CellStation

Operating Manual

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CellStation	10000005701e	1.00
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Operating Manual	**Checked by**	**Date**
	Approved by	**Date**

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1. Introduction

This document describes the operation and configuration of CellStation using the local Operator Panel. The same parameters are valid for CellStations without the local panel. For these CellStations either a portable panel or a DCS connection with proper functionality must be used for operation and parameter settings. The document is valid for CellStation version 1.00.

CellStation in brief

CellStation is an intelligent multiloop PID controller capable of controlling flotation machines with one to three separate air feeds and a common slurry level. The level controller can have one or two output discharge valves. The functioning of the station is defined by parameter settings only and hence there is no need for programming.

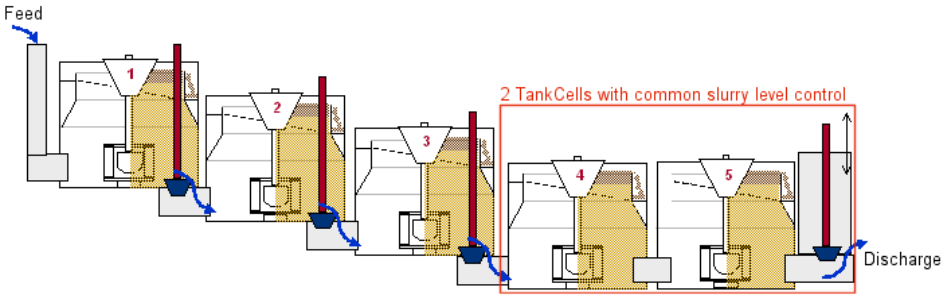


Figure 1.1: Typical installation of flotation machines.

In figure 1.1 a bank of flotation cells is installed in typical fashion with slurry feed coming to cell 1 on the left. The air feed and slurry level of cell 1 need to be controlled with an air valve and a slurry discharge valve respectively. Similarly cells 2 and 3 need air and slurry level controls. Cells 4 and 5 are connected together without an intermediate discharge valve thus sharing the same slurry level. To control this combination of five flotation cells four CellStations are needed i.e. cells 1 to 3 each have a separate CellStation while cells 4 and 5 share one CellStation.

Feed variations to cell 1 cause slurry level variations, which are controlled by the level controller using the cell 1 discharge valve(s). This again causes disturbances to cell 2 slurry level and thus the original feed variations propagate trough the whole chain of cells. While this effect can be minimized with proper tuning of level controller parameters the result may be sluggish controls with associated losses in production capacity and energy.

To address this problem each CellStation node can connect to the previous node and obtain information about the previous cell disturbances even before it propagates to the next cell. With a special Feedforward control mechanism the station can then compensate the expected disturbances effectively in advance.

Profibus DP technology is used for communications between CellStation nodes. Each CellStation also contains a separate Profibus DP/DP Coupler for a connection to a Distributed Control System (DCS). The DP/DP Coupler connects to a Profibus DP Master controller of the DCS. On this Master controller the DP/DP Coupler must be configured as a slave module (use GSD file si018070.gse). For connection details see document “CellStation Connection to Automation System” (document code 10000005690).

1.1 CellStation versions and structure

Product versions

CellStation CSS	CellStation Standard, which has no Operator Panel. This station type can only be used with connection to a DCS. The DCS must have special CellStation connectivity function blocks to be able to support the CSS configuration via the Profibus DP connection. Note: CSS can be upgraded to CSP version on-site with an upgrade kit.
CellStation CSP	CellStation Panel, which is equipped with the touch-sensitive Operator Panel. This panel provides a full user interface for local parameterisation and operation of the CellStation. This station type can be used independent from a DCS, but it also has the same possibilities for configuration from DCS as the CSS version.

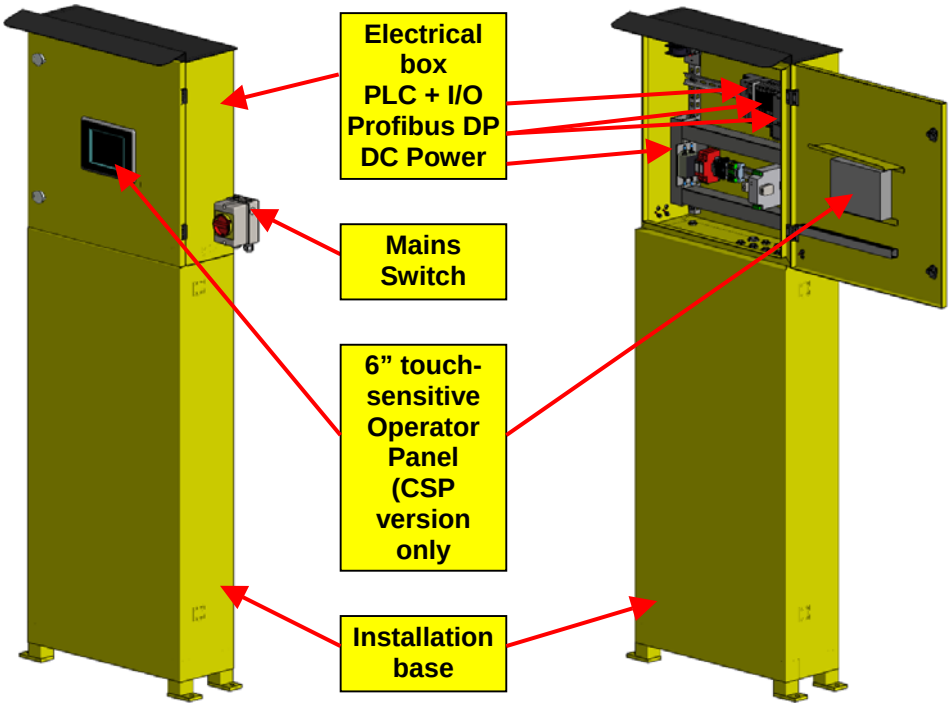


Figure 1.2.1: CellStation main hardware components

Main hardware components

Electrical box	This electrical box conforms to IP56 / NEMA 4X environmental standards. Inside the box are installed: • Programmable Logic Controller (PLC) with Flash Memory containing the programs necessary for the station. This memory will also store all the user-defined parameters. • Separate Profibus DP interfaces for connecting to another CellStation (Master controller) and to a DCS (DP/DP Coupler). • Analog input and output modules for the level and air measurements and control actuators. • Terminals for power connection, I/O signal cables, grounding etc. • Power-line surge arresters, fuses and a 100-240VAC to 24VDC Instrument power supply. • Operator Panel with 6” touch-sensitive display (CSP version only).
Installation base	Installation base comes attached to the electrical box. This freestanding base makes the installation of CellStation easy and serves also as a convenient cover for the instrument, communications and power cables entering the CellStation box. The base can be detached from the CellStation box if necessary.
Mains Switch	The power switch can be attached to either side of the CellStation box or to its immediate vicinity.

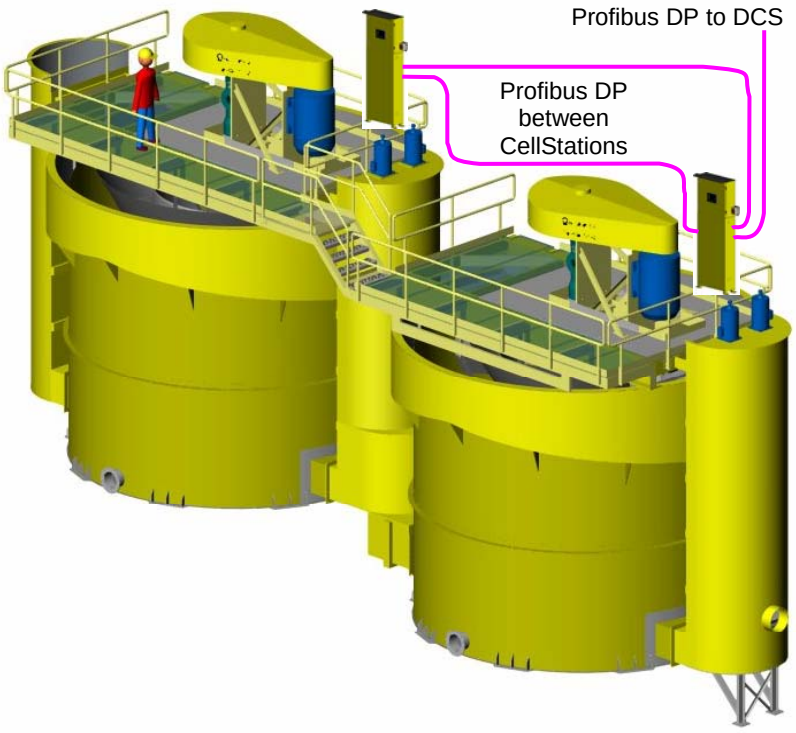


Figure 1.2.1: Example of CellStations installed on TankCells.

