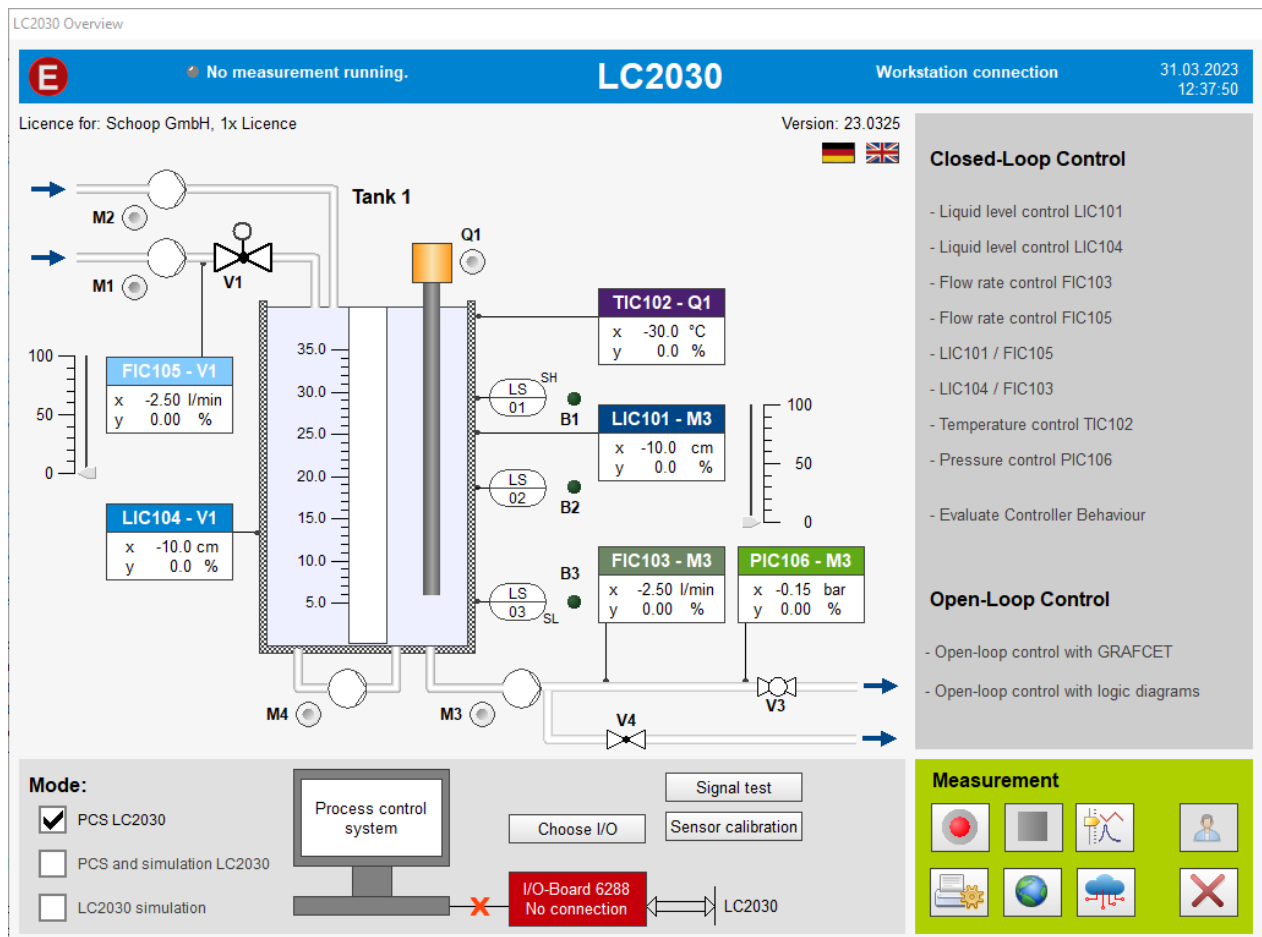


## INSTRUCTION MANUAL LC2030 – TRAINING PROGRAM



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## 1 INTRODUCTION

LC2030 Training allows you to work with either the real LC2030 workstation or with a simulated system.

Three operation modes are available

1. PCS LC2030, Process control system of the real workstation via I/O module,
2. PCS and Simulation LC2030 Process control system of the simulated system,
3. Simulation LC2030, Simulation of the workstation.

With the process control system, you can edit and control tasks in the field of open-loop and closed-loop control technology. You can implement open-loop and sequence controls using GRAFCET plans or logic diagrams. Liquid level, flow rate and temperature control are available in closed-loop control engineering. They can be controlled with standard controllers (P, I, PI and PID) and two-position controllers.

If Simulation is set as operation mode an external process control system is necessary. Therefore the simulation must be connected with PLC or via OPC.

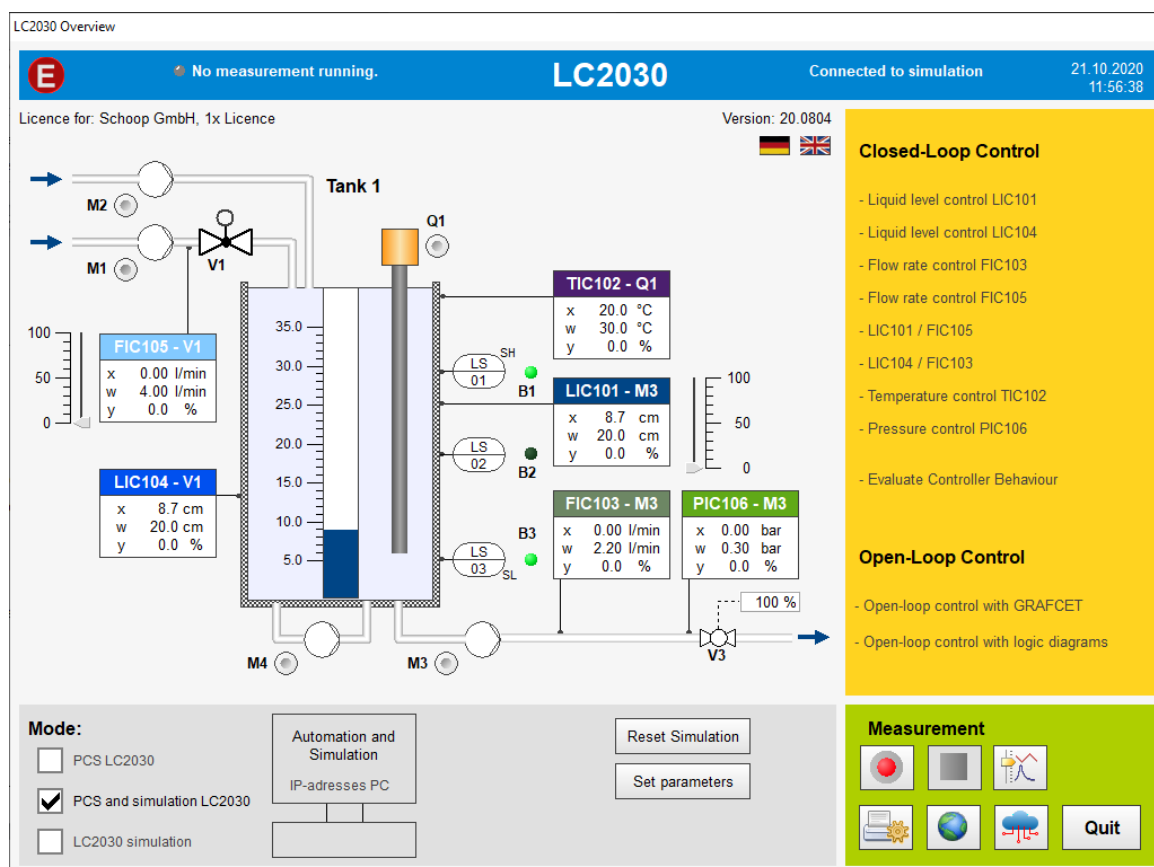


FIGURE 1 OVERVIEW OF LC2030 TRAINING PROGRAM

All experiments, including closed-loop, open-loop and sequence controls with GRAFCET or logic diagrams, can be performed in the operation modes PCS LC2030 and PCS and Simulation LC2030.

In the overview window of the LC2030 Training program, you are able to choose which task you would like to edit.

- Liquid level control via:
  - Outflow (adjustable pump)
  - Inflow (adjustable valve)
- Flow rate control via:
  - Outflow (adjustable pump)
  - Inflow (adjustable valve)
- Combined liquid level and flow rate control via:
  - Outflow (adjustable pump)
  - Inflow (adjustable valve)
- Temperature control
- Pressure control

or

- Open-loop and sequence controls using GRAFCET
- Open-loop and sequence controls using logic diagrams

If you have chosen **PCS LC2030**, meaning the program is connected to a real plant, the sensor calibration menu item is enabled for liquid level, flow rate and temperature.

If you have chosen **PCS and simulation**, meaning the simulated system is selected, you can adjust the parameters for the simulated system.

With the *Record Button* a measurement is started and all signals are stored. The signal sequence can then be examined via measurement view button.



Measurement start



Measurements stop



Measurements view

## 2 CLOSED-LOOP CONTROL ENGINEERING

The following controlled systems are available in closed-loop control engineering: liquid level, flow rate, pressure and temperature.

### 2.1 LIQUID LEVEL CONTROL

The liquid level can be controlled either via outflow using the adjustable pump M3 (*Liquid Level Control LIC101*) or via inflow using the adjustable valve V1 (*Liquid Level Control LIC104*). The control type can be selected in the overview window.

To control the liquid level, pumps M1 and/or M2 and M3 need to be switched on. Press the switch next to the pump symbol to turn on the pump.

Next, select whether the level will be controlled automatically or manually by selecting the appropriate mode.

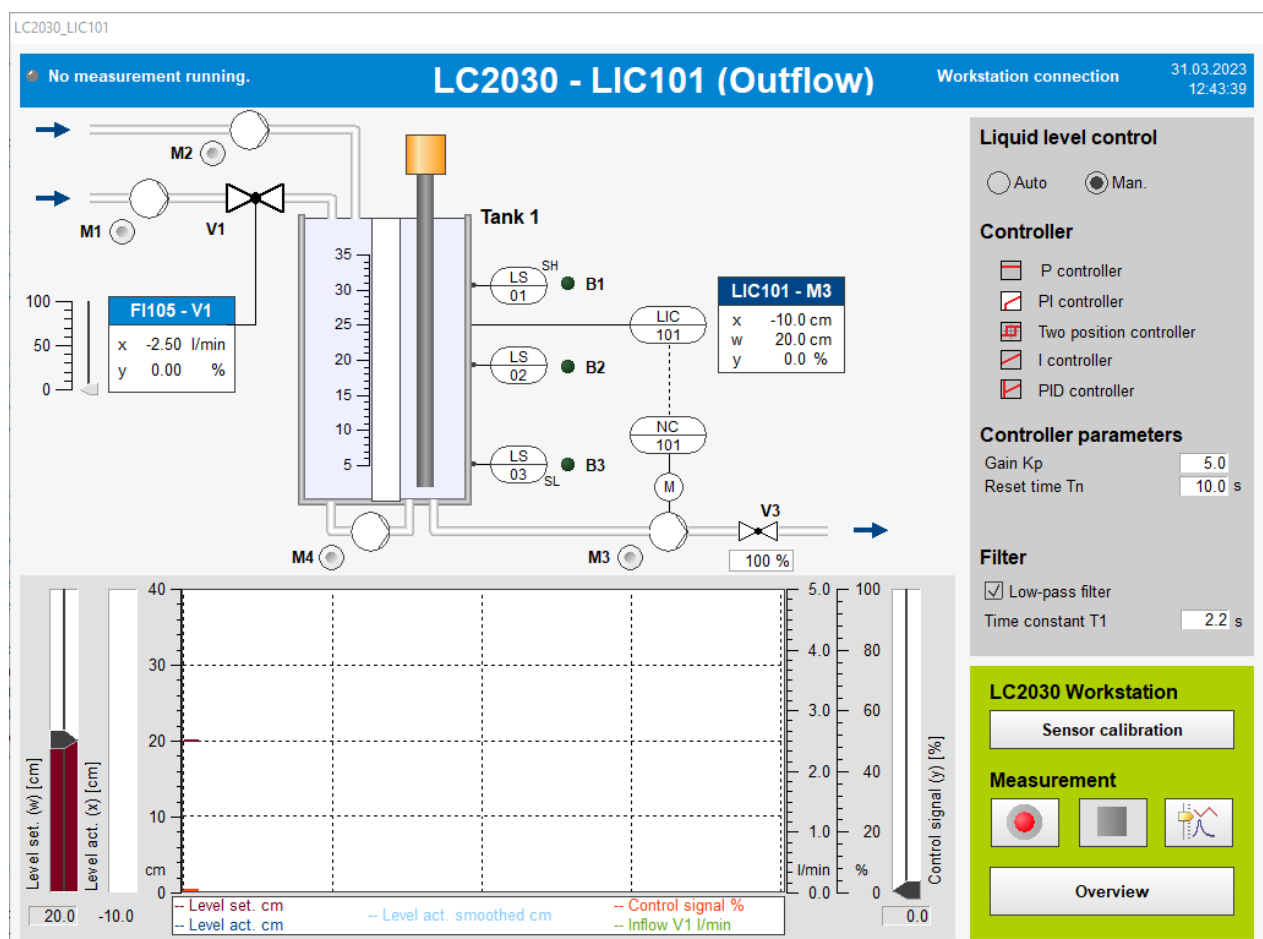


FIGURE 2 LIQUID LEVEL CONTROL VIA OUTFLOW

When Manual mode is enabled, you can alter the output signal  $y$  with the slide controller or by entering an output value numerically.

When Auto mode is enabled, you can select P, I, PI, PID or Two-position controller. Then enter a set point and the different controller parameters. The controller parameters that are displayed depend on the chosen controller type (i.e. gain, reset time and derivative time, hysteresis).

To reduce the noise of the level signal, a low pass filter can be activated. The time constant "T1" controls the amount of noise reduction.

To return to the main menu click Overview.

