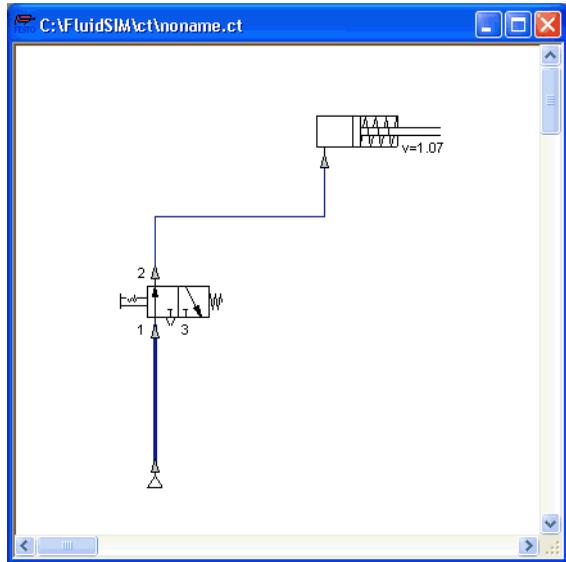


The circuit diagram has been completely drawn and connected. Attempt to simulate this circuit.

- Start the simulation by clicking on  (or under **Execute Start** or with the **F9** key).
- Move the mouse cursor over the valve and click with the index finger  on the valve.

### 3. Introduction to Simulating and Creating Circuits

During simulation all pressures and flow rates are calculated, all lines are colored, and the cylinder's piston extends.



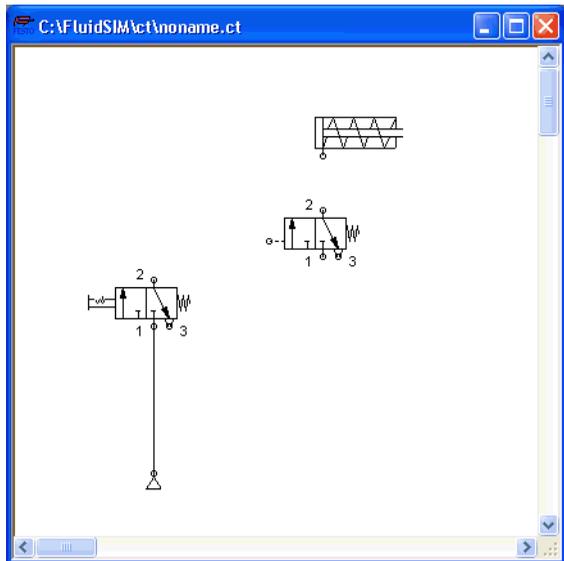
After the cylinder has been extended, the pressure in the cylinder supply line must inevitably increase. This situation is recognized by FluidSIM and the parameters are recalculated; the pressure at the compressed air supply increases to the preset operating pressure.

→ Click on the valve so that the cylinder may retract.

In complex pneumatic systems, or for the transmission of high switching powers, valves may be operated indirectly. In the following we will replace the direct manual operation by an indirect pneumatic operation.

### 3. Introduction to Simulating and Creating Circuits

- Activate the Edit Mode by clicking on  (or under **Execute** **Stop** or with the **F5** key).
- Select and delete the line that connects the cylinder and the valve.
- Drag another 3/n-way valve onto the drawing area and open by a double click (or by **Edit Properties...**) the dialog box for the valve configuration. “Construct” a pneumatic valve, normally closed, and close the dialog box. Then, connect an exhaust at connection “3” and arrange the components as follows:



- Connect the output connection of the new valve with the cylinder.
- Draw a line from the output connection of the manually operated valve to the control connection of the pneumatically operated valve.



In reality, to connect a component to an existing line requires a T-connection . FluidSIM automatically creates a T-connection when you draw a line from a connection to an existing line.

→ Using the cross-wires cursor  draw a line between the input connection of the pneumatically operated valve to the line connecting the compressed air supply and the manually operated valve. Notice how the arrows in the cross-wires turn inwards .

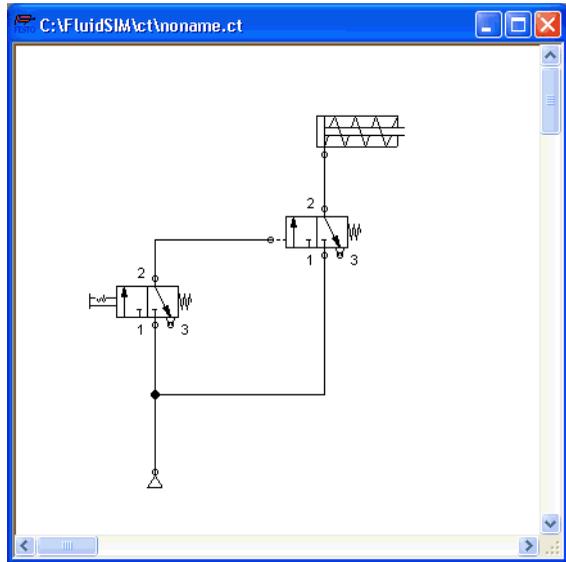
→ Release the mouse button.

The T-connection appears on the line at the point where the mouse button was released.

→ If necessary, draw the line so that the wiring diagram is arranged clearly.

### 3. Introduction to Simulating and Creating Circuits

The circuit diagram should now appear somewhat like the following diagram:



→ Save the circuit by clicking on  or **File Save**. FluidSIM automatically opens the File Selector dialog box, if the title is new; here you must give the circuit a name.

→ Start the **simulation** by clicking ; then click on the manually operated valve.

When you click on a valve, its real behavior is simulated. Here, the clicked valve switches over, immediately followed by a recalculation. As a result, the piloted operated pneumatic valve switches over and the cylinder extends.



FluidSIM not only animates manually operated components during changeover, but nearly all components with multiple states.

The following figure shows a 3/2-way valve in closed and open position:



Components whose switching status is not locked remain activated as long as the mouse button is held down.

→ Stop the simulation, which also brings you to Edit Mode. Select from the component library the state diagram component, and place it onto the drawing area.

The **state diagram** records the state quantities of important components and depicts them graphically.

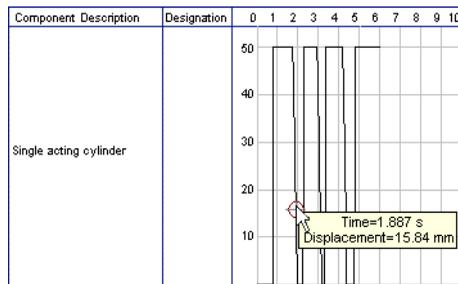
→ Move the state diagram to a free place in the drawing. Drag the cylinder and drop it onto the state diagram.

A dialog opens where you may choose the desired status variables. In this particular case only the position is of interest, so you may confirm the default selection by choosing OK.



### 3. Introduction to Simulating and Creating Circuits

When resting on the diagram for approximately one second, the mouse cursor will call a window indicating the exact values of time and of the applicable status variable. The display will move along and update the values when you move the mouse alongside the graph.



You may use several status diagrams in one window as well as you may display several components in the same diagram. By dragging a component onto the diagram you will add the component to the status diagram. A selection dialog will appear where you may choose the applicable status variables and different colors. A repeated drag onto the diagram will open the dialog again, so you may change your choice. In case no status variable of a component is selected, the component will be removed from the diagram. The following components and the applicable status variables may be displayed in the status variable diagram:

### 3. Introduction to Simulating and Creating Circuits

<b>Component</b>	<b>State</b>
cylinder	position, velocity acceleration, force
way valve	position
pressure meter, accumulator	pressure
shutoff valve and throttle valve	opening level
pump, motor	rpm
semi-rotary actuator	position
pressure valve and switching valves	state, pressure
flow control valves	flow
flow meter	flow, volume
pressure or switching valve	state
switch	state
relay, valve solenoid	state
indicator light, buzzer, pressure indicator	state
counter	state, counter value
function generator, voltmeter	voltage
status controller, PID-controller	voltage

The example is now finished. Further editing and simulation concepts are described in the next chapter.

# 4. Advanced Concepts in Simulating and Creating Circuits

This chapter contains advanced concepts and functions, which can be used when simulating and creating circuits with FluidSIM.

## 4.1 Configurable Symbols

FluidSIM is capable of simulating a vast number of different cylinders and valves. The combination of all part designs and functional types would lead to displaying many thousands of symbols. Therefore you will find, alongside some common part designs in the component library, configurable and representative components. In order to adapt a cylinder or a way valve, drag one of these representatives in the circuit and open the status dialog. Here you will find settings helping you to define layout and function of the component.

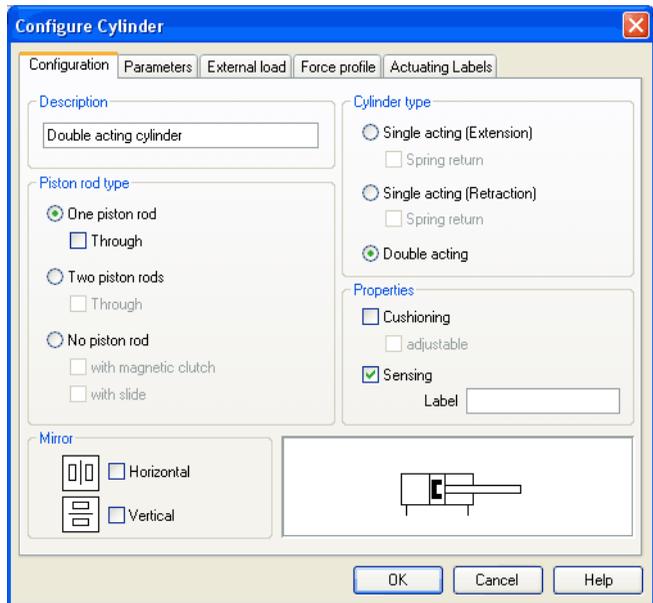
### Configure Cylinders

Double-click the cylinder to define part design, parameter and external influence of a cylinder. The status dialog of the cylinder will open.

The dialog consists of several registers, providing a convenient overview despite the vast number of settings.

Find descriptions of the dialog boxes of individual registers below.

## Register “Configuration”



Description of the dialog box:

- “Component Description”

You may enter a description for the cylinder into the text field, it will show in the **state diagram** and in the **parts list**.

- “Cylinder Type”

cylinder type (single-acting, double-acting, spring return)

#### 4. Advanced Concepts in Simulating and Creating Circuits

- “Piston Rod Type”

piston rod type (quantity, part design, magnet coupling, slide unit)

- “Properties”

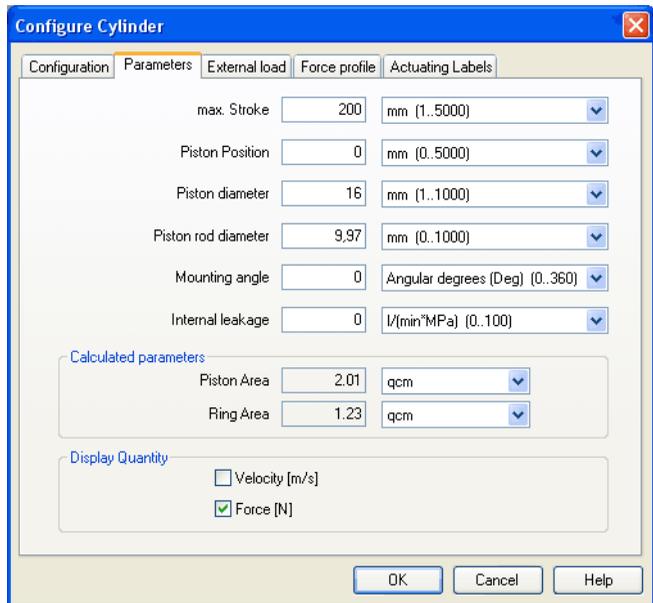
More properties of the cylinder (end position cushioning, sensing)

The label you may define at “sensing” serves as an interconnection with the [displacement encoder](#). This is how, e. g. in combination with [proportional valves](#), controlled systems can be constructed. Please find more reference to proportional technology in section [4.18](#).

- “Mirror”

This is where you may define whether the cylinder will be mirrored horizontally or vertically. The effect will be the same as when mirrored as in [Edit Mirror](#).

## Register “Parameter”



Description of the dialog box:

- “Max. Stroke”

Maximum cylinder stroke

- “Piston Position”

Piston position at the start of the simulation

- “Piston Diameter”

Diameter of the Piston

- “Piston Rod Diameter”

Diameter of the piston rod of the cylinder

- “Mounting Angle”

The bracket affects the friction force of the moved load. You may define the mass as well as the friction coefficients in the register “external load”.

- “Internal Leakage”

This is where you may define the inner leakage of a cylinder. In reality there is never an ideal cylinder, since the piston never seals the chassis perfectly. Thus and despite the cut off cylinder port, the piston gradually slides under the load.

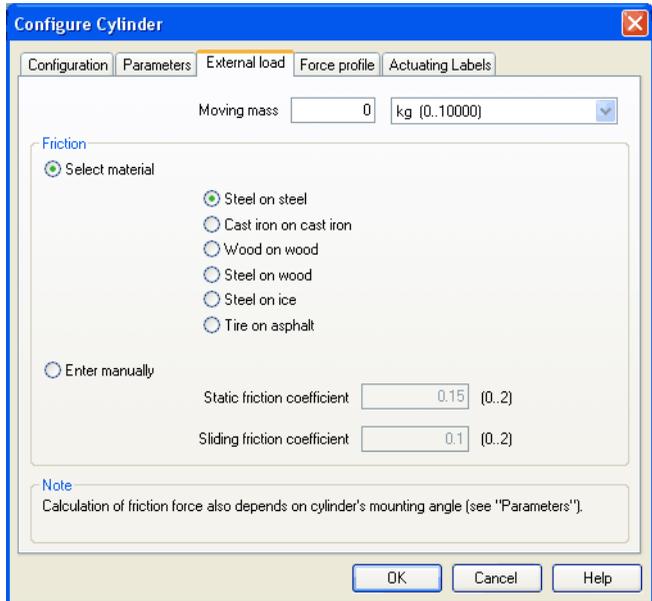
- “Calculated Parameters”

Piston surface and annular surface will be automatically calculated from piston diameter and piston rod diameter.

- “Display Quantities”

In the field “Display Quantities” you may tick state variables that are to be displayed alongside the cylinder when the “selected”-option is switched on for these state variables in the state variable box. In case in the state variable dialog box “no”-option is switched on, the particular cylinder related state variables will not be displayed.

## Register “External Load”



Description of the dialog box:

- “Moving Mass”

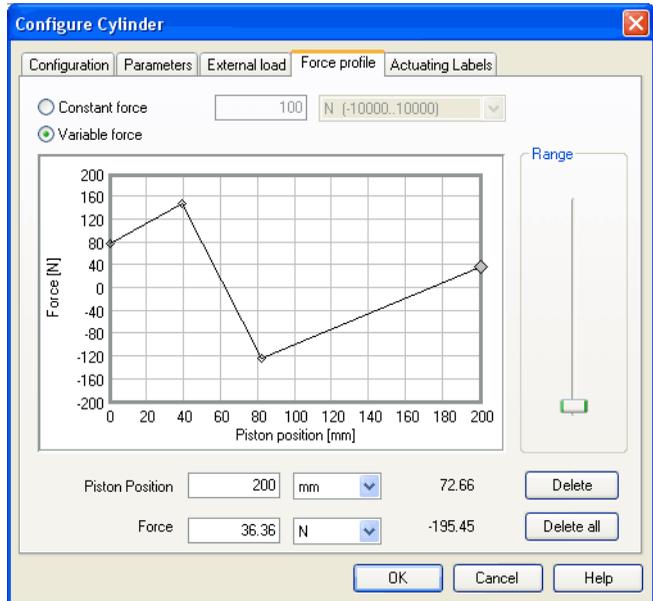
Please enter the mass of the load here that is supposed to move cylinder. The mass of the cylinder piston and of the piston rod will be automatically and appropriately calculated by FluidSIM from the entered cylinder dimensions; thus the mass in this case refers only to the external load. Particularly, entering “0” does not conclude in the moving parts being massless.

- “Friction”

Static friction and sliding friction determine the friction of the moving load on a surface. The internal friction inside the cylinder will be automatically and appropriately calculated by FluidSIM from the entered cylinder dimensions. Please enter “0” for both values if the load is lifted or pulled without touching a surface. In reality it is very difficult to achieve reliable values for friction. Therefore FluidSIM offers set friction coefficients for some combinations of material, providing a roundabout orientation. When comparing other tables of friction values you will notice that the (often experimentally measured) specifications differ in major ways. Please interpret these carefully and concurrently take into account the results of simulations generated by friction. Nevertheless, the variation of the friction values allows you to distinctly notice the physical influence of static and sliding friction.

Please note also that the mounting angle influences the friction force through the moved load. You may define the mounting angle in the register “parameter”.

## Register “Force Profile”



Description of the dialog box:

- “Constant Force”

Please choose this option and enter a force if a constant force is meant to take effect for the entire distance of the cylinder movement.

- “Variable Force”

Please choose this option if the force changes depending on the position of the cylinder rod. You may interactively define applicable points in the chart field by clicking the mouse, these applicable points will be linked to be one lineament. Alternatively, you may mark an existing applicable point and enter the two values numerically for piston position and applicable force using the input field.

- “Range”

Using this slider you may define the range of values to be displayed for the force.

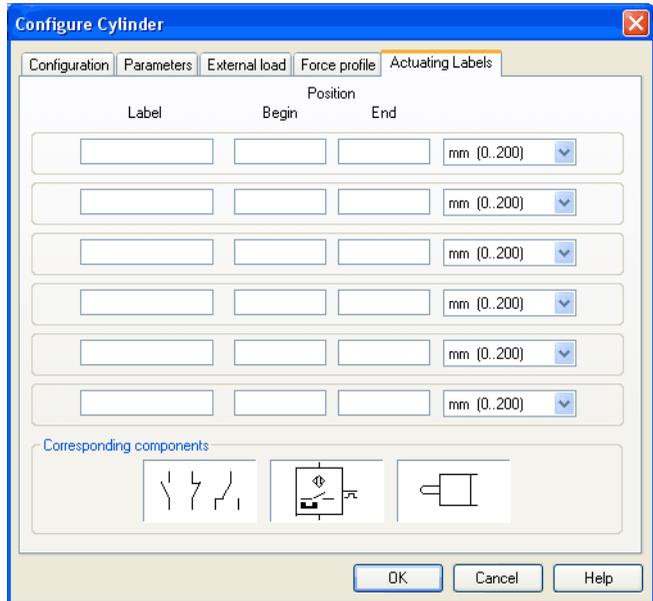
- “Delete”

Deletes the marked applicable point and links the two adjoining points with one straight line.

- “Delete all”

Deletes all applicable points and defines a constant force. Use this option to delete an existing lineament without having to delete each single applicable point.

## Register “Actuating Labels”

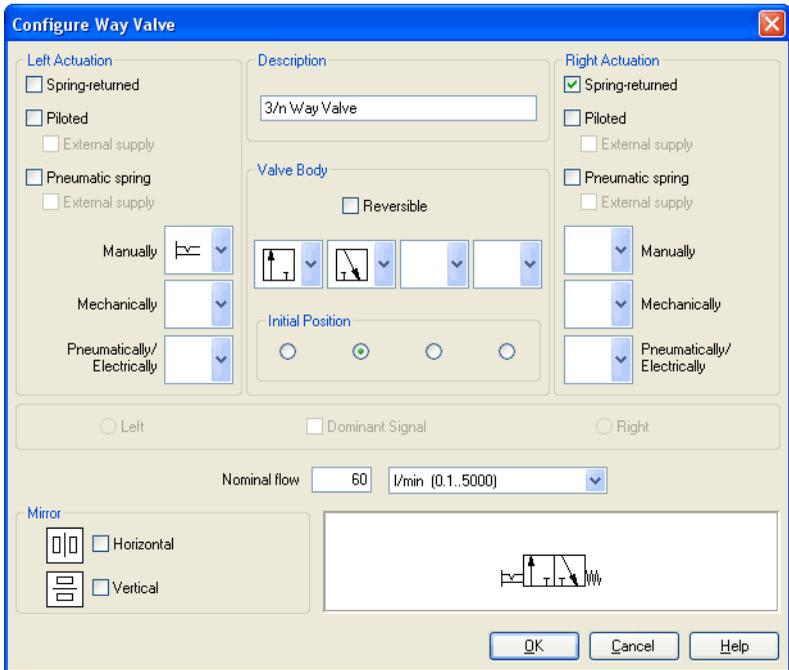


This is where you may define new actuating labels or change existing ones. This dialog box is identical to the one that is opened when you double-click on a [distance rule](#).

### Configuring Way Valves

The body of a valve or its operation concept can be changed by double-clicking the valve. The following dialog box is opened.

#### 4. Advanced Concepts in Simulating and Creating Circuits



Description of the dialog box:

- “Left/Right Actuation”

For both sides the actuation modes of the valve can be defined individually; it can be one or more of the categories “Manually”, “Mechanically”, or “pneumatically/Electrically”. An operation mode is set by clicking on the down-arrow at the right-hand side of the list and selecting a symbol. If for a category no operation mode is desired, simply choose the blank symbol from the list. Moreover, for each side of the valve the attributes “Spring-returned” and “Piloted” can be set.

#### 4. Advanced Concepts in Simulating and Creating Circuits

- “Description”

Enter here a name for the valve. This name is used in the [state diagram](#) and in the [parts list](#).

- “Valve Body”

A configurable valve has at most four positions. For each of the positions a valve body element can be chosen individually. Such an element is set by clicking on the down-arrow at the right-hand side of the list and selecting a symbol. If for a position no element is desired, simply choose the blank symbol from the list. The valve may be marked as “Reversible” to display that it has no particular direction of flow.

- “Initial Position”

This button defines the valve’s initial position (sometimes also called normal position or neutral position), which is the position without having any operation applied to the valve. Note that this setting is only exploited if it physically does not contradict a spring-returned setting, possibly defined above.

- “Dominant Signal”

A “Dominant signal” to the left-hand or right-hand side defines which signal will be overriding when the valve is addressed from both sides simultaneously.

- “Standard Nominal Flow Rate”

This is where you may define the standard nominal flow rate of the valve.

## 4. Advanced Concepts in Simulating and Creating Circuits

- “Mirror”

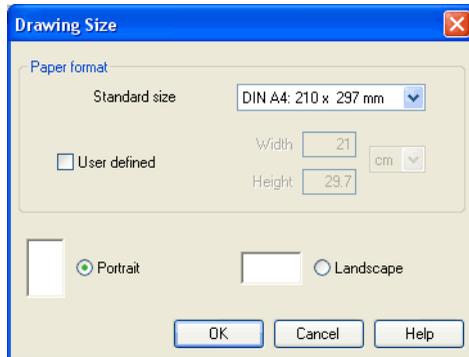
This is where you may define whether the valve be mirrored horizontally or vertically. The effect is the same as when mirrored using [Edit Mirror](#).

### 4.2 Additional Editing Functions

In addition to the commands that were introduced in section 3.3, the Edit Mode in FluidSIM provides you with a higher level of important editing functions:

#### Setting the Paper Size

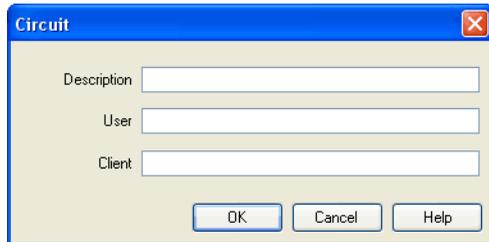
In Edit Mode the size of the paper is indicated by a red rectangle. The default setting of the paper size is “DIN A4, portrait”. The default setting can be changed in the menu [File Drawing Size...](#).



The size and the orientation of the paper can be set here. If the drawing size exceeds the paper size of your printer, the total area of several smaller papers can be tiled with the drawing.

## 4. Advanced Concepts in Simulating and Creating Circuits

For orientation purposes, under **File Properties...** additional information can be stored along with each drawing. The text that is entered in `description` is shown in the **preview window** below the respective diagram.



### Undoing Editing Steps

By clicking on **↶** or **Edit Undo** and with **Edit Redo**, each step given in the Edit Mode can be undone in the following manner:

By clicking on **↶** (**Edit Undo**), the last editing step that was taken is undone. FluidSIM recalls the last 128 editing steps, which can be undone.

The function **Edit Redo** serves as a way to “withdraw the last undone step”. When using **↶** to undo an editing step, you may go too far. By clicking under **Edit Redo**, the circuit is returned to its original state before **↶** was initiated. The function **Edit Redo** can be invoked until there are no more undo steps to be redone.

The function **Edit Undo** applies to all possible editing steps in the Edit Mode.

### Multiple Selection

A component can be highlighted, that is to say selected, by clicking on it with the left mouse button. However, by clicking on another component with the left mouse button, the first component is no longer selected, but the second component is. Only *one* component at a time may be selected when clicking with the left mouse button.

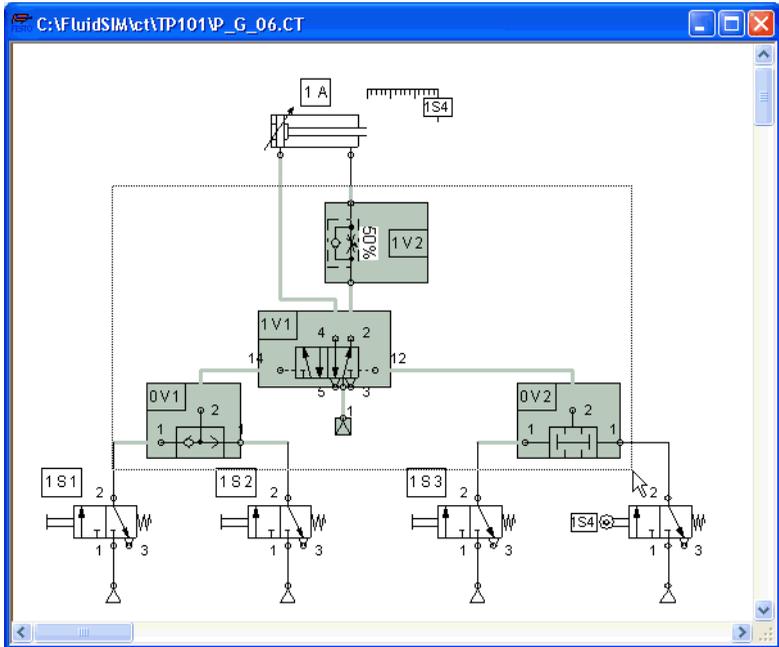
#### 4. Advanced Concepts in Simulating and Creating Circuits

If, while you are clicking on components, you hold down the `Ctrl` key, the components that are already selected will remain so. In addition, the component underneath the mouse cursor will also be selected, if not already selected, or de-selected, if already selected. In this sense, the component's state of selection is reversed.

Another efficient concept for selecting multiple components is by using the *rubber band*. The rubber band is opened by pressing and holding down the left mouse button, and then moving the mouse cursor. The mouse cursor cannot be located directly over a component if the rubber band shall be opened.

#### 4. Advanced Concepts in Simulating and Creating Circuits

All components enclosed, either partially or fully, by the rubber band, are selected.



All components and lines of the current circuit diagram can be selected by clicking under **Edit Select All** or typing **Ctrl | A**.



Editing functions such as dragging or moving, copying and, deleting apply to all selected components.

## 4. Advanced Concepts in Simulating and Creating Circuits

### Right Mouse Button

When you click the mouse button on the right in a FluidSIM window, the appropriate context menu is opened. If the mouse cursor is located above a component or component connection, the item will become selected. If this component was not yet selected, then a possibly existing selection of other components will be de-selected.

Clicking the right mouse button on a component (connection) is actually a short cut for the following two actions: Clicking the left mouse button on the component (connection) and opening a menu.

### Double Clicking with the Mouse

Double clicking the left mouse button on a component (connection) is a short cut for the following two actions: Selecting the component (connection) and clicking on [Edit Properties...](#).

### Copying

Selected components can be copied to the clipboard by clicking on  or [Edit Copy](#); the component can then be inserted in the circuit diagram by clicking on  or [Edit Paste](#). In the same way it is possible to paste the contents of the clipboard into another graphic or word processing program.

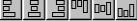
Within a circuit diagram selected components can also be copied by holding down the [Shift](#) key and moving them. The mouse cursor changes then to the copy symbol .

### Copying between Windows

Components can simply be copied between windows by selecting the desired components and dragging them in the other window.

## 4. Advanced Concepts in Simulating and Creating Circuits

### Aligning Objects

To align objects, firstly select these objects and then click on the icon  or on the appropriate entry in the [Edit | Align](#) menu. Reference object is always the object which lies furthestmost in the desired direction. If, for instance, several components shall become aligned left, all but one objects are moved to the left so that they align with the left-most object. Note that pneumatic and electrical components obey the constraint that their connections must lie on the grid. As a consequence, an alignment may not always coincide with the symbol bounding.

### Rotate and Mirror

Selected components may be rotated by 90°, 180° or 270° by using [Edit | Rotate](#). If you wish only *one* component to be rotated you may alternatively perform a double-click on the component while holding the [Ctrl](#)-key, the component will then be rotated counterclockwise in 90°-steps. If you also hold the [Shift](#)-key in doing so, the component will be rotated *clockwise*.

In order to mirror marked objects, please select [Edit | Mirror](#). The applicable objects will be mirrored at its own axis, provided they are not part of a group. Grouped objects will be mirrored at the central shaft of the applicable group.

Instead of using the menu entries, you may also rotate or mirror through the applicable symbols .

### Deleting Lines

If only one component *connection* is selected, its connected (but de-selected) lines can be deleted using [Edit | Delete](#) or by pressing the [Del](#) key. This concept provides an alternative way to delete lines.

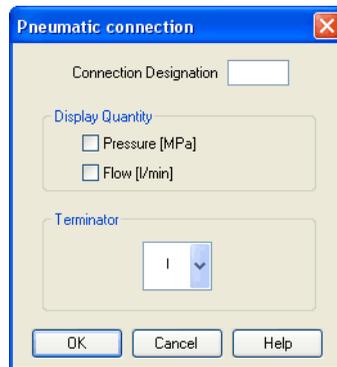
#### 4. Advanced Concepts in Simulating and Creating Circuits

##### Setting Line Type

The type of each fluidic line can be changed from the standard line type, “Main Line”, to the special line type “Control Line”. Being in Edit Mode, double clicking on a fluidic line or selecting the line and choosing the menu entry [Edit Properties...](#) brings up a dialog box in which you can set the line type. A control line is shown dashed. Note that—aside from a different appearance—changing line type has no impact respecting simulation.

##### Connection Descriptors, Blind Plugs, and Exhausts

Pneumatic [connections](#) can be closed with blind plugs—among others, to adapt their function. To avoid FluidSIM warning you in case of open connections you may also add mufflers to the connection. In FluidSIM you may place or remove these plugs and mufflers by double-clicking the applicable pneumatic connection while in edit mode. This will open a dialog box where you may choose an appropriate *connector* for the applicable connection. Instead of double-clicking a connection you may also mark a single connection and select the menu option [Edit Properties...](#) to open the applicable dialog box.



Description of the dialog box:

- “Connection Designation”

If enabled via [View Show Connection Descriptors](#), the contents of this field is displayed at the connection.

FluidSIM automatically places the connection designations in such way that they usually show at an appropriate position near the connection. You may alternatively relocate the connection designations using your mouse or your keyboard. Hence click on the designation and move the text to the desired position. To change the position with your mouse, please mark the designation (or the applicable connection) and move the text by using the cursor keys.



FluidSIM keeps you from moving away the connection designation too far from the applicable connection. In case a particular distance is exceeded, you won't be permitted to move it any further into that particular direction.

- “Display Quantity”

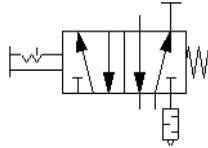
Check out the state values to be displayed when the “selected”-option in the state values dialog box is chosen. However, if the “no”-option in the state values dialog box is chosen, even the checked state values are not displayed.

- “Terminator”

Defines whether an open connection either is left open, closed by a blind plug, or closed by an exhaust.

## 4. Advanced Concepts in Simulating and Creating Circuits

A blind plug is indicated by a crossbar, an exhaust is indicated by its respective DIN symbol:



### Zoom Features

The content of windows can be enlarged by clicking on or [View | Zoom In](#) or reduced by using or [View | Zoom Out](#). The short cut keys for this function are and respectively. If your mouse device is equipped with a mouse wheel you can roll the wheel while holding down the key to zoom in and out, respectively

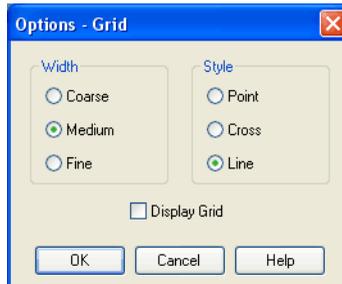
If you click on or [View | Zoom by Rubber Band](#) and then draw a rectangle with the rubber band, the selected area will be shown enlarged. You can also switch between the current and previous view of a window by clicking on or [View | Previous View](#).

or [View | Fit to Window](#) fits the entire circuit to the window; or [View | Standard Size](#) shows the circuit diagram without enlargement or reduction.

#### 4. Advanced Concepts in Simulating and Creating Circuits

##### Background Grid

By clicking on , the background grid is shown. By clicking under [Options | Grid...](#), a dialog box appears that allows you to select between grid types and line resolution.



Description of the dialog box:

- “Width”

The grid width defines how close together the lines of the grid should be. You can choose between “Coarse”, “Medium”, or “Fine”.

- “Style”

There are three types of grid to choose from “Point”, “Cross”, or “Line”.

- “Display Grid”

This selection displays or hides the background grid.

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### Grouping Objects

If objects shall be subsumed under a single group, select them and click **Edit Group**. Groups can be nested. The objects of a group can be selected, moved, deleted, or copied only all at once. However, component properties can be edited individually, as usual, by either double clicking the object or choosing the respective entry in the component's context menu.

### Ungrouping Objects

To ungroup a collection of objects, click **Edit Ungroup**. Note that only the outermost group is resolved; repeated ungrouping will resolve nested groups.

### 4.3 Additional Simulation Functions

#### Simultaneous Actuation of Several Components

This section describes in detail additional functions that apply to the simulation of circuit diagrams.

During the Simulation Mode, it is sometimes necessary to actuate more switches or valves simultaneously. It is possible in FluidSIM to simulate just such an actuation by means of setting a component in a permanently actuated state. A button (or a manually operated valve) will become permanently actuated when clicking on it while holding down the **Shift** key. This permanent actuation will be released by a simple click on the component.

At times it may be necessary to release several actuated objects at once. In this case, while clicking the object, hold the **Ctrl** key instead of the **Shift** key. The reversed components will remain actuated until the **Ctrl** key is released again; this is how all applicable objects will simultaneously switch back to their original position.

### Switching to the Edit Mode

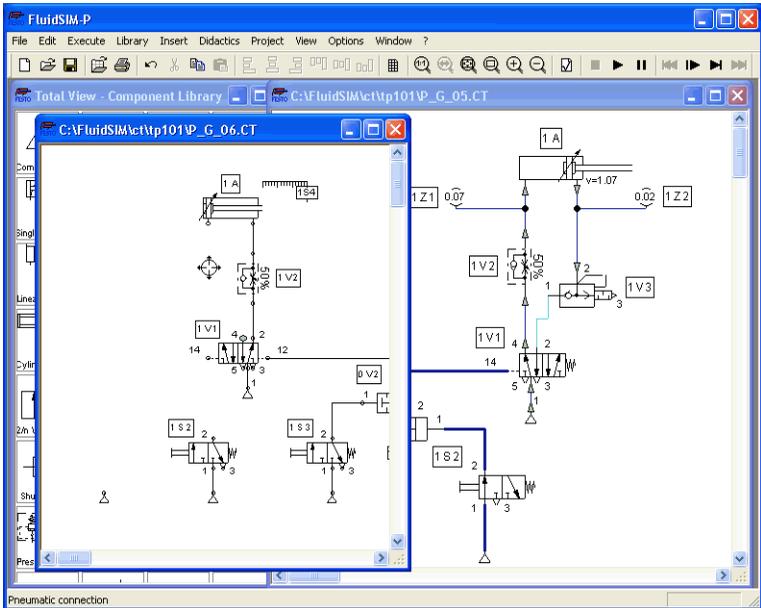
If a component is dragged from the component library to the circuit in the drawing area, and the simulation has been paused **||**, FluidSIM automatically switches to the Edit Mode.

#### 4. Advanced Concepts in Simulating and Creating Circuits

Editing and Simulating in Parallel

In FluidSIM it is possible to open more than one circuit diagram at a time. Each circuit can either be simulated or edited. This fact means that the Simulation Mode and the Edit Mode are applied uniquely and independently to each window containing a circuit diagram.

This concept means that it is possible to edit one circuit diagram, while other circuits are in the background running in simulation:





The simulation of pneumatic circuits may turn out to be a demanding problem. Therefore, when using a lower-performance computer, the editing of new circuit diagrams often appears jerky when simulations of other circuits are simultaneously running in the background. So that working in the Edit Mode goes more smoothly, all simulations performed in the background should be stopped.

### 4.4 Linking Components Automatically

Insertion of T-connections

In order to make circuit design efficient, FluidSIM provides more functions to facilitate component linking.

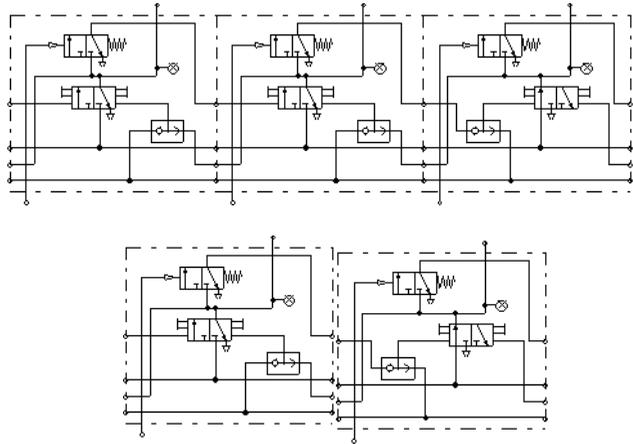
FluidSIM automatically inserts a T-connection when a line is drawn from a component *connection*. to an already existing line. This functionality applies to pneumatic as well as electrical and digital lines.

Connecting Components in  
Series

To realize larger circuits, stepper modules are often connected in series. In reality, these modules have specially standardized connections, which facilitate the realization of such series connections. FluidSIM simulates this concept as follows. Let several modules be arranged in the drawing area such that they will both align vertically and have no horizontal distance. Then FluidSIM automatically links these modules, if their corresponding input and output connections overlap.

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These links will emerge in the form of lines, if the modules are dragged apart. The subsequent figures give two examples.



This concept of an automatic component linking is not restricted to stepper modules only; in fact, automatic component linking applies whenever connections of the same type overlap.



FluidSIM will establish a link only if either the simulation is started or the circuit diagram is checked superficially (see section 4.10).

### 4.5

#### **Current Path Numbering and Switching Elements Table**

The automatic generation of current paths simplifies the identification of switches and relays when constructing electrical circuits. Along with the generated switching element tables FluidSIM makes it easy to understand which switches are controlled by which relays. To make the automatic labeling feature a satisfactorily working concept, the following points should be obeyed.

- The +24V current path should form the top horizontal line.
- The 0V current path should form the bottom horizontal line.
- The electric make/break/changeover switches should be placed above the relays.
- The relays should be placed closed to the bottom 0V current path.
- All connections of a vertical current path should align.
- The horizontal distances between the paths should be equal and of reasonable distance.

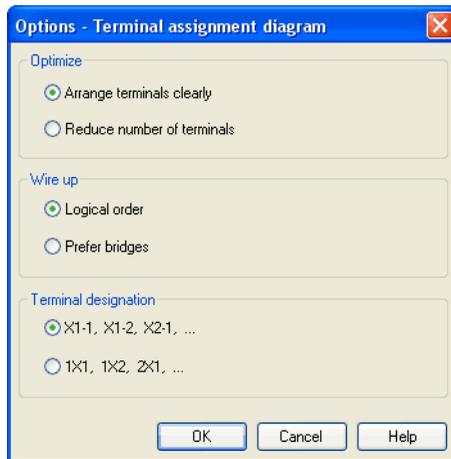
If the automatic numbering or the label positions are not entirely satisfying, a manual adjustment of a few lines or components will yield the desired layout quality in most cases. If two separated electrical circuits cause an unfavorable numbering, try to increase the distance between these circuits.

The automatic current path numbering can enabled or disabled via [View](#) / [Display current path numbering and switching elements table](#).

## 4.6 Terminal Assignment Diagrams

The automatic establishment of terminal assignment diagrams will help you with the clear wiring of external switches, sensors and state indicators outside the control cabinet with the relays and switches inside. FluidSIM automatically and appropriately numbers the terminals in the electrical part of the circuit as soon as you place the component “terminal assignment diagram” in the circuit.

Using [Options Terminal Assignment Diagram...](#) you may define several presettings:



Description of the dialog box:

- “Optimize”

You may choose either a better overview or a reduced number of terminals for an optimization goal.

- “Wire up”

Please choose whether FluidSIM is to commit to the logical order when numbering the terminals or, if possible, whether it is to privilege bridges, even if this causes to disturb the strict order of numbering.

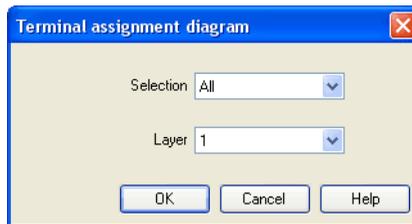
- “Terminal Designation”

Defines which convention will rule the designation of the terminals in the electrical circuit.



Please leave plenty of space in the electrical circuit between the components and towards the voltage supply paths to give enough room for the automatically inserted terminal connections as well as their designation to be seen.

FluidSIM starts a new terminal strip for each partial circuit that provides no connection with other electrical circuits. These are numbered by “X1”, “X2”, “X3”, etc. Each terminal allocation list may either show all terminal strips or a single one. In order to do this please open the status dialog of the terminal allocation list by double-clicking it:



Description of the dialog box:

- “Selection”

Defines for which electrical partial circuit the allocation will be listed in this table.

- “Layer”

In this selection list you will select the **drawing layer** of the diagram. The **drawing layer** may be set by clicking on the downward arrow on the right-hand side of the list and choosing a layer.

Depending on the setting of the **drawing layers**, the rectangle may happen to be non-displayed or to be non-editable. To make the object visible or to change the settings, you need to temporarily activate the **drawing layer** in the menu [View | Layers...](#)

### 4.7 Displaying Quantity Values

The values for all or only selected quantities of a circuit can also be displayed without measuring instruments.

#### 4. Advanced Concepts in Simulating and Creating Circuits

→ Click under the **View** menu on **Quantity Values...** to open the dialog box for the display of quantities:

	None	Particular	All	Shortcut
<b>Cylinder</b>				
Velocity v [m/s]	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	V
Force F [N]	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	F
<b>Throttle valve</b>				
Opening Level [%]	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	D
<b>Pneumatic Connection</b>				
Pressure p [MPa]	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	P
Flow q [l/min]	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	Q
<b>Electrical Connection</b>				
Voltage U [V]	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	U
Current I [A]	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	I
<b>Digital Connection</b>				
State [Lo/Hi]	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	D
<input type="checkbox"/> Display Measurement Units				E
OK				Cancel
Help				

For each of the listed quantities (“Velocity”, “Pressure”, ...) a display mode can be chosen.



The display of pressure, flows and force values allows the choice of different units. This settings influence the display of state variables of connections, components and state diagrams.

Description of the dialog box:

- “None”

No values are displayed for this quantity.

- “Particular”

Values are displayed at those connections that the user has previously chosen.

- “All”

Values are displayed at all connections for this quantity.

- “Display Measurement Units”

Enable this option if both state values and the related units shall be displayed.



For each quantity there is a key short cut for toggling between the three display modes. The “Shortcut” column of the dialog box for the quantity display shows the appropriate keys.

Selecting connections for the display of single parameters is explained here:

.....> Open a circuit diagram.

.....> Change into the Edit Mode and double click on a component connection, or click under the **Edit** menu on **Properties...**

A dialog box with the connection settings opens. The field “Show Values” defines the state values to be displayed when the “selected”-option in the state values dialog box is chosen. However, if the “no”-option in the state values dialog box is chosen, even the checked state values are not displayed.



The settings for the display behavior for state values belong to the current circuit diagram only. Hence, for several open circuit diagrams, different view options can be defined. By clicking on [Options](#) [Save Settings Now](#), the view option settings of the current circuit are saved and serve as default for newly opened circuit diagrams.

#### Special Features of the Quantity Display

Vector quantities are characterized by an absolute value along with a direction. To indicate the direction within a circuit diagram the signs “+” (into or toward a component) and “-” (out of or away from a component) are used. An arrow may also be used to display direction. FluidSIM uses both representations:

Quantity	Direction indicator
Flow	Sign, arrow
Velocity	Sign
Force	Sign
Current	Sign

The arrow as a direction of flow indicator can be turned on or off by clicking under [View](#) [Display Flow Direction](#). The arrow for the direction of flow will be shown clear the component connection, that is, as long as the flow is other than zero.

If the total value of a quantity is extremely near to zero ( $\ll 0.0001$ ), no numerical value will be displayed. Rather, the symbol “ $\rightarrow 0$ ” for a small positive value or “ $\leftarrow 0$ ” for a small negative value is shown.

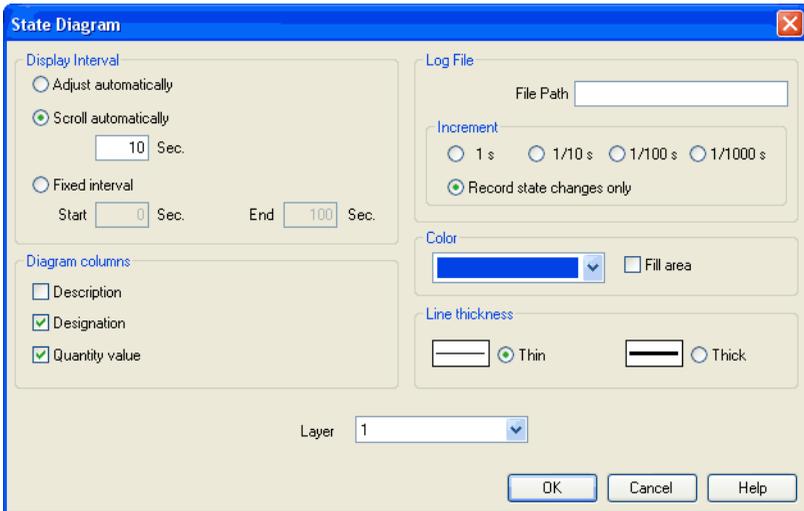
### 4.8 Displaying State Diagrams

The **state diagram** records the state quantities of important components and depicts them graphically.