1.2 CellStation configuration principles

On CellStation there are basically three levels of parameters the user must define in order to get the station to work properly:

- Operator controls

  These controls address the functioning of individual control loops in real time.

  Operator Panel's **Operator Interface** displays are used to manipulate these controls. No password is needed.

  All of these parameters can also be set from the DCS connection.

- Configuration parameters

  Configuration parameters define the identification and functioning of the Level and Air control loops.

  Use Operator Panel's **Configuration Tools** displays to define these parameters. To gain access to these tools you need to login using the **Configuration Password** of the station.

  All of these parameters can also be set from the DCS connection.

- Device parameters

  Device parameters address mainly the hardware's functionality of the station.

  Device parameters are defined using **Maintenance Tools** displays of the station's Operator Panel. To gain access to these tools you need to login using the **Maintenance Password** of the station.

  Most of the device parameters can also be set from the DCS provided the connection is enabled. On a CellStation without an Operator Panel (the CSS version) the DCS connection is enabled by default.

  During Installation and Commissioning a separate Operator Panel can be used for setting the device parameters.

The Operator Panel is touch-sensitive. To modify a parameter touch it with a finger or other pointing device. The intended action takes place immediately (parameter ON/OFF, value UP/DOWN, display selection etc.) or a keyboard will appear (for numerical or alpha-numerical fields). Type in the desired value and press ENTER to accept the typed value.

Do not use any pointing device with sharp or abrasive edges. Since the panel's touch-surface is made of quite durable plastics material, scratches may eventually make the surface opaque and thus unreadable.

2. Operator Interface

The **Operator Interface** includes displays for monitoring and operating the CellStation controllers. For monitoring purposes trend views with various time spans are provided. For operating purposes function buttons exist for changing controller setpoints and outputs and switching the control loop operation between MANUAL and AUTO modes.

Home display is the starting point of the Operator Interface. No password is needed for opening the Home display or any of the other Operator Interface displays. Clicking the TOOLS button opens the GIVE PASSWORD display and depending on the password given either CONFIGURATION TOOLS or MAINTENANCE TOOLS display will open.

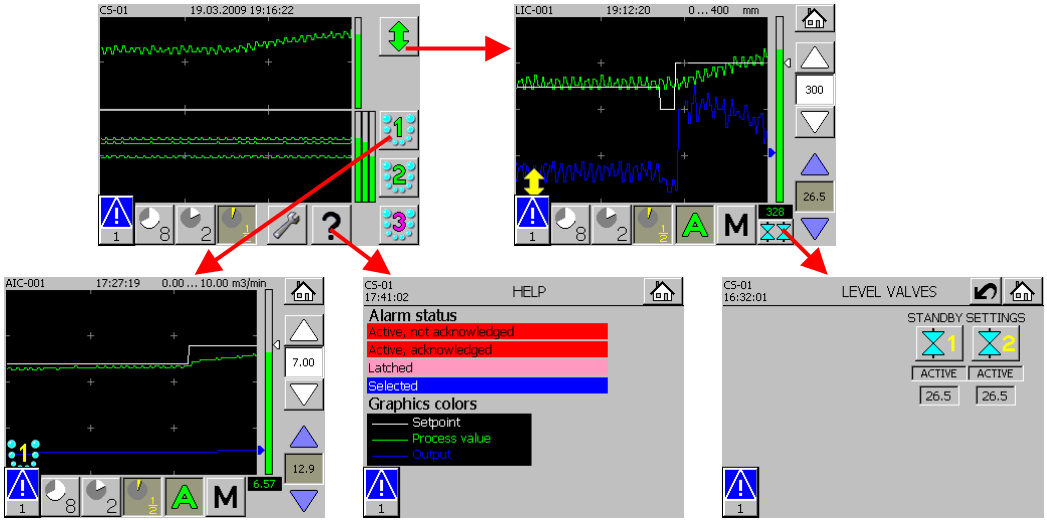


Figure 2: Operator Interface display hierarchy

On the Operator Interface displays the buttons and input fields imitate 3-dimensional operation. The following table lists the basic conventions of the Operator Interface.

Mimics of buttons and fields

	Button with light grey face is on top of background	The associated operation (opening a display or setting a parameter) is enabled and clicking the button will execute the operation.
	Button with dark grey face is visibly pressed down.	The associated function or selection is ON and clicking the button has no effect.
	Button's 3-D shading is removed or the whole button is invisible.	The associated operation is not possible in the current state and thus is not enabled. Clicking on the field has no effect.
	Input field with white background.	Parameter entry is enabled. Clicking the field opens a display with a keyboard for parameter entry.
	Input field with dark grey background.	Change of the parameter is not permitted in the current state. Clicking on the field has no effect.

2.1 Home display

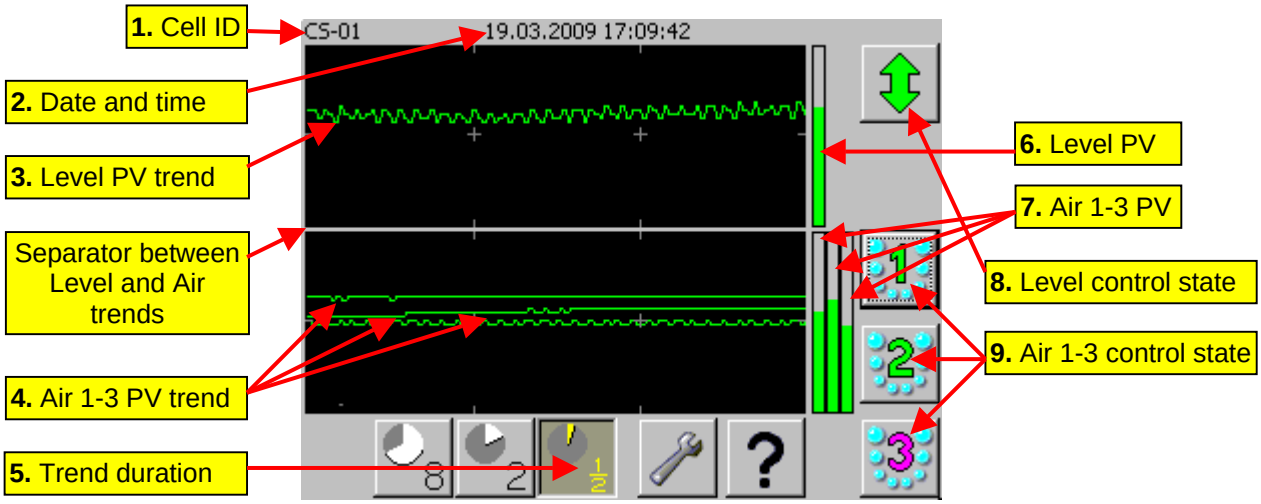
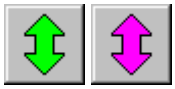


Figure 2.1.1: Home display fields.

Home display fields

1.	**Cell ID**	CellStation identification text (max. 14 characters).
2.	**Date and time**	Current date and time (default format = dd.MM.yyyy HH:mm:ss, changed from Control Panel).
3.	**Level PV trend**	Trend of Level Control loop process measurement value, green color.
4.	**Air1-3 PV trend**	Trends of Air1 - Air3 Control loop process measurement values, green color.
5.	**Trend duration** 	The trend duration selected at any time is shown with these symbols. Selected trend duration is ½ hours (default). The values on the trend graphs are averaged over (approximately) 30 seconds. Selected trend duration is 2 hours. The values on the trend graphs are averaged over (approximately) 2 minutes. Selected trend duration is 8 hours. The values on the trend graphs are averaged over (approximately) 8 minutes.
6.	**Level PV**	Level Control loop process measurement current value bargraph.
7.	**Air1-3 PV**	Air1 - Air3 Control loop process measurement current value bargraphs.
8.	**Level control state** 	The control state of the Level controller is indicated with color. Green color indicates the **AUTO** control state and pink color the **MANUAL** control state.
9.	**Air1-3 control state** 	The control state of each of the Air controllers 1-3 is indicated with color. Green color indicates the **AUTO** control state and pink color the **MANUAL** control state.