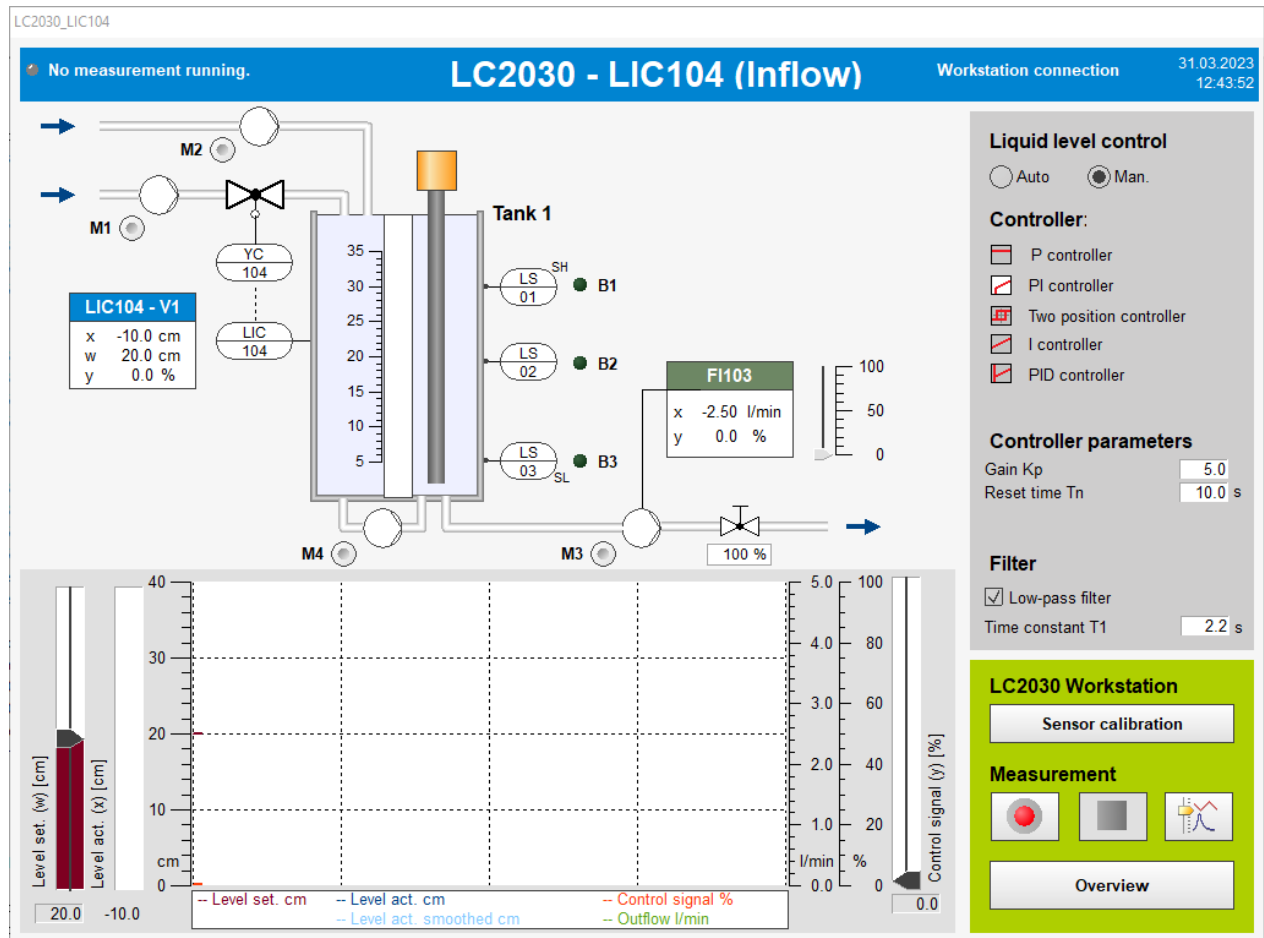


FIGURE 3 LIQUID LEVEL CONTROL VIA INFLOW

## 2.2 FLOW RATE CONTROL

The flow rate can either be controlled via outflow using the adjustable pump M3 (*Flow Rate Control FIC103*) or via inflow using the adjustable valve V1 (*Flow Rate Control FIC105*). The control type can be selected in the overview window.

To control the flow rate, the pumps M1 and/or M2 and M3 need to be switched on. Press the switch next to the pump symbol to turn on the pump.

Next, select whether the level will be controlled automatically or manually by selecting the appropriate mode.

When Manual mode is enabled, you can alter the output signal  $y$  with the slide controller or you can enter an output value numerically.

When Auto mode is enabled, you can select P, I, PI, PID or Two-position controller. Then enter a set point and the different controller parameters. The controller parameters that are displayed depend on the chosen controller type (i.e. gain, reset time and derivative time, hysteresis).

To reduce the noise of the level signal, a low pass filter can be activated. The time constant "T1" controls the amount of noise reduction.

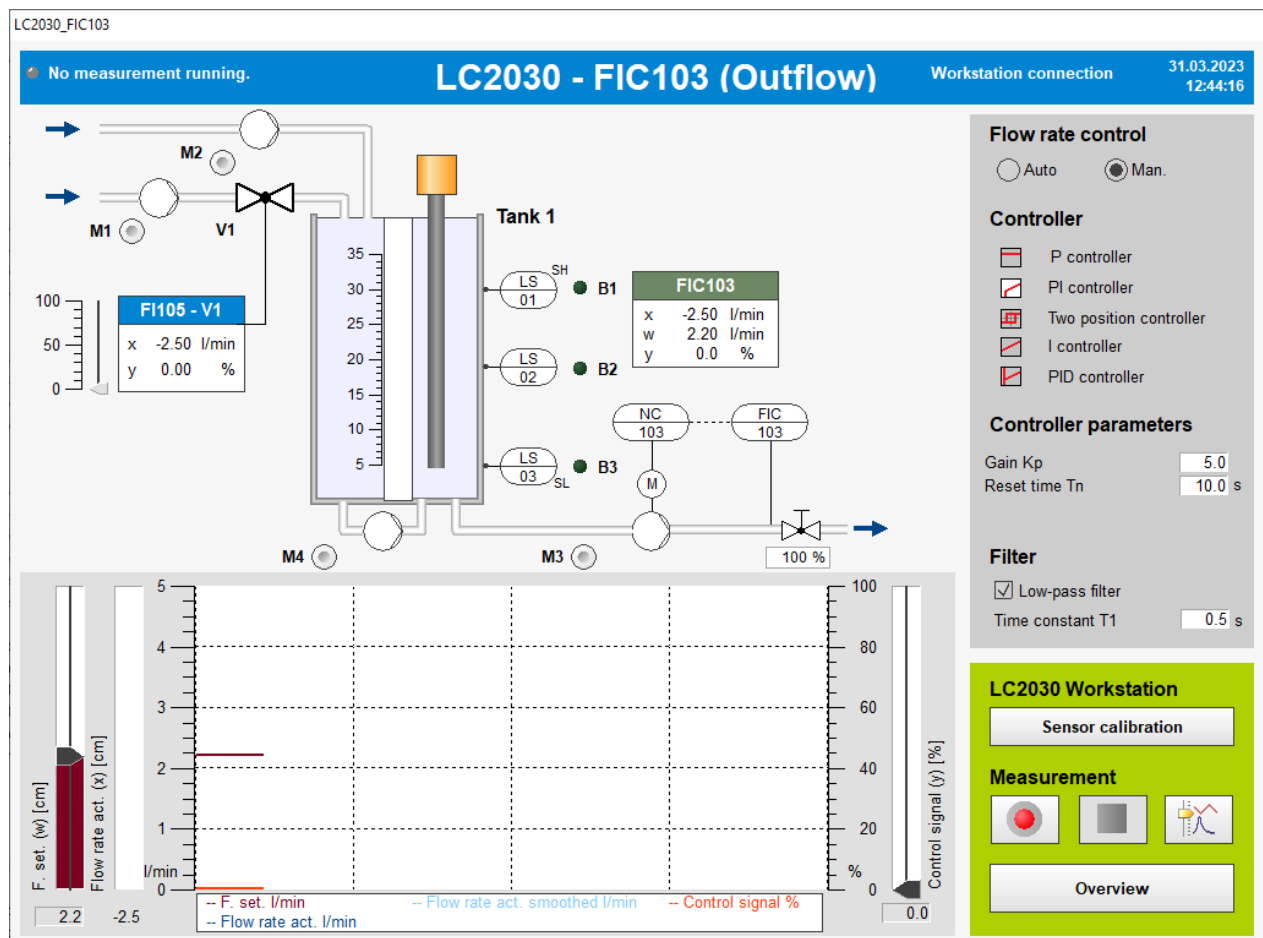


FIGURE 4 FLOW RATE CONTROL VIA OUTFLOW



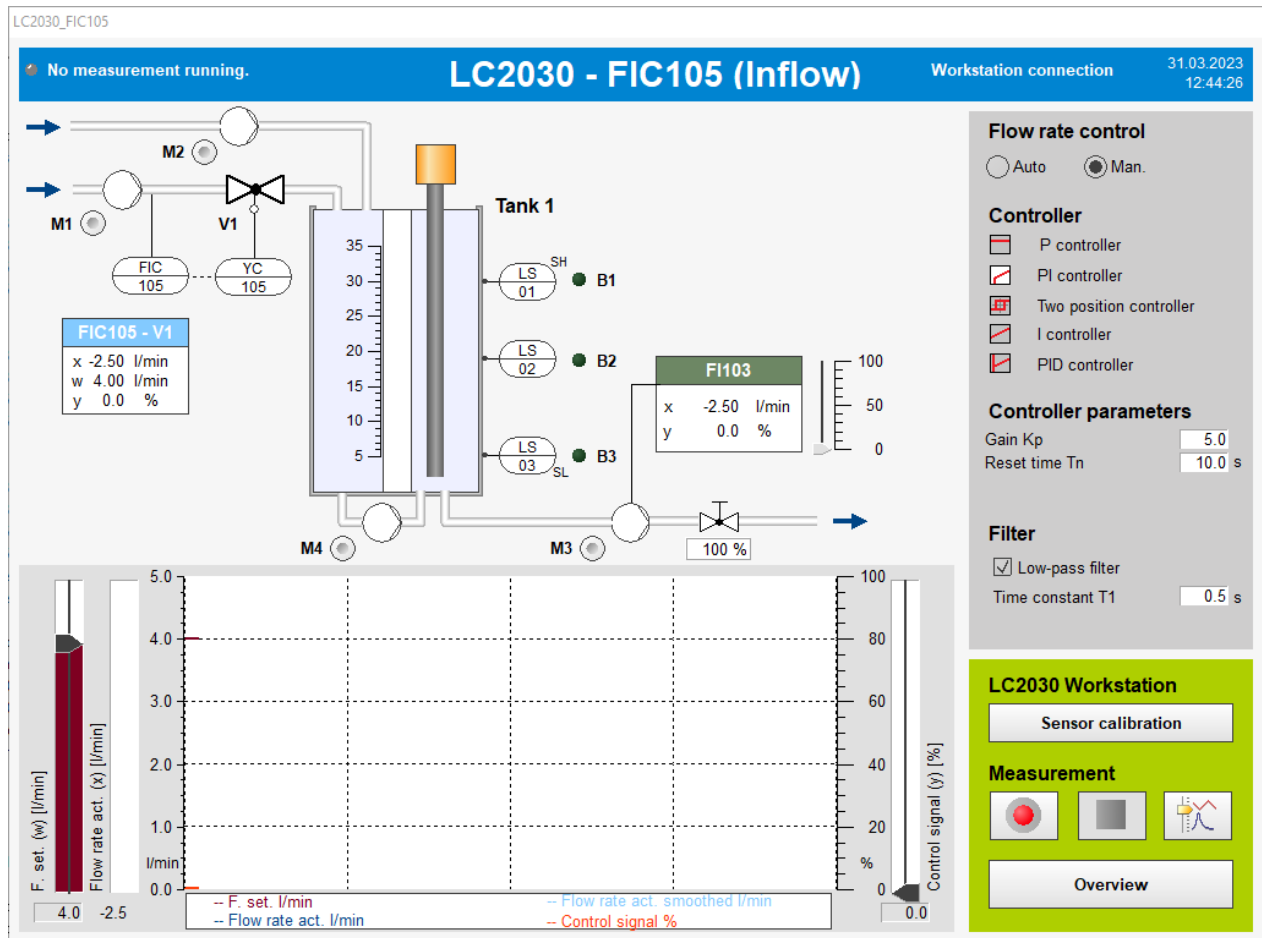


FIGURE 5 FLOW RATE CONTROL VIA INFLOW

To return to the main menu click Overview.

## 2.3 COMBINED CONTROLS

The controls of liquid level and flow rate are combined in following combinations:

- Liquid level LIC101 (outflow) and flow rate FIC105 (inflow) (Figure 6)
- Liquid level LIC104 (inflow) and flow rate FIC103 (outflow)

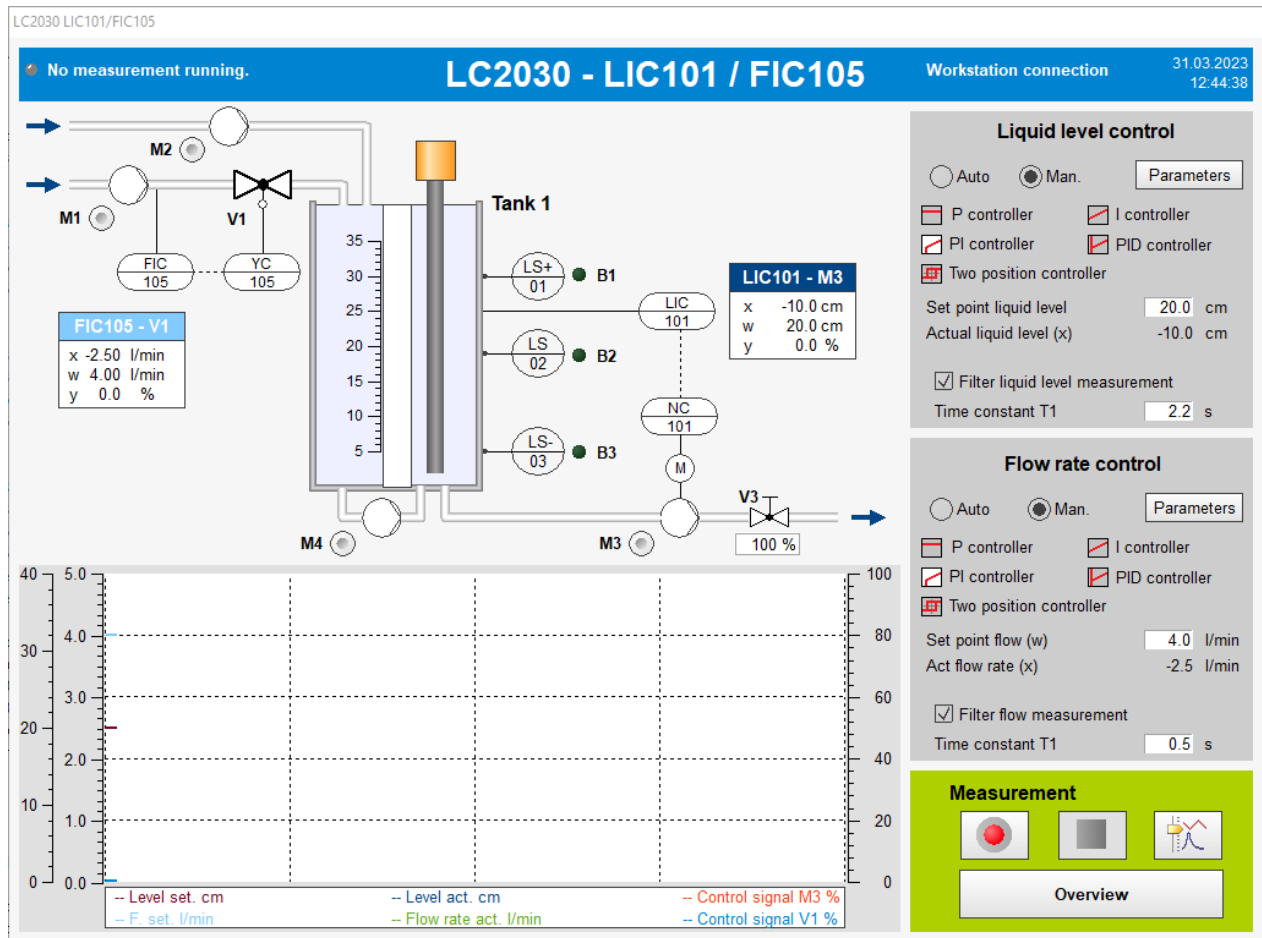


FIGURE 6 FLOW RATE CONTROL FIC105 COMBINED WITH LIQUID LEVEL CONTROL LIC101

For the combined controls at least pumps M1 and M3 have to be switched on. Press the switch next to the pump symbol to turn on the pump.

