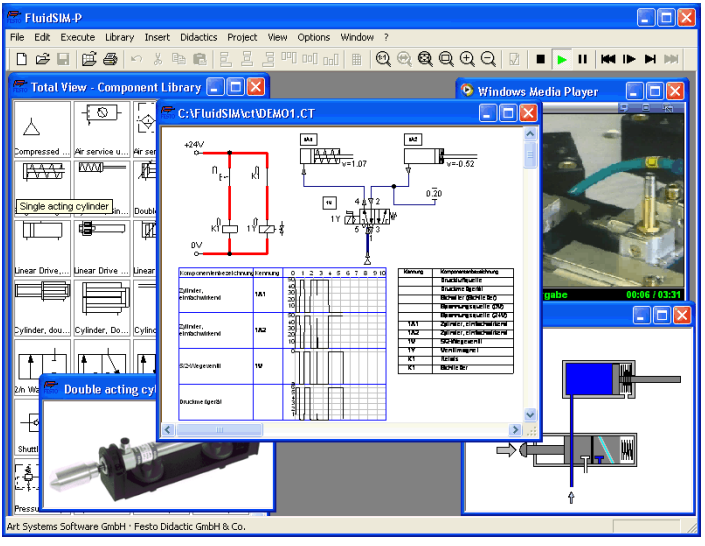
FESTO

FluidSIM® 3.6
Pneumatics

User's Guide



398029 GB
04/04

FluidSIM was launched at the Knowledge-based Systems Department of the University of Paderborn.

Concept and development of FluidSIM® 3 Pneumatics is based on research work carried out by Dr. Daniel Curatolo, Dr. Marcus Hoffmann, and Dr. habil. Benno Stein.

Order No.:	398029
Description:	HANDBUCH
Designation:	D:HB-FSP3-GB
Edition:	4/2004
Author:	Art Systems
Layout:	Art Systems

© Festo Didactic GmbH & Co. KG, D-73770 Denkendorf, 1996-2004
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1. Welcome!

Welcome to FluidSIM !

Thank you for purchasing the FluidSIM®3 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
did@festo.com

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

www.fluidsim.com
www.festo.com/didactic

April 2004 The Authors

1.1 About FluidSIM

FluidSIM®3 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.

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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 7 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.

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 framed; function keys are represented with their appropriate key symbol. For example ▶ is the icon used to start a simulation; File Open... indicates the "Open..." entry under the "File" menu; F9 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
Flow (q)	l/min
Velocity (v)	m/s
Opening level (%)	-
Voltage (U)	V
Current (I)	A

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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 Windows9x®, Microsoft WindowsME®, Microsoft WindowsNT®, Microsoft Windows2000® or Microsoft WindowsXP®.

If you intend to draw simple circuit diagrams or to simulate the existing circuit diagrams, 64 MB RAM is adequate. However, minimum 128 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

When you purchased FluidSIM, you received a CD and possibly a license connector . Aside from the educational films, the CD contains both the full version and the student version of FluidSIM.

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.

2.2.1 Installation with Program Activation

With the first start of FluidSIM you will be asked to activate FluidSIM. The activation follows one of the following three variants.

- 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.

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 *blue* license connector for single-position systems defines how many times FluidSIM can be installed. If, for instance, you have bought a classroom license, exactly the corresponding number of single-position installations can be performed. Note, however, that by each de-installation the license connector can be "recharged" by simply connecting it and starting the de-installation program (see section 2.4).

The *green* 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.

FluidSIM Full Version: Installation from CD

⇢ If you purchased a version with single-position license connector, make sure that your computer is switched off and attach the license connector to the parallel interface (LPT 1) of your PC.

Often there is a printer attached to the computer. The printer cables must be removed while installing FluidSIM.

⇢ Turn the computer on and start Microsoft Windows®.

⇢ Insert the CD.

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⇢ Click Run... in the Start Menu.

A dialog box opens.

⇢ 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 ⇢⇢”.

Note that with each start of FluidSIM the user name appears. Also note that the company’s name is stored in the license connector.

Import Online Activation Notes

During the activation of FluidSIM several features of your PC and the product ID are used to generate an individual license ID. 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 transfered to the new hardware. This happens automatically, if you again activate FluidSIM when starting the program with the new hardware.

Note that reactivation means license transferral: After a reactivation on a new hardware FluidSIM cannot be activated again on the original PC.

Blue License Connector for Single-Position Systems—Important Usage Notes

To avoid a mistakenly loss of your licenses, please consider the following tips:

- Modification of the system configuration
  De-install FluidSIM temporarily before you modify the system configuration (exchange of hardware components, re-installation of the operating system).
- Temporary de-installation of FluidSIM
  When temporarily de-installing FluidSIM, modified and newly created files can be preserved. A subsequent re-installation of FluidSIM will recognize these files.
- Hard disk failure
  In the case of a hard disk failure Festo Didactic GmbH & Co. KG will help to reactivate your FluidSIM license if you own a backup of the hard disk (phone: 0049-711-3467-0).

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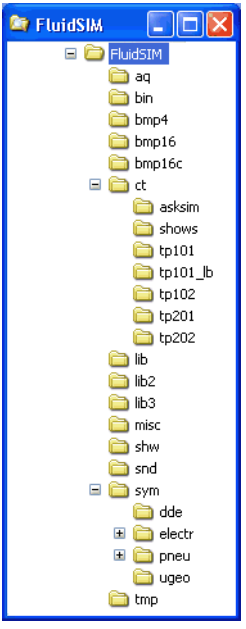
2.3 Supplied Files

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



The directory `aq` contains the knowledge bases for FluidSIM.

The directory `bin` contains the executable FluidSIM program along with additional libraries.
This directory also contains the registration information and the program `fduninst.exe`, which is necessary for de-installation.

You should not make any changes to this directory `bin`.

The directory `bmp4` contains the photos of components in the component library. These pictures have four gray scales for use with Microsoft Windows® with sixteen colors.

The directory `bmp16` also contains the photos of components in the component library. These pictures have sixteen gray scales for use with Microsoft Windows® with at least 256 colors.

The directory `bmp16c` contains the figures of both the component illustrations and the didactics material.

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:

- `asksim`: Circuits that were delivered with the “ASKSIM 2.0” simulation program.
- `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”.
- `tp101_lb`: Circuits in the textbook “Pneumatics Basic Level TP 101”.
- `tp102`: Circuits in the workbook “Pneumatics Advanced Level TP 102”.
- `tp201`: Circuits in the workbook “Electro-pneumatics Basic Level TP 201”.
- `tp202`: Circuits in the workbook “Electro-pneumatics Advanced Level TP 202”.

The directory `lib` contains the component library of FluidSIM as total view.

The directory `lib2` contains the component library of the versions 2.x of FluidSIM.

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The directory `misc` contains auxiliary files and option files for FluidSIM.

The directory `snd` contains sound files for FluidSIM.

The directory `sym` shows the component library of FluidSIM as a hierarchical view. In the same hierarchical fashion the contents of this directory is also shown in the menu Insert.

The directory `shw` contains files for use with presentations.

The directory `tmp` contains the pre-calculated circuit models and temporary files created by FluidSIM.

The complete FluidSIM software takes up approximately 16 MB of memory on the hard disk.

2.4 De-installation of a Single-Position License

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

- Connect the blue license connector to the parallel port (LPT 1).
- Click on the program icon `Remove FluidSIM-P` in the Start Menu `Program Files/Festo Didactic`. If the program icon cannot be found, start the program `fduninst.exe` in the `bin`-subdirectory of the FluidSIM directory.

The license connector will charge and you will be asked whether or not you would like to preserve user-modified files.

⇢ You should answer “Yes”, if you would like to keep the files that you created with FluidSIM, for example new circuit diagrams and presentations, and also information that you changed while using FluidSIM. When re-installing FluidSIM, you should use the same directory path.
You should answer “No”, if you want to completely remove FluidSIM from your computer.

If a problem occurs during de-installation, do not attempt to manually change or delete FluidSIM. Instead report problems and errors to Festo Didactic GmbH & Co. KG (phone: 0049-711-3467-0).

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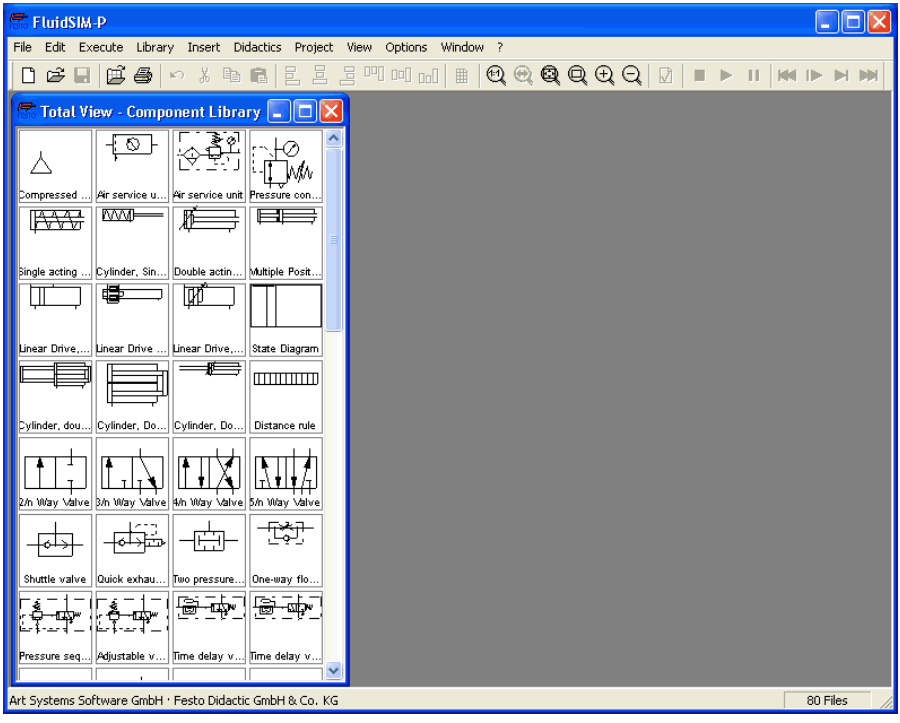
3. Introduction to Simulating and Creating Circuits

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.

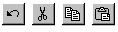
⇢ Start FluidSIM via the Start Menu under `Program Files/ Festo Didactic`.

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



The left-hand side shows the component library of FluidSIM in its total view; it contains pneumatic and electrical components for the creation of new circuit diagrams. The menu bar at the top of the window lists all the functions needed for the simulation and creation of circuit diagrams. The toolbar beneath this menu displays frequently used menu functions.

The toolbar contains the following nine 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.
   using a grid
6.
   zooming in and zooming out of circuit diagrams, component pictures, and other windows
7.
   superficial circuit checking
8.
   simulating circuit diagrams, directing animation (basic level)
9.
   simulating circuit diagrams, directing animation (additional functions)

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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®.

3.1 Simulating Existing Circuit Diagrams

Included with the FluidSIM installation disks are a number of working circuit diagrams. These circuit diagrams will be utilized in the following sections as demonstration and learning material. A more detailed description of the circuits can be found in the following workbooks “Pneumatics Basic Level TP 101”, “Pneumatics Advanced Level TP 102”, “Electro-pneumatics Basic Level TP 201” and “Electro-pneumatics Advanced Level TP 202” (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.

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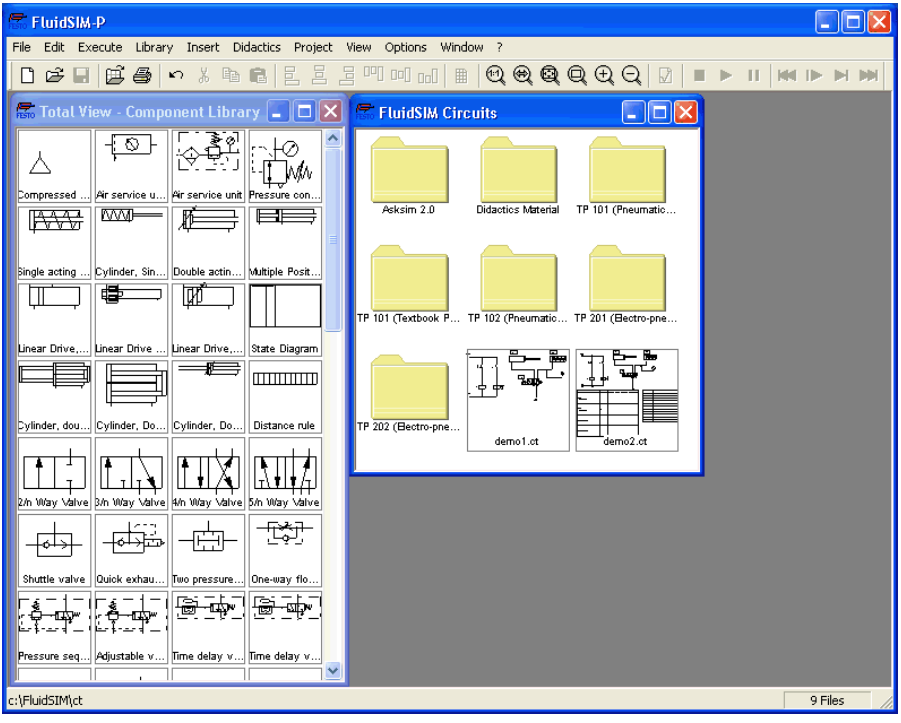
Preview windows containing overviews of existing circuit diagrams should appear:



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`.

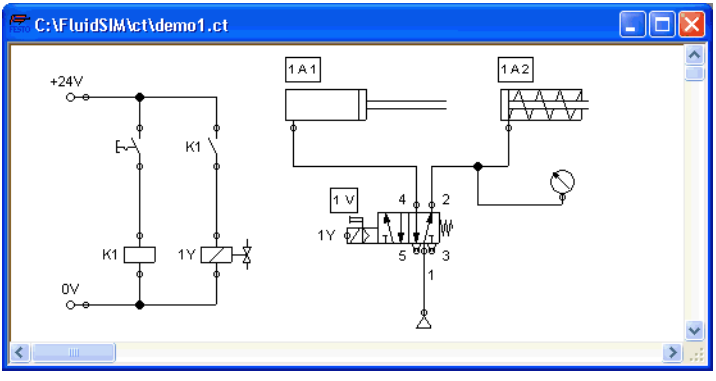
By double clicking a directory icon you go down to the respective subdirectory.

In the `ct` subdirectory of the `fl_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.

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.

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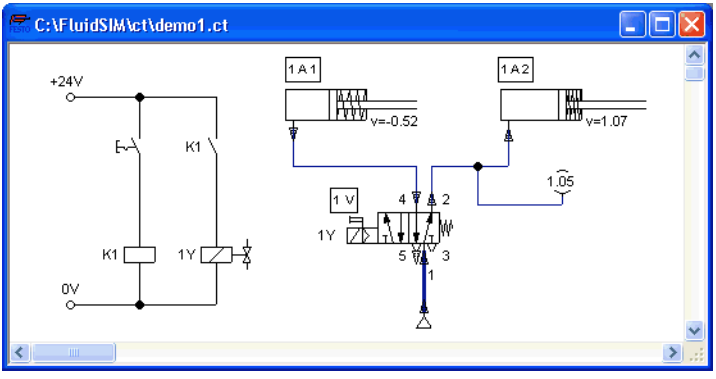
FluidSIM switches to the *simulation mode* and starts the simulation of the circuit diagram. When in the simulation mode, the mouse cursor changes to a hand.

During the simulation FluidSIM first calculates all electrical parameters. This step is followed by formulating the model of the pneumatic circuit, and, based on the model, the entire distribution for flow and pressure is calculated.

Formulating models is demanding. Depending on a circuit's complexity and the computer's power, a circuit's simulation may take considerable time.

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 then maximum
	Maximum pressure

The exact numeric values for pressures, flow rates, voltages, and currents are displayed on the attached measuring instruments. Section 4.5 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.

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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

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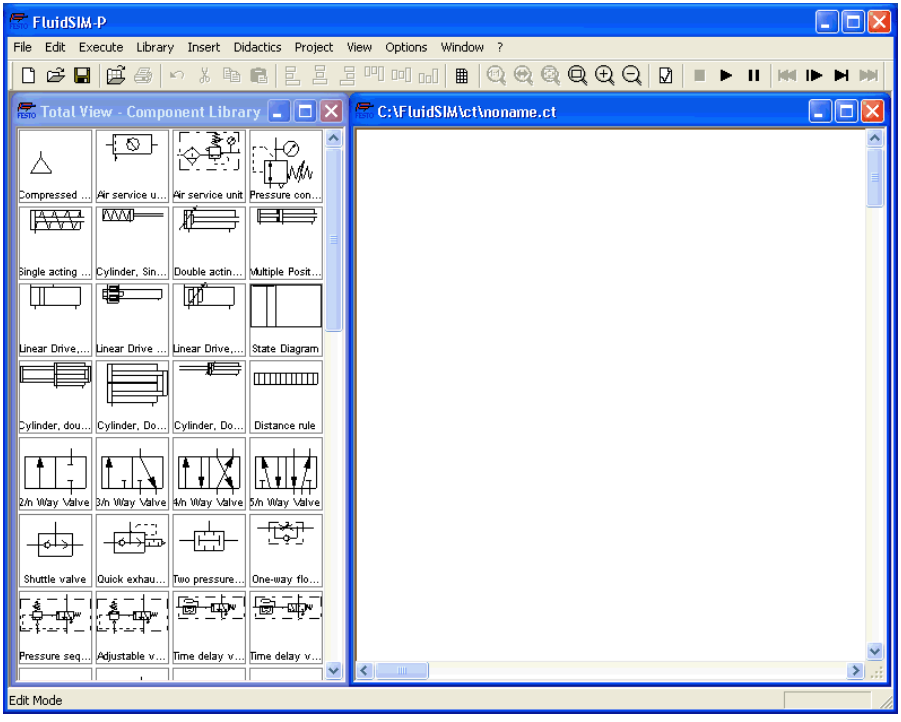
3. a relay switches
4. a switch is operated

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.

⇢ 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.

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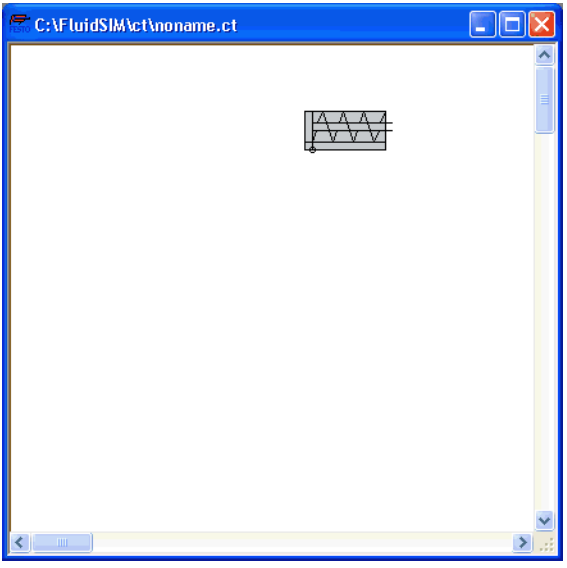
Using the scrollbars found to the right of and underneath the component library, you can scroll through the components. Using the mouse, you can “drag” and “drop” components from the component library onto the drawing area:

- 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 . 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:



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.

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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.

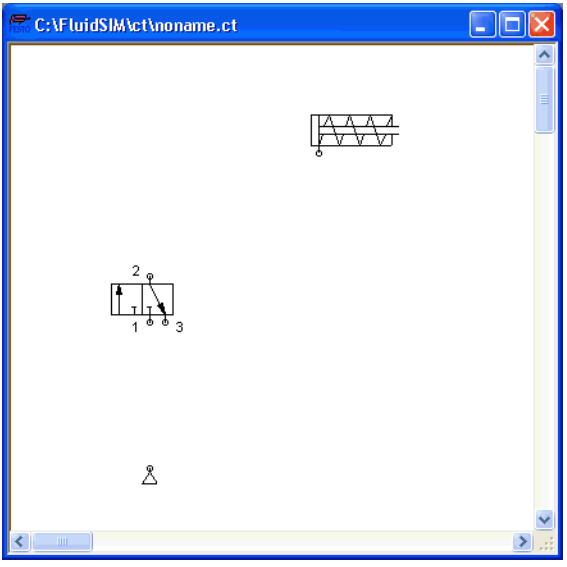
⇢ Highlight, say, select the first cylinder by clicking on it.

⇢ Delete the cylinder by clicking on ✂ (cut) or under Edit Delete or by pressing the Del 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.

⇢ Arrange the components in the following manner:



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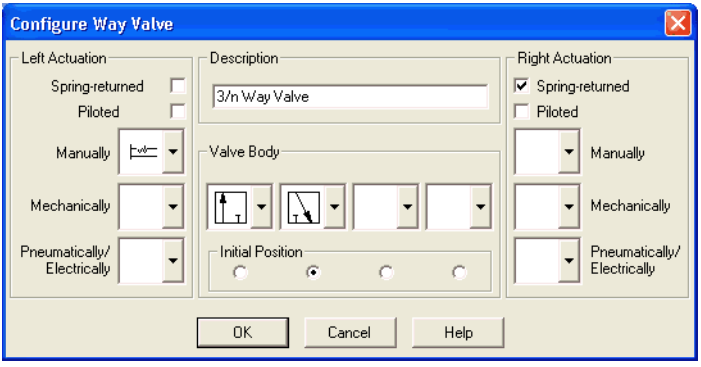
Double click the valve to assign an operation mode to it. A dialog box appears:



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 “manual”, “mechanical”, or “pneumatic/electrical”. 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.