Note 1: Depending on the number of Air controllers configured (see **DEVICE PARARAMETERS** display) 1 to 3 Air trends and controls are shown on the Home display.

Note 2: The selected trend duration will not change when switching from one display to any other.

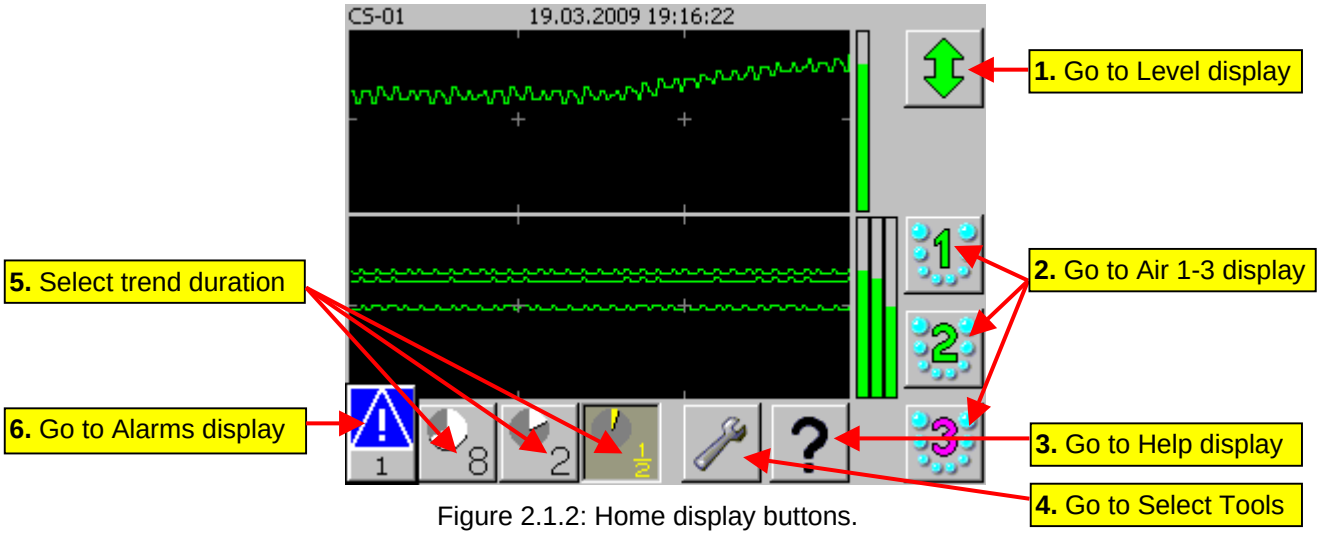
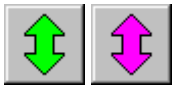


Figure 2.1.2: Home display buttons.

Home display buttons

1.		Open **Level Control** display.
2.		Open **Air1 Control** display. Open **Air2 Control** display. Note: Air2 button is shown only if 2 or more Air control loops exist. Open **Air3 Control** display. Note: Air3 button is shown only if 3 Air controls loops exist.
3.		**HELP** button opens the **HELP** display.
4.		**TOOLS** button opens the **GIVE PASSWORD** display. Depending on the password entered either **CONFIGURATION TOOLS** or **MAINTENANCE TOOLS** display opens. Incorrect password will repeat the password request.
5.		Select trends to show last ½ hours. Select trends to show last 2 hours. Select trends to show last 8 hours.
6.		Open **Alarms** display. Note: The **ALARMS** button is visible only if alarms exist. Default location for this button is lower left corner and the button may appear in any display. The button can be dragged and dropped anywhere on the display.

The selected trend duration will not change when switching from one display to any other. The time duration can only be selected from a trend display.

2.2 Level Control display

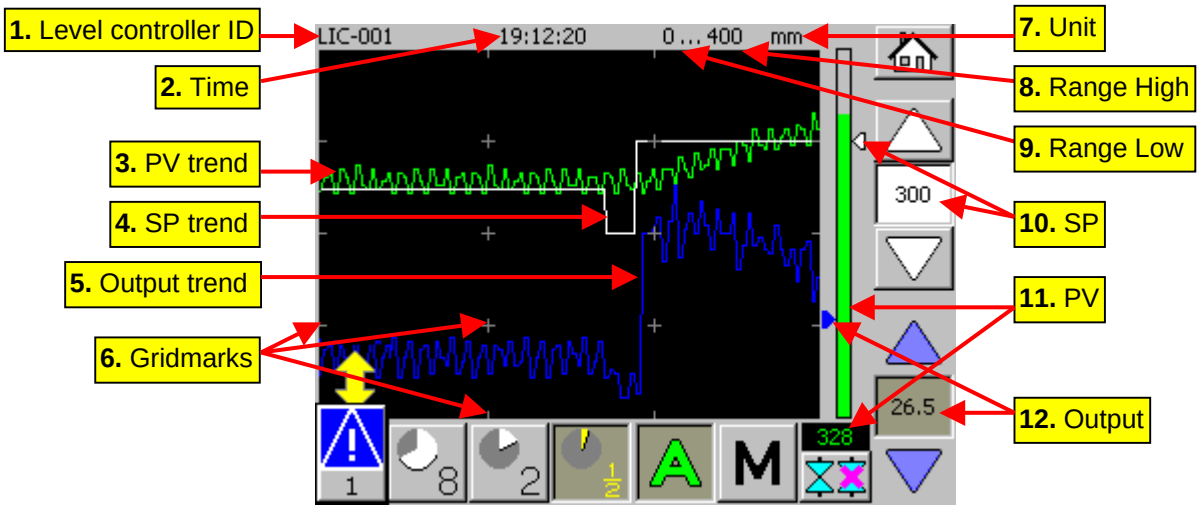


Figure 2.2.1: Level Control display fields.

Level Control display fields

1	**Level controller ID**	Identification code or name of Level Control loop.
2	**Time**	Current time.
3	**PV trend**	Trend of process value (scale Range Low…Range High), green color.
4	**SP trend**	Trend of controller setpoint (scale Range Low…Range High), white color.
5	**Output trend**	Trend of controller output (scale 0…100%), blue color.
6	**Gridmarks**	Vertical axis has markers for 25%, 50% and 75% of full range. Horizontal axis markers depend on selected trend duration: for ½h trend marker interval is 10 minutes for 2h trend marker interval is 30 minutes i.e.½h for 8h trend marker interval is 120 minutes i.e. 2h
7	**Unit**	Engineering unit of level measurement and setpoint.
8	**Range High**	Highest possible value of level measurement and setpoint and also the value at the top of trend view.
9	**Range Low**	Lowest possible value of level measurement and setpoint and also the value at the bottom of trend view.
10	**SP**	Level controller setpoint current value shown graphically ◁ and numerically.
11	**PV**	Level measurement current value shown as bargraph and numerically.
12	**Output**	Level controller output current position shown graphically ▶ and numerically.