Next, select whether the control shall run automatically or manually by selecting the appropriate mode.

When Auto mode is enabled, you can select P, I, PI, PID or Two-position controller. Then enter a set point and the different controller parameters. The controller parameters that are displayed depend on the chosen controller type (i.e. gain, reset time and derivative time, hysteresis).

When Manual mode is enabled, you can alter the output signal y with the slide controller or you can enter an output value numerically.

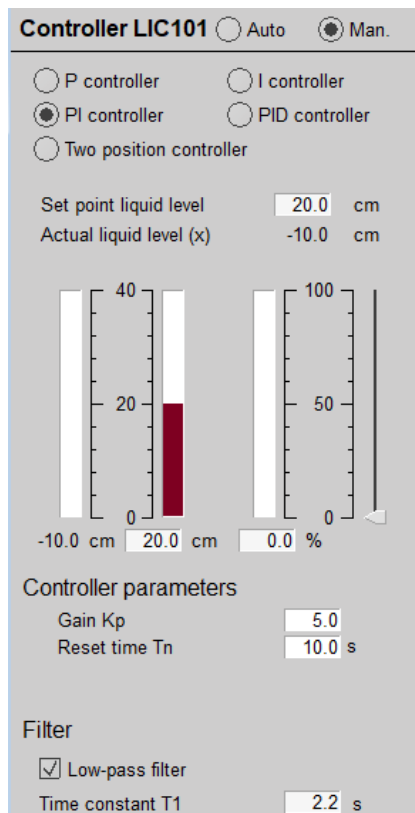


FIGURE 7 CONTROLLER PARAMETERS FOR COMBINED CONTROL

The controller parameters and output signal slider appears in a new window, when button Parameters is pressed (Figure 7).

To return to the main menu click Overview.

## 2.4 TEMPERATURE CONTROL

The temperature control is started with the *Temperature Control TIC102* button.

The pumps M1, M2 and M3 should be switched off for temperature control. Switch on the pump M4 for thorough temperature distribution in the tank.

Temperature control is realised through the use of a heating element that can be switched on or off. For quasi-analogue control, a pulse-width-modulation (PWM) control is implemented. The PWM cycle time is adjustable.

In pulse-width modulated control, the controller switches the heating element on or off for a particular amount time.

The controller output determines the length of the heating period within the PWM interval (cycle time). You can choose to control the temperature in automatic or manual mode.

When Manual mode is enabled, you can alter the output signal  $y$  with the slide controller or you can enter an output value numerically.

When Auto mode is enabled, you can select P, I, PI, PID or Two-position controller. Then enter a set point and the different controller parameters. The controller parameters that are displayed depend on the chosen controller type (i.e. gain, reset time and derivative time, hysteresis).

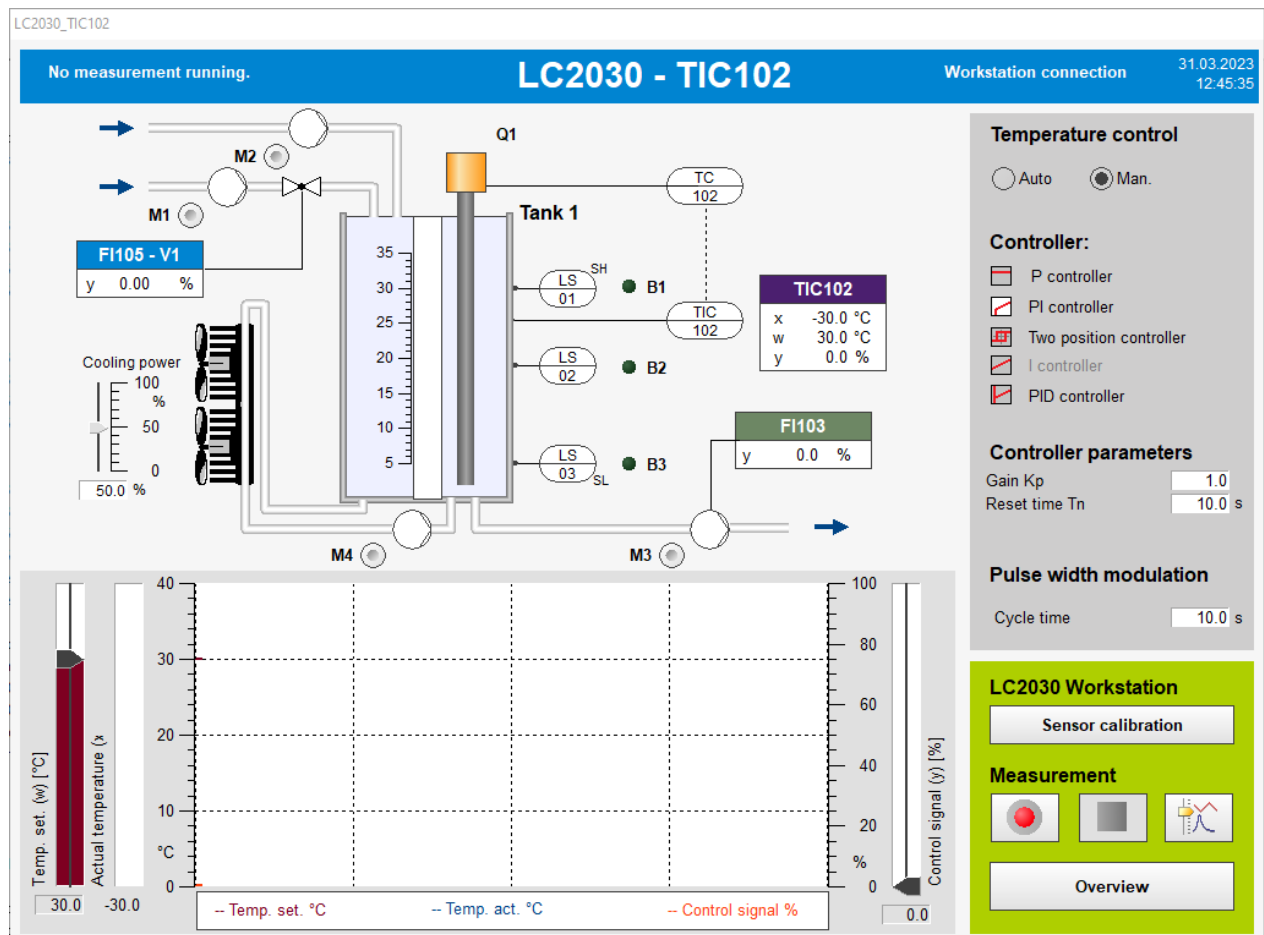


FIGURE 8 TEMPERATURE CONTROL

When working with the simulated workstation, M4 influences the temperature of the vessel. It is as if a cooling unit is connected to the circulation pump. This has the advantage that the water in the tank cools down quickly. To return to the main menu click Overview.

To return to the main menu click Overview.

## 2.5 PRESSURE CONTROL

The pressure is build up with pump M3 and valve V3.

To control the flow rate, the pumps M1 and/or M2 and M3 need to be switched on. Press the switch next to the pump symbol to turn on the pump. The valve position of the manual valve V3 is

entered numerically (in %) in the simulation. If the workstation is connected the valve is adjusted manually.

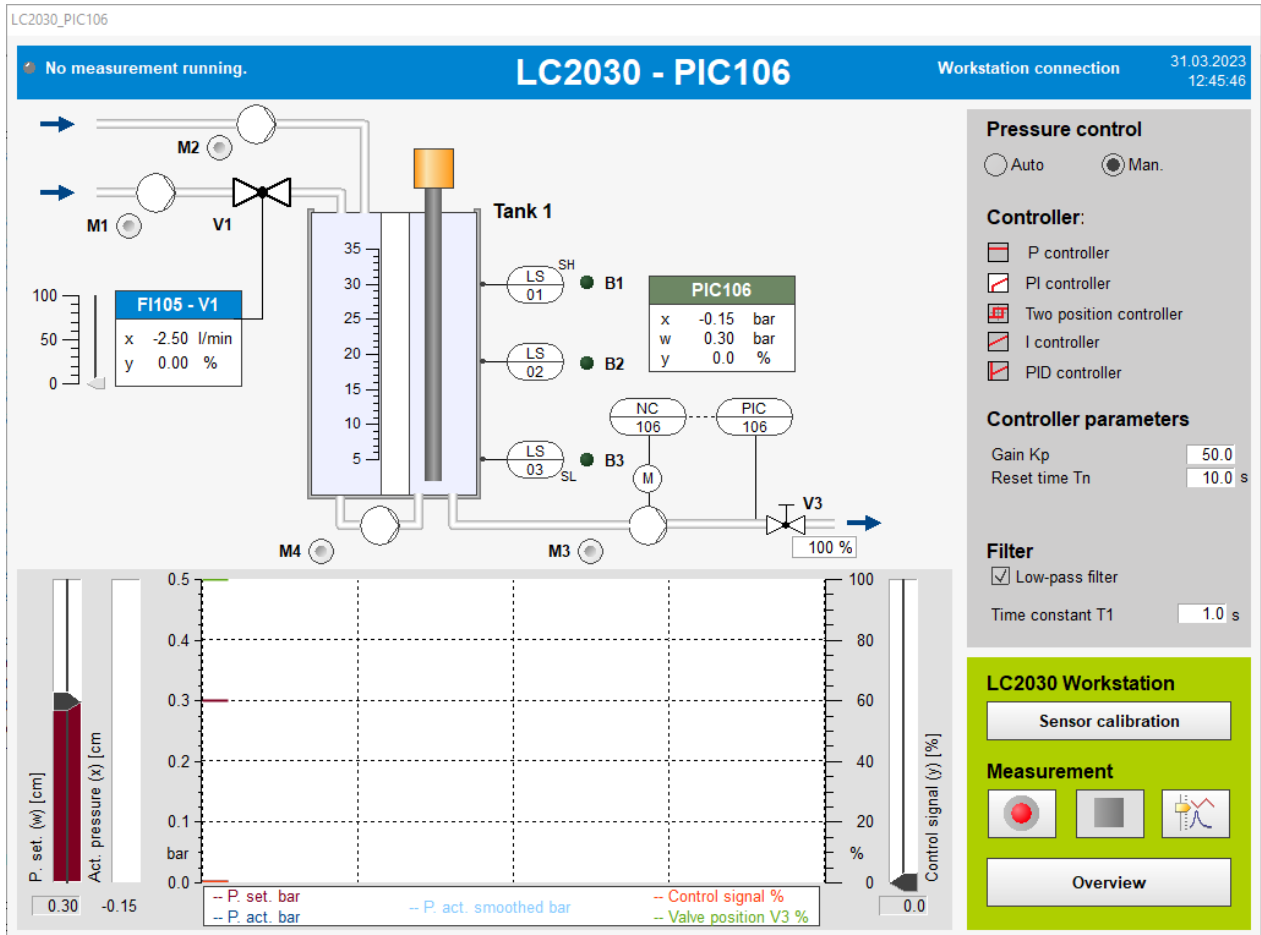


FIGURE 9 PRESSURE CONTROL

Next, select whether the level will be controlled automatically or manually by selecting the appropriate mode.

When Manual mode is enabled, you can alter the output signal  $y$  with the slide controller or you can enter an output value numerically.

When Auto mode is enabled, you can select P, I, PI, PID or Two-position controller. Then enter a set point and the different controller parameters. The controller parameters that are displayed depend on the chosen controller type (i.e. gain, reset time and derivative time, hysteresis).

To reduce the noise of the level signal, a low pass filter can be activated. The time constant "T1" controls the amount of noise reduction.

To return to the main menu click Overview.