You may use several state diagrams in one window as well as to display several components in the same diagram. By dragging a component on the diagram you will add the component to the state diagram. A selection dialog will open where you may select the state variables to be logged as well as to define different colors. Dragging on the diagram again will reopen the dialog, allowing you to change your choice. In case no state variable of a component is selected, the component will be removed from the diagram.

→ When in edit mode please double-click the state diagram or select the menu option **Edit | Properties...**

The following dialog box opens:



Description of the dialog box:

- “Display Interval”

This is where you may enter starting point and terminal point of the interval, defining how the state variables be logged. Prior to the simulation, you don't need to necessarily know when the interesting events are going to happen; the display interval may also be changed after the simulation, since FluidSIM internally logs all values all the time of the simulation.

If you select the field “adjust automatically”, the defined limits will be ignored and the time axis will be scaled in such way that the entire period of the simulation can be displayed.

Activate the field “run automatically”, if the diagram is to the last  $n$  seconds. In this case, the time axis will be displaced to the left-hand side once the simulation period exceeds the defined time window. In the input field you may define how many seconds are to be displayed in the applicable time window.

- “Log File”

The state values be written to a file. To enable this option enter the complete path of a file and set a reasonable step width.

Note that a large amount of data can be written the step width is very small. Hence, if necessary, shorten the simulation interval or increase the step width.

If the option “Record state changes only” is enabled, FluidSIM lists only values if at least one state variable incurred a state change. This option simplifies the detection of interesting simulation points-

#### 4. Advanced Concepts in Simulating and Creating Circuits

- “Color”

Defines the color of the diagram. It is set by clicking on the down-arrow at the right-hand side of the list and selecting a color.

- “Fill Area”

Defines whether the entire diagram or only its frame is filled with specified the color.

- “Line Thickness”

This is where you define whether curves in the diagram are to be thick or thin. Thin lines are appropriate for exact reading of the values, thick lines are appropriate for spotting the curve from a distance.

- “Diagram Columns”

This is where you select the columns to be displayed at the left-hand side of the diagram. The columns “Description”, “Designation” and “Quantity value” can be combined to your choice.

- “Layer”

Sets the **drawing layer** of the diagram. It is set by clicking on the down-arrow at the right-hand side of the list and selecting a layer.

Depending on **drawing layer** the diagram may be invisible or not selectable. In such a case the **drawing layer** must be activated via  before the diagram can be modified.

State quantities of the following components can be recorded and displayed in the state diagram:

Component	State
Cylinder	Position
Way valve	Position
Pressure Meter, Accumulator	Pressure
Shutoff Valve and Flow Control Valve	Opening Level
Pump, Engine	Speed
Swivel Cylinder	Position
Pressure and Switching Valves	Status, Pressure
Flow Control Valves	Flow
Flow meter	Flow, Volume
Switch	Status
Relay, Valve Solenoid	Status
Indicator Light, Buzzer, Pressure Indicator	Status
Counter	Status, Counter Value
Function Generator, Voltmeter	Voltage
Status Controller, PID-Controller	Voltage

#### 4.9

##### Functional diagram editor

Using the functional diagram editor, you may easily generate function diagrams, such as e. g. distance-step diagrams.

By dragging the window edges, the window can be resized. It is also possible to maximize the window.

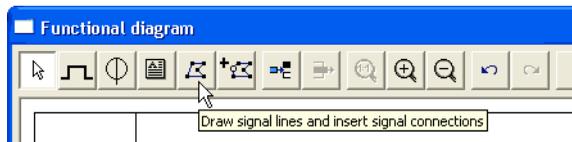
The tool bar buttons are used to edit a functional diagram. With the following six buttons you can chose an operation mode.

-  Edit mode
-  Draw diagram curves
-  Insert signal elements
-  Insert text boxes
-  Draw signal lines and insert signal connections
-  Insert additional nodes into signal lines

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The chosen mode is pointed out in white.  for example indicates that signal lines are drawn by clicking into the diagram area.

If the mouse pointer remains for more than one second on a button, a short description appears on the screen.



#### Edit mode

 This mode is used to adjust the objects in the functional diagram. You can move elements in the diagram. The size of text boxes can be changed in this mode only.

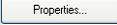
Move- and resize operations can be aborted with the  button.

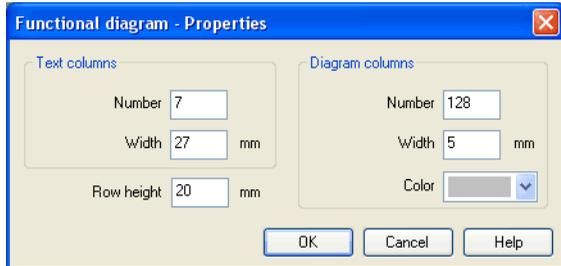
If you move the mouse pointer out of the window area by keeping the left mouse button pressed, the view is scrolled automatically.

A double-click on a diagram element (diagram row, text, signal element, etc.) opens a dialog box where the requested adjustments can be made.

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Set up diagram properties

A click on the button  opens a dialog box in which you can set up the diagram properties.



- “Text columns – Number”

If the number of the text columns is changed, all table’s text boxes are distributed equally in a horizontal direction.

- “Text columns – Width”

If the width of the text columns is changed, all table-text boxes are distributed equally in a horizontal direction.

- “Diagram columns – Number ”

The diagram columns are located on the right side of the functional diagram. In this area the diagram curves can be drawn. The number of diagram columns can also be changed by moving the mouse on the right margin of the diagram.

- “Diagram columns – Width”

#### 4. Advanced Concepts in Simulating and Creating Circuits

- “Color”

Color used for drawing the grid lines in the diagram area.

- “Row height”

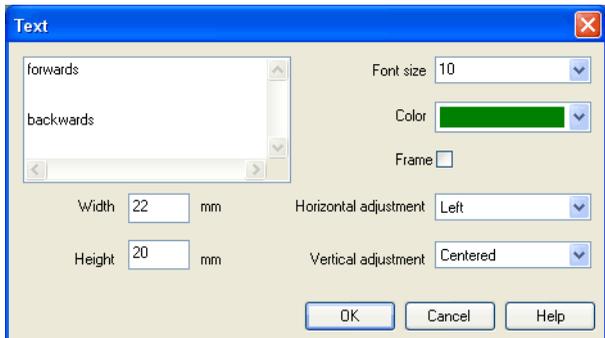
Determines the height of all rows.

Table text boxes

On the left side of the functional diagram the table’s text boxes are located.

Description	Designation	Function	State	Sc
				3
				2
				1

A double-click on a table text box opens the corresponding dialog box.



- “Font size”

Font size of the text to be represented.

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- “Color”

Choice between sixteen standard colors for the text to be represented.

- “Width”

The width of the table column you have chosen can also be changed by moving the mouse.

- “Height”

The height of the table column you have chosen can also be changed by moving the mouse.

- “Horizontal adjustment”

Following adjustments are available: “Left”, “Centered” and “Right”.

- “Vertical adjustment”

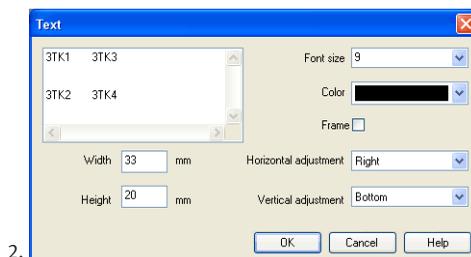
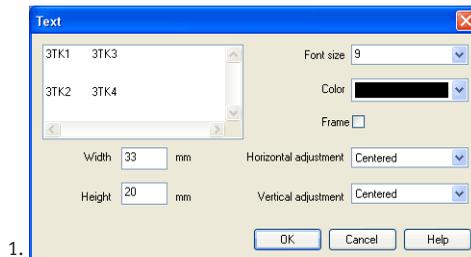
Following adjustments are available: “Top”, “Centered” and “Bottom”.

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- “Table-like adjustment within a table cell”

In order to get a table-like adjustment of text within a text box, tabulators are inserted between the separate parts of the text. The text is represented in the text box according to the number of tabulators and the defined horizontal and vertical adjustments. In order to set tabulators within a text field of a dialog box it is necessary to keep the **Ctrl** button pressed.

Examples:

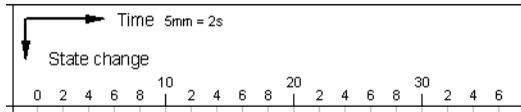


## 4. Advanced Concepts in Simulating and Creating Circuits

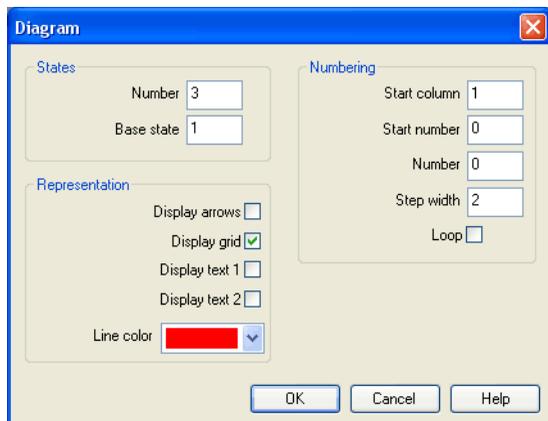
### 4.9.1

Adjust the representation of the diagrams

On the right side of a diagram row you can find the area in which the curves can be drawn.



A double-click on this area opens a corresponding dialog box. You can determine the appearance of the drawing area with it. Please make sure that there is no diagram element under the mouse like e.g. a signal element.



- “States – Number”

The entry defines the number of states and by that the number of horizontal lines in the diagram row.

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- “States – Base state”

Horizontal lines through the base state are drawn with a thin pen.

- “Numbering – Start column”

The start column indicates at which column the numbering is to begin.

- “Numbering – Start number”

The start number indicates with which number the numbering is to begin.

- “Numbering – Number”

The number indicates how many steps are to be numbered.

- “Numbering – Step width”

Defines the step width between two numbers.

- “Numbering – Loop”

If this field is marked, an equals sign and the start number display additionally after the last number.

- “Representation – Display arrows”

If this field is marked, two arrows display.

- “Representation – Display grid”

If this field is marked, the background grid displays.

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- “Representation – Display text 1”

If this field is marked, a text box displays. It can be used for marking purposes. This text box belongs to the row you have chosen and cannot be shifted into another row.

- “Representation – Display text 2”

If this field is marked, an additional text box displays. It can be used for marking purposes. This text box belongs to the row you have chosen and cannot be shifted into another row.

- “Representation – Line color”

Defines the color of the diagram lines.

#### Draw diagram curve

 In this mode you can draw the diagram curves. Nodes can only be inserted on the grid. Every left mouse click creates a new node.

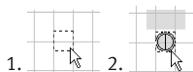


If you keep the left mouse button pressed, nodes can be moved like in the edit mode.

Marked nodes are shown in gray color. With the  button a marked node is deleted.

#### Insert signal elements

 In this mode you can insert signal elements with a left-click.

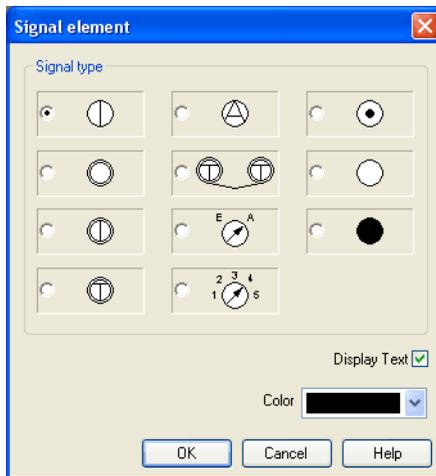


If you keep the left mouse button pressed, signal elements can be moved like in the edit mode.

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Marked signal elements are shown in gray color. With the  button a marked signal element is deleted.

A double-click on a signal element in the edit mode opens a corresponding dialog box. You can adjust the representation of the signal element with it.



- “Signal type”
- “Display text”

If this field is marked, a text which can be used to mark the signal element displays.

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- “Color”

This is the color showing the signal element.

Insert text boxes

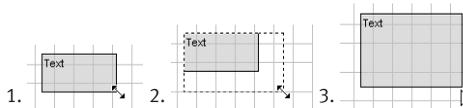
 In this mode you can insert text boxes by a left mouse button click.



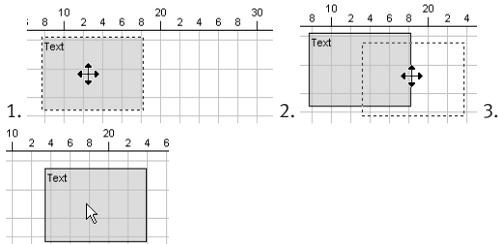
Marked text boxes are shown in gray color. With the  button a marked text box is deleted.

In the edit mode the size and position of a text box can be changed with the mouse.

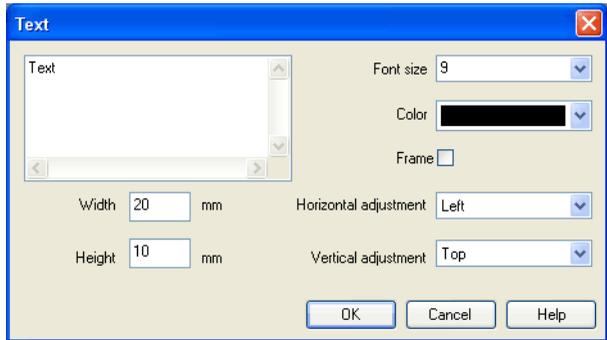
Adjust size:



Move text box:



A double-click on a text box in the edit mode opens a corresponding dialog box. You can adjust the representation of the text box with it.



- “Font size”

Font size of the text to be represented.

- “Color”

Choice between sixteen standard colors for the text which can be represented.

- “Frame”

If this field is marked, the text box is drawn with a frame.

- “Width”

The width of the text box.

- “Height”

The height of the text box.

- “Horizontal adjustment”

Following adjustments are available: “Left”, “Centered” and “Right”.

- “Vertical adjustment”

Following adjustments are available: “Top”, “Centered” and “Bottom”.

Draw signal lines and  
insert signal connections

 In this mode signal lines can be drawn arbitrarily or can be transferred automatically by signal elements.

### Draw signal lines arbitrarily

Every left-click creates an additional node. You can stop this operation by clicking on the present line and keeping the  button pressed, by pressing the  button or by changing the operation mode. With the  button a marked signal line is deleted. If only one node is marked, just this node is removed from the line.

In the edit mode you can move the nodes of the signal lines. If you keep the  button pressed when you place or move nodes, the corresponding node is adjusted vertically and horizontally, respectively.

Change the representation of the lines in the edit mode with a double-click.



- “Display description”

A framed description on the line and a description next to the framed description displays.

The framed description can be moved freely on the line. The additional description can be moved freely.

- “Start with arrow”

An arrow displays at the beginning of the line. The arrow can be moved freely on the line.

- “End with arrow”

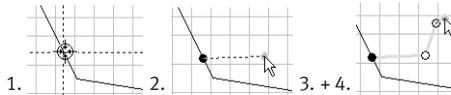
An arrow displays at the end of the line. The arrow can be moved freely on the line.

- “Color”

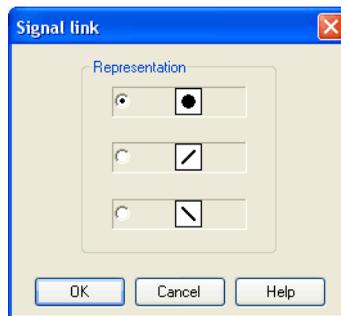
Line color.

#### 4. Advanced Concepts in Simulating and Creating Circuits

If you click on a finished signal line in the mode draw signal lines , a signal connection is inserted. This connection node can be moved freely on the line.



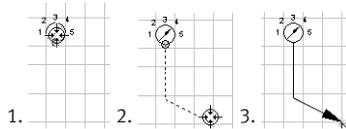
In the edit mode the representation of the signal connection can be changed by a double-click:



### Draw signal lines from signals onwards

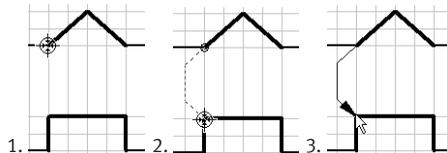
In the mode draw signal lines , signal lines can be drawn from signals onwards. Click with the left mouse button on a signal and keep the mouse button pressed. Move the mouse to a position which you have chosen as the end point of a signal line. After having released the mouse button, the signal line is being drawn.

## 4. Advanced Concepts in Simulating and Creating Circuits



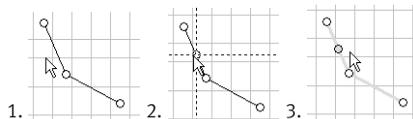
### Draw signal lines from diagram-nodes onwards

In the mode draw signal lines , signal lines can be drawn from curve nodes onwards. Click with the left mouse button on a node and keep the mouse button pressed. Move the mouse on a second node. After having released the mouse button on top of the second node, the signal line is being drawn.



Insert additional nodes into signal lines

In the mode insert additional nodes into signal lines , additional nodes can be inserted into existing signal lines.



Add row

By clicking on the button , a new diagram row is inserted on top of the current selection. If there is no selection on a cell, a new line is added to the end of the diagram.

Delete row

By clicking on the button , a selected diagram row is deleted. If nothing is selected, the button is disabled.

### Additional functions

#### Zoom

With the button 1:1 view  the view is reset to the standard zoom level.

With the button  the view is enlarged in size.

With the button  the view is reduced in size.

#### Undo actions

With the button undo , you can undo the last 50 actions.

With the button redo , the actions you have undone before can be redone.

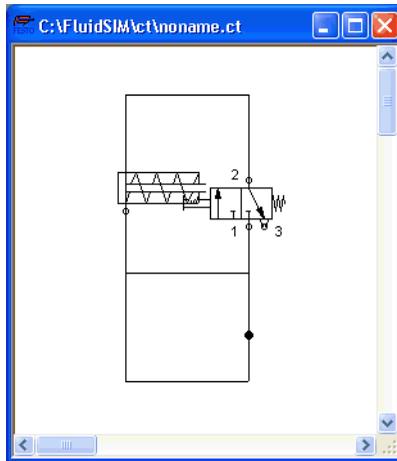
#### 4.10 Superficial Circuit Checking

Before a simulation is started, the circuit diagram can be checked to see if there are any *graphic* drawing mistakes present. The mistakes that lead to errors include the following:

1. objects outside of the drawing area
2. lines that cross through components
3. superimposed lines
4. superimposed components
5. superimposed connections or connections that do not go together
6. open pneumatic connections
7. components that have the same identification assigned
8. mismatched labels (see section 4.11)
9. lines that cross through connections to which they are not connected

#### 4. Advanced Concepts in Simulating and Creating Circuits

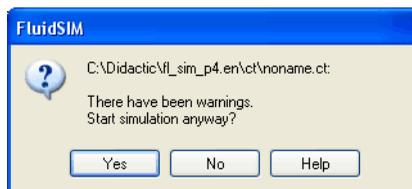
The following circuit diagram contains mistakes of type 1 to 3:



→ Click on  or [Execute](#) [Check Superficially](#).

Message boxes should now appear, which inform the user of the graphic mistakes.

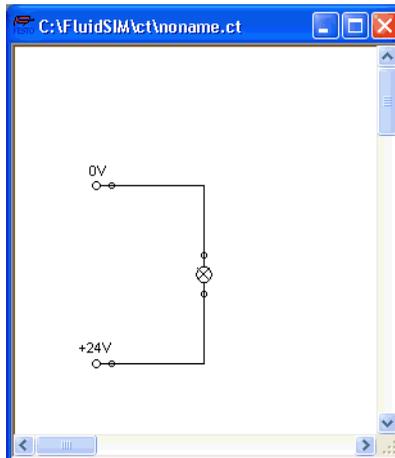
After the instructions, you may decide if the circuit should be simulated anyway:



### 4.11 Coupling Pneumatics, Electrics and Mechanics

In the same way FluidSIM allows you to create pneumatic circuit diagrams, the software also allows you to design electrical circuits. The components for the electrical circuits can be found in the component library and dragged from there to be inserted on the drawing area. Electrical components are connected in the same way that fluidic components are.

The following illustration shows a small example:



→ Create this circuit diagram on your computer.

→ Start the simulation and observe that the indicator light is illuminated.

There are also electrical components that link electrical circuits with pneumatic circuits. These linking components include switches that are pneumatically operated and solenoids that control directional valves.

#### 4. Advanced Concepts in Simulating and Creating Circuits

Electrical circuits are drawn independently of pneumatic circuits. Therefore, there needs to be a way to create definite links between electrical components (such as a control solenoid) and pneumatic components (such as a directional valve). So-called *labels* bridge the difference and link both circuit diagrams together.

A label has a specific name and can be assigned to a component. If two components have the same label name they are linked together, although no apparent line is visible between them.

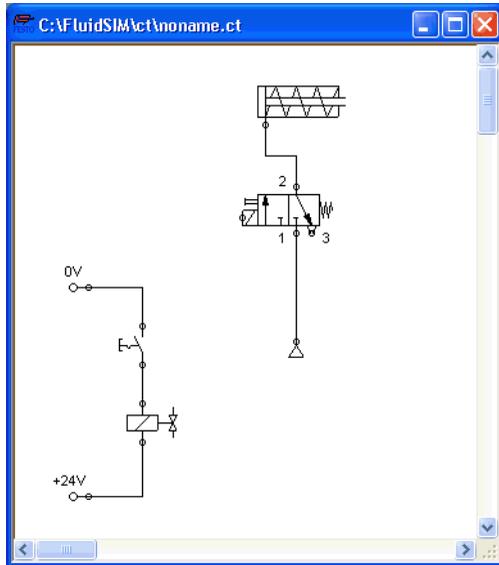
Entering a label takes place in a dialog box, which can be opened by either double clicking on the desired component or selecting the component and then clicking [\[Edit Properties...\]](#). Labels can be established on the left and right sides of an electrically operated valve by double clicking on the appropriate side, as opposed to clicking in the middle of the component.

The following example explains how labels can be used in FluidSIM.

→ Activate the Edit Mode by clicking on  or [\[Execute Stop\]](#).

#### 4. Advanced Concepts in Simulating and Creating Circuits

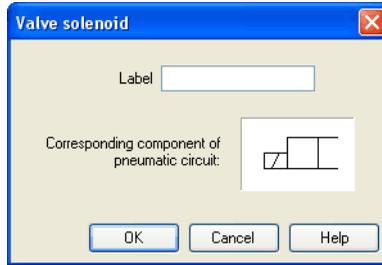
→ Create the circuit diagram as shown in the following figure:



So that the valve can be controlled by the solenoid, you have to link the components with a label.

→ Double click on the control solenoid or simply select the control solenoid and click under [Edit Properties...](#)

The following dialog box appears:



Description of the dialog box:

- “Label”

This text field gives the label its name. A label can be up to 32 characters in length consisting of letters, numbers, and symbols.

→ Enter a name for this label, for example “Y1”.

→ Double click on the outside of the valve solenoid to open the dialog box for the label name.

→ Input the same label name as for the solenoid, for example “Y1”.

The solenoid is now linked to the valve.



In practice the valve solenoid would not be directly controlled by the switch, rather via an intermediate relay. This component has been neglected here for the sake of simplicity.

→ Start the simulation.

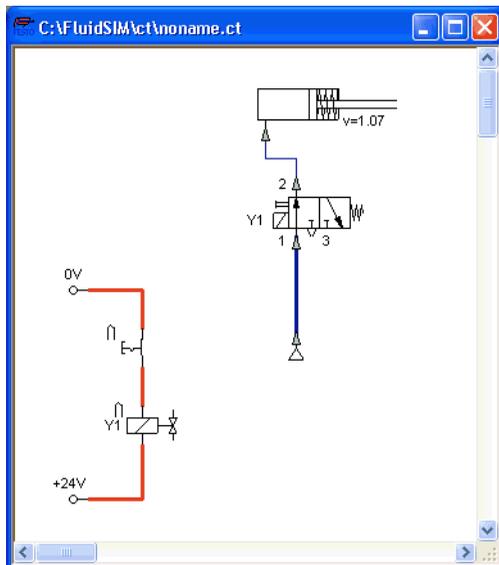
#### 4. Advanced Concepts in Simulating and Creating Circuits

The electrical current as well as the pressure and flow distribution are computed; the pressures are shown in color.

If you want to see the exact values of the quantities at hand, you can mark them by clicking under [View Quantity Values...](#). The marked quantities are displayed next to the components' connections. Section 4.7 applies here.

→ Operate the electrical switch.

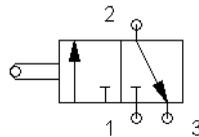
As a result the valve switches and the cylinder's piston extends:



#### 4. Advanced Concepts in Simulating and Creating Circuits

Aside from a manual or electrical operation, valves can be controlled *mechanically*, either through a cylinder piston or a magnet mounted at the piston. Such a coupling is realized in the same way an electrical coupling is established: By means of labels, which are assigned to the cylinder's distance rule and the mechanical valve connection.

→ Draw a configurable valve on the drawing area and furnish it with a mechanical actuator.



→ Double click the mechanical actuator.

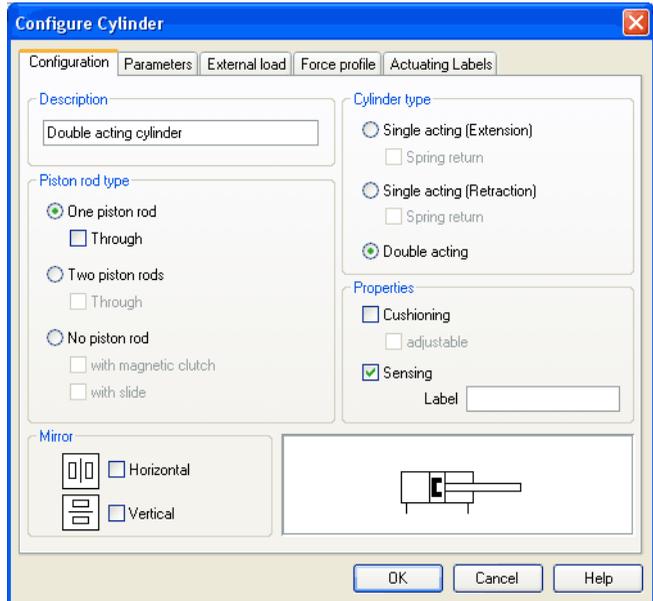
A dialog opens where a string for the related label can be entered. If the same label is assigned to the cylinder's distance rule, the valve will become actuated mechanically if the cylinder piston reaches its predefined position.

A particular form of interconnection is presented by the connection of a cylinder with a **displacement encoder**. This is how, e. g. in combination with **proportional valves**, you may create controlled systems. You will find further advice on proportional technology in section **4.18**.

→ Double-click a cylinder.

#### 4. Advanced Concepts in Simulating and Creating Circuits

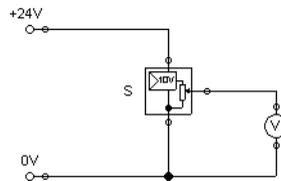
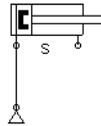
A dialog box opens where you may define the cylinder properties. Please make sure to have the register “Configuration” in the foreground if applicable.



→ Activate the box “Sensing” and add a label.

#### 4. Advanced Concepts in Simulating and Creating Circuits

→ Insert the displacement encoder from the component library in the circuit and double-click to open the properties dialog. Please enter the same label here as for the cylinder.

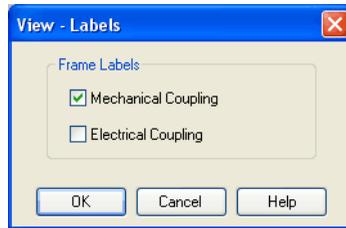


At the output the displacement encoder system provides a voltage proportional to the piston position of the interconnected cylinder. This voltage will be at its defined minimum when the cylinder is retracted completely; the voltage will be at its defined maximum when the cylinder is advanced completely.

#### Display Styles for Labels

If a label shall be displayed framed, similar to the display of component descriptions, click onto [View Labels...](#).

The following dialog box opens:



In the dialog box for each label of the circuit its style, framed or not framed, can be defined.

FluidSIM will place the labels automatically in such order that they will usually be at an appropriate position near the component resp. near the connection. Instead, you may also move the labels using the mouse or the keyboard. To do this, please click the label and move it to the desired position. To change the position using the keyboard, please mark the label (or the applicable connection) and move it with the cursor keys.



FluidSIM keeps you from moving the label too far away from the applicable component or the connection. Once a particular distance is exceeded, you won't be able to move the label any further away in that particular direction.

### 4.12 Operating Switches

#### Switches at Cylinders

This section describes how to operate switches by means of cylinders, relays, pressure, or other switches.

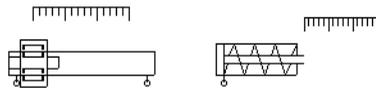
Limit switches, proximity switches, and mechanically operated valves can be activated by the piston of the cylinder. Therefore, it is necessary to use a distance rule at the cylinder to position the switches correctly:

→ Drag a cylinder and a distance rule  to the drawing area.

→ Drag the distance rule near to the cylinder.

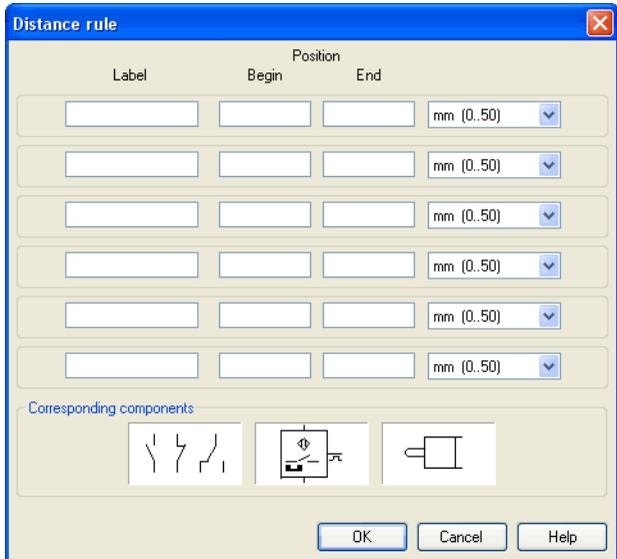
When the distance rule is dropped near the cylinder, it automatically snaps in the right position. Move the cylinder just slightly and the distance rule moves with it. If you move the cylinder more than a centimeter in distance, the connection between distance rule and cylinder is broken, and the distance rule does not travel with.

The correct position for a distance rule depends on the type of cylinder. Distance rules can be set *above* the cylinder, *before* the cylinder (on the moving piston), or at both positions at the same time:



→ Double click on the distance rule.

The following dialog box appears:



Description of the dialog box:

- “Label”

The text insertion fields on the left are for naming labels from proximity switches or limit switches in electrical circuits, which are actuated by the movement of the cylinder's piston.

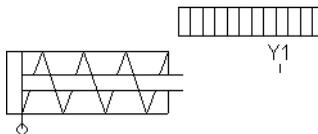
- “Position”

The description fields on the right-hand column define the precise begin and end positions of the switches and of the limit switch at the cylinder.

#### 4. Advanced Concepts in Simulating and Creating Circuits

→ At the first line, please enter 35 for both labels “Y1” and for begin and end position, then please close the dialog box by clicking “OK”.

Immediately following, a mark with the appropriate label appears beneath the distance rule:



I.e., this cylinder activates the switch or the valve with the label “Y1”, when its piston has moved 35 mm, provided the switch in the electrical part of the circuit resp. the mechanical “connection” of the valve was given the same label.

Once the cylinder in the above example has exceeded the position 35 mm, the switch will be put off. If you wish the activation of the switch to last over a longer distance, please enter the applicable begin and end positions in the dialog.

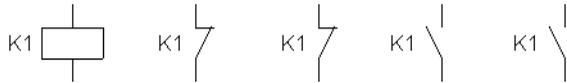
To place labels for electrical switches, please double-click the component; valves with mechanical actuation come with a particularly designed “connection”, e. g. at the end of the stem, or at the center of the roller. If the component or the connection has already got a label you may double-click the label straight away instead of the connection in order to change the designation.

#### Relays

By using relays, more than one switch can be actuated simultaneously. It is therefore necessary to couple the relay with the appropriate switches. Thus in FluidSIM also relays possess labels, which can be used to couple relays and switches in the previously described way. By double clicking on a relay, the dialog box for a label name appears.

#### 4. Advanced Concepts in Simulating and Creating Circuits

The following illustration shows an electrical circuit in which a relay operates two break switches and two make switches at the same time:



Besides simple relays, relays with switch-on delay, relays with switch-off delay, and relay counter exist. These relays are used when the linked switch should be actuated after a preset time interval or a number of pulses received. By double clicking on these relays, a dialog box appears where the appropriate values can be entered.

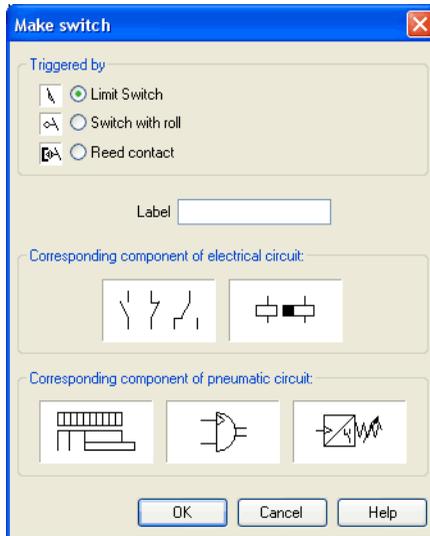
#### Coupling Mechanical Switches

To mechanically couple mechanical (manually operated) switches in FluidSIM, you have to use labels. When more than one mechanical switch has the same label, all these switches operate with the switching of only one.

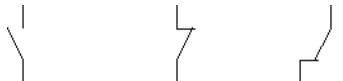
#### 4. Advanced Concepts in Simulating and Creating Circuits

##### Automatic Switch Altering

FluidSIM recognizes delay switches, limit switches, and pressure switches by the nature of their usage and by their labels and supplies the corresponding symbol for the switch in the electrical circuit: ← for **switch-on delayed**, → for **switch-off delayed**, ↖ for **mechanical operated switches**, and ↗ for **pressure operated switches**. The representation of switches that are actuated by cylinders can be determined by selecting the corresponding switch type in the component's properties dialog:



This means that there do not exist special symbols for these switches in the FluidSIM component library. Instead the symbols for simple switches can be utilized:



### 4.13 Adjustable Components

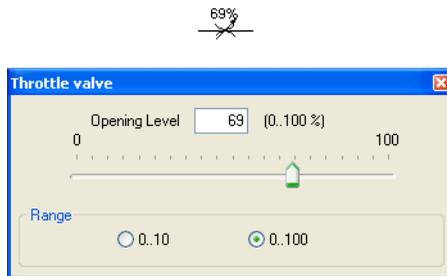
Certain components contain parameters that can be set in the Edit Mode. A number of these components have been discussed in earlier sections.

The dialog box for setting these parameters can be opened with a double click or [Edit Properties...](#).

During the simulation, some components may be adjusted in the same way as in reality. Thus e. g. the operating pressure of the compressed air or the opening level of the throttle allow to be continuously changed. To do so, it is not necessary to open the properties dialog and to subsequently close it using OK ; instead a simple click on the component is enough to open a window providing slide controllers. Changes will effect the simulation immediately. Once you click another component or a blank area in the window, the properties dialog will disappear automatically.



When in simulation mode and moving the mouse across a component, the mouse cursor will change to the slider symbol  if the applicable “real-time settings” are available.



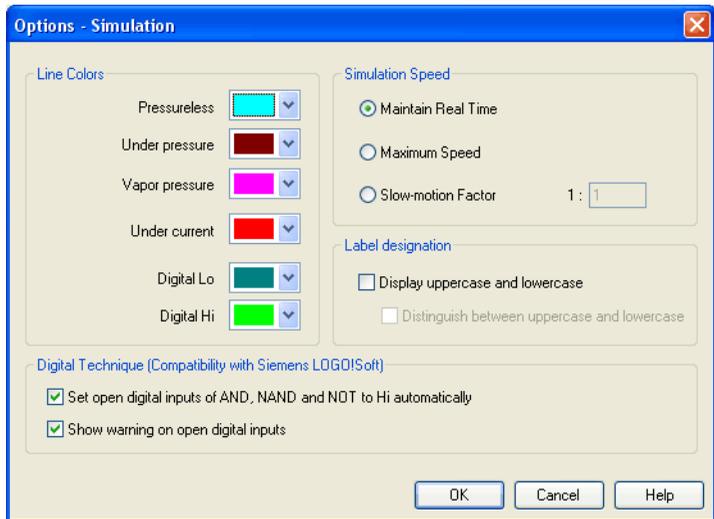
To help with precision adjustment some controllers provide an optional control range. You may alternatively enter the numeric value using the input field.

#### 4.14 Settings for Simulation

By clicking **Simulation...** or **Sound...** under the **Options** menu, parameters and options can be set for simulation.

#### Simulation Parameters

By clicking under **Options Simulation...** a dialog box appears with parameters for simulation:



Description of the dialog box:

- “Line Colors”

During simulation the electrical, the pneumatic and the digital lines get colored, depending on their state. The mapping from a state to a color is set by clicking on the down-arrow at the right-hand side of the list and selecting a color.

- “Maintain Real Time”

Using the option “Maintain Real Time” will attempt the cylinder movement to move as fast as in reality. Please note that real time movement requires a computer with sufficient computing power.

- “Maximum Speed”

The option “maximum speed” utilizes the entire computing power. The aim is to run the simulation as fast as possible. The actual acceleration of the simulation depends on the performance of the computer. If your computer does not at least achieve “real-time”, the simulation cannot be accelerated to any higher speed.

- “Slow-motion Factor”

The slow-motion factor controls whether the simulation should go more slowly than it would in reality. With a slow-motion factor of 1:1, the simulation should proceed in real-time.

- “Label designation”

By default, FluidSIM does not distinguish between uppercase and lowercase characters in label identifiers of mechanical or electrical connections. I. e., label identifiers are automatically converted to uppercase. Now, using the option “Display uppercase and lowercase”, label identifiers are treated case sensitively. Case sensitivity can be enabled for both display purposes and a more strict label identity checking. In the former case, upper- and lowercase characters, say, for instance “a” and “A”, are displayed as such, but treated as the same character. In the latter case, which is enabled by the option “Distinguish between uppercase and lowercase”, “a” and “A” are treated as different labels.

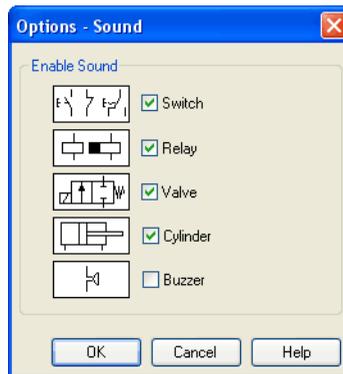
#### 4. Advanced Concepts in Simulating and Creating Circuits

- “Digital Technique (Compatibility with Siemens LOGO!Soft)”

It is a useful convention in the field of digital technology setting open input ports of AND, NAND, and NOT components to "Hi". Otherwise, e. g. an AND gate with three input ports would not function as expected if only two of its input ports were connected. Many *constant* "Hi" connections may clutter up a circuit unnecessarily, and hence FluidSIM can be configured to set open input ports of the respective components always to "Hi". This option can be disabled of course. If open input ports have been detected at the start of the simulation, FluidSIM issues a warning message. The display of this message can also be disabled.

#### Sound Parameters

By clicking under [Options](#) [Sound...](#) a dialog box appears with parameters for sound settings:



Description of the dialog box:

- “Enable Sound”

An acoustic signal can be activated or deactivated for each of the following four component types: switch, relay, valve, cylinder, and buzzer.

If there is no sound hardware, the settings can be set but not applied.

FluidSIM can directly address the EasyPort that is connected to the serial port your computer. No other drivers or software tools are required. The interconnection is effected by implementing special electrical in/out components that provide both eight inputs and outputs. The components are the same as the ones used for the interconnection via OPC or DDE. The operation mode of these input and output components is defined by the use of the menu option [Options](#) [EasyPort/OPC/DDE Connection...](#).

The EasyPort-hardware may also be addressed by using OPC-communication. This is how you may also address remote EasyPort-modules that are not connected locally (e. g. using a LAN-connection). Provided the EasyPort-modules are connected locally to the simulating computer, you are recommended to define a direct connection.

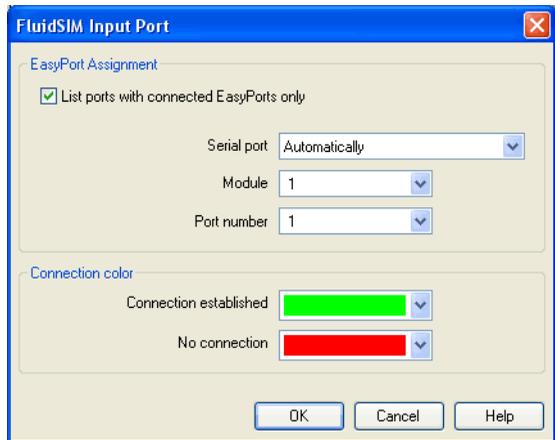
→ Initially, please select the option “direct EasyPort-connection” in the menu [Options](#) [EasyPort/OPC/DDE Connection...](#).

→ Please drag an input or output component from the component library in the circuit diagram window and open the properties dialog by double-clicking or by accessing menu [Edit](#) [Properties...](#).



#### 4.15 Use of the EasyPort-Hardware

The following dialog box will open:



Description of the dialog box:

- “EasyPort Assignment”

This is where you may define which serial port the hardware uses to connect to your computer, which EasyPort-module and which port number is assigned to the i/o module. If you don't know exactly which number is used by the serial interface, please use “automatically” setting, FluidSIM will scan all COM-ports for connected EasyPorts.



By standard the EasyPort-hardware comes with a serial interface, which has proved to work well for years in the world of computers as well as in the world of industrial use. Modern computers and most of all mobile ones tend to leave out this interface more and more. Still, you may inexpensively and simply add a serial interface by using a USB-serial converter, enabling you to use the EasyPort. The converter's own software defines a virtual COM-port that will be assigned a number higher than the existing physical interfaces (usually COM 5). This virtual port will enable you to address the hardware as usual.

- “Connection Color”

Defines the color of the connection indicator for the i/o component when either the EasyPort-connection is active or when the connection is not available or out of order.

The color may be defined by clicking the downward arrow on the right-hand side of the list and then select a color.



If FluidSIM doesn't find the EasyPort hardware on starting the simulation, a related warning will be shown. The simulation can still be started, but until the end or until restarting the simulation FluidSIM will not attempt to detect any EasyPorts. If the connection fails during the simulation, (e. g. due to unintentionally removing connecting cable), the simulation will continue without EasyPort-interconnection, but FluidSIM will attempt to reestablish the connection. Once the hardware is again available at the defined interface, the connection will once again be established and the simulation will continue including the EasyPort-communication.

**4.16  
OPC and DDE  
communication with Other  
Applications**



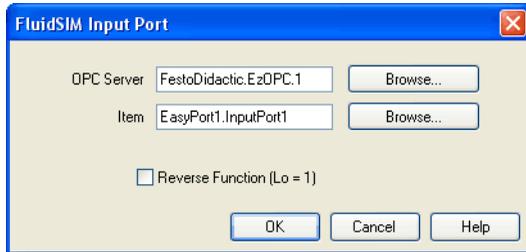
FluidSIM can exchange data with other applications; thus it may be coupled with programmable logic controllers, PLC, for instance. Prerequisite for such a coupling is the ability of the partner application to provide an “OPC interface” and to act as a so-called “DDE client”, respectively. From within a FluidSIM circuit the DDE coupling is realized by means of two electrical DDE components, each of which providing eight inputs and outputs respectively.

Further information and examples regarding the DDE communication can be found on the FluidSIM-CD in the DDE directory.

→ Firstly, enable the option “OPC mode” in the **Options** **EasyPort/OPC/DDE Connection...**.

→ Drag an input (or output) component from the component library and open the property dialog box by double clicking the component or by clicking on **Edit Properties...**.

The following dialog box opens:



Description of the dialog box:

- “OPC Server”

Enter the OPC server here or click on [Select ...](#) and select a server from the list.

- “Item”

Enter the data item here or click on [Select ...](#) and select an item from the list.

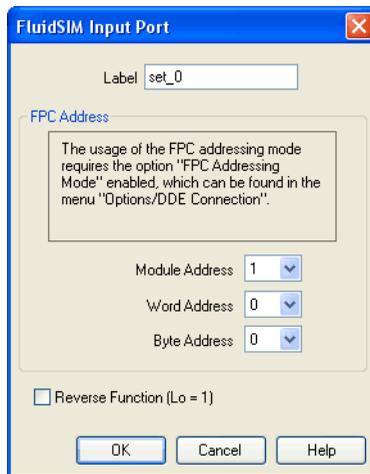
- “Reverse Function”

Inverts the logical values of the DDE components. Normally, current flow corresponds to a logical 1.

→ Select the option “Use DDE” by clicking [Options](#) [EasyPort/OPC/DDE Connection...](#).

→ Select a DDE component from the library, place it onto the drawing area, and open its property dialog box by either double clicking or via [Edit Properties...](#).

The following dialog box opens:



Description of the dialog box:

- “Label”

Label of the DDE component. This label is used from within the partner application to request or to set values in FluidSIM via DDE.

- “FPC Address”

If FluidSIM is coupled with an application that also provides FPC addressing support, the addresses of assembly, word, and byte can be entered here. These settings are necessary only if the option **FPC mode** is active.