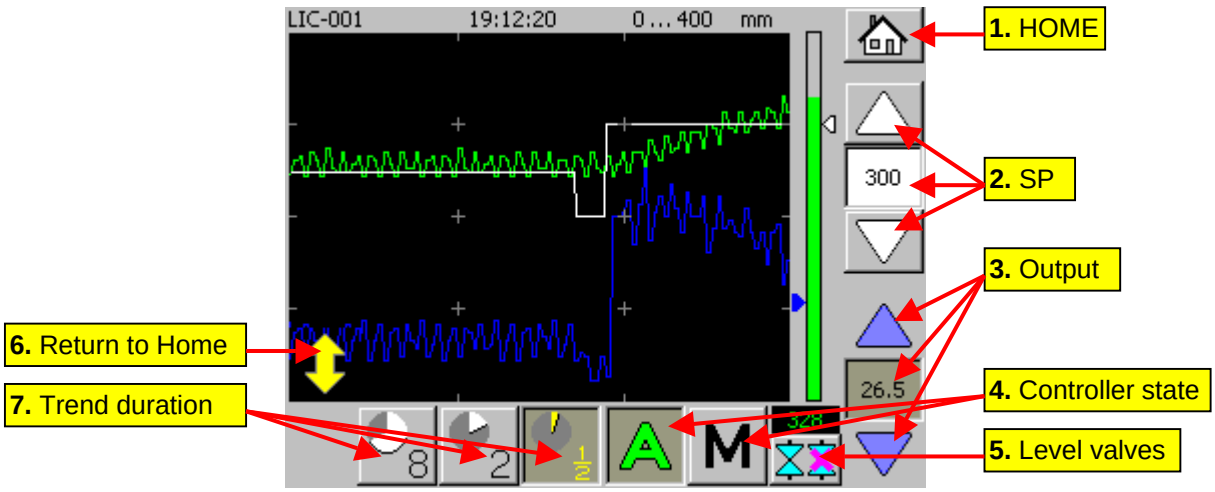
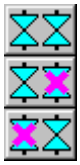


Figure 2.2.2: Level Control display buttons.

Level Control display buttons

1		Open **Home** display.
2		Each click on the **Up** and **Down** arrows increase or decrease the controller setpoint by the value set to SP increment (see **LEVEL PARAMETERS** display). Clicking the numerical value in the middle will open a keyboard for entering the new setpoint value numerically.
3		Each click on the **Up** and **Down** arrows increase or decrease the controller output by 1%. Clicking the numerical value in the middle will open a keyboard for entering the new output value numerically. Note: Output can only be changed when the controller is in **MANUAL** state. The button colors (light blue/blue) and background colors (grey/white) also indicate the controller state (**AUTO**/**MANUAL**).
4	**Controller state** 	Indication and setting the Level controller state. Controller is in **MANUAL** state. Clicking the **A**-button switches the controller to **AUTO** state. (**M**-button pops up). Controller is in **AUTO** state. Clicking the **M**-button switches the controller to **MANUAL** state (**A**-button pops up).
5	**Level valves** 	Open **LEVEL VALVES** display for setting valve **ACTIVE**/**STANDBY** states. Indicates both output valves are in **ACTIVE** state. Indicates output valve 1 is in **ACTIVE** and valve 2 in **STANDBY** state. Indicates output valve 1 is in **STANDBY** and valve 2 in **ACTIVE** state. Note: **Level valves** button is shown only if multiple valves are configured for the Level controller (see **DEVICE PARAMETERS** display).
6		Returns to **Home** display.
7		Trend duration selectors.

2.3 LEVEL VALVES display

LEVEL VALVES display can only be opened it only if multiple valves are configured for the Level controller (see **DEVICE PARAMETERS** display).

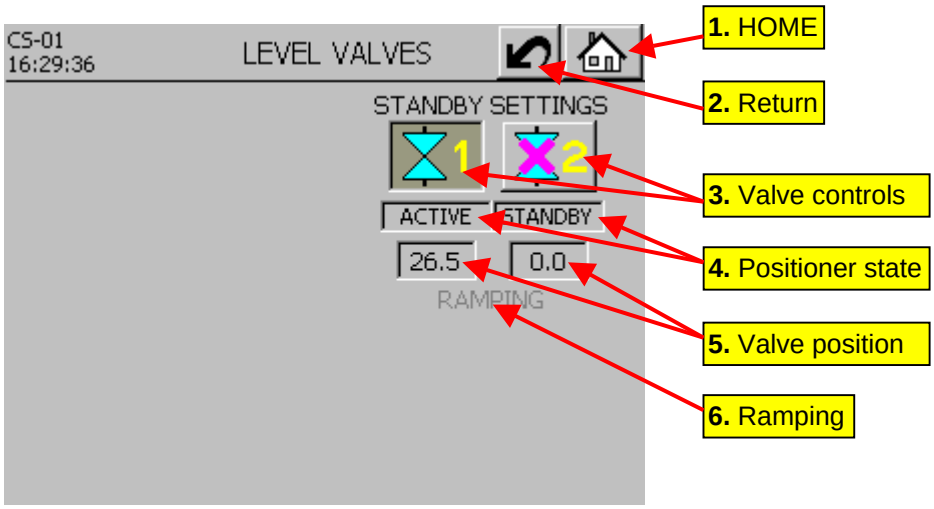
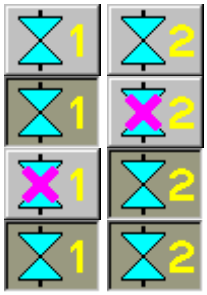
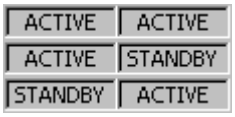
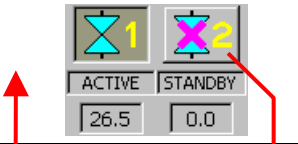
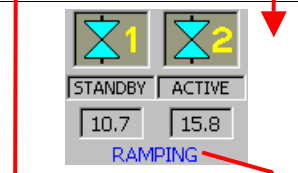
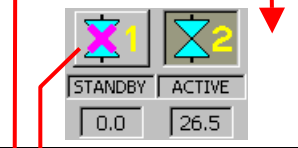
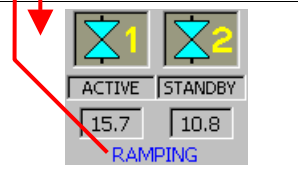


Figure 2.2.1: LEVEL VALVES display.

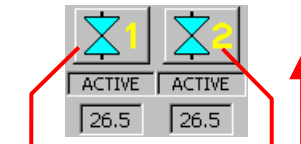
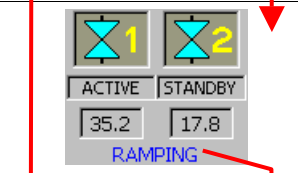
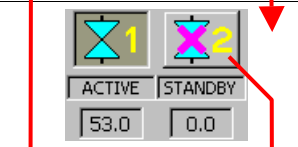
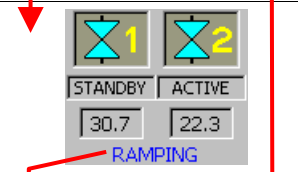
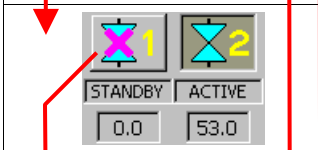
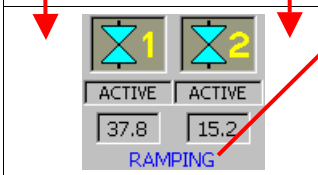
LEVEL VALVES display fields and buttons

1		Open **Home** display.
2		Return to **Level Control** display.
3	**Valve controls** 	Depending on the Level controller MODE setting and the positioner current states the valve control buttons and indications look different. Valve 1 and valve 2 both in **ACTIVE** state. Valve 1 in **ACTIVE**, valve 2 in **STANDBY** state, only valve 2 button enabled. Valve 1 in **STANDBY**, valve 2 in **ACTIVE** state, only valve 1 button enabled. Valve buttons are both disabled until state transition is completed.
4	**Positioner state** 	Indication of the cell discharge valve positioner states. Valve 1 and valve 2 both in **ACTIVE** state. Valve 1 in **ACTIVE**, valve 2 in **STANDBY** state. Valve 1 in **STANDBY** and valve 2 in **ACTIVE** state.
5	**Valve position**	Numerical values of the valve1 and 2 positions (0 to 100 %).
6	**Ramping**	**RAMPING** indicator, visible and flashing only during valve state transition between **STANDBY** and **ACTIVE** states.

STANDBY SETTINGS for MODE 2 (2 output discharge valves operating in main/backup fashion)

	Valve 1 is **ACTIVE** and the position is between Output Low and Output High. Valve 2 is **STANDBY** and it is fully closed. Valve 2 button is enabled. Clicking valve 2 button initiates transition to reverse the valve 1 and valve 2 operating states.
	Valve 1 is transiting to **STANDBY** and it's position is ramping to fully closed. Valve 2 is **ACTIVE** and Level controller uses the valve to maintain the cell level at the given setpoint thus ramping the position starting from fully closed. **RAMPING** text is flashing and valve buttons are both disabled until the transition is completed.
	Valve 1 is **STANDBY** and it is fully closed. Valve 2 is **ACTIVE** and the position is between Output Low and Output High. Clicking valve 1 button initiates transition to reverse the valve 1 and valve 2 operating states.
	Valve 1 is **ACTIVE** and Level controller uses the valve to maintain the cell level at the given setpoint thus ramping the position starting from fully closed. Valve 2 is transiting to **STANDBY** and it's position is ramping to fully closed. **RAMPING** text is flashing and valve buttons are both disabled until the transition is completed.