- “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.

⇢ 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.

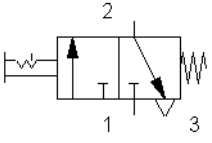
Since the connection “3” of the valve serves as air discharge, an exhaust should be assigned to it.

⇢ 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:



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

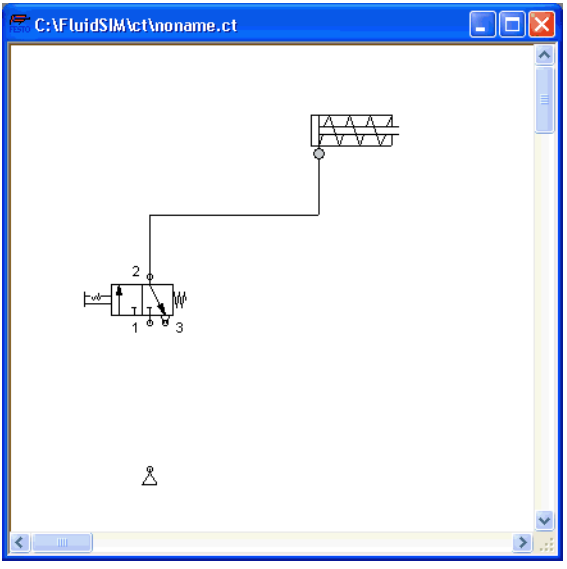
In Edit Mode, the mouse cursor changes to a cross-wires pointer ⌖, when it is above a component *connection*.

⇢ 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.

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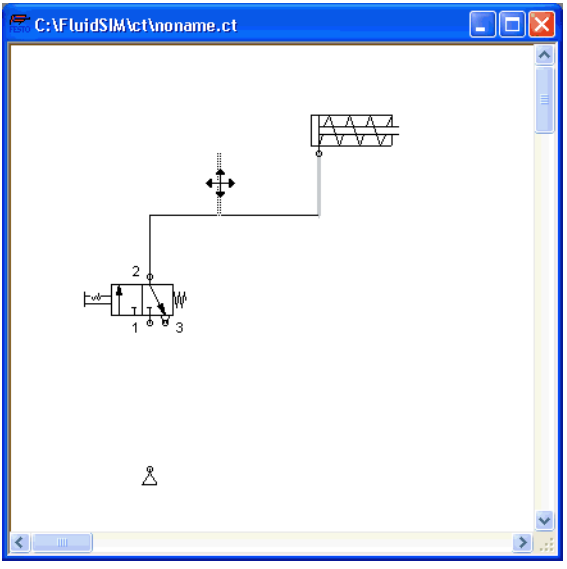
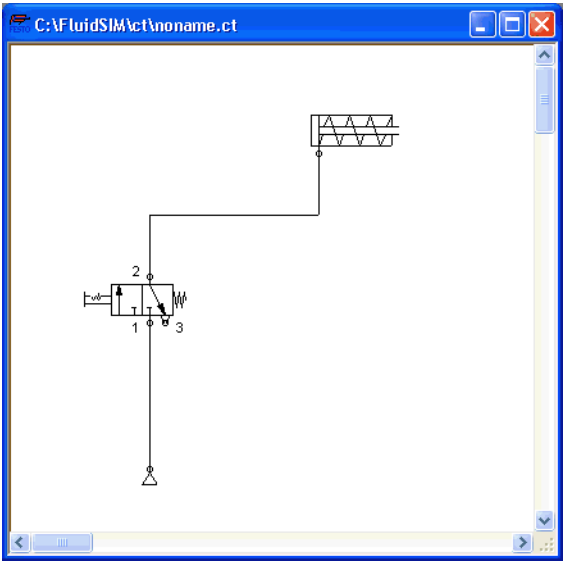
Immediately, the line is redrawn:



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.

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.

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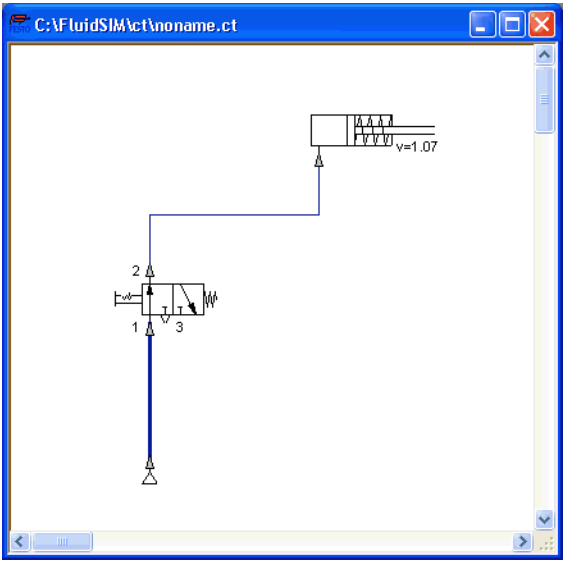
During simulation all pressures and flow rates are calculated, all lines are colored, and the cylinder's piston extends.



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.

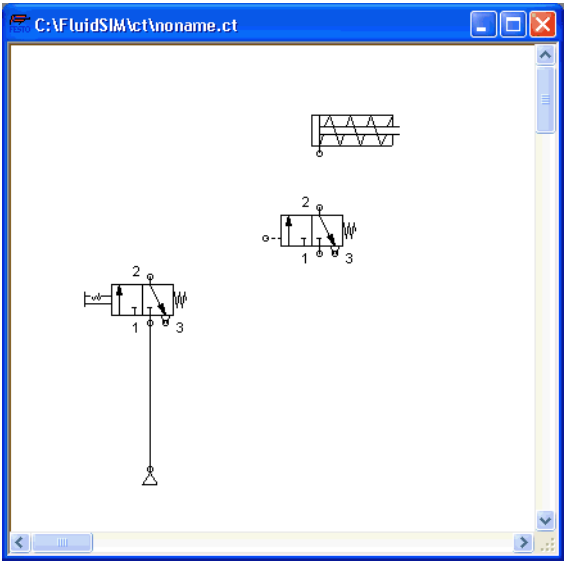
⇢ Click on the valve so that the cylinder may retract.

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.

⇢ 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.

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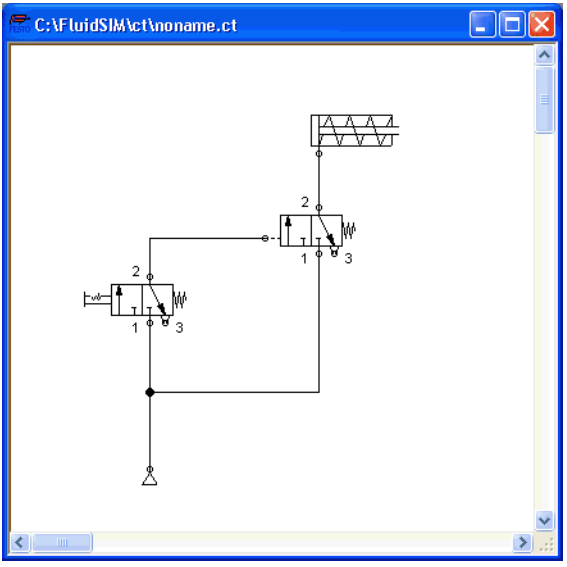
In reality, to connect a component to an existing line requires a T-connection . FluidSIM automatically creates a T-connection when you draw a line from a connection to an existing line.

- 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.

- When possible, draw the line so that the wiring diagram is arranged clearly.

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.

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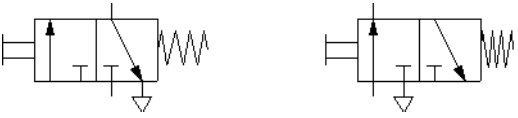
FluidSIM not only animates manually operated components during changeover, but nearly all components with multiple states.

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



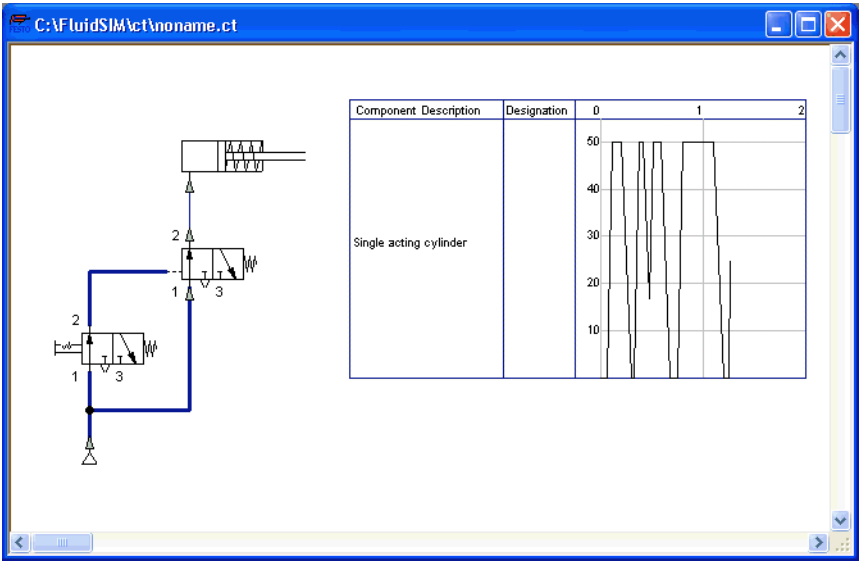
Components whose switching status is not locked remain activated as long as the mouse button is held down.

⇢ 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.

⇢ Start the simulation and observe the state diagram.



Note that several state diagrams can be used in the same circuit; however, several components may also share the same state diagram. A component is added by simply dropping it onto the state diagram. If a component is dropped a second time on the diagram, it will be removed from there. State quantities of the following components can be recorded and displayed in the state diagram:

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Component	State
Cylinder	Position
Way valve	Position
Manometer	Pressure
Pressure or switching valve	State
Switch	State

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

4. Advanced Concepts in Simulating and Creating Circuits

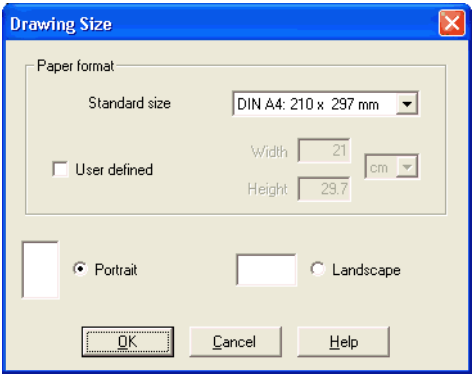
This chapter contains advanced concepts and functions, which can be used when simulating and creating circuits with FluidSIM.

4.1 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.

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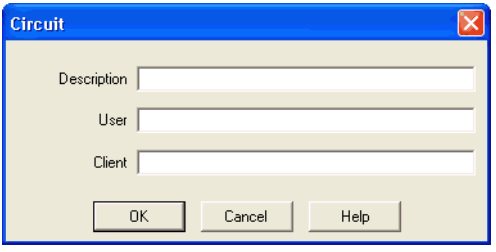
For orientation purposes, under File | Properties... additional information can be stored along with each drawing. The text that is entered in `description` is shown in the preview window below the respective diagram.



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 to far. By clicking under Edit | Redo, the circuit is returned to its original state before undo ↶ 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.

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.

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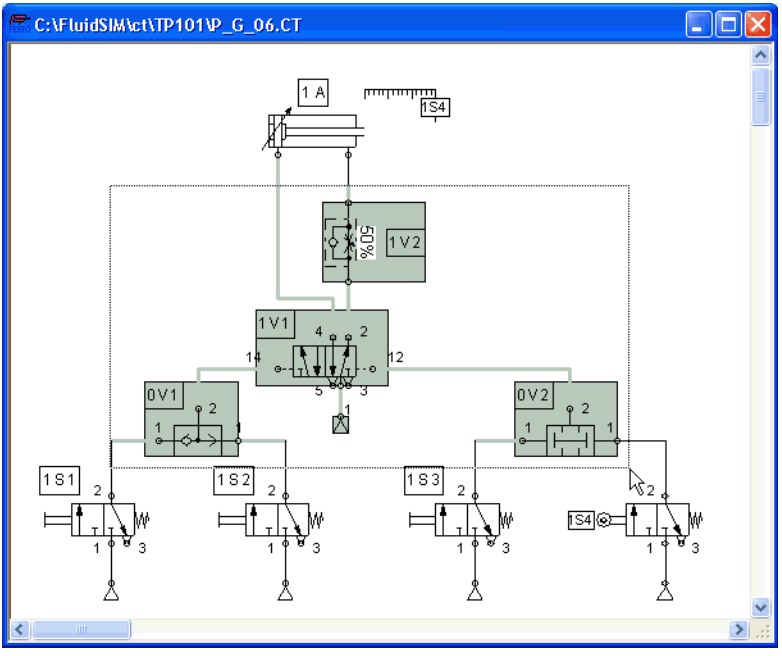
All components enclosed, either partially or fully, by the rubber band, are selected.



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.

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.

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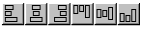
Aligning Objects

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 furthermost 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.

Rotation

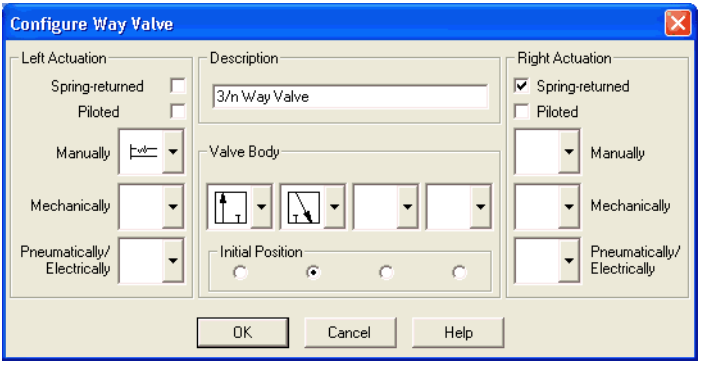
Selected components can be rotated by 90°, 180° or 270°. There is a short cut for rotating a *single* component in steps of 90° : pressing the Ctrl key and double clicking on the component.

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.

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.



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 "manual", "mechanical", or "pneumatic/electrical". 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.

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- “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.

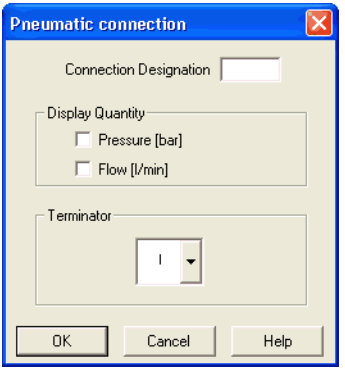
- “Initial Position”
  This button defines the valve’s initial position (sometimes also called normal position or neutral position), which is the position without having any operation applied to the valve. Note that this setting is only exploited if it physically does not contradict a spring-returned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

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. In FluidSIM blind plugs can be set or deleted by double clicking a connection when being in Edit Mode. Likewise a connection can be selected and the menu entry Edit | Properties... be clicked. In either case the following dialog box opens.



Description of the dialog box:

- "Connection Designation"
  If enabled via View | Show Connection Descriptors, the contents of this field is displayed at the connection.

- "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.

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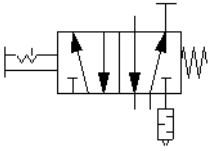
A blind plug is indicated by a crossbar, an exhaust is indicated by its respective DIN symbol:



Zoom Features

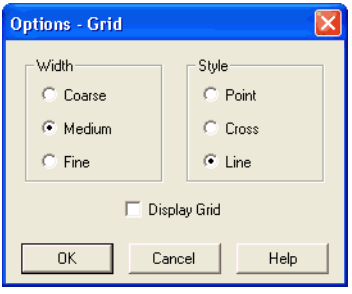
The content of windows can be enlarged by clicking on or View Zoom In or reduced by using or View Zoom Out. The short cut keys for this function are and respectively. If your mouse device is equipped with a mouse wheel you can roll the wheel while holding down the Ctrl key to zoom in.and out, respectively

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.

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.

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.

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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.

4.2 Additional Simulation Functions

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

Simultaneous Actuation of Several Components

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.

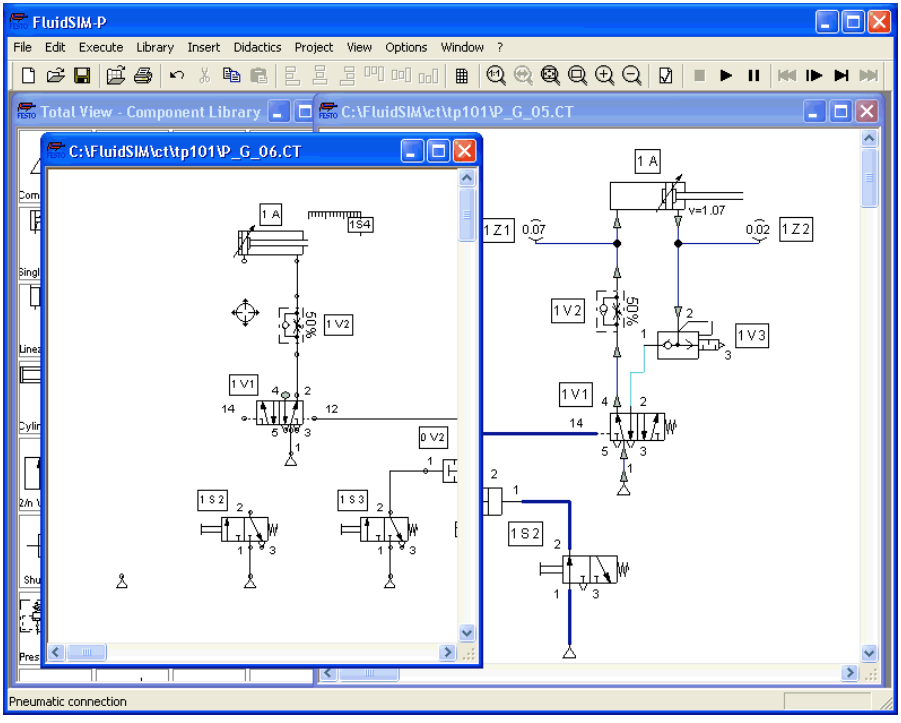
Switching to the Edit Mode

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.

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.

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4.3 Linking Components Automatically

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

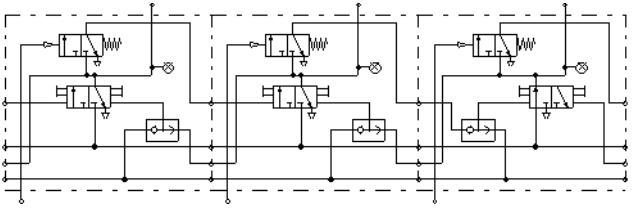
Insertion of T-connections

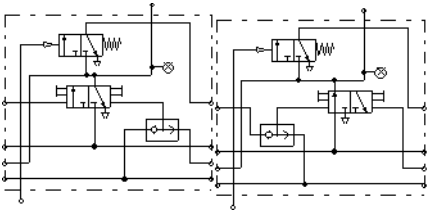
FluidSIM automatically inserts a T-connection when a line is drawn from a component *connection*. to an already existing line. This functionality applies to pneumatic as well as electrical lines.

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.

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 4.7).

4.4 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.

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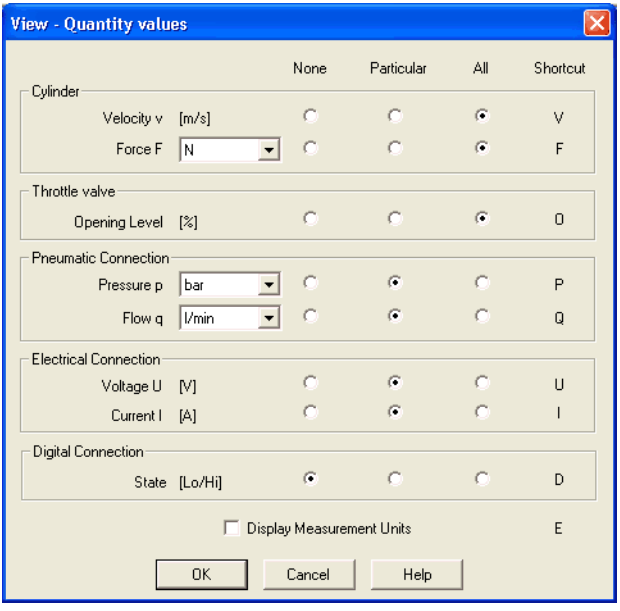
4.5 Displaying Quantity Values

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

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



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

When displaying pressure values it can be chosen between two different units, “Bar” and “MPa”. This setting affects the display of pressure values at connections, at components, and within 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.

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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
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 (⇠ 0.0001), no numerical value will be displayed. Rather, the symbol “⇢ 0” for a small positive value or “⇠ 0” for a small negative value is shown.