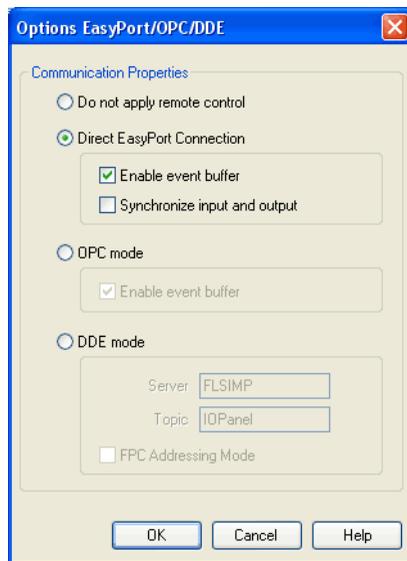
## 4. Advanced Concepts in Simulating and Creating Circuits

- “Reverse Function”

Inverts the logical values of the DDE components. Normally, current flow corresponds to a logical 1.

### 4.17 Settings for the EasyPort/OPC/DDE communication

Clicking on [Options EasyPort/OPC/DDE Connection...](#) opens the following dialog box with settings for the EasyPort, OPC, and DDE communication:



Description of the dialog box:

- “Do not apply remote control”

Please click this field if you don't wish FluidSIM to communicate with connected EasyPorts or other applications. If this option is activated, FluidSIM may ignore any connected EasyPort-module and may neither respond to other applications trying to establish an OPC or DDE connection.

#### 4. Advanced Concepts in Simulating and Creating Circuits

- “Direct EasyPort-Connection”

Select this option if you wish to interconnect FluidSIM with other locally connected EasyPort-modules.

- “Enable event buffer”

Enable this field, if FluidSIM shall buffer all events and process them in a first-in-first-out manner. If this option is disabled, events that occur during high computational load may go lost.

- “Synchronize input and output”

Using this option you will define whether FluidSIM is to check, with every change of bit pattern at an output, for the status of the inputs. This may be useful if the output values, by means of a circuit that involves the EasyPort-module, influence the status of the inputs. Please note that the operation mode may massively reduce the simulation speed, since FluidSIM may occasionally need to wait, with every step, for an answer of the connected EasyPorts.

- “OPC mode”

Choose this option, if FluidSIM shall be coupled with other applications via OPC.

- “DDE mode”

Choose this option, if FluidSIM shall be coupled with other applications via DDE.

- “Server”

Defines the name under which name FluidSIM logs on the partner application. As the case may be, this name must be told the partner application as the *server* name.

- “Topic”

A topic is necessary to agree upon a common label for the data exchange. As the case may be, the topic must be told the partner application.

- “FPC Addressing Mode”

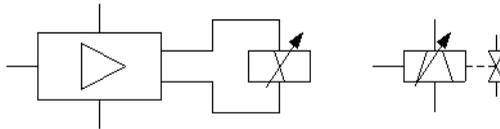
This option must be checked if FluidSIM is coupled with an application that also provides FPC addressing support.



You will find notes on interconnecting FluidSIM with EasyPort hardware in chapter 4.15, handling the OPC or DDE interface is described in chapter 4.16.

#### 4.18 Open-loop and Closed-loop Control

Among simple way valves with only discrete switching positions, FluidSIM also provides a number of continuous valves. These are particularly interesting because they may represent continuous intermediate positions. These components are addressed - in the same way as electrically operated way valves - by using a proportional amplifier or a valve solenoid. These are represented by specific symbols:



The individual proportional valve solenoid is used with position controlled continuous valves that integrate the controller and amplifier part in their valve.



If you unintentionally link a way valve with a proportional valve solenoid or vice versa a proportional valve with a simple valve solenoid by using a label, FluidSIM will show a warning.

The following two sections will introduce you to the possibilities of *open-loop control* and *closed-loop control* with FluidSIM. The term “open-loop control” means here that an *output variable* changes depending on an *input variable*. In detail the voltage represents the input variable at the proportional valve solenoid or at the amplifier. Depending on the value (and on the direction) of the electrical current caused by the voltage (assisted by an amplifier), the valve piston of the proportional valve will more or less be deflected to one direction. This is the output variable. In the case of a constant pressure at the valve port you may therefore manage the flow. Instead, in the case of a constant flow, the pressure drop will change depending on the opening level that is defined by the valve position.

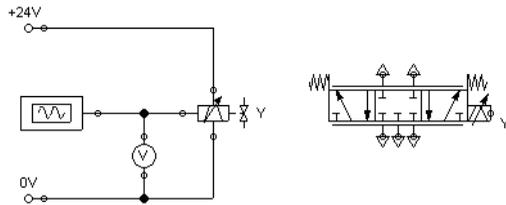
We speak of “closed-loop control” when the output variable or a state variable influenced by this output variable itself serves as an input variable. In the course of this several output variables as well as pending state variables may well be combined with further input variables when a calculation rule is used. A classical example is represented by a *position control* that defines a particular position to be reached by a cylinder. In this case the valve will be electrically addressed in such a way that the cylinder travels. The position of the cylinder (in consequence of the travel depending on the valve position) will again be used as an input value while the deviation from the desired position of the cylinder is considered. Once the cylinder has reached its target position, the deviation is 0 and the valve returns to mid-position (closed position). Thus the cylinder stops. Should the cylinder, by inertia or because of outside malfunction or interference, pass the target position, the valve will switch to the opposite side and will reverse the direction of flow; the cylinder travels back. This already represents the simplest form of controlling, the so-called “P-control”.

## 4. Advanced Concepts in Simulating and Creating Circuits

### 4.18.1

#### Open-loop Control

In order to understand the mode of operation of the continuous components, please reconstruct the following circuit (voltage supply, function generator, voltmeter, proportional valve solenoid, continuous valve):



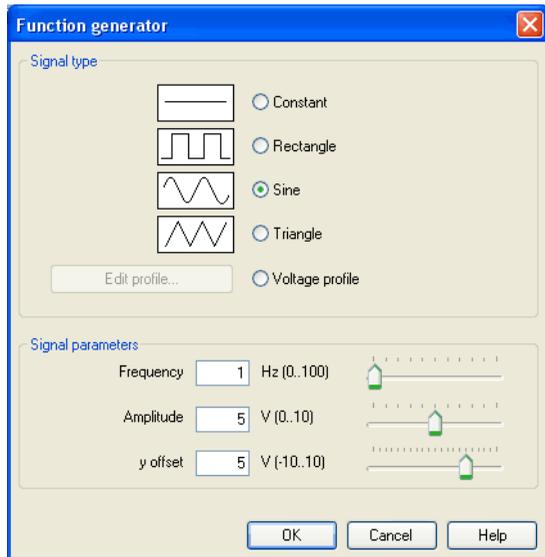
In the case of the five pneumatic connections of the valve, please don't forget to apply mufflers, to avoid warnings issued by FluidSIM.

→ Please launch the simulation and observe the continuous valve.

The function generator generates a signal between 0 and 10 volts. This varying voltage is converted in the valve by using a proportional amplifier to assign an applicable current to activate the proportional valve solenoid; converted in such way that the linked valve can be deflected to a maximum to both sides according to the applied signal voltage.

#### 4. Advanced Concepts in Simulating and Creating Circuits

In order to be deflected less, the valve needs to have less maximum voltage. We may achieve this by double-clicking and therefore opening the properties dialog of the function generator.



→ Please define 2 for an “amplitude”, close the dialog and launch the simulation again.

Now the voltage will alternate between 3 and 7 volt. This will still cause the valve to swing symmetrically, but it will show less deflection around the mid-position.

→ Please open the properties of the function generator again and define 3 for the y-offset.

#### 4. Advanced Concepts in Simulating and Creating Circuits

The function generator now supplies a voltage between 1 and 5 volts, causing the valve to deflect more to the left-hand side than to the right-hand side.

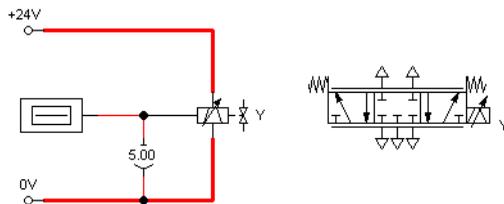
→ Please open the properties of the function generator and define “Constant” for a type of signal.



The slider of the function generator for “Frequency” and “Amplitude” provide no function for the type of signal “Constant”. Therefore we may model a manually adjustable potentiometer.

→ Please launch the simulation and click (by a *single* click) on the function generator.

A window will open showing the slider of the function generator.

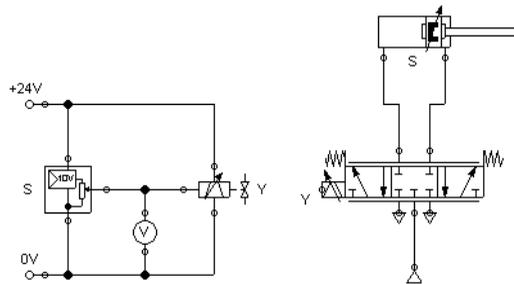


→ Gradually change the y-offset and observe how the valve moves subject to the controller setting.

## 4. Advanced Concepts in Simulating and Creating Circuits

### 4.18.2 Closed-loop Control

Now a simple position control is to be put into practice. Please change the circuit according to the following illustration. Please note that you need to remove the muffler from the valve connection before you may define connections. Instead of the function generator, the **displacement encoder** now supplies the input voltage for the proportional valve solenoid. To define the label for the cylinder, please choose the option “Sensing” in the register “Configuration” of the properties dialog.



Please note that in this example the continuous valve is mirrored horizontally.

→ Please launch the simulation and observe that the cylinder stops when it reaches half of the distance.

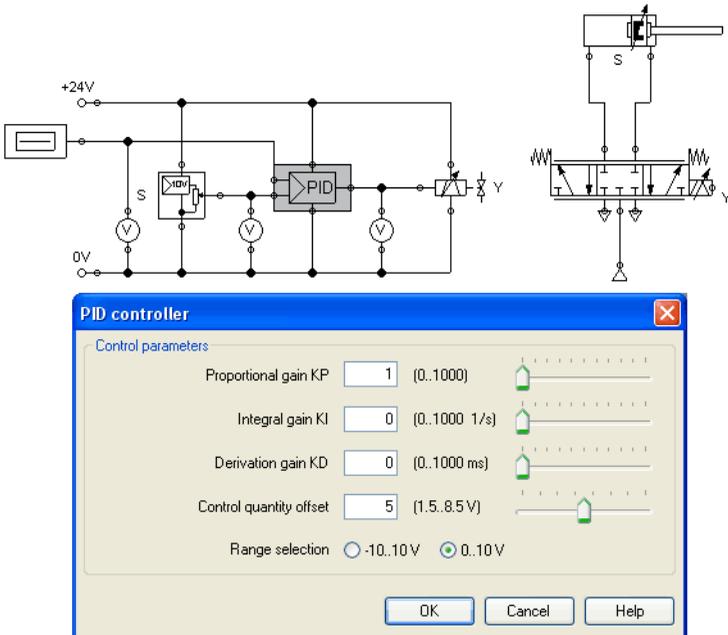
Now we wish to expand the circuit in such way that the cylinder may arrive, as rapidly as possible and still exactly, at any desired position that we define during the simulation by adjusting a controller. For this we will use a **PID-controller**.

→ Please construct the following circuit and adjust the parameter values of the PID-controller as indicated.

#### 4. Advanced Concepts in Simulating and Creating Circuits



Please note that the continuous valve, according to the above example, is mirrored.



→ Launch the simulation and gradually change the y-offset of the function generator between 0 and 10.

The cylinder will travel until it has found its desired position and will stop there. The target position of the cylinder acts proportionally to the defined voltage at the function generator: 0 volts correspond to “entirely retracted”, 10 volts correspond to “entirely advanced”. The value 5 is therefore the mid-position of the cylinder piston. In the course of this the position from which the cylinder begins to travel is irrelevant, it will still stop at the desired target position.

→ Change the initial piston position and observe how accurately the cylinder reaches its target position each time.

To achieve a more precise analysis of the control procedure we will observe the travel and the speed of the cylinder until it reaches its desired position. Therefore we include a state diagram, scale it to an adequate size and drag the cylinder on the diagram. A dialog will open where we choose the two state variables “Position” and “Velocity”.

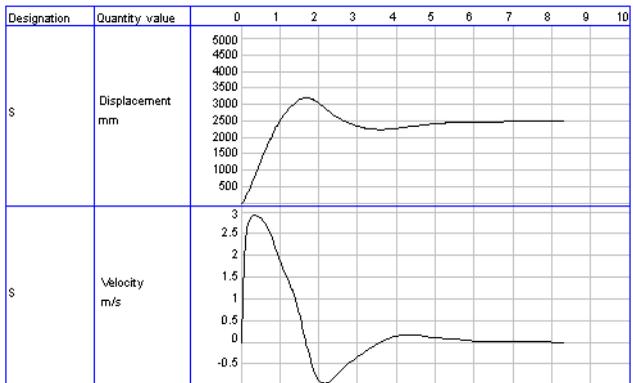
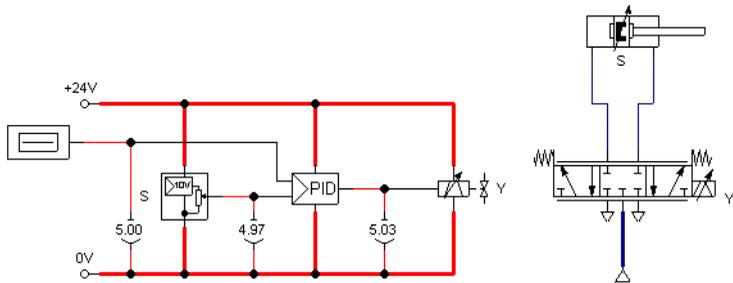


Pneumatics are fast. To make observing the following effects easier, please adjust the stroke of the cylinder to 5000 mm.

→ Please adjust the y-offset of the function generator to 5 and the start position of the cylinder's piston rod to 0 and then launch the simulation.

#### 4. Advanced Concepts in Simulating and Creating Circuits

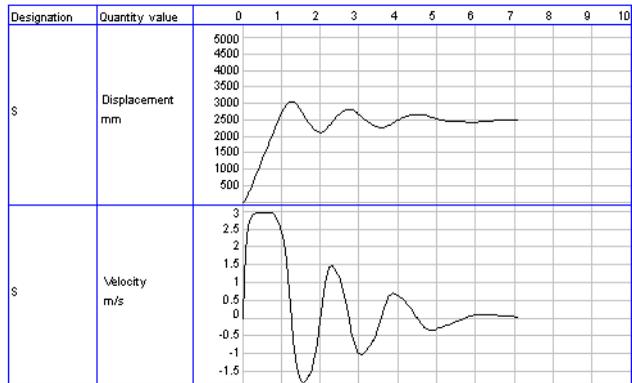
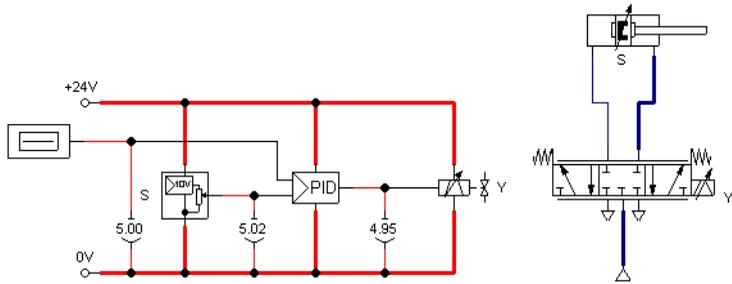
The cylinder travels as far as the middle and gradually decreases its speed until it stops.



It often may be desirably to make a cylinder travel by maximum speed until it reaches its desired position, and to make it stop most spontaneously. To achieve this we can amplify the position signal of the displacement encoder and therefore accelerate the reversing of the control valve. In doing so we make use of the fact that the PID-controller limits the output voltage of the proportional valve magnet to 10 volts.

#### 4. Advanced Concepts in Simulating and Creating Circuits

→ Please adjust the “proportional coefficient” of the PID-controller to 3 and launch the simulation.



It is clear that cylinder now travels at a constant speed over a long distance. It will then be firmly slowed down and will finally stop completely.



One would still observe that the cylinder piston, because of its inertia and because of the air's compressibility, firmly passes the target and that it travels back and forth a few times until it finally comes to rest. These vibrations around the desired position are typical for such a basic control. In reality one would attempt, by trimming the additional parameter of the PID-controller or the [status controller](#), to cushion the vibrations. At this point we wish to stay with the basics and would like to draw your attention to the advanced literature on proportional technology and control technology.

# 5. Learning, Teaching, and Visualizing Pneumatics

Beside the creation and simulation of electro-pneumatic circuit diagrams, FluidSIM also supports teaching basic pneumatic knowledge. This knowledge is presented in the form of texts, overview pictures, sectional views, exercises, and educational films. Functions that realize the selection of this instruction material are found under the [Didactics](#) menu.

One group of these functions refers to information about single, selected components. Another group of functions refers to ordered overviews of the didactics material, allowing the selection of an interesting topic. Finally, it is also possible to select and link together arbitrary topics into so-called “presentations”.



Appendix B, “The Component Library”, and C, “Didactics Material Survey”, offer a complete and concise summary of the instructional material in FluidSIM.

The following sections contain a description of the functions found under the [Didactics](#) menu.

### 5.1 Information about Single Components

The first three entries under the [Didactics](#) menu refer to selected components and are context sensitive. More precisely:

When a component in the current circuit diagram window is selected, or all selected components are of the same type, the menu entry [Component Description](#) will be enabled.

#### Component Descriptions

All components possess a page with a technical description. This page contains the diagram symbol for the component according to the DIN standard (“Deutsche Industrienorm”), a textual description of the component’s function, the designations of the connections, and a listing of the adjustable parameters along with their value ranges.

You will find a photograph of the real-life part provided for most components. In the case that a component cannot exist singularly in a real system, FluidSIM displays a photo of the assembly group that this component belongs to. Examples for such components include the indicator light, relays, switches, and the electrical power supply.

Components, that do not exist in reality, simply have no photo. Examples include the text component and the distance rule.

→ Select the one-way flow control valve, and click on the menu item [Component Description](#) under the [Didactics](#) menu.

The following page opens:

**Component library**

Component library < Pneumatic Components < Shutoff Valves and Flow Control Valves < One-way flow control valve

**One-way flow control valve**

The one-way flow control valve is made up of a throttle valve and a check valve. The check valve stops the flow from passing in a certain direction. The flow then passes through the throttle valve. The cross-section of the throttle is adjustable via a regular screw. In the opposite direction the flow can pass through the check valve.

**Adjustable parameters**

<b>Opening level:</b>	0 ... 100 %	(100)
<b>Standard nominal flow rate:</b>	0.1 ... 5000 l/min	(100)

**Related Topics**

- [\[94\] One-way flow control valve](#)
- [\[95\] Throttle valve](#)
- [Throttle valve](#)
- [Pilot operated check valve](#)

Navigation icons: Home, Back, Forward

Under the heading “Related Topics”, but also when appropriate in the component description, cross references for related instruction material and components are defined. By clicking on a cross reference, the related page will automatically be displayed.

### Component Illustrations

Component illustrations provide useful information relating a component’s function. This may include a sectional view of the component, but also illustrations of the component’s usage within a circuit diagram. For several components, their sectional view can be animated like a cartoon.

→ Select an air motor and click on **Component Description** under the **Didactics** menu.

The following dialog box appears:

The screenshot shows a software interface window titled "Component library". The breadcrumb navigation at the top reads: "Component library < Pneumatic Components < Actuators < Air motor Pneumatischer Motor".

The main content area is titled "Air motor" and features a schematic symbol of an air motor (a circle with two V-shaped ports and two electrical terminals). Below the symbol, a descriptive text states: "The air motor transforms pneumatic energy into mechanical energy."

On the left side, under the heading "Related Topic", there is a blue hyperlink: "[35] Air motor".

On the right side, under the heading "Adjustable parameters", there is a table of parameters:

<b>Displacement:</b>	0.01 ... 1000 Liter	(0.1)
<b>Friction:</b>	0.01 ... 100 N*m*s/rad	(3)
<b>Moment of inertia:</b>	0.00001 ... 1 kg*m <sup>2</sup>	(0.0001)
<b>External torque:</b>	-1000 ... 1000 Nm	(0)

At the bottom of the window, there are navigation controls: a refresh button (circular arrow), a back button (left arrow), and a forward button (right arrow).

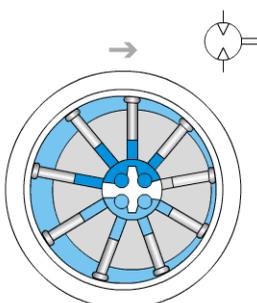
→ Please click the line with the relevant topic [35] Air motor.  
The following picture appears:

**Didactics material**

Didactics material < Basics and working principles < Actuators < Air motor

**[35] Air motor**

Devices which transform pneumatic energy into mechanical rotary motion, with the possibility of continuous motion. They are categorized into the groups of piston motors, sliding vane motors, gear motors and turbines.



→ Discuss applications for the air motor.

Navigation icons: Refresh, Home, Previous, Next

Often it is easier to understand the functional nature of a component, when its behavior is visualized through the use of animation. For this reason, several components possess different sectional views showing the component at different states. These sectional views can be animated in much the same way as a flip book.

→ Please mark a quick-exhaust valve and click the menu option [Didactics Component Description](#) to open the window with the component description. Now click the link with the function illustration [87] quick exhaust valve

This function illustration can be animated.

→ Click on  or [Execute Start](#) to start the animation.

An animation can be “frozen” with  or by clicking on [Pause](#) in the [Execute](#) menu.  or [Execute Stop](#) stops an animation, whereas  or [Execute Reset](#) restarts an animation.

### 5.2 Selecting Didactics Material from a List

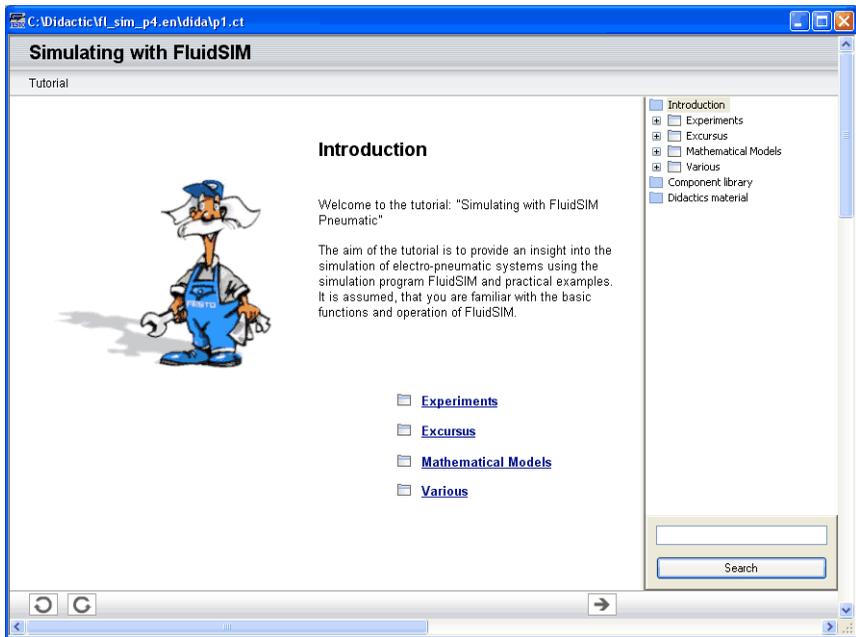
The entries [Tutorial](#), [Component Library](#) and [Didactics Material](#) under the [Didactics](#) menu present the didactics material of FluidSIM organized in the form of overview pages. From these pages topics can be chosen and viewed independently of the current window and possibly selected components.

#### Tutorial

Below this menu option you can launch the tutorial “Simulating with FluidSIM”, which contains a variety of interesting experiments and an excursus. By means of these useful examples you will get to know the possibilities of simulating with FluidSIM. Furthermore, for the most important components the mathematic models used in FluidSIM are also described.

## 5. Learning, Teaching, and Visualizing Pneumatics

→ Please click the menu option **Didactics** **Tutorial** to open the tutorial.



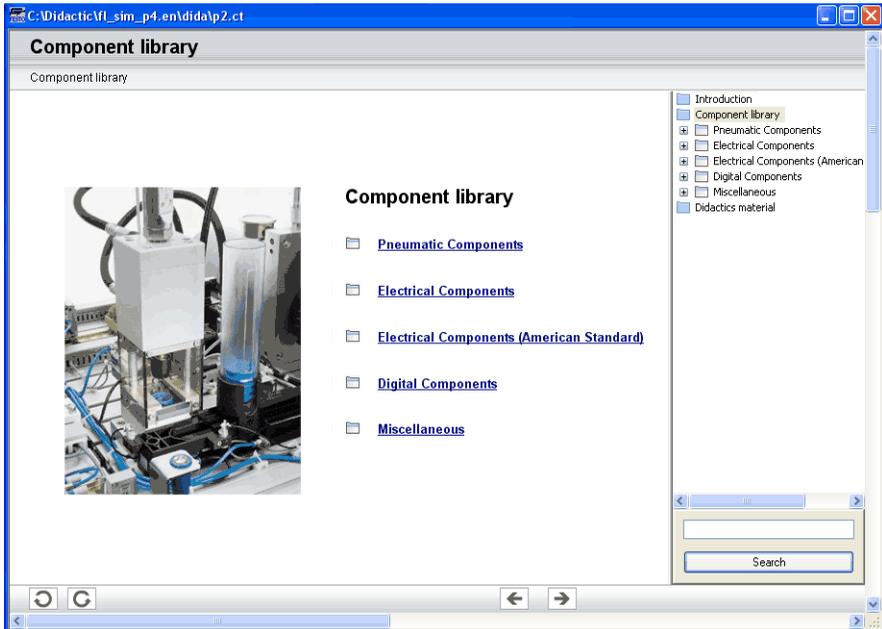
On the right-hand side the hierarchical directory is displayed. By double-clicking the directory symbols you may list off or close the applicable subsections. Clicking a page symbol will display the contents of the page in the open window.

### Component Library

Below the menu option **Component Library** you will find descriptions and photos of all FluidSIM-components.

## 5. Learning, Teaching, and Visualizing Pneumatics

→ Click a menu option **Didactics** **Component Library** to open the help pages of the component library.

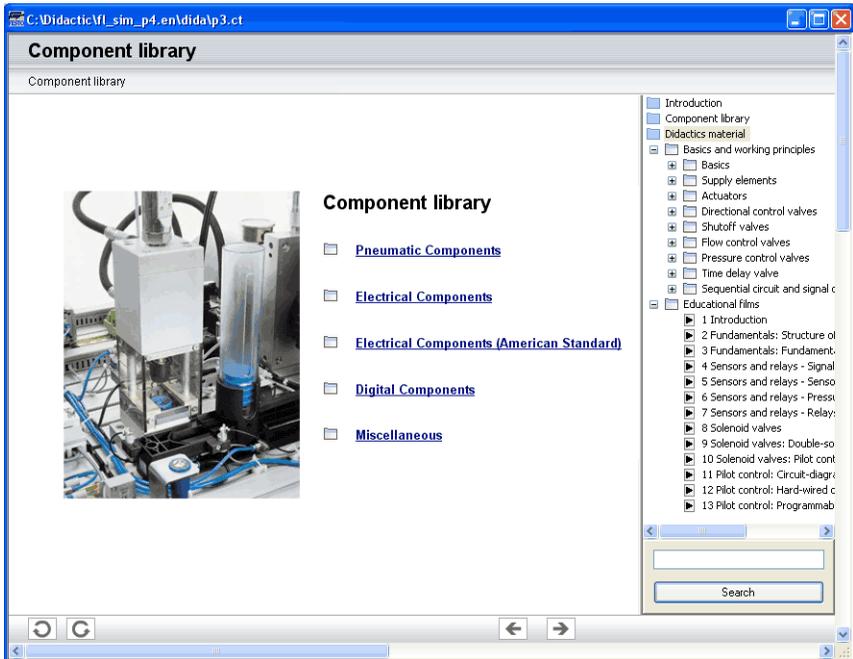


### Didactics Material

FluidSIM, alongside the tutorial and the component reference, contains further didactics material particularly useful for group work. Moreover, here you will find educational films, provided you have copied them onto the hard disk during the installation. If you haven't installed the film files, you may choose a chapter via the menu option **Didactics** **Educational Film...** to view the applicable film from the included video-CD.

## 5. Learning, Teaching, and Visualizing Pneumatics

→ Click the menu option **Didactics | Didactics Material** to open the overview of the didactics material.



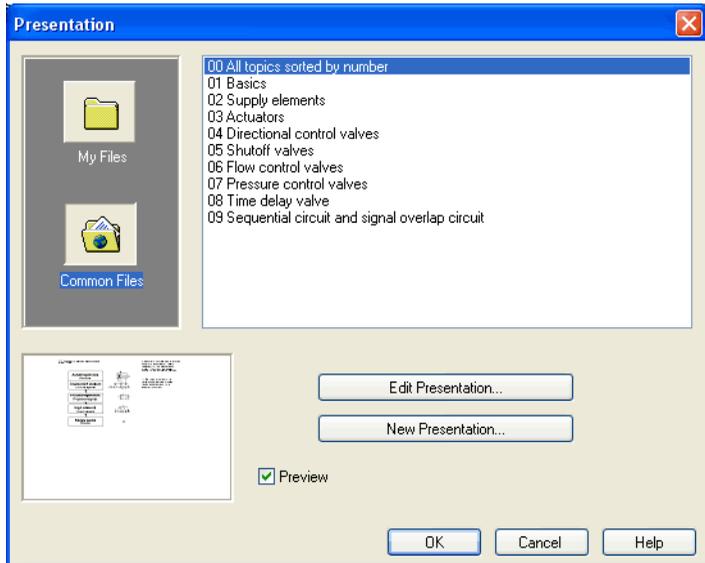
### 5.3 Presentations: Combining Instructional Material

Sometimes you may want to examine a topic from different angles or combine individual topics into a lesson. For this purpose FluidSIM offers the concept entitled “presentation”.

There are a number of already prepared presentations, which can be found on the FluidSIM installation disks. However, editing presentations or creating new presentations is also possible with FluidSIM. All presentations can be found under **Presentation...** in the **Didactics** menu.

→ Click on **Didactics** **Presentation...**.

The following dialog box appears:



Description of the dialog box:

- “Available Presentations”

This field contains a list of already created presentations.

- “New Presentation...”

Clicking on “New Presentation...” opens a second dialog box for the creation of a new presentation.

## 5. Learning, Teaching, and Visualizing Pneumatics

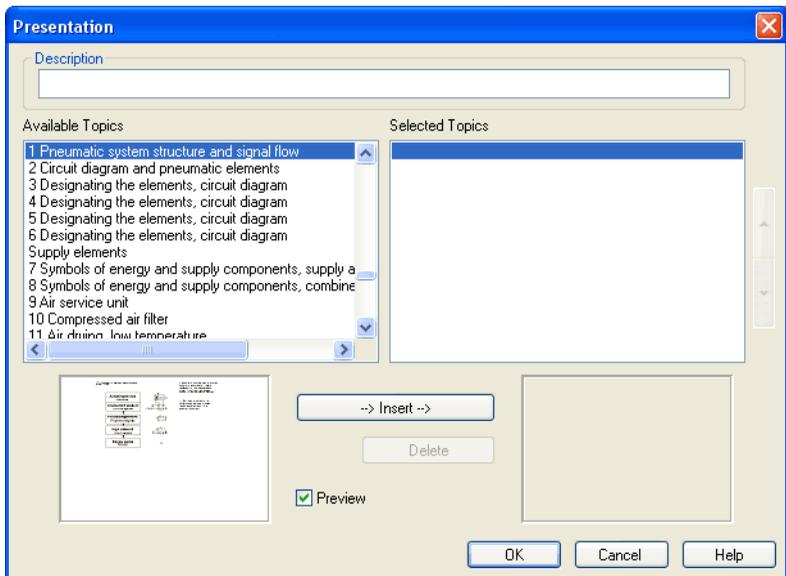
- “Edit Presentation...”

Clicking on “Edit Presentation...” opens a second dialog box to begin editing a presentation.

- “Preview”

When the “Preview” setting is activated, the picture that pertains to the selected presentation appears underneath the topics list.

→ Click on “New Presentation” to open the following dialog box.



Description of the dialog box:

- “Description”

In this text field a short description of the presentation can be entered. This text may consist of up to 128 characters and will appear with the other presentations, the next time the presentation dialog box is opened.

- “Available Topics”

This field contains a list of all available topics dealing with “Pneumatics Basics”, “Working Principles”, and “Exercises”. Moreover, there exist two pictures that can be used to announce a refreshment and a lunch break respectively. A double click on a line in the “Available Topics” list inserts this line in the “Selected Topics” list above the highlighted bar. In this way a presentation can be created or altered.

Moreover, a user can integrate his own circuit diagrams, DXF files, BMP- and WMF-picture files, or even multimedia files such as sounds or video clips. To do so, click on “User File...”: A dialog box opens that allows for the selection of the desired data source on the file system.

- “Selected Topics”

This field contains a list of topics chosen for the current presentation.

- “Insert”

Clicking on “Insert” is the same as double clicking a line in the “Available Topics” list: The selected line in “Available Topics” will be inserted in the “Selected Topics” list.

- “Delete”

Clicking on “Delete” deletes the selected line of the “Selected Topics” list.

- “Preview”

When the “Preview” setting is activated, the picture that pertains to the selected topic appears underneath the respective list.

Within both topics lists the highlighted bar can be moved using the arrow keys. Maybe it will be necessary to click and select the list you want to work with.

After creating a new presentation and closing the dialog box by clicking on “OK”, FluidSIM asks you to name the presentation *file*. Presentation files have the extension `.shw` and are located in the subdirectory `shw` under the `fl_sim_p` directory.

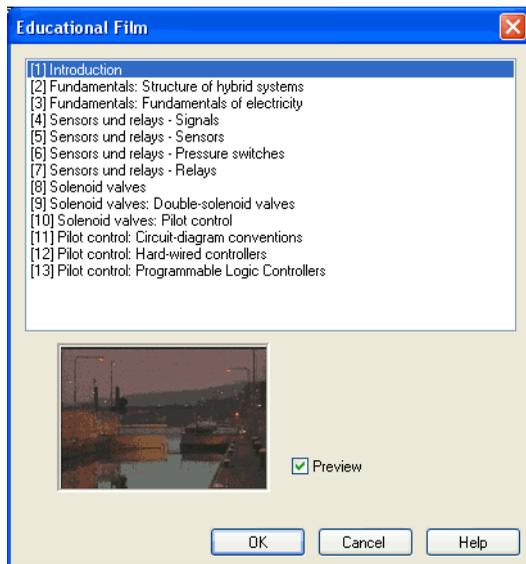
The structure of a presentation file is described more thoroughly in [section 8.2](#).

#### 5.4 Playback of Educational Films

The FluidSIM CD-ROM contains 13 educational films, which last between 1 to 10 minutes in length and cover a specific area of electro-pneumatics.

Provided you have copied the film files onto the hard disk during the installation, this menu option will not appear; in this case the films are not available directly at [Didactics](#) [Didactics Material](#).

→ Click on [Didactics](#) [Educational Film...](#) to open the dialog box that contains a list of the educational films.



Description of the dialog box:

- “Available Educational Films”

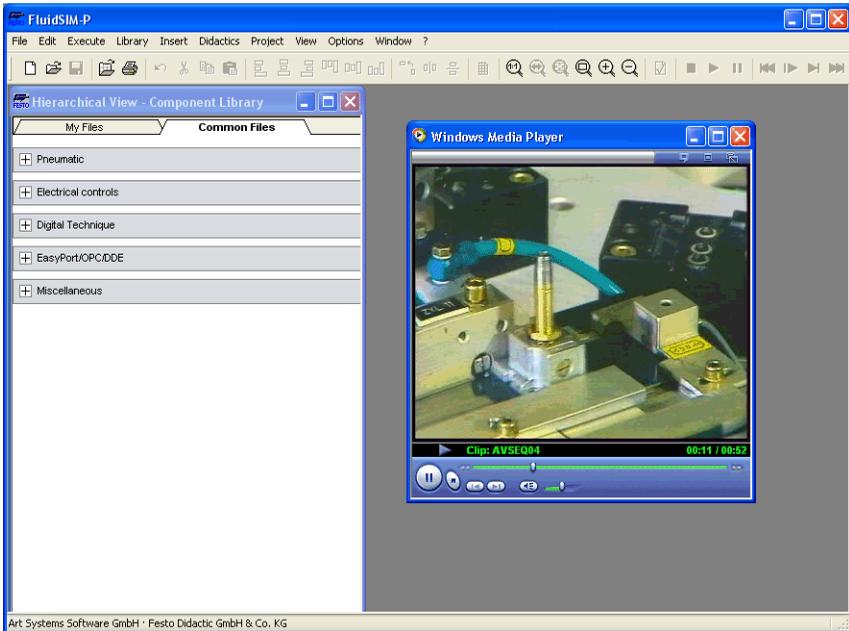
This field contains a list of [available educational films](#). By double clicking on a line in the list, the dialog box closes and the media playback starts playing the selected film.

- “Preview”

When the “Preview” setting is activated, a typical scene from the film appears underneath the list of titles.

## 5. Learning, Teaching, and Visualizing Pneumatics

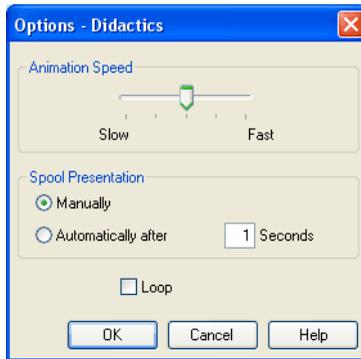
→ Click on Sensors and relays--Signals to start the playback of the selected film:



Underneath the window for the media playback, you will find the control elements to start, stop, and wind the film. A detailed description of the media playback is available under the standard Microsoft Windows® help.

### 5.5 Settings for Didactics

By clicking on **Didactics... Options**, a dialog box appears that contains the settings for didactics:



Description of the dialog box:

- “Animation Speed”

This setting defines the speed at which the animations should run.

- “Spool Presentation”

A presentation in FluidSIM can be set to automatically run. For this the setting “Automatically after ...Seconds” must be activated. The time span that can be entered defines how long FluidSIM waits before switching to the next topic of the presentation. By clicking on , the presentation will immediately change to the next topic in the presentation. With the setting set to “Manually”, no automatic switching will take place during the presentation.

- “Loop”

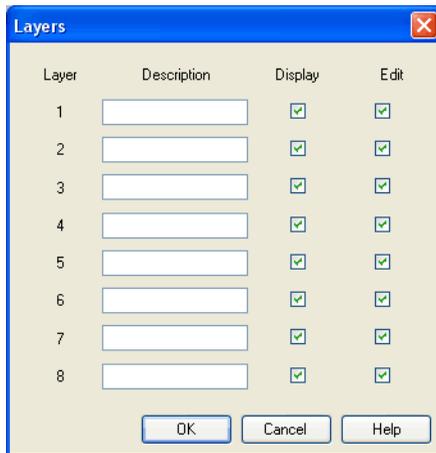
Defines whether a running presentation is reset and started over again after all topics have been displayed. This is known as loop mode.

# 6. Special Functions

This chapter develops further concepts and functions of FluidSIM.

## 6.1 Drawing Layers

Components in FluidSIM that cannot be simulated, such as texts, DXF import data, rectangles, circles, state diagrams, and parts lists, can be assigned to one of eight drawing layers. Each layer can be shown or hidden as well as set locked or unlocked. These properties are defined under [View Layers...](#); here also a layer can be given a name. Components of FluidSIM that can be simulated are always on layer 1.



- “Description”

The layer name is displayed in the dialog box of an object’s properties instead of the layer number.

- “Display”

If the option “Show” is disabled, the respective drawing layer is invisible, and, of course, can not be edited.

## 6. Special Functions

- “Edit”

If the option “Edit” is disabled, the respective drawing layer is still visible but cannot be edited. I. e., the objects that belong to such a locked layer can neither be selected, nor moved or deleted. By this concept e. g. a drawing frame can be protected. To edit objects on a locked layer, first unlock the layer.

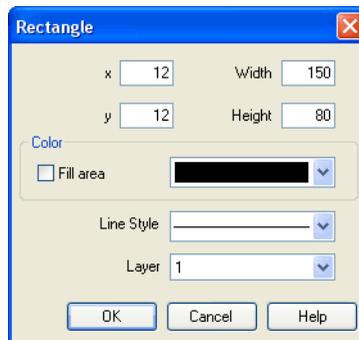


The identifiers of components and connections in FluidSIM’s standard circuit library stand on drawing layer two. By disabling the “Show”-option for this layer, the identifiers are made invisible.

### 6.2 Graphic Primitives

#### Rectangles

By selecting a rectangle and clicking on [Edit Properties...](#), or by simply double clicking it, its property dialog box is opened.



Description of the dialog box:

- “x”

Defines the x-coordinate of the rectangle. Instead of providing a number, the rectangle can also be moved with the mouse.

## 6. Special Functions

- “y”

Defines the y-coordinate of the rectangle. Instead of providing a number, the rectangle can also be moved with the mouse.

- “Width”

Defines the width of the rectangle. Instead of providing a number, the rectangle can also be resized by dragging the mouse: If the mouse pointer is moved onto the rectangle's border, the mouse pointers becomes a resize indicator,  $\leftrightarrow$ ,  $\updownarrow$ , or  $\nwarrow$ . Now the rectangle can be resized as indicated by holding down the left mouse button.

- “Height”

Defines the height of the rectangle. Instead of providing a number, the rectangle can also be resized by dragging the mouse: If the mouse pointer is moved onto the rectangle's border, the mouse pointers becomes a resize indicator,  $\leftrightarrow$ ,  $\updownarrow$ , or  $\nwarrow$ . Now the rectangle can be resized as indicated by holding down the left mouse button.

- “Color”

Defines the color of the rectangle's border. A color is set by clicking on the down-arrow at the right-hand side of the list and selecting a color.

- “Fill Area”

Defines whether the entire area or only the border of the rectangle is colored.

- “Line Style”

Defines the line style of the rectangle. A line style is set by clicking on the down-arrow at the right-hand side of the list and selecting a style.

- “Layer”

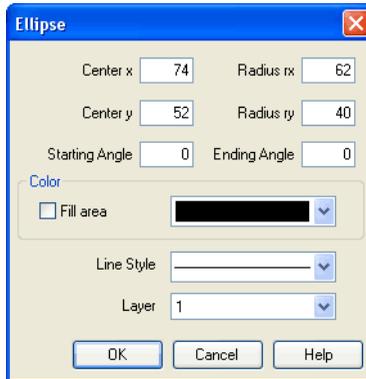
Defines the [drawing layer](#) of the rectangle. The drawing layer is set by clicking on the down-arrow at the right-hand side of the list and selecting a layer.

Depending on the settings of [drawing layer](#), the rectangle may not be visible or may not be selectable. To display an invisible rectangle or to change its properties in such a case, the [drawing layer](#) must be activated via the menu [View Layers...](#).

## 6. Special Functions

### Ellipses

By selecting an ellipse and clicking on [Edit Properties...](#) or by simply double clicking it, its property dialog box is opened.



Description of the dialog box:

- “Center x”  
Defines the x-coordinate of the ellipse center. Instead of providing a number, the ellipse can also be moved with the mouse.
- “Center y”  
Defines the y-coordinate of the ellipse center. Instead of providing a number, the ellipse can also be moved with the mouse.
- “Radius rx”  
Defines the x-radius of the ellipse. Instead of providing a number, the ellipse can also be resized by dragging the mouse: If the mouse pointer is moved onto the ellipse’s border, the mouse pointers becomes a resize indicator,  $\leftrightarrow$ ,  $\updownarrow$ , or  $\nwarrow$ . Now the ellipse can be resized as indicated by holding down the left mouse button.

- “Radius ry”

Defines the y-radius of the ellipse. Instead of providing a number, the ellipse can also be resized by dragging the mouse: If the mouse pointer is moved onto the ellipse's border, the mouse pointers becomes a resize indicator,  $\leftrightarrow$ ,  $\updownarrow$ , or  $\nwarrow$ . Now the ellipse can be resized as indicated by holding down the left mouse button.

- “Starting Angle”

Defines the ellipse's start angle, specified in degree. A value of zero degree corresponds to the three o'clock watch hands position.

- “Ending Angle”

Defines the ellipse's end angle, specified in degree. A value of zero degree corresponds to the three o'clock watch hands position.

- “Color”

Defines the color of the ellipse's border. A color is set by clicking on the down-arrow at the right-hand side of the list and selecting a color.

- “Fill Area”

Defines whether the entire area or only the border of the ellipse is colored.

- “Line Style”

Defines the line style of the ellipse. A line style is set by clicking on the down-arrow at the right-hand side of the list and selecting a style.

- “Layer”

Defines the **drawing layer** of the ellipse. The drawing layer is set by clicking on the down-arrow at the right-hand side of the list and selecting a layer.

Depending on the settings of **drawing layer**, the ellipse may not be visible or may not be selectable. To display an invisible ellipse or to change its properties in such a case, the **drawing layer** must be activated via the menu **View Layers...**

### 6.3 Text Components and Identifications

The concept of text components in FluidSIM gives the user a way in which to describe components in diagrams, assign identification texts, or to provide commentary on the diagram. The text and the appearance of text components can be customized to the user's liking.

Text components function in much the same as other fluidic or electrical components in FluidSIM. The dummy text component *Text* can be found in the component library, and it can be dragged onto the drawing area. However, text components contain no connections.

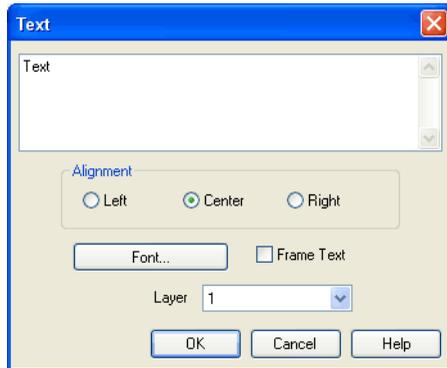
As long as the setting **Options Protect Text Components** remains switched off, the text components can be marked, dragged, deleted, and rotated in the same way that other components are handled. When this setting is activated, the text components can neither be marked nor moved or deleted. This concept allows the text components to be anchored in the background. They are out of the way and cannot interfere with changes or manipulations made to the circuit diagram while in the Edit Mode.