## 3 OPEN-LOOP AND SEQUENCE CONTROL WITH GRAFCET

In the LC2030 Training program it is possible to develop open-loop and sequence controls using GRAFCET charts. On the main page of LC2030 training, click *Open-Loop Control with GRAFCET*. The following window will open:

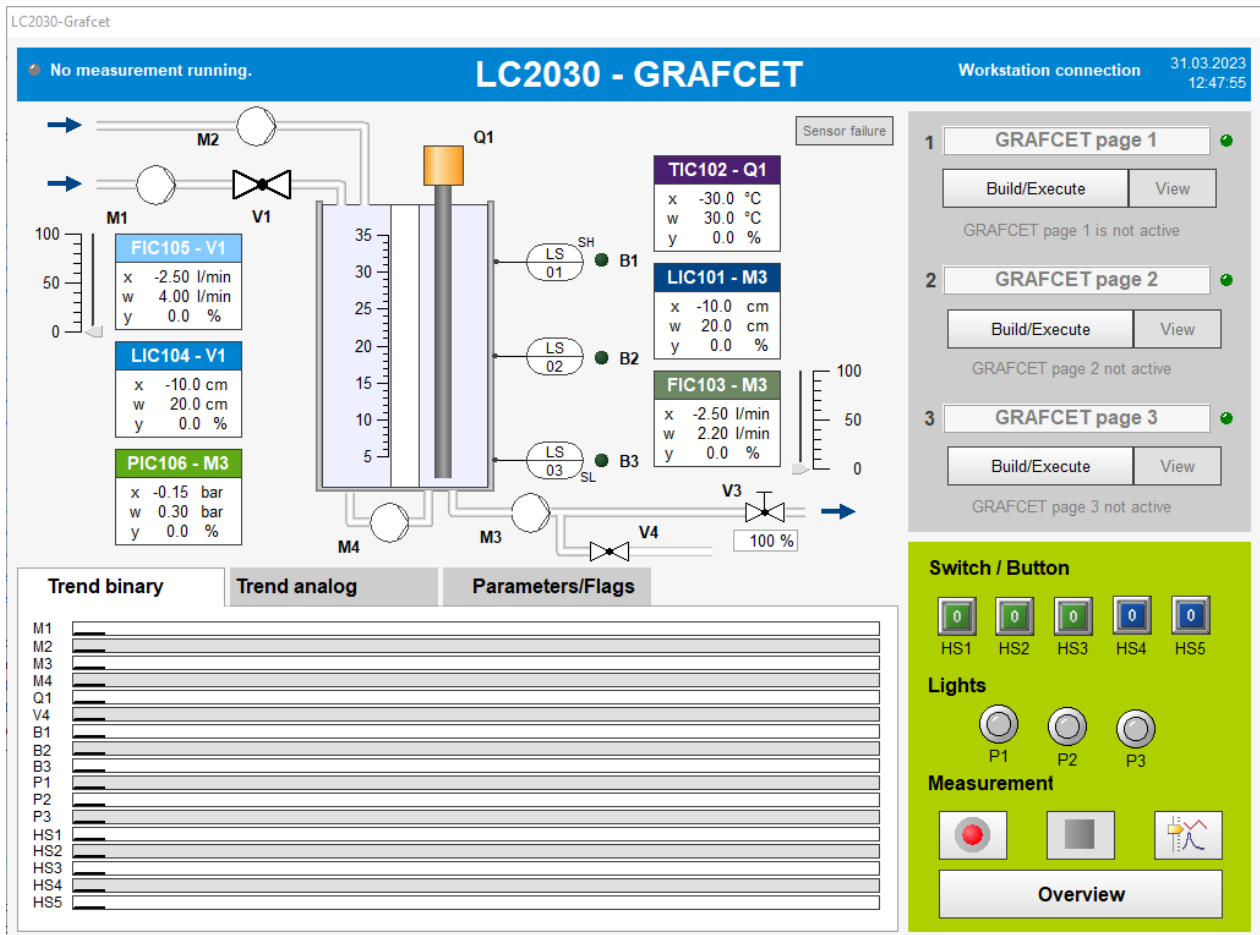


FIGURE 10 DEVELOP GRAFCET CHARTS FOR SEQUENCE AND OPEN-LOOP CONTROL

Up to three GRAFCET charts can be edited and run simultaneously. Via Edit/Run you can edit, modify and test/monitor the GRAFCET structure. To monitor an active structure, press View.

Comments can be inserted in the yellow boxes next to the appropriate numbers to describe the function of the GRAFCET pages.

The LED next to the comment box or the text indicates whether the page is activated or not. If a GRAFCET page is active and running, it can be edited or deactivated by pressing the Edit/Run button a second time.

### 3.1 GRAFCET-EDITOR

By clicking *Edit/Run*, the GRAFCET-Editor window opens. The window will appear empty with only the tool box visible if no GRAFCET charts were created.

The size of the editor window can be varied, by clicking +/- next to the magnifier sign (top right).

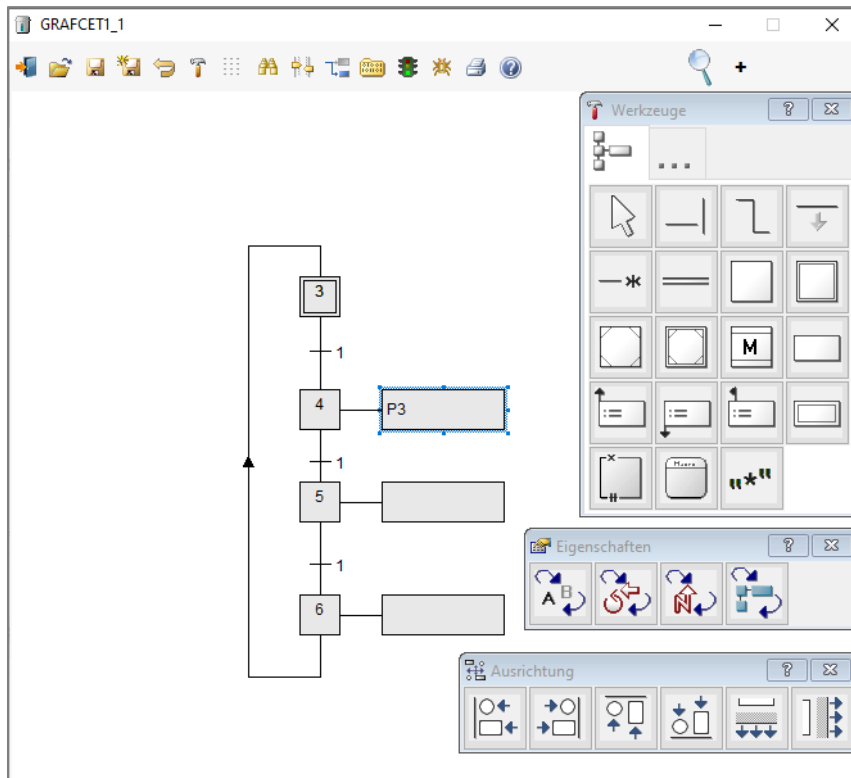


FIGURE 11 GRAFCET EDITOR

GRAFCET charts are created and modified within the GRAFCET-Editor by using the elements in the tool box.

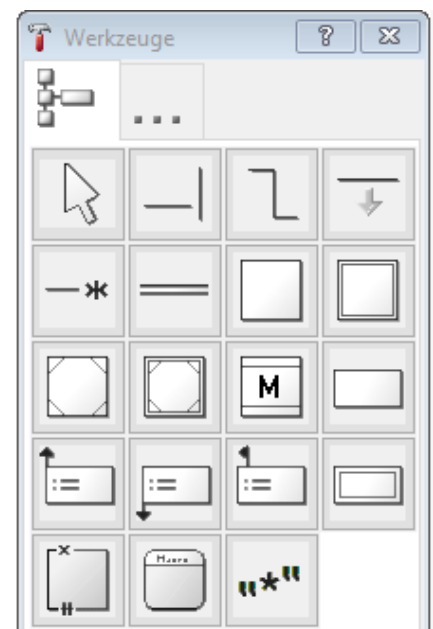
Select any GRAFCET item in the tool box by left clicking on it. Click in the editor to position one or more elements. Use the Esc key or right click to reset the current tool to the mouse pointer.

The elements on the page are connected by directed lines or directed polygons.

To insert an element to a GRAFCET page, select it from the tool box and click the desired position within the GRAFCET page. Elements with inputs or outputs may be placed at the beginning, middle or end of directed lines. The directed lines will automatically be shortened or split if necessary.

Create directed lines or polygons by dragging with your mouse after selecting the appropriate tool from the tool box.

All inserted elements will be aligned to the current input grid.



Left click on an element to select it. By simultaneously pressing the Control key (Ctrl) and clicking other elements, multiple elements are selected at once. By first selecting one element and clicking on another while holding down the Shift key, all elements lying in this imaginary rectangle are selected. The selected elements can be moved by holding down the mouse button and dragging the elements into position.

By left clicking in an empty part of the screen and dragging the mouse while holding down the button, you can select any elements that are fully enclosed in the rectangle that is created.

All mouse operations can be cancelled by clicking the right mouse button or hitting the Esc key.

Press the Tab or Shift+Tab keys to go through the elements on a GRAFCET page. The settings dialog for the selected element appears by pressing the Enter key or double-clicking the marked elements. Marked items can be moved using the cursor keys. Please note that this can interfere with the alignment of the grid.

When an element from the tool box is selected, it is added by clicking the GRAFCET page. It is possible to position and modify the form using the mouse if the object is resizable.

You can draw connections directly from one element to another if the auto-routing function is enabled (note the tool bar information below). The software will then automatically find a connection between the elements. The auto-routing function only works with the directed line tool. When the directed polygon tool is selected the grid points need to be set manually.

All elements added to the GRAFCET editor will be aligned to a specified grid. You can view the grid or modify the spacing by selecting the grid function in the tool bar at top of the GRAFCET window.

When moving elements, you can choose whether the connections are to be tracked (auto-routing) or not (adjustable on the tool bar). The auto-routing always uses a fixed eight pixel grid, regardless of the alignment grid.

When auto-routing is activated, you can temporarily suppress this function by holding the Alt key when moving elements.

Some elements, such as steps, can only be resized to a certain limit. Other elements, such as comments, are fully resizable.

By holding the F6 key, you can temporarily show the operating direction of the directed lines/polygons. Holding the F7 key will display a crosshair. This may be used to check the alignment of the elements.

Use <Ctrl>+Insert and <Shift>+Insert to copy and paste elements. You can get information on an item by selecting it and pressing the F1 key.



Double-clicking on an element opens the configuration dialog for the item. Here you can select signals, conditions or GRAFCET macros.

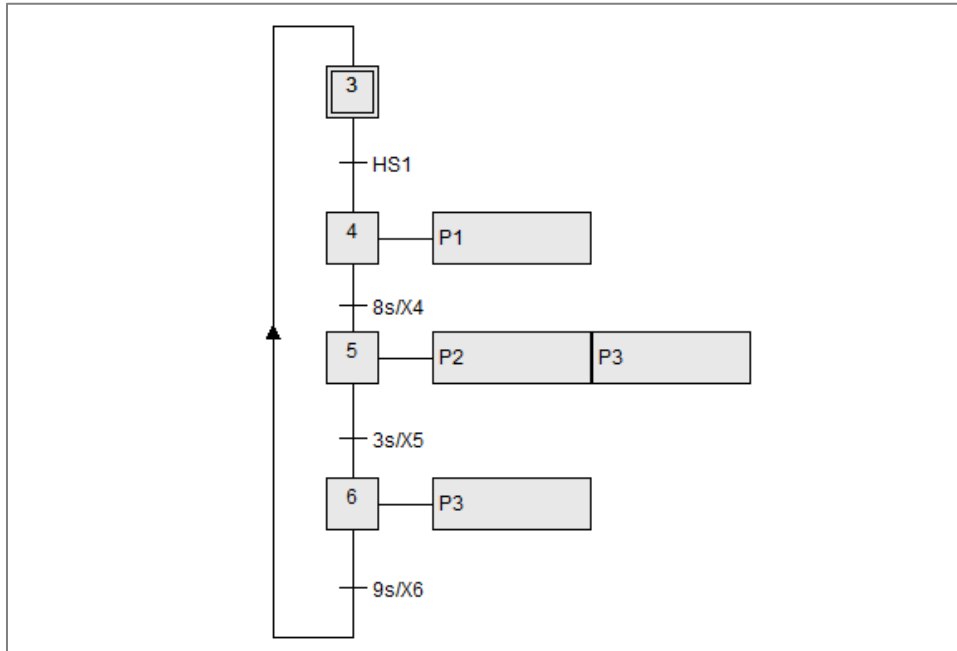


FIGURE 12 EXAMPLE OF A GRAFCET STRUCTURE IN THE GRAFCET EDITOR

The following functions can be found in the tool bar above the GRAFCET editor:



From left to right:

- Close active sub window
- Open – insert a file
- Save the current version
- Save all or the selected items to a file
- Restore to last saved version
- Fade in tool box
- Modify grid alignment settings
- General settings for the active window
- Toggle auto-routing on/off
- Compile GRAFCET page
- Activate GRAFCET page

- Print the active sub window
- Help for the active sub window

## 3.2 COMPILE / ACTIVATE GRAFCET CHARTS

Create the GRAFCET chart using the previous information.



Click the index card symbol to check whether the GRAFCET chart is syntactically correct.



Click the traffic light symbol to compile and activate the GRAFCET chart. The chart will only be activated if it is syntactically correct.

If the GRAFCET chart was not created properly, an error message is displayed and you will be asked if the compilation messages should be shown. By clicking on the error, the erroneous part in the GRAFCET chart is highlighted.

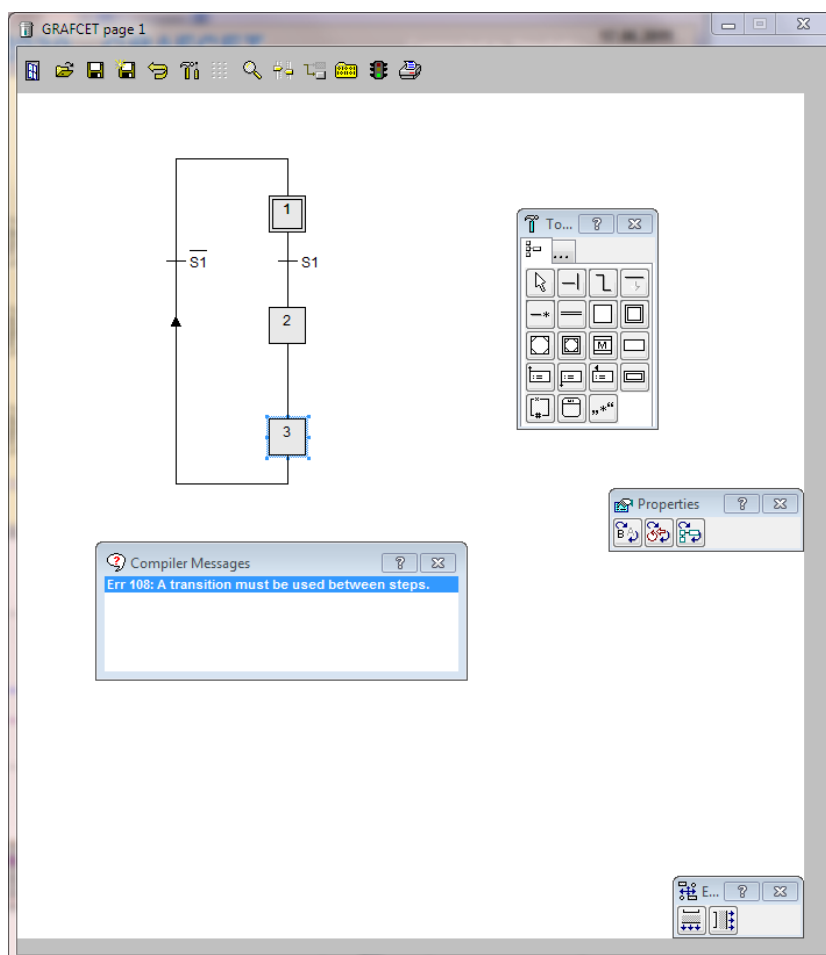


FIGURE 13 ERROR MESSAGES AFTER COMPILATION / ACTIVATION OF GRAFCET CHART

If the GRAFCET chart was created properly, it can be activated by clicking the traffic light symbol. All initial steps will be activated instantly.

The following window (GRAFCET view) will appear. Here you can observe the sequence of the GRAFCET chart.