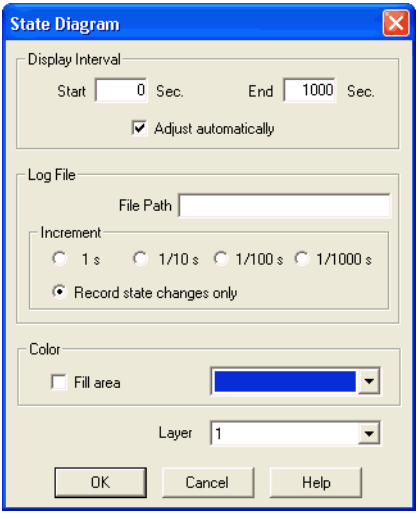
4.6 Displaying State Diagrams

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

Note that several state diagrams can be used in the same circuit; however, several components may also share the same state diagram. A component is added by simply dropping it onto the state diagram. If a component is dropped a second time on the diagram, it will be removed from there.

⇢ Being in Edit Mode click on Edit | Properties... .

The following dialog box opens:



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Description of the dialog box:

- “Display Interval”
  Defines start and end point in time for state value recording. These boundaries must not be known prior to a simulation but can be set afterwards since FluidSIM records always all state values during the entire simulation period.
  If the “Adjust automatically”-option is enabled, boundaries of the time interval are ignored. The timeline is scaled such that the entire simulation time is always displayed.

- “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-

- “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.

- “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 View | Layers... 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
Manometer	Pressure
Pressure or switching valve	State
Switch	State

4.7 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 4.8)
9. lines that cross through connections to which they are not connected

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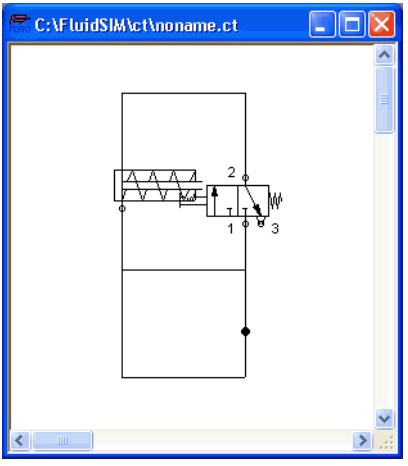
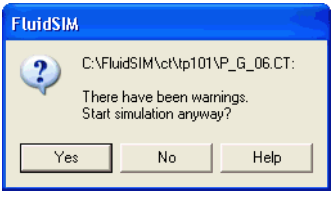
The following circuit diagram contains mistakes of type 1 to 3:



⇢ Click on ☑ or Execute | Check Superficially.

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

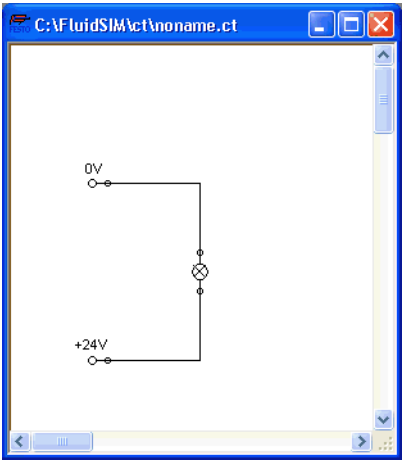
After the instructions, you may decide if the circuit should be simulated anyway:



4.8 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.

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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.

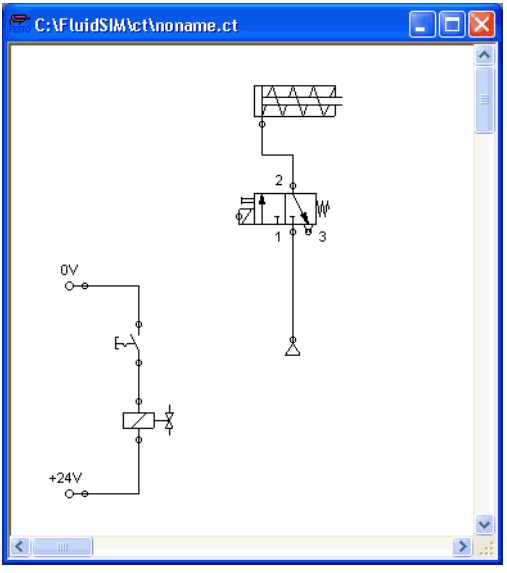
A label has a specific name and can be assigned to a component. If two components have the same label name they are linked together, although no apparent line is visible between them.

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 .

⇢ 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... .

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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.

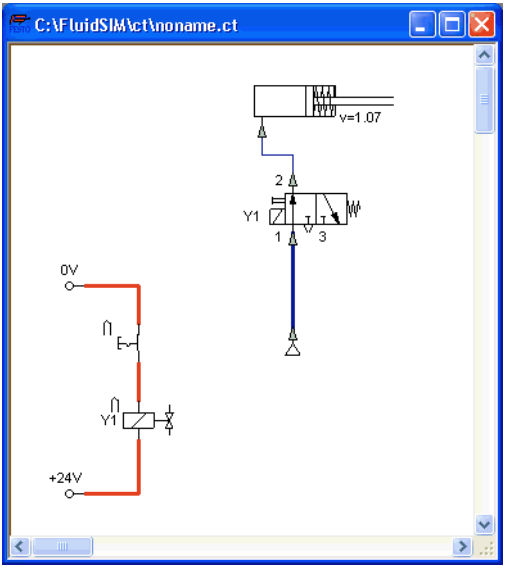
⇢ Start the simulation.

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 4.5 applies here.

⇢ Operate the electrical switch.

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



Electrically or pneumatically operated valves can only be switched manually, when there is no control signal applied.

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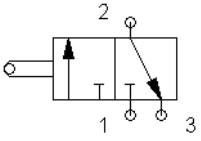
Aside from a manual or electrical operation, valves can be controlled *mechanically*, either through a cylinder piston or a magnet mounted at the piston. Such a coupling is realized in the same way an electrical coupling is established: By means of labels, which are assigned to the cylinder's distance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

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



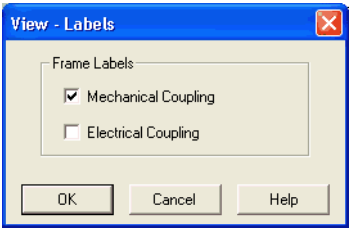
⇢ Double click the mechanical actuator.

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.

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.

4.9 Operating Switches

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

Switches at Cylinders

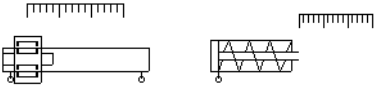
Limit switches, proximity switches, and mechanically operated valves can be activated by the piston of the cylinder. Therefore, it is necessary to use a distance rule at the cylinder to position the switches correctly:

⇢ 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.

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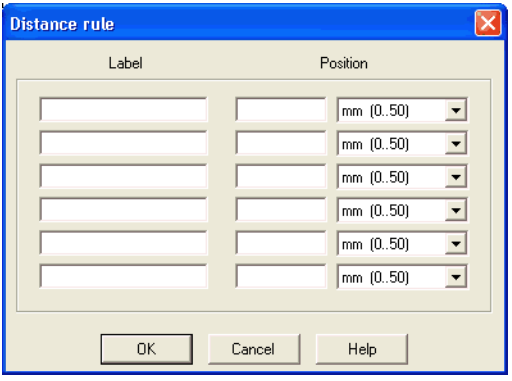
The following dialog box appears:



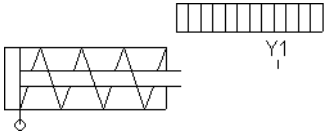
Description of the dialog box:

- “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 text insertion fields on the right are for defining the exact position of the switches on the cylinder.

⇢ Insert “Y1” as the label name in the first row and “35” for its position. Close the dialog box by clicking on “OK”.

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

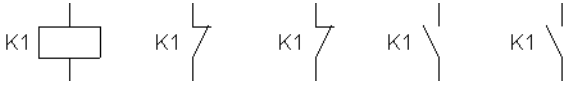


As a consequence, the cylinder will activate the switch or the valve labeled “Y1” if its piston has traveled by 35 mm. To define a label in the electrical circuit double click on the respective component; to define a label at a mechanical actuator of a valve double click the respective “connection” of the valve.

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.

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.

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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.

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:

4.10 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 following table gives a complete overview:

Component	Adjustable parameter
Adjustable vacuum actuator	Nominal pressure
Air service unit	Operating pressure
Analog pressure sensor	Switching pressure
Compressed air supply	Operating pressure
Counter (electrical)	Counting pulses
Counter (pneumatic)	Counting pulses
Cylinder	Identifier, max. stroke, piston position, piston area, piston ring area
Delay relay	Delay time
Differential pressure switch	Differential pressure
Distance rule	Switch positions
One-way flow control valve	Opening level
Pressure control valve	Operating pressure
Time Delay valve	Opening level

The dialog box for setting these parameters can be opened with a double click or Edit | Properties... .

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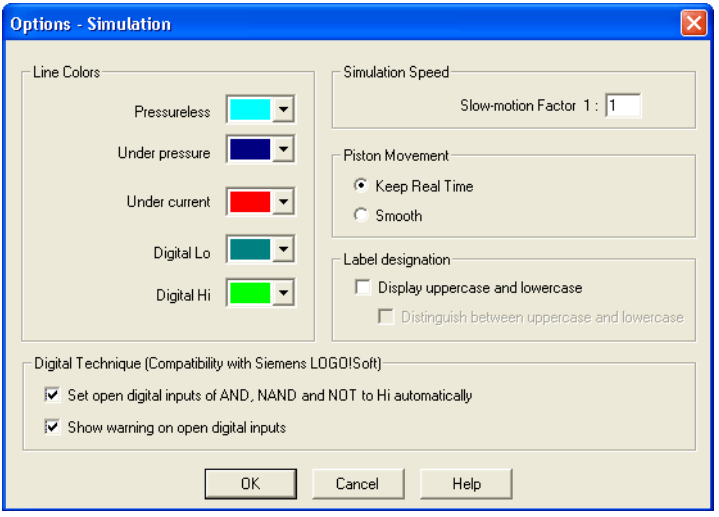
4.11 Settings for Simulation

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.

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

- “Piston Movement”
  With the setting “Keep Real-time” FluidSIM animates the piston as it would move in reality (real-time). The slow-motion factor is still considered. The requirement for the observance of real-time requires a powerful computer.
  The setting “Smooth” uses the available power of a computer to its best advantage. The goal here is to run the simulation without a sticky piston movement. Hence the movement of the piston can be faster or slower than the piston movement in reality.

- “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.

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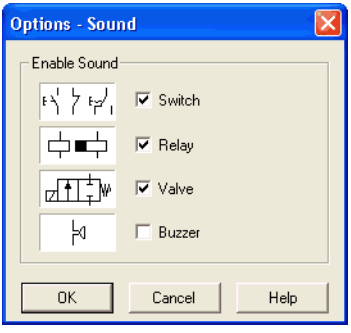
- “Digital Technique (Compatibility with Siemens LOGO!Soft)”
  It is a useful convention in the field of digital technology setting open input ports of AND, NAND, and NOT components to "Hi". Otherwise, e. g. an AND gate with three input ports would not function as expected if only two of its input ports 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, and buzzer.

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

4.12 OPC and DDE communication with Other Applications

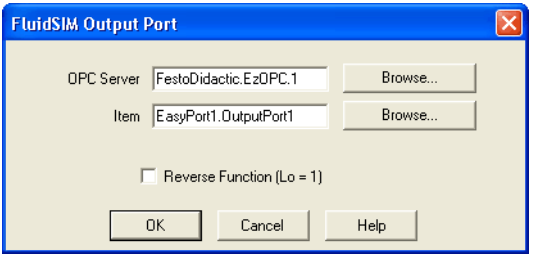
FluidSIM can exchange data with other applications; thus it may coupled with programmable logic controllers, SPS, for instance. Prerequisite for such a coupling is the ability of the partner application to provide an “OPC interface” and to act as a so-called “DDE client”, respectively. From within a 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 “Use OPC” in the Options 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.

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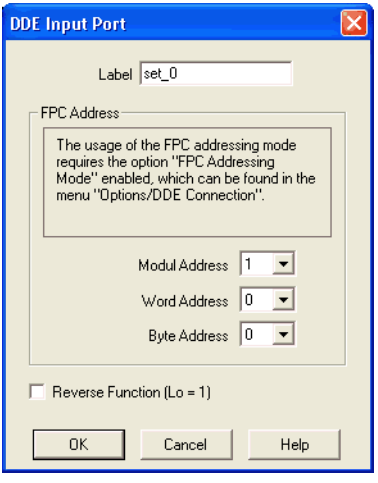
- “Item”
  Enter the data item here or click on Select ... and select an item from the list.

- “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 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:

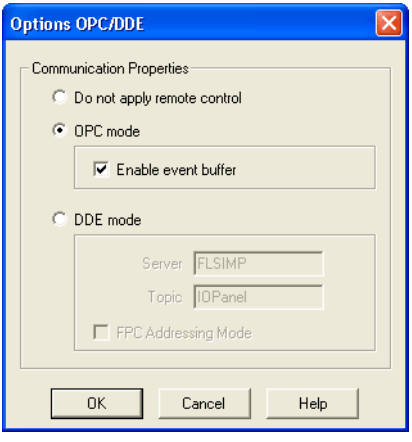
- “Label”
  Label of the DDE component. This label is used from within the partner application to request or to set values in FluidSIM via DDE.

- “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.

- “Reverse Function”
  Inverts the logical values of the DDE components. Normally, current flow corresponds to a logical 1.

4.13 Settings for the OPC/DDE communication

Clicking on Options OPC/DDE Connection... opens the following dialog box with settings for the OPC and DDE communication:



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Description of the dialog box:

- “Do not apply remote control”
  This option disables OPC and DDE communication in FluidSIM. If this option is checked FluidSIM will not respond on attempts to open a connection by other applications.

- “OPC mode”
  Choose this option, if FluidSIM shall be coupled with other applications via OPC.

- “Buffer events”
  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.

- “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.

The usage of the OPC/DDE interface is introduced in Chapter 4.12.

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.

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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.

In the case that a photo or a further illustration exists relative the selected components, the following functions can also be utilized: Component Photo and Component Illustration. In the case that varying types of components have been selected, the choice of components is not clear, and none of the above three menu entries will be enabled.

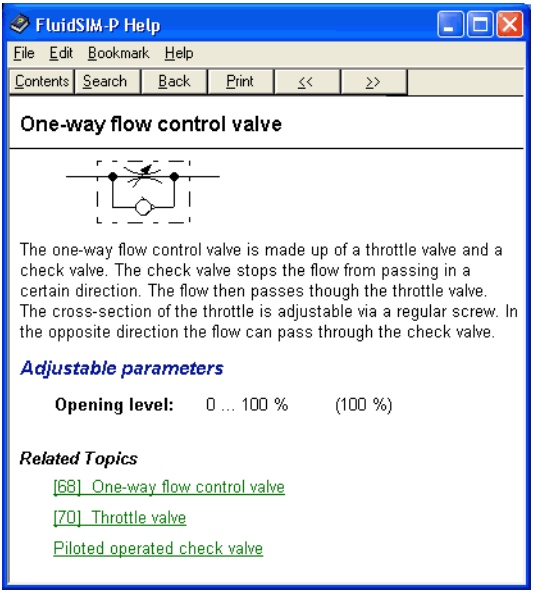
If the current window shows a picture from the didactics material, the menu entry Topic Description will be enabled.

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.

⇢ Select the one-way flow control valve, and click on the menu item Component Description under the Didactics menu.

The following page opens:



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 Photos

In FluidSIM most components possess an accompanying photo.

⇢ Select for example a cylinder and click on Component Photo in the Didactics menu.

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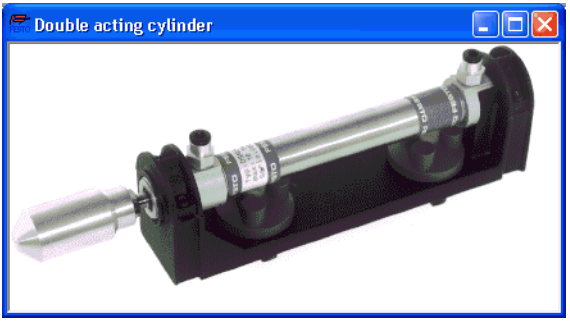
The following photo appears on the screen:



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.

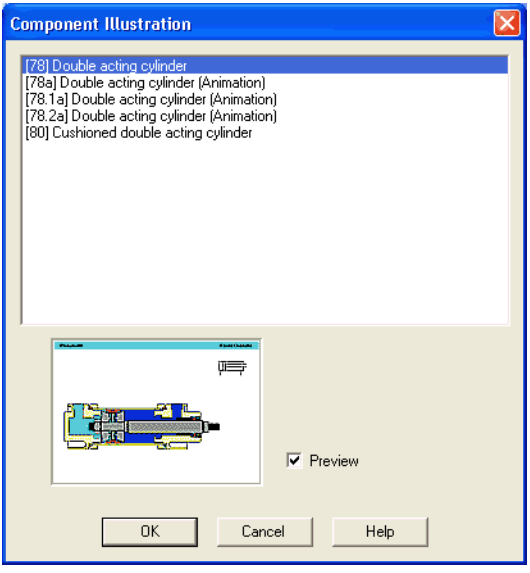
Components, that do not exist in reality, simply have no photo. Examples include the text component and the distance rule.

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 a cylinderand click on Component Illustration under the Didactics menu.

The following dialog box appears:



Description of the dialog box:

- “Topics”
  This field contains a listing of sectional views, animations, and circuits which refer to the functional characteristics of a single component. By double clicking on a line in the list, the dialog box disappears, and a window with the selected information is opened. The highlighted bar in the topics list can be moved by mouse click or by using the arrow keys; however, the highlighted bar will not respond to any movement of the scrollbars.

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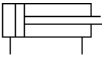
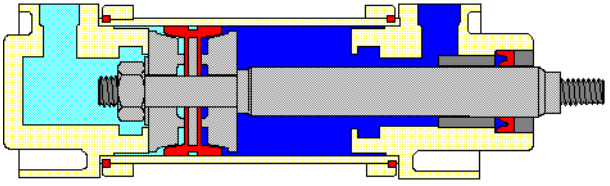
- “Preview”
  When the “Preview” setting is activated, the picture that pertains to a selected topic appears underneath the topics list.

⇢ Click on the line for topic `[78] Double acting cylinder.`

The following picture appears:





Double acting cylinder

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.

⇢ Select a quick exhaust valve, and click on Component Illustration in the Didactics menu.

⇢ Double click on a topic referring a sectional view that 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.

In addition, there is a loop mode for animation. When this mode is turned on, an animation will run and repeat itself until ■ is clicked. The loop mode can be activated in the dialog box for the didactics options, which is opened by clicking on Didactics... Options.

When more than one topic pertains to a component, or there exist additional topics to similar components, a dialog box containing a listing of these topics is opened when clicking on Component Illustration.

Topic Descriptions

FluidSIM also provides a textual description for all topics in the didactics material. If the current window contains a picture from the didactics material, for example a sectional view of a component or an exercise, a page with the related topic description can be opened by clicking on Didactics Topic Description.

⇢ Open the topic 33 by clicking on Working Principle... in the Didactics menu.

⇢ Click on Topic Description in the Didactics menu.

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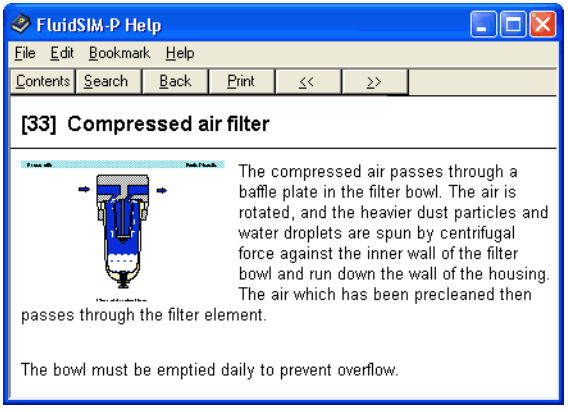
The following page opens:



Beneath the textual description, also a miniaturized representation of the related picture is given.

5.2 Selecting Didactics Material from a List

The entries Pneumatics Basics..., Working Principle..., and Exercise... under the Didactics menu present the didactics material of FluidSIM organized in the form of three topics lists. From these lists topics can be chosen and viewed independently of the current window and possibly selected components.

Pneumatics Basics

Under this menu entry those overview pictures, sectional views, and animations are comprised that aid in teaching basic pneumatic knowledge. Here you can find information for such topics as the representation of diagram symbols and their meaning, animations relating to element designations, and simple circuit diagrams that demonstrate the interaction of individual components.

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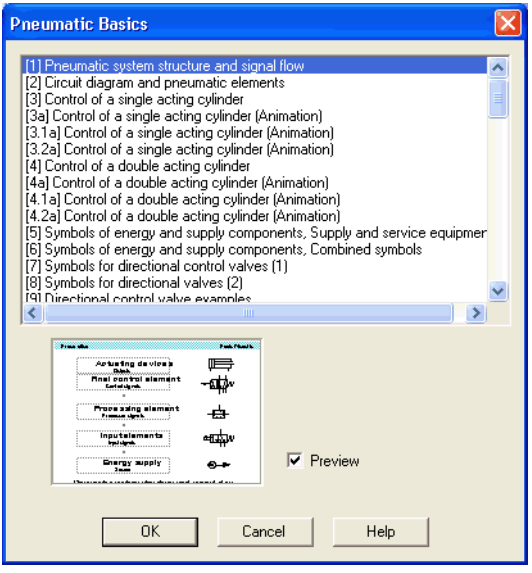
⇢ Click on Pneumatics Basics... under the Didactics menu to open a dialog box containing the topics list for basic concepts in pneumatics.