→ Drag the text component from the component library to the drawing area.

→ Make sure that **Options Protect Text Components** is switched off.

## 6. Special Functions

→ Double click on the text component or click under [Edit Properties...](#) to open the dialog box for entering new text.



Description of the dialog box:

- “Text”

In this field the text to be displayed is entered. A new line is entered by holding down the Ctrl-key while hitting the [Return](#) key.

- “Alignment”

Activates horizontal text alignment.

- “Font...”

By clicking on “Font...”, a Microsoft Windows® common dialog box opens, which allows you to set the font attributes for the given text.

## 6. Special Functions

- “Frame Text”

Draws a border around the text.

- “Layer”

Defines the **drawing layer** of the text component. The drawing layer is set by clicking on the down-arrow at the right-hand side of the list and selecting a layer.

Depending on the settings of **drawing layer**, the text component may not be visible or may not be selectable. To display an invisible text component or to change its properties in such a case, the **drawing layer** must be activated via the menu **View | Layers...**.

The dialog box can be closed by clicking on “OK”. As a result the text along with its font attributes is inserted into the drawing area.

→ Click on **Options | Protect Text Components** to protect the text.

The protected text can no longer be selected. Therefore, components can be placed over the text.

### 6.4 Embedding Pictures

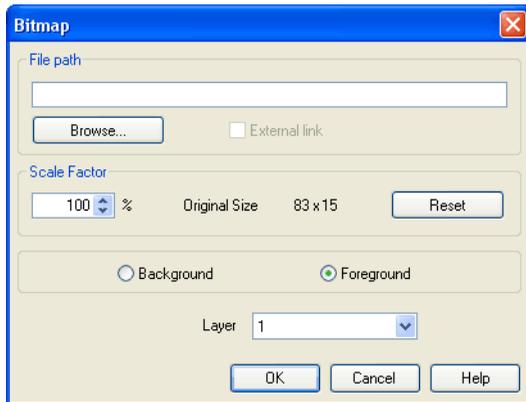
Alongside denominating texts and comments you may furthermore include picture files in circuits. This way you may conveniently complement your circuits by using your own visual material. This may be a photo of a real construction, an illustrating sectional drawing or even a small company logo in the drawing corner.

Pictures in FluidSIM, like all other components and objects, may be included and placed, dragged, rotated and mirrored. Furthermore, in the same way as **rectangles** and **ellipses**, pictures may also be freely scaled.



Since picture files are not vector graphics, a **DXF-export** will only show a frame instead of the picture.

Double-clicking a picture or using **Edit Properties...** will open the properties dialog for bitmaps.



Description of the dialog box:

- “File Path”

Defines the path to the picture file. Please enter the path of an existing picture file here or choose one by using the file selection dialog.

- “External Link”

Bitmaps may be assigned as an external reference or may be stored with circuit file. The advantage of the latter is that of a transported circuit automatically containing the pictures. When you only work within your own environment, the reference to a file path is convenient because the circuit files remain compact and changes of the pictures also take effect in FluidSIM.

- “Scale Factor”

Defines the scale factor of a picture file. Instead of entering the value, you may also change the picture's size by using the mouse. When moving the mouse pointer across the border of an object, the pointer will change to the size modification symbol  $\leftrightarrow$ ,  $\updownarrow$  or  $\nwarrow$ . Keeping the left mouse button pressed, you may magnify or downsize it in the displayed direction.

Pictures in FluidSIM are always scaled according to the aspect ratio. You cannot change just one side by narrowing or stretching.

- “Reset”

Changes back the scaling factor to 100 %.

- “Background/Foreground”

Defines whether the picture is to be positioned in front of all other circuit objects or behind them. The option “in the foreground” is favorable with small logos, while big pictures should be assigned the option “in the background” because a large part of the circuit could be concealed.

- “Layer”

In this selection list you may define the **drawing layer** of the picture file. The **drawing layer** may be set by clicking the downward arrow on the right-hand side of the list, you may then choose a layer.

Depending on the setting of the **drawing layers**, the picture file may not be displayed or you may not be able to change it. To make the object visible or to change the settings, you need to temporarily activate the **drawing layer** in the menu [View Layers...](#)



Large background pictures may massively reduce edit speed and simulation speed, since dragging or animating symbols always forces parts of the picture in the layer below to be re-drawn.

## 6. Special Functions

### 6.5

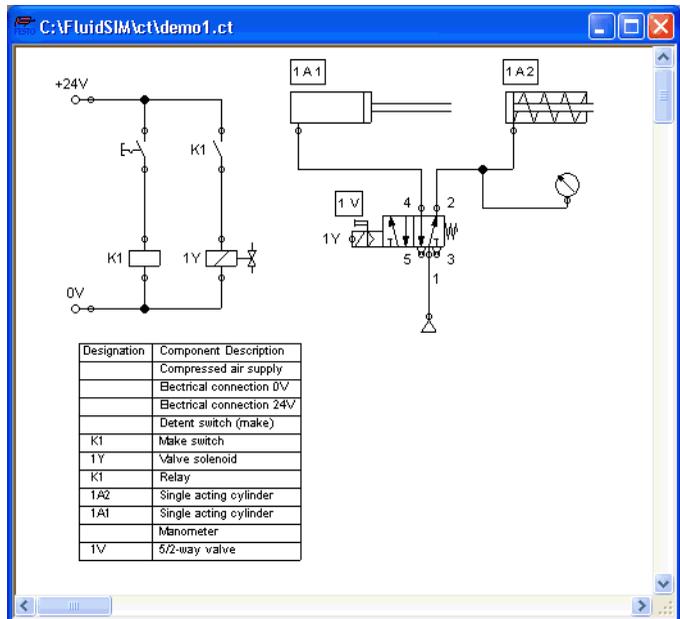
#### Parts Lists

With FluidSIM parts lists can be generated automatically. A parts list is represented by a “parts list component”, which can be inserted, moved, or deleted like every other component. The parts list is updated automatically while a drawing is edited. The automated update may slow down the drawing process of large circuits and thus, a parts list component should be inserted in the end of a drawing process.

Inserting a Parts List

→ Open the circuit demo1.ct.

→ Select the **parts list component** from either the **Insert** menu or the component library and add it to the drawing. Move the parts list such that it overlaps no other component.



The screenshot shows the FluidSIM software interface with a circuit diagram and a parts list table. The circuit diagram includes a +24V power source, a 0V ground, a detent switch (K1), a make switch (K1), a valve solenoid (1Y), a relay (K1), a single acting cylinder (1A1), another single acting cylinder (1A2), a manometer, and a 5/2-way valve (1V). The parts list table is as follows:

Designation	Component Description
	Compressed air supply
	Electrical connection 0V
	Electrical connection 24V
	Detent switch (make)
K1	Make switch
1Y	Valve solenoid
K1	Relay
1A2	Single acting cylinder
1A1	Single acting cylinder
	Manometer
1V	5/2-way valve

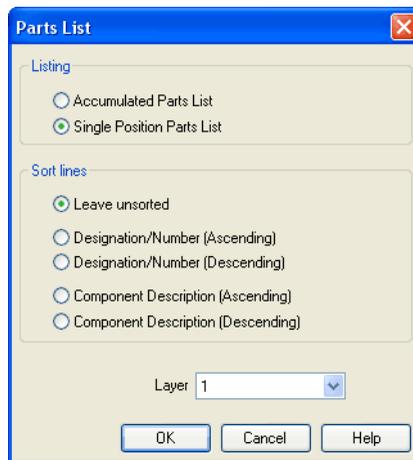
## 6. Special Functions

The **parts list component** analyzes all components of the diagram and generates table with columns for the component identifications and the component designations. In this connection, FluidSIM uses existing labels and texts as component identifications.

The sorting of the table can be customized to the user's liking; moreover, the parts list can be exported as a text file. Also note that more than one **parts list component** can be inserted in a diagram.

### Properties of Parts Lists

→ Double-click on a **parts list component** or select a parts list component and click on **Properties...** in the **Edit** menu.



Description of the dialog box:

- “Listing”

With the “Accumulated Parts List” option enabled, all components of the same type become comprised into a single row. As a consequence, the first column of the **parts list component** shows the number of the comprised components.

With the “Single Position Parts List” option enabled, each component gets its own row within the parts list. The first column of the **parts list component** then shows a possible existing identification.

- “Sort Lines”

The lines of a parts list can be sorted in “ascending” order, in “descending” order, by the “component description”, by the “component number”, or by the “component designation”.

- “Layer”

Defines the **drawing layer** of the **parts list component**. The drawing layer is set by clicking on the down-arrow at the right-hand side of the list and selecting a layer.

Depending on the settings of **drawing layer**, the parts list component may not be visible or may not be selectable. To display an invisible **parts list component** or to change its properties in such a case, the **drawing layer** must be activated via the menu **View Layers...**

### Exporting Parts Lists

Aside from printing a **parts list component**, it can also be exported in the form of a text file.

→ Select a **parts list component** click on **File Parts list Export...**

## 6. Special Functions

A file selector box opens where an existing file can be selected or a new file name can be entered. After a file has been specified and the file selector box been closed, a dialog box opens where a column separator can be defined.



Description of the dialog box:

- “Tabulator”

The tab-character is used as column separator.

- “Semicolon”

The semicolon is used as column separator.

- “Other”

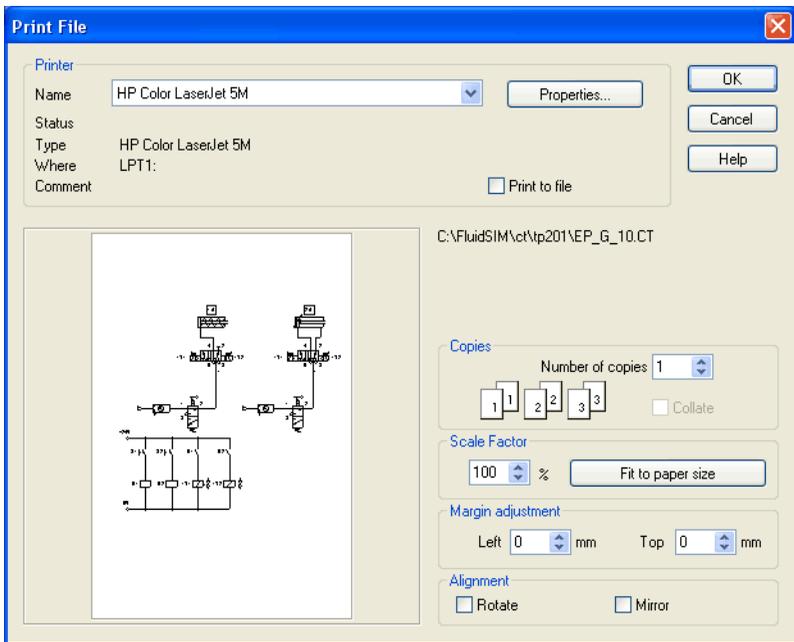
The entered character is used as column separator.

## 6. Special Functions

### 6.6 Printing a Window's Contents

FluidSIM contains a practical printing function that is always available, whether you are in the Edit Mode or the Simulation Mode. The contents of any window in FluidSIM can be printed.

→ Click on **File Print...** to open the print preview dialog box:



Description of the dialog box:

- “Printer”

This list contains all available local as well as network printers. A printer is set by clicking on the down-arrow at the right-hand side of the list and selecting a printer.

- “Properties...”

Opens a dialog box with available printer options.

- “Copies”

In the number field “Number of copies” the desired number of copies is typed in. If the printout consists of several pages you can check the “Collate” to have the pages sorted automatically.

- “Scale factor”

In the number field “Scale factor” enlargement or reduction of the circuit diagram is typed in as a percentage. The print preview window then re-scales the circuit diagram according to the size proportion that was given.



If the **paper size** in combination with the chosen scaling factor exceeds the printer's printing area, the diagram is printed in a tiled fashion. The expected number of pages is indicated in the printer preview dialog box. Pressing the “Fit to paper size” button sets the scale factor so that the circuit diagram fills out the entire paper area.

## 6. Special Functions

- “Margin adjustment”

In order to take the printable regions of different output devices into account, or enlarge the margin of a printout, an offset in mm can be defined for the left as well as the upper margin. Positive values move the drawing to the right or down, negative values move the drawing to the left or up.

- “Alignment”

In some cases it could be useful to rotate or to mirror the drawing. E. g. some printer drivers do not support rotating by themselves.

Printing begins by clicking on “OK”.

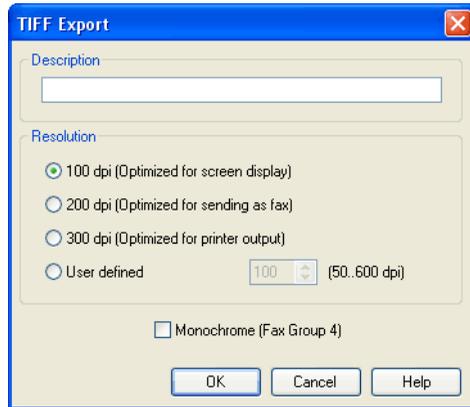
### 6.7 TIFF Export

FluidSIM-circuits may be exported as TIFF e. g. to process them using a non-vector oriented software.

→ Please click [TIFF Export...](#) on the [File](#)-menu to export the current circuit.

## 6. Special Functions

If you do not define a new name for the TIFF file, the file will be saved using the name of the circuit and the file extension `.tif`.



Description of the dialog box:

- “Description”

Please enter an optional description here. By default, the description you’ve defined at [circuit properties](#) will be used. In case nothing is entered there, the circuit description will be used.

- “Resolution”

Please choose an adequate resolution for the picture file here. Please note that a high resolution may particularly increase the file size and that it may cause the export to take a lot more time. You may stop the export at any time if it takes too long.

## 6. Special Functions

- “Monochrome”

This export option will save the entire drawing black and white. This will help the files to become compact ones, but naturally all other colors will be lost.

### 6.8

#### DXF Export

FluidSIM contains a filter module to export circuit diagram in the DXF format. Hence circuit diagrams from FluidSIM can be imported into a CAD program, where they can still be edited.

→ Click on **DXF Export...** under the **File** menu to export the actual circuit diagram.

If no new name is given for the DXF file, the exported circuit diagram file is saved with the extension `.dxf`.

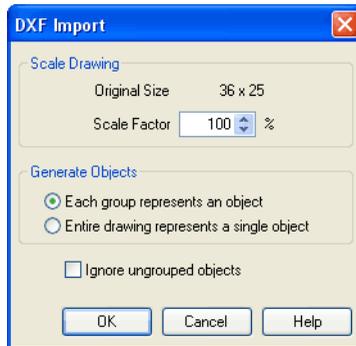
The exported drawings in the DXF format differ from those in FluidSIM in the following manner:

1. Component connections are shown without circles.
2. The DIN symbol is inserted for the cylinder.
3. The text font is set to `STANDARD` for the text components.

### 6.9 DXF Import

Files that are of the DXF format type can be imported, retaining most of the DXF element attributes. Clearly, imported circuit diagrams or symbols cannot be simulated since the DXF standard does not provide for a definition language of physical behavior models. However, the import functionality is useful if a circuit diagram shall contain elements that cannot be realized from within FluidSIM. For example, CAD drawing frames or terminal strip plans, which have been created by means of another CAD program, can be inserted into a FluidSIM drawing. Depending on whether a single symbol or a complex drawing is to be imported, particular conventions relating the grouping should be obeyed.

Having selected a DXF file via **File | Open...**, the dialog box for the DXF import opens.



Description of the dialog box:

- “Scale Drawing”

The scaling factor defines scaling in percent that is applied to DXF file.

- “Each group represents an object”

Enable this option if the DXF file contains several symbols. Note that symbol elements that belong together can only be identified as such, if they have been grouped within the CAD program in such a way, that the outermost group of the symbol occurs in the ENTITIES section. This means among others that no two symbols can belong to the same group. However, different symbols are allowed to share blocks; the import filter of FluidSIM creates copies for shared blocks.

- “Entire drawing represents a single object”

If this option is enabled, the entire drawing is treated as a single object.

- “Ignore ungrouped objects”

Enable this option if only for the grouped elements objects shall be generated. The elements mentioned in section ENTITIES are not considered.

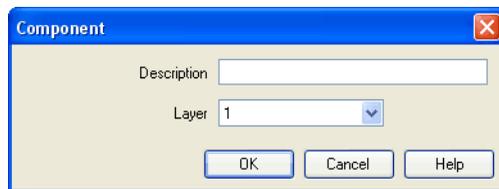
If this option is disabled, FluidSIM comprises all ungrouped elements within a single object.

Elements that have been imported can be placed on each of the eight [drawing layers](#). Moreover, they can be equipped with a designation, which is displayed in the [parts list](#).



If you have imported a CAD frame, it makes sense to place this frame on a drawing layer whose “Edit”-option is disabled: This way the frame is anchored and will not interfere when placing components.

By double clicking on an imported DXF symbol, the following dialog box is opened:



Description of the dialog box:

- “Description”

In this field a designation can be entered, which is also displayed in the [parts list](#).

- “Layer”

Defines the [drawing layer](#) of the symbol. The drawing layer is set by clicking on the down-arrow at the right-hand side of the list and selecting a layer.

Depending on the settings of [drawing layer](#), the symbol may not be visible or may not be selectable. To display an invisible symbol or to change its properties in such a case, the [drawing layer](#) must be activated via the menu [View Layers...](#)

### 6.10 Using and Organizing Component Libraries

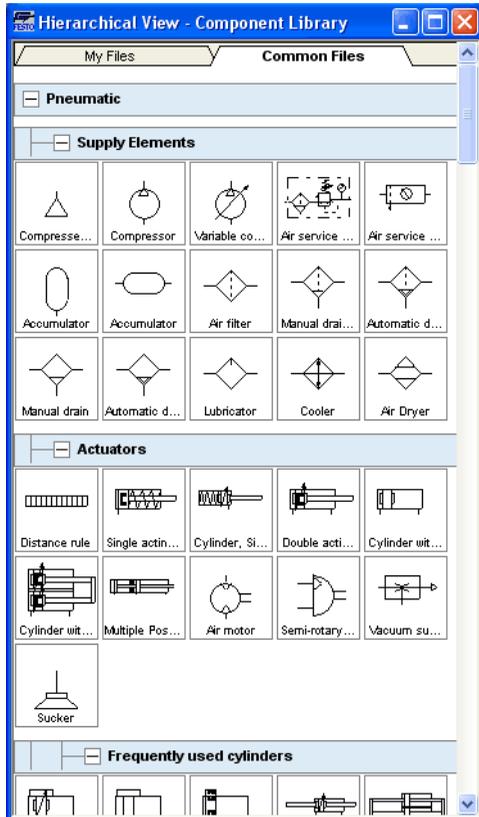
#### Displaying the Component Library

FluidSIM offers two ways of displaying the component libraries:

- **Tree View**  
This will display the entire structure tree-like. Subgroups, as opposed to their superordinate groups, are indented to the right-hand side. Below the applicable group designation you will find the symbols. To keep track of the overview despite the large number of component symbols, you may display or hide entire branches by clicking the group designation. By holding the Shift-key you can display or hide a group including all subgroups (see 3.3).

## 6. Special Functions

This way of displaying is similar to the one on the left-hand side of the Windows Explorer.

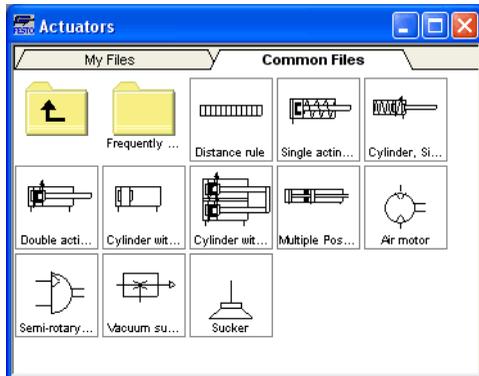


## 6. Special Functions

- Folder View

The folder view only shows the symbols of a single level in its hierarchy at a time. Subgroups are represented by folder symbols. To access a subordinate level please open the folder by double-clicking it. You may access a superordinate level by double-clicking the “upwards”-folder (see 3.1).

This way of displaying is similar to the symbol view on the right-hand side of the Windows Explorer.



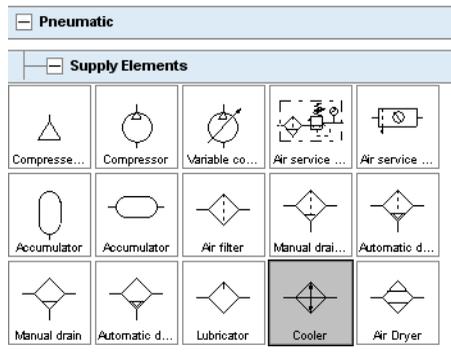
### Rearranging a Component Library

The components in the component library can be rearranged according to their usefulness and the desire of the user.

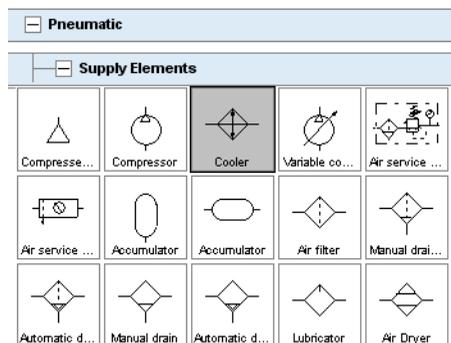
In the tree view you may drag separate symbols or also entire groups of one level to another position.

## 6. Special Functions

→ Please mark a component in the lower section of the group:



→ Drag the marked component to the top left:

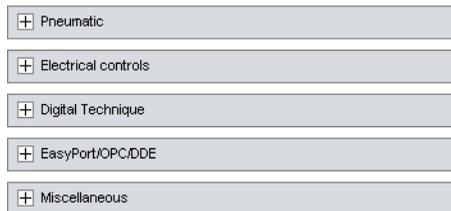


FluidSIM adds the symbol to the applicable position. The order of the other symbols will be maintained. FluidSIM keeps the symbols from being on top of each other or from creating “gaps”.

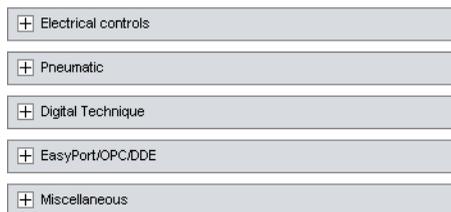
## 6. Special Functions

You may also relocate an entire group including all subgroups.

→ Close all component groups:



→ Move the group “Electrical controls” up:



You cannot change the hierarchy's layer structure this way. You may only relocate symbols and groups within the same level. Relocating a group will automatically relocate the entire branch below the group.

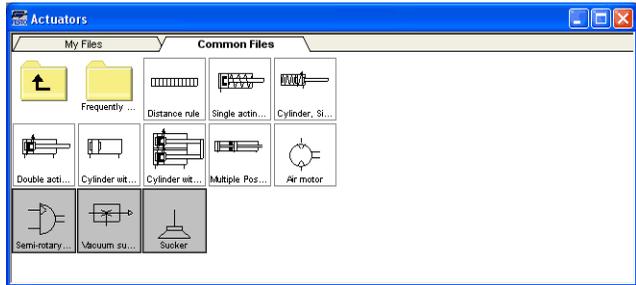
In the folder view you may freely relocate and rearrange the symbols. Particularly, “gaps” are allowed to exist between the symbols; FluidSIM does not relocate them next to each other like in the tree view.

→ Select the folder view at [View](#) and open the group “Pneumatic” and then “Actuators”.

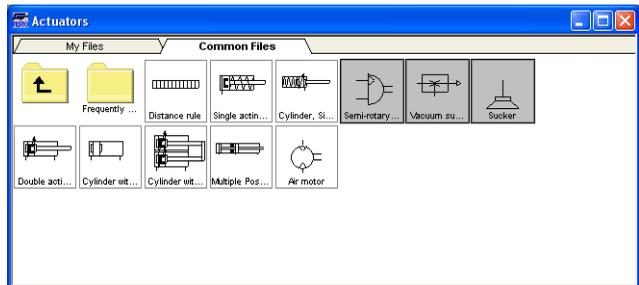
## 6. Special Functions

→ Enlarge the window of the component library.

→ Using the rubber band, select for example the bottom row:

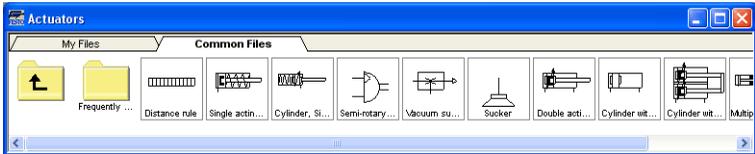


→ Drag the selected components, for example up and to the right:



## 6. Special Functions

→ It is also possible to rearrange the components in the library horizontally, in just a few steps:



It is not possible for the user to add components to or delete components from the *standard* component libraries. However, own libraries can be constructed at the user's will.

### Building New Component Libraries

In addition to the standard component library, where the available FluidSIM-components are located, you may assemble additional libraries.

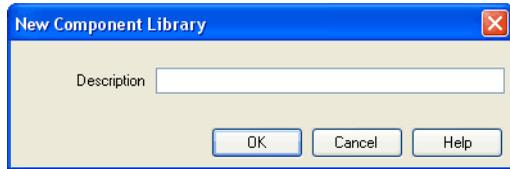
In contrast to the FluidSIM standard libraries both the arrangement and the contents of such user-defined libraries can be defined, by means of operations that add and delete components.

To display available libraries, to create a new one, or to rename an existing one, choose the respective entry from the **Library** menu.

The first entry in this menu opens the standard library. Below you will find entries for the user defined libraries. When these entries are selected, the applicable library windows will open. At the end of the **Library**-menu you will find functions for creating a new library (**New...**), for renaming a user defined library (**Rename...**) and for deleting a created library (**Delete**). The menu entries for renaming and for deleting always refer to the active library window.

## 6. Special Functions

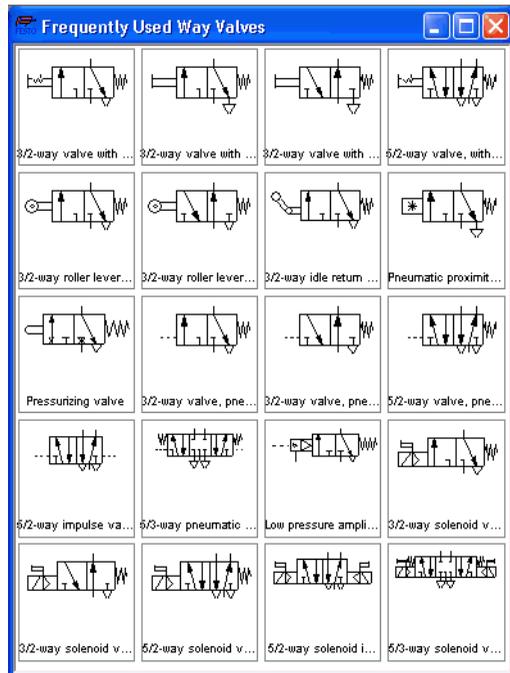
When clicking on **Library New...** a dialog box opens, where a description of the new library can be entered:



The text that has been entered here is shown as a menu entry in the **Library** menu. The text can be modified anytime, by opening the library and clicking on **Library Rename...**

## 6. Special Functions

- Enter an appropriate name for new library and drag a few symbols from the standard library or from a circuit window in the empty window of the created library. You may also add symbols using the **Insert** menu.



### Inserting Components Via Menu

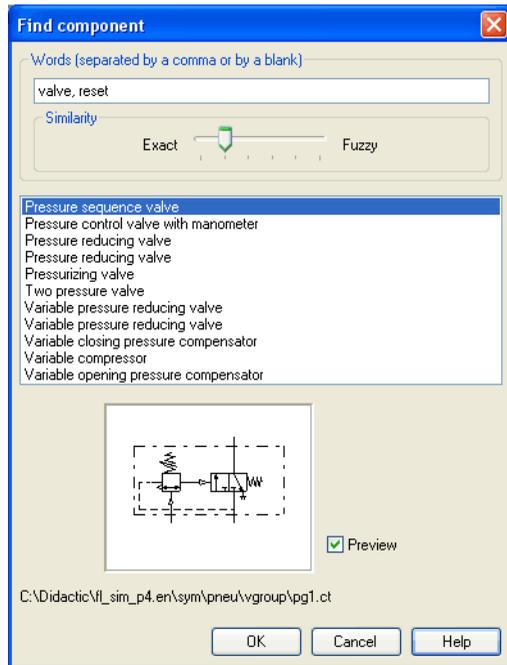
In FluidSIM, several alternative concepts exist to insert a component into a circuit diagram. One concept is “Drag-and-Drop”, which has been used in the preceding examples.

## 6. Special Functions

Alternatively, components can be selected through the **Insert** menu, either by navigating along the hierarchical menu structure or by entering one or more search strings. While mousing a component description in the menu, the related symbol is shown either in the preview window of the search dialog or in the upper left corner of the FluidSIM main window.

## 6. Special Functions

→ Open a new circuit window, select the menu item **Insert** / **Find Component...** and enter one or more search strings; e. g., valve, reset.



Description of the dialog box:

- “Words”

In this field one or more search items can be entered in order to find a particular component. The order of the search items does not play a role, they are combined by a logical “AND”. Also note that partial matches are allowed. I. e., if you are unsure respecting the correct spelling of a component name, simply partition this name into several comma-separated search strings.

- “Similarity”

Determines the accuracy of the match between “Exact” and “Fuzzy”. This setting can be used to allow a tolerance respecting different spelling variants or typing errors.

- “Results”

Contains a list of component descriptions, which contain the provided search strings. This list is ordered with respect to the accuracy of the match. By double-clicking onto a line in the list the dialog box is closed and the related component is inserted in the circuit diagram. The selection marker in the list can be moved by simply clicking the mouse, but also by using the arrow keys. Note that the selection marker does not follow the scroll bars.

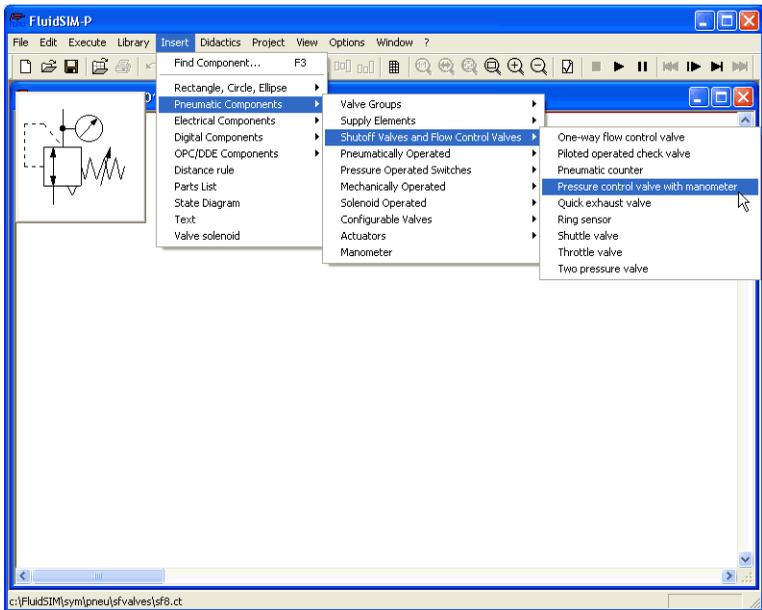
- “Preview”

If the “preview” option is enabled, the component symbol of the selected entry is shown below the list.

Recall that a component can also be searched by navigating along the hierarchical menu structure.

## 6. Special Functions

- Open a new diagram window and navigate through the menu hierarchy until you have reached the component “pressure control valve with manometer”. Observe the preview window in the left corner while navigating.



- After a symbol has been chosen, it is inserted in the current diagram and gets selected. It then can be moved and connected as usual.

### 6.11 Managing Projects

FluidSIM allows of including various settings and files in a project file with a unique name, thereby facilitating project management. When opening a project, the previously saved project settings are used as default. The project menu realizes a quick access of all files that belong to a particular project.

#### Creating a New Project

Before a new project is created some preparatory actions to facilitate project management and to save several process steps at a later stage must be undertaken.

→ Open all files to be added to the new project. This may include, for example, preview windows for often used symbols, libraries as well as circuit files.

All files that are open when creating a new project will be automatically added to the project.

→ Select **Project New...** and enter a file name for the new project.

Project files have the extension `prj` and should, for best results, reside in the same `ct` subdirectory as the circuit files of the project.

After having entered the file name in the dialog box, the system creates the project file with all open files.

→ Close all windows which you don't need right now, and arrange the remaining windows according to your preferences.

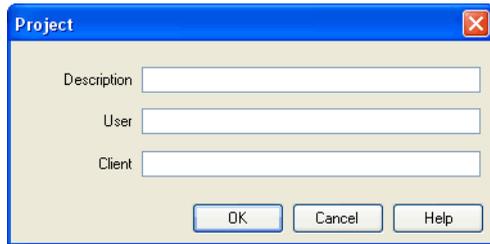
Any closed windows that belong to the project can be opened at any time by clicking **Files** or **Overviews** in the project menu.

→ Save the settings and the window arrangement as default for this project by clicking **Options Save Settings Now**.

## 6. Special Functions

### Entering Project Properties

To enter project data, select **Properties...** from the **Project** menu. The text entered in the **description** field will be displayed in the status line of the main window while the project is open.



### Adding Files to a Project

To add a new symbol, a library, or a circuit file to a project, open or activate the appropriate window, then click **Add Current Window** in the **Project** menu. Depending on whether the window is a circuit file or a preview window, it is automatically added to **Files**, **Overviews**, and **Presentations** respectively.

### Removing Files from a Project

To remove a symbol, a library, or a circuit file from a project, open or activate the appropriate window. Then click **Delete Current Window** in the **Project** menu.

### Opening Project Files

To open the files and previews (overviews) of a project, go to the **Project** menu and click **Files**, **Overviews**, or **Presentations**, whatever is appropriate. Alternatively, you may open the files by selecting **Open...** from the file menu or by selecting them from the list of files that were last opened, by selecting them from **preview windows**, or by using "Drag-and-Drop" in the Windows Explorer.

### 6.12 Saving Settings

FluidSIM distinguishes between three types of settings: global settings, circuit diagram specific settings, and window specific settings. Although most of these settings have already been in discussed in preceding sections, this section comprises the possible settings from FluidSIM and their relationship to one another.

#### Global Settings

The global settings are found under the **Options** and the **View** menu and belong to the following groups.

Global settings for various display features:

1. **View Large Mouse Cursor**  
Activates or deactivates the large mouse cursor.
2. **View Toolbar**  
Displays or hides the toolbar.
3. **View Status Bar**  
Displays or hides the status bar.

Global settings in the dialog boxes:

1. **Options Simulation...**
2. **Options Sound...**
3. **Options Didactics...**
4. **Options Grid...**

Other global settings:

1. **Options Protect Text Components**  
Switches the protection for the text components on or off.
2. **Options Create Backup Files**  
Enables or disables the automatic creation of a backup file for circuit diagrams. Backup files have the file name extension bak. The backup files are created when the circuit diagram is saved and are updated each time the circuit diagram is saved.
3. **Options Default Directory on Network**

Defines the default directory for circuit diagrams and presentation files. If this option is enabled the default directory for the mentioned files is on the network file server. Otherwise, the default directory is on the local PC. This menu entry is available only in the network version.

4. [Options](#) [Save Settings on Exit](#)  
Determines whether the global settings and the circuit diagram specific settings of each open circuit diagram should be saved before exiting FluidSIM.

All global settings can be saved with [Options](#) [Save Settings Now](#).



By clicking on [Save Settings Now](#) under the [Options](#) menu, the circuit diagram specific settings of the current circuit will also be saved. These settings then become the default for all new circuit diagrams that are created. The following settings belong in the circuit diagram specific category: display of quantity values, the flow direction indicator, and the background grid (see next section).

### Circuit Diagram-Specific Settings

The following belong to the circuit diagram specific settings:

1. [View](#) [Quantity Values...](#)
2. [View](#) [Display Flow Direction](#)
3. [View](#) [Display Grid](#)

These settings can be adjusted for each open circuit diagram individually, although they cannot be saved as such. Instead, the user has a way to define a default setting for the creation of new circuit diagrams: By clicking on [Save Settings Now](#) under [Options](#), the display settings of the current circuit diagram are saved as the default. These default settings apply to the display of quantities, the flow direction indicator, and the background grid of each newly opened circuit diagram.

The term “current circuit” refers to the selected circuit diagram window. A selected window will always be fully visible and its title bar will be highlighted.

## 6. Special Functions

### Window-Specific Settings

The following settings are window specific:

1. zoom factor
2. window size
3. window position

Window-specific settings can be saved by clicking on [Save Settings Now](#) under the [Options](#) menu.

## 7. GRAFCET

This chapter provides an introduction to creating and simulating GRAFCET plans with FluidSIM. See norm DIN EN 60848 for the complete specification of the GRAFCET description language. Festo Didactic provides a range of training documentation for more detailed introductions to GRAFCET.

Unlike an SPS programming language, such as Sequential Function Chart (SFC), GRAFCET is a graphic description language that describes the logical behaviour and operation of a control system or a process - regardless of the technical software and hardware implementation. FluidSIM can be used to both create and simulate GRAFCET plans. The term GRAFCET is also used as a synonym for a GRAFCET plan. It should be obvious from the context whether the word GRAFCET refers to the plan or the language.

A GRAFCET essentially describes two aspects of a control system, according to specified rules: the actions (commands) to be carried out and the sequence of execution. The elementary components of a GRAFCET are steps, actions and transitions and can be used in the same way as pneumatic or electrical components. To achieve a uniform operating concept, the GRAFCET elements feature connections that can be used to link them to each other (as with all other FluidSIM components).

**7.1**  
**Steps**

Steps are either active or inactive and can be linked by actions. The actions of active steps are executed. The sequence of a GRAFCET is described by the transitions from a previous to a subsequent step. Steps and transitions have to alternate in the plan.

The creation and simulation of GRAFCETS in FluidSIM is illustrated in the following using simple examples.

.....> Drag a step into a newly created circuit diagram.



Each step has to be assigned a name. If a step is to be active at the start of the sequence control, it is marked as the initial step.

.....> Open the step's dialogue box by double-clicking on it or via the menu (**Edit Properties...**), enter "1" as the name and select the type "initial step".



.....> Start simulation with  or via the menu (**Execute Start**).

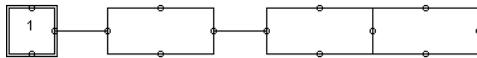


Active steps are marked with a point. Additionally, active steps are framed in green.

## 7.2

**Actions**

To execute commands, you can link any number of actions to a step. Actions do not have to be directly linked to a step; you can also link them to each other. To make it easier to create the drawing, it is enough to place actions next to each other, without having to draw connecting lines. If the connections for the elements overlap each other, they are automatically connected.



Actions can be defined by a textual description or by setting (or changing) variable values. If you want to simulate a GRAFCET with FluidSIM, the variable values are taken into account in the simulation. When displaying a GRAFCET graphically, you can decide whether the variable name or the descriptive text is shown in an action. If you want to display the description, you can set the checkmark next to “Display description instead of formula” in the action’s properties dialogue (see example: `Grafcet/Grafcet18.ct`). At [View GRAFCET...](#), you can specify whether the descriptions are displayed instead of the formulae for all GRAFCET components.

There are two types of action: continuously effective and stored effective actions. For a continuously effective action, its associated variable is set to the Boolean value (logical value) “TRUE” (1), provided that the step connected to the action is active. If the step is inactive, the value is set to “FALSE” (0). This way of setting a variable is referred to as “assignment” in the GRAFCET specifications.

For a stored effective action, the set value of the variable remains unchanged until it is changed by another action. This way of setting a variable is referred to as “allocation” in the GRAFCET specifications.

At the start of a sequence, all the variable values are initialised with “0”.

## 7. GRAFCET

- Create the following GRAFCET. Select the action “Simple action” in the properties dialogue and enter “A” under “Variable/output”. Then start the simulation.



Step “1” is active and the action connected to the step is executed. Variable “A” is set to “1”. The value of an action variable is shown during simulation in brackets after the variable’s name.

### 7.3 Transitions

Transitions are used to describe the sequence of a control system. To do this, add the following information to GRAFCET:

- Select “2” as the name of the second (simple) step. The transition conditions that specify when the system moves from one step to the next are still missing. A transition is considered released once all the immediately preceding steps are active. A transition is triggered once it has been released and its condition has the value “1”. A transition with the value “1” is displayed in green in FluidSIM. You can show a descriptive text instead of the formula, as with the actions.

A Boolean value is automatically generated for each step. The name begins with an “X”, followed by the name of the step. In the example here, the variables “X1” and “X2” are generated. The value of a step variable is “1” if the step is active; otherwise it is “0”.

Transition conditions can be time-dependent. These have the following form:

$t_1 \text{ s} / \text{“term”} / t_2 \text{ s}$

Where  $t_1$  and  $t_2$  have to be replaced by numbers and “term” by a Boolean term.

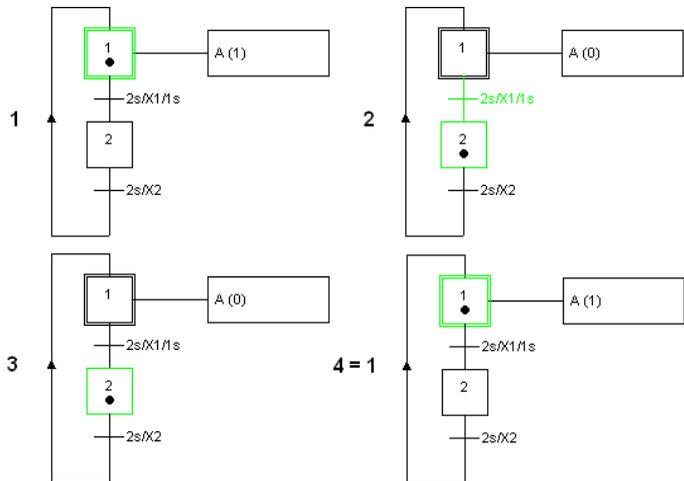
## 7. GRAFCET

The transition condition becomes true (“1”)  $t_1$  seconds after “term” has changed its value from “0” to “1”. This is called a “rising edge”. The transition condition becomes false again (“0”)  $t_2$  seconds after “term” has changed its value from “1” to “0”. This is called a “falling edge”.

The short form  $t_1 \text{ s} / \text{“term”}$  is also allowed. The system then assumes that  $t_2$  is 0 seconds.

→ Enter the transition conditions into the transitions’ properties dialogue as shown and then start the simulation.

The following cycle runs through:

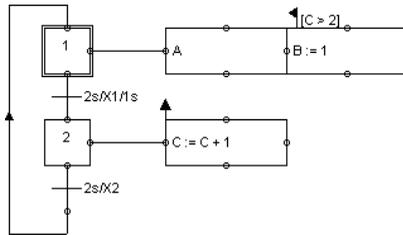


**7.4  
Stored effective actions  
(allocations)**

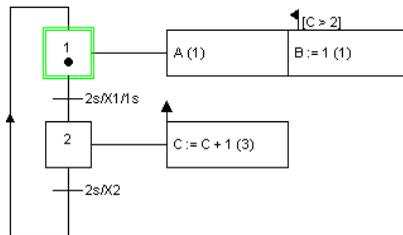
In the next example, a counter is to be implemented. This works using a stored effective action (allocation) and an action on an event.

To do this, add the following information to GRAFCET:

→ Select “Action on activation” for the action of the second step, “C” as the variable and “C + 1” as the allocation. “C” will work as a counter. For the second action of the first step, select “Action on event”, “B” as the variable with the allocation. “1” and “[C > 2]” as the condition/event. Then start the simulation.



Each time step “2” is activated, “C” is raised by one. As soon as “C” has the value “3” and step “1” is activated, “B” receives value “1”.

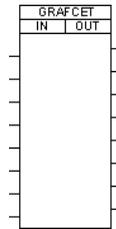


### 7.5 Linking GRAFCET with electrics



The GRAFCET I/O component is used to link the GRAFCET variables with the electrical part of FluidSIM.

The access to labels associated with FluidSIM components is explained in section 7.6.10.

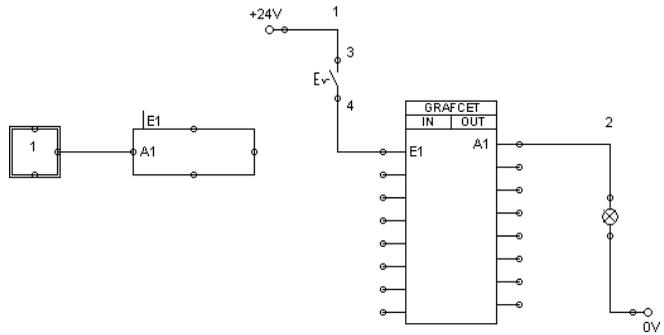


In the GRAFCET I/O component, you can specify GRAFCET variables to be used as inputs or outputs. The actions' variables serve as outputs. The inputs can be the conditions of actions and transitions.

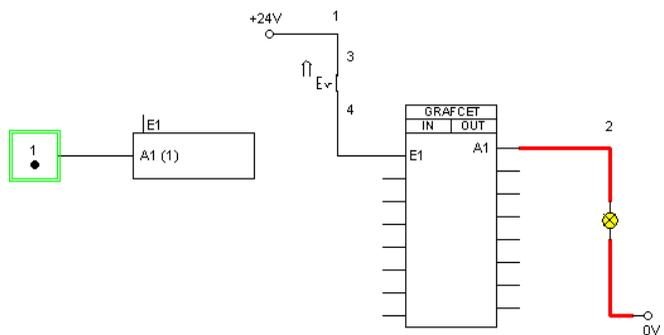
If a potential is created as the input of the GRAFCET I/O component, the corresponding variable is set to “1”. If an output variable has a value other than “0”, an electric potential (24V) is present at the corresponding output of the GRAFCET I/O component.

## 7. GRAFCET

The following simple example illustrates the use of the GRAFCET I/O component.