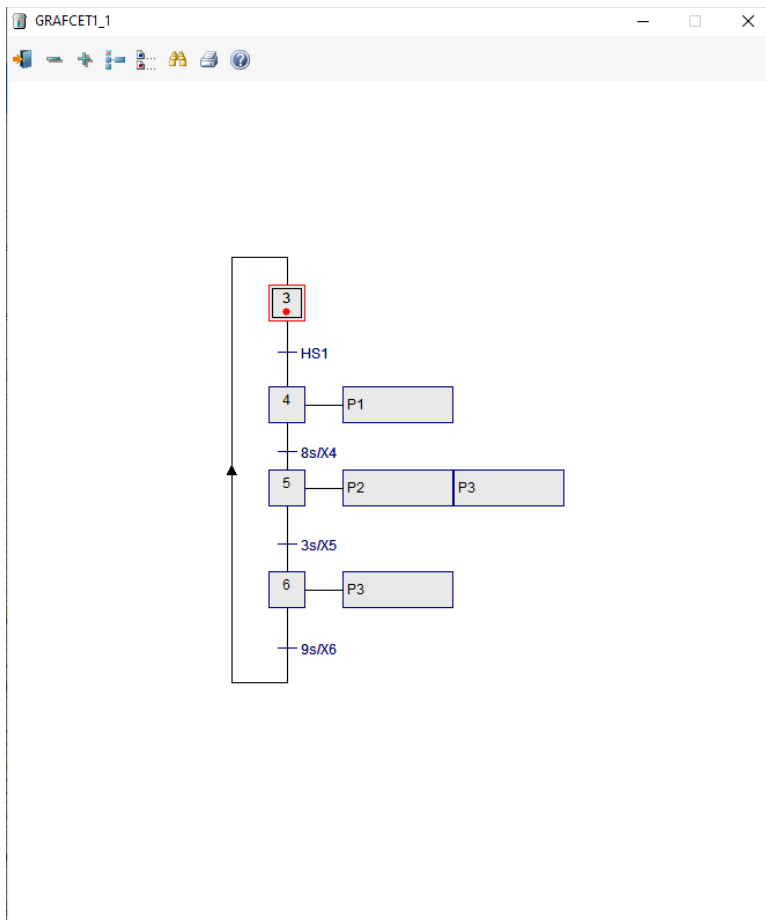


FIGURE 14 ACTIVATED GRAFCET CHART

The initial step in the GRAFCET chart shown in **FIGURE 14** is active. When the signal S1 changes from Low to High, the condition of the transition is fulfilled and the following step will be activated. Hence, the signal L1 will be set (due to the continuous effective action).



It is possible to specifically initiate, activate or reset certain steps. To perform the initialisation, click the initialisation symbol in the tool bar.

The following dialog is shown, these options are available:

- Empty situation (reset and stop the whole structure)
- Initial situation (all initial steps will be activated)
- Set selected steps (enter the step numbers you want to activate)

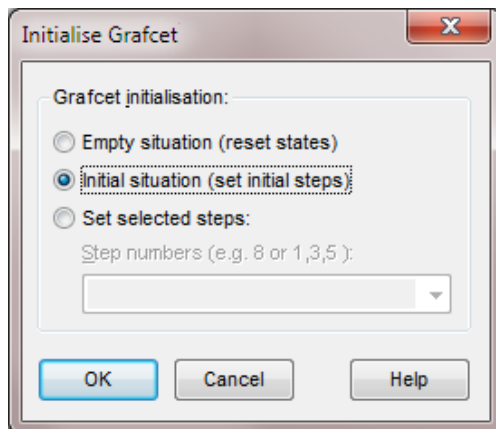


FIGURE 15 INITIALISE GRAFCET DIALOG

## 3.3 GRAFCET ELEMENTS

You can find all the elements that are necessary to create a GRAFCET chart in the tool box of the GRAFCET editor

When a GRAFCET item is selected from the tool box, the mouse cursor transforms into a symbol resembling its function.



By clicking the arrow icon, pressing the ESC key or right clicking the mouse, the current tool selection will be reset to pointer mode.

To keep the tool box clearly structured, not all tools are displayed simultaneously. The two tabs shown in the top of the box represent the tools for:



Standard GRAFCET elements, provided in DIN EN 60848.



Extended GRAFCET elements, not defined in DIN EN 60848.

### Standard GRAFCET Elements (as found in DIN EN 60848)



Directed line (connecting line) for directed links



Polygon line (multiple point connecting line) for directed links



Link label for linking to other structures



Transition condition



Synchronisation



Step



Initial step



Enclosing step



Initial enclosing step



Macro step



Continuous action



Action on activation



Action on deactivation



Action on event



Constraining command



Enclosing structure (Sub-GRFCET)



Macro structure (Sub-GRFCET)



Comment

Extended GRAFCET elements are not part of DIN EN 60848, hence they are not specified further here.

## 4 OPEN-LOOP CONTROL WITH LOGIC DIAGRAMS

In the LC2030 Training program it is possible to develop open-loop and sequence controls using GRAFCET charts or logic diagrams.

On the main page of the LC2030 program, click *Open-Loop Control with Logic Diagrams*. The following window will open:

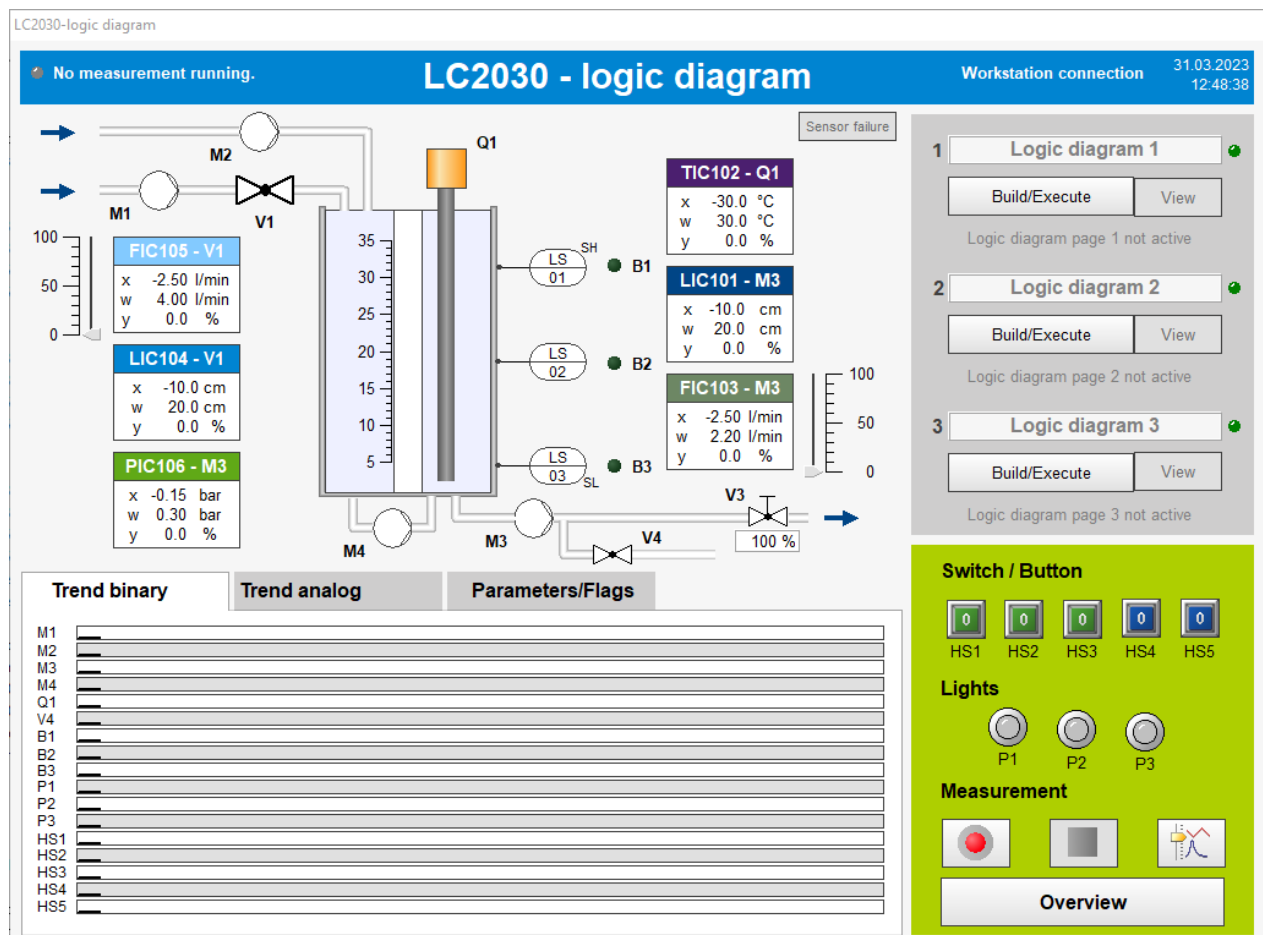


FIGURE 16 OPEN-LOOP CONTROL WITH LOGIC DIAGRAMS

Up to three logic diagrams can be edited and run simultaneously. They can be used to control the real or simulated LC2030 workstation. Via *Edit/Run* you can edit, modify and test/monitor the logic diagram structure. To monitor an activated structure press *View*.

You can insert comments in the yellow boxes next to the numbers to describe the function of your logic diagram pages.

The LED next to the comment box or the text indicates whether or not the page is active. If a GRAFCET page is active and running, it can be edited or deactivated by pressing the *Edit/Run* button a second time.

## 4.1 LOGIC DIAGRAM EDITOR

By clicking *Edit/Run* the logic diagram editor window opens. The window will appear empty with only the tool box visible if no logic diagram charts were created.

The size of the editor window can be varied, by clicking +/- next to the magnifier sign (top right).

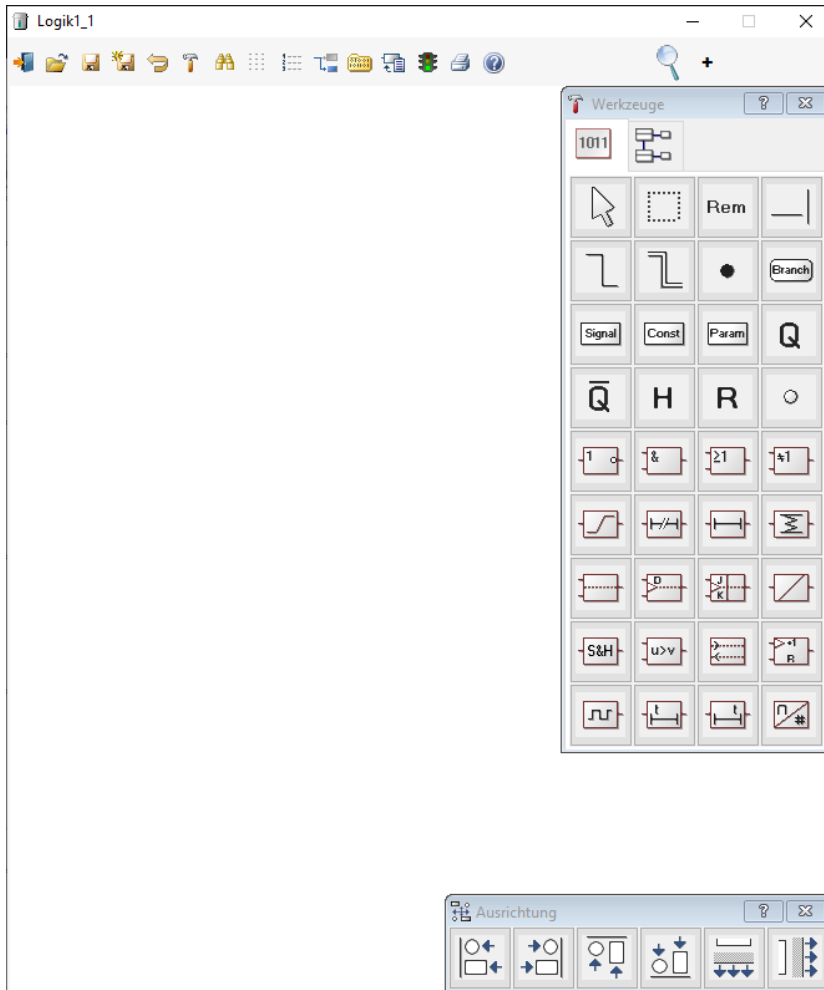


FIGURE 17 LOGIC DIAGRAM EDITOR

Within the logic diagram-editor logic diagrams are created and modified by using the elements in the tool box.

You can select any item in the tool box by left clicking it. Position the element by clicking in an open space in the editor. Use the Esc key or right click with the mouse to reset the current tool to the standard mouse pointer.

The elements on the page are connected by directed lines or directed polygons.

To insert an element into a logic diagram, select it from the tool box and click the desired position within the logic diagram page. Elements with inputs or outputs may be placed at the beginning, middle or end of directed lines. The directed lines will automatically be shortened or split if necessary.

Create directed lines or polygons by dragging with your mouse after selecting the appropriate tool from the tool box.

All inserted elements will be aligned to the current input grid.

Left click on any element to select it. By simultaneously pressing the Control key (Ctrl) and clicking other elements, multiple elements are selected at once. By first selecting one element and clicking on another while holding down the Shift key, all elements lying in this imaginary rectangle are selected. The selected elements can be moved by holding down the mouse button and dragging the elements into position.

By left clicking in an empty part of the screen and dragging the mouse while holding down the button, you can select any elements that are fully enclosed in the rectangle that is created.

**All mouse operations can be cancelled by clicking the right mouse button or hitting the Esc key.**

Press the Tab or Shift+Tab keys to go through the elements on a logic diagram page. The settings dialog for the selected element appears by pressing the Enter key or double-clicking the marked elements. Marked items can be moved using the cursor keys. Please note that this can interfere with the alignment to the grid.

When an element from the tool box is selected, it is added by clicking the logic diagram page. It is possible to arrange and position it by modifying the form using the mouse if the object is resizable.

You can draw connections directly from one element to another if the auto-routing function is enabled (note the tool bar information below). The software will then automatically find a connection between the elements. The auto-routing function only works with the directed line tool. When the directed polygon tool is selected the grid points need to be set manually.

All elements added to the logic diagram editor will be aligned to a specified grid. You can view the grid or modify the spacing by selecting the grid function in the tool bar at top of the logic diagram window.

When moving elements, you can choose whether the connections are to be tracked (auto-routing) or not (adjustable on the tool bar). The auto-routing always uses a fixed eight pixel grid, regardless of the alignment grid.

You can temporarily suppress this function by holding the Alt key when moving elements as long as auto-routing is activated.

Some elements, such as steps, can only be resized to a certain limit. Other elements, such as comments, are fully resizable.

Holding the F7 key will display a crosshair. This may be used to check the alignment of the elements.

Use <Ctrl>+Insert and <Shift>+Insert to copy and paste elements. You can get information on an item by selecting it and then pressing the F1 key.