Description of the dialog box:

- “Topics”
  This field contains a listing of topics pertaining to basic pneumatic knowledge. By double clicking on a line in the list, the dialog box disappears, and a window with the selected information is opened. The highlighted bar in the topics list can be moved by mouse click or by using the arrow keys; however, the highlighted bar will not respond to any movement of the scrollbars.

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

Clicking on “OK” has the same function as double clicking on a line in the topics list; clicking on “Cancel” closes the dialog box without choosing a topic.

If the chosen topic is an animation, it can be started by clicking on (see section 5.1).

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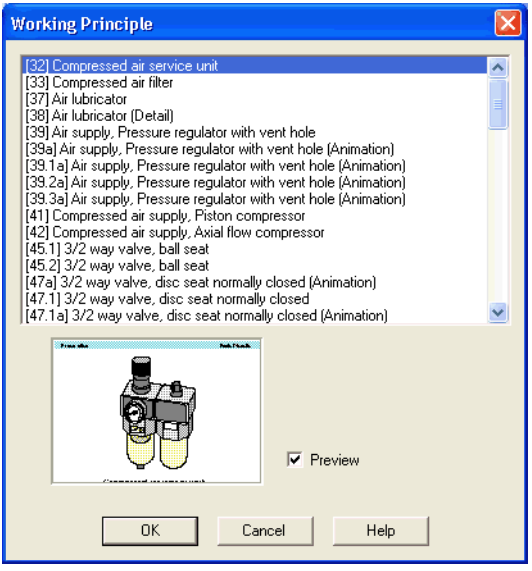
Working Principles

Sectional views that refer to the function of single components can be found under Working Principle... in the Didactics menu. For several components, their sectional view can be animated. In the same way that a topics list is opened for the pneumatics basics, a dialog box containing a list of topics is opened when clicking on Didactics Working Principle....



Description of the dialog box:

- "Topics"
  This field contains a listing of sectional views that refer to the function of single components. By double clicking on a line in the list, the dialog box disappears, and a window with the selected information is opened. The highlighted bar in the topics list can be moved by mouse click or by using the arrow keys; however, the highlighted bar will not respond to any movement of the scrollbars.

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

Exercises

FluidSIM provides eight practice assignments with standard exercises in the field of electro-pneumatics. Each assignment consists of three pictures. The first picture shows the problem, and the second picture shows one attempt at solving to demonstrate a basic idea. The third picture shows the complete solution in the form of a circuit diagram.

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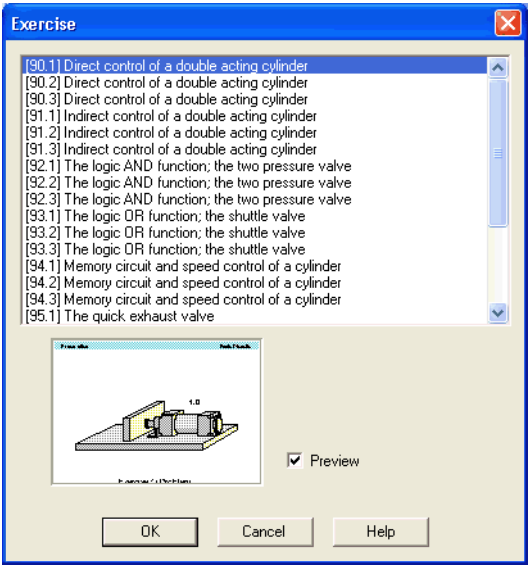
⇢ Click on Didactics Exercise... to open a dialog box that contains the exercises.



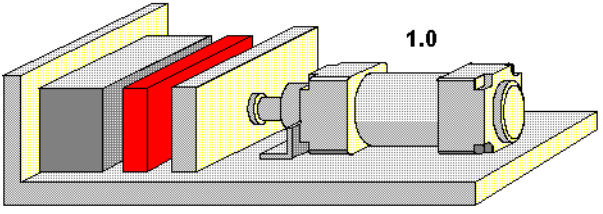
Description of the dialog box:

- “Topics”
  This field contains a listing of exercises, which are always based on three pictures. By double clicking on a line in the list, the dialog box disappears, and a window with the selected information is opened. The highlighted bar in the topics list can be moved by mouse click or by using the arrow keys; however, the highlighted bar will not respond to any movement of the scrollbars.

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

⇢ By double clicking on its name in the dialog box, choose the exercise `The time delay valve.`

The following window is opened:



Exercise 8: Problem

To go on to the next picture, you must either click on ▶ or set the exercise to an automatic continuation (see section 5.5).

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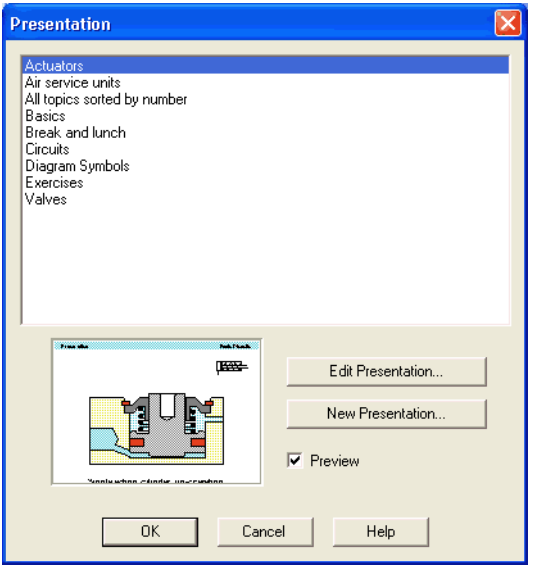
5.3 Presentations: Combining Instructional Material

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.

- “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.

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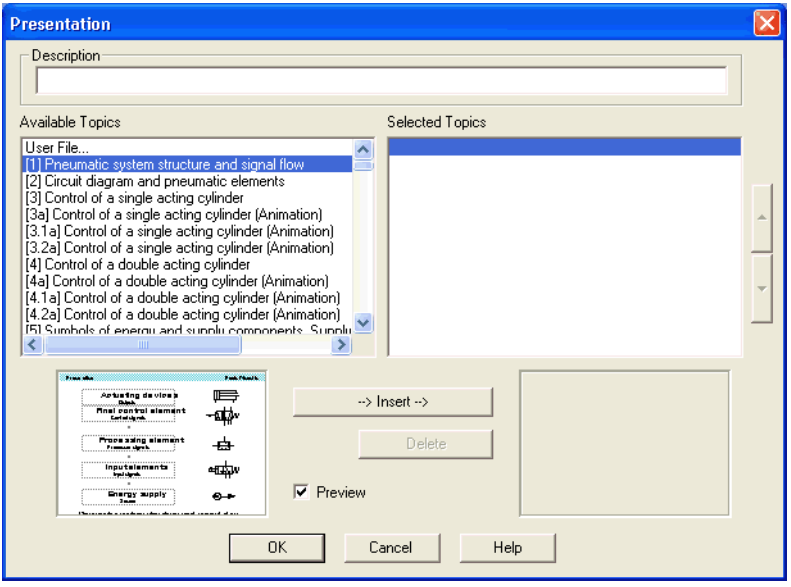
⇢ Click on “New Presentation” to open the following dialog box.



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.

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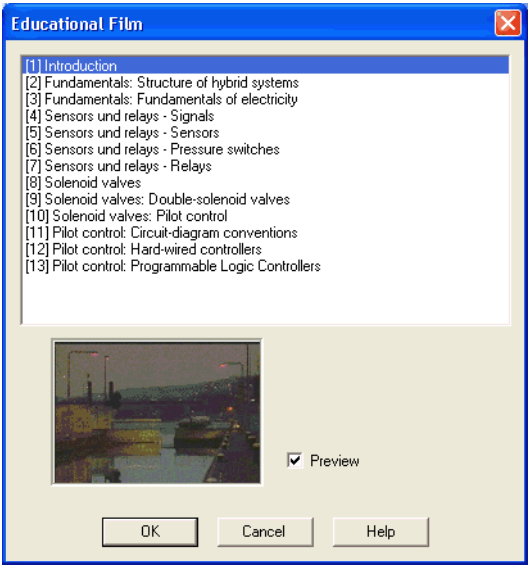
After creating a new presentation and closing the dialog box by clicking on “OK”, FluidSIM asks you to name the presentation *file*. Presentation files have the extension `.shw` and are located in the subdirectory `shw` under the `fl_sim_p` directory.

The structure of a presentation file is described more thoroughly in section 7.2.

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.

⇢ 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.

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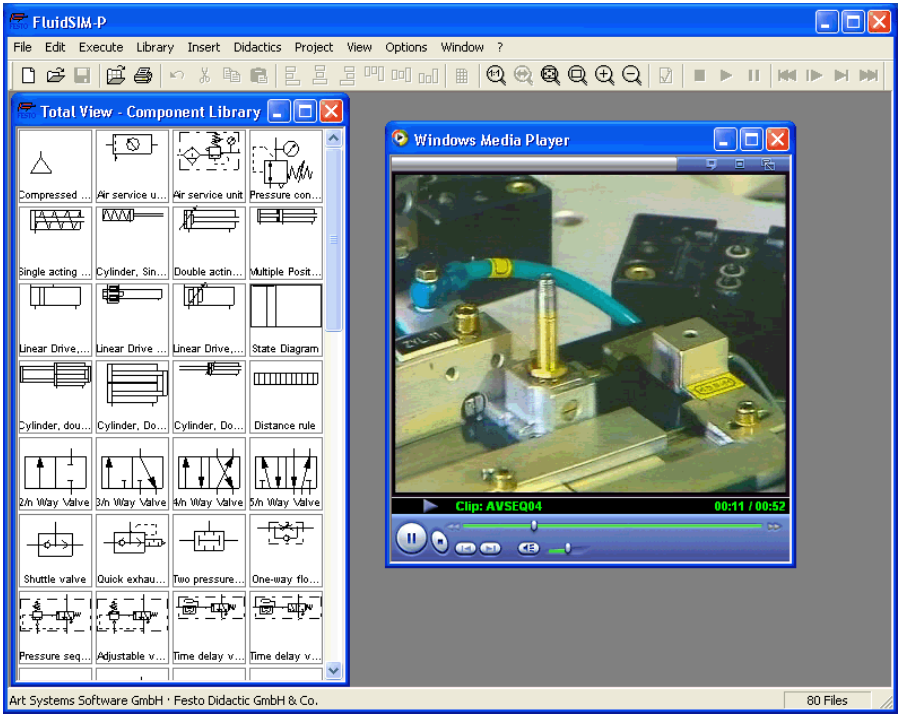
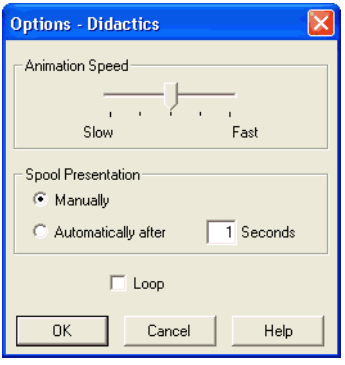
⇢ Click on `Sensors and relays--Signals` to start the playback of the selected film:



Underneath the window for the media playback, you will the 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.

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

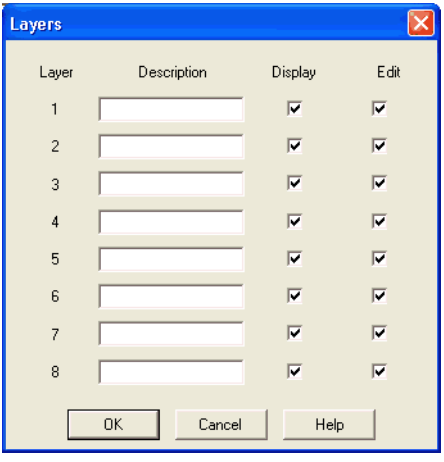
  If an animation is running unattached to a presentation, for example when started via Didactics | Component Illustration, this setting defines as to whether or not the animation will automatically repeat itself.

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.

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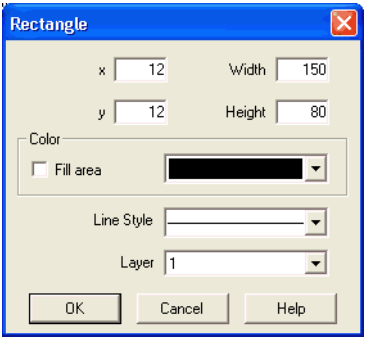
- “Edit”
  If the option “Edit” is disabled, the respective drawing layer is still visible but cannot be edited. I. e., the objects that belong to such a locked layer can neither be selected, nor moved or deleted. By this concept e. g. a drawing frame can be protected. To edit objects on a locked layer,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

- “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, ↔, ↕, or ↖↘. 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, ↔, ↕, or ↖↘. 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.

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- “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... .

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, ↔, ↕, or ↖↘. 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, ↔, ↕, or ↖↘. 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.

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- “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.

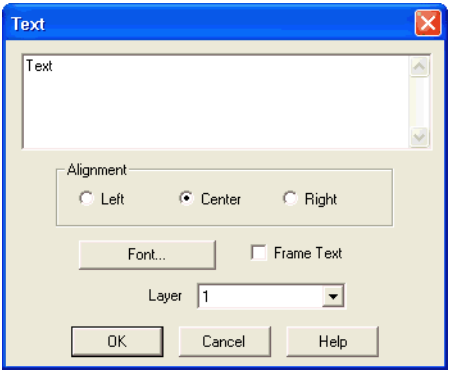
Text components function in much the same as other fluidic or electrical components in FluidSIM. The dummy text component *Text* can be found in the component library, and it can be dragged onto the drawing area. However, text components contain no connections.

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.

⇢ 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.

- "Frame Text"
  Draws a border around the text.

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- “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.

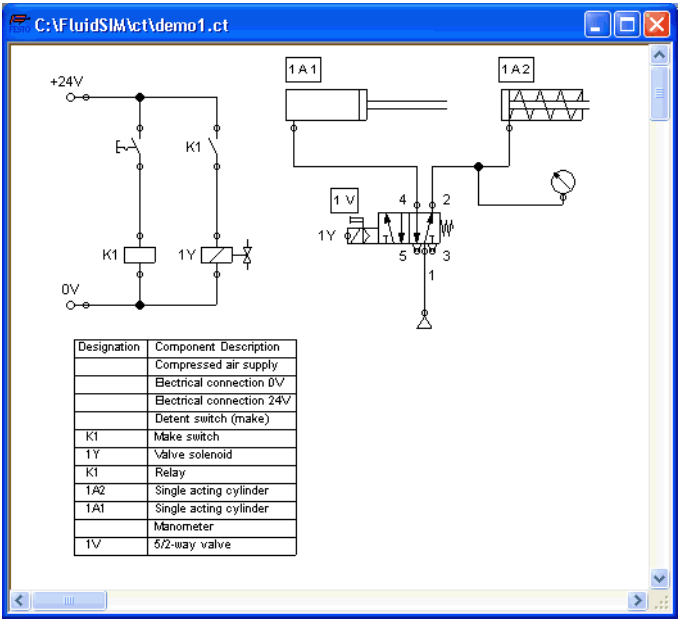
6.4 Parts Lists

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.



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

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.

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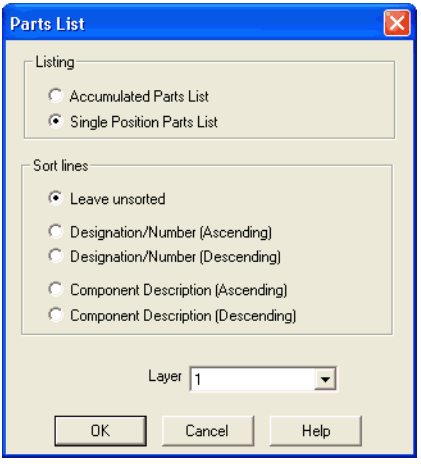
Properties of Parts Lists

⇢ 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:

- "Parts List"
  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”.

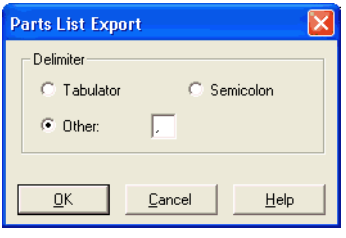
- “Layer”
  Defines the drawing layer of the parts list component. The drawing layer is set by clicking on the down-arrow at the right-hand side of the list and selecting a layer.
  Depending on the settings of drawing layer, the parts list component may not be visible or may not be selectable. To display 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...

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.



- “Tabulator”
  The tab-character is used as column separator.

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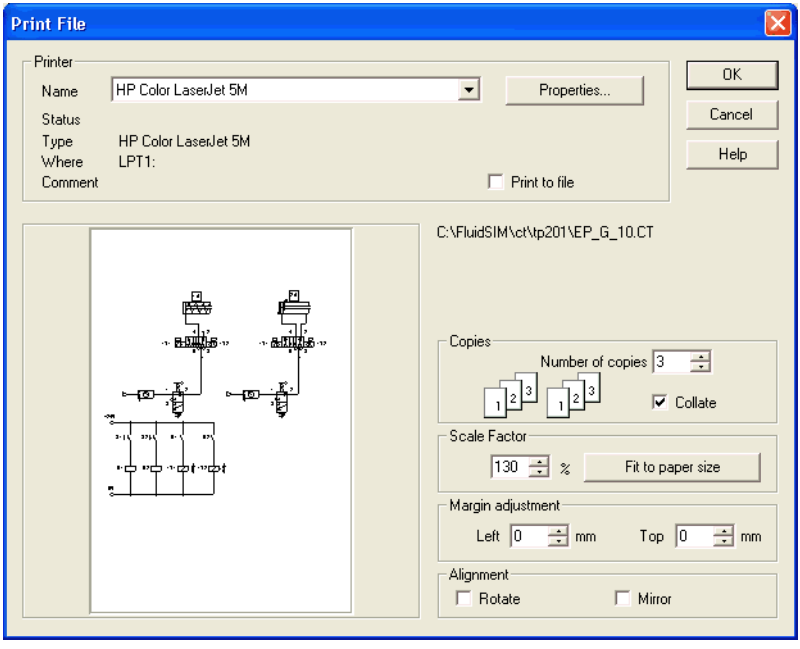
- “Semicolon”
  The semicolon is used as column separator.

- “Other”
  The entered character is used as column separator.

6.5 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.

- “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.

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- “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”.

6.6 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`.

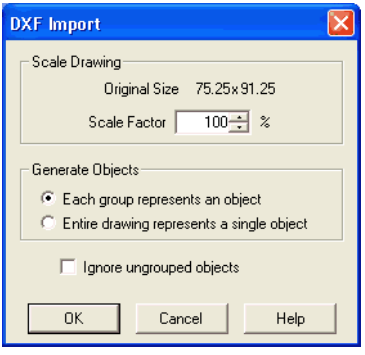
The exported drawings in the DXF format differ from those in FluidSIM in the following manner:

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.

6.7 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 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.

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- “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.

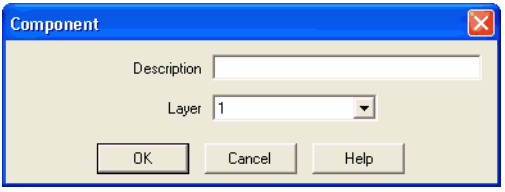
- “Entire drawing represents a single object”
  If this option is enabled, the entire drawing is treated as a single object.

- “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... .