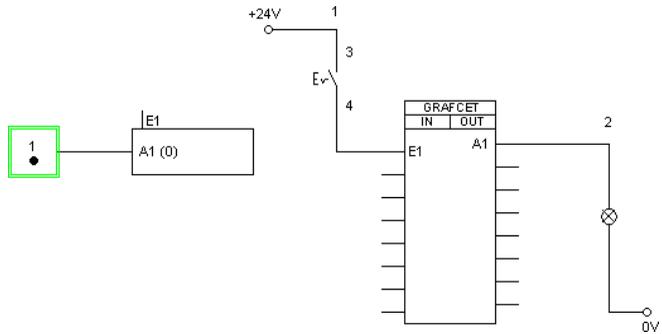


In the GRAFCET I/O component's properties dialogue, "E1" is specified as the input and "A1" as the output. As soon as the electrical switch is closed, there is a potential at the input of "E1"; this potential causes the GRAFCET variable "E1" to change its value from "0" to "1". As a consequence of this, the condition in the action becomes true ("1") and the value of variable "A1" is set to "1". This in turn leads to a potential being created at the output of "A1" and the indicator light lights up.



## 7. GRAFCET

As soon as the switch is opened again, the following situation arises:



### 7.6

#### Quick reference for the FluidSIM-relevant GRAFCET concepts

##### 7.6.1

Initialization

##### 7.6.2

Sequence rules

The next sections introduce all GRAFCET concepts that are related to FluidSIM.

All the variables in a GRAFCET are preset with the value "0" at the start of the simulation.

- A transition is considered released once all the immediately preceding steps are active. A transition is triggered once it has been released and its condition has the value "1". A transition with the value "1" is shown in green in FluidSIM, regardless of whether the step linked to it is active or inactive.
- The relevant transition is triggered at the same time and does not take any time.
- Since triggering a transition does not take any time, a step can be activated and deactivated at the same time (even across various intermediate steps). An active step remains active in this situation. A loop of steps is only run through once at one point in time (see example: Grafcet/Grafcet06.ct).

## 7. GRAFCET

### 7.6.3 Sequence selection

A step can branch off into various partial sequences. In the GRAFCET specifications, these partial sequences have to be exclusive. Since this can generally only be checked during the sequence, this exclusivity is not required in FluidSIM (see example: *Grafcet/Grafcet07.ct*).

### 7.6.4 Synchronization

The GRAFCET synchronization component can be used to implement synchronizations (see example: *Grafcet/Grafcet08.ct*).

### 7.6.5 Transient sequence / unstable step

As described in 7.6.2, triggering a transition does not take any time. As a consequence of this, multiple consecutive steps can be activated at the same point in time one after the other. This sequence is called transient (continuous).

The intermediate steps in the sequence chain are referred to as unstable. The continuously effective actions connected to them are not displayed in the simulation. The allocations in the stored effective actions are carried out. Triggering the intermediate steps and their associated transitions is called virtual triggering (see example: *Grafcet/Grafcet06.ct*).

### 7.6.6 Determining the values of GRAFCET variables

Variables of continuously effective actions (allocations) receive the value “1” if the corresponding action is linked to an active step and any action condition present has the value “1”.

Variables of stored effective actions (assignment) are changed if the corresponding action is linked to an active step and the relevant action event occurs (e.g. action on event or on activation).

FluidSIM does not check whether the two types of variable identification contradict each other for a variable. If this case occurs, the variable value is determined by an internal calculation, which the user cannot predict (see example: *Grafcet/Grafcet09.ct*).

## 7. GRAFCET

### 7.6.7 Checking the entries

FluidSIM checks the validity of entries for conditions and assignments. If this kind of term does not match the specifications, the term in question is displayed in red. The simulation is only released once all the terms are valid.

### 7.6.8 Admissible characters for steps and variables

Only the following characters may be used for steps and variables:

- Numbers from “0” to “9”
- Lower-case letters from “a” to “z”
- Upper-case letters from “A” to “Z”
- The underscore “\_”

There are no limitations for the descriptions that can be shown for conditions and actions, because these are only displayed and are not used for simulation.



Labels of fluidic or electrical components that are intended to be used from GRAFCETs (see 7.6.10) are allowed to contain only the characters mentioned above.

### 7.6.9 Variable names

There are four different types of variables. All variables can be used in conditions and assignments.

- “Action variables”

Action variables are available throughout GRAFCET and can be set in actions (see example: `Grafcet/Grafcet10.ct`).

- “Step variables”

Step variables are inserted automatically for each step and have the value “1” when and only when the corresponding step is active. Step variables have the form  $X + \text{“step name”}$ . If, for example, the step name is “12”, then the associated variable is “X12”.

Step names are only ever valid within a partial GRAFCET or within the global GRAFCET. This means that the same step name can be used in different partial GRAFCETs. In order to be able to address step variables across partial GRAFCETs in FluidSIM, the step variable has to be preceded by the partial GRAFCET name.

Example:

Partial GRAFCET “1” contains step “2” and is meant to be addressed in the global GRAFCET. Within the global GRAFCET, the step variable name “G1.X2” has to be used. Within partial GRAFCET “1”, “X2” is enough (see example: `Grafcet/Grafcet11.ct`).

Variables of macro-steps have the form  $XM + \text{“step name”}$ , macro inputs have  $XE + \text{“step name”}$  and macro outputs have  $XS + \text{“step name”}$  (see example: `Grafcet/Grafcet15.ct`).

- “Partial GRAFCET variables”

Partial GRAFCET variables are automatically inserted for each partial GRAFCET and have the value “1” when and only when at least one step in the corresponding partial GRAFCET is active. Partial GRAFCET variables have the form  $XG + \text{“partial GRAFCET name”}$ . If, for example, the partial GRAFCET name is “1”, the associated variable is “XG1” (see example: `Grafcet/Grafcet12.ct`).

## 7. GRAFCET

- “Labels of fluidic or electrical components”

These labels can be used as GRAFCET input variables (see 7.6.10).

### 7.6.10

Access to labels of fluidic and electrical components

GRAFCET-I/O components are the standard means to access electrical components in FluidSIM. In addition, certain labels of a circuit can be used as Boolean input variables in GRAFCET directly, without using a GRAFCET-I/O component (see example `Grafcet/TP201_09gc2.ct`). Such a direct access pertains to labels of the following components:

- Distance rule
- Semi-rotary actuator
- Pressure switch
- Manually actuated switch
- Relay
- Valve solenoid

### 7.6.11

Functions and formula entry

A range of functions can be used in conditions and assignments. These functions are displayed according to the GRAFCET specifications (e.g. upwards arrow for rising edge). Entering GRAFCET-specific functions is supported by the buttons in the dialogues with the relevant labels:

- “+” (logical OR)
- “\*” (logical AND)
- “NOT” (logical NOT)
- “RE” (rising edge)
- “FE” (falling edge)
- “s / / s” (delay)
- “s / ” (delay, short form)
- “NOT(s / )” (time limit)

If the functions “NOT”, “RE” or “FE” refer to a term, the term has to be placed in brackets.

Examples:

## 7. GRAFCET

NOT a

NOT (a + b)

RE X1

RE (X1 \* X2)

The following additional mathematical functions are available:

- abs (absolute amount)
- sign (algebraic sign: +1, 0, -2)
- max (maximum of two numbers)
- min (minimum of two numbers)
- ^ (to the power of, e.g.  $a^3$ )
- sqrt (square root)
- exp (to the power of constant "e")
- log (natural logarithm)
- sin (sine)
- cos (cosine)

### 7.6.12

Delays / time limits

Delays have the following form (see example: `Grafcet/Grafcet03.ct`):

"Time in seconds" s / "Boolean term" / "time in seconds"

or

"Time in seconds" s / "Boolean term"

Examples:

1 s / X1 / 2s

3s/X3

## 7. GRAFCET

Time limits have the following form:

NOT (“time in seconds” s / “Boolean term”)

Example:

NOT(6s/X28)

### 7.6.13 Boolean value of an assertion

In GRAFCET, you can use Boolean values to calculate an assertion, for example: a counter “C” should be larger than 6 and step “X1” should be activated. “C” is larger than “6” can be calculated as with a variable. To do this, the assertion has to be set in square brackets. So in this example:

[C > 6 ] \* X1

If a Boolean assertion is positioned on its own in a condition, then you can omit the square brackets in FluidSIM, for example C > 6 instead of [C > 6]. (See example: *Grafcet/Grafcet13.ct*)

### 7.6.14 Target information

If you want to interrupt an operative connection from a transition to a step, you can enter the name of the target step in the transition's properties dialogue (see example: *Grafcet/Grafcet14.ct*).

### 7.6.15 Partial GRAFCETs

Partial GRAFCETs can be used to separate a GRAFCET into different hierarchy levels. This function is most often used for enclosing steps and compulsory commands. The name of a partial GRAFCET is always preceded by a “G”.

## 7. GRAFCET

In order to determine partial GRAFCETs in FluidSIM, the partial GRAFCET frame has to be placed over the relevant GRAFCET part and you have to assign a name in the properties dialogue. The preceding “G” is not part of the name that you have to enter; it is added automatically by FluidSIM and shown at the bottom left of the partial GRAFCET frame. You can alter the size of the partial GRAFCET frame by dragging its edges with the mouse (see example: *Grafcet/Grafcet11.ct*). It is important that all the elements of the partial GRAFCET are located entirely within the relevant frame and that there are no “foreign” elements overlapping the frame.

### 7.6.16

#### Macro-steps

Macro-steps can be specified using a step’s properties dialogue. The preceding “M” is not a part of the name that you have to enter; it is added automatically by FluidSIM. You can specify macro inputs and macro outputs in the same way. The preceding “E” and “S” in these cases are not part of the name either and are automatically added by FluidSIM (see example: *Grafcet/Grafcet15.ct*).

### 7.6.17

#### Compulsory commands

Compulsory commands can be used to control partial GRAFCETs regardless of their normal sequence. There is an entry mask to help you enter these commands in FluidSIM. There are four types of compulsory command. They are shown here using four examples (see example: *Grafcet/Grafcet16.ct*).

- “G12 {8, 9, 11}”

Setting a specific situation. This example activates steps 8, 9 and 11 of partial GRAFCET 12.

- “G12 {\*}”

Freezing a partial GRAFCET. In this example, the current situation for partial GRAFCET 12 is maintained as it is. No further transitions are triggered.

## 7. GRAFCET

- “G12 {}”

Setting a blank situation. All steps in partial GRAFCET 12 are deactivated in this example.

- “G12 {INIT}”

Setting the initial situation. In this example, the steps in partial GRAFCET 12 that are marked as initial steps are activated.

### 7.6.18 Enclosing step

Enclosing steps can be specified using a step's properties dialogue. You can either enter the enclosed partial GRAFCETs directly or select them from a list. You have to separate individual partial GRAFCETs with a comma or a blank space.

During simulation, the name of the enclosing step is shown at the top left of the partial GRAFCET frame, as soon as the step is activated (see example: `Grafcet/Grafcet17.ct`).

You have to set the “Activation link” field in the properties dialogue for steps within the enclosed partial GRAFCET that you wish to activate when the enclosing step is activated.

### 7.6.19 Action when a transition is triggered

FluidSIM does not support the execution of an action when a transition is triggered.

# 8. Help and Advanced Tips

This chapter serves as the first place to find help, when dealing with questions that come from working with FluidSIM. The second section of this chapter provides background information for advanced users.

## 8.1 The Most Frequently Occurring Problems

 When attempting to perform certain actions, you are prompted to insert the FluidSIM CD.

FluidSIM cannot find certain installation directories on the hard disk. Probably not all of the software components were loaded at the time of installation. Either insert the CD or reinstall the missing software components.

 Component cannot be moved or deleted.

Make sure that you are in the Edit Mode (); components can only be moved or deleted in the Edit Mode.

 Components cannot be dragged onto the drawing area.

Make sure that you are in the Edit Mode.

 Components cannot be moved or deleted in the Edit Mode.

Make sure that you have selected a component and not a *component connection*.

 A line cannot be drawn between two connections.

Make sure to check the following points:

1. FluidSIM is in the Edit Mode.
2. No other connections are selected.
3. Both connections do not have a blind plug.
4. Both connections are of the same type.

 The parameters of a component cannot be changed.

Make sure that FluidSIM is in the Edit Mode or that the simulation has been paused ().

 The hard disk is running non-stop and the simulation is going slowly.

There is not enough memory available. A workaround is to quit other running applications or to quit Microsoft Windows® and restart the computer.

 Already drawn lines, which are reported to be superimposed, cannot be found.

Press the  key immediately after accepting the message; then draw a new line.

 FluidSIM does not behave normally.

Exit both FluidSIM and Microsoft Windows®, and then restart Microsoft Windows® and FluidSIM.

 Components cannot be marked.

Please ensure that the option  is not activated and that the edit mode for the applicable drawing layer is activated.

 Certain editing functions are not available in the context menu.

The context menu contains a practical subset of possible editing functions. Probably the operation that you would like to utilize applies only to one component at a time; if this is the case check to see that only one component is selected.

- ❓ There is no pressure drop in the circuit, although a T-connection is apparently open.

T-connections are considered to be different from other connections: As an aid in drawing, they must not be provided with blind plugs because they are automatically closed if no line is connected.

- ❓ The simulation time runs irregularly, although the slow-motion factor has been set to 1:1, and “Keep real-time” has been activated.

Both a complex circuit diagram and a slow computer could be reasons for the inability of FluidSIM to guarantee adherence to real-time.

- ❓ At certain connections arrows for the flow direction are not displayed. The option [Display Flow Direction](#) has been activated.

The arrows only appear when a connection actual has a flow passing through it. This situation is not to be confused with a high pressure at a connection.

- ❓ The animation is not repeated, although the “Loop” option has been activated.

The “Loop” option only applies to an animation that is not contained in part of a presentation.

- ❓ FluidSIM is not behaving as expected, and you have already exited Microsoft Windows® and started FluidSIM new again many times.

Please uninstall FluidSIM and run a new installation.

- ❓ [Paste](#) is not available from the menu, although a [Copy](#) operation has already taken place.

Only selected objects can be copied to the clipboard. If no objects are selected, only the picture will be copied to the clipboard.

 No educational film will start playing.

Video playback requires appropriate hardware and software. Furthermore, FluidSIM needs to access the movie files. To ensure this, the FluidSIM-CD-ROM needs to be present in the drive or the video files need to have been copied to the hard disk during the installation.

 The student version of FluidSIM is being loaded each time you start, although you have purchased the full version.

The FluidSIM CD contains both the student version and the full version of FluidSIM. During the installation procedure you are asked whether the full version or the student version shall be installed.

 The mouse cursor is not switching as described, especially on top of connections.

Make sure that the option [Large Mouse Cursor](#) has not been activated. The large mouse cursor is designed to be used with a projector; here the switching of the mouse cursor is undesirable.

 [DXF Export...](#) is not available from the menu.

Make sure that you are in the Edit Mode and that the window is not empty.

 The text that was exported using the DXF filter does not appear as it did in FluidSIM.

The DXF format does not sufficiently support textual objects. I.e., CAD programs may not possess the ability to translate all fonts, font attributes, font colors, and special symbols.

### 8.2 Tips for the Advanced User

#### Data Formats of the Clipboard

This section contains some technical information about different concepts in FluidSIM.

When information from a FluidSIM window is copied to the clipboard, both a meta file and a bitmap are generated. When pasting into another application (a word processing program or a drawing program), the program automatically finds the format that will contain the most information. However, it could be intended to insert a circuit diagram, for example into Microsoft Word®, as a bitmap as opposed to the meta file representation. In this case you simply paste the contents of the clipboard into bitmap editor such as Paintbrush, and then recopy it back to the clipboard. Following this action, Microsoft Word® then will find the bitmap when pasting from the clipboard.

#### Media Playback

Provided the video files have been copied to the hard disk during the installation, they will be played within the FluidSIM window. Launching playback of the FluidSIM-educational films manually from the video-CD will open the “Media Player”. Further hints are described in the Microsoft Windows® Help under the media playback topic.

#### Opening FluidSIM files via the Explorer

Normally, to open a file from within FluidSIM, you would click on [Open...](#) under the [File](#) menu. It is also possible to open files via the Explorer. There are two possible ways to go about doing this:

1. You can connect files with FluidSIM that have the same extension, for example `.ct`. By double clicking on a file with this extension, it will be opened by FluidSIM. If FluidSIM is not running at this time, it will be started by the File Manager.
2. Select the files that are to be opened in the usual way in the Explorer. Here the window of the Explorer with the selected files should either appear next to an open FluidSIM window or next to the FluidSIM program icon on the desktop. You can open the files by dragging them over FluidSIM.

## 8. Help and Advanced Tips

### Opening FluidSIM Files by Command Line Entry

Besides the possibilities listed above for opening FluidSIM files, you can also open files by entering an appropriate command line. Once in the Start menu, click on **Run...** and enter the file name after the program name.

### Reorganization of the Internal Memory

While working with FluidSIM, particular information is cached in the memory for performance purposes. In some cases it is desirable to free up memory or to force a window refresh. By pressing the **ESC** key, FluidSIM reorganizes its memory, removes the cached data, rebuilds the internal data structures, and refreshes all windows. If the topmost window is a circuit diagram preview window, the contents of the corresponding directory will also be read as new.

### Changing the Sound Files

Provided your computer has an audio-interface capable of playing back audio, sounds will optionally play while actuating relays, switches, valves and while activating the buzzer. You may use your own sound files instead of the preset ones by replacing the sound files in the `snd`-folder. The sound for switch/pushbutton and for relays is `switch.wav`, the sound for valves is `valve.wav`, the buzzer activates the sound `horn.wav` and the cylinder end position stop triggers `cylinder.wav`.

### File Operations via Preview Windows

Aside from opening circuit diagrams by double clicking on a circuit's miniature representation, a preview window does also provide some File Manager functionality. Analogous to the Edit Mode for objects in a circuit diagram, the miniaturized circuit diagrams can be selected, deleted, copied between overview windows (or moved by holding down the **Shift** key), copied to the clipboard, or dragged into the a circuit diagram window.



Please remember, that delete operations and move operations take place on the file system. Therefore, if a miniaturized circuit diagram is deleted, its related file will also be deleted in the file system.

### Creating Presentation Files

This section describes how presentations can be created using a common text editor: more specifically, not using FluidSIM.

The file names of presentation files have the extension `.shw`. A `shw` file has the following structure:

The first line shows the description of the presentation which will also be represented in the selection box. In the following lines, in the applicable order, you will find file names with respect to the installation path. User files will simply be represented by their absolute path.

The shw-file of the presentation `basics of pneumatics` will be as follows:

```
01 Basics of Pneumatics
\didac\p3_1_1_1.ct
\didac\p3_1_1_2.ct
\didac\p3_1_1_3.ct
\didac\p3_1_1_4.ct
\didac\p3_1_1_5.ct
\didac\p3_1_1_6.ct
```

### Network Installation of FluidSIM

If several PCs are running in a network, a complete installation of FluidSIM must only be performed once, on the network file system. Then on the local PCs merely the license information and a few configuration files are required. This concept serves several purposes: the saving of disk space on the local hard disks, the simplification of software maintenance, the quick distribution of circuit diagrams, or the installation of new releases of FluidSIM.

The installation of the network version happens within the following steps:

- Perform a standard installation of FluidSIM on the network file system. Note that the local PCs must be authorized to read the FluidSIM files on the network file system.
- Use the network option when installing FluidSIM on the other local PCs by calling the installation program as follows: `setup.exe -N`



During a local installation, the installation program asks for the network path of the FluidSIM `bin`-directory. Thus FluidSIM must have been installed on the network file system *before* any local installation can be performed.

User-specifically, FluidSIM stores user files and settings in those file locations that are defined by the operation system. In the case of a standard-Microsoft Windows®-installation these are `MyDocuments` and `ApplicationData` of the particular user account.

An aside: The PC used during the FluidSIM standard installation on the network file system also reads and writes the FluidSIM configuration files on the network. Moreover, a FluidSIM de-installation from this PC will delete the FluidSIM program files, and, consequently, FluidSIM is no longer available on the network.



If local PCs are not equipped with a CD-ROM drive, and if these PCs have no access to a CD-ROM drive of some other PC, the educational films may also be played from the network file system: If sufficient disk space is left on the network file system, the movie files can be copied to the installation folder during the setup procedure.

# A. FluidSIM Menus

This chapter contains a complete listing of the menus in FluidSIM and can be utilized as a quick-reference guide. The term “current circuit” refers to the selected circuit diagram window. A selected window will always be fully visible and its title bar will be highlighted.

## A.1 File

**New** Ctrl +N 

Opens a new window to create a circuit diagram. The default name for the new circuit diagram is `noname.ct`. If a circuit with this name already exists, a number is appended to the title `noname` to create a unique file name.

**Open...** Ctrl +O 

Opens the File Selector dialog box, which allows you to select and open a circuit diagram.

**Close** Ctrl +W

Closes the active window. Provided the window content has not been saved, a corresponding request will be prompted.

**Save** Ctrl +S 

Saves the current circuit diagram. The circuit diagram window remains open.

**Save As...**

Opens the File Selector dialog box, and you can save the current circuit under a different name. This name appears in the title bar of the circuit diagram window and becomes the new name for the circuit.

Circuit Preview Ctrl+U 

Opens the circuit diagram preview windows. Double clicking on a miniature circuit diagram will load the circuit. Circuit diagrams can be selected and deleted in the preview window. When saving circuit diagrams, the preview window is automatically updated.

In the `fluidsim` directory, subdirectories can be created for the saving of circuit diagrams. FluidSIM recognizes all circuit diagram directories and generates appropriate circuit diagram preview windows.

TIFF Export...

The file selection box will open; the graphic information of the present circuit can be converted and saved to the TIFF format. If no new name is entered for the TIFF file, it will be saved using the circuit description and the file extension `.tif`.

The TIFF export filter is useful to provide the graphic circuit information as a picture file for the use in other applications.

DXF Export...

Opens the File Selector dialog box, and you can then export the current circuit diagram in the DXF format. If no new name is given for the DXF file, then it is saved under the circuit diagram name with the file extension `.dxf`.

The DXF export filter allows the graphic information from the circuit diagram to be exported to other CAD systems.

Parts list Export...

The file selector box is opened; the contents of the selected parts list is saved as a text file.

When file name has been specified, another dialog box opens where a character can be declared as column separator.

Properties...

Opens a dialog box where the circuit properties can be defined.

Drawing Size...

Opens a dialog box where the paper size can be defined.

Print... Ctrl +P 

Opens the Print Preview dialog box, which allows you to print the current circuit diagram with an optional scaling factor.

Previously Opened Files

Displays a list with the eight previously opened files. When selecting one entry of this list the associated file is opened. The list is sorted: The most recently opened file forms the topmost entry.

Exit Alt+F4

Quits FluidSIM.

### A.2 Edit

Undo Alt+Backspace 

Undoes the last edit step. Up to 128 previous editing steps, which have been stored, can be made undone.

Redo Alt+Shift +Backspace

Withdraws the last action performed by [Edit | Undo](#). The function can be used up until there are no more undo steps to be redone.

Cut Shift +Del 

Cuts the selected components and saves them to the clipboard.

Copy Ctrl +Ins 

Copies the selected components to the clipboard. In this way circuit diagrams and parts of diagrams can be inserted easily as vector graphics, for example into word-processing applications.

Paste Shift +Ins 

Inserts components from the clipboard onto the drawing area of the current circuit diagram.

Delete Del

Deletes the selected components from the circuit diagram.

If a *connection* is selected and deleted, a possibly connected line or fitted blind plug is deleted. However, the component is not deleted.

Select All Ctrl +A

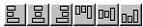
Selects all components and lines of the current circuit diagram.

Group Ctrl +G

Groups the selected objects. Groups can be nested by applying the grouping operation recursively on already existing groups.

Ungroup

Ungroups the selected groups. Each ungroup operation removes only the outermost group when applied to a selection that contains nested groups.

Align 

Aligns the selected objects.

Rotate

Rotates the marked components by 90°, 180° or 270°.

If only one component is to be rotated (counterclockwise), this action is accomplished by holding down the Ctrl key and double clicking on the component. If additionally the Shift key is held down, rotation happens in a clockwise fashion.

Mirror 

Mirrors the marked components horizontally or vertically.

Properties...

Opens a dialog box that contains the parameters for a single, selected component. This dialog box will also contain an input field for a label name, as long as a label can be assigned to the component.

If a *fluidic line* is selected, a dialog box will appear in which you can change the line type from the standard line type, “Main Line”, to the special line type “Control Line”. Note that—aside from a different appearance—changing line type has no impact respecting simulation. If a *fluidic connection* is selected, a dialog box will appear containing input fields for the selected connection. The input fields define which of the quantities are to be displayed and, in the case of a pneumatic connection, if the connection is fitted with a blind plug or a muffler.

### A.3

#### Execute

Check Superficially F6 

Checks the current circuit diagram for mistakes in drawing.

Stop F5 

Switches the current circuit diagram in the Edit Mode.

Start F9 

Starts the simulation or, as the case may be, animation in the current circuit diagram.

Pause F8 

Pauses the current circuit diagram during simulation without leaving the Simulation Mode. The simulation can then be re-animated from this point and continue as if it had not been halted.

If **Pause** is clicked while being in the *Edit Mode*, the circuit diagram switches to the Simulation Mode without starting the simulation. In this manner, the components' states can be set before the simulation is started.

Reset 

Sets an already running or paused simulation back to the initial state. The simulation is immediately restarted.

Single Step 

Stops the simulation after it has run only a little bit. The simulation will run for a short time period and is then paused (). The single step mode can be applied at any time to an already running simulation.

Simulate until State Change 

Starts the simulation until a state change happens; the simulation is then paused (). A state change occurs when a cylinder piston travels a stop, a valve switches, a relay or a switch is actuated. The state change mode can be applied at any time to an already running simulation.

Next Topic 

Switches to the next topic in a presentation.

#### A.4 Library

Hierarchical View

Opens a library window where the FluidSIM components are organized hierarchically, i. e. within a tree.

New...

Opens a dialog box for the creation of a user-defined component library. User-defined component libraries can be rearranged according to the user's will—and, in contrast to the FluidSIM standard libraries, components can be added or deleted from them.

Rename...

Opens a dialog box to rename a user-defined component library.

Delete

Deletes that user-defined component library whose overview window is currently active.

## A.5

### Insert

A hierarchically organized menu from which an object can be selected and inserted in the current circuit diagram.

F3

Opens the dialog for the string-based search of components.

## A.6

### Didactics

Opens the page with the technical description for the selected component. This page contains the DIN symbol of the component, a textual description of the component's function, the connection designations, and a listing of the adjustable parameters including their value ranges.

Opens the Tutorial "Simulating with FluidSIM".

Opens the reference of the component library.

Opens the overview of the didactics material. Provided you've copied the movie files on your hard disk during the installation, the educational film chapters will appear here.

Opens a dialog box that can be utilized to recall available presentations along with creating new presentations. Presentations allow for the combination of individual topics into a lesson, ideal for teaching pneumatics.

## A.7 Project

Educational Film...

Opens a dialog box with educational films related to electro-pneumatics. By double clicking on a topic in the list, the dialog box closes, and the media playback starts playing the selected film.

This menu option only appears if the movie files have not been copied on your hard disk during the installation. Otherwise you will find the educational films in the menu option [Didactics Material](#).

New...

The file selector box is opened, and a new project can be created. Project files get the file extension `prj`.

Open...

The file selector box is opened, and a project can be selected and opened.

Close

The current project is closed and the standard settings are loaded.

Add Current Window

Adds the current window to the list of project files.

Delete Current Window

Removes the current window from the list of project files.

Properties...

Opens a dialog box where the project properties can be defined.

Files

Shows the list of files that belong to the current project.

Overviews

Shows the list of preview windows that belong to the current project.

Presentations

Shows the list of presentations that belong to the current project.

## A.8 View

The functions of the **View** menu are circuit diagram specific, that is, they only apply to the current circuit diagram. Thus it is possible to apply individually different display options to each circuit diagram, which is loaded.

Folder View 

Shows the content of the active **component library** or of the active **circuit diagram overview** using the folder view instead of the tree view.

Sort Symbols Alphabetically 

Sorts the symbols of the current preview window with respect to their description and extension respectively.

Standard Size 

Displays the circuit diagram without enlargement or reduction.

Previous View 

Switches between the last view and the current enlargement of the current circuit diagram.

Fit to Window 

Sets the scale factor so that the entire circuit diagram can be displayed in the window. The proportion between height and width remains unaltered.

Zoom by Rubber Band 

Changes the mouse cursor to a rubber band, allowing a section of a window to be selected and then enlarged.

Zoom In 

Enlarges the diagram at a factor of 1.4 ( $\sqrt{2}$ ). To repeat this action twice means a doubling in the diagram's size.

Zoom Out 

Reduces the diagram at a factor of 1.4 ( $\sqrt{2}$ ). To repeat this action twice means a cutting in half of the diagram's size.

Quantity Values... 

Opens a dialog box for the display of quantities. For each of the quantities “Velocity”, “Pressure”, ..., different types of display options can be defined (“None”, “Particular”, “All”).

GRAF CET... 

Opens a dialog box with settings for the display of formulas and descriptions in GRAFCET components. If the option “Use settings of individual elements” is chosen, all formulas and descriptions are shown as transitions and actions according to the individual component settings, which is defined under “Display description instead of formula”. If the option “Description, if available” is chosen, descriptions are shown in place of their related formulas. If the option “Always show formula” is chosen, formulas are shown even if a description exists as well.

Display Flow Direction 

Turns on or off the arrow as a direction of flow indicator. The arrow for the direction of flow will be shown near the component connection, that is, as long as the flow is other than zero.

Display counter values and delay times T

Displays or hides the current values of components with counting and delay behavior.

Display current path numbering and switching elements table N

Displays or hides the current path numbering and the switching elements table in electrical circuits.

Show Connection Descriptors C

Enables or disables the display of the component's connection descriptors.

Labels...

Opens a dialog box for the label display style. It can be defined whether or not the labels are drawn framed.

Display Grid G

Activates the background grid, according to the set style. The style of the grid can be chosen under [Options](#) [Grid...](#).

Layers...

Opens a dialog box for renaming and activating the FluidSIM drawing layers. For drawing object that cannot be simulated, such as texts, DXF imports, rectangles, circles, state diagrams, or parts lists, up to eight drawing layers are provided. The FluidSIM components that can be simulated live always on the drawing layer number one.

Large Mouse Cursor M

Activates or deactivates the large mouse cursor.

Toolbar

Displays or hides the toolbar.

Status Bar

Displays or hides the status bar.

## A.9 Options

Simulation...

Opens a dialog box with settings for the simulation. Here, parameters such as the maximum recording time, the slow-motion factor, and the priority are defined.

EasyPort/OPC/DDE Connection...

Opens a dialog box with options for the EasyPort/OPC/DDE connection. This is where you may define various options for interconnecting FluidSIM with the EasyPort hardware or with other applications.

Sound...

Opens a dialog box in which the acoustic signal is switched on for the following component types: switch, relay, valve, and buzzer.

Didactics...

Opens a dialog box with settings for the didactics. These settings include factors that apply to animation speed and repeat mode.

Grid...

Opens a dialog box allowing you to activate the background grid and select its style ("Point", "Cross", "Line") and its resolution ("Coarse", "Medium", "Fine").

Terminal Assignment Diagram...

Opens a dialog box where you may define the options for the terminal assignment diagrams.

### Protect Text Components

Enables or disables the protection of text components. Protected text components can neither be marked nor moved or deleted.

### Create Backup Files

Enables or disables the automatic creation of a backup file for circuit diagrams. Backup file names have the extension `bak`. The backup files are created when the circuit diagram is saved and are updated each time the circuit diagram is saved.

### Default Directory on Network

Defines the default directory for circuit diagrams and presentation files. If this option is enabled the default directory for the mentioned files is on the network file server. Otherwise, the default directory is on the local PC. This menu entry is available only in the network version.

### Save Settings Now

Saves the current global and window specific settings. Defines the circuit diagram specific settings of the current circuit diagram as the default settings.

Global settings pertain to the toolbar and the status bar, to the simulation, sound, didactic, and grid options, to the creation of backup files, as well as quitting FluidSIM. Window specific settings pertain to zoom levels, window size, and window position. The quantity display, as well as the flow direction indicator and the background grid are considered circuit diagram specific.

### Save Settings on Exit

Defines as to whether or not the current global and window specific settings should be saved upon quitting FluidSIM.

**A.10**  
**Window**

Cascade Shift +F5

Arranges the circuit diagram windows in an overlapping format.

Tile Horizontally

Arranges the circuit diagram windows next to each other.

Tile Vertically Shift +F4

Arranges the circuit diagram windows below to each other.

Arrange Icons

Arranges the iconified windows on the desktop.

Window list

Opens a dialog box with all currently opened windows. The windows can be activated, minimized or closed by clicking the appropriate buttons.

**A.11**  
**?**

Contents... F1

Opens a help window pertaining to a list of contents from the FluidSIM online help.

How to Use Help

Describes how help can be used.

Addendum to the User Manual

Opens a help window pertaining to the additions to the handbook for FluidSIM. Note that this menu entry must not be available.

Looking up FluidSIM Updates on the Internet...

Connects to an update server to check for available FluidSIM-updates. To use this function you need to be connected to the internet. If an update is available for your software version, you will be prompted and may download the installation file directly. Following the download the update will be launched automatically.

## A. FluidSIM Menus

About FluidSIM...

Opens the Program Information box about FluidSIM. Among others, the FluidSIM serial number (including the number of the license connector, if applicable) looked up.

# B. The Component Library

In FluidSIM each component found in the component library is assigned a physical model. Based on a circuit diagram, FluidSIM takes all relevant separate component models and creates a total model of the system, which is then processed and simulated.

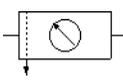
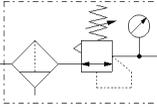
This chapter provides a short description of each of the components in FluidSIM's component library. If a component has adjustable parameters, a value range is been given. A number enclosed in brackets following a value range indicates the default setting for that parameter.

## B.1

### Pneumatic Components

#### Supply Elements

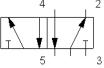
	<p><b>Compressed air supply</b></p> <p>The compressed air supply provides the needed compressed air. It contains a <b>pressure control valve</b> that can be adjusted to output the desired operating pressure.</p> <p>Adjustable parameters:          Operating pressure: 0 ... 2 MPa (0.6 MPa)          Max. flow rate: 0 ... 5000 l/min (1000 l/min)</p>
	<p><b>Compressor</b></p> <p>The compressor provides the necessary compressed air. The pressure is restricted to the preset operating pressure.</p> <p>Adjustable parameters:          Operating pressure: 0 ... 2 MPa (0.6 MPa)          Max. flow rate: 0 ... 5000 l/min (1000 l/min)</p>
	<p><b>Compressor, adjustable</b></p> <p>The adjustable compressor provides the necessary compressed air, whereby the maximum flow rate can be adjusted under actual operating conditions and in the simulation. The pressure is restricted to the preset operating pressure.</p> <p>Adjustable parameters:          Operating pressure: 0 ... 2 MPa (0.6 MPa)          Max. flow rate: 0 ... 5000 l/min (1000 l/min)</p>

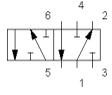
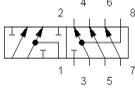
	<p><b>Air service unit, simplified representation</b></p> <p>The service unit is made up of a compressed air filter with water separator and a <b>pressure control valve</b>.</p> <p>Adjustable parameters:          Nominal pressure: 0 ... 2 MPa (0.6 MPa)          Standard nominal flow rate: 0.1 ... 5000 l/min (750 l/min)</p>
	<p><b>Air service unit</b></p> <p>The service unit is made up of a compressed air filter with water separator and a <b>pressure control valve</b>.</p> <p>Adjustable parameters:          Nominal pressure: 0 ... 2 MPa (0.6 MPa)          Standard nominal flow rate: 0.1 ... 5000 l/min (750 l/min)</p>
	<p><b>Air pressure reservoir</b></p> <p>The air pressure reservoir serves as compensation for pressure fluctuations and is utilized (as a reservoir) for abruptly occurring air consumption. Large time delays can be attained when used in conjunction with time delay- und throttle valves.</p> <p>Adjustable parameters:          Volume: 0.001 ... 1000 Liter (1 Liter)</p>
	<p><b>Air pressure reservoir (2 Connections)</b></p> <p>The air pressure reservoir serves as compensation for pressure fluctuations and is utilized (as a reservoir) for abruptly occurring air consumption. Large time delays can be attained when used in conjunction with time delay- und throttle valves.</p> <p>Adjustable parameters:          Volume: 0.001 ... 1000 Liter (1 Liter)</p>
	<p><b>Filter</b></p> <p>The compressed air filter removes contamination from the compressed air. The size of the filterable particles is dependent upon the filter class.</p> <p>Adjustable parameters:          Standard nominal flow rate: 0.1 ... 5000 l/min (1000 l/min)</p>

	<p><b>Filter, manual condensate drain</b></p> <p>The compressed air filter removes contamination from the compressed air. The size of the filterable particles is dependent upon the filter class. Condensation, which can occur through sinking temperatures or the expansion of the compressed air, can be manually drained off.</p> <p>Adjustable parameters: Standard nominal flow rate: 0.1 ... 5000 l/min (1000 l/min)</p>
	<p><b>Filter, automatic condensate drain</b></p> <p>The compressed air filter removes contamination from the compressed air. The size of the filterable particles is dependent upon the filter class. Condensation, which can occur through sinking temperatures or the expansion of the compressed air, is automatically drained off.</p> <p>Adjustable parameters: Standard nominal flow rate: 0.1 ... 5000 l/min (1000 l/min)</p>
	<p><b>Water separator</b></p> <p>The water separator drains off accrued water.</p> <p>Adjustable parameters: Standard nominal flow rate: 0.1 ... 5000 l/min (1000 l/min)</p>
	<p><b>Water separator, automatic condensate drain</b></p> <p>The water separator drains off accrued water and is automatically emptied.</p> <p>Adjustable parameters: Standard nominal flow rate: 0.1 ... 5000 l/min (1000 l/min)</p>
	<p><b>Lubricator</b></p> <p>The lubricator enriches the compressed air with oil.</p> <p>Adjustable parameters: Standard nominal flow rate: 0.1 ... 5000 l/min (1000 l/min)</p>
	<p><b>Cooler</b></p> <p>The cooler cools the compressed air.</p> <p>Adjustable parameters: Standard nominal flow rate: 0.1 ... 5000 l/min (1000 l/min)</p>

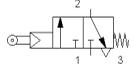
	<p><b>Adsorption dryer</b></p> <p>The adsorption dryer reduces the humidity in the compressed air.</p> <p>Adjustable parameters: Standard nominal flow rate: 0.1 ... 5000 l/min (1000 l/min)</p>
	<p><b>Connection (pneumatic)</b></p> <p>A pneumatic connection is a place where a pneumatic line can be attached to. To simplify the line drawing process, a connection appears as a small circle in Edit Mode. Pneumatic connections can be shut by means of a blind plug. An open pneumatic connection may result in leaking air; FluidSIM Pneumatics thus pops up a warning message, if some pneumatic connection was left open.</p> <p>Note that at each pneumatic connection values for the flow and pressure can be displayed.</p>
	<p><b>Line (pneumatic)</b></p> <p>A pneumatic line links two pneumatic connections. Note that a pneumatic connection may be a simple <b>pneumatic connection</b> or a <b>T-junction</b>. A pneumatic line causes no pressure drop, i. e., it has no fluidic resistance.</p> <p>From a drawing point of view, FluidSIM distinguishes between control lines and main lines. The former is represented by a dashed line, the latter is represented by a solid line and establishes the default case.</p> <p>Adjustable parameters: Line Type: One of {Main Line or Control Line} (Main Line)</p>
	<p><b>T-junction (pneumatic)</b></p> <p>A T-junction joins up to four <b>pneumatic lines</b>, thus having a single pressure potential. Note that T-junctions are introduced automatically by FluidSIM when dropping the line drawing cursor onto another line in Edit Mode.</p>

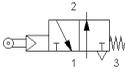
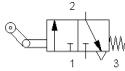
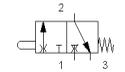
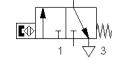
Configurable Way Valves

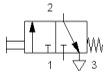
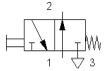
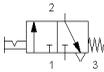
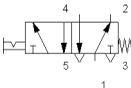
	<p><b>Configurable 2/n way valve</b></p> <p>The configurable 2/n way valve is a way valve with two connections, where both its <b>body elements</b> and its <b>operation modes</b> are user-definable. Additionally, the pneumatic connections can be closed with either <b>blind plugs</b> or <b>exhausts</b>.</p> <p>Adjustable parameters: Standard nominal flow rate: 0.1 ... 5000 l/min (60 l/min)</p>
	<p><b>Configurable 3/n way valve</b></p> <p>The configurable 3/n way valve is a way valve with three connections, where both its <b>body elements</b> and its <b>operation modes</b> are user-definable. Additionally, the pneumatic connections can be closed with either <b>blind plugs</b> or <b>exhausts</b>.</p> <p>Adjustable parameters: Standard nominal flow rate: 0.1 ... 5000 l/min (60 l/min)</p>
	<p><b>Configurable 4/n way valve</b></p> <p>The configurable 4/n way valve is a way valve with four connections, where both its <b>body elements</b> and its <b>operation modes</b> are user-definable. Additionally, the pneumatic connections can be closed with either <b>blind plugs</b> or <b>exhausts</b>.</p> <p>Adjustable parameters: Standard nominal flow rate: 0.1 ... 5000 l/min (60 l/min)</p>
	<p><b>Configurable 5/n way valve</b></p> <p>The configurable 5/n way valve is a way valve with five connections, where both its <b>body elements</b> and its <b>operation modes</b> are user-definable. Additionally, the pneumatic connections can be closed with either <b>blind plugs</b> or <b>exhausts</b>.</p> <p>Adjustable parameters: Standard nominal flow rate: 0.1 ... 5000 l/min (60 l/min)</p>

	<p><b>Configurable 6/n way valve</b></p> <p>The configurable 6/n way valve is a way valve with six connections, where both its <b>body elements</b> and its <b>operation modes</b> are user-definable. Additionally, the pneumatic connections can be closed with either <b>blind plugs</b> or <b>exhausts</b>.</p> <p>Adjustable parameters: Standard nominal flow rate: 0.1 ... 5000 l/min (60 l/min)</p>
	<p><b>Configurable 8/n way valve</b></p> <p>The configurable 8/n way valve is a way valve with eight connections, where both its <b>body elements</b> and its <b>operation modes</b> are user-definable. Additionally, the pneumatic connections can be closed with either <b>blind plugs</b> or <b>exhausts</b>.</p> <p>Adjustable parameters: Standard nominal flow rate: 0.1 ... 5000 l/min (60 l/min)</p>

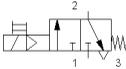
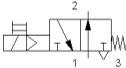
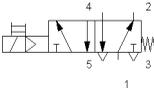
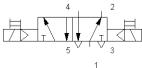
Mechanically Operated Directional Valves

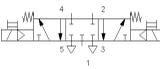
	<p><b>3/2-way roller lever valve, normally closed</b></p> <p>The roller lever valve is operated by pressing on the lever, for example through the use of a <b>switching cam</b> of a cylinder. The flow passes through from 1 to 2. After releasing the lever, the valve returns to its initial position through the use of a return spring. Connection 1 is shut.</p> <p>In the Simulation Mode, the valve can be switched manually by clicking on the component, thus not requiring a cylinder to operate the valve.</p> <p>This valve is derived from a configurable <b>3/n way valve</b>. You find this valve in the component library “Frequently used Way Valves”, under the <b>Library</b> menu.</p>
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	<p><b>3/2-way roller lever valve, normally open</b></p> <p>The roller lever valve is operated by pressing on the lever, for example through the use of a <b>switching cam</b> of a cylinder. Connection 1 is shut. After releasing the lever, the valve returns to its initial position through the use of a return spring. The flow may pass through freely from 1 to 2.</p> <p>In the Simulation Mode, the valve can be switched manually by clicking on the component, thus not requiring a cylinder to operate the valve.</p> <p>This valve is derived from a configurable <b>3/n way valve</b>. You find this valve in the component library “Frequently used Way Valves”, under the <a href="#">Library</a> menu.</p>
	<p><b>3/2-way idle return roller valve, normally closed</b></p> <p>The idle return roller valve is operated when the roller is driven in a specific direction by the <b>switching cam</b> of a cylinder. After releasing the roller, the valve returns to its initial position through the use of a return spring. Connection 1 is shut. When the roller is driven in the opposite direction, the valve is not operated.</p> <p>In the Simulation Mode, the valve can be switched manually by clicking on the component, thus not requiring a cylinder to operate the valve.</p> <p>This valve is derived from a configurable <b>3/n way valve</b>. You find this valve in the component library “Frequently used Way Valves”, under the <a href="#">Library</a> menu.</p> <p>Adjustable parameters:          Operation: One of {Extension, Retraction} (Retraction)</p>
	<p><b>Pressurizing valve</b></p> <p>The pressurizing valve with plunger control is operated by the surface of the <b>cylinder cam</b>. When the plunger is operated, compressed air flows freely until the nozzle is closed. A signal up to the level of the boost pressure is assembled at exit connection 2.</p> <p>In the Simulation Mode, the valve can be switched manually by clicking on the component, thus not requiring a cylinder to operate the valve.</p> <p>Adjustable parameters:          Standard nominal flow rate: 0.1 ... 5000 l/min (16 l/min)</p>
	<p><b>Pneumatic proximity switch, solenoid operated</b></p> <p>A permanent solenoid found on the <b>piston</b> of a cylinder drives this 3/2 pneumatic directional valve and triggers the control signal. The flow passes freely from 1 to 2.</p> <p>In the Simulation Mode, the valve can be switched manually by clicking on the component, thus not requiring a cylinder to operate the valve.</p> <p>This valve is derived from a configurable <b>3/n way valve</b>. You find this valve in the component library “Frequently used Way Valves”, under the <a href="#">Library</a> menu.</p>