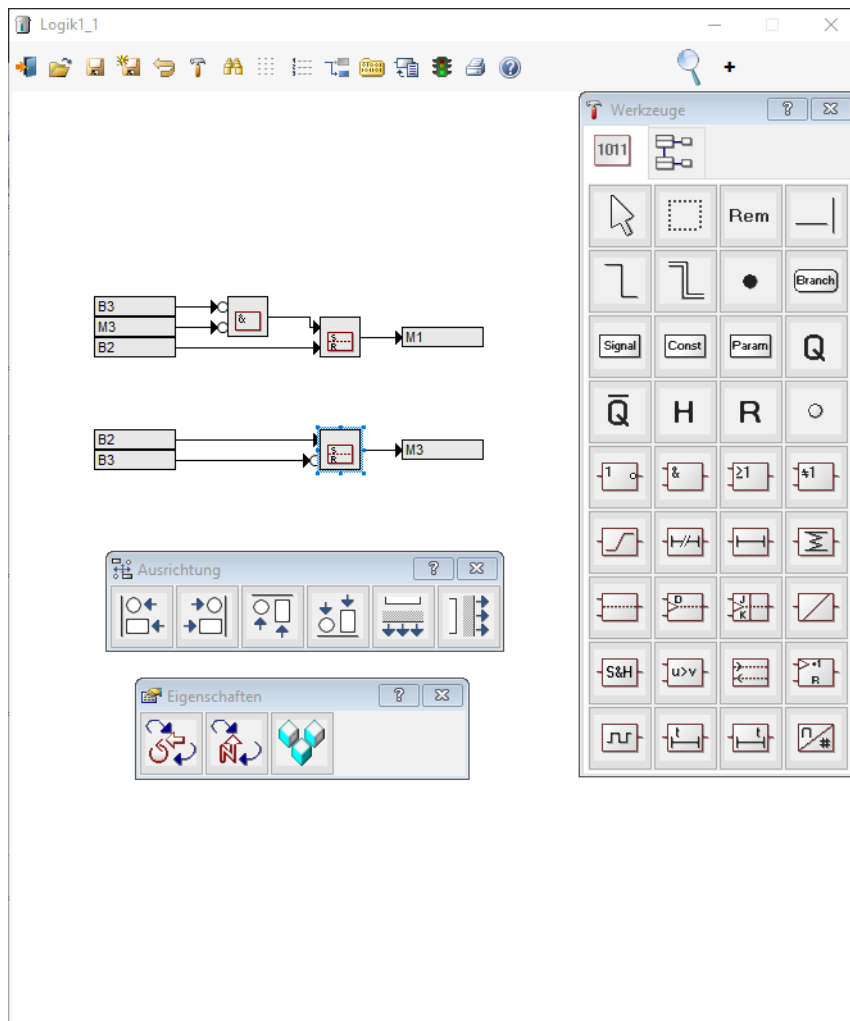
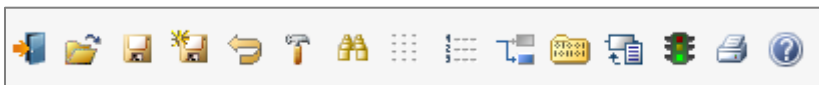


FIGURE 18 EXAMPLE OF LOGIC PLAN

The following functions can be found in the tool bar above the logic diagram editor:



From left to right:

- Close active sub window
- Open – insert a file
- Save current version
- Save all or the selected items to a file
- Restore to last saved version
- Show tool box (if hidden)
- Modify grid alignment settings
- Toggle auto-routing on/off

- Compile logic diagram
- Switch parameter mode on/off after compilation
- Activate logic diagram
- Print the active sub window
- Help on active sub window

## 4.2 LOGIC DIAGRAM COMPILATION AND ACTIVATION

You can find all the elements that are necessary to create a logic diagram in the toolbox.



Click the index card symbol to check whether the logic diagram is syntactically correct.



This button enables parameter mode. You can set the block parameters (e.g. timer) after they have been compiled correctly and verified. Double-click the block you want to adjust and a dialog with the corresponding parameters will open



Click the traffic light symbol to compile and activate the logic diagram. The logic diagram will only be activated if it is syntactically correct.

If the plan was not properly created, an error message is displayed and you will be asked if the compilation messages should be shown. By clicking on the error, the erroneous part in the logic diagram is highlighted.

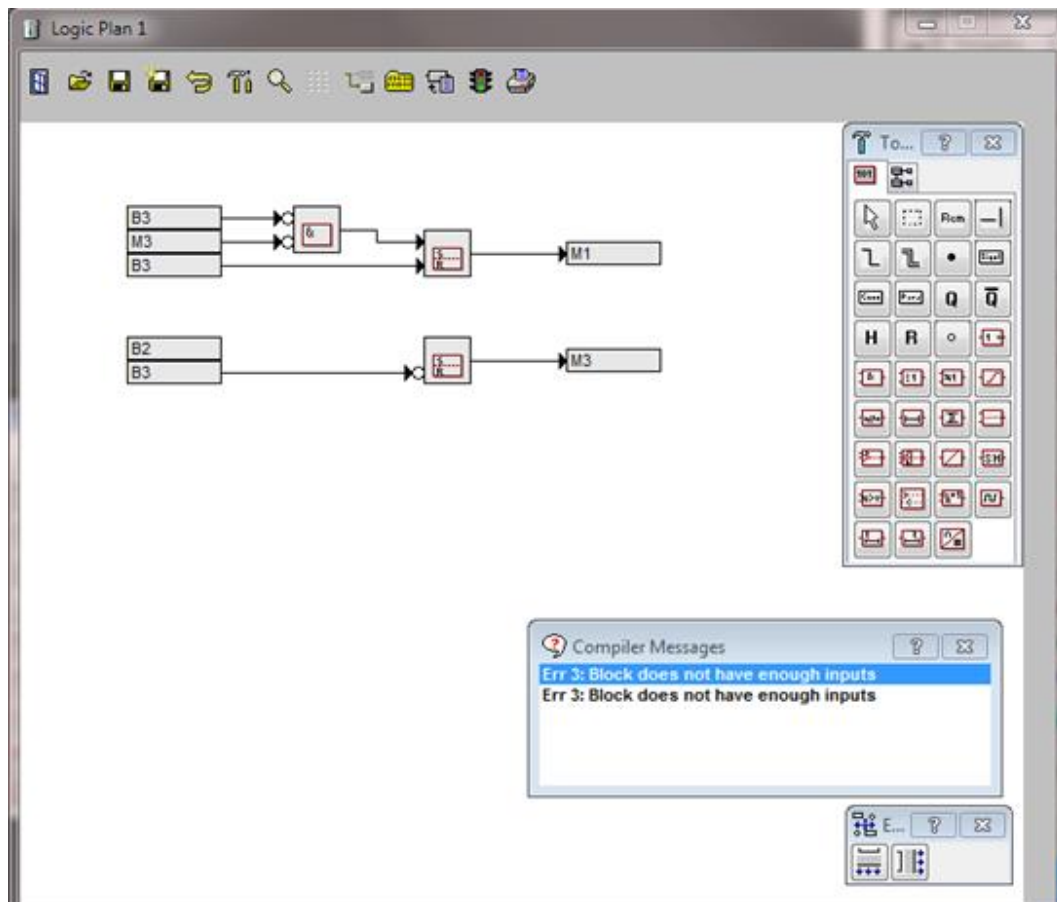


FIGURE 19 ERROR MESSAGES AFTER COMPILATION OF THE LOGIC DIAGRAM

If the plan was created properly, you can switch to parameter mode to further configure blocks or you can activate the logic diagram by clicking the traffic light symbol.

The following window (logic diagram view) will appear. Here you can observe the sequence of the logic diagram chart or change parameters of logic blocks by double-clicking them with the left mouse button.

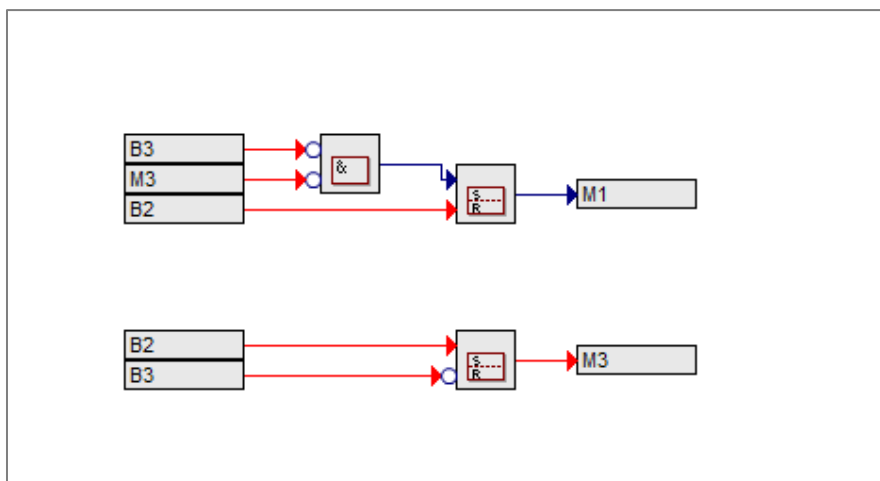



























FIGURE 20 ACTIVATED LOGIC DIAGRAM IN VIEW MODE











## 4.3 LOGIC DIAGRAM ELEMENTS



Please find a short description of the logic plan elements below.

	Switch back to pointer mode	Turn off current tool
	Frame	Add a frame to the logic diagram
	Comment display	Add a comment box to the logic diagram
	Flow or connecting line	Use lines to connect various elements
	Flow or connecting polygon	Use polygons to connect various elements
	Flow or connecting vector polygon	Use vector polygons to create multiple connecting lines in just one polygon. You must set vector dimension (i.e. the number of combined lines)
	Branching point	Click on a line to add a branching point for a second (or third) line from the original line
	Signal block	Double-click with the left mouse button for signal selection
	Constant block	Set as a binary or analog constant. The value cannot be changed while the logic diagram is active
	Parameter block	Set as a binary or analog parameter. The value can be changed while the logic diagram is active
	Identifier for non-negative binary outputs	These output identifiers specify which outputs are negative and which are non-negative

	of blocks	
	Identifier for negative binary outputs of blocks	
	Identifier for hold input	Some blocks may be halted, use this identifier to determine the hold input
	Identifier for reset input	Some blocks may be reset, use this identifier to determine the reset input
	Negation point	Invert binary inputs or outputs to blocks
	Negation block	Invert the input signal. Needs one input and one output
	AND-block	AND function, 2-8 input signals possible
	OR-block	OR function, 2-8 input signals possible
	XOR-block	XOR function, 2 input signals
	Binary trigger-block	Set to "Positive edge", "Negative edge" or "Positive and negative edge". When the input signal changes from low to high, the output of the "Positive edge" trigger will switch from 0 to 1 for one program cycle (0.1s)
	Binary break-block	Not required for the tasks in this program, delays the input signal for one cycle (0.1s)
	Binary delay block	Delays the input for an adjustable number of cycles
	Binary debouncer block	Use to debounce input signals, signal state must be constant for the configured time span to toggle the output signal
	RS-flip-flop	Reset or set-flip-flop, reset input has priority. You can use one or two outputs. When only one output is used, it will be the non-negative. When two outputs are used, output identifiers must be used. You can use the identifier "R" for the reset input. If you do not want to use the reset identifier, the first input is defined as the set command and the second as the reset command.
	D-flip-flop	The D-flip-flop has two inputs and one output. The first input is the signal, the second is the clock/trigger signal. You can use one or two outputs. When one output is used, it will be the non-negative. When two outputs are used, output identifiers must be used.

	JK-master-slave-flip-flop	The JK-master-slave-flip-flop element has three inputs (J signal, clock, K signal). You can use one or two outputs. When one output is used, it will be the non-negative. When two outputs are used, output identifiers must be used.
	Relay-block	The relay block can be used as a toggle or switch relay. If you use two inputs, the function resembles the function of an AND-block. When using three inputs, the first two are the inputs and the third is the switch signal. If any of the other two signals should be the switch signals, use the "S" identifier (on the second tab in the tool box). The switch signal assigns either input 1 or input 2 to the output signal.
	Sample & hold-block	Sample & hold blocks have one analog input, one binary input and one analog output. As long as the state of the binary input is low, the analog input is assigned to the output. When the binary input is high, the last value of the analog input is held.
	Comparison block	Two analog inputs can be compared. Double-click to select mode.
	Limit indicator	The limit indicator can have three analog inputs (upper limit, analog input signal, lower limit) or one analog input. When the value of the analog input is within the limit, the binary output signal is low. When only one analog input is assigned to the block, parameters for upper and lower limit must be set in parameter mode.
	Impulse-counter-block	The impulse counter can be configured as an up counter (2 inputs: count, reset) or as an up/down counter (3 inputs: count, direction, reset). Double-click to select the counter mode. A reset identifier can be used.
	Binary clock generator	Double-click in parameter mode to set the time period.
	Timer block, starting delayed	Uses one (input) or three (input, hold, reset) binary input signals. A "high" input signal will be assigned to the output signal when the timer has expired.
	Timer block, stopping delayed	Uses one (input) or three (input, hold, reset) binary input signals. A "low" input signal will be assigned to the output signal when the timer has expired.
	Analog-to-binary function	Converts analog values greater than zero to the "high" binary signal state

## 5 MEASUREMENTS VIEW

With the *Record Button* a measurement is started and all signals are stored. The signal sequence can then be examined or cleared via measurement view button.



Measurement start



Measurements stop



Measurement view

The window in Figure 21 shows up when View Measurements is clicked if data logging is deactivated. You can select a measurement number and a group of signals.

When data logging is activated, the window in Figure 12 shows up. Here you can perform numerical, graphical and statistical analysis of the signal data.