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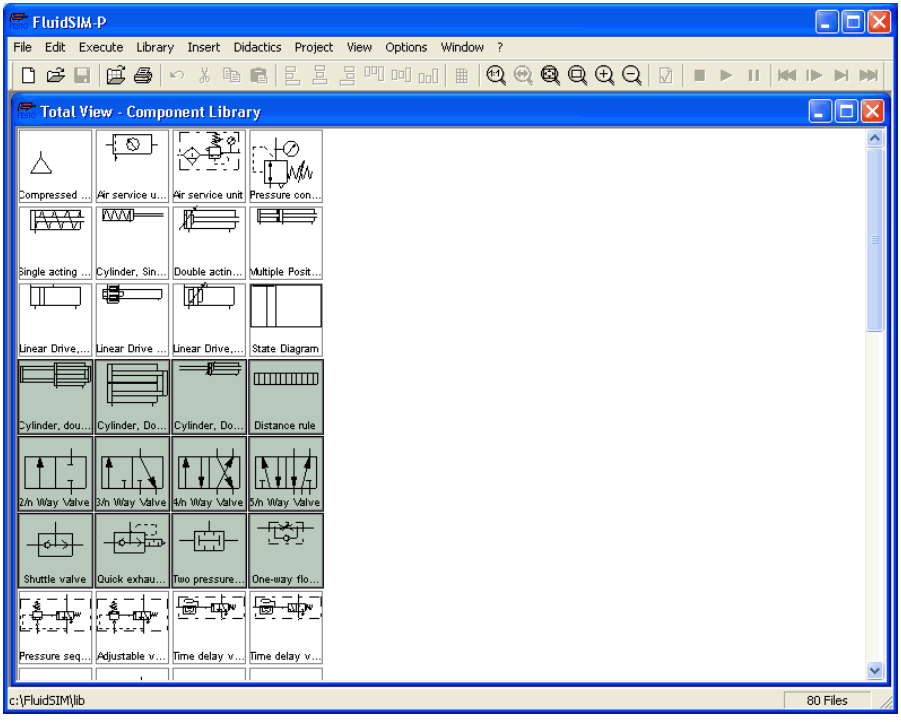
6.8 Using and Organizing Component Libraries

Rearranging a Component Library

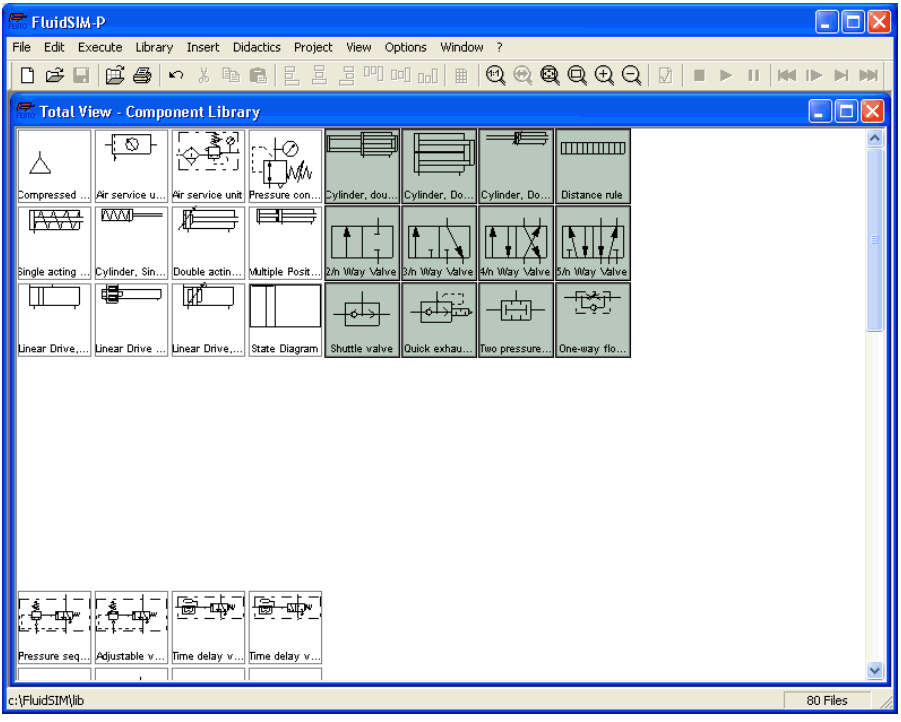
The components in the component library can be rearranged according to their usefulness and the desire of the user.

⇢ Enlarge the window of the component library.

⇢ Using the rubber band, select for example the following twelve components:



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



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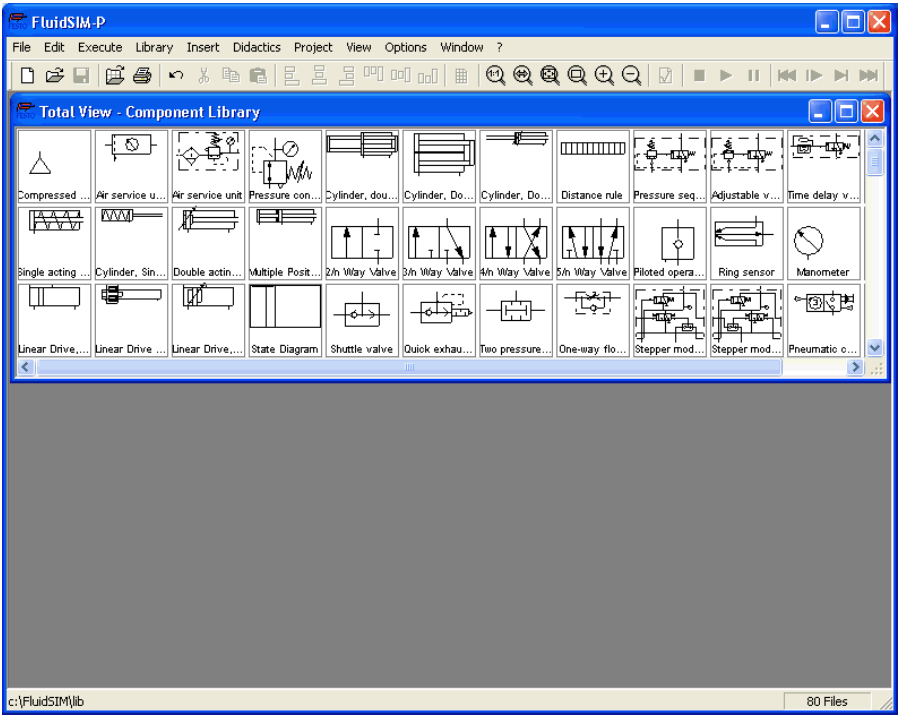
⇢ It is also possible to rearrange the components in the library horizontally, in just a few steps:

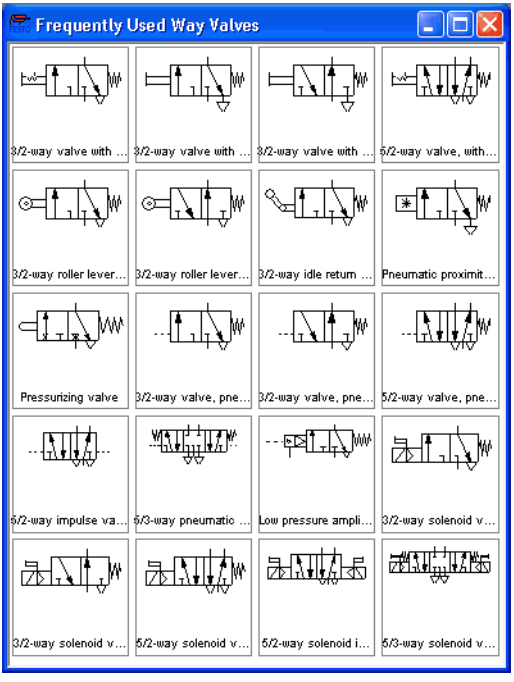


It is not possible for the user to add components to or delete components from the *standard* component libraries. However, own libraries can be constructed at the user's will.

Building New Component Libraries

In addition to the standard component libraries, which show the FluidSIM-components in *total view*, *hierarchical view*, or according to the *FluidSIM Version 2*-style, new libraries can be built. A sample component library has automatically been set up during the FluidSIM installation.

⇢ Choose from the Library menu the library “Frequently Used Way Valves”.



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

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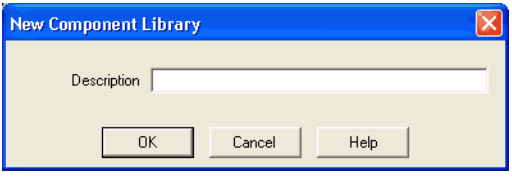
To display available libraries, to create a new one, or to rename an existing one, choose the respective entry from the Library menu. The first three entries of this menu belong to the standard libraries. Below, separated by a line, stand the user-defined libraries.

The bottom entries of the Library menu realize the functions for creating a new library, New..., for renaming an existing user-defined library, Rename..., and for deleting a user-defined library, Delete. The latter two entries relate to active library window.

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



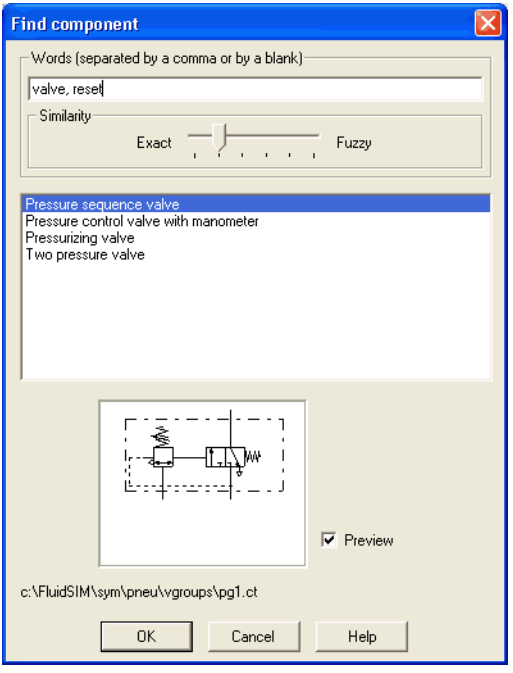
The text that has been entered here is shown as a menu entry in the Library menu. The text can be modified anytime, by opening the library and clicking on Library Rename....

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.

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.

⇢ 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 partion this name into several comma-separated search strings.

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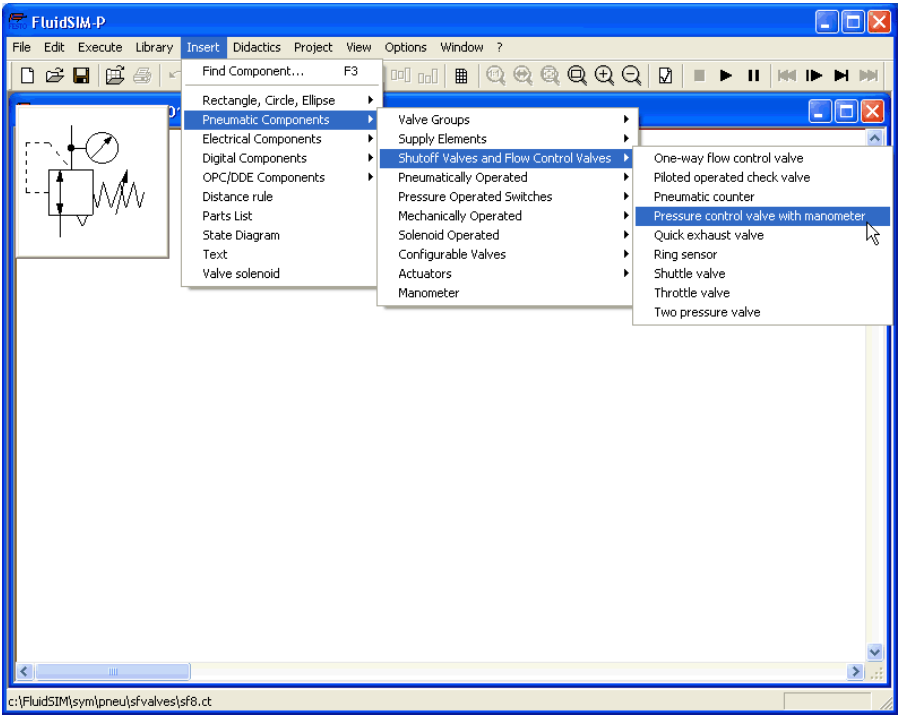
- “Similarity”
  Determines the accuracy of the match between “Exact” and “Fuzzy”. This setting can be used to allow a tolerance respecting different spelling variants or typing errors.

- “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.

⇢ 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.

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6.9 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.

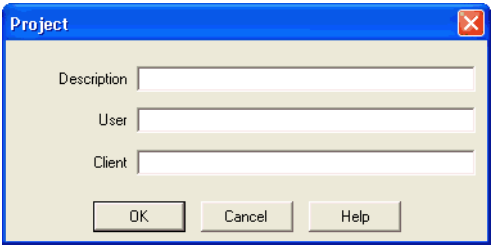
⇢ Close all windows which you don't need right now, and arrange the remaining windows according to your preferences.

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.

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 File Manager or Windows Explorer.

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6.10 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.

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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. 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.

7.1 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 Del 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.

Text components cannot be selected.

Make sure that the option Protect Text Components has not been activated.

Valves cannot be switched.

Electrically or pneumatically operated valves can be switched by hand only if no sort of control signal is applied.

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.

Highly likely is that temporary files are corrupt. Attempt to completely delete the contents of the `fl_sim_p\tmp` directory.

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.

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The playback of the educational films appears jerky.

The playback of video sequences on any computer requires quite a bit of power. Besides that, enlargement of the video window requires even more complex computations. The following points should be considered:

1. In the Device menu of the Media Player, under the Configure... menu, set the size to normal.
2. Exit all other programs; stop all running simulations and animations in FluidSIM.
3. Set the number of colors to 256.

No educational film will start playing.

Video playback requires suitable hardware and software. Moreover, FluidSIM needs access to the movie files on the CD-ROM.

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.

At certain connections no quantity values are displayed, although the display option has been activated.

Quantity values are only displayed when FluidSIM can compute the values. For physical reasons, the values for pressure and flow are not deterministic in some cases. Given such a situation FluidSIM simply displays no values.

7.2 Tips for the Advanced User

This section contains some technical information about different concepts in FluidSIM.

Data Formats of the Clipboard

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

When playing the educational films of FluidSIM, the Windows Media Player is loaded. 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:

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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.

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

If your computer is equipped with an audio playback facility, sounds can be played during the changeover of relays, switches, and valves or during the activation of a buzzer. You can add your own sounds to replace the preselected ones by replacing the sound files in the `snd` directory. The sound file for the switches and relays is named `switch.wav`, the sound file for a valve is named `valve.wav`, and the sound file for the activation of the buzzer is named `horn.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 contains the description of the presentation, which also appears in the selection box. The following lines contain the numbers of the topics for the presentation in corresponding order. When a `shw` file is created by FluidSIM, the topic numbers are written within brackets, followed by the appropriate name for the topic.

The `shw` file for the presentation named `Exercises` does appear as follows:

```
Exercises
[90.1] Direct control of a double acting cylinder
[91.1] Indirect control of a double acting cylinder
[92.1] The logic AND function, the two pressure valve
[93.1] The logic OR function, the shuttle valve
[94.1] Memory circuit and speed control of a cylinder
[95.1] The quick exhaust valve
[96.1] Pressure dependent control, embossing of plastic
```


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```
[97.1] The time delay valve
```

The brackets and the topic names can be left out, when the file is manually created. I.e., the contents of the presentation `Exercises` could look like the following:

```
Exercises
90.1
91.1
92.1
93.1
94.1
95.1
96.1
97.1
```

FluidSIM automatically inserts the brackets and topic names, if you select this file in the presentation dialog box for editing purposes and then exit the dialog box by clicking on “OK”.

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.

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 these side effects are to be avoided, the network installation of FluidSIM can be performed manually:

⇢ Install FluidSIM *without* the network option on a local PC, using its local hard drive.

⇢ Copy the entire FluidSIM directory on the network file system.

⇢ De-install FluidSIM from the local PC. The license connector will be credited with the license, and the FluidSIM files reside on the network without having wasted a license.

⇢ Now perform the local installation procedure as described above.

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

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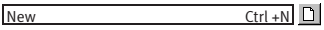
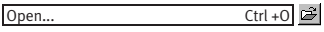
A. FluidSIM Menus

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.

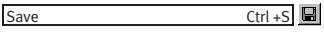
A.1 File



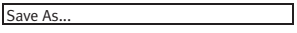
Opens a new window to create a circuit diagram. The default name for the new circuit diagram is `noname.ct`. If a circuit with this name already exists, a number is appended to the title `noname` to create a unique file name.



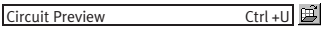
Opens the File Selector dialog box, which allows you to select and open a circuit diagram.



Saves the current circuit diagram. The circuit diagram window remains open.



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.



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.

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.

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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 selected components in 90° angles.
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.

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.

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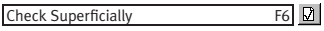
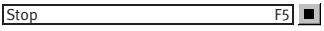
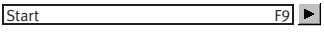
A.3 Execute



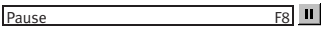
Checks the current circuit diagram for mistakes in drawing.



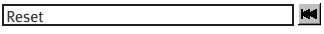
Switches the current circuit diagram in the Edit Mode.



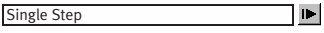
Starts the simulation or, as the case may be, animation in the current circuit diagram.



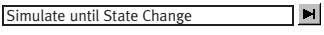
Pauses the current circuit diagram during simulation without leaving the Simulation Mode. The simulation can then be re-animated from this point and continue as if it had not been halted.
If Pause is clicked while being in the *Edit Mode*, the circuit diagram switches to the Simulation Mode without starting the simulation. In this manner, the components' states can be set before the simulation is started.



Sets an already running or paused simulation back to the initial state. The simulation is immediately restarted.



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.



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.

Total View

Opens a library window that shows a total view of all FluidSIM components.

FluidSIM Version 2

Opens a library window that shows the original component library of the FluidSIM Version 2.
If only these components are used, the constructed circuit diagrams can be opened and simulated by all previous versions of FluidSIM.

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.

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A.5 Insert

A hierarchically organized menu from which an object can be selected and inserted in the current circuit diagram.

Find Component... F3

Opens the dialog for the string-based search of components.

A.6 Didactics

Component Description

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.

Component Photo

Opens a window containing a photo of the selected component. 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. There is no photo for components that do not have a counterpart in reality.

Component Illustration

Opens for the selected component either a window containing a sectional view or a dialog box with a list of topics relating the component's function. In the latter case the selection may include sectional views 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.

Topic Description

Opens for a window with a didactics material picture, for example a sectional view of a component or an exercise, the page with the textual description of the topic.

Pneumatics Basics...

Opens a dialog box that contains a topics list of pneumatics basics. Here, those overviews, functional illustrations, and animation are comprised that are useful when teaching basic concepts of pneumatics. By clicking on a topic in the list, the dialog box closes, and a window with a picture of the chosen topic appears.

Working Principle...

Opens a dialog box with sectional views that focus on the function of single components. For several components, their sectional view can be animated like a cartoon. By double clicking on a topic in the list, the dialog box closes, and a window with the chosen sectional view appears.

Exercise...

Opens a dialog box with exercises related to electro-pneumatics. By double clicking on a topic in the list, the dialog box closes, and a window with the chosen exercise appears. Each exercise consists of three pictures, which can be spooled manually or automatically.

Presentation...

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.

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.

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A.7 Project

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 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.

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.

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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... A

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").

Display Flow Direction D

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.

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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.

OPC/DDE Connection...

Brings up a dialog box with OPC and DDE options, respectively. These settings relate the communication behavior when coupling FluidSIM 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”).

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.

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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.

About FluidSIM...

Opens the Program Information box about FluidSIM. Among others, the FluidSIM version number and the number off the license connector looked up.

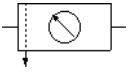
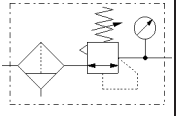
B. The Component Library

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

	Compressed air supply The compressed air supply provides the needed compressed air. It contains a pressure control valve that can be adjusted to output the desired operating pressure. Adjustable parameters: Operating pressure: 0 ... 20 bar (6 bar)
	**Air service unit, simplified representation** The service unit is made up of a compressed air filter with water separator and a pressure control valve. Adjustable parameters: Operating pressure: 0 ... 20 bar (5 bar)
	**Air service unit** The service unit is made up of a compressed air filter with water separator and a pressure control valve. Adjustable parameters: Operating pressure: 0 ... 20 bar (5 bar)

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	Connection (pneumatic) 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®3 Pneumatics thus pops up a warning message, if some pneumatic connection was left open. Note that at each pneumatic connection values for the flow and pressure can be displayed.
	Line (pneumatic) A pneumatic line links two pneumatic connections. Note that a pneumatic connection may be a simple pneumatic connection or a T-junction. A pneumatic line causes no pressure drop, i. e., it has no fluidic resistance. 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. Adjustable parameters: Line Type: One of {Main Line or Control Line} (Main Line)
	T-junction (pneumatic) A T-junction joins up to three pneumatic lines, 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.

Configurable Way Valves

	Configurable 2/n way valve The configurable 2/n way valve is a way valve with two connections, where both its body elements and its operation modes are user-definable. Additionally, the pneumatic connections can be closed with either blind plugs or exhausts.
	Configurable 3/n way valve The configurable 3/n way valve is a way valve with three connections, where both its body elements and its operation modes are user-definable. Additionally, the pneumatic connections can be closed with either blind plugs or exhausts.
	Configurable 4/n way valve The configurable 4/n way valve is a way valve with four connections, where both its body elements and its operation modes are user-definable. Additionally, the pneumatic connections can be closed with either blind plugs or exhausts.
	Configurable 5/n way valve The configurable 5/n way valve is a way valve with five connections, where both its body elements and its operation modes are user-definable. Additionally, the pneumatic connections can be closed with either blind plugs or exhausts.

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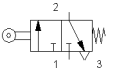
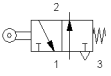
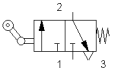
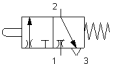
Mechanically Operated Directional Valves

	**3/2-way roller lever valve, normally closed** The roller lever valve is operated by pressing on the lever, for example through the use of a switching cam 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. In the Simulation Mode, the valve can be switched manually by clicking on the component, thus not requiring a cylinder to operate the valve. This valve is derived from a configurable 3/n way valve. You find this valve in the component library “Frequently used Way Valves”, under the Library menu.
	**3/2-way roller lever valve, normally open** The roller lever valve is operated by pressing on the lever, for example through the use of a switching cam 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. In the Simulation Mode, the valve can be switched manually by clicking on the component, thus not requiring a cylinder to operate the valve. This valve is derived from a configurable 3/n way valve. You find this valve in the component library “Frequently used Way Valves”, under the Library menu.

	**3/2-way idle return roller valve, normally closed** The idle return roller valve is operated when the roller is driven in a specific direction by the switching cam 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. In the Simulation Mode, the valve can be switched manually by clicking on the component, thus not requiring a cylinder to operate the valve. This valve is derived from a configurable 3/n way valve. You find this valve in the component library “Frequently used Way Valves”, under the Library menu. Adjustable parameters: Operation: One of {Extension, Retraction} (Retraction)
	**Pressurizing valve** The pressurizing valve with plunger control is operated by the surface of the cylinder cam. 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. In the Simulation Mode, the valve can be switched manually by clicking on the component, thus not requiring a cylinder to operate the valve.

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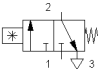
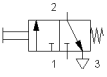
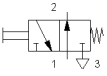
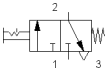
	**Pneumatic proximity switch, solenoid operated** A permanent solenoid found on the piston of a cylinder drives this 3/2 pneumatic directional valve and triggers the control signal. The flow passes freely from 1 to 2. In the Simulation Mode, the valve can be switched manually by clicking on the component, thus not requiring a cylinder to operate the valve. This valve is derived from a configurable 3/n way valve. You find this valve in the component library “Frequently used Way Valves”, under the Library menu.
	**3/2-way valve with pushbutton, normally closed** 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. By holding down the Shift 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. This valve is derived from a configurable 3/n way valve. You find this valve in the component library “Frequently used Way Valves”, under the Library menu.

	**3/2-way valve with pushbutton, normally open** Pressing the pushbutton operates the valve. Connection 1 is shut. Releasing the pushbutton allows the valve to returns to its starting position through the use of a return spring. The passes freely from 1 to 2. By holding down the Shift 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. This valve is derived from a configurable 3/n way valve. You find this valve in the component library “Frequently used Way Valves”, under the Library menu.
	**3/2-way valve with selection switch or striking button** 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. This valve is derived from a configurable 3/n way valve. You find this valve in the component library “Frequently used Way Valves”, under the Library menu.

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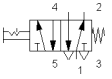
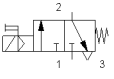
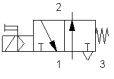
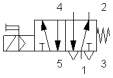
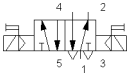
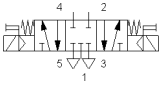
	**5/2-way valve, with selection switch** Turning the selection switch operates the valve. The flow passes freely from 1 to 4. Releasing the switch has no effect; the valve remains in its operating position. Turning the switch back to its original position allows the flow to pass freely from 1 to 2. This valve is derived from a configurable 5/n way valve. You find this valve in the component library “Frequently used Way Valves”, under the Library menu.

Solenoid Operated Directional Valves

	**3/2-way solenoid valve, normally closed** 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. This valve is derived from a configurable 3/n way valve. You find this valve in the component library “Frequently used Way Valves”, under the Library menu.
	**3/2-way solenoid valve, normally open** 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. This valve is derived from a configurable 3/n way valve. You find this valve in the component library “Frequently used Way Valves”, under the Library menu.

	**5/2-way solenoid valve** 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. This valve is derived from a configurable 5/n way valve. You find this valve in the component library “Frequently used Way Valves”, under the Library menu.
	**5/2-way solenoid impulse valve** 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. This valve is derived from a configurable 5/n way valve. You find this valve in the component library “Frequently used Way Valves”, under the Library menu.
	**5/3-way solenoid valve, mid-Position closed** 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. This valve is derived from a configurable 5/n way valve. You find this valve in the component library “Frequently used Way Valves”, under the Library menu.

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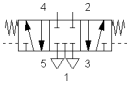
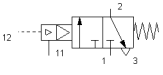
Pneumatically Operated Directional Valves

	3/2-way valve, pneumatically operated, normally closed 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. This valve is derived from a configurable 3/n way valve. You find this valve in the component library “Frequently used Way Valves”, under the Library menu.
	3/2-way valve, pneumatically operated, normally open 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. This valve is derived from a configurable 3/n way valve. You find this valve in the component library “Frequently used Way Valves”, under the Library menu.
	5/2-way valve, pneumatically operated 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. This valve is derived from a configurable 5/n way valve. You find this valve in the component library “Frequently used Way Valves”, under the Library menu.

	5/2-way impulse valve, pneumatically operated 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 5/n way valve. You find this valve in the component library "Frequently used Way Valves", under the Library menu. Adjustable parameters: Initial position: One of {Left, Right} (Left)
	**5/3-way pneumatic valve, mid-Position closed** 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 5/n way valve. You find this valve in the component library "Frequently used Way Valves", under the Library menu.
	**Low pressure amplifier unit, 2 compartments** Each of the two double-level low pressure amplifier units has the function of a 3/2 directional valve that is normally closed. 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.

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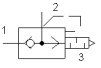
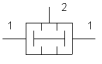
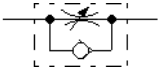
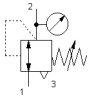
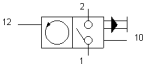
Shutoff Valves and Flow Control Valves

	Shuttle valve 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).
	**Quick exhaust valve** 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.
	**Two pressure valve** 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).
	Piloted operated check valve If the entering pressure at connection 1 is higher that 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.
	Throttle valve The setting of the throttle valve is set by means of a rotary knob. Please note that by the rotary knob no *absolute* resistance value can be set. This means that, in reality, different throttle valves can generate different resistance values despite identical settings. Adjustable parameters: Opening level: 0 ... 100 % (100 %)

	**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 though 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: Opening level: 0 ... 100 % (100 %)
	**Pressure control valve with manometer** The pressure control valve regulates the supplied pressure based on the adjustable operating pressure and the variations in the pressure. The manometer displays the pressure at connection 2. Adjustable parameters: Operating pressure: 0 ... 20 bar (4 bar)
	**Pneumatic counter** 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. Adjustable parameters: Counter: 0 ... *9999* (3)
	Ring sensor 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. To simulate an object in the air flow, as presented above, simply click on the component during FluidSIM Simulation Mode.

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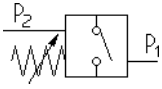
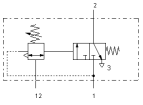
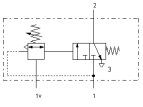
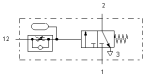
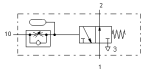
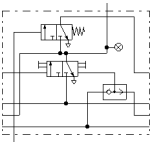
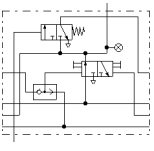
Pressure Operated Switches

	Analog pressure sensor The pressure sensor measures the pressure and operates the pressure switch when the adjustable switching pressure has been exceeded. Adjustable parameters: Switching pressure: 0.001 ... 20 bar (1 bar)
	**Differential pressure switch** 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 pneumatic to electric converter is operated when the difference in pressure between P1-P2 exceeds the adjustable switching pressure. Adjustable parameters: Differential pressure: 0.001 ... 20 bar (1 bar)

Valve Groups

	**Pressure sequence valve** 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. The pressure of the control signal is infinitely adjustable via a pressure setting screw. Adjustable parameters: Nominal pressure: 0 ... 20 bar (1 bar)
	**Adjustable vacuum actuator valve** 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. Adjustable parameters: Nominal pressure: -0.6 ... -0.25 bar (-0.25 bar)

	**Time delay valve, normally closed** 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. Adjustable parameters: Opening level: 0 ... 100 % (100 %)
	**Time delay valve, normally open** 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. Adjustable parameters: Opening level: 0 ... 100 % (100 %)
	**Stepper module, type TAA** The stepper module is made up of a memory unit (3/2-way impulse valve), an AND and an OR component, a viewable announcement, and an auxiliary manual operation. Adjustable parameters: Initial position: One of {Left, Right} (Left)
	**Stepper module, type TAB** The stepper module is made up of a memory unit (3/2-way impulse valve), an AND and an OR component, a viewable announcement, and an auxiliary manual operation. Adjustable parameters: Initial position: One of {Left, Right} (Right)

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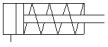
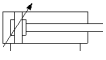
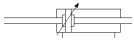
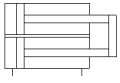
Actuators

	**Single acting cylinder** 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. Adjustable parameters: Max. stroke: 1 ... 100 mm (50 mm) Piston position: 0 ... Max. stroke mm (0 mm) Piston Area: 0,07 ... 80 qcm (3,14 qcm) Piston Ring Area: 0,03 ... 65 qcm (2,72 qcm)
	Single acting cylinder with return spring 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. Adjustable parameters: Max. stroke: 1 ... 100 mm (50 mm) Piston position: 0 ... Max. stroke mm (50 mm) Piston Area: 0,07 ... 80 qcm (3,14 qcm) Piston Ring Area: 0,03 ... 65 qcm (2,72 qcm)
	**Double acting cylinder** 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. Adjustable parameters: Max. stroke: 1 ... 5000 mm (100 mm) Piston position: 0 ... Max. stroke mm (0 mm) Piston Area: 0,25 ... 810 qcm (3,14 qcm) Piston Ring Area: 0,1 ... 750 qcm (2,72 qcm)

	**Double acting cylinder with in and out piston rod** 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. Adjustable parameters: Max. stroke: 1 ... 5000 mm (100 mm) Piston position: 0 ... Max. stroke mm (0 mm) Piston Area: 0,25 ... 810 qcm (3,14 qcm) Piston Ring Area: 0,1 ... 750 qcm (2,72 qcm)
	**Double acting cylinder with two in and out piston rods and single trestle.** 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. Adjustable parameters: Max. stroke: 1 ... 5000 mm (100 mm) Piston position: 0 ... Max. stroke mm (0 mm) Piston Area: 0,5 ... 1620 qcm (6,28 qcm) Piston Ring Area: 0,2 ... 1500 qcm (5,44 qcm)

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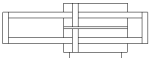
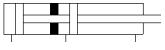
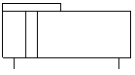
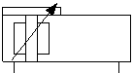
	**Double acting cylinder with two in and out piston rods and double trestle.** This twin cylinder has two in and out piston rods that move in parallel and that are coupled by a double trestle. The construction guarantees minimum torsion when positioning and moving tools or assemblies. Moreover, coming along with the same construction height, the double piston rod conveys the double force as compared to standard cylinders. Adjustable parameters: Max. stroke: 1 ... 5000 mm (100 mm) Piston position: 0 ... Max. stroke mm (0 mm) Piston Area: 0,5 ... 1620 qcm (6,28 qcm) Piston Ring Area: 0,2 ... 1500 qcm (5,44 qcm)
	**Multiple position cylinder** 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. Adjustable parameters: Max. stroke: 1 ... 2000 mm (100 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 (2,72 qcm)

	Linear drive with solenoid coupling The sliding of the piston in the double rod cylinder is controlled by a reciprocal input of compressed air. Adjustable parameters: Max. stroke: 10 ... 5000 mm (200 mm) Piston position: 0 ... Max. stroke mm (0 mm) Piston Area: 0,5 ... 80 qcm (2,01 qcm)
	**Pneumatic linear drive with shape-fitting adaptor** 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. Adjustable parameters: Max. stroke: 10 ... 5000 mm (200 mm) Piston position: 0 ... Max. stroke mm (0 mm) Piston Area: 0,5 ... 80 qcm (2,01 qcm)
	**Pneumatic linear drive with shape-fitting adaptor** 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. Adjustable parameters: Max. stroke: 10 ... 5000 mm (200 mm) Piston position: 0 ... Max. stroke mm (0 mm) Piston Area: 0,5 ... 80 qcm (2,01 qcm)
	Semi-Rotary actuator The semi-rotary actuator is controlled by a reciprocal input of compressed air. Adjustable parameters: Initial position: One of {Left, Right} (Left)

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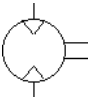
	Vacuum suction nozzle The vacuum suction nozzle creates its vacuum based on the ejector principle. In this case, compressed air flows from connection 1 to 3, creating a vacuum at connection 1v. A sucker can be connected to the vacuum connection 1v. Stopping the input of compressed air at connection 1 stops any suction also.
	Sucker The sucker can be used in connection with the vacuum suction nozzle to suck in objects. The sucking in of objects can be simulated in FluidSIM®3 Pneumatics by clicking on the component when in the Simulation Mode.
	**Air motor** The air motor transforms pneumatic energy into mechanical energy.

Measuring Instruments

	Manometer The manometer displays the pressure at its connection.

B.2 Electrical Components

Power Supply

	Electrical connection 0V 0V connection of the power supply.
	Electrical connection 24V 24V connection of the power supply.
	Connection (electrical) 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. Note that at each electric connection values for the voltage and current can be displayed.
	Line (electrical) A electrical line links two electrical connections. Note that a electrical connection may be a simple electrical connection or a T-junction. A electrical line causes no voltage drop, i. e., it has no electrical resistance.
	T-junction (electrical) A T-junction joins up to three electrical lines, 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.

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Signal Devices

	Indicator light If current flows, the indicator light is displayed in the user-defined color. Adjustable parameters: Color: One of {16 standard colors} (Yellow)
	Buzzer If current flows, a flashing ring around the buzzer is shown. Moreover, if “buzzer” is activated in the menu under Options Sound..., the buzzer is activated if a sound hardware is installed.

General Switches

	Break switch 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 switch-off delay relay, the break switch changes to a switch-off delay break switch in the circuit diagram.
	Make switch 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 switch-on delayed relay, the make switch changes to a switch-on delayed make switch in the circuit diagram.
	Changeover switch General changeover switch that is tailored according to the component that actuates it. For example, if the changeover switch is linked via a label to a switch-on delayed relay, the changeover switch changes to a switch-on delayed changeover switch in the circuit diagram.

Delay Switches