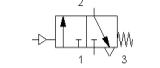
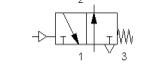
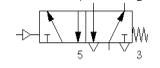
	<p><b>3/2-way valve with pushbutton, normally closed</b></p> <p>Pressing the pushbutton operates the valve. The flow passes freely from 1 to 2. Releasing the pushbutton allows the valve to return to its starting position through the use of a return spring. Connection 1 is shut.</p> <p>By holding down the <b>Shift</b> key and simultaneously clicking on the component with the mouse cursor, FluidSIM keeps the valve in permanent operating position. Simply clicking on the component cancels the operated state and returns the valve to its starting position.</p> <p>This valve is derived from a configurable <b>3/n way valve</b>. You find this valve in the component library “Frequently used Way Valves”, under the <b>Library</b> menu.</p>
	<p><b>3/2-way valve with pushbutton, normally open</b></p> <p>Pressing the pushbutton operates the valve. Connection 1 is shut. Releasing the pushbutton allows the valve to return to its starting position through the use of a return spring. The flow passes freely from 1 to 2.</p> <p>By holding down the <b>Shift</b> key and simultaneously clicking on the component with the mouse cursor, FluidSIM keeps the valve in permanent operating position. Simply clicking on the component cancels the operated state and returns the valve to its starting position.</p> <p>This valve is derived from a configurable <b>3/n way valve</b>. You find this valve in the component library “Frequently used Way Valves”, under the <b>Library</b> menu.</p>
	<p><b>3/2-way valve with selection switch or striking button</b></p> <p>Pressing the red striking button operates the valve. The flow passes freely from 1 to 2. Releasing the button has no effect; the valve remains in its operating position. Turning the button to the right sets the striking button back to its original position and the valve returns to its starting position through the use of a return spring. Connection 1 is shut.</p> <p>This valve is derived from a configurable <b>3/n way valve</b>. You find this valve in the component library “Frequently used Way Valves”, under the <b>Library</b> menu.</p>
	<p><b>5/2-way valve, with selection switch</b></p> <p>Turning the selection switch operates the valve. The flow passes freely from 1 to 4. Releasing the switch has no effect; the valve remains in its operating position. Turning the switch back to its original position allows the flow to pass freely from 1 to 2.</p> <p>This valve is derived from a configurable <b>5/n way valve</b>. You find this valve in the component library “Frequently used Way Valves”, under the <b>Library</b> menu.</p>

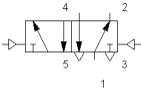
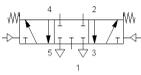
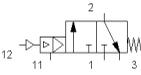
Solenoid Operated Directional Valves

	<p><b>3/2-way solenoid valve, normally closed</b></p> <p>The solenoid valve is controlled by applying a voltage signal at the solenoid coil. The flow passes freely from 1 to 2. By stopping the signal the valve is set back to its starting position through the use of a return spring. Connection 1 is shut. If no signal is applied to the valve, it can be manually operated.</p> <p>This valve is derived from a configurable <a href="#">3/n way valve</a>. You find this valve in the component library “Frequently used Way Valves”, under the <a href="#">Library</a> menu.</p>
	<p><b>3/2-way solenoid valve, normally open</b></p> <p>The solenoid valve is controlled by applying a voltage signal at the solenoid coil. Connection 1 is shut. By stopping the signal the valve is set back to its starting position through the use of a return spring. The flow passes freely from 1 to 2. If no signal is applied to the valve, it can be manually operated.</p> <p>This valve is derived from a configurable <a href="#">3/n way valve</a>. You find this valve in the component library “Frequently used Way Valves”, under the <a href="#">Library</a> menu.</p>
	<p><b>5/2-way solenoid valve</b></p> <p>The solenoid valve is controlled by applying a voltage signal at the solenoid coil. The flow passes freely from 1 to 4. By stopping the signal the valve is set back to its starting position through the use of a return spring. The flow passes freely from 1 to 2. If no signal is applied to the valve, it can be manually operated.</p> <p>This valve is derived from a configurable <a href="#">5/n way valve</a>. You find this valve in the component library “Frequently used Way Valves”, under the <a href="#">Library</a> menu.</p>
	<p><b>5/2-way solenoid impulse valve</b></p> <p>The solenoid valve is controlled by applying a voltage signal at the solenoid coil (flow passes from 1 to 4) and remains in this operating position even when the signal is cut off. Only by applying an opposite signal will the valve return to its starting position (flow passes freely from 1 to 2). If no signal is applied to the valve, it can be manually operated.</p> <p>This valve is derived from a configurable <a href="#">5/n way valve</a>. You find this valve in the component library “Frequently used Way Valves”, under the <a href="#">Library</a> menu.</p>

	<p><b>5/3-way solenoid valve, mid-Position closed</b></p> <p>The solenoid valve is controlled by applying a voltage signal at the solenoid coil (flow passes from 1 to 4 or from 1 to 2). By stopping the signal the valve is set back to its starting position through the use of a return spring. Connections 1, 2, and 4 are shut. If no signal is applied to the valve, it can be manually operated.</p> <p>This valve is derived from a configurable <a href="#">5/n way valve</a>. You find this valve in the component library “Frequently used Way Valves”, under the <a href="#">Library</a> menu.</p>
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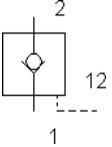
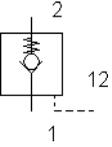
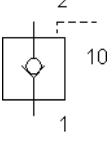
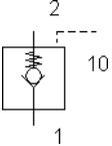
Pneumatically Operated Directional Valves

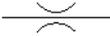
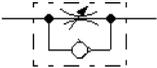
	<p><b>3/2-way valve, pneumatically operated, normally closed</b></p> <p>The pneumatic valve is controlled by applying a pilot pressure at connection 12. The flow passes freely from 1 to 2. By stopping the signal the valve is set back to its starting position through the use of a return spring. Connection 1 is shut.</p> <p>This valve is derived from a configurable <a href="#">3/n way valve</a>. You find this valve in the component library “Frequently used Way Valves”, under the <a href="#">Library</a> menu.</p>
	<p><b>3/2-way valve, pneumatically operated, normally open</b></p> <p>The pneumatic valve is controlled by applying a pilot pressure at connection 10. Connection 1 is shut. By stopping the signal the valve is set back to its starting position through the use of a return spring. The flow passes freely from 1 to 2.</p> <p>This valve is derived from a configurable <a href="#">3/n way valve</a>. You find this valve in the component library “Frequently used Way Valves”, under the <a href="#">Library</a> menu.</p>
	<p><b>5/2-way valve, pneumatically operated</b></p> <p>The pneumatic valve is controlled by applying a pilot pressure at connection 14. The flow passes freely from 1 to 4. By stopping the signal the valve is set back to its starting position through the use of a return spring. The flow passes freely from 1 to 2.</p> <p>This valve is derived from a configurable <a href="#">5/n way valve</a>. You find this valve in the component library “Frequently used Way Valves”, under the <a href="#">Library</a> menu.</p>

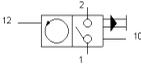
	<p><b>5/2-way impulse valve, pneumatically operated</b></p> <p>The pneumatic valve is controlled by applying reciprocal pilot pressures at connection 14 (flow passes from 1 to 4) and connection 12 (flow passes from 1 to 2). The valve's operating position remains until an opposite signal is received by the valve. This valve is derived from a configurable <a href="#">5/n way valve</a>. You find this valve in the component library "Frequently used Way Valves", under the <a href="#">Library</a> menu.</p>
	<p><b>5/3-way pneumatic valve, mid-Position closed</b></p> <p>The pneumatic valve is controlled by applying reciprocal pilot pressures at connection 14 (flow passes from 1 to 4) and connection 12 (flow passes from 1 to 2). By stopping the signals the valve is set back to its starting position through the use of a return spring. Connections 1, 2, and 4 are shut. This valve is derived from a configurable <a href="#">5/n way valve</a>. You find this valve in the component library "Frequently used Way Valves", under the <a href="#">Library</a> menu.</p>
	<p><b>Low pressure amplifier unit, 2 compartments</b></p> <p>Each of the two double-level low pressure amplifier units has the function of a <a href="#">3/2 directional valve that is normally closed</a>. The signal at connection 12 is raised to a higher boost pressure level through the use of a double-level amplifier and is put out by connection 2.</p> <p>Adjustable parameters: Standard nominal flow rate: 0.1 ... 5000 l/min (60 l/min)</p>

Shutoff Valves and Flow Control Valves

	<p><b>Shuttle valve</b></p> <p>The shuttle valve is switched based on the compressed air entering into either input connection 1 and leaving via an output connection 2. Should both input connections begin receiving compressed air, the connection with the higher pressure takes precedence and is put out (OR function).</p> <p>Adjustable parameters: Standard nominal flow rate: 0.1 ... 5000 l/min (550 l/min)</p>
	<p><b>Quick exhaust valve</b></p> <p>The compressed air passes from connection 1 to connection 2. If the pressure should decrease at connection 1, then the compressed air from connection 1 will escape to the outside via the installed silencer.</p> <p>Adjustable parameters: Standard nominal flow rate: 0.1 ... 5000 l/min (550 l/min)</p>
	<p><b>Two pressure valve</b></p> <p>The two pressure valve is switched based on the compressed air entering into both input connections 1 and leaving via an output connection 2. Should both input connections begin receiving compressed air, the connection with the lower pressure takes precedence and is put out (AND function).</p> <p>Adjustable parameters: Standard nominal flow rate: 0.1 ... 5000 l/min (550 l/min)</p>
	<p><b>Check valve</b></p> <p>If the inlet pressure at 1 is higher than the outlet pressure at 2, then the check valve allows the flow to pass, otherwise it blocks the flow.</p> <p>Adjustable parameters: Standard nominal flow rate: 0.1 ... 5000 l/min (108 l/min)</p>
	<p><b>Check valve, spring loaded</b></p> <p>If the inlet pressure at 1 is higher than the outlet pressure at 2 and the nominal pressure, then the check valve allows the flow to pass, otherwise it blocks the flow.</p> <p>Adjustable parameters: Nominal pressure: 0.001 ... 2 MPa (0.1 MPa) Standard nominal flow rate: 0.1 ... 5000 l/min (108 l/min)</p>

	<p><b>Check valve with pilot control</b></p> <p>If the entering pressure at connection 1 is higher than the outgoing pressure at 2, the check valve allows the flow to pass freely. Otherwise, the valve stops the flow. Additionally, the check valve can be opened via the control line 12. This action allows the flow to pass freely in both directions.</p> <p>Adjustable parameters:          Area ratio: 1 ... 10 (5)          Standard nominal flow rate: 0.1 ... 5000 l/min (108 l/min)</p>
	<p><b>Check valve with pilot control, spring loaded</b></p> <p>If the inlet pressure at 1 is higher than the outlet pressure at 2 and the nominal pressure, then the check valve allows the flow to pass, otherwise it blocks the flow. Additionally, the check valve can be released using the pilot line 12, thus enabling the flow in both directions.</p> <p>Adjustable parameters:          Nominal pressure: 0.001 ... 2 MPa (0.1 MPa)          Area ratio: 1 ... 10 (5)          Standard nominal flow rate: 0.1 ... 5000 l/min (108 l/min)</p>
	<p><b>Pilot to close check valve</b></p> <p>If the inlet pressure at 1 is higher than the outlet pressure at 2, then the non-return valve allows the flow to pass, otherwise it blocks the flow. Additionally, the non-return valve can be closed using the pilot line 10.</p> <p>Adjustable parameters:          Area ratio: 1 ... 10 (5)          Standard nominal flow rate: 0.1 ... 5000 l/min (108 l/min)</p>
	<p><b>Pilot to close check valve, spring loaded</b></p> <p>If the inlet pressure at 1 is higher than the outlet pressure at 2 and the nominal pressure, then the non-return valve allows the flow to pass, otherwise it blocks the flow. Additionally, the non-return valve can be closed using the pilot line 10.</p> <p>Adjustable parameters:          Nominal pressure: 0.001 ... 2 MPa (0.1 MPa)          Area ratio: 1 ... 10 (5)          Standard nominal flow rate: 0.1 ... 5000 l/min (108 l/min)</p>

	<p><b>Nozzle</b></p> <p>The nozzle represents a pneumatic resistance.</p> <p>Adjustable parameters: Standard nominal flow rate: 0.1 ... 5000 l/min (100 l/min)</p>
	<p><b>Throttle valve</b></p> <p>The setting of the throttle valve is set by means of a rotary knob. Please note that by the rotary knob no <i>absolute</i> resistance value can be set. This means that, in reality, different throttle valves can generate different resistance values despite identical settings.</p> <p>Adjustable parameters: Opening level: 0 ... 100 % (100 %) Standard nominal flow rate: 0.1 ... 5000 l/min (100 l/min)</p>
	<p><b>Orifice</b></p> <p>The orifice represents a pneumatic resistance.</p> <p>Adjustable parameters: Standard nominal flow rate: 0.1 ... 5000 l/min (100 l/min)</p>
	<p><b>Orifice, adjustable</b></p> <p>The orifice represents a variable pneumatic resistance.</p> <p>Adjustable parameters: Opening level: 0 ... 100 % (100 %) Standard nominal flow rate: 0.1 ... 5000 l/min (100 l/min)</p>
	<p><b>One-way flow control valve</b></p> <p>The one-way flow control valve is made up of a throttle valve and a check valve. The check valve stops the flow from passing in a certain direction. The flow then passes through the throttle valve. The cross-section of the throttle is adjustable via a regular screw. In the opposite direction the flow can pass through the check valve.</p> <p>Adjustable parameters: Opening level: 0 ... 100 % (100 %) Standard nominal flow rate: 0.1 ... 5000 l/min (100 l/min)</p>

	<p><b>Pneumatic counter</b></p> <p>The counter registers pneumatic signals starting at a predetermined number and counting backwards. If zero is reached, then the counter releases an output signal. This output signal continues until the counter is reset either by hand or from at signal at connection 10.</p> <p>Adjustable parameters:  Counter: 0 ... 9999 pulses (3 pulses)  Standard nominal flow rate: 0.1 ... 5000 l/min (60 l/min)</p>
	<p><b>Ring sensor</b></p> <p>The ring sensor is a non-contact pneumatic signal output module. It is supplied with low pressure at connection 1. If, due to an object, the entering air flow is disturbed, a low pressure signal will be put out by connection 2.</p> <p>To simulate an object in the air flow, as presented above, simply click on the component during FluidSIM Simulation Mode.</p>

Pressure Control Valves

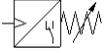
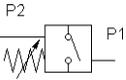
	<p><b>2-way pressure regulator valve</b></p> <p>The pressure regulator valve regulates the compressed air supply to the preset nominal pressure and equalizes pressure fluctuations. The valve closes when the pressure at connection 2 exceeds the nominal pressure. The setting for the real components is component dependent and cannot be changed.</p> <p>Adjustable parameters:  Nominal pressure: 0.01 ... 2 MPa (0.4 MPa)  Standard nominal flow rate: 0.1 ... 5000 l/min (300 l/min)</p>
	<p><b>2-way pressure regulator valve, adjustable</b></p> <p>The pressure regulator valve regulates the compressed air supply to the preset nominal pressure and equalizes pressure fluctuations. The valve closes when the pressure at connection 2 exceeds the nominal pressure.</p> <p>Adjustable parameters:  Nominal pressure: 0.01 ... 2 MPa (0.4 MPa)  Standard nominal flow rate: 0.1 ... 5000 l/min (300 l/min)</p>

	<p><b>Pressure regulator valve with manometer</b></p> <p>The pressure control valve regulates the supplied pressure based on the adjustable operating pressure and the variations in the pressure. The <b>manometer</b> displays the pressure at connection 2.</p> <p>Adjustable parameters:          Nominal pressure: 0.01 ... 2 MPa (0.4 MPa)          Standard nominal flow rate: 0.1 ... 5000 l/min (300 l/min)</p>
	<p><b>3-way pressure regulator valve</b></p> <p>The pressure regulator valve regulates the compressed air supply to the preset nominal pressure and equalizes pressure fluctuations. The compressed air is discharged via connection 3 when the pressure at connection 2 exceeds the nominal pressure. The setting for the real components is component dependent and cannot be changed.</p> <p>Adjustable parameters:          Nominal pressure: 0.01 ... 2 MPa (0.4 MPa)          Standard nominal flow rate: 0.1 ... 5000 l/min (300 l/min)</p>
	<p><b>3-way pressure regulator valve, adjustable</b></p> <p>The pressure regulator valve regulates the compressed air supply to the preset nominal pressure and equalizes pressure fluctuations. The compressed air is discharged via connection 3 when the pressure at connection 2 exceeds the nominal pressure.</p> <p>Adjustable parameters:          Nominal pressure: 0.01 ... 2 MPa (0.4 MPa)          Standard nominal flow rate: 0.1 ... 5000 l/min (300 l/min)</p>
	<p><b>Closing pressure compensator</b></p> <p>The pressure compensator represents a pressure dependent pneumatic resistance. The pressure compensator closes when the pressure difference <math>p_3 - p_4</math> exceeds the nominal pressure. A pressure regulating valve is implemented by the combination of connections 2 and 3. The nominal pressure setting of the real components is component dependent and cannot be changed.</p> <p>Adjustable parameters:          Nominal pressure: 0.01 ... 2 MPa (0.4 MPa)          Standard nominal flow rate: 0.1 ... 5000 l/min (300 l/min)</p>

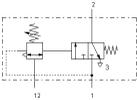
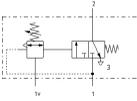
	<p><b>Closing pressure compensator, adjustable</b></p> <p>The pressure compensator represents a pressure dependent pneumatic resistance. The pressure compensator closes when the pressure difference <math>p_3-p_4</math> exceeds the nominal pressure. A pressure regulating valve is implemented by the combination of connections 2 and 3.</p> <p>Adjustable parameters:          Nominal pressure: 0.01 ... 2 MPa (0.4 MPa)          Standard nominal flow rate: 0.1 ... 5000 l/min (300 l/min)</p>
	<p><b>Opening pressure compensator</b></p> <p>The pressure compensator represents a pressure dependent pneumatic resistance. The pressure compensator opens when the pressure difference <math>p_3-p_4</math> exceeds the nominal pressure. A sequence valve is implemented by the combination of connections 1 and 3. The nominal pressure setting of the real components is component dependent and cannot be changed.</p> <p>Adjustable parameters:          Nominal pressure: 0.01 ... 2 MPa (0.4 MPa)          Standard nominal flow rate: 0.1 ... 5000 l/min (300 l/min)</p>
	<p><b>Opening pressure compensator, adjustable</b></p> <p>The pressure compensator represents a pressure dependent pneumatic resistance. The pressure compensator opens when the pressure difference <math>p_3-p_4</math> exceeds the nominal pressure. A sequence valve is implemented by the combination of connections 1 and 3.</p> <p>Adjustable parameters:          Nominal pressure: 0.01 ... 2 MPa (0.4 MPa)          Standard nominal flow rate: 0.1 ... 5000 l/min (300 l/min)</p>

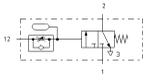
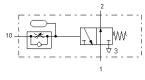
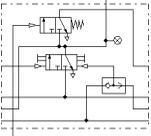
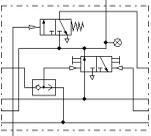
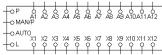
## B. The Component Library

### Pressure Operated Switches

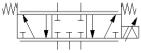
	<p><b>Analog pressure sensor</b></p> <p>The pressure sensor measures the pressure and operates the <a href="#">pressure switch</a> when the adjustable switching pressure has been exceeded.</p> <p>Adjustable parameters: Switching pressure: 0.0001 ... 2 MPa (0.3 MPa)</p>
	<p><b>Differential pressure switch</b></p> <p>The differential pressure switch can be employed as a pressure switch (connection P1), a vacuum switch (connection P2) or as a differential pressure switch (P1-P2). The respective <a href="#">pneumatic to electric converter</a> is operated when the difference in pressure between P1-P2 exceeds the adjustable switching pressure.</p> <p>Adjustable parameters: Differential pressure: -2 ... 2 MPa (0.3 MPa)</p>

### Valve Groups

	<p><b>Pressure sequence valve</b></p> <p>The sequence valve is operated when the control pressure at connection 12 has been reached. The flow passes freely from 1 to 2. Removing the signal allows the valve to return to its starting position through the use of a return spring. Connection 1 is shut.</p> <p>The pressure of the control signal is infinitely adjustable via a pressure setting screw.</p> <p>Adjustable parameters: Nominal pressure: 0 ... 2 MPa (0.1 MPa) Standard nominal flow rate: 0.1 ... 5000 l/min (100 l/min)</p>
	<p><b>Adjustable vacuum actuator valve</b></p> <p>The vacuum actuator valve is employed through the conversion of a vacuum signal. As soon as the vacuum reaches the adjustable value at connection 1v, the attached valve body is switched.</p> <p>Adjustable parameters: Nominal pressure: -0.06 ... -0.025 MPa (-0.025 MPa) Standard nominal flow rate: 0.1 ... 5000 l/min (100 l/min)</p>

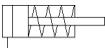
	<p><b>Time delay valve, normally closed</b></p> <p>The time delay valve is made up of a pneumatically operated 3/2-way valve, a one-way flow control valve, and small air accumulator. When the necessary pressure is reached at the control connection 12 of the unit, the 3/2-way valve switches and the flow passes freely from 1 to 2.</p> <p>Adjustable parameters:          Opening level: 0 ... 100 % (100 %)          Volume: 0.001 ... 100 Liter (0.01 Liter)          Standard nominal flow rate: 0.1 ... 5000 l/min (50 l/min)</p>
	<p><b>Time delay valve, normally open</b></p> <p>The time delay valve is made up of a pneumatically operated 3/2-way valve, a one-way flow control valve, and small air accumulator. When the necessary pressure is reached at the control connection 10 of the unit, the 3/2-way valve switches and stops the flow from passing between 1 and 2.</p> <p>Adjustable parameters:          Opening level: 0 ... 100 % (100 %)          Volume: 0.001 ... 100 Liter (0.01 Liter)          Standard nominal flow rate: 0.1 ... 5000 l/min (50 l/min)</p>
	<p><b>Stepper module, type TAA</b></p> <p>The stepper module is made up of a memory unit (3/2-way impulse valve), an <b>AND</b> and an <b>OR</b> component, a viewable announcement, and an auxiliary manual operation.</p> <p>Adjustable parameters:          Initial position: One of {Left, Right} (Left)</p>
	<p><b>Stepper module, type TAB</b></p> <p>The stepper module is made up of a memory unit (3/2-way impulse valve), an <b>AND</b> and an <b>OR</b> component, a viewable announcement, and an auxiliary manual operation.</p> <p>Adjustable parameters:          Initial position: One of {Left, Right} (Right)</p>
	<p><b>Quickstepper</b></p> <p>The Quickstepper is a ready to be fitted, mechanical/pneumatic control device with 12 in- and outputs. The outputs are successively synchronized with the input signals.</p>

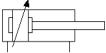
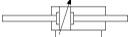
Continuous valves

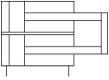
	<p><b>5/3-way proportional valve</b></p> <p>The proportional valve transforms an analog electrical input signal into corresponding opening cross-sections at the outputs. At half nominal voltage i.e. 5 V, the pneumatic mid-position is taken. Here all leading edges are closed, so that no air flows through the valve. Beneficial static and dynamic characteristics with minimal hysteresis (less than 0,3 %), short actuating time (typically 5 ms), and a higher upper frequency limit (approx. 100 Hz), are achieved through an integrated electronic position control for the slide distance. Thus the valve, as control element and especially in combination with a higher ranked position controller, is suitable for the positioning of a pneumatic cylinder.</p> <p>Adjustable parameters: Standard nominal flow rate: 0.1 ... 5000 l/min (773 l/min)</p>
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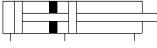
Actuators

	<p><b>Configurable cylinder</b></p> <p>The configurable cylinder can be customized via its <a href="#">properties dialog</a>. Almost any combination of piston type (single-acting, double-acting), the specification of the piston rods (double ended, with magnetic coupling or slide) and the number (none, one, two) is possible. An end position cushioning (without, with, adjustable) can also be defined. FluidSIM automatically adjusts the symbol according to the preset configuration.</p> <p>In addition, a load to be moved (including possible static and sliding friction) and a variable force profile can be defined in the <a href="#">properties dialog</a>.</p> <p>In the component library of FluidSIM there are several pre-configured cylinders that can be inserted in your circuit and directly used. Should no suitable symbol be available, then simply choose the component with the most similarity to the required component, open the <a href="#">properties dialog</a> and adjust the configuration accordingly.</p> <p>Adjustable parameters:</p> <ul style="list-style-type: none"> <li>Max. stroke: 1 ... 5000 mm (50 mm)</li> <li>Piston position: 0 ... Max. stroke mm (0 mm)</li> <li>Piston diameter: 1 ... 1000 mm (20 mm)</li> <li>Piston rod diameter: 0 ... 1000 mm (8 mm)</li> <li>Mounting angle: 0 ... 360 Deg (0 Deg)</li> <li>Internal leakage: 0 ... 100 l/(min*MPa) (0 l/(min*MPa))</li> <li>Moving mass: 0 ... 10000 kg (0 kg)</li> <li>Static friction coefficient: 0 ... 2 (0)</li> <li>Sliding friction coefficient: 0 ... 2 (0)</li> <li>Force: -10000 ... 10000 N (0 N)</li> </ul>
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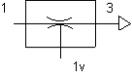
	<p><b>Single acting cylinder</b></p> <p>The piston rod of a single acting cylinder is operated by the input of compressed air at the front end position. When the compressed air is shut off, the piston returns to its starting position via a return spring. The piston of the cylinder contains a permanent solenoid which can be used to operate a proximity switch.</p> <p>Adjustable parameters:</p> <p>Max. stroke: 1 ... 5000 mm (50 mm)  Piston position: 0 ... Max. stroke mm (0 mm)  Piston diameter: 1 ... 1000 mm (20 mm)  Piston rod diameter: 0 ... 1000 mm (8 mm)  Mounting angle: 0 ... 360 Deg (0 Deg)  Internal leakage: 0 ... 100 l/(min*MPa) (0 l/(min*MPa))  Moving mass: 0 ... 10000 kg (0 kg)  Static friction coefficient: 0 ... 2 (0)  Sliding friction coefficient: 0 ... 2 (0)  Force: -10000 ... 10000 N (0 N)</p>
	<p><b>Single acting cylinder with return spring</b></p> <p>The piston of the single acting cylinder is extended to its back position by the input of compressed air. When the compressed air is switched off, a return spring moves the piston back to its front position.</p> <p>Adjustable parameters:</p> <p>Max. stroke: 1 ... 5000 mm (50 mm)  Piston position: 0 ... Max. stroke mm (50 mm)  Piston diameter: 1 ... 1000 mm (20 mm)  Piston rod diameter: 0 ... 1000 mm (8 mm)  Mounting angle: 0 ... 360 Deg (0 Deg)  Internal leakage: 0 ... 100 l/(min*MPa) (0 l/(min*MPa))  Moving mass: 0 ... 10000 kg (0 kg)  Static friction coefficient: 0 ... 2 (0)  Sliding friction coefficient: 0 ... 2 (0)  Force: -10000 ... 10000 N (0 N)</p>

	<p><b>Double acting cylinder</b></p> <p>The piston rod of a double acting cylinder is operated by the reciprocal input of compressed air at the front and back of the cylinder. The end position damping is adjustable via two regular screws. The piston of the cylinder contains a permanent solenoid which can be used to operate a proximity switch.</p> <p>Adjustable parameters:          Max. stroke: 1 ... 5000 mm (100 mm)          Piston position: 0 ... Max. stroke mm (0 mm)          Piston diameter: 1 ... 1000 mm (20 mm)          Piston rod diameter: 0 ... 1000 mm (8 mm)          Mounting angle: 0 ... 360 Deg (0 Deg)          Internal leakage: 0 ... 100 l/(min*MPa) (0 l/(min*MPa))          Moving mass: 0 ... 10000 kg (0 kg)          Static friction coefficient: 0 ... 2 (0)          Sliding friction coefficient: 0 ... 2 (0)          Force: -10000 ... 10000 N (0 N)</p>
	<p><b>Double acting cylinder with in and out piston rod</b></p> <p>The in and out piston rod of the double acting cylinder is controlled by alternating the compressed air input. The cushioning can be adapted with two adjustment screws.</p> <p>Adjustable parameters:          Max. stroke: 1 ... 5000 mm (100 mm)          Piston position: 0 ... Max. stroke mm (0 mm)          Piston diameter: 1 ... 1000 mm (20 mm)          Piston rod diameter: 0 ... 1000 mm (8 mm)          Mounting angle: 0 ... 360 Deg (0 Deg)          Internal leakage: 0 ... 100 l/(min*MPa) (0 l/(min*MPa))          Moving mass: 0 ... 10000 kg (0 kg)          Static friction coefficient: 0 ... 2 (0)          Sliding friction coefficient: 0 ... 2 (0)          Force: -10000 ... 10000 N (0 N)</p>

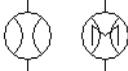
	<p><b>Double acting cylinder with two in and out piston rods and single trestle.</b></p> <p>This twin cylinder has two in and out piston rods that move in parallel and that are coupled by a trestle. The construction guarantees minimum torsion when positioning and moving tools or assemblies. Moreover, coming along with the same construction height, the double piston rod conveys the double force as compared to standard cylinders.</p> <p>Adjustable parameters:          Max. stroke: 1 ... 5000 mm (100 mm)          Piston position: 0 ... Max. stroke mm (0 mm)          Piston diameter: 1 ... 1000 mm (28.28 mm)          Piston rod diameter: 0 ... 1000 mm (10.5 mm)          Mounting angle: 0 ... 360 Deg (0 Deg)          Internal leakage: 0 ... 100 l/(min*MPa) (0 l/(min*MPa))          Moving mass: 0 ... 10000 kg (0 kg)          Static friction coefficient: 0 ... 2 (0)          Sliding friction coefficient: 0 ... 2 (0)          Force: -10000 ... 10000 N (0 N)</p>
	<p><b>Double acting cylinder with two in and out piston rods and double trestle.</b></p> <p>This twin cylinder has two in and out piston rods that move in parallel and that are coupled by a double trestle. The construction guarantees minimum torsion when positioning and moving tools or assemblies. Moreover, coming along with the same construction height, the double piston rod conveys the double force as compared to standard cylinders.</p> <p>Adjustable parameters:          Max. stroke: 1 ... 5000 mm (100 mm)          Piston position: 0 ... Max. stroke mm (0 mm)          Piston diameter: 1 ... 1000 mm (28.28 mm)          Piston rod diameter: 0 ... 1000 mm (10.5 mm)          Mounting angle: 0 ... 360 Deg (0 Deg)          Internal leakage: 0 ... 100 l/(min*MPa) (0 l/(min*MPa))          Moving mass: 0 ... 10000 kg (0 kg)          Static friction coefficient: 0 ... 2 (0)          Sliding friction coefficient: 0 ... 2 (0)          Force: -10000 ... 10000 N (0 N)</p>

	<p><b>Multiple position cylinder</b></p> <p>By connecting two cylinders of same piston diameter but different maximum stroke three piston stop positions can be realized. From the first stop position the third stop can be reached either directly or via the intermediate stop. Note that the maximum stroke of the second piston must be larger than the preceding one. When moving back, an intermediate stop requires a particular control. The shorter maximum stroke is half of the other maximum stroke.</p> <p>Adjustable parameters:          Force: -1000 ... 1000 N (0 N)          Max. stroke: 1 ... 2000 mm (200 mm)          Piston position: 0 ... Max. stroke mm (0 mm)          Intermediate Stop: 0 ... Piston position mm (0 mm)          Piston Area: 0,25 ... 810 qcm (3,14 qcm)          Piston Ring Area: 0,1 ... 750 qcm (2,64 qcm)</p>
	<p><b>Linear drive with solenoid coupling</b></p> <p>The sliding of the piston in the double rod cylinder is controlled by a reciprocal input of compressed air.</p> <p>Adjustable parameters:          Max. stroke: 1 ... 5000 mm (200 mm)          Piston position: 0 ... Max. stroke mm (0 mm)          Piston diameter: 1 ... 1000 mm (16 mm)          Piston rod diameter: 0 ... 1000 mm (0 mm)          Mounting angle: 0 ... 360 Deg (0 Deg)          Internal leakage: 0 ... 100 l/(min*MPa) (0 l/(min*MPa))          Moving mass: 0 ... 10000 kg (0 kg)          Static friction coefficient: 0 ... 2 (0)          Sliding friction coefficient: 0 ... 2 (0)          Force: -10000 ... 10000 N (0 N)</p>

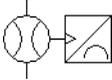
	<p><b>Pneumatic linear drive with shape-fitting adaptor</b></p> <p>The sledge of the double acting cylinder without a piston rod is controlled by alternating the compressed air input. This type of linear drive conveys forces by means of a shape-fitting piston-sledge construction. The slitted cylinder prohibits the torsion of the slider.</p> <p>Adjustable parameters:          Max. stroke: 1 ... 5000 mm (200 mm)          Piston position: 0 ... Max. stroke mm (0 mm)          Piston diameter: 1 ... 1000 mm (16 mm)          Piston rod diameter: 0 ... 1000 mm (0 mm)          Mounting angle: 0 ... 360 Deg (0 Deg)          Internal leakage: 0 ... 100 l/(min*MPa) (0 l/(min*MPa))          Moving mass: 0 ... 10000 kg (0 kg)          Static friction coefficient: 0 ... 2 (0)          Sliding friction coefficient: 0 ... 2 (0)          Force: -10000 ... 10000 N (0 N)</p>
	<p><b>Pneumatic linear drive with shape-fitting adaptor</b></p> <p>The sledge of the double acting cylinder without a piston rod is controlled by alternating the compressed air input. This type of linear drive conveys forces by means of a shape-fitting piston-sledge construction. The slitted cylinder prohibits the torsion of the slider.</p> <p>Adjustable parameters:          Max. stroke: 1 ... 5000 mm (200 mm)          Piston position: 0 ... Max. stroke mm (0 mm)          Piston diameter: 1 ... 1000 mm (20 mm)          Piston rod diameter: 0 ... 1000 mm (8 mm)          Mounting angle: 0 ... 360 Deg (0 Deg)          Internal leakage: 0 ... 100 l/(min*MPa) (0 l/(min*MPa))          Moving mass: 0 ... 10000 kg (0 kg)          Static friction coefficient: 0 ... 2 (0)          Sliding friction coefficient: 0 ... 2 (0)          Force: -10000 ... 10000 N (0 N)</p>

	<p><b>Air motor</b></p> <p>The air motor transforms pneumatic energy into mechanical energy.</p> <p>Adjustable parameters:  Displacement: 0.01 ... 1000 Liter (0.1 Liter)  Friction: 0.01 ... 100 N*m*s/rad (3 N*m*s/rad)  Moment of inertia: 0.00001 ... 1 kg*m<sup>2</sup> (0.0001 kg*m<sup>2</sup>)  External torque: -1000 ... 1000 Nm (0 Nm)</p>
	<p><b>Semi-Rotary actuator</b></p> <p>The semi-rotary actuator is controlled by a reciprocal input of compressed air. In the end positions the semi-rotary actuator can activate switches or valves via labels.</p> <p>Adjustable parameters:  Rotation angle: 1 ... 360 Deg (180 Deg)  Displacement: 0.01 ... 1000 Liter (0.1 Liter)  Friction: 0.01 ... 100 N*m*s/rad (0.1 N*m*s/rad)  Moment of inertia: 0.00001 ... 1 kg*m<sup>2</sup> (0.0001 kg*m<sup>2</sup>)  External torque: -1000 ... 1000 Nm (0 Nm)  Initial position: One of {Left, Right} (Left)</p>
	<p><b>Vacuum suction nozzle</b></p> <p>The vacuum suction nozzle creates its vacuum based on the ejector principle. In this case, compressed air flows from connection 1 to 3, creating a vacuum at connection 1v. A <b>sucker</b> can be connected to the vacuum connection 1v. Stopping the input of compressed air at connection 1 stops any suction also.</p>
	<p><b>Sucker</b></p> <p>The sucker can be used in connection with the <b>vacuum suction nozzle</b> to suck in objects.</p> <p>The sucking in of objects can be simulated in FluidSIM Pneumatics by clicking on the component when in the Simulation Mode.</p>

Measuring Instruments

	<p><b>Manometer</b></p> <p>The manometer displays the pressure at its connection.</p>
	<p><b>Differential pressure gauge</b></p> <p>The differential pressure gauge displays the pressure difference between the adjacent pressures at the left and the right connection.</p>
	<p><b>Pressure indicator</b></p> <p>An optical signal is activated when the pressure at the connection to the pressure indicator exceeds the preset switching pressure.</p> <p>Adjustable parameters:          Switching pressure: 0.0001 ... 2 MPa (0.3 MPa)          Color: One of {16 standard colors} (Blue)</p>
	<p><b>Pressure sensor, analog</b></p> <p>This symbol represents the pneumatic part of the analog pressure sensor. The analog pressure sensor measures the adjacent pressure and transforms it into a proportional electrical voltage signal. In the process, only pressures in the specified pressure ranges are considered. Within this range, the pressure in the voltage range from 0 V to 10 V is represented, i.e. the minimum pressure delivers 0 V and the maximum pressure 10 V.</p>
	<p><b>Flow meter</b></p> <p>The flow meter measures the flow rate. Either the current flow or the total quantity flowed can be displayed. The component image is automatically adjusted accordingly.</p> <p>Adjustable parameters:          Standard nominal flow rate: 0.1 ... 5000 l/min (2000 l/min)</p>

## B. The Component Library

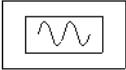
	<p><b>Flow meter, analog</b></p> <p>This symbol represents the pneumatic part of the analog flow meter. The analog flow meter measures the volumetric flow and transforms it into a proportional electrical voltage signal. In the process, only flow rates in the specified pressure ranges are considered. Within this range, the flow rate in the voltage range from 0 V to 10 V is represented, i.e. the minimum volumetric flow delivers 0 V and the maximum volumetric flow 10 V.</p> <p>Adjustable parameters: Standard nominal flow rate: 0.1 ... 5000 l/min (2000 l/min)</p>
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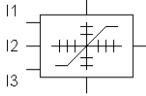
### B.2

#### Electrical Components

##### Power Supply

0V 	<p><b>Electrical connection 0V</b></p> <p>0V connection of the power supply.</p>
+24V 	<p><b>Electrical connection 24V</b></p> <p>24V connection of the power supply.</p>

	<p><b>Function generator</b></p> <p>The function generator is a voltage source that can create constant, rectangle, sine and triangle signals. The voltage range is restricted to -10 V to +10 V. The frequency, the amplitude and the Y-offset of the signal can be set within this range.</p> <p>A voltage profile can be additionally specified. Data points can be set interactively with a mouse-click in the relevant graphic field. These can then be combined to a closed polygon. Alternatively, existing data points can be marked and both numeric values for the time and the corresponding voltage can be entered in the input fields. If the option “loop” is selected, then the voltage profile is started again.</p> <p>Adjustable parameters: Frequency: 0 ... 100 Hz (1 Hz) Amplitude: 0 ... 10 V (5 V) y offset: -10 ... 10 V (5 V)</p>
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	<p><b>Setpoint value card</b></p> <p>Voltage profiles in the range -10 V to +10 V can be created using the setpoint value card. Up to 8 setpoints W1 to W8 can be specified in the voltage range -10 V to +10 V. The setpoint card requires a power supply of 24 V.</p> <p>The increase from the current setpoint to the next setpoint is defined using 4 ramps R1 to R4 with values between 0 s/V and 10 s/V, i.e. a low ramp value signifies a large increase, whereas a high ramp value results in a small increase. The active ramp is defined as follows: R1 by a positive increase of 0 V, R2 by a negative increase up to 0 V, R3 by a negative increase of 0 V and R4 by a positive increase up to 0 V.</p> <p>Three operating modes can be selected: “Wait for switching time”, “Advance setpoints” and “External control”.</p> <p>In operating mode “Wait for switching time” the setpoints are sequentially advanced when the preset change over time has expired.</p> <p>If “Advance setpoints” is selected then, upon attaining the active setpoint, the next setpoint is started without delay.</p> <p>In operating mode “External control” the selection of the active setpoint is effected by gating the inputs I1, I2 and I3 with at least 15 V. The corresponding setpoint is selected by means of the specified bit table. During the process, the internal switching time is inactive.</p> <p style="text-align: center;"> <b>W1:</b> I1=0, I2=0, I3=0  <b>W2:</b> I1=1, I2=0, I3=0  <b>W3:</b> I1=0, I2=1, I3=0  <b>W4:</b> I1=1, I2=1, I3=0  <b>W5:</b> I1=0, I2=0, I3=1  <b>W6:</b> I1=1, I2=0, I3=1  <b>W7:</b> I1=0, I2=1, I3=1  <b>W8:</b> I1=1, I2=1, I3=1         </p>
	<p><b>Connection (electrical)</b></p> <p>An electric connection is a place where an electric line can be attached to. To simplify the line drawing process, a connection appears as a small circle in Edit Mode.</p> <p>Note that at each electric connection values for the voltage and current can be displayed.</p>

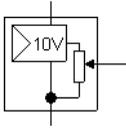
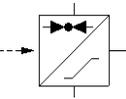
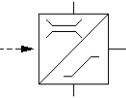
## B. The Component Library

	<p><b>Line (electrical)</b></p> <p>A electrical line links two electrical connections. Note that a electrical connection may be a simple <a href="#">electrical connection</a> or a <a href="#">T-junction</a>. A electrical line causes no voltage drop, i. e., it has no electrical resistance.</p>
	<p><b>T-junction (electrical)</b></p> <p>A T-junction joins up to four <a href="#">electrical lines</a>, thus having a single voltage potential. Note that T-junctions are introduced automatically by FluidSIM when dropping the line drawing cursor onto another line in Edit Mode.</p>

### Actuators / Signal Devices

	<p><b>DC motor</b></p> <p>The DC motor transforms electrical energy into mechanical energy. DC motors produce the continual rotation through repeated changes in the direction of current. The characteristics of the 24 V Dc motor relate to the motor used by the Festo Didactic conveyor belts.</p> <p>Adjustable parameters:          No load speed: 10 ... 20000 1/min (75 1/min)          Torque: 0 ... 20 Nm (0 Nm)</p>
	<p><b>Indicator light</b></p> <p>If current flows, the indicator light is displayed in the user-defined color.</p> <p>Adjustable parameters:          Color: One of {16 standard colors} (Yellow)</p>
	<p><b>Buzzer</b></p> <p>If current flows, a flashing ring around the buzzer is shown. Moreover, if "buzzer" is activated in the menu under <a href="#">Options</a> <a href="#">Sound...</a>, the buzzer is activated if a sound hardware is installed.</p>

Measuring Instruments / Sensors

	<p><b>Voltmeter</b></p> <p>With a voltmeter, the voltage between two positions in a circuit can be measured.</p>
	<p><b>Ammeter</b></p> <p>With an ammeter, the amperage (current strength) of the current between two positions in a circuit can be measured.</p>
	<p><b>Displacement encoder</b></p> <p>The displacement encoder is a slide potentiometer with longitudinal contact and no connecting-rods. It delivers a voltage signal that is proportional to the pick up position. The pick up position is determined by the piston stroke. The voltage range, which will depict the minimal and maximal piston position, can be defined within the range -10 V to +10 V by the user. The displacement encoder requires a power supply of at least 13 V.</p>
	<p><b>Pressure sensor, analog</b></p> <p>This symbol represents the electrical part of the <a href="#">Analog-pressure sensor</a></p>
	<p><b>Flow meter, analog</b></p> <p>This symbol represents the electrical part of the <a href="#">Analog-flow meter</a></p>

## B. The Component Library

### General Switches

	<p><b>Break switch</b></p> <p>General break switch that is tailored depending on the type of component that actuates it.</p> <p>For example, if the break switch is linked via a label to a <a href="#">switch-off delay relay</a>, the break switch changes to a <a href="#">switch-off delay break switch</a> in the circuit diagram.</p>
	<p><b>Make switch</b></p> <p>General make switch that is tailored according to the component that actuates it.</p> <p>For example, if the make switch is linked via a label to a <a href="#">switch-on delayed relay</a>, the make switch changes to a <a href="#">switch-on delayed make switch</a> in the circuit diagram.</p>
	<p><b>Changeover switch</b></p> <p>General changeover switch that is tailored according to the component that actuates it.</p> <p>For example, if the changeover switch is linked via a label to a <a href="#">switch-on delayed relay</a>, the changeover switch changes to a <a href="#">switch-on delayed changeover switch</a> in the circuit diagram.</p>

### Delay Switches

	<p><b>Break switch (switch-on delayed)</b></p> <p>Switch with delayed opening after pickup. Switch-on delayed break switches are created by using a <a href="#">general break switch</a> and setting a label.</p>
	<p><b>Make switch (switch-on delayed)</b></p> <p>Switch with delayed closing after pickup. Switch-on delayed make switches are created by using a <a href="#">general make switch</a> and setting a label.</p>

	<p><b>Changeover switch (switch-on delayed)</b></p> <p>Changeover switch with delayed changeover after pickup. Switch-on delayed changeover switches are created by using a <a href="#">general changeover switch</a> and setting a label.</p>
	<p><b>Break switch (switch-off delayed)</b></p> <p>Switch with delayed closing after dropout. Switch-off delayed break switches are created by using a <a href="#">general break switch</a> and setting a label.</p>
	<p><b>Make switch (switch-off delayed)</b></p> <p>Switch with delayed opening after dropout. Switch-off delayed make switches are created by using a <a href="#">general make switch</a> and setting a label.</p>
	<p><b>Changeover switch (switch-off delayed)</b></p> <p>Changeover switch with delayed changeover after dropout. Switch-off delayed changeover switches are created by using a <a href="#">general changeover switch</a> and setting a label.</p>