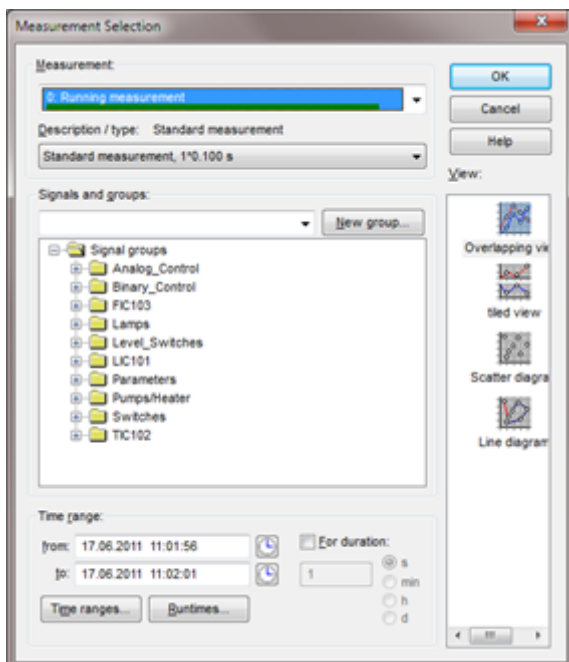


FIGURE 21 SELECT MEASUREMENT DIALOG

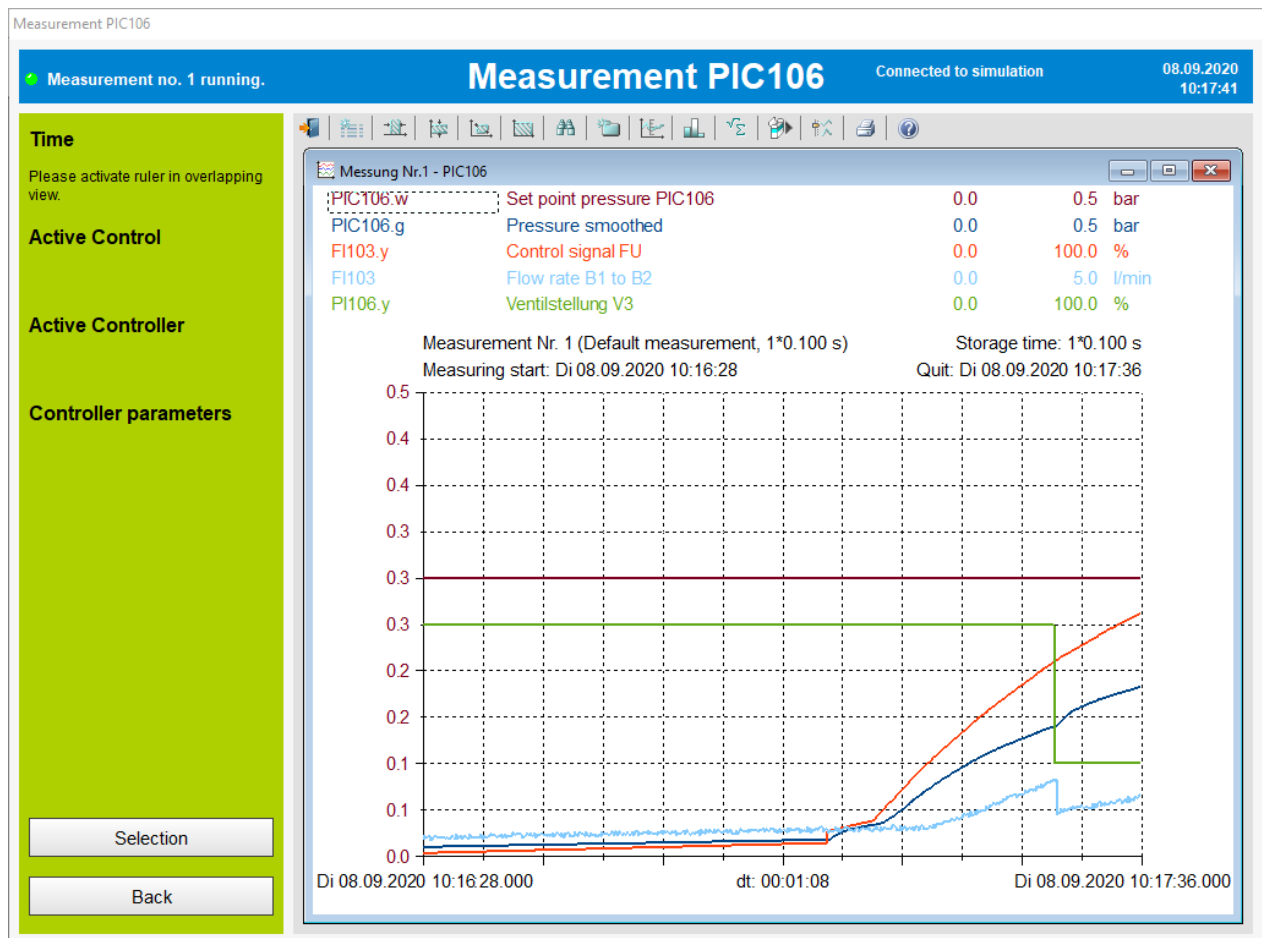


FIGURE 22 MEASUREMENT VIEW



If the ruler is switched on the active control for the selected time is displayed in the left column. Furthermore the controller and parameters are displayed.

Via Selection the window shown in Figure Figure 21 opens.

The signal sequence is displayed in Figure 22 Various operations can be performed by clicking the buttons in the header:



Add or remove signals



Change time range numerically



Change display range numerically



Select time and display range by click-and-drag



Restore the original view



Search





Apply current settings to group



Turn ruler on or off



Statistical analysis



Statistical evaluation



Export data displayed in window to a text file (TXT or CSV)



Adjust setting for representation of measured values



Print the active sub window



Help for the active sub window

By clicking on a signal name, you can adjust the scaling of the y-axis for analogue signals. By double-clicking the signal name, you can adjust/hide the signal sequence. Using the “+” key on the numeric keypad toggles the display type for all signals.

Left clicking on the chart displays the value and time stamp of the active signal at the position of the cursor. By holding the left mouse button and moving the cursor you can measure the chart time and value range to determine the corresponding slope.

Click *Return* to go back to the previous window.

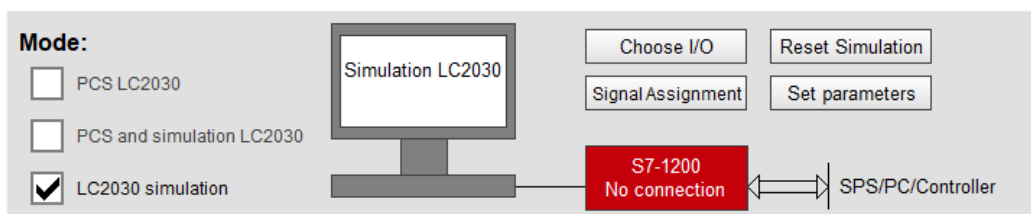
## 6 OPERATION MODE AND CONNECTION TO THE WORKSTATION

The operating mode can be set in the lower section of the start page.

### 6.1 PROCESS CONTROL SYSTEM FOR WORKSTATION LC2030 (PCS LC2030)

In this operating mode, an LC2030 must be connected to the software. The system's connection is shown in the lower area of the process display. The I/O block can have three different states.

- Operational rights, the block is green (operating and monitoring)
- View rights, the block is blue (monitoring only)
- No connection, block is red



The I/O selection button opens a window in which the existing connection can be selected.

**Attention:** When you choose Reset program, while opening the program the connection is reset to I/O 6288.

- I/O Board 6288

The I/O Board 6288 is connected to the computer via USB.

- I/O Board 8488

The I/O Board 8488 is connected using an Ethernet cable.

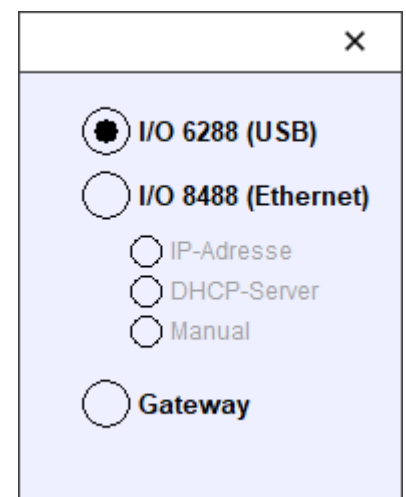
You can choose between three different network settings:

- Fixed IP adress

The computer and the I/O board must be in the same network. The fixed IP address 172.16.17.1 is assigned to the I/O board. An IP address of 172.16.XXX.YYY must therefore be set for the connected computer, which must not be the same as that of the I/O board. Further information can be found in the operating instructions for the LC2030 workstation.

- DHCP-Server

- The I/O board gets the device name BK9050-1. The IP address is assigned by the DHCP server. For more information, see the user manual of the workstation.



- Manual

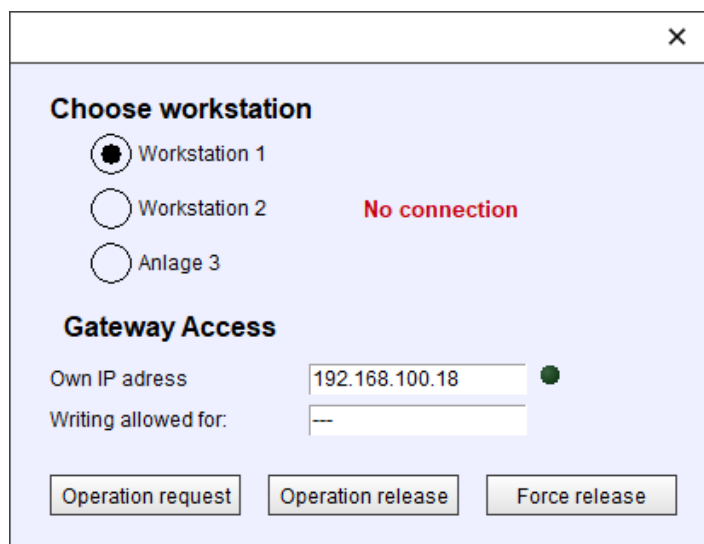
Any other IP or device name can also be assigned to the I/O board. The driver must be set accordingly for this. Read the "Connection\_Beckhoffsystem" manual and the operating instructions for the BK9050 (Beckhoff company).

Attention: If you switch to a fixed IP address or DHCP server, your settings will be pushed over again.

See the LC2030 User Guide for more information.

- Gateway

The gateway is a hardware module that can be integrated into an existing network with multiple operator stations (LC2030 training). The gateway regulates the rights for the system. Only one operator station can have operatoral rights, all others have viewing rights. Operator access can be requested and released by clicking on the I/O block.



If there are several systems, there must also be a corresponding number of gateways. Each gateway is connected to the workstation via an I/O board 8488. Operational rights can only be requested if no other computer has operatoral rights at the moment. The "Operation request" button is used for this. The operational rights are given via the "Operation release" button. The operator rights can be withdrawn from another computer using the "Force release" button. This option requires special user rights. The user superuser must be logged in. The password for the superuser can be found on the installation medium. If the operator station that has operational rights is shut down or switched to simulation mode, the operational rights are released automatically after 30s.

## 6.1.1 SIGNAL ASSIGNMENT IN PCS LC2030

If mode is *PLS2030* with the button *Signal test* the window in Figure 25 opens. Here all signals can be tested and assigned.

All default values are set with the button *Reset assignment*. Changing the assignment is only recommended when an additional analogue input for the pressure control is needed.

Test signals

**Digital Inputs**

- BI1 ☒
- BI2 ☒
- BI3 ☒
- BI4 ☒
- BI5 ☒
- BI6 ☒
- BI7 ☒
- BI8 ☒

**Digital Outputs**

- BO1 ☒
- BO2 ☒
- BO3 ☒
- BO4 ☒
- BO5 ☒
- BO6 ☒
- BO7 ☒
- BO8 ☒

**Analog Outputs**

A01

A02

**Assignment of analog inputs**

AI1

- ☒ L1
- ☐ F1
- ☐ F2
- ☐ T1
- ☐ P1
- ☐ P2

AI2

- ☐ L1
- ☒ F1
- ☐ F2
- ☐ T1
- ☐ P1
- ☐ P2

AI3

- ☐ L1
- ☐ F1
- ☒ F2
- ☐ T1
- ☐ P1
- ☐ P2

AI4

- ☐ L1
- ☐ F1
- ☐ F2
- ☐ T1
- ☒ P1
- ☐ P2

AI5

- ☐ L1
- ☐ F1
- ☐ F2
- ☒ T1
- ☐ P1
- ☐ P2

AI6

- ☐ L1
- ☐ F1
- ☐ F2
- ☐ T1
- ☐ P1
- ☐ P2

Assign analog inputs by choosing signals.  
With the button "Reset assignment" default values are set.

- L1: Liquid level
- F1: Flow rate in outflow
- F2: Flow rate in inflow
- T1: Temperature
- P1: Pressure in outflow
- P2: Pressure in pressure tank

Reset assignment

Back

FIGURE 23 ANALOG SIGNAL ASSIGNMENT

## 6.1.2 SENSOR ADJUSTMENT IN PLS LC2030 OPERATING MODE

The corresponding page is opened via the Sensor calibration button.

The operation is described in the window.

Messung läuft nicht.
**Sensorabgleich**
Anschluss Anlage 20.10.2022 15:57:09

Die Eingangssignale (Rohwerte) haben einen normierten Definitionsbereich von 0.0 ... 1.0. Um die Eingänge in physikalische Einheiten umzurechnen, muss ein Signalabgleich durchgeführt werden.

Dieses Fenster öffnet sich stets im Ansicht-Modus. Um in den Edit-Modus umzuschalten, wählen Sie das Signal, das Sie abgleichen möchten, aus.

Für alle Werte besteht ein linearer Zusammenhang zwischen Rohwert und physikalischer Größe, der durch zwei Stützstellen beschrieben wird.

Geben Sie den physikalische Wert der Stützstellen über Tastatur ein. Die Rohwerte können Sie über Tastatur eingeben oder Sie übernehmen mit den Stützstellen-Buttons den aktuellen Wert.

☐ **Temperatur TIC102 [°C]**

	Stützstelle 1	Stützstelle 2	Aktueller Wert
Normierter Rohwert	0.000	1.000	0.000
Temperatur	-30.0	0.0	-30.0

☐ **Füllstand LIC101/LIC104 [cm]**

	Stützstelle 1	Stützstelle 2	Aktueller Wert
Normierter Rohwert	0.200	1.000	0.822
Füllstand	0.0	40.0	31.111

☐ **Durchfluss FIC103 [L/min]**

	Stützstelle 1	Stützstelle 2	Aktueller Wert
Normierter Rohwert	0.200	1.000	0.000
Durchfluss	0.0	10.0	-2.5

☐ **Durchfluss FI105 [L/min]**

	Stützstelle 1	Stützstelle 2	Aktueller Wert
Normierter Rohwert	0.200	1.000	0.000
Durchfluss	1.0	2.0	0.8

☐ **Druck PIC106 [bar]**

	Stützstelle 1	Stützstelle 2	Aktueller Wert
Normierter Rohwert	0.000	1.000	0.000
Druck	0.0	0.6	0.0

## 6.2 PROCESS CONTROL SYSTEM FOR THE SIMULATED WORKSTATION (PCS AND SIMULATION LC2030)

In this mode, no hardware needs to be connected. All tasks can be performed on the simulated plant.

## 6.3 SIMULATED WORKSTATION (LC2030 SIMULATION)

If you work with the simulated system in the overview window current states of the workstation are displayed. As well lamps and switches are displayed.

You can adjust the floating switches, set valves manually, set the environmental and inlet temperature or reset the unit to its original state via set parameters button.