	Break switch (switch-on delayed) Switch with delayed opening after pickup. Switch-on delayed break switches are created by using a general break switch and setting a label.
	Make switch (switch-on delayed) Switch with delayed closing after pickup. Switch-on delayed make switches are created by using a general make switch and setting a label.
	Changeover switch (switch-on delayed) Changeover switch with delayed changeover after pickup. Switch-on delayed changeover switches are created by using a general changeover switch and setting a label.
	Break switch (switch-off delayed) Switch with delayed closing after dropout. Switch-off delayed break switches are created by using a general break switch and setting a label.
	Make switch (switch-off delayed) Switch with delayed opening after dropout. Switch-off delayed make switches are created by using a general make switch and setting a label.
	Changeover switch (switch-off delayed) Changeover switch with delayed changeover after dropout. Switch-off delayed changeover switches are created by using a general changeover switch and setting a label.

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Limit Switches

	Limit switch (break) 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 general break switch and setting a label.
	Switch with roll (break) 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 general break switch, setting a label and selecting the switch type in the component's properties dialog.
	Reed contact (break) 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 general break switch, setting a label and selecting the switch type in the component's properties dialog.
	Limit switch (make) 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 general make switch and setting a label.
	Switch with roll (make) 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 general make switch, setting a label and selecting the switch type in the component's properties dialog.

	Reed contact (break) 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 general make switch, setting a label and selecting the switch type in the component's properties dialog.
	Limit switch (changeover) 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 general changeover switch and setting a label.
	Switch with roll (changeover) 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 general changeover switch, setting a label and selecting the switch type in the component's properties dialog.
	Reed contact (changeover) 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 general changeover switch, setting a label and selecting the switch type in the component's properties dialog.

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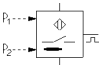
Manually Operated Switches

	Pushbutton (break) 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 Shift key. This permanent actuation is released by a simple click on the component.
	Pushbutton (make) 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 Shift key. This permanent actuation is released by a simple click on the component.
	Pushbutton (changeover) 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 Shift key. This permanent actuation is released by a simple click on the component.
	Detent switch (break) Switch that opens and locks when actuated.
	Detent switch (make) Switch that closes and locks when actuated.

	Detent switch (changeover) Switch that changes over and locks when actuated.

Pressure Switches

	**Pneumatic to electric converter** The converter produces an electrical signal, if the preset differential pressure of the differential pressure switch is exceeded.
	Pressure switch (break) Switch that opens when the preset switching pressure of the analog pressure sensor is exceeded. Pressure switches are created by using a general break switch and setting a label.
	Pressure switch (make) The switch closes when the preset switching pressure of the analog pressure sensor is exceeded. Pressure switches are created by using a general make switch and setting a label.
	Pressure switch (changeover) The switch changes over when the preset switching pressure of the analog pressure sensor is exceeded. Pressure switches are created by using a general changeover switch and setting a label.

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Proximity Switches

	Magnetic proximity switch 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.
	Inductive proximity switch 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.
	Capacitive proximity switch Switch that closes when its electrostatic field is changed. In the Simulation Mode the proximity switch can also be actuated by clicking on it.
	Optical proximity switch Switch that closes when the light barrier is interrupted. In the Simulation Mode the proximity switch can also be actuated by clicking on it.

Relays

	Relay The relay picks up immediately when current is supplied and drops out immediately when current is removed.
	Relay with switch-on delay The relay picks up after a preset time when current is supplied and drops out immediately when current is removed. Adjustable parameters: Delay time: 0 ... 100 s (5 s)
	Relay with switch-off delay The relay picks up immediately when current is supplied and drops out after a preset time when current is removed. Adjustable parameters: Delay time: 0 ... 100 s (5 s)
	Relay counter The relay picks up after a predefined number of current pulses has 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. In the Simulation Mode the relay counter can also be reset by clicking on it. Adjustable parameters: Counter: 0 ... *9999* (5)

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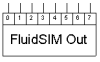
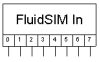
OPC/DDE Components

	**FluidSIM Output Port** The FluidSIM output realizes the communication with other applications.
	**FluidSIM Input Port** The FluidSIM input realizes the communication with other applications.

B.3 Electrical Components (American Standard)

Power Supply

	Electrical connection 0V (ladder) 0V connection of the power supply.
	Electrical connection 24V (ladder) 24V connection of the power supply.

General Switches

	Break switch (ladder) 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 switch-off delay relay, the break switch changes to a switch-off delay break switch in the circuit diagram.
	Make switch (ladder) 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 switch-on delayed relay, the make switch changes to a switch-on delayed make switch in the circuit diagram.

Delay Switches

	Break switch (switch-on delayed, ladder) Switch with delayed opening after pickup. Switch-on delayed break switches are created by using a general break switch and setting a label.
	Make switch (switch-on delayed, ladder) Switch with delayed closing after pickup. Switch-on delayed make switches are created by using a general make switch and setting a label.
	Break switch (switch-off delayed, ladder) Switch with delayed closing after dropout. Switch-off delayed break switches are created by using a general break switch and setting a label.
	Make switch (switch-off delayed, ladder) Switch with delayed opening after dropout. Switch-off delayed make switches are created by using a general make switch and setting a label.

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Limit Switches

	Limit switch (break, ladder) 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 general break switch and setting a label.
	Limit switch (make, ladder) 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 general make switch and setting a label.

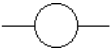
Manually Operated Switches

	Pushbutton (break, ladder) 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 Shift key. This permanent actuation is released by a simple click on the component.
	Pushbutton (make, ladder) 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 Shift key. This permanent actuation is released by a simple click on the component.
	Pushbutton (changeover, ladder) 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 Shift key. This permanent actuation is released by a simple click on the component.

Pressure Switches

	Pressure switch (break, ladder) Switch that opens when the preset switching pressure of the analog pressure sensor is exceeded. Pressure switches are created by using a general break switch and setting a label.
	Pressure switch (make, ladder) The switch closes when the preset switching pressure of the analog pressure sensor is exceeded. Pressure switches are created by using a general make switch and setting a label.

Relays

	**Relay (ladder)** The relay picks up immediately when current is supplied and drops out immediately when current is removed.
	Relay with switch-on delay (ladder) The relay picks up after a preset time when current is supplied and drops out immediately when current is removed. Adjustable parameters: Delay time: 0 ... 100 s (5 s)
	Relay with switch-off delay (ladder) The relay picks up immediately when current is supplied and drops out after a preset time when current is removed. Adjustable parameters: Delay time: 0 ... 100 s (5 s)

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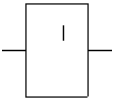
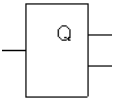
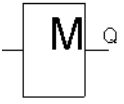
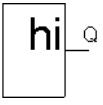
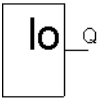
B.4
Digital Components

Constants and Connectors

	**Digital input** Digital inputs are designated with an “I”. In FluidSIM digital components can be used inside and outside a digital module. 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 “I0” to “I7”. 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”. 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”. 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”.
	**Digital output** 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. 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 “Q0” to “Q7”. If the status of the digital output is “Hi”, a potential of 24V is set at the corresponding output connector of the digital module. 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 a this connection.

	**Memory bits** Memory bits are designated with a “M”. Memory bits are virtual outputs, with a value at their output analog to that at their input. 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. After the simulation start the value at the output is set to the value of the input.
	**Logic level HI** At the output Q you have the logic level “Hi”.
	**Logic level LO** At the output Q you have the logic level “Lo”.
	Connection (digital) 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.
	Line (digital) A digital line links two digital connections. Note that a digital connection may be a simple digital connection or a T-junction.

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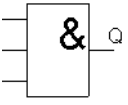
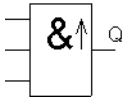
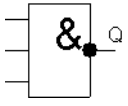
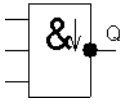
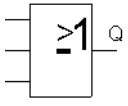
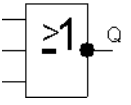
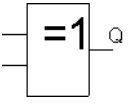
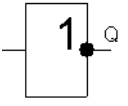
	T-junction (digital) A T-junction joins up to three digital lines, thus having a single digital level. Note that T-junctions are introduced automatically by FluidSIM when dropping the line drawing cursor onto another line in Edit Mode.

Basic Functions

	**AND** 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”.
	**Edge-triggered AND** 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”.
	**NAND (AND not)** 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”.
	**NAND With Edge Evaluation** 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”.
	**OR** 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”.

	**NOR (OR not)** 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”.
	**XOR (exclusive OR)** 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”.
	**NOT (Negation, Inverter)** The output Q is “Hi” if the input is “Lo”. The NOT block is an input status inverter.

Special Functions

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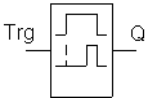
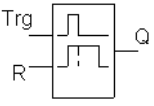
	Digital module The digital module is used for a compact embedding of a digital switching circuit into a electropneumatic circuit. The digital module offers 8 electrical inputs and outputs, which transfer their states to its digital switching circuit in the inner part. Therefore the digital switching 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 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 inputs and 8 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 in 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).

	**On delay** 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”. Adjustable parameters: On delay time: 0 ... 100 s (3 s)
	**Off delay** 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. Adjustable parameters: Off delay time: 0 ... 100 s (3 s)

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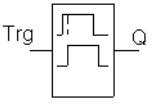
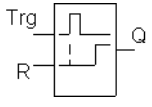
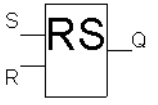
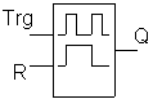
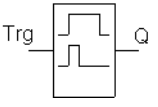
	**On/Off delay** An output with on/off delay is switched on after a specified time and is reset on expiration of a second specified time. As soon as the status at input Trg changes from “Lo” to “Hi”, the configured on delay time starts. If the status at input Trg remains “Hi” at least for the duration 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. Adjustable parameters: On delay time: 0 ... 100 s (3 s) Off delay time: 0 ... 100 s (3 s)
	**Retentive On delay** A specified time starts after an input pulse. The output is set on expiration of this time. 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”. Adjustable parameters: On delay time: 0 ... 100 s (3 s)

	**Latching Relay** Input S sets output Q. Another input R resets the output Q. A latching relay is a simple logic memory. The output value depends on the input states and on the previous output status.
	**Pulse Relay** A short one-shot at the input is used to set and reset the output. 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”.
	**Wiping Relay - Pulse Output** An input signal generates a signal of specified length at the output. 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. Adjustable parameters: Delay time: 0 ... 100 s (3 s)

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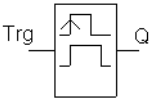
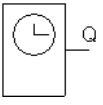
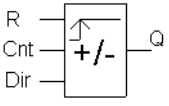
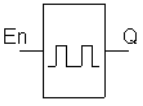
	**Edge-triggered Wiping Relay** An input signal generates a signal of specified length at the output (retriggering). The output status is switched to “Hi” after the input Trg is set to “Hi”. The configured time is started at the same time. After expiration of the configured time, the output Q status 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. Adjustable parameters: Delay time: 0 ... 100 s (3 s)
	**Timer Switch** 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. 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)

	**Up/Down Counter** 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. 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. Adjustable parameters: Counter: 0 ... 9999 (5)
	**Symmetric Clock Generator** 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. Adjustable parameters: Impulse time: 0,1 ... 100 s (0,5 s)

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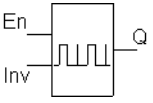
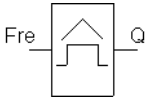
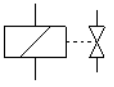
	**Asynchronous Pulse Generator** The pulse profile of the output can be changed via the configurable pulse duration and pulse pause duration. It is possible to invert the output with input INV. The input INV only negates the output, if the block is enabled via EN. Adjustable parameters: Impulse time: 0,1 ... 100 s (3 s) Impulse pause time: 0,1 ... 100 s (1 s)
	**Frequency Threshold Trigger** The output is switched on and off depending on two frequencies which can be specified. 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. 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)

B.5 Miscellaneous

Miscellaneous

	Connection (mechanical) 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.
	**Valve solenoid** The valve solenoid switches the valve. By means of a label the valve solenoid can be linked to a valve that is solenoid operated.
	Valve solenoid (ladder) The valve solenoid switches the valve. By means of a label the valve solenoid can be linked to a valve that is solenoid operated.
	Distance rule 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.
	Status indicator In Edit Mode, the status indicator is automatically displayed at those components that are actuated in the circuit's initial position.
	Cam switch In Edit Mode, the cam switch is automatically displayed at those mechanically operated way valves that are actuated in the circuit's initial position.

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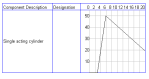
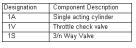
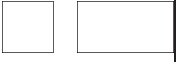
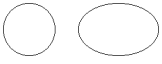
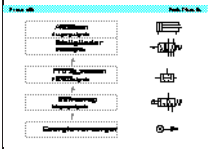
Text	**Text** The concept of text components in FluidSIM gives the user a way in which to describe components in diagrams, assign identification texts, or to provide commentary on the diagram. The text and the appearance of text components can be customized to the user's liking.
	**State diagram** The state diagram records the state quantities of important components and depicts them graphically.
	**Parts list** The parts list component creates from the components of a circuit diagram a table, which contains for each component its designation and its description.
	**Rectangle** Rectangles are graphic primitives, which can also be used within circuit diagrams.
	**Ellipse** Ellipses are graphic primitives, which can also be used within circuit diagrams.

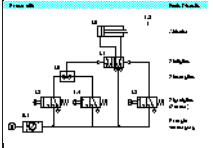
C. Didactics Material Survey

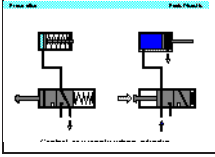
This chapter provides a comprehensive listing of those parts of the didactics material in FluidSIM that are not covered by chapter B “The Component Library”. Basically, this material consists of the components’ behavior illustrations, the animations, the exercises, and the educational films, which all 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
	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. ☞ The topic highlights the relationship between signals, levels and elements in a pneumatic system.

2	Circuit diagram and pneumatic elements
	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. ☞ The topic highlights the various levels in a circuit.

3	Control of a single acting cylinder
	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 topic can be used as an intermediate stage for explanation of the related symbols.

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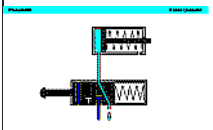
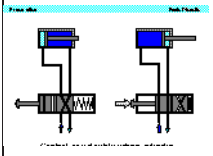
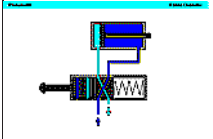
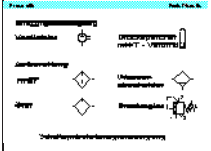
3..	Control of a single acting cylinder
	The animation shows the operation of the push-button and the extension of the cylinder. Pressure is maintained on the piston until the push-button is released. The next stage shows retraction of the cylinder and the release of air via the exhaust port of the 3/2-way valve. ☞ Animations 3.1a and 3.2a show a step-wise operation. Animation 3a shows a complete cycle repeated 3 times.

4	Control of a double acting cylinder
	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 topic can be used as an intermediate stage for explanation of the related symbols.

4..	Control of a double acting cylinder
	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. ☞ Animations 4.1a and 4.2a show a step-wise operation. Animation 4a shows a complete cycle repeated 3 times.

C.2
Diagram Symbols

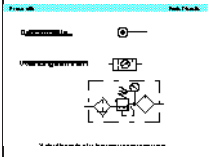
5	Symbols of energy and supply components, supply and service equipment



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.

☞ Compare the symbols with the combined symbols.

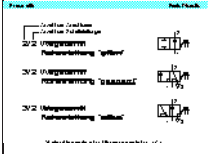
6	Symbols of energy and supply components, combined symbols



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.

☞ Compare the symbols with the previous topic.

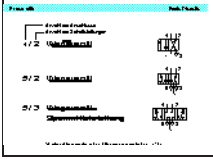
7	Symbols for directional control valves (1)



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.

☞ Compare the full range of symbols for directional control valves.

8	Symbols for directional valves (2)



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.

☞ Compare the full range of symbols for directional control valves.

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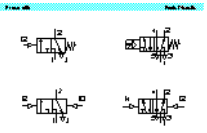
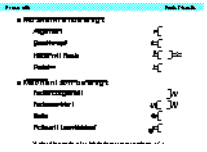
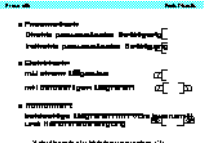
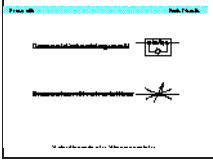
9	Designation of connections
	The designations for directional control valves are in accordance with ISO 5599-3, edition 1990. Prior to this a lettering system was utilized. ☞ Discuss the examples and emphasize the numbering systems.

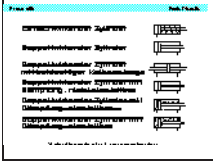
10	Methods of actuation (1)
	The methods of actuation of pneumatic directional control valves is dependent upon the application. The methods of actuation include manual, mechanical, pneumatic, electrical and combined. ☞ Discuss the actuation and return actuation methods.

11	Methods of actuation (2)
	When applied to a directional control valve, consideration must be given to the method of initial actuation of the valve and also the method of return actuation. They are both shown on the symbol either side of the position boxes. There may also be additional methods such as manual overrides separately indicated. ☞ Discuss the actuation and return actuation methods.

12	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.

13	Flow control valves
	Most flow control valves are adjustable. If the non-return valve is fitted, then the element is a one-way flow control valve. ☞ Discuss the flow in both directions in both cases.

14	Pressure control valves
	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. ☞ Compare the sensing line positions and flow arrows.

15	Symbols for actuators, linear actuators
	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. ☞ Refer to topics 76 - 84 for construction details.

16	Symbols for actuators, rotary motion
	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. ☞ Refer to topics 86 and 87 for construction details.

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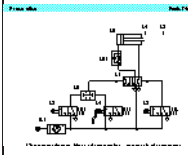
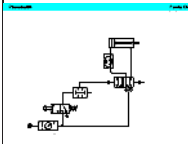
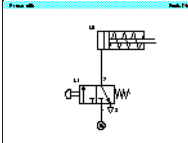
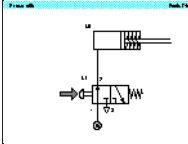
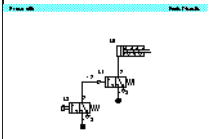
17	Designating the elements, circuit diagram
	All elements should be shown in the circuit diagram in the initial position. If valves have been drawn with an actuated initial position, this fact is indicated for example by an arrow, or for a limit switch, by drawing the cam. ☞ Explain the differences between the following terms: initial position and starting position.

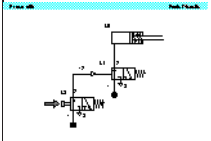
17..	Designating the elements, circuit diagram
	The animation shows the relationship between levels in a circuit, the physical positioning of roller valves and the circuit positioning of roller valves. The numbering system and the connection of ports are indicated. ☞ Animations 17.1a to 17.6a show step-wise circuit development. Animation 17.a is a complete cycle.

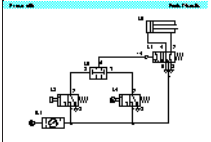
C.3
Circuits

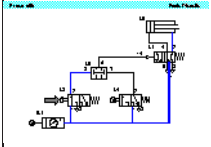
18.1	Direct control, unactuated
	A single acting cylinder of 25 mm diameter is to clamp a component when a push-button is pressed. As long as the push-button is operated, the cylinder is to remain in the clamped position. ☞ Discuss the circuit layout standard, numbering and operation. Note the circuit is shown in the initial state.

18.2	Direct control (actuated)
	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. ☞ Discuss the circuit layout standard, numbering and operation. Note the circuit is shown in the actuated state.

19.1	Indirect control (unactuated)
	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. ☞ Discuss the circuit layout standard, numbering and operation. Note the circuit is shown in the initial state.

19.2	Indirect control (actuated)
	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. ☞ Discuss the circuit layout standard, numbering and operation. Note the circuit is shown in the actuated state.

20.1	Two pressure valve
	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. ☞ Discuss the circuit layout standard, numbering and operation.

20.2	Two pressure valve
	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. ☞ Discuss the logic function “AND”. Refer to the following topic for additional conditions.

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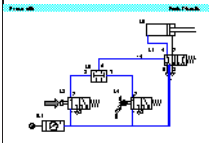
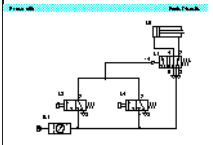
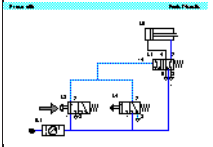
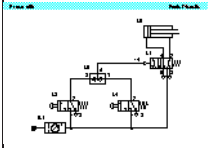
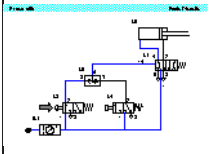
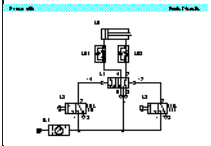
20.3	Two pressure valve
	If the roller lever valve 1S2 is also operated, then the two pressure valve will produce a 1-signal at port 2 which operates the control valve, via pilot port 1V1, against the return spring and the cylinder advances. ☞ Compare this result to the following circuit.

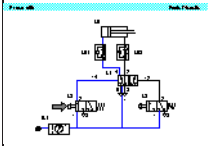
21.1	Circuit diagram development, shuttle valve
	If the condition states that either of two push-buttons are to advance a cylinder, the inexperienced designer may attempt to use a junction for the output signals of 1S1 and 1S2. The circuit is not functional due to the escape of air through the exhaust ports of the valves. ☞ Discuss the sequence of circuits for the shuttle valve.

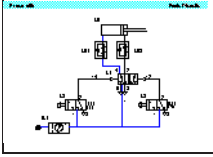
21.2	Circuit diagram development, shuttle valve
	If push-button 1S1 is operated, the air escapes to atmosphere through the exhaust port of 1S2. The air takes the easiest path and the pressure will be very low and inadequate to operate the valve 1V1. This is an inadequate solution to the problem. A shuttle valve is required. ☞ Compare the topic with the previous one.

21.3	Circuit diagram, shuttle valve
	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. ☞ Note the function of the ball in the shuttle valve acting as a non-return valve.

21.4	Circuit diagram, shuttle valve
	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. ☞ Compare the result with topic 12, two pressure valve.

22.1	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.

22.2	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.

22.3	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.

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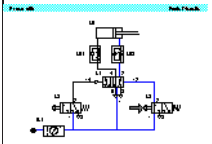
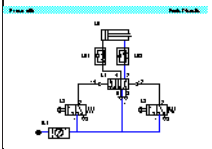
22.4	Memory circuit, 5/2-way bistable valve



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.

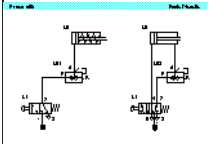
22.5	Memory circuit, 5/2-way bistable valve



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.

☞ Discuss the situation when both 1S1 and 1S2 are operated together.

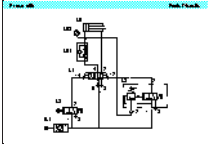