Limit Switches

	<p><b>Limit switch (break)</b></p> <p>Switch that is opened by a cam attached to the cylinder rod. The switch closes immediately when the cam has passed the switch. Limit switches are created by using a <a href="#">general break switch</a> and setting a label.</p>
	<p><b>Switch with roll (break)</b></p> <p>Switch that is opened by a cam attached to the cylinder rod. The switch closes immediately when the cam has passed the switch. Switches with roll are created by using a <a href="#">general break switch</a>, setting a label and selecting the switch type in the component's properties dialog.</p>
	<p><b>Reed contact (break)</b></p> <p>Switch that is opened by a cam attached to the cylinder rod. The switch closes immediately when the cam has passed the switch. Reed contacts are created by using a <a href="#">general break switch</a>, setting a label and selecting the switch type in the component's properties dialog.</p>
	<p><b>Limit switch (make)</b></p> <p>Switch that is closed by a cam attached to the cylinder rod. The switch opens immediately when the cam has passed the switch. Limit switches are created by using a <a href="#">general make switch</a> and setting a label.</p>
	<p><b>Switch with roll (make)</b></p> <p>Switch that is closed by a cam attached to the cylinder rod. The switch opens immediately when the cam has passed the switch. Switches with roll are created by using a <a href="#">general make switch</a>, setting a label and selecting the switch type in the component's properties dialog.</p>
	<p><b>Reed contact (make)</b></p> <p>Switch that is closed by a cam attached to the cylinder rod. The switch opens immediately when the cam has passed the switch. Reed contacts are created by using a <a href="#">general make switch</a>, setting a label and selecting the switch type in the component's properties dialog.</p>

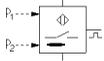
	<p><b>Limit switch (changeover)</b></p> <p>Switch that is changed over by a cam attached to the cylinder rod. The switch changes back immediately when the cam has passed the switch. Limit switches are created by using a <a href="#">general changeover switch</a> and setting a label.</p>
	<p><b>Switch with roll (changeover)</b></p> <p>Switch that is changed over by a cam attached to the cylinder rod. The switch changes back immediately when the cam has passed the switch. Switches with roll are created by using a <a href="#">general changeover switch</a>, setting a label and selecting the switch type in the component's properties dialog.</p>
	<p><b>Reed contact (changeover)</b></p> <p>Switch that is changed over by a cam attached to the cylinder rod. The switch changes back immediately when the cam has passed the switch. Reed contacts are created by using a <a href="#">general changeover switch</a>, setting a label and selecting the switch type in the component's properties dialog.</p>

Manually Operated Switches

	<p><b>Pushbutton (break)</b></p> <p>Switch that opens when actuated and closes immediately when released. In FluidSIM switches can be actuated permanently (locked) when continuing to hold down the mouse button and pushing the <a href="#">Shift</a> key. This permanent actuation is released by a simple click on the component.</p>
	<p><b>Pushbutton (make)</b></p> <p>Switch that closes when actuated and opens immediately when released. In FluidSIM switches can be actuated permanently (locked) when continuing to hold down the mouse button and pushing the <a href="#">Shift</a> key. This permanent actuation is released by a simple click on the component.</p>

	<p><b>Pushbutton (changeover)</b></p> <p>Switch that changes over when actuated and changes back immediately when released.</p> <p>In FluidSIM switches can be actuated permanently (locked) when continuing to hold down the mouse button and pushing the <b>Shift</b> key. This permanent actuation is released by a simple click on the component.</p>
	<p><b>Detent switch (break)</b></p> <p>Switch that opens and locks when actuated.</p>
	<p><b>Detent switch (make)</b></p> <p>Switch that closes and locks when actuated.</p>
	<p><b>Detent switch (changeover)</b></p> <p>Switch that changes over and locks when actuated.</p>

Pressure Switches

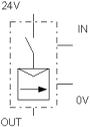
	<p><b>Pneumatic to electric converter</b></p> <p>The converter produces an electrical signal, if the preset differential pressure of the <a href="#">differential pressure switch</a> is exceeded.</p>
	<p><b>Pressure switch (break)</b></p> <p>Switch that opens when the preset switching pressure of the <a href="#">analog pressure sensor</a> is exceeded. Pressure switches are created by using a <a href="#">general break switch</a> and setting a label.</p>
	<p><b>Pressure switch (make)</b></p> <p>The switch closes when the preset switching pressure of the <a href="#">analog pressure sensor</a> is exceeded. Pressure switches are created by using a <a href="#">general make switch</a> and setting a label.</p>
	<p><b>Pressure switch (changeover)</b></p> <p>The switch changes over when the preset switching pressure of the <a href="#">analog pressure sensor</a> is exceeded. Pressure switches are created by using a <a href="#">general changeover switch</a> and setting a label.</p>
	<p><b>Pressure switch</b></p> <p>The switch relays an electrical signal when the preset switching pressure at the <a href="#">pneumatic pressure switch</a> is exceeded.</p>

Proximity Switches

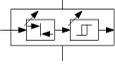
	<p><b>Magnetic proximity switch</b></p> <p>Switch that closes when a solenoid is brought near by. In the Simulation Mode the proximity switch can also be actuated by clicking on it.</p>
	<p><b>Inductive proximity switch</b></p> <p>Switch that closes when the induced electro-magnetic field is changed. In the Simulation Mode the proximity switch can also be actuated by clicking on it.</p>
	<p><b>Capacitive proximity switch</b></p> <p>Switch that closes when its electrostatic field is changed. In the Simulation Mode the proximity switch can also be actuated by clicking on it.</p>
	<p><b>Optical proximity switch</b></p> <p>Switch that closes when the light barrier is interrupted. In the Simulation Mode the proximity switch can also be actuated by clicking on it.</p>

## B. The Component Library

### Relays

	<p><b>Relay</b></p> <p>The relay picks up immediately when current is supplied and drops out immediately when current is removed.</p>
	<p><b>Relay with switch-on delay</b></p> <p>The relay picks up after a preset time when current is supplied and drops out immediately when current is removed.</p> <p>Adjustable parameters: Delay time: 0 ... 100 s (5 s)</p>
	<p><b>Relay with switch-off delay</b></p> <p>The relay picks up immediately when current is supplied and drops out after a preset time when current is removed.</p> <p>Adjustable parameters: Delay time: 0 ... 100 s (5 s)</p>
	<p><b>Relay counter</b></p> <p>The relay picks up after a predefined number of current pulses has/have been counted between the connections A1 and A2. If a potential is supplied between the connections R1 and R2, the counter is reset to its predefined value.</p> <p>In the Simulation Mode the relay counter can also be reset by clicking on it.</p> <p>Adjustable parameters: Counter: 0 ... 9999 pulses (5 pulses)</p>
	<p><b>Starting current limiter</b></p> <p>The starting current limiter consists essentially of a relay, whose coil is situated between the connections IN and 0V, and whose switch contact is situated between the connections 24V and OUT. An electronic longitudinal controller restricts, with a switched relay contact, the current flow to the preset value for the specified duration.</p> <p>The starting current limiter is usually deployed in combination with the <b>electric motor</b>.</p> <p>Adjustable parameters: Duration: 1 ... 10000 ms (50 ms) Max. current: 0.1 ... 100 A (2 A)</p>

Controller

	<p><b>Comparator</b></p> <p>The comparator is a discontinuous (switching) two-step action controller with differential gap (hysteresis). When activated, it delivers a predefined voltage signal. The switch-on value for the activation is defined by nominal value + 1/2 hysteresis and the switch-off value by nominal value - 1/2 hysteresis. The comparator requires a power supply of 24 V.</p> <p>Adjustable parameters:          Set value voltage: -10... 10 V (5 V)          Hysteresis: 0... 5 V (1 V)</p>
	<p><b>PID controller</b></p> <p>The PID-Controller is a continuous controller consisting of three control elements: Proportional, Integral and Derivative. The adjustable parameters refer to the PID-Controller in the Technology Package TP111 pneumatic control from Festo Didactic. The output voltage restriction can be set within the range (i) -10 V to +10 V or (ii) 0 V to +10 V. In the range (i), a manipulated variable offset from -7 V to +7 V can be specified, and in the range (ii) a manipulated variable offset from 1.5 V to 8.5 V can be specified. The PID-controller requires a power supply of 24 V.</p> <p>Adjustable parameters:          Proportional gain: 0 ... 1000 (1)          Integral gain: 0 ... 1000 1/s (0 1/s)          Derivation gain: 0 ... 1000 ms (0 ms)</p>

	<p><b>Status controller</b></p> <p>The status controller is especially suitable for controlling pneumatic positioning circuits. A pneumatic positioning circuit counts to the controlled systems that can only be unsatisfactorily controlled with a standard controller. Three parameters can be attributed to the present status controller: position, speed and acceleration of the piston. The controller is therefore referred to as a “triple loop” controller. Speed and acceleration are not measured with sensors out of cost reasons. They are calculated by the controller from the differences in position. The adjustable parameters refer to the status controller in the Technology Package TP111 Closed-loop pneumatics from Festo Didactic.</p> <p>The output voltage restriction can be set within the range (i) -10 V to +10 V or (ii) 0 V to +10 V. In the range (i), a manipulated variable offset from -7 V to +7 V can be specified, and in the range (ii) a manipulated variable offset from 1.5 V to 8.5 V can be specified. The status controller requires a power supply of 24 V.</p> <p>Adjustable parameters:          Deviation gain: 0 ... 10 (1)          Velocity damping: 0 ... 100 ms (0 ms)          Acceleration damping: 0 ... 10 ms<sup>2</sup> (0 ms<sup>2</sup>)          Total gain: 0 ... 1000 (1)</p>
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EasyPort/OPC/DDE Components

	<p><b>FluidSIM Output Port</b></p> <p>Communication with the EasyPort-Hardware and other applications is implemented with the FluidSIM-Output.</p>
	<p><b>FluidSIM Input Port</b></p> <p>The FluidSIM input realizes the communication with other applications. Communication with the EasyPort-Hardware and other applications is implemented with the FluidSIM-Output.</p>

**B.3**

**Electrical Components  
(American Standard)**

Power Supply

	<p><b>Electrical connection 0V (ladder)</b> 0V connection of the power supply.</p>
	<p><b>Electrical connection 24V (ladder)</b> 24V connection of the power supply.</p>

General Switches

	<p><b>Break switch (ladder)</b> General break switch that is tailored depending on the type of component that actuates it. For example, if the break switch is linked via a label to a <a href="#">switch-off delay relay</a>, the break switch changes to a <a href="#">switch-off delay break switch</a> in the circuit diagram.</p>
	<p><b>Make switch (ladder)</b> General make switch that is tailored according to the component that actuates it. For example, if the make switch is linked via a label to a <a href="#">switch-on delayed relay</a>, the make switch changes to a <a href="#">switch-on delayed make switch</a> in the circuit diagram.</p>

Delay Switches

	<p><b>Break switch (switch-on delayed, ladder)</b></p> <p>Switch with delayed opening after pickup. Switch-on delayed break switches are created by using a <a href="#">general break switch</a> and setting a label.</p>
	<p><b>Make switch (switch-on delayed, ladder)</b></p> <p>Switch with delayed closing after pickup. Switch-on delayed make switches are created by using a <a href="#">general make switch</a> and setting a label.</p>
	<p><b>Break switch (switch-off delayed, ladder)</b></p> <p>Switch with delayed closing after dropout. Switch-off delayed break switches are created by using a <a href="#">general break switch</a> and setting a label.</p>
	<p><b>Make switch (switch-off delayed, ladder)</b></p> <p>Switch with delayed opening after dropout. Switch-off delayed make switches are created by using a <a href="#">general make switch</a> and setting a label.</p>

## B. The Component Library

### Limit Switches

	<p><b>Limit switch (break, ladder)</b></p> <p>Switch that is opened by a cam attached to the cylinder rod. The switch closes immediately when the cam has passed the switch. Limit switches are created by using a <a href="#">general break switch</a> and setting a label.</p>
	<p><b>Limit switch (make, ladder)</b></p> <p>Switch that is closed by a cam attached to the cylinder rod. The switch opens immediately when the cam has passed the switch. Limit switches are created by using a <a href="#">general make switch</a> and setting a label.</p>

### Manually Operated Switches

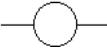
	<p><b>Pushbutton (break, ladder)</b></p> <p>Switch that opens when actuated and closes immediately when released. In FluidSIM switches can be actuated permanently (locked) when continuing to hold down the mouse button and pushing the <a href="#">Shift</a> key. This permanent actuation is released by a simple click on the component.</p>
	<p><b>Pushbutton (make, ladder)</b></p> <p>Switch that closes when actuated and opens immediately when released. In FluidSIM switches can be actuated permanently (locked) when continuing to hold down the mouse button and pushing the <a href="#">Shift</a> key. This permanent actuation is released by a simple click on the component.</p>
	<p><b>Pushbutton (changeover, ladder)</b></p> <p>Switch that changes over when actuated and changes back immediately when released. In FluidSIM switches can be actuated permanently (locked) when continuing to hold down the mouse button and pushing the <a href="#">Shift</a> key. This permanent actuation is released by a simple click on the component.</p>

## B. The Component Library

### Pressure Switches

	<p><b>Pressure switch (break, ladder)</b></p> <p>Switch that opens when the preset switching pressure of the <a href="#">analog pressure sensor</a> is exceeded. Pressure switches are created by using a <a href="#">general break switch</a> and setting a label.</p>
	<p><b>Pressure switch (make, ladder)</b></p> <p>The switch closes when the preset switching pressure of the <a href="#">analog pressure sensor</a> is exceeded. Pressure switches are created by using a <a href="#">general make switch</a> and setting a label.</p>

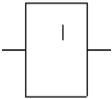
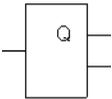
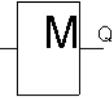
### Relays

	<p><b>Relay (ladder)</b></p> <p>The relay picks up immediately when current is supplied and drops out immediately when current is removed.</p>
	<p><b>Relay with switch-on delay (ladder)</b></p> <p>The relay picks up after a preset time when current is supplied and drops out immediately when current is removed.</p> <p>Adjustable parameters: Delay time: 0 ... 100 s (5 s)</p>
	<p><b>Relay with switch-off delay (ladder)</b></p> <p>The relay picks up immediately when current is supplied and drops out after a preset time when current is removed.</p> <p>Adjustable parameters: Delay time: 0 ... 100 s (5 s)</p>

**B.4**

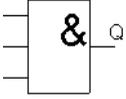
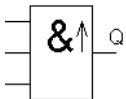
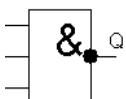
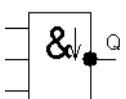
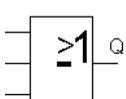
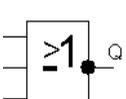
**Digital Components**

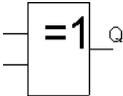
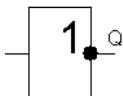
Constants and Connectors

	<p><b>Digital input</b></p> <p>Digital inputs are designated with an “I”. In FluidSIM digital components can be used inside and outside a digital module.</p> <p>If a digital input is used inside a digital module, you can determine the input connector of the digital module in question with which the digital input shall be linked by allocating a number “I1” to “I16”. If there is an analog signal of more than 10V at the chosen input of the digital module, the digital input is set to “Hi”.</p> <p>If a digital input is used outside a digital module, there is an additional analog electrical connection at the digital input. If there is an analog signal of more than 10V at this connection, the digital input is set to “Hi”.</p> <p>As an alternative you can click on the digital input with the left mouse button in order to set it to “Hi”. Another click resets the value to “Lo”.</p>
	<p><b>Digital output</b></p> <p>Digital outputs are designated with an “Q”. The output connects a digital signal through from its input to its output. In FluidSIM digital components can be used inside and outside a digital module.</p> <p>If a digital output is used inside a digital module, you can determine the output connector of the digital module in question with which the digital output shall be linked by allocating a number “Q1” to “Q16”. If the status of the digital output is “Hi”, a potential of 24V is set at the corresponding output connector of the digital module.</p> <p>If a digital output is used outside a digital module, there is an additional analog electrical connection at the digital output. If the status of the digital output is “Hi”, a potential of 24 V is set at this connection.</p>
	<p><b>Memory bits</b></p> <p>Memory bits are designated with a “M”. Memory bits are virtual outputs, with a value at their output analog to that at their input.</p> <p>When the simulation start is activated, you can define by using the property dialog box if the output Q shall be set to “Lo” or to “Hi”, independent on the input value.</p> <p>After the simulation start the value at the output is set to the value of the input.</p>

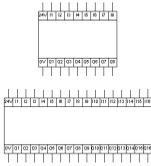
	<p><b>Logic level HI</b> At the output Q you have the logic level “Hi”.</p>
	<p><b>Logic level LO</b> At the output Q you have the logic level “Lo”.</p>
	<p><b>Connection (digital)</b> An digital connection is a place where a digital line can be attached to. To simplify the line drawing process, a connection appears as a small circle in Edit Mode. Note that at each digital connection its level “Lo” / “Hi” can be displayed.</p>
	<p><b>Line (digital)</b> A digital line links two digital connections. Note that a digital connection may be a simple <a href="#">digital connection</a> or a <a href="#">T-junction</a>.</p>
	<p><b>T-junction (digital)</b> A T-junction joins up to four <a href="#">digital lines</a>, thus having a single digital level. Note that T-junctions are introduced automatically by FluidSIM when dropping the line drawing cursor onto another line in Edit Mode.</p>

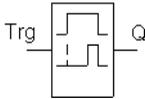
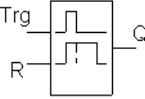
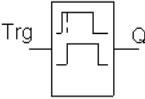
Basic Functions

	<p><b>AND</b></p> <p>The output Q of the AND is only “Hi” when all inputs are “Hi”, that is, if they are closed. If an input pin of this module is not connected, its status is automatically “Hi”.</p>
	<p><b>Edge-triggered AND</b></p> <p>The output Q of the edge-triggered AND is only “Hi” when all inputs are “Hi” and if at least one input was “Lo” in the previous cycle. If an input pin of this block is not connected, its status is automatically “Hi”.</p>
	<p><b>NAND (AND not)</b></p> <p>The output Q of the NAND is only “Lo”, when all inputs are “Hi”, that is, if they are closed. If an input pin of this block is not connected, its status is automatically “Hi”.</p>
	<p><b>NAND With Edge Evaluation</b></p> <p>The output Q of the NAND with edge evaluation is only “Hi”, if at least one input is “Lo” and if all inputs were “Hi” in the previous cycle. If an input pin of this block is not connected, its status is automatically “Hi”.</p>
	<p><b>OR</b></p> <p>The output Q of the OR is only “Hi”, if at least one input is “Hi”, that is, if it is closed. If an input pin of this block is not connected, its status is automatically “Lo”.</p>
	<p><b>NOR (OR not)</b></p> <p>The output Q of the NOR is only “Hi” when all inputs are “Lo”, that is, if they are switched off. As soon as any input is switched on (status “Hi”), the output of the NOR is set to “Lo”. If an input pin of this block is not connected, its status is automatically “Lo”.</p>

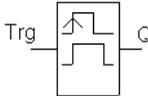
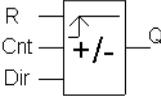
	<p><b>XOR (exclusive OR)</b></p> <p>The output Q of the XOR is “Hi”, if the inputs are nonequivalent. If an input pin of this block is not connected, its status is automatically “Lo”.</p>
	<p><b>NOT (Negation, Inverter)</b></p> <p>The output Q is “Hi” if the input is “Lo”. The NOT block is an input status inverter.</p>

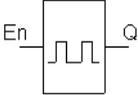
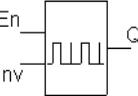
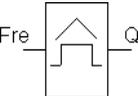
Special Functions

	<p><b>Digital module</b></p> <p>The digital module is used for a compact embedding of a digital switching circuit into an electropneumatic circuit. The digital module offers 8 (16) electrical inputs and outputs, which transfer their states to its digital switching circuit in the inner part. Therefore the digital switching circuit does not need much space in the electropneumatic circuit for the display of the digital module as a rectangle with a total number of 18 (34) connections. By making a double-click with the left mouse button on the digital module you come to the digital circuit in the inner part of the module. A new window opens. It shows the digital circuit and can be handled in the usual way. The standard configuration in the inner part of a new inserted digital module is a row with 8 (16) inputs and 8 (16) outputs each. They correspond to the inputs and outputs of the module in the electropneumatic circuit. In order to be able to test the digital circuit during the set-up, it can be simulated separated from the electropneumatic circuit. As soon as the processing window of the digital module is closed or the original circuit window is put into the foreground, the previously effected changes in the digital circuit are automatically adopted into the digital module of the electropneumatic circuit. Inside the digital module only digital components can be inserted. Furthermore, an encapsulating of additional digital modules inside a module is not possible. However, you can use several digital modules inside one electropneumatic circuit. Please note that the digital circuit inside a digital module only works correctly if corresponding potentials are set at the electrical power supply units of the module (+24 V) and (0 V).</p>
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	<p><b>On delay</b></p> <p>An output with on delay is not switched on until a specified time has expired. When the status of input Trg changes from “Lo” to “Hi”, the on delay time starts. If the status of input Trg is “Hi” at least for the duration of the configured time, the output Q is set to “Hi” on expiration of this time. The output follows the input with on delay. The time is reset, when the status of the input changes again to “Lo” before the time has expired. The output is reset to “Lo”, when the status at the input is “Lo”.</p> <p>Adjustable parameters: On delay time: 0 ... 100 s (3 s)</p>
	<p><b>Off delay</b></p> <p>The output is not reset until a configured time has expired. When the input status turns to “Hi”, the output Q is switched instantaneously to “Hi”. If the status at input Trg changes from “Hi” to “Lo”, the off delay starts. After expiration of the configured time, the output is reset to “Lo” (off delay). When the input Trg is switched on and off again, the off delay restarts. The input R (Reset) is used to reset the delay time and the output before the configured time has expired.</p> <p>Adjustable parameters: Off delay time: 0 ... 100 s (3 s)</p>
	<p><b>On/Off delay</b></p> <p>An output with on/off delay is switched on after a specified time and is reset on expiration of a second specified time. As soon as the status at input Trg changes from “Lo” to “Hi”, the configured on delay time starts. If the status at input Trg remains “Hi” at least for the duration of the configured time, the output Q is set to “Hi” on expiration of the on delay time (the output follows the input on delayed). If the status at input Trg changes again to “Lo”, before the configured on delay time has expired, the time is reset. When the status at input returns to “Lo”, the configured off delay time starts. If the status at the input remains “Lo” at least for the duration of the configured off delay time, the output is set to “Lo” on expiration of that time (the output follows the input off delayed). If the status at the input returns to “Hi” before this time has expired, the time is reset.</p> <p>Adjustable parameters: On delay time: 0 ... 100 s (3 s) Off delay time: 0 ... 100 s (3 s)</p>

	<p><b>Retentive On delay</b></p> <p>A specified time starts after an input pulse. The output is set on expiration of this time.</p> <p>As soon as the status at the input Trg changes from “Lo” to “Hi”, the specified time starts. After expiration on the configured time, the output Q is set to “Hi”. Further switching actions at input Trg have no influence on the running time. The output and the time are only reset to “Lo” when the status at input R is “Hi”.</p> <p>Adjustable parameters: On delay time: 0 ... 100 s (3 s)</p>
	<p><b>Latching Relay</b></p> <p>Input S sets output Q. Another input R resets the output Q.</p> <p>A latching relay is a simple logic memory. The output value depends on the input states and on the previous output status.</p>
	<p><b>Pulse Relay</b></p> <p>A short one-shot at the input is used to set and reset the output.</p> <p>Output Q status is toggled at every “Lo” to “Hi” transition of the status at input Trg, that is, the output is switched on or off. Use input R to reset the pulse relay to initial state, that is, the output is set to “Lo”.</p>
	<p><b>Wiping Relay - Pulse Output</b></p> <p>An input signal generates a signal of specified length at the output.</p> <p>The output status is switched to “Hi” after the input Trg is set to “Hi”. The configured time is started at the same time and the output remains set. After expiration of the configured time, the output is reset to the status “Lo” (pulse output). If the input status changes from “Hi” to “Lo” before the specified time has expired, also the output follows immediately with a with a “Hi” to “Lo” transition.</p> <p>Adjustable parameters: Delay time: 0 ... 100 s (3 s)</p>

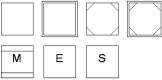
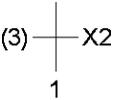
	<p><b>Edge-triggered Wiping Relay</b></p> <p>An input signal generates a signal of specified length at the output (retriggering). The output status is switched to “Hi” after the input Trg is set to “Hi”. The configured time is started at the same time. After expiration of the configured time, the output Q status is reset to “Lo” (pulse output). If the input status changes again from “Lo” to “Hi” (retriggering), before the specified time has expired, the time is reset and the output remains switched on.</p> <p>Adjustable parameters:                  Delay time: 0 ... 100 s (3 s)</p>
	<p><b>Timer Switch</b></p> <p>With the timer switch you can create timer switches referring to days, weeks and years. Upon reach of the specified on-transition time, the output Q of the timer switch is set to “Hi” and upon reach of the specified off-transition time to “Lo”. If you have chosen the option “repeat all”, the on and off transition is repeated each time according to the specified repetition time.</p> <p>Adjustable parameters:                  On time: 0 ... 1000 s (10 s)                  Off time: 0,1 ... 1000 s (30 s)                  Repeat every: 0,1 ... 1000 s (60 s)</p>
	<p><b>Up/Down Counter</b></p> <p>Depending on the configuration of the input Dir, an internal value is counted up or down through an input pulse. The output is set when the configured count value is reached.</p> <p>With every status change at the input Cnt from “Lo” to “Hi”, the internal counter is increased (Dir = “Lo”) or decreased (Dir = “Hi”) by one unit. If the internal counter is equal or larger compared to the specified value, the output Q is set to “Hi”. You can use the reset input R to reset the internal count value and the output to “Lo”. As long as R=“Hi”, also the output is “Lo” and the pulses at input Cnt are not counted.</p> <p>Adjustable parameters:                  Counter: 0 ... 9999 pulses (5 pulses)</p>

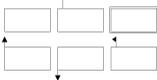
	<p><b>Symmetric Clock Generator</b></p> <p>A timing signal with a configurable period is given at the output. Via the duration of the pulses you can determine the length of the on and off times. Via the input En (for Enable) you can switch on the clock generator, that is, the clock generator sets the output to “Hi” for the duration of the pulse, subsequent the output to “Lo” for the duration of the pulse and so on, until the input status is “Lo” again.</p> <p>Adjustable parameters:          Impulse time: 0,1 ... 100 s (0,5 s)</p>
	<p><b>Asynchronous Pulse Generator</b></p> <p>The pulse profile of the output can be changed via the configurable pulse duration and pulse pause duration.</p> <p>It is possible to invert the output with input INV. The input INV only negates the output, if the block is enabled via EN.</p> <p>Adjustable parameters:          Impulse time: 0,1 ... 100 s (3 s)          Impulse pause time: 0,1 ... 100 s (1 s)</p>
	<p><b>Frequency Threshold Trigger</b></p> <p>The output is switched on and off depending on two frequencies which can be specified.</p> <p>The threshold trigger measures the signals at input Fre. The pulses are captured across a measuring interval which can be specified. If the frequency measured within the measuring interval higher than the input frequency, the output Q is switched to “Hi”. Q is switched again to “Lo” when the measured frequency has reached the value of the output frequency or if it is lower.</p> <p>Adjustable parameters:          On frequency: 0,1 ... 10 pulses/sec (6 pulses/sec)          Off frequency: 0,1 ... 10 pulses/sec (2 pulses/sec)          Time interval: 0,1 ... 100 s (5 s)</p>

**B.5**

**GRAFCET Elements**

GRAFCET

	<p><b>Step</b></p> <p>The name of a step may contain the following characters: “0-9”, “a-z”, “A-Z” and the underscore “_”.</p> <p>You can select from the following seven different step types: simple step, initial step, macro-step, macro input, macro output, enclosing step and initial enclosing step. Furthermore, you can give the step an activation link.</p>
	<p><b>Transition</b></p> <p>You can give a transition a name, which is shown to the left of the transition in brackets.</p> <p>Entering a transition condition is supported by buttons for special symbols (AND, OR, NOT, falling edge, rising edge, delay). Via Variable... you can select an existing GRAFCET variable from a list. Alternatively to the formula, you can show a descriptive text. To do this, you have to select the option “Display description instead of formula”.</p> <p>In the “Connection ID/target information” field, you can enter a step that links to the transition’s output without having to draw a connecting line. You can select an existing step from a list.</p>

	<p><b>Action</b></p> <p>There are three types of action: assignments, allocations and compulsory commands. For assignments and allocations, you can enter a variable or an output, whose value is changed by the action. The name of a variable may contain the following characters: “0-9”, “a-z”, “A-Z” and the underscore “_”.</p> <p>For a “conditional action” or an “action on event”, you can enter a condition that has to be fulfilled before the action is executed. Entering a condition is supported by buttons for special symbols (AND, OR, NOT, falling edge, rising edge, delay). Via Variable... you can select an existing GRAFCET variable from a list. Alternatively to the formula, you can show a descriptive text. To do this, you have to select the option “Display description instead of formula”.</p> <p>For an allocation (“action on activation”, “action on deactivation” and “action on event”), you can enter any term whose value is to be allocated to the action variable. Entering a term is supported by buttons for special symbols (AND, OR, NOT, falling edge, rising edge). Via Variable... you can select an existing GRAFCET variable from a list. Alternatively to the formula, you can show a descriptive text. To do this, you have to select the option “Display description instead of formula”.</p> <p>For a “compulsory command”, you can enter the name of the partial GRAFCET directly or select an existing partial GRAFCET from a list. You can also enter the relevant steps directly or select them from a list of existing steps. You have to separate the step names with commas. You can select the special commands “*” and “INIT” using the relevant buttons.</p>
	<p><b>Synchronization</b></p> <p>You can connect synchronizations like other FluidSIM components. However, they do not initially have any connections. You always have to draw connecting lines to a synchronization. The corresponding connections are then generated automatically.</p>
	<p><b>Partial GRAFCET</b></p> <p>If you want to allocate GRAFCET elements to a specific partial GRAFCET, place the partial GRAFCET frame over the relevant GRAFCET part and give it a name. The preceding “G” is not part of the name that you have to enter; it is added automatically by FluidSIM and shown at the bottom left of the partial GRAFCET frame. You can alter the size of the partial GRAFCET frame by dragging its edges with the mouse. For the partial GRAFCET to function correctly, it is important that all its elements are completely within the frame and that the frame does not overlap with any foreign elements or other frames.</p>

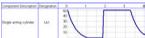
	<p><b>GRAFCET-I/O</b></p> <p>The GRAFCET I/O component is used to link the GRAFCET variables with the electrical part of a circuit. You can enter eight GRAFCET input variables and eight GRAFCET output variables into the GRAFCET I/O component. The actions' variables serve as outputs. The inputs can be the allocations and conditions of actions and transitions. If a potential is created as the input of the GRAFCET I/O component, the corresponding variable is set to "1". If an output variable has a value other than "0", a potential of 24V is created at the corresponding output of the GRAFCET I/O component.</p>
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**B.6**

**Miscellaneous**

Miscellaneous

	<p><b>Connection (mechanical)</b></p> <p>A mechanical connection constitutes a place holder for the label of a valve solenoid. To simplify clicking, a mechanical connection appears as a small circle in Edit Mode.</p>
	<p><b>Valve solenoid</b></p> <p>The valve solenoid switches the valve. By means of a label the valve solenoid can be linked to a valve that is solenoid operated.</p>
	<p><b>Proportional valve solenoid, position controlled</b></p> <p>In FluidSIM the proportional valve solenoid is coupled to the respective continuous directional valve with the help of a label. The required slide position is predetermined via a voltage signal. The valve slide distance is position controlled. The control and amplifier component is integrated in the valve.</p>

	<p><b>Valve solenoid (ladder)</b></p> <p>The valve solenoid switches the valve. By means of a label the valve solenoid can be linked to a valve that is solenoid operated.</p>
	<p><b>Distance rule</b></p> <p>The distance rule is a device for attaching switches at the cylinder. The labels at the distance rule define links to the actual proximity switches or limit switches in the electrical circuit.</p>
	<p><b>Status indicator</b></p> <p>In Edit Mode, the status indicator is automatically displayed at those components that are actuated in the circuit's initial position.</p>
	<p><b>Cam switch</b></p> <p>In Edit Mode, the cam switch is automatically displayed at those mechanically operated way valves that are actuated in the circuit's initial position.</p>
<p>Text</p>	<p><b>Text</b></p> <p>The concept of text components in FluidSIM gives the user a way in which to describe components in diagrams, assign identification texts, or to provide commentary on the diagram. The text and the appearance of text components can be customized to the user's liking.</p>
	<p><b>State diagram</b></p> <p>The state diagram records the state quantities of important components and depicts them graphically.</p>

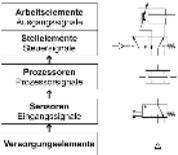
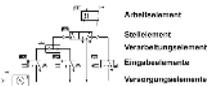


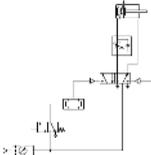
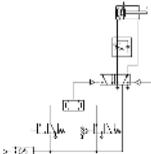
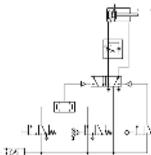
# C. Didactics Material Survey

This chapter provides a comprehensive listing of those parts of the didactics material in FluidSIM that are not covered by chapter B “The Component Library”. Basically, this material consists of the components’ behavior illustrations, the animations, the exercises, and the educational films, which all can be activated under the [Didactics](#) menu.

The subsequent sections are arranged thematically. The  icon indicates that an animation exists for the related topic. The last section gives an overview of the educational films.

## C.1 Basics

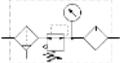
1	Pneumatic system structure and signal flow
	<p>A pneumatic system can be broken down into a number of levels representing the hardware and signal flow from the energy source to the actuating devices.</p> <p> The topic highlights the relationship between signals, levels and elements in a pneumatic system.</p>
2	Circuit diagram and pneumatic elements
	<p>Circuit diagrams are drawn in such a way that signals, for instance energy or potential values, are oriented downwards. The numbering of the components is derived from their respective function in the diagram.</p> <p> The topic highlights the various levels in a circuit.</p>

3	Designating the elements, circuit diagram
	<p>This topic shows the relationship between levels in a circuit.</p>
4	Designating the elements, circuit diagram
	<p>The figures contrasts the position of a roller lever valve (initial position: actuated by the cylinder) in a circuit diagram and its physical setup in a plant.</p>
5	Designating the elements, circuit diagram
	<p>The figures contrasts the position of a roller lever valve (initial position: not actuated) in a circuit diagram and its physical setup in a plant.</p>
6	Designating the elements, circuit diagram
	<p>All elements should be shown in the circuit diagram in the initial position. If valves have been drawn with an actuated initial position, this fact is indicated for example by an arrow, or for a limit switch, by drawing the cam.</p> <p>☞ Explain the differences between the following terms: initial position and starting position.</p>

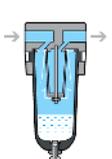
C.2

Supply elements

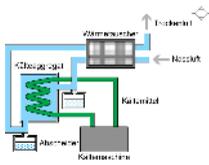
<b>7</b> Symbols of energy and supply components, supply and service equipment		
<p><b>Energieerzeugung</b></p> <p>Stromerzeuger   Dielektrischer Kompressor  </p> <p><b>Aufbereitung</b></p> <p>Filter   Wasserabscheider  </p> <p>Ölöl   Dr. abregler  </p>	<p>The Symbols are from the DIN ISO 1219 “Circuit symbols for fluidic power components and systems”. The symbols for the energy supply system can be represented as individual components or as combined elements.</p> <p>☞ Compare the symbols with the combined symbols (<a href="#">topic 8</a>).</p>	

<b>8</b> Symbols of energy and supply components, combined symbols		
<p>Druckquelle  </p> <p>Wartungseinheit  </p> 	<p>In general where specific technical details are to be given, such as requirements for non-lubricated air or micro-filtering, the complete detailed symbol should be used. If a standard and common air supply is used for all components, the simplified symbols can be used.</p> <p>☞ Compare the symbols with the <a href="#">previous topic</a>.</p>	

<b>9</b> Air service unit		
	<p>The filter is normally combined with the pressure regulator and lubricator to form a compressed air service unit. The selection of the correct filter plays an important role in determining the quality and performance of the control system which is to be supplied with compressed air.</p> <p>☞ Refer to <a href="#">topic 10</a> for construction of the filter.</p>	

<b>10</b> Compressed air filter		
	<p>The compressed air passes through a baffle plate in the filter bowl. The air is rotated, and the heavier dust particles and water droplets are spun by centrifugal force against the inner wall of the filter bowl and run down the wall of the housing. The air which has been precleaned then passes through the filter element.</p> <p>☞ The bowl must be emptied daily to prevent overflow.</p>	

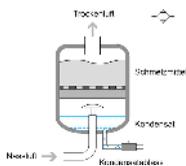
**11** Air drying, low temperature



The lower the dew point the more the water will condense and reduce the amount entrapped in the air. Using refrigeration methods, it is possible to achieve dew points of between 2°C and 5°C.

☞ Compare with [adsorption](#) and [absorption](#) drying.

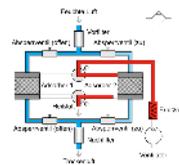
**12** Air drying, absorption



Absorption drying is a purely chemical process. The moisture in the compressed air forms a compound with the drying agent in the tank. This causes the drying agent to break down; it is then discharged as a fluid at the base of the tank. The drying agent must be replenished at a rate which is dependent on the compressed air temperature, water content and flow rate.

☞ Compare with [adsorption drying](#).

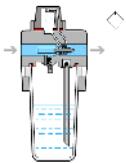
**13** Air drying, adsorption



The lowest equivalent dew points (down to -90°C) can be achieved by means of adsorption drying. In this process, the compressed air is passed through gel and the water is deposited on the surface, i.e. it is adsorbed.

☞ Compare with [absorption drying](#).

**14** Air lubricator

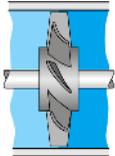


As a rule, the compressed air which is generated should be dry and free of oil. For some components, lubricated air is damaging, for others, it is undesirable, and for power components, it may in certain cases be necessary. Lubrication of the air should therefore be limited to the sections of the plant which require it.

☞ Refer to picture of [topic 9](#) for general arrangement.



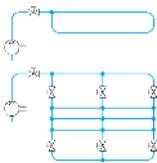
**19** Axial flow compressor



Flow compressors produce large volumes of air at small increases in stage pressure. The air is accelerated by the blades of the compressor but there is only a small increase in pressure.

☞ The kinetic energy is converted to pressure energy.

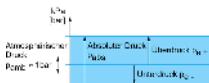
**20** Distribution



For ease of maintenance, repair or extension of the air network, it is advisable to sub-divide the network into individual sections by means of shut-off valves. Branches with T-pieces and manifolds with plug-in couplings make it possible to supply additional consuming devices as the need arises.

☞ To discharge condensate, the pipes should be inclined 1-2 % and include water separators at low points.

**21** Absolute pressure and atmospheric pressure



Absolute pressure is calculated from the absolute zero mark. Below atmospheric pressure the pressure is in the vacuum range. The atmospheric pressure fluctuates but is approximately 100 kPa (1 bar).

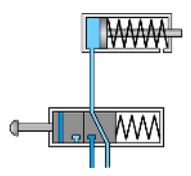
☞ Gauge pressure is normally that component above atmospheric pressure and is not an absolute value.

C.3

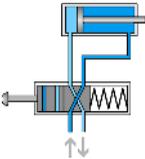
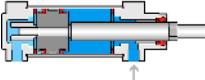
Actuators

22 Symbols for actuators, linear actuators		
<p>Einfachwirkender Zylinder</p> 	<p>The single acting cylinder and the double acting cylinder form the basis for design variations. The use of cushioning to reduce loads on the end caps and mountings during deceleration of the piston is important for long-life and smooth operation.</p> <p>☞ Refer to topics 25 - 30 for construction details.</p>	
<p>Doppelwirkender Zylinder</p> 		
<p>Doppelwirkender Zylinder mit abschaltbarer Rückverriegelung</p> 		
<p>Doppelwirkender Zylinder mit einseitiger Dämpfung, abschaltbar</p> 		
<p>Doppelwirkender Zylinder mit einseitiger Dämpfung, nicht abschaltbar</p> 		

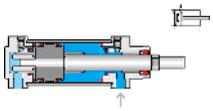
23 Symbols for actuators, rotary motion		
<p>Pneumatischer Kontinuummotor mit einer Stromungsrichtung</p> 	<p>Rotary actuators are divided into continuous motion and limited angle of rotation. The air motor is normally a high speed device with either fixed or adjustable speed control. Units with limited angle of rotation are fixed or adjustable in angular distance. The rotary actuator may be cushioned depending on the load and speed of operation.</p> <p>☞ Refer to topics 34 and 35 for construction details.</p>	
<p>Pneumatischer Winkelmotor mit einer Stromungsrichtung</p> 		
<p>Pneumatischer Winkelmotor mit zwei Stromungsrichtungen</p> 		
<p>Schwenkmotor</p> 		

24 Control of a single acting cylinder		▶
	<p>The position rod of a single acting cylinder is to move forward when air is applied. A valve is to create a signal when a push-button is released. The animation shows the operation of the push-button and the extension of the cylinder. Pressure is maintained on the piston until the push-button is released. The next stage shows retraction of the cylinder and the release of air via the exhaust port of the 3/2-way valve.</p> <p>☞ The topic can be used as an intermediate stage for explanation of the related symbols.</p>	

25 Single acting cylinder	
	<p>The cylinder requires one pneumatic connection and an exhaust port. The exhaust port must be clear of obstructions to ensure that the piston is not restricted by the air passage. A filter is normally fitted to the exhaust port.</p> <p>☞ Discuss the importance of selecting the size of the cylinder to match the load conditions.</p>

26	Single acting cylinder	▶
<div style="display: flex; justify-content: space-between;"> <div style="width: 25%;">  </div> <div style="width: 70%;"> <p>With single acting cylinders, compressed air is applied on only one side of the piston face. The other side is open to atmosphere. The cylinders can perform work in only one direction. The return movement of the piston is effected by a built-in spring or by the application of an external force. The spring force returns the piston to its start position with a reasonably high speed under no load conditions. The stroke is limited by the natural length of the spring. Single acting cylinders are therefore only available in stroke lengths of up to 100 mm.</p> <p>☞ Compare the construction with the double acting type. Discuss the spring size and return speed.</p> </div> </div>		
27	Control of a double acting cylinder	▶
<div style="display: flex; justify-content: space-between;"> <div style="width: 25%;">  </div> <div style="width: 70%;"> <p>The 4/2-way directional control valve is suitable for the control of a double acting cylinder. Normal practice is to use the 5/2-way valve. The cylinder motion is controlled by air in both directions of motion. The animation shows the advance and retraction sequences as separate phases. The fully advanced position is related as long as the push-button is actuated.</p> <p>☞ The topic can be used as an intermediate stage for explanation of the related symbols.</p> </div> </div>		
28	Double acting cylinder	
<div style="display: flex; justify-content: space-between;"> <div style="width: 25%;">  </div> <div style="width: 70%;"> <p>Double acting cylinders are used particularly when the piston is required to perform a work function in both directions of motion. The construction is in general similar to the single acting cylinder.</p> <p>☞ Refer to the large number of variants, which result from the different designs, materials, etc.</p> </div> </div>		
29	Double acting cylinder	▶
<div style="display: flex; justify-content: space-between;"> <div style="width: 25%;">  </div> <div style="width: 70%;"> <p>The first sequence shows the piston rod advancing. The second stage the retraction. The speed of advance and retraction are fairly constant under no load conditions.</p> <p>☞ Point at the positions of cylinder body, piston cover, cylinder cover, piston seal, piston rod, bearing bush, and scraper ring.</p> </div> </div>		

**30 Cushioned double acting cylinder**



If large masses are moved by a cylinder, cushioning is used in the end positions. Before reaching the end position, a cushioning piston interrupts the direct flow of air to the outside. For the last part of the stroke the speed is slowed to reduce impact on the cylinder.

☞ Discuss the different concept of throttling the exhausting air by means of one-way flow control valve.

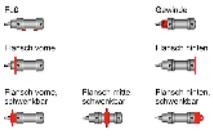
**31 Cylinder seals**



The various piston seal arrangements are shown. The double-cup seal materials used are, Perbunan for -20°C to +80°C Viton for -20°C to +190°C Teflon for -80°C to +200°C.

☞ Emphasize correct temperature range selection for reliability.

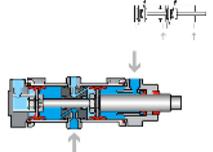
**32 Mounting arrangements for cylinders**



The type of mounting is determined by the manner in which the cylinder is to be fitted to a machine or fixture. The cylinder can be designed with a permanent type of mounting if it does not have to be altered at any time. Alternatively, the cylinder can utilize adjustable types of mounting which can be altered by using suitable accessories on the modular construction principle.

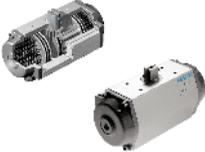
☞ Discuss application examples for each type of mounting.

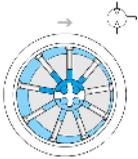
**33 Tandem double acting cylinder**



This design features the characteristics of two double acting cylinders forming a single unit. This increases the effective piston area of the unit for high force applications. It is suitable for applications where a large force is required but the cylinder diameter is restricted.

☞ Compare the double acting cylinder in [topic 29](#).

<b>34</b>	<b>Semi-rotary actuator</b>
	
<p>The rotary actuator is compact with high torque ratings. The force is transmitted to the drive shaft by a rotary vane. The range of angular movement is adjustable with end stops. The angle can be adjusted between 0° and 180°.</p> <p>The adjustable stop system is separate to the rotary vanes. This allows force to be absorbed by the stop blocks. At the end positions, impacts are cushioned by elastic cushioning rings.</p> <p>☞ Discuss the mounting arrangements for the actuator. Discuss applications for the rotary actuator.</p>	

<b>35</b>	<b>Air motor</b>
	
<p>Devices which transform pneumatic energy into mechanical rotary motion, with the possibility of continuous motion. They are categorized into the groups of piston motors, sliding vane motors, gear motors and turbines.</p> <p>☞ Discuss applications for the air motor.</p>	

**C.4**

**Directional control valves**

<b>36</b>	<b>Symbols for directional control valves (1)</b>
<p>— Anzahl der Anschlüsse — Anzahl der Schaltstellungen</p> <p>2/2 Wegeventil Ruhestellung "offen"</p> <p>3/2 Wegeventil Ruhestellung "geserrt"</p> <p>3/2 Wegeventil Ruhestellung "offen"</p>	
<p>The directional control valve is represented by the number of ports and the number of switching positions. Additional information is required to fully describe the symbol function, including the methods of actuation and special flow path characteristics.</p> <p>☞ Compare the full range of symbols for directional control valves.</p>	

<b>37</b>	<b>Symbols for directional valves (2)</b>
<p>— Anzahl der Anschlüsse — Anzahl der Schaltstellungen</p> <p>3/2 Wegeventil</p> <p>5/2 Wegeventil</p> <p>5/3 Wegeventil Spezialstellung</p>	
<p>Each valve position is shown as a separate square. The designation of the ports is important when interpreting the circuit symbols and the valve as fitted to the physical system.</p> <p>☞ Compare the full range of symbols for directional control valves.</p>	



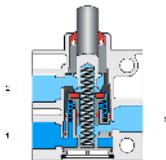
**42** 3/2-way valve, ball seat



The ball seat valve is compact with the possibility of fitting various types of actuating heads. The limitation for directly actuated valves is the force required to operate the stem. If the flow rate required is very high, the valve ball will have a large working area. This requires a large operating force. This limits the size of valve for this design.