STANDBY SETTINGS for MODE 3 (2 output discharge valves operating in tandem)

	Both cell discharge valves are in **ACTIVE** state and valve positions are identical. Clicking valve 1 or valve 2 button initiates transition of the respective valve to **STANDBY** state. The other valve will remain in **ACTIVE** state.
	Valve 1 is **ACTIVE** and Level controller uses the valve to maintain the cell level at the given setpoint thus in effect ramping to 2x the previous position. Valve 2 is transiting to **STANDBY** and it's position is ramping to fully closed. **RAMPING** text is flashing and valve buttons are both disabled until the transition is completed.
	Valve 1 is **ACTIVE** and the position is between Output Low and Output High. Valve 2 is **STANDBY** and it is fully closed. Valve 2 button is enabled. Clicking valve 2 button initiates transition to set valve 2 back to **ACTIVE** state.
	Valve 1 is transiting to **STANDBY** and it's position is ramping to fully closed. Valve 2 is **ACTIVE** and Level controller uses the valve to maintain the cell level at the given setpoint thus in effect ramping to 2x the previous position. **RAMPING** text is flashing and valve buttons are both disabled until the transition is completed.
	Valve 1 is **STANDBY** and it is fully closed. Valve 1 button is enabled. Valve 2 is **ACTIVE** and the position is between Output Low and Output High. Clicking valve 1 button initiates transition to set valve 1 back to **ACTIVE** state.
	Both cell discharge valves are in **ACTIVE** state and valve positions are ramped to equal positions. During the transition the Level controller continues to maintain the cell level at the given setpoint. **RAMPING** text is flashing and valve buttons are both disabled until the transition is completed i.e. the positions have reached equal values.

2.4 Air1 – Air3 Control displays

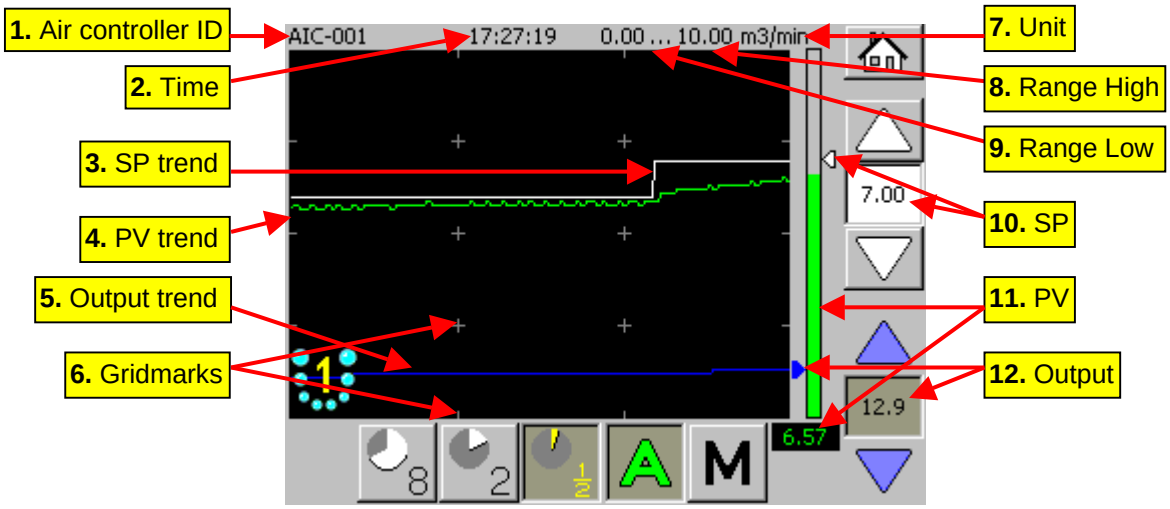


Figure 2.3.1: Air Control display fields.

Air1 – Air3 Control display fields

1	**Air controller ID**	Identification code or name of Air1 - Air3 Control loop.
2	**Time**	Current time.
3	**SP trend**	Trend of controller setpoint (scale Range Low…Range High), white color.
4	**PV trend**	Trend of process value (scale Range Low…Range High), green color.
5	**Output trend**	Trend of controller output (scale 0…100%), blue color.
6	**Gridmarks**	Vertical axis has markers for 25%, 50% and 75% of full range. Horizontal axis markers depend on selected trend duration: for ½h trend marker interval is 10 minutes for 2h trend marker interval is 30 minutes i.e.½h for 8h trend marker interval is 120 minutes i.e. 2h
7	**Unit**	Engineering unit of air measurement and setpoint.
8	**Range High**	Highest possible value of air measurement and setpoint and also the value at the top of trend view.
9	**Range Low**	Lowest possible value of air measurement and setpoint and also the value at the bottom of trend view.
10	**SP**	Air controller setpoint current value shown graphically and numerically.
11	**PV**	Air measurement current value shown as bargraph and numerically.
12	**Output**	Air controller output current position shown graphically and numerically.

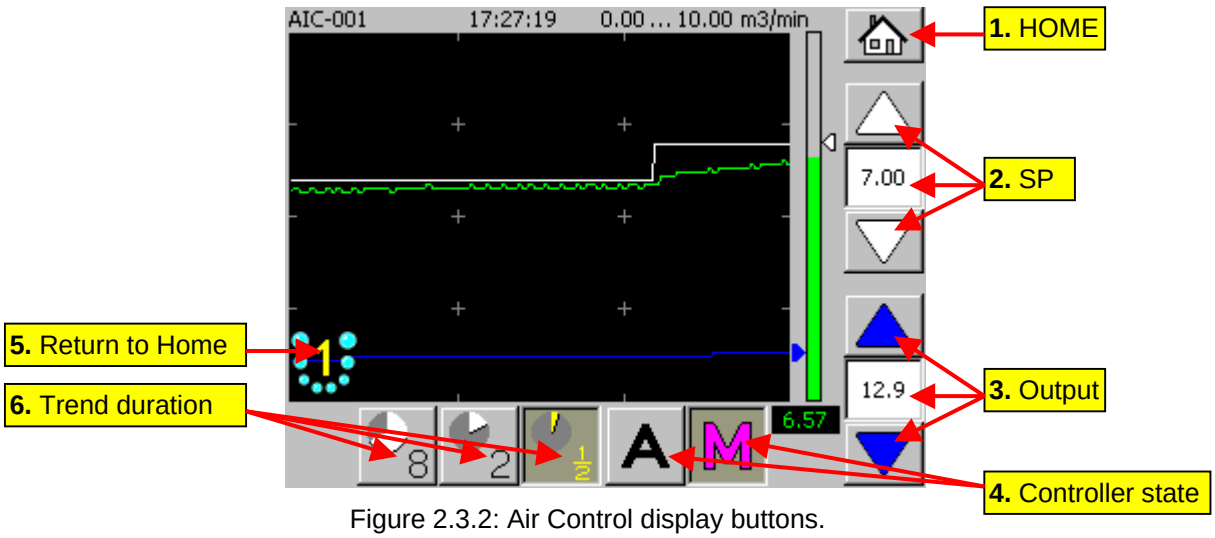


Figure 2.3.2: Air Control display buttons.

Air1 – Air3 Control Display buttons

1		Open **Home** display.
2	7.00	Each click on the **Up** and **Down** arrows increase or decrease the controller setpoint by the value set to SP increment (see **AIR PARAMETERS** display). Clicking the numerical value in the middle will open a keyboard for entering the new setpoint value numerically.
3	12.9 12.9	Each click on the **Up** and **Down** arrows increase or decrease the controller output by 1%. Clicking the numerical value in the middle will open a keyboard for entering the new output value numerically. Note: Output can only be changed when the controller is in **MANUAL** state. The button colors (light blue/blue) and background colors (grey/white) also indicate the controller state (**AUTO**/**MANUAL**).
4	**Controller state** A M A M	Indication and setting the Air controller state. Controller is in **MANUAL** state. Clicking the **A**-button switches the controller to **AUTO** state. (**M**-button pops up). Controller is in **AUTO** state. Clicking the **M**-button switches the controller to **MANUAL** state (**A**-button pops up).
5	1 2 3	Returns to **Home** display when **Air Control** display is open.
6	8 2 1/2	Trend duration selectors.