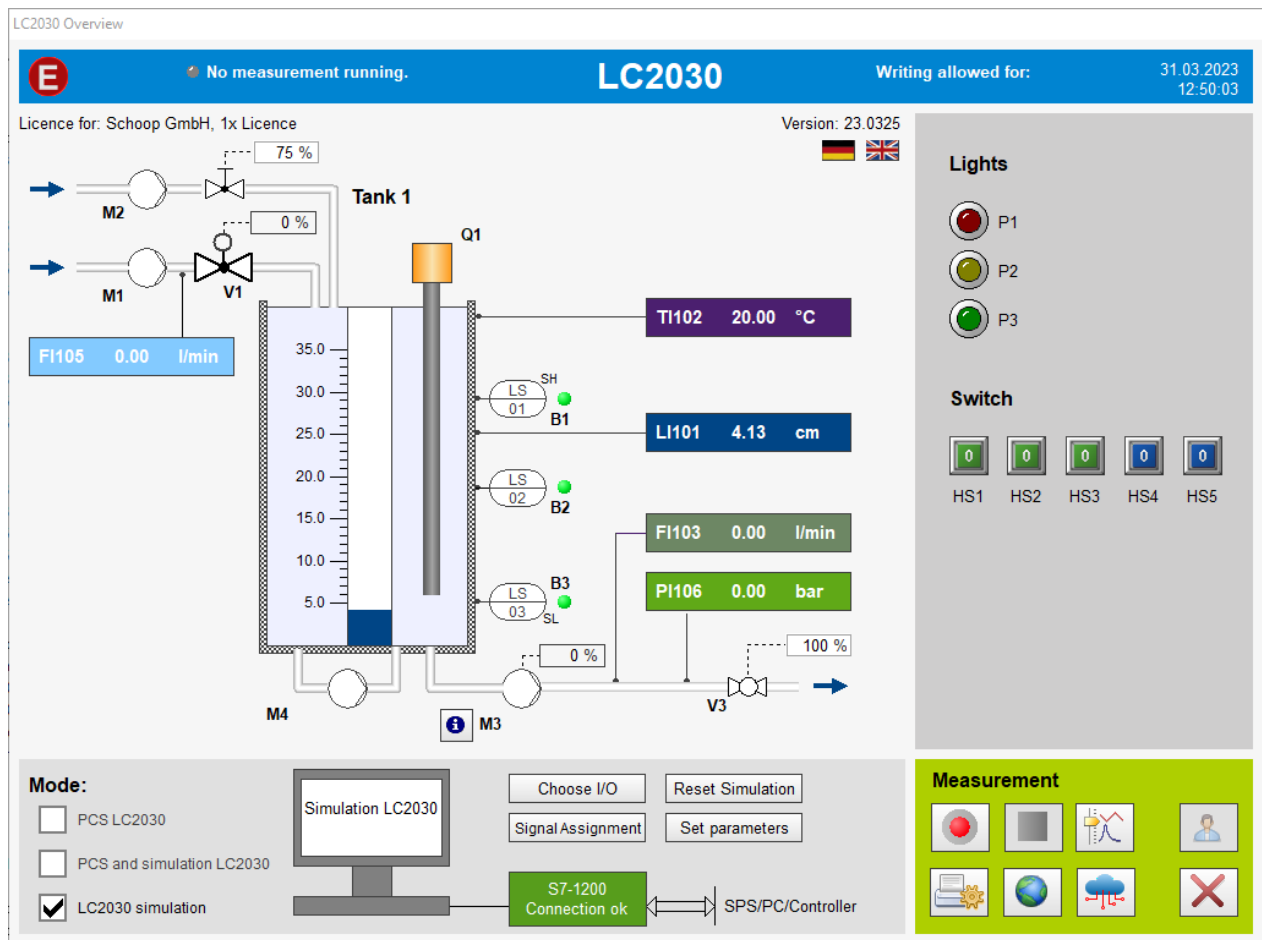
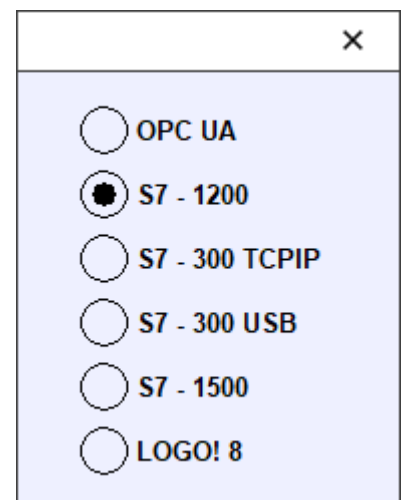


FIGURE 24 VIEW OF SIMULATED WORKSTATION FOR EXTERNAL CONTROL

With the button *Choose I/O* a setup window opens, in which the control soft-/hardware is chosen:

- MQTT (activated via MQTT button)
- OPC UA
- S7-1200
- S7-300 (USB or TCP/IP)
- S7-1500
- LOGO! 8

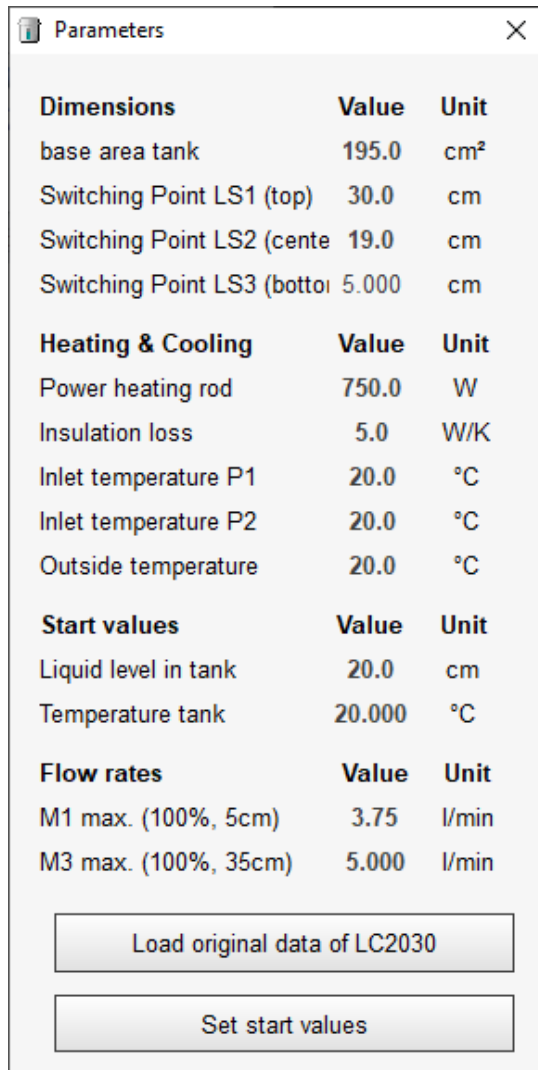


The driver needed for connection is set in the background window WRP-Serv. A detailed description of all necessary settings is in the document *SPS-Configuration.pdf*.

With the button *Signal assignment* a pdf opens, in which all signal addresses are summarised.

The necessary settings for the connection via MQTT can be found in the document *"MQTT\_activation.pdf"*.

To change parameters such as ambient temperature and inlet temperatures or to change the position of the hand valves, the button *set parameters* can be used.



Dimensions	Value	Unit
base area tank	195.0	cm <sup>2</sup>
Switching Point LS1 (top)	30.0	cm
Switching Point LS2 (center)	19.0	cm
Switching Point LS3 (bottom)	5.000	cm

Heating & Cooling	Value	Unit
Power heating rod	750.0	W
Insulation loss	5.0	W/K
Inlet temperature P1	20.0	°C
Inlet temperature P2	20.0	°C
Outside temperature	20.0	°C

Start values	Value	Unit
Liquid level in tank	20.0	cm
Temperature tank	20.000	°C

Flow rates	Value	Unit
M1 max. (100%, 5cm)	3.75	l/min
M3 max. (100%, 35cm)	5.000	l/min

Load original data of LC2030

Set start values

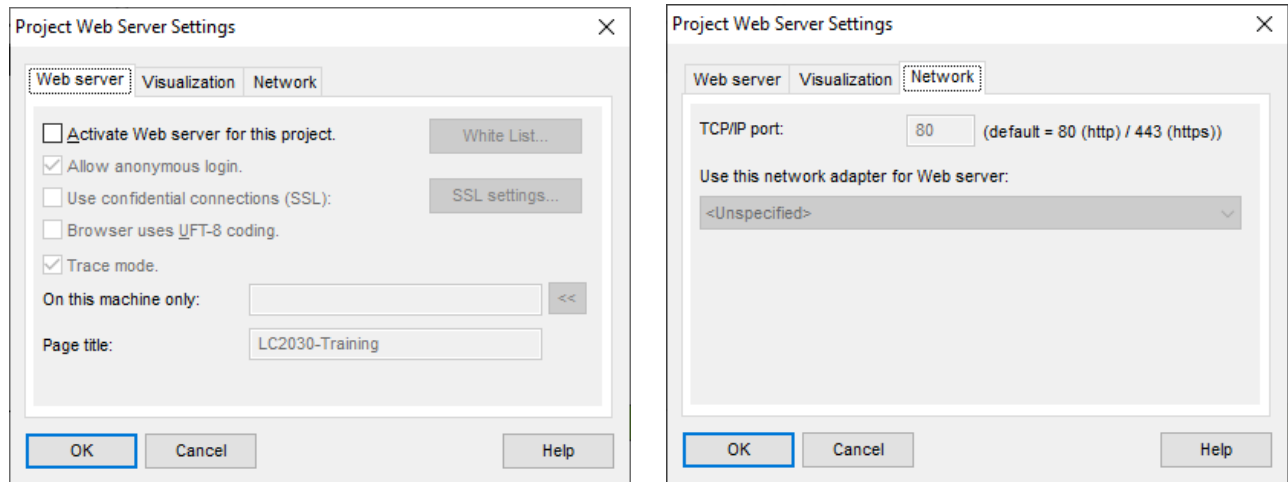
FIGURE 25 PARAMETER PAGE SIMULATED WORKSTATION

## 6.4 ACTIVATE WEBSERVER

In the LC2030 Training a webserver can be activated with which the user interface can be called in a browser.

The setup is opened via web server button.





In the first tab *Web server* following settings are possible:

- *Activate web server for this project*
- The *white list* sets PC-names which are allowed to show the interface. If it's empty all PCs are allowed.
- Allow anonymous login has no influence.
- When *use confidential connections (SSL)* is activated the browser works with SSL/TLS certificate encryption.
- *Browser uses UTF-8 coding* is necessary if your browser only sends UTF-8 codes.
- *Trace mode* should be deactivated.
- Under *on this machine only* no setup is necessary
- *Page title* is any desired

In the tab *Visualization* no changes should be made. In the tab *Network* the settings of *port* and *network adapter* are available.

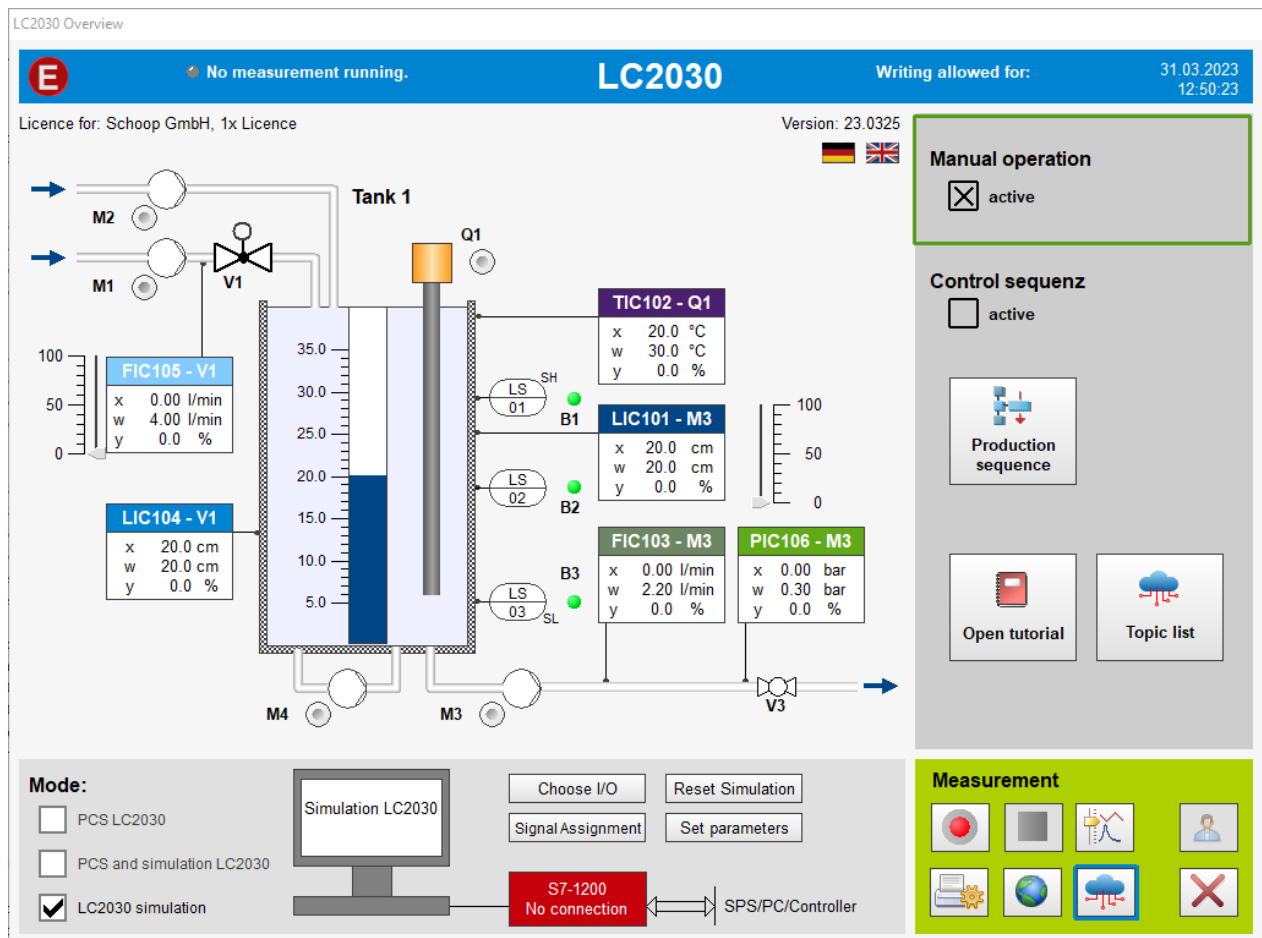
## 6.5 ACTIVATE MQTT CLIENT

In the operation modes PCS LC2030 and PCS and simulation LC2030 it is possible to activate a MQTT client, with which the process control system is able to send and subscribe MQTT messages.

The client is activated via according button.







With activated MQTT client the interface switches to MQTT view. There're two options:

1. *Manual operation:* All operations are available over MQTT and PCS in dial mode.
2. *Sequence control:* A pre-defined production sequence is automatically activated. It's realised with GRAFCET. You can open it with the *Production sequence* button.

Via *Open tutorial* a PDF is opened with a detailed description of the operation. Furthermore it contains tasks and solutions.

If you would like further information on the process control and simulation system WinErs, please contact us at:

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