☞ The load on the stem is dependent on the size of valve.

**43** 3/2-way valve, disc seat, normally closed

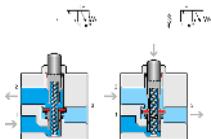


The valve is constructed on the disc seat principle. The response time is short and a small movement results in a large area being available for air flow. Valves of the single disc seat type are non-overlapping. Using this topic, discuss the term “blocked normal position”. When operated slowly, there is no loss of air. A 3/2-way valve with flow blocked between ports 1 and 2 in the normal condition, is referred to as a normally closed valve. The valves are insensitive to dirt and thus have a long service life.

Explain the term “non-overlapping” with this figure and the animation.

☞ The animation sequence shows the operation of the 3/2 way valve. The first sequence describes the actuation and the supply of a signal from 1 to 2. The second sequence shows the closing of the disc seat and the release of air from 2 to 3 which exhausts to atmosphere.

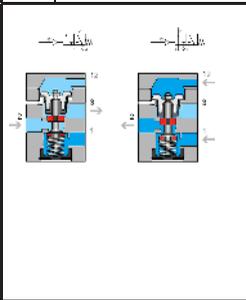
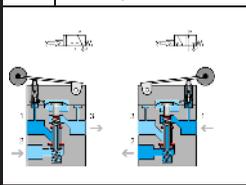
**44** 3/2-way valve, disc seat, normally open



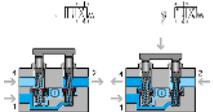
A 3/2-way valve with free flow between ports 1 and 2 in the normal condition, is referred to as normally open. Valves can be operated manually, mechanically, electrically or pneumatically. The configuration of the valve head is changed to meet the actuation method.

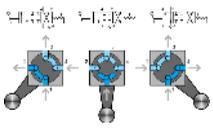
Upon operation of the actuating stem, the disc seat is sealed and air supply port 1 is blocked. The air at port 2 is exhausted to atmosphere via port 3.

☞ Note the change of construction compared to the normally closed valve topic 43.

<p><b>45</b> 3/2-way valve, single pilot, normally closed</p>	
	<p>The pneumatically operated 3/2-way valve is operated by a directly acting signal at port 12. This is referred to as a single pilot valve since there is only one control signal and the valve has a spring return.</p> <p>A signal is applied at port 12 and the valve plunger is moved against the reset spring. The connections 1 and 2 are then inter-connected creating a signal 2. The pressure at port 12 must be sufficient to move the disc against the supply pressure.</p> <p>☞ Note the pneumatic symbol shows direct application of the signal at port 12.</p> <p>Compare the construction of the valve to the 3/2-way disc seat valve <a href="#">topic 43</a>.</p>
<p><b>46</b> 3/2-way valve, single pilot</p>	
	<p>The valve ports are labeled to ensure the correct connections are made. The pilot valve is available in a range of sizes depending upon the flow rate.</p> <p>☞ Note the need to designate and label the ports.</p>
<p><b>47</b> 3/2-way valve, internal pilot, roller operated</p>	
	<p>This type of valve can be used as either a normally closed valve or as a normally open valve by exchanging connections 1 and 3 and rotating the actuating head 180 degrees. The force required on the roller lever is small due to the pilot operation.</p> <p>☞ Show the requirements to alter the valve configuration.</p>
<p><b>48</b> 3/2-way valve, internal pilot, normally closed</p>	
	<p>To avoid high actuating force, mechanically controlled directional valves can be equipped with an internal pilot valve to assist opening. A small hole connects the pressure connection 1 and the pilot valve. If the roller is operated, the pilot valve opens. Compressed air flows to the main piston and actuates the main valve disc.</p> <p>☞ The symbol shows the roller operating a pilot signal.</p>

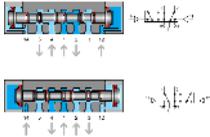
<b>49</b>	<b>4/2-way valve, disc seat</b>	
		<p>The valve is robust. Two stems directly operate the disc seats. The load required to move the stems may be large for high flow rate valves.</p> <p>☞ Compare the construction with the <a href="#">3/2-way valve</a>.</p>

<b>50</b>	<b>4/2-way valve, disc seat</b>	
		<p>The 4/2-way valve has four ports and two positions. A disc seat 4/2-way valve is similar in characteristic to the combination of two 3/2-way valves, one valve normally closed and the other normally open. The plungers can be operated by an auxiliary mounted device such as a roller lever or push-button.</p> <p>When the two plungers are actuated simultaneously, 1 to 2 and 4 to 3 are closed by the first movement. By pressing the valve plungers further against the discs, opposing the reset spring force, the passages between 1 to 4 and from 2 to 3 are opened.</p> <p>☞ Show the similarities to the 3/2-way valve construction. Discuss the valve overlap.</p>

<b>51</b>	<b>4/3-way valve, mid-position closed</b>	
		<p>The 4/3-way valve has four ports and three positions. An example of the 4/3-way valve is the plate slide valve with hand or foot actuation. By turning two discs, channels are interconnected with one another.</p> <p>☞ Compare the symbol with the valve construction.</p>

<b>52</b>	<b>5/2-way valve, longitudinal slide valve</b>	
		<p>The valve can be mounted onto a common sub-base for supply and exhaust air. This compact arrangement also ensures adequate flow is available to the valve.</p> <p>☞ Discuss the DIN ISO 5599/1 standard for 5 port valves.</p>

**53** 5/2-way valve, longitudinal slide valve

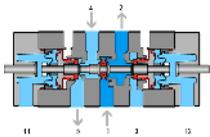


The 5/2-way valve has five ports and two positions. The 5/2-way valve is used for the control of cylinders primarily as a final control element. In pneumatic valves, the gap between spool and housing bore should not exceed 0.002–0.004 mm. The valve is shown here with pilot pressure applied at port 12.

To avoid damage to seals, the ports can be distributed around the circumference of the housing. The actuation travel is considerably larger than with seat valves. The valve is shown here with pilot pressure at 14.

- ☞ Discuss the load conditions on the O-rings.
- ☞ Compare the construction with the [disc seat valve](#).

**54** 5/2-way valve, suspended disc seat



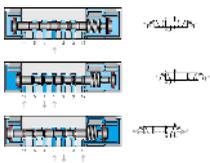
A method of sealing the 5/2-way valve is to use a suspended disc seat with a relatively small switching movement. The disc seat seal connects the 1 port to either the 2 port or the 4 port. The 5/2-way double air pilot valve has the characteristic of memory control.

The last switched position is retained until a new switching position is initiated by a unique pilot signal from the opposite side. There are two manual override buttons to manually operate valve spool.

The animation shows the two switched positions. The air pilot signals are applied from both directions. The manual override operations are also shown. The manual overrides are used to manually actuate the valve or initialize the valve position.

- ☞ Compare the suspended disc seat construction to the longitudinal slide principle [topic 53](#).
- ☞ Explain the working principle of the manual override button and its related diagram symbol.

**55** 5/3-way valve



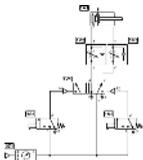
The 5/3-way valve has five ports and three positions. Signals applied at ports 14 or 12 operate the valve. If the valve is not actuated it is closed in the mid-position.

After actuation via a pilot signal at port 14 air flows from 1 to 4. Port 2 exhausts via 3.

After actuation via a pilot signal at port 12 air flows from 1 to 2. Port 4 exhausts via port 5.

- ☞ Show the three valve positions.

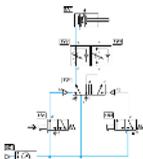
**56** Memory circuit, 5/2-way bistable valve



The piston rod of a double acting cylinder is to advance when a 3/2-way push-button valve is actuated. The cylinder is to remain extended until a second push-button is actuated. The cylinder is to then return to the initial position. The speed of the cylinder is to be adjustable in both directions.

☞ Discuss the memory characteristic of the bistable valve.

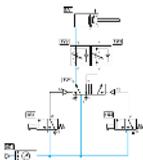
**57** Memory circuit, 5/2-way bistable valve



Signals initiated by the push-button signaling devices can be of short or pulse duration due to the memory characteristics of the bistable valve. Upon operation of push-button 1S1, a 1-signal is generated at port 14 of the control valve 1V3. The 5/2-way memory valve switches and the cylinder 1A1 advances.

☞ The circuit is shown at the first operation of the button.

**58** Memory circuit, 5/2-way bistable valve



When the push-button 1S1 is released, the signal at port 14 is exhausted. The valve 1V3 remains in the current position. The last position is retained until a new input signal is given.

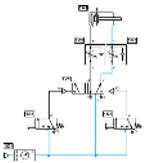
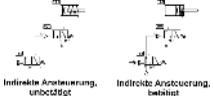
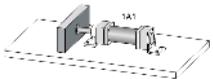
☞ Compare the sequence of operation.

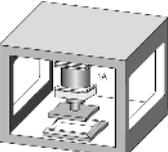
**59** Memory circuit, 5/2-way bistable valve



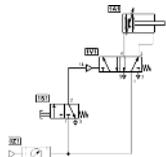
The valve 1V3 remains in the current position until the push-button 1S2 is operated. The cylinder then retracts. The cylinder remains retracted until a new signal is generated at port 14 by the valve 1S1.

☞ Compare the sequence of operation.

60	Memory circuit, 5/2-way bistable valve
	<p>The flow control valves throttle the exhausting air in both directions of piston motion. The cylinder remains retracted until a start signal is generated at port 14 by the valve 1S1. The 5/2-way valve remains in the current position with air supplied continuously to the return side of the cylinder.</p> <p>☞ Discuss the situation when both 1S1 and 1S2 are operated together.</p>
61	Direct control, unactuated
 <p>Direkte Ansteuerung, unbetätigt</p> <p>Direkte Ansteuerung, betätigt</p>	<p>A single acting cylinder of 25 mm diameter is to clamp a component when a push-button is pressed. As long as the push-button is operated, the cylinder is to remain in the clamped position.</p> <p>Since the cylinder is the only working element or actuator in the circuit, it is designated 1A1. The final control element that advances the cylinder is designated 1S1.</p> <p>☞ Discuss the circuit layout standard, numbering and operation. Note the circuit is shown in the initial state.</p>
62	Indirect control (unactuated)
 <p>Indirekte Ansteuerung, unbetätigt</p> <p>Indirekte Ansteuerung, betätigt</p>	<p>A large diameter single acting cylinder is to extend upon operation of a push-button valve. The valve is situated at a remote and distant position. The cylinder is to retract once the remote push-button is released.</p> <p>The signal at the pilot port 12 remains as long as the push-button is held down. This is an indirect push-button control of the cylinder. If the push-button is released, the spring return closes the 3/2-way valve and removes the pilot signal at the control valve.</p> <p>☞ Discuss the circuit layout standard, numbering and operation. Note the circuit is shown in the initial state.</p>
63	Exercise: Direct control of a double acting cylinder – Problem
	<p>A double acting cylinder is to advance when a push-button is operated. Upon release of the push-button, the cylinder is to retract. The cylinder is of small bore (25 mm diameter) requiring a small flow rate to operate at the correct speed.</p>

64	Exercise: Direct control of a double acting cylinder – Solution
	 <p>The control valve for a double acting cylinder can be selected as a 4/2 way or a 5/2 way valve. In this case, since the cylinder has a small capacity, the operation can be directly controlled by a push-button control valve with spring return. On operating the push-button, the air passes through the valve from port 1 to the port 4 and advances the piston rod. On release of the push-button, the valve spring returns the control valve to its initial position and the cylinder retracts. Air escapes from the cylinder via the exhaust port. Since the cylinder is the only working element or actuator in the circuit, it is designated 1A1. The final control element that advances the cylinder is designated 1S1.</p>
65	Exercise: Direct control of a double acting cylinder – Note
	 <p>⚠ If the push-button is pressed for a very short period, the cylinder only partially advances and then retracts, since the spring resets the control valve as soon as the push-button is released. In order to achieve full extension in this case, the push-button must be held down until the cylinder moves fully forward.</p>
66	Exercise: Indirect control of a double acting cylinder – Problem
	<p>A double acting cylinder is to advance when a push-button is operated. Upon release of the push-button the cylinder is to retract. The cylinder is 250 mm diameter and consumes a large volume of air. For controlling cylinders at high speed or of large diameter large size control valves should be used. The operating force to actuate the valve may be relatively large and in this case indirect control is preferable.</p>
67	Exercise: Indirect control of a double acting cylinder – Solution
	 <p>Operating valve 1S1 supplies a pilot signal to port 14 of control valve 1V1. This generates a 1-signal at the outlet 4 and the cylinder advances. If the push-button is released the return signal is supplied via port 2 of valve 1V1 and the return air is vented via exhaust port 5. If the push-button is released before the cylinder fully advances, the cylinder immediately returns to the initial position. The control valve requires a sustained signal for it to remain operated.</p>

**68** Exercise: Indirect control of a double acting cylinder – Note



☞ The supply line can be short since the control valve can be mounted close to the cylinder. The other advantage is that the signal element (i.e. push-button 3/2 way valve) can be small, as it only provides a signal to operate the control valve and is not required to operate the cylinder directly.

**C.5**

**Shutoff valves**

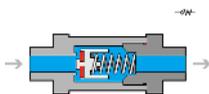
**69** Non-return valves



The non-return or check valve will open due to the supply pressure exceeding the resistance of the spring (if fitted) and the inertia of the valve. The non-return valve is the basis for development of many combined components. The shuttle valve, two pressure valve and quick exhaust valve incorporate features of the non-return valve.

☞ Indicate the valves that include the non-return function.

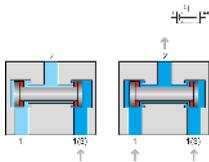
**70** Non return valve



Non return valves can stop the flow completely in one direction. In the opposite direction the flow is free with a minimal pressure drop due to the resistance of the valve. The one-way blocking action can be effected by cones, balls, plates or diaphragms.

☞ Discuss the relationship between pressure to open and the spring size.

**71** Two pressure valve

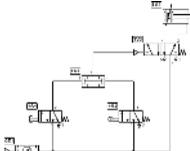
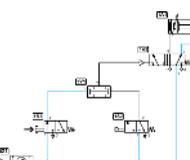
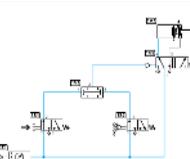
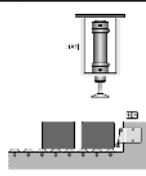


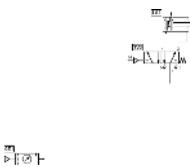
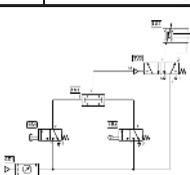
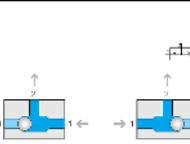
The two pressure valve has two inputs 1 and one output 2. The two pressure valve is used mainly for interlocking controls, safety controls, check functions or logic operations. The application of a signal at a single input produces no pressure at output 2.

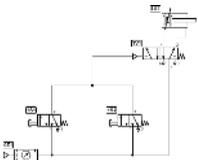
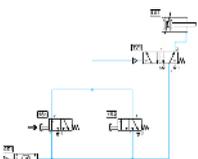
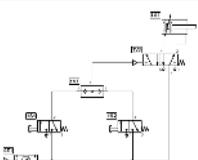
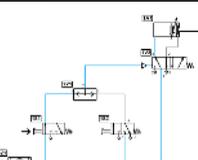
If pressure is applied at both inputs 1, the signal which is last applied passes to the output 2. The two pressure circuit is equivalent to two input signaling devices in series, i.e. one after the other.

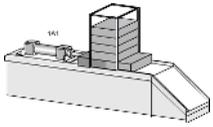
☞ Refer to topics 72 - 74 for the circuit example.

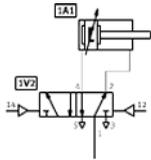
Discuss the advantages of the shown solution against series connection.

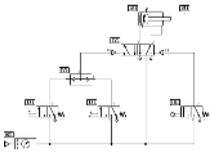
72	Circuit: Two pressure valve I	
		<p>The piston rod of a double acting cylinder is to advance when a 3/2-way push-button valve and a roller lever valve are actuated. If either of the actuations is released, then the cylinder is to return to the initial position.</p> <p>☞ Discuss the circuit layout standard, numbering and operation.</p>
73	Circuit: Two pressure valve II	
		<p>The inputs of the two pressure valve is connected to the outputs of the two 3/2-way valves. Upon operation of the push-button 1S1, a signal is generated at the left side of input 1 of the two pressure valve. The signal is blocked by the two pressure valve. No output is given at 2.</p> <p>☞ Discuss the logic function “AND”. Refer to the <a href="#">following topic</a> for additional conditions.</p>
74	Circuit: Two pressure valve III	
		<p>If the roller lever valve 1S2 is also operated, then the two pressure valve will produce a 1-signal at port 2 which operates the control valve, via pilot port 1V1, against the return spring and the cylinder advances.</p> <p>☞ Compare this topic to <a href="#">topic 73</a>.</p>
75	Exercise: The logic AND function, the two pressure valve – Problem	
		<p>A transfer station removes a product from a conveyor belt. If the product is detected as present and if the operator presses the push-button, the pick-up cylinder 1A1 advances. The product is sensed by a 3/2 way roller lever valve. Upon release of the push-button, cylinder 1A1 is to retract to the initial position. The operating condition for the pick-up cylinder to advance is a logic AND function between the product sensor and the operator push-button. Therefore if a two pressure valve is used to combine the signals from the sensor and push-button the logic conditions can be met.</p>

<p><b>76</b></p>	<p>Exercise: The logic AND function, the two pressure valve – Solution</p>
	<p>The two pressure valve is connected between the outlet lines of the two 3/2 way valves. Operating the push-button, a 1-signal is generated at left input 1 of the two pressure valve. Once the part is sensed as present, the 3/2 way roller valve generates a second 1-signal, this time at the right input 1 of the two pressure valve. A signal is passed through to port 2. This signal operates the control valve pilot signal 14 against the spring return and the cylinder advances. If either of the two signals created by the 3/2 way valves is set to zero, the two pressure valve will release the 14 signal back through the exhaust port of one of the 3/2 way valves. The return spring in the control valve then switches the control valve to the initial position. The control valve outlet port 2 is active and with outlet port 4 exhausted to atmosphere the cylinder retracts. The control valve can be a 4/2 or 5/2 way valve and can be sized to suit the flow rate required for the cylinder speed.</p>
<p><b>77</b></p>	<p>Exercise: The logic AND function, the two pressure valve – Note</p>
	<p>Discuss also the advantages of the shown solution against series connection.</p>
<p><b>78</b></p>	<p>Shuttle valve</p>
	<p>This non-return element has two inputs 1 and one output 2. If compressed air is applied to one input, the valve seat seals off the opposing input and the air flows to the output 2. Note the similarity in construction to the two pressure valve.</p> <p>☞ Compare the two pressure valve construction <a href="#">topic 71</a>.</p>

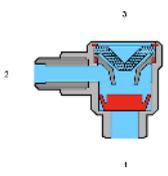
79	Circuit: Shuttle valve I	 <p>If the condition states that either of two push-buttons are to advance a cylinder, the inexperienced designer may attempt to use a junction for the output signals of 1S1 and 1S2. The circuit is not functional due to the escape of air through the exhaust ports of the valves.</p> <p>☞ Discuss the sequence of circuits for the shuttle valve.</p>
80	Circuit: Shuttle valve II	 <p>If push-button 1S1 is operated, the air escapes to atmosphere through the exhaust port of 1S2. The air takes the easiest path and the pressure will be very low and inadequate to operate the valve 1V1. This is an inadequate solution to the problem. A shuttle valve is required.</p> <p>☞ Compare the topic with the <a href="#">previous one</a>.</p>
81	Circuit: Shuttle valve III	 <p>The piston rod of a double acting cylinder is to advance when either of two 3/2-way push-buttons are actuated. If both push-buttons are then released, the cylinder is to retract. The shuttle valve is incorporated at the junction and the circuit now functions correctly.</p> <p>☞ Note the function of the ball in the shuttle valve acting as a non-return valve.</p>
82	Circuit: Shuttle valve IV	 <p>The shuttle valve is connected to the junction between the two 3/2-way push-button valves. Upon operation of one of the push-buttons, a signal is generated at the X or Y port of the shuttle valve and an output signal is emitted at port 2. The cylinder advances.</p> <p>☞ Compare the topic with the <a href="#">previous one</a>.</p>

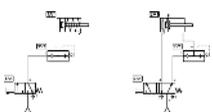
<b>83</b>	<b>Exercise: The logic OR function, the shuttle valve – Problem</b>
	<p>A cylinder is used to transfer parts from a magazine. If either a push-button or a foot pedal is operated, then the cylinder is to advance. Once the cylinder has fully advanced, it is to retract to the initial position. A 3/2 way roller lever valve is to be used to detect forward end position of the cylinder.</p>

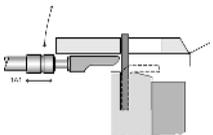
<b>84</b>	<b>Exercise: The logic OR function, the shuttle valve – Solution</b>
	<p>The shuttle valve is connected to the junction between the two manual 3/2 way valves. Upon operation of one of the manual 3/2 way valves, a 1-signal is generated at either input 1 of the shuttle valve. This signal passes through the shuttle valve and is emitted at port 2. This operates the control valve via pilot port 14, and the cylinder advances. A limit valve 1S2 senses that the cylinder has fully extended. Pilot signal 2 from valve 1S2 actuates the 5/2 way valve via port 12 and the cylinder retracts. The signal at port 12 is only effective, if the opposing signal at port 14 is released. If both of the signals produced via the push-button valves are set to zero, then the shuttle valve will release the pilot signal 14 back through the exhaust port of one of the 3/2 way valves. In other words, both the push-button and the foot pedal must be inactive for retraction to occur. The control valve can be a 4/2 way or 5/2 way valve and can be sized to suit the flow rate required for the cylinder speed.</p>

<b>85</b>	<b>Exercise: The logic OR function, the shuttle valve – Note</b>
	<p>☞ The necessity of the shuttle valve can be explained with <a href="#">topic 79</a>.</p>

<b>86</b>	<b>Quick exhaust valve</b>
	<p>To reduce resistance to flow, the air is expelled to atmosphere through a large orifice thus increasing cylinder piston speed. The valve is normally silenced so as to reduce exhaust air noise.</p>

<b>87</b>	<b>Quick exhaust valve</b>	▶
	<p>Quick exhaust valves are used to increase the piston speed of cylinders. Lengthy return times can be avoided, particularly with single acting cylinders. To reduce resistance to flow, the air is expelled to atmosphere close to the cylinder and through a large orifice.</p> <p>In the direction 1 to 2 the air is passed freely via the opening of the non-return seal. Port 3 is blocked by the disc. If air is supplied to port 2, the disc seals port 1. Air is expelled to atmosphere through the large orifice 3. Mount the quick exhaust valve directly on the cylinder, or as near as possible.</p> <p>☞ Refer to <a href="#">topic 88</a> for the circuit example.</p>	

<b>88</b>	<b>Circuit: Quick exhaust valve</b>
	<p>A cylinder piston rod is to travel at an increased speed, utilizing the quick exhaust valve. The forward motion of the piston rod is assisted by the release of exhausting air at the quick exhaust valve. The return stroke is unchanged due to the bypass non-return valve.</p> <p>☞ Refer to <a href="#">topic 70</a> for construction of the valve.</p>

<b>89</b>	<b>Exercise: The quick exhaust valve – Problem</b>
	<p>A cylinder advances a forming tool on an edge-folding device. If a sheet is detected as present and if a push-button is pressed, then the cylinder is to advance. For rapid forward travel, the circuit utilizes a quick exhaust valve. The forward movement folds the edge of a flat sheet. If the push-button is released, the double acting cylinder is to return slowly to the initial position.</p>

<b>90</b>	<b>Exercise: The quick exhaust valve – Solution</b>
	<p>Initial position: In the initial state, the cylinder assumes the retracted position. If both of the 3/2 way valves are actuated, pressure is present at the output port 2 of the two pressure valve 1V4. This reverses the 5/2 way control valve. The cylinder advances with air being supplied via an unrestricted passage through the one-way flow control valve 1V1. The actuator travels rapidly to its forward end position since the pressure space on the piston rod side is rapidly exhausted through the quick exhaust valve. If both 3/2 way valves remain actuated, the cylinder remains in the forward end position. If the push-button is released, the actuator is no longer pressurized, since the control valve reverses via the return spring. The actuator travels to its initial position under conditions of restricted flow (valve 1V1) and therefore at a reduced speed.</p>

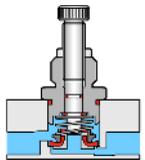
<b>91</b>	<b>Exercise: The quick exhaust valve – Note</b>
	<p>☞ The quick exhaust valve should be fitted as near as possible to the connection of the cylinder to reduce resistance to flow.</p>

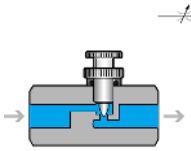
C.6

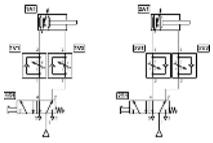
Flow control valves

<b>92</b>	Flow control valves	
	<p>Drosselrückschlagventil </p> <p>Drosselventil, einstellbar </p>	<p>Most flow control valves are adjustable. If the non-return valve is fitted, then the element is a one-way flow control valve.</p> <p>☞ Discuss the flow in both directions in both cases.</p>

<b>93</b>	One-way flow control valve	
		<p>The valve is generally mounted as close to the cylinder as possible. The valve is usually provided with a locking nut to allow finite adjustments to be regulated and then set.</p> <p>☞ If no real valve is at hand, use this slide instead.</p>

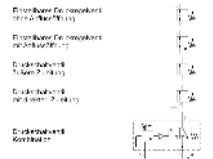
<b>94</b>	One-way flow control valve	
		<p>One-way flow control valves influence the volumetric flow of the compressed air. One-way flow control valves are normally adjustable and the setting can be locked in position. The influence of speed control is in one direction only. The first sequence of the animation shows the total cross section of the one-way flow control valve. The animation will be shown in detail by zooming into the air passage area.</p> <p>☞ Refer to <a href="#">topic 96</a> for the circuit example.</p>

<b>95</b>	Throttle valve	
		<p>Throttle valves are normally adjustable and the setting can be locked in position. These valves are used to regulate the speed regulation of actuators and if possible, should be mounted directly on the cylinder.</p> <p>☞ Compare the flow control with throttle valves and one-way flow control valve <a href="#">topic94</a>.</p>

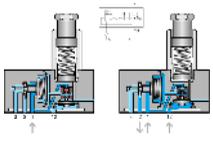
<b>96</b>	<b>Supply and exhaust air throttling</b>	
		<p>Exhaust air throttling should be used with double acting cylinder circuits. For supply air throttling, the flow valves are installed so that the air entering the cylinder is throttled. With exhaust air throttling, the supply air flows freely to the cylinder and the exhaust air is throttled.</p> <p>☞ Discuss the numbering system. Even numbers relate to advancing signals and odd numbers to the retracting signals.</p>

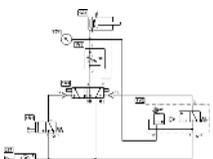
**C.7**

**Pressure control valves**

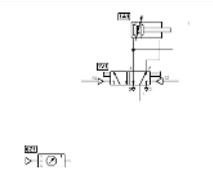
<b>97</b>	<b>Pressure control valves</b>	
		<p>The pressure control valves are generally adjustable against a compression spring. The sensing line for regulators is at the valve outlet and for sequence valves the sensing is before the valve, i.e. that pressure which is to be measured.</p> <p>☞ Compare the sensing line positions and flow arrows.</p>

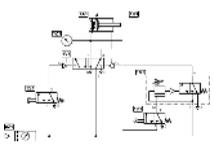
<b>98</b>	<b>Adjustable pressure sequence valve</b>	
		<p>The adjusting screw normally incorporates a lock nut to set the desired position. The valve body is fitted to a sub-base which can frame mounted with other compact valves.</p> <p>☞ Some applications for the valve are clamping, pressing, gluing and safety interlocks.</p>

<b>99</b>	<b>Adjustable pressure sequence valve (unactuated)</b>	
		<p>Sequence valves are installed in pneumatic controls where a specific pressure is required for a switching operation. The output signal is transmitted only after the required operation pressure has been reached. If the signal pressure at port 12 exceeds that set on the spring, the valve opens. Outlet port 2 is opened only if a preset pressure has built up in pilot line 12. A pilot spool opens the passage between ports 1 to 2.</p> <p>☞ Discuss the two elements in the control symbol.</p> <p>Discuss the adjustment required to set the desired operation pressure. A pressure gauge is required.</p>

<b>100</b>	<b>Circuit: Pressure sequence valve</b>	
		<p>A plastic component is embossed using a die powered by a double acting cylinder. The die is to advance and emboss the plastic when a push-button is operated. The return of the die is to be effected when a preset pressure is reached. The pressure is to be adjustable.</p> <p>☞ Refer to <a href="#">topic 99</a> for construction of the valve.</p>

<b>101</b>	<b>Exercise: Pressure dependent control, embossing of plastic – Problem</b>	
		<p>A plastic component is embossed using a die and a double acting cylinder. The die is to advance and emboss the plastic when a push-button is operated. The return of the die is to occur when the cylinder rod has fully advanced to the embossing position and a preset pressure is reached. A roller limit valve is to be used to confirm full extension. The embossing pressure is adjustable and is indicated on a pressure gauge.</p>

<b>102</b>	<b>Exercise: Pressure dependent control, embossing of plastic – Solution</b>	
		<p>The cylinder advances if valve 1V1 is switched by push-button valve 1S1. The pressure on the advancing side of the cylinder is fed from a junction to the limit valve 1S2 and then in series to the sequence valve. The signal port 12 at the sequence valve acts against the preset compression of the adjustable spring. If the limit valve 1S2 is operated due to full extension of the cylinder and the preset value is reached, then the sequence valve opens from 1 to 2 and sends a pilot signal to port 12 of the control valve 1V1. The memory valve switches and the cylinder retracts. At the same time the air from port 4 is exhausted and the pilot signal at the sequence valve is relieved through the limit valve.</p>

<b>103</b>	<b>Exercise: Pressure dependent control, embossing of plastic – Note</b>	
		<p>☞ If the pressure does not reach the preset limit, then the cylinder will remain advanced. If the cylinder is obstructed during extension to the forward position, the cylinder will not retract due to the dependency upon operation of the limit valve 1S2. The power circuit must be initialized by operating the 5/2 way memory valve manually (via the manual overrides) with the air off. The air can then be turned on.</p>

C.8

Time delay valve

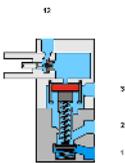
**104** Time delay valve, normally closed



The valve has a lock-able adjusting screw for setting time. The valve is sized to meet the flow requirements.

☞ Discuss the accuracy of the time delay valve.

**105** Time delay valve, normally closed

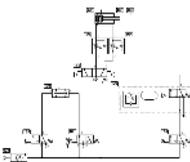


The time delay valve is a combinational valve consisting of a 3/2-way valve, throttle relief valve and an air reservoir. The 3/2-way valve can be a valve with normal position open or closed. The delay time is generally 0-30 seconds for both types of valves. By using additional reservoirs, the time can be extended.

When the necessary control pressure from 12 has built up in the air reservoir, the pilot spool of the 3/2-way valve is actuated. An accurate switch-over time is assured if the air is clean and the pressure constant.

☞ Discuss the need for clean and stable air for accuracy.  
Discuss the relationship between time delay and the reservoir size.

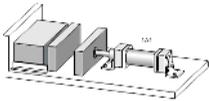
**106** Circuit: Time delay valve



A double acting cylinder is to glue components. The push-button operates the clamping cylinder and trips a roller lever valve. The cylinder is to remain fully extended for a time of 6 seconds and then immediately retracts to the initial position. A new start cycle is only possible after the cylinder has fully retracted. The cylinder advance is to be slow and the retraction adjustable but fast.

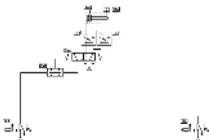
☞ Refer to [topic 104](#) for construction of the valve.

**107** Exercise: The time delay valve – Problem



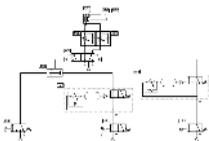
A double acting cylinder is used to press together glued components. Upon operation of a push-button, the clamping cylinder advances and trips a roller lever valve. Once the forward end position is reached, the cylinder is to remain for 6 seconds and then immediately retract to the initial position. A new start cycle is only possible after the cylinder has fully retracted and after a delay of 5 seconds. The cylinder extension is to be slow and the retraction adjustable, but relatively fast.

**108** Exercise: The time delay valve – Solution



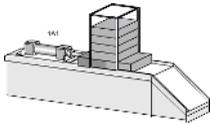
The start conditions are the actuation of roller limit valve 1S3, a delay of 5 seconds after the end of cycle and the operation of 1S1. The two pressure valve 1V4 actuates the 5/2 way memory valve at port 14. The cylinder advances at a preset speed via the flow control valve 1V2. The limit switch 1S3 is deactivated and therefore even if the start button is still held, the signal at port 14 is exhausted by the removal of the limit switch signal, which resets the timer 1V6 until the cylinder has retracted again. The cylinder reaches the limit valve 1S2 and produces a pilot signal for the time delay valve 1V5. The time delay valve opens port 2 if the preset time is reached. A pilot signal is produced 6 seconds after the limit valve 1S2 is operated. The 5/2 way valve switches to the initial position and the cylinder retracts and with speed controlled by the valve 1V1. The roller limit valve 1S2 is deactivated and the pilot signal to the timer 1V5 is cut-off, removing the signal at port 12 of the 5/2 way valve.

**109** Exercise: The time delay valve – Note



⚠ The memory valve must be positioned manually before air is supplied to the circuit to ensure that the cylinder will be retracted initially.

**110** Exercise: Memory circuit and speed control of a cylinder – Problem



A double acting cylinder is to fully advance when a push-button is actuated and to retract after full extensions is reached (confirmed by a roller lever valve). The cylinder is to continue forward even if the push-button is released. Speed of the cylinder is to be adjustable.

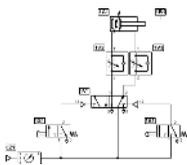
**111** Exercise: Memory circuit and speed control of a cylinder – Solution



111-1

Operating the push-button 1S1 then advances the cylinder 1A1. Operation of valve 1V3 produces pressure at port 14 which switches the air to port 4. Once the cylinder travels to the limit valve 1S2, a pilot signal is sent to port 12 of the control valve switching the control valve if the push-button valve is released. If the push-button is held operated after the cylinder has fully advanced, it will remain advanced until valve 1S1 is released. The final control element 1V3 is a memory valve and the last position is retained until a unique opposing signal is received. The speed of advance and retraction is controlled by the throttle valves 1V1 and 1V2 and in both cases the speed control is by exhaust air throttling. If the roller lever valve is fitted at the mid-stroke position of the cylinder, it will advance up to the limit valve and then retract.

**112** Exercise: Memory circuit and speed control of a cylinder – Note



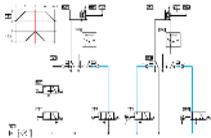
The memory control valve 1V3 when first fitted could be in either of two positions 14 or 12. It is not easy to predict the position of the valve when fitted. If a manual override button is available the valve should be manually set to the 12 position before turning on the air to ensure that the cylinder remains retracted initially.

C.9

**Sequential circuit and signal overlap circuit**

<p><b>113</b> Sequential circuit, distance-step diagram</p>	<p>Confirmation is required that cylinder 2A1 is retracted before start of the cycle. The sequence is, A+ B+ A- B-. The valves 2S2 and 1S3 are initially operated. There is no signal overlap at the final control elements 1V2 and 2V2.</p> <p>☞ Discuss the relationship between the circuit and the distance-step diagram.</p>
<p><b>114</b> Sequential circuit</p>	<p>A sequential circuit has the following characteristics; when a 3/2-way push-button valve is operated, cylinder 1A1 extends. Confirmation is required at each step of the sequence. The sequence is A+ B+ A- B-.</p> <p>☞ There is no signal overlap with the circuit.</p>
<p><b>115</b> Signal overlap circuit I</p>	<p>It is necessary to identify the points in the circuit where signal overlap occurs on the 5/2-way valves 1V2 and 2V2. With this distance step diagram the circuit design using roller valves cannot operate due to signal overlap.</p> <p>☞ Refer to the <a href="#">next topics</a> for the overlap conditions.</p>
<p><b>116</b> Signal overlap circuit II</p>	<p>The first overlap condition occurs at the start. The pilot signals at the valve 1V2 from the valves 1S3 and 1S2 are opposed. The bistable valve cannot move due to overlap.</p> <p>☞ Discuss the options for removal of overlap.</p>

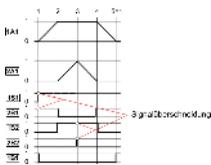
**117** Signal overlap circuit III



The second overlap condition occurs in the third step. The valve 2V2 has signals generated by 2S1 and 2S2 opposing each other and causing a signal overlap condition.

☞ Review the control diagram topic 118.

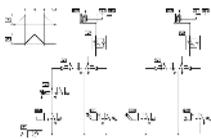
**118** Control diagram, signal overlap



The first control valve 1V2 has an overlap problem in the first step. The first of these signals must be out short and therefore valve 1S2 could be an idle return roller lever valve. The second overlap problem is with valve 2V2 in step 3, when the cylinder 2A1 is fully advanced. Valve 2S1 could be an idle return roller valve only active in step 2 for a short duration.

☞ Idle return roller valves are not a recommended solution.

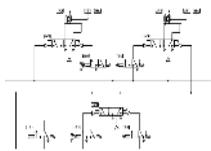
**119** Idle return roller valve solution



The idle return roller limit switch can be used to remove the signal overlap points, i.e. replace the roller lever limit switches identified, with an idle return roller lever valve. Valves 1S2 and 2S1 generated the signal overlap and therefore these valves should be idle return roller valves.

☞ Idle return roller valves are not a recommended solution.

**120** Reversing valve solution



An alternative method of shortening the duration of signals is to remove the air supply to the two signal valves, except at the steps required. Using the reversing valve 1V2, lines S1 and S2 can be activated consecutively and the signals are prevented from overlapping at the memory valves 1V1 and 2V1.

☞ Emphasize the increased reliability of the circuit.

**C.10**  
**Educational Films**

No.	Title	Length
1	Introduction	2:42
2	Fundamentals: Structure of hybrid systems	4:32
3	Fundamentals: Fundamentals of electricity	10:26
4	Sensors and relays—Pressure switches	0:48
5	Sensors and relays—Sensors	3:24
6	Sensors and relays—Pressure switches	2:41
7	Sensors and relays—Relays	3:34
8	Solenoid valves	2:48
9	Solenoid valves: Double-solenoid valves	1:47
10	Solenoid valves: Pilot control	3:58
11	Pilot control: Circuit-diagram conventions	4:14
12	Pilot control: Hard-wired controllers	4:58
13	Pilot control: Programmable Logic Controllers	2:25

**C.11**  
**Standard Presentations**

For several topics useful presentations have been provided within FluidSIM. The following table lists the titles of the predefined presentations.

Presentation Title
All topics sorted by number
Basics
Supply elements
Actuators
Directional control valves
Shutoff valves
Flow control valves
Pressure control valves
Time delay valve
Sequential circuit and signal overlap circuit
Educational films

# D. Messages

This section contains information about the messages that may appear from FluidSIM while working in the Edit Mode, the Simulation Mode, or while saving circuit diagrams.

## D.1 Electrical Errors



Simulation aborted. A short-circuit was detected in an electrical circuit.

The positive and negative poles of a voltage source are directly connected without a load (indicator light, buzzer, relay, or control solenoid). The short circuit must be eliminated before simulation can take place.

## D.2 Drawing Errors



Objects are placed outside the drawing area.

At least one object has been placed outside the drawing area. After acknowledging the dialog box the respective objects are shown selected. Either change the [papersize](#) or place the selected objects inside the marked drawing area.



Open connections.

At least one component has an open pneumatic connection. After acknowledging the dialog box, all components with an open pneumatic connection are selected.



Incompatible connections are superimposed.

When two connections are superimposed, FluidSIM automatically connects them. When these two connections do not go together, a warning message is given.



Superimposed lines.

At least two lines are superimposed. After acknowledging the dialog box, these line segments are selected.

 Lines through components.

At least one line is passing through a component. After acknowledging the dialog box, the appropriate components are selected.

 Lines through connections.

At least one line is crossing through a connection to which the line is not connected. After acknowledging the dialog box, these lines are selected.

 Superimposed components.

At least two components are superimposed. After acknowledging the dialog box, these components are selected.

 Duplicate or incompatible labels.

A label has been used incorrectly. After acknowledging the dialog box, the appropriate components are selected. To set the circuit diagram into simulation, other labels will have to be chosen.

 There are components with the same description.

The same description has been assigned to more than one component. After acknowledging the dialog box the respective components appear selected. Modify the component description(s), or, as the case may be, rearrange them such that their assignment becomes definite.

 There have been warnings. Start simulation anyway?

This prompt appears when any of the above drawing errors can be found in the circuit diagram. If the simulation is started while connections are open, air will escape at these places. However, open connections can be fit with a blind plug, if this behavior is not desired.

 There is no cylinder close to the distance rule.

A distance rule can only be given a label when it is assigned to a cylinder. Move the distance rule near a cylinder, so that it snaps into place. Now a label can be entered by double clicking the measuring scale.

 No superficial errors detected.

The circuit diagram does not contain any of the above described drawing errors.

### D.3 Operating Errors

 No objects found.

You tried to check a circuit diagram for drawing errors or to start the simulation; but there are no components located in the current window.

 Objects cannot be deleted from the FluidSIM standard libraries.  
Create a new library if you want to set up a custom library.

Objects can neither be added nor deleted from the FluidSIM *standard libraries*. However, new custom libraries can be created instead, which contain merely your preferred selection of components (see Section 6.10).

 The value range of 'abc' is x...x.

The value range for the field has been exceeded. Make sure to observe the indicated limits.

#### D.4

#### Opening and Saving Files

 The circuit diagram has been changed. Save current changes?

You want to close a circuit diagram window or quit FluidSIM. Since the last save, changes have been made to the current circuit diagram.

 The file 'abc' already exists. Replace?

A circuit diagram with the name `name.ct` already exists on the hard disk. To save the current circuit diagram, you must either change the file name, or the already existing file will be replaced with the new circuit diagram.

 Cannot save DXF file.

The file (either the current circuit diagram or the component library) cannot be saved due to insufficient disk space or a write-protected disk.

 Unknown file format.

The file cannot be opened since its format is not supported by FluidSIM.

 Cannot open file 'abc'.

FluidSIM cannot open the file because Microsoft Windows® refuses access to the file. Either the file does not exist or is locked by another application.

 'abc' does not exist. Create?

You have tried to open a file that does not exist. However, the file can be opened as a new file.

 The file 'abc' can not be deleted.

You have tried to delete a file that does not exist or is write-protected.

 Circuit ' abc ' is already opened. Close this window before?

You want to save a circuit diagram under another name. There is, however, already another open window with this name. If you close this window, the file will be replaced.

## D.5 System Errors

 Simulation aborted. The circuit is too large.

The size of circuit diagrams that can be simulated is bound. You must reduce the number of components.

 Internal capacity of FluidSIM exceeded.

The previous action exceeded the capacity of the internal memory. The action cannot be completed.

 No more windows available.

Microsoft Windows® cannot provide any more windows most likely because the system resources have been exhausted.

 Memory capacity exceeded. Quit other running applications.

There is not enough memory readily available to complete the parameter calculations. To make more memory available, other circuit diagrams should be closed, along with any other Microsoft Windows® programs that are running. Then attempt to run the simulation again. When there is no other possibility to free up memory, the virtual memory can be increased. Microsoft Windows® then utilizes a section of the hard drive to increase the memory. However, as a result the execution speed of the program decreases greatly. It would be wiser to extend the main memory by increasing the computer's RAM.

 This version is not registered. Please repeat the installation procedure.

You have tried to start an unlicensed version of FluidSIM. Most likely you have changed your system configuration, or important system files have become corrupt. Attempt to reinstall FluidSIM into the same directory. If there is a problem with the re-installation, you will receive a message on the screen pertaining to the problem. Notify Festo Didactic GmbH & Co. KG of the error or the problem.

 Out of memory. Please save changed circuits and quit FluidSIM.

While completing an operation (for example loading a circuit diagram, displaying a component photo, rebuilding the desktop) an error in the memory occurred. FluidSIM could not cancel the operation in a proper manner. You are recommended to quit FluidSIM because the program's stability cannot be assured. However, it is still possible to save changes to circuit diagrams before quitting FluidSIM.

 Fatal error. Please save changed circuits and quit FluidSIM.

A program error has occurred. Please save changes to any open circuit diagrams, quit FluidSIM and Microsoft Windows®, and restart.

 The circuit filename.ct has not been saved when the last FluidSIM session was terminated improperly. Shall this file be recovered?

FluidSIM has been terminated in an unexpected manner. However, a backup file was written from which an actual version of the unsaved circuit can be constructed. If the question is answered with "Yes" a window with the recovered circuit is opened; however, the original circuit remains unchanged. You then can decide if to whether the recovered circuit shall be saved under the original name.

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