23	Quick exhaust valve circuit



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.

☞ Refer to topic 65 for construction of the valve.

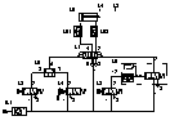
24	Pressure sequence valve circuit



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.

☞ Refer to topic 72 for construction of the valve.

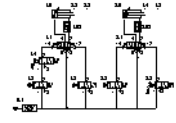
25	Time delay valve circuit



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 75 for construction of the valve.

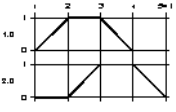
26	Sequential circuit



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−.

☞ There is no signal overlap with the circuit.

27	Sequential circuit, distance-step diagram



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.

☞ Discuss the relationship between the circuit and the distance-step diagram.

28.1	Signal overlap circuit

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.

☞ Refer to the next topics for the overlap conditions.

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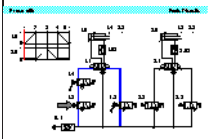
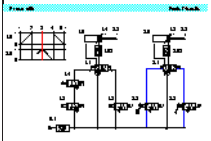
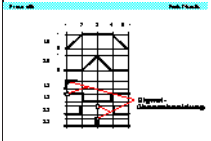
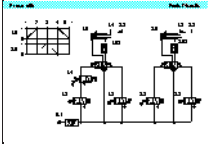
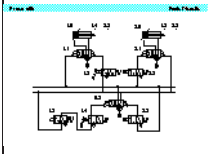
28.2	Signal overlap circuit
	The first overlap condition occurs at the start. The pilot signals at the valve 1V2 from the valves 1S3 and 1S2 are opposed. The bistable valve cannot move due to overlap. ☞ Discuss the options for removal of overlap.

28.3	Signal overlap circuit
	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 29.

29	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.

30	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.

31 Reversing valve solution

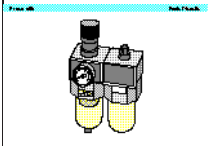


An alternative method of shortening the duration of signals is to remove the air supply to the two signal valves, except at the steps required. Using the reversing valve 1V2, lines S1 and S2 can be activated consecutively and the signals are prevented from overlapping at the memory valves 1V1 and 2V1.

☞ Emphasize the increased reliability of the circuit.

C.4 Air Service Units

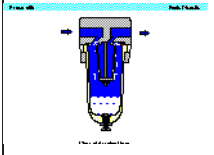
32 Air service unit



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.

☞ Refer to topic 33 for construction of the filter.

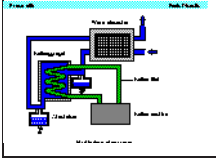
33 Compressed air filter



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.

☞ The bowl must be emptied daily to prevent overflow.

34 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.

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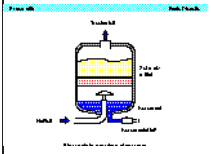
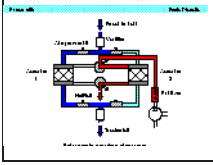
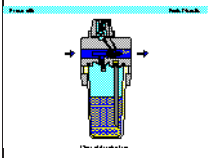
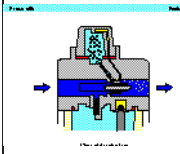
35	Air drying, absorption
	Absorption drying is a purely chemical process. The moisture in the compressed air forms a compound with the drying agent in the tank. This causes the drying agent to break down; it is then discharged as a fluid at the base of the tank. The drying agent must be replenished at a rate which is dependent on the compressed air temperature, water content and flow rate. ☞ Compare with adsorption drying.

36	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.

37	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 32 for general arrangement.

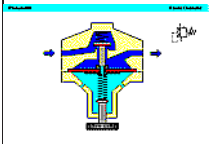
38	Air lubricator



Air passing through the lubricator causes a pressure drop between the oil reservoir and the upper part of the lubricator. This pressure difference forces the oil upwards through a tube and it then drips into a nozzle which can be seen through an inspection glass. The oil is atomized and carried along by the air stream.

☞ It is necessary to carefully adjust the oil discharge rate.

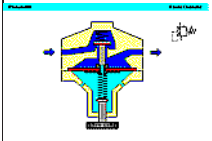
39	Air supply, pressure regulator with vent hole



The purpose of the regulator is to maintain the operating pressure (secondary pressure) virtually constant regardless of fluctuations in the line pressure (primary pressure). When air consumption increases, the operating pressure drops and the spring opens the valve.

☞ Show the animations of the following topic.

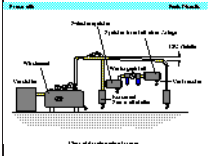
39..	Air supply, pressure regulator with vent hole



If the pressure on the secondary side increases considerably, the center-piece of the diaphragm then opens and the compressed air can flow to atmosphere through the vent holes in the housing.

☞ Animations 39.1a to 39.3a show a step-wise operation. Animation 39a shows a complete cycle.

40	Compressed air supply, delivery



Due to the pressure losses in the system, the compressor should deliver between 6.5 and 7 bar. The operating components of the system should be regulated to between 5 and 6 bar for economic use. The receiver is used to even out fluctuations in pressure due to demand. The drainage points are at the lowest points.

☞ The gradient should be away from the compressor.

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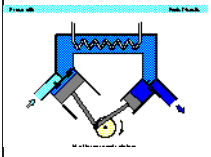
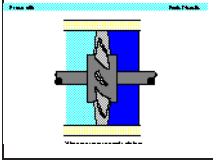
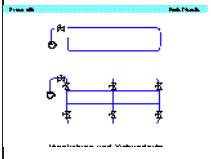
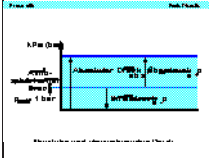
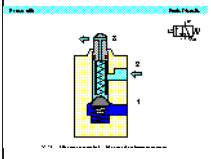
41	Compressed air supply, piston compressor
	The piston compressor is widely used. Multi-stage compressors are required for compressing to high pressure. The drawn in air is compressed by the first piston, cooled and then compressed further by the next stage. ☞ Discuss the advantages and disadvantages of piston compressors.

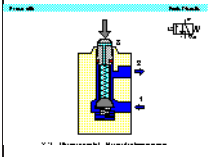
42	Compressed air supply, axial flow compressor
	Flow compressors produce large volumes of air at small increases in stage pressure. The air is accelerated by the blades of the compressor but there is only a small increase in pressure. ☞ The kinetic energy is converted to pressure energy.

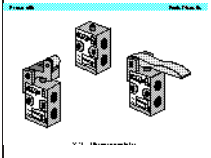
43	Compressed air supply, distribution
	For ease of maintenance, repair or extension of the air network, it is advisable to sub-divide the network into individual sections by means of shut-off valves. Branches with T-pieces and manifolds with plug-in couplings make it possible to supply additional consuming devices as the need arises. ☞ To discharge condensate, the pipes should be inclined 1-2 % and include water separators at low points.

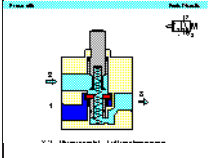
44	Absolute pressure and atmospheric pressure
	Absolute pressure is calculated from the absolute zero mark. Below atmospheric pressure the pressure is in the vacuum range. The atmospheric pressure fluctuates but is approximately 100 kPa (1 bar). ☞ Gauge pressure is normally that component above atmospheric pressure and is not an absolute value.

C.5
Valves

45.1	3/2-way valve, ball seat
	A spring forces a hemisphere against the valve seat preventing the compressed air from flowing from the air connection 1 to the working line 2. Initially port 1 is blocked and the output port 2 is exhausted through the stem of the plunger. ☞ Compare the symbol and the valve construction.

45.2	3/2-way valve, ball seat (actuated)
	Actuation of the valve plunger causes the sealing element to be forced away from the seat. In doing this, the opposing force of the reset spring and that generated from the compressed air must be overcome. The air supply is then open to the output side of the valve and a signal is generated. ☞ The load on the stem is dependent on the size of valve.

46	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. ☞ Compare the construction of the disc seat valve.

47.1	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”.

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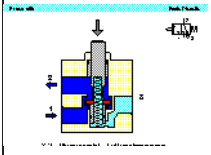
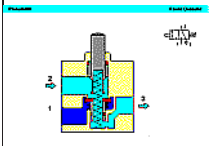
47.2	3/2-way valve, disc seat, normally closed (actuated)



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 following animation.

47..	3/2-way valve, disc seat, normally closed



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.

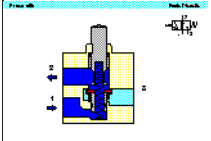
☞ Animations 47.1a and 47.2a show a step-wise operation. Animation 47a shows a complete cycle repeated 3 times.

48	3/2-way valve

The 3/2-way valve with disc seat is capable of producing large flow rates. The actuating force can be large due to the surface area of the disc seat.

☞ Present the physical attributes of the disc seat valve and the robust construction.

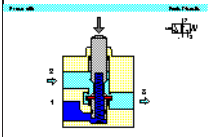
49.1	3/2-way valve, disc seat, normally open



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.

☞ Note the change of construction compared to the normally closed valve (see topic 47).

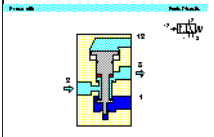
49.2	3/2-way valve, disc seat, normally open (actuated)



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.

☞ Compare the flow paths with that of the normally closed valve (see topic 47).

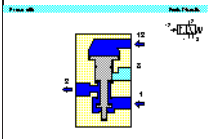
50.1	3/2-way valve, single pilot, normally closed



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.

☞ Note the pneumatic symbol shows direct application of the signal at port 12.

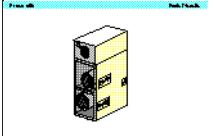
50.2	3/2-way valve, single pilot, normally closed (actuated)



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.

☞ Compare the construction of the valve to the 3/2-way disc seat valve (see topic 47).

51	3/2-way valve, single pilot



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.

☞ Note the need to designate and label the ports.

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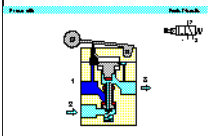
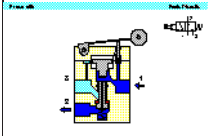
52	3/2-way valve, internal pilot, normally closed



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.

☞ The symbol shows the roller operating a pilot signal.

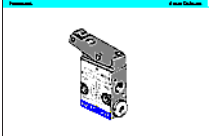
53	3/2-way valve, internal pilot, normally open



This type of valve can be used as either a normally closed valve or as a normally open valve by exchanging connection 1 and 3 and rotating the actuating head 180°. The valve actuating force is often the determining factor in applications and the servo assistance allows for larger flow rates.

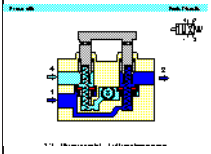
☞ Compare the construction of the valve configurations.

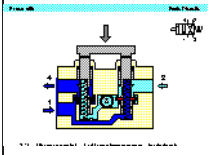
54	3/2-way valve, internal pilot

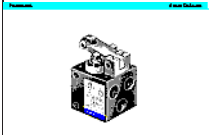


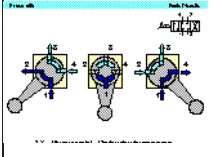
This type of valve can be used as either a normally closed valve or as a normally open valve by exchanging connections 1 and 3 and rotating the actuating head 180 degrees. The force required on the roller lever is small due to the pilot operation.

☞ Show the requirements to alter the valve configuration.

55.1	4/2-way valve, disc seat
	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. ☞ Show the similarities to the 3/2-way valve construction.

55.2	4/2-way valve, disc seat (actuated)
	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. ☞ Discuss the valve overlap.

56	4/2-way valve, disc seat
	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. ☞ Compare the construction with the 3/2-way valve.

57	4/3-way valve, mid-position closed
	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. ☞ Compare the symbol with the valve construction.

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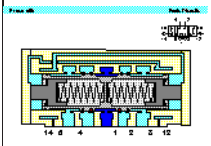
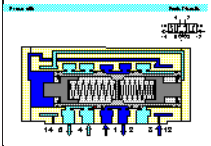
58.1 5/3-way valve



The 5/3-way valve has five ports and three positions. Signals applied at ports 14 or 12 operate the valve. It is shown closed in the mid-position. The valve is spring centered.

☞ Show the three valve positions.

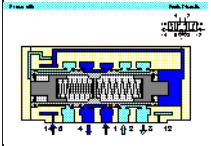
58.2 5/3-way valve



The 5/3-way valve is shown here after actuation via a pilot signal at port 12. The air flows from 1 to 2. Port 4 exhausts via 5.

☞ Show the three valve positions.

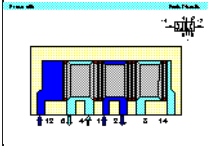
58.3 5/3-way valve



The 5/3-way valve is shown here after actuation via a pilot signal at port 14. The air flows from 1 to 4. Port 2 exhausts via 3.

☞ Show the three valve positions.

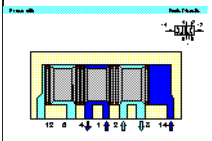
59.1 5/2-way valve, longitudinal slide valve



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.

☞ Compare the construction with the disc seat valve.

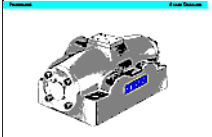
59.2	5/2-way valve, longitudinal slide valve



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.

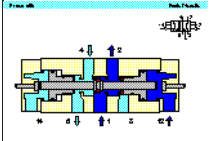
60	5/2-way valve, longitudinal slide valve



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.

☞ Discuss the DIN ISO 5599/1 standard for 5 port valves.

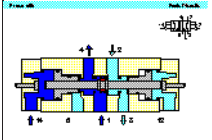
61.1	5/2-way valve, suspended disc seat



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.

☞ Compare the suspended disc seat construction to the longitudinal slide principle (see topic 59).

61.2	5/2-way valve, suspended disc seat



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.

☞ Explain the working principle of the manual override button and its related diagram symbol.

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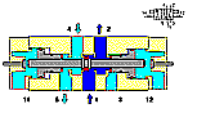
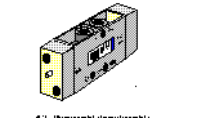
61..	5/2-way valve, suspended disc seat



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.

☞ Animations 61.1a to 61.4a show a step-wise operation. Animation 61a shows a cycle repeated 3 times.

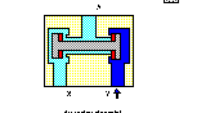
62	5/2-way valve, suspended disc seat



Note the position of the manual override stems. The ports are all designated and labeled.

☞ If no real valve is at hand, use this slide instead.

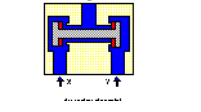
63.1	Two pressure valve



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.

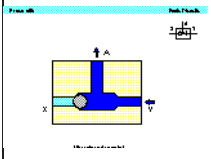
☞ Refer to topic 20 for the circuit example.

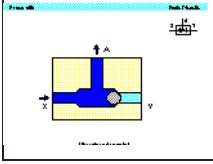
63.2	Two pressure valve

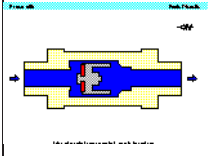


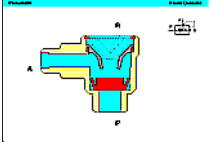
If pressure is applied at both inputs 1, the signal which is last applied passes to the output 2. The two pressure circuit is equivalent to two input signaling devices in series, i.e. one after the other.

☞ Discuss the advantages of the shown solution against series connection.

64.1	Shuttle valve
	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. ☞ Compare the two pressure valve construction (see topic 63).

64.2	Shuttle valve
	If compressed air applied to one input 1, the valve seat seals off the opposing input and the air flows to the output 2. This valve incorporates the logic function “OR”. A signal at either input 1 generates a signal at output 2. ☞ Refer to topic 21 for the circuit example.

65	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.

66	Quick exhaust valve
	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. ☞ Refer to topic 23 for the circuit example.

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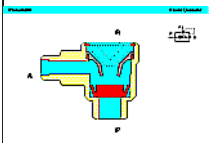
66..	Quick exhaust valve



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.

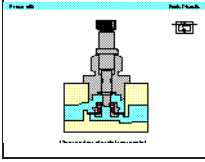
☞ Animations 66.1a and 66.2a show a step-wise operation. Animation 66a shows a complete cycle repeated 3 times.

67	Quick exhaust valve

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.

☞ If no real valve is at hand, use this slide instead.

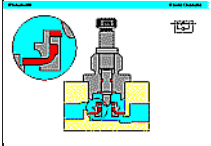
68	One-way flow control valve



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.

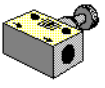
☞ Refer to topic 71 for the circuit example.

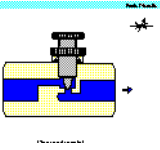
68..	One-way flow control valve

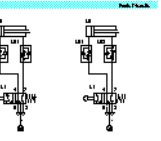


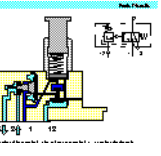
The first slide of the animation shows the total cross section of the one-way flow control valve. The animation will be shown in detail by zooming into the air passage area.

☞ Animations 68.1a and 68.2a show a step-wise operation. Animation 68a shows a complete cycle repeated 3 times.

69	One-way flow control valve
	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. ☞ If no real valve is at hand, use this slide instead.

70	Throttle valve
	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. ☞ Compare the flow control with throttle valves and one-way flow control valve (see topic 68).

71	Supply and exhaust air throttling
	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. ☞ Discuss the numbering system. Even numbers relate to advancing signals and odd numbers to the retracting signals.

72.1	Adjustable pressure sequence valve (unactuated)
	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. ☞ Discuss the two elements in the control symbol.

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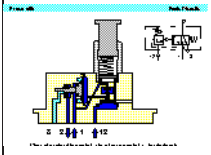
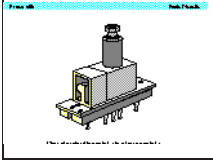
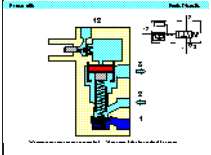
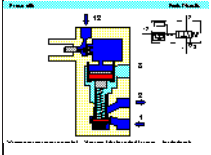
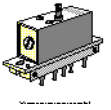
72.2	Adjustable pressure sequence valve (actuated)
	If the signal pressure at port 12 exceeds that set on the spring, the valve opens. Outlet port 2 is opened only if a preset pressure has built up in pilot line 12. A pilot spool opens the passage between ports 1 to 2. ☞ Discuss the adjustment required to set the desired operation pressure. A pressure gauge is required.

73	Adjustable pressure sequence valve
	The adjusting screw normally incorporates a look nut to set the desired position. The valve body is fitted to a sub-base which can frame mounted with other compact valves. ☞ Some applications for the valve are clamping, pressing, gluing and safety interlocks.

74.1	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. ☞ Discuss the need for clean and stable air for accuracy.

74.2	Time delay valve, normally closed (actuated)
	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 relationship between time delay and the reservoir size.

75	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.

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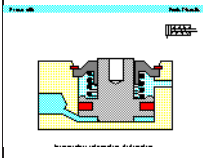
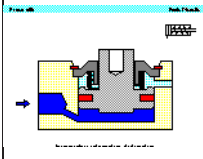
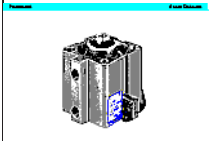
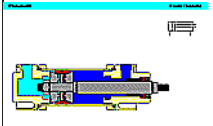
C.6
Actuators

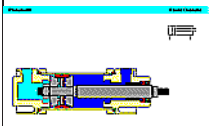
76.1	Single acting cylinder
	With single acting cylinders, compressed air is applied on only one side of the piston face. The other side is open to atmosphere. The cylinders can perform work in only one direction. The return movement of the piston is effected by a built-in spring or by the application of an external force. ☞ Compare the construction with the double acting type.

76.2	Single acting cylinder
	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 therefor only available in stroke lengths of up to 100 mm. ☞ Discuss the spring size and return speed.

77	Single acting cylinder
	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. ☞ Discuss the importance of selecting the size of the cylinder to match the load conditions.

78	Double acting cylinder
	In front of the bearing bush is a scraper ring. This ring prevents dirt particles from entering the cylinder chamber. A sealing ring is fitted in the bearing cap to seal the piston rod. The bearing bush guides the piston rod and is made of sintered bronze or plastic-coated metal. ☞ Point at the positions of cylinder body, piston cover, cylinder cover, piston seal, piston rod, bearing bush, and scraper ring.

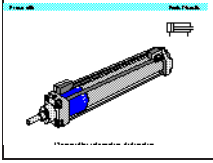
78..	Double acting cylinder



The first animation shows the piston rod advancing. The second stage the retraction. The speed of advance and retraction are fairly constant under no load conditions.

☞ Animations 78.1a and 78.2a show a step-wise operation. Animation 78a shows a complete cycle repeated 5 times.

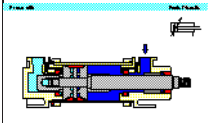
79	Double acting cylinder



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.

☞ Refer to the large number of variants, which result from the different designs, materials, etc.

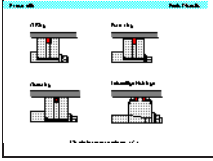
80	Cushioned double acting cylinder



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 throttleling the exhausting air by means of one-way flow control valve.

81	Cylinder seals (1)



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.

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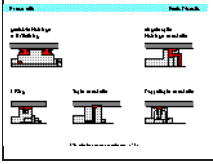
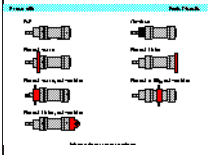
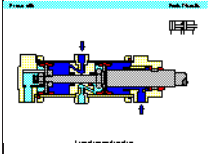
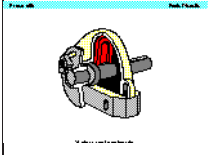
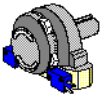
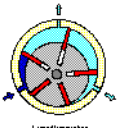
82	Cylinder seals (2)
	The various piston seal arrangements are shown. The double-cup seal materials used are, Perbunan for -20°C to +80°C Viton for -20°C to +190°C Teflon for -80°C to +200°C. ☞ Emphasize correct temperature range selection for reliability.

83	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.

84	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 78.

85	Semi-rotary actuator
	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°. ☞ Discuss the mounting arrangements for the actuator.

86	Semi-rotary actuator
	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. ☞ Discuss applications for the rotary actuator.

87	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.

C.7
Exercises

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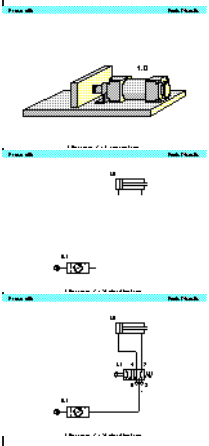
90..	Exercise: Direct control of a double acting cylinder

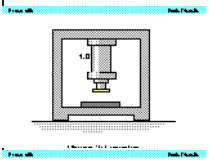


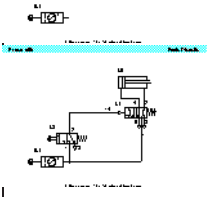
Problem: A double acting cylinder is to advance when a push-button is operated. Upon release of the push-button, the cylinder is to retract. The cylinder is of small bore (25 mm diameter) requiring a small flow rate to operate at the correct speed.

Solution: 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.

☞ 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.

91..	Exercise: Indirect control of a double acting cylinder





Problem: 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.

Solution: 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.

☞ 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.

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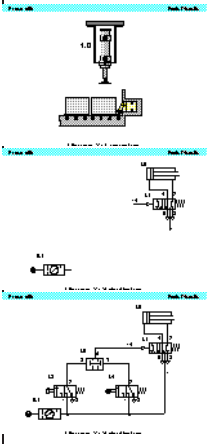
92..	Exercise: The logic AND function, the two pressure valve

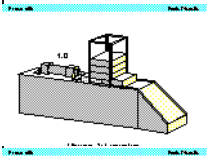


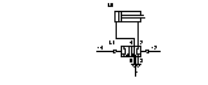
Problem: A transfer station removes a product from a conveyor belt. If the product is detected as present and if the operator presses the push-button, the pick-up cylinder 1A1 advances. The product is sensed by a 3/2 way roller lever valve. Upon release of the push-button, cylinder 1A1 is to retract 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.

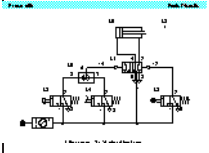
Solution: The two pressure valve is connected between the outlet lines of the two 3/2 way valves. Operating the push-button, a 1-signal is generated at left input 1 of the two pressure valve. Once the part is sensed as present, the 3/2 way roller valve generates a second 1-signal, this time at the right 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.

☞ Discuss also the advantages of the shown solution against series connection.

93..	Exercise: The logic OR function, the shuttle valve







Problem: 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.

Solution: 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.

☞ The necessity of the shuttle valve can be explained with the slides of topic 21.

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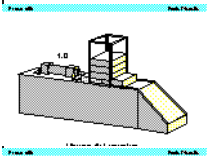
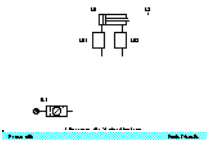
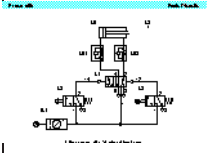
94..	Exercise: Memory circuit and speed control of a cylinder





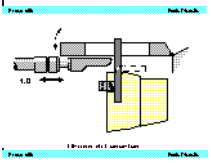


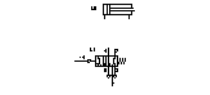
Problem: A double acting cylinder is to fully advance when a push-button is actuated and to retract after full extensions is reached (confirmed by a roller lever valve). The cylinder is to continue forward even if the push-button is released. Speed of the cylinder is to be adjustable.

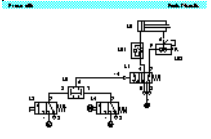
Solution: Operating the push-button 1S1 then advances the cylinder 1A1. Operation of valve 1V3 produces pressure at port 14 which switches the air to port 4. Once the cylinder travels to the limit valve 1S2, a pilot signal is sent to port 12 of the control valve switching the control valve if the push-button 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.

☞ 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.

95..	Exercise: The quick exhaust valve







Problem: 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.

Solution: 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.

☞ The quick exhaust valve should be fitted as near as possible to the connection of the cylinder to reduce resistance to flow.

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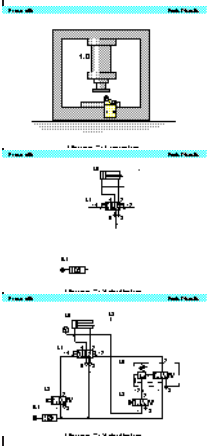
96..	Exercise: Pressure dependent control, embossing of plastic

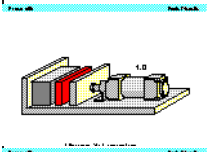


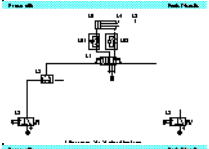
Problem: A plastic component is embossed using a die and a double acting cylinder. The die is to advance and emboss the plastic when a push-button is operated. The return of the die is to occur when the cylinder rod has fully advanced to the embossing position and a preset pressure is reached. A roller limit valve is to be used to confirm full extension. The embossing pressure is adjustable and is indicated on a pressure gauge.

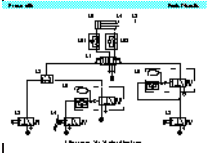
Solution: The cylinder advances if valve 1V1 is switched by push-button valve 1S1. The pressure on the advancing side of the cylinder is fed from a junction to the limit valve 1S2 and then in series to the sequence valve. The signal port 12 at the sequence valve acts against the preset compression of 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.

☞ 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 vale 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.

97..	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.

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.

☞ The memory valve must be positioned manually before air is supplied to the circuit to ensure that the cylinder will be retracted initially.

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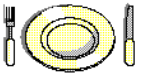
C.8 Extensions

98 Refreshment break

Announcement of a short break.

☞ Describe the objectives of the next session indicating what activities will take place. Also, review the achievements of the current session.

99 Lunch break



Announcement of a longer break

☞ Describe the objectives of the next session indicating what activities will take place. Also, review the achievements of the current session.

C.9 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.10 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
Exercises
Break and lunch
Basics
Diagram Symbols
Circuits
Air service units
Valves
Actuators

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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.

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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 6.8).

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.

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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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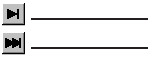 53, 154

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