2.5 Alarms display

Clicking the Alarm indicator button opens the **Alarms** display.

When alarms display is open clicking the alarm indicator closes the display and returns to the previous display.

Alarm indicator disappears when all alarms are acknowledged and causes of the alarms do not exist any more.

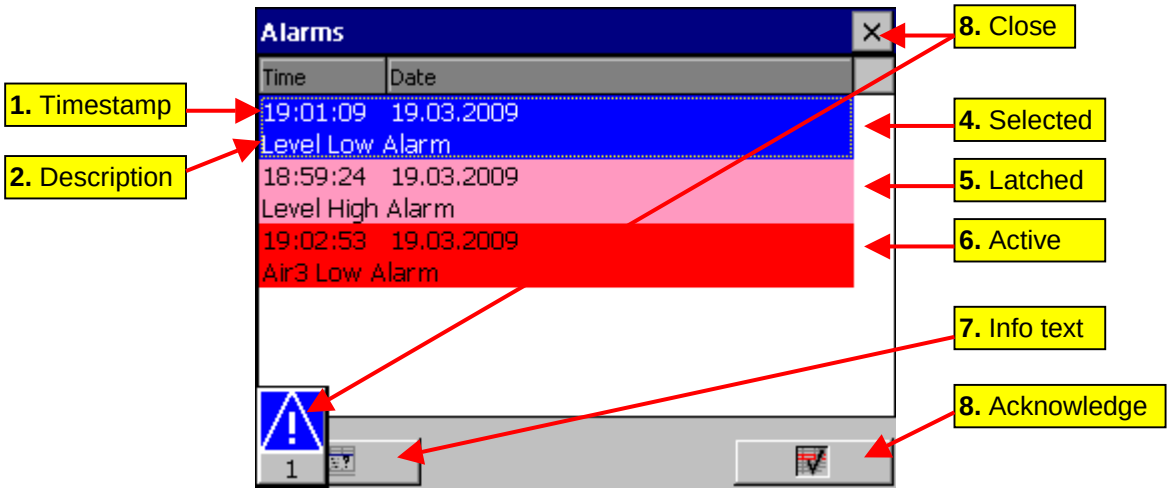
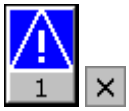


Figure 2.4: Alarms display.

Alarm display fields and buttons

1	**Timestamp**	Date and time of alarm generation.
3	**Description**	Textual description of the cause of the alarm.
4	**Selected**	Blue background shows which alarm is selected for acknowledgement or info. Default is the first line in the list.
5	**Latched**	**Flashing** pink background means that the cause of alarm does not exist any more but the alarm is not acknowledged. Acknowledge will remove the alarm from the list.
6	**Active**	**Flashing** red background means that the cause of alarm exists and the alarm is not acknowledged. **Stable** red background means that the cause of alarm exists and the alarm is acknowledged.
7		Open **Info text** of selected alarm.
8		Acknowledges the selected alarm.
9		Closes **Alarms** display, returns to previous display. Note: The **Alarm indicator** can be moved to any location on the display by dragging.

2.6 Info txt and HELP displays

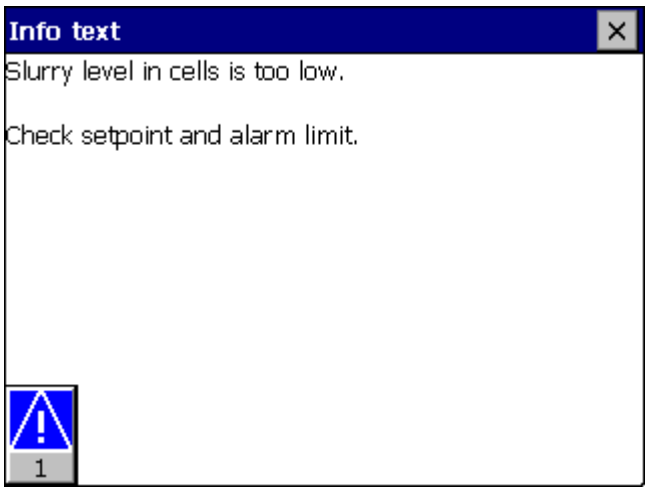


Figure 2.4.1: Alarm Info display.

Info text button opens the Info display containing additional information and help for the operator.

Open **HELP** display by clicking the HELP button on the **Home** display. The display contains explanations of color usage in CellStation touch-panel displays.

Also version information of the touch-panel software is shown on the **HELP** display.

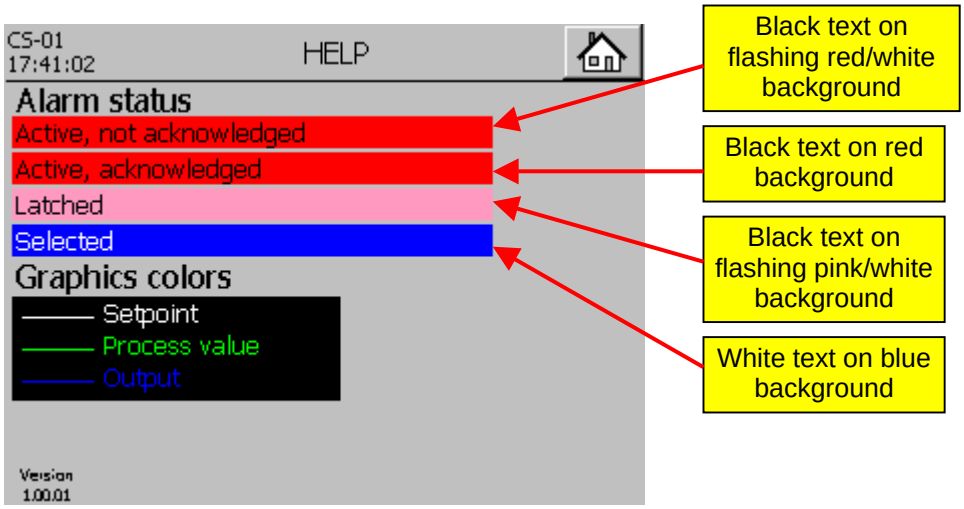


Figure 2.5: HELP display.

3. CONFIGURATION TOOLS

Configuration Tools are used to define the identification and functioning of the Level and Air control loops.

All configuration parameters may also be changed using the DCS connection provided if this is enabled, see **DEVICE PARAMETERS**.

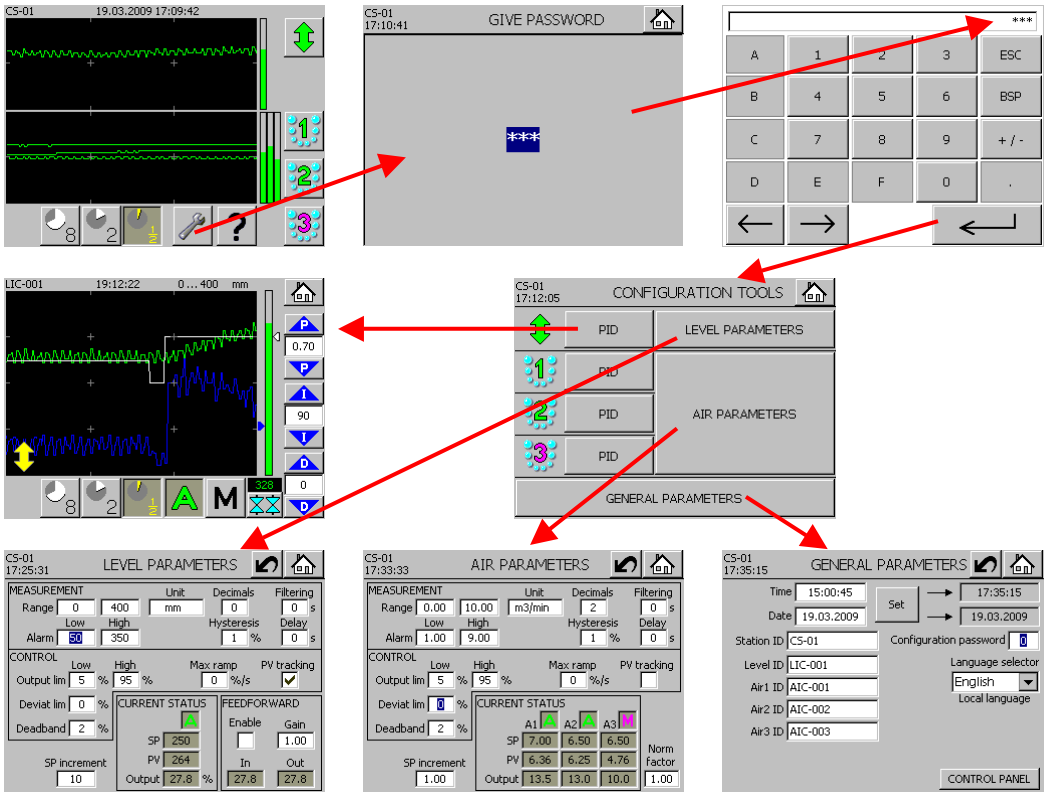


Figure 3: CONFIGURATION TOOLS display hierarchy

To gain access to the CONFIGURATION TOOLS click the TOOLS button on the **Home** display. The **GIVE PASSWORD** display will open and clicking anywhere on the lower part of the display the numerical input display for password entry will open.

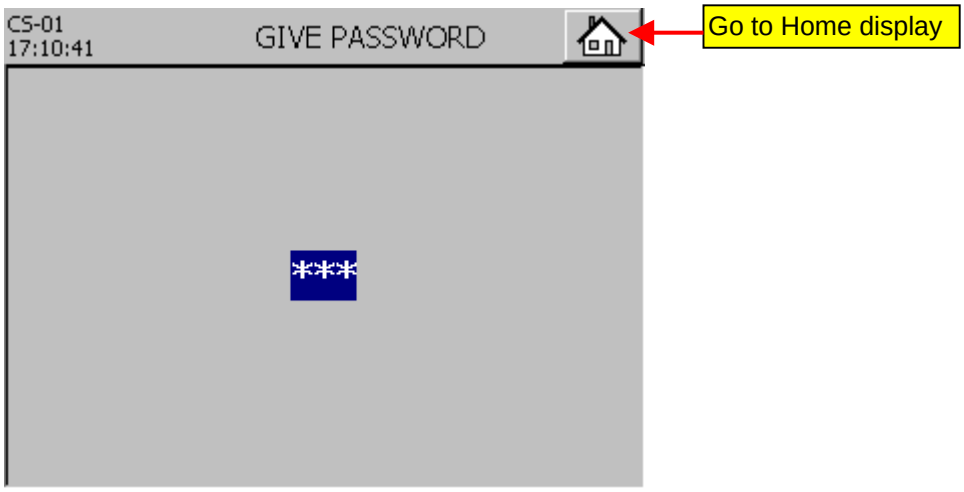


Figure 3.0.1: GIVE PASSWORD display.

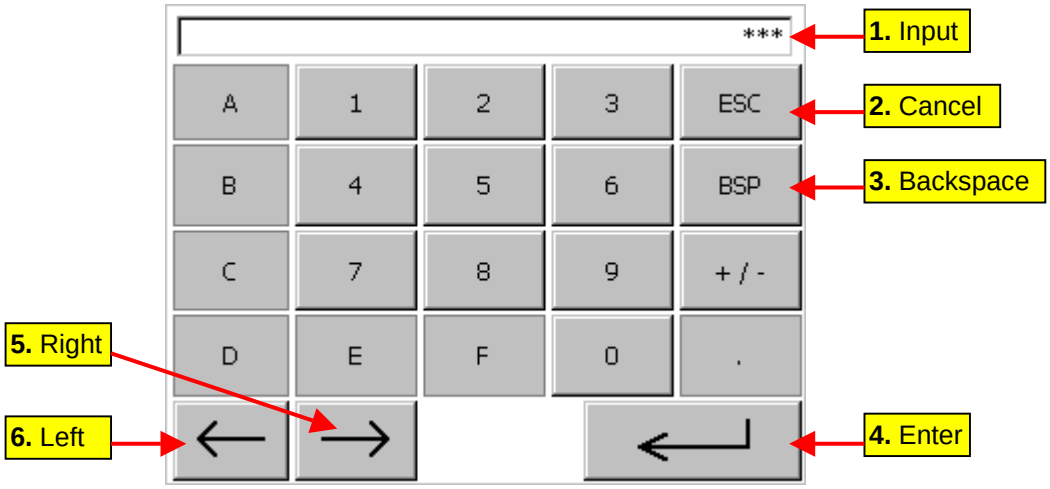


Figure 3.0.2: Password input using the numerical input display.

To gain access to the Configuration Tools the Engineering Password must be given. In case the password is not correct the password must be given again or return to Home display may be done using the HOME button.

Password input

1	**Input**	Input field (scrambled).
2	**Cancel**	Discards any input and returns to GIVE PASSWORD display.
3	**Backspace**	Deletes the character left of input cursor or all selected characters.
4	**Enter**	Ends the password input and forwards the given password to checking. In case the password is incorrect the GIVE PASSWORD display is opened.
5	**Right**	Moves the input cursor one character to right.
6	**Left**	Moves the input cursor one character to left.

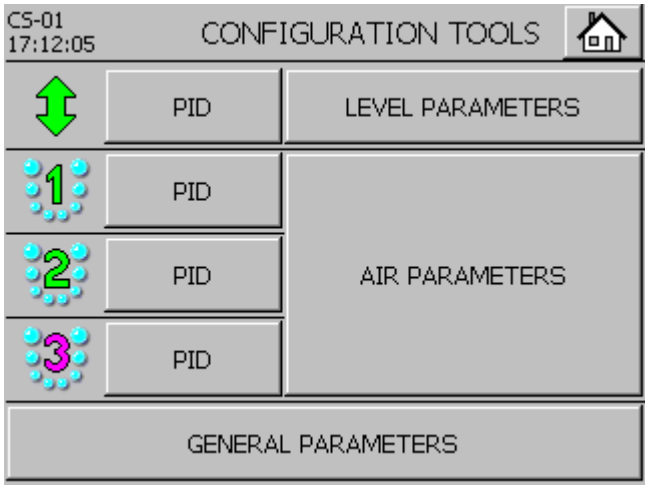


Figure 3.0.3: CONFIGURATION TOOLS display.

Air 2 and Air 3 controller indicators and buttons are shown only, if they are enabled, see DEVICE PARAMETERS display. The control state of each controller is indicated with the color (green if **AUTO** mode and pink if **MANUAL** mode.

CONFIGURATION TOOLS buttons

Level PID	Open Level controller display for setting PID parameters.
Level parameters	Open Level controller measurement and control parameters display.
Air 1 – Air 3 PID	Open Air 1 – Air 3 controller display for setting PID parameters. Note: PID buttons for Air2 and Air3 are hidden if the controllers do not exist.
Air parameters	Open Air controller measurement and control parameters display. Note: All Air controllers share the same measurement and control parameters.
General parameters	Open display for setting the CellStation date and time, identification texts and the Operator Panel local language.

3.1 GENERAL PARAMETERS

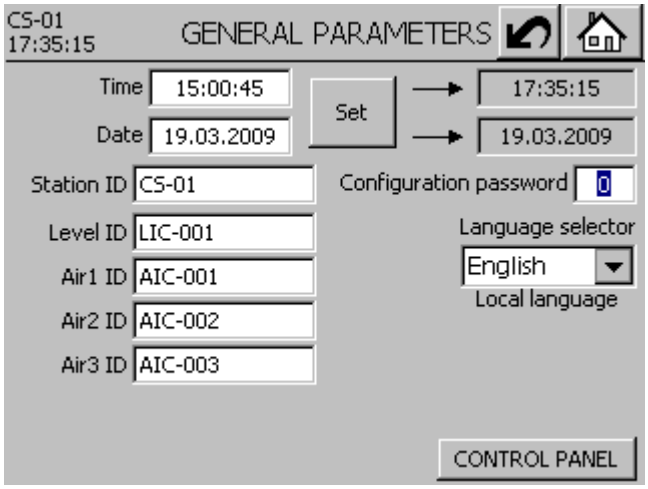


Figure 3.1: GENERAL PARAMETERS display.

GENERAL PARAMETERS fields and buttons

Time **Date** Set	CellStation contains a real-time clock with time and date information. The time and date can be set from Operator Panel only when the DCS connection to CellStation is not enabled. When CellStation is connected to a DCS with at least the run-time controls enabled the time and date are automatically set by the DCS. Set time and date manually by first entering correct values to **Time**- and **Date**-fields and then push **Set**-button to confirm the change. The station's time and date will change within 10 seconds.
Station ID	Identification name of the CellStation. **Cell ID** can be 14 characters or less.
Level ID **Air1 ID** **Air2 ID** **Air3 ID**	Identification codes for the control loops (Level and Air 1-3). Text string length is maximum 14 characters. Note: Air2 and Air3 fields are hidden if the controllers do not exist.
Configuration password	Password which allows the user to access the Configuration Tools displays: • **PID** displays of Level and Air1 - Air3 controllers. • **LEVEL PARAMETERS** displays • **AIR PARAMETERS** displays • **GENERAL PARAMETERS** displays
Language selector English English Suomi Русско Español Português Türk	Local language for the Operator Panel. Select any of the pre-defined languages.
CONTROL PANEL	See Control Panel operations section of this document.

3.2 LEVEL PARAMETERS

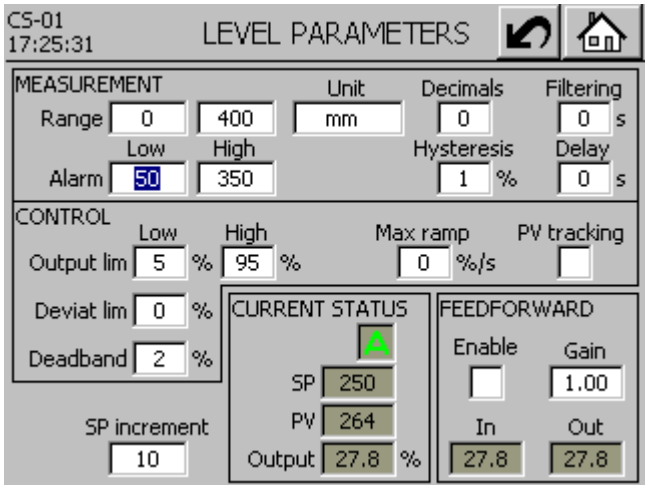


Figure 3.2: LEVEL PARAMETERS display.

MEASUREMENT parameters for Level controller

Range Low	Level measurement. Lowest value corresponding to 4mA input signal. **NOTE: Range Low ≤ Range High**
Range High	Level measurement. Highest value corresponding to 20mA input signal. **NOTE: Range High ≥ Range Low**
Unit	Engineering unit for Level controller (setpoint and process value).
Decimals	Number of decimals used when displaying and setting Level measurement value, limits and Level controller setpoint. Note: Adding more decimals (max 2 decimals) decreases the number of whole numbers in use. With 1 decimal there are 2 whole numbers in use and with 2 decimals there is 1 whole number in use. With 0 decimals there are 4 whole numbers in use.
Filtering	Filtering is the time for controller to filter out disturbances in the measurement signal. The 2.nd order low-pass filtering method is used. (0 to 999 seconds)
Alarm Low	Low limit for process measurement. If the limit is exceeded, an alarm is generated. For eventual delaying of the alarm generation see **Delay** below. **NOTE: Range High ≥ Alarm –Low ≥ Range Low**
Alarm High	High limit for process measurement. If the limit is exceeded, an alarm is generated. For eventual delaying of the alarm generation see **Delay** below. **NOTE: Range High ≥ Alarm High ≥ Range Low**
Alarm Hysteresis	Hysteresis is the area over Alarm Low and under Alarm High that must be passed by process value before the alarm condition will be released. For eventual delaying of the alarm release see **Delay** below.
Alarm Delay	The time an alarm condition must be on continuously before an alarm is generated. (0 to 999 seconds). If the alarm condition goes off before the delay ends the timer is reset. The delay applies to **Low**, **High** and **Deviation** alarms. After a successful alarm generation the delay applies similarly to the release of the alarm.

CONTROL parameters for Level controller

Output lim Low	Lowest permissible value for the controller output signal when controller is in **AUTO** mode. Note: In **MANUAL** mode the controller output has no limits.
Output-lim High	Highest permissible value for the controller output signal when controller is in **AUTO** mode. Note: In **MANUAL** mode the controller output has no limits.
Max ramp	Highest permissible speed for the output actuator movement (0 to 99%/s).
PV tracking	Select if the control loop setpoint follow the process values when the controller is in **MANUAL** mode. At change to AUTO mode the setpoint retains it's latest value thus having the same value as the process measurement. This ensures a bumbles operation of control output when changing to **AUTO** mode.
Deadband	Area around the controller setpoint (above and below). If the measurement is inside this area no action is forwarded to the controller output. The purpose of this function is to eliminate unnecessary control actions due to minor process measurement fluctuations. (0 to 99%)
Deviat lim	Limit for the difference between the controller setpoint and the process measurement value. If the limit is exceeded a deviation alarm will be generated. (0 to 100%, 0 = alarm disabled)

CURRENT STATUS of Level controller

	Control loop in **AUTO** mode.
	Control loop in **MANUAL** mode.
SP	Current controller setpoint. **NOTE: Alarm High ≥ SP ≥ Alarm Low**
PV	Current process measurement value.
Output	Current controller output value. **NOTE: Output-lim High ≥ SP ≥ Output-lim Low** This is the value forwarded to Level Valve output control block. Depending on the Valve control MODE the actual valve positions may have different values.

FEEDFORWARD parameters

Enable	Selector to Enable/Disable the FEEDFORWARD functionality.
Gain	Multiplier used to forward the **In** disturbance from the previous CellStation node to the output of this node.
In	Current value of FEEDFORWARD correction coming from previous CellStation in a bank of flotation cells (in case connection exists).
Out	Current value of FEEDFORWARD correction going to next CellStation in line.

Other parameters

SP increment	The setpoint increment/decrement value of one click of **Up** and **Down** arrows in Operator Interface **Level Control** display.

3.3 AIR PARAMETERS

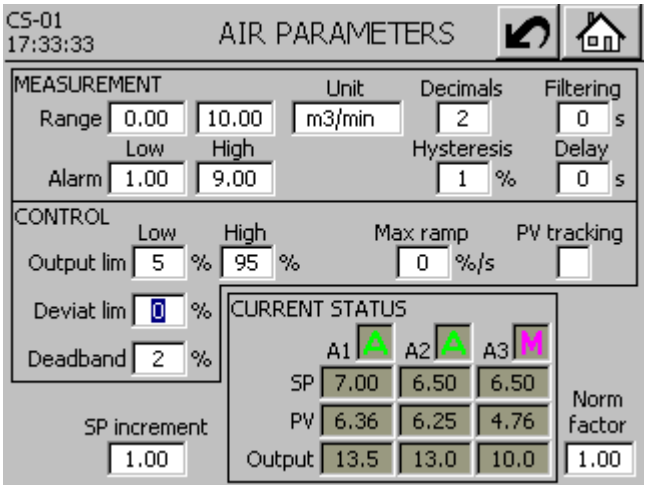


Figure 3.3: AIR PARAMETERS display.

MEASUREMENT parameters for Air controllers

Range Low	The Air measurement value corresponding to 4mA input signal. **NOTE: Range Low ≤ Range High**
Range High	The Air measurement value corresponding to 20mA input signal. **NOTE: Range High ≥ Range Low**
Unit	Engineering unit for air controller(s) (setpoint and process value).
Decimals	Number of decimals used when displaying and setting Level measurement value, limits and Level controller setpoint. Note: Adding more decimals (max 2 decimals) decreases the number of whole numbers in use. With 1 decimal there are 2 whole numbers in use and with 2 decimals there is 1 whole number in use. With 0 decimals there are 4 whole numbers in use.
Filtering	Filtering is the time for controller to filter out disturbances in the measurement signal. The 2.nd order low-pass filtering method is used. (0 to 999 seconds)
Alarm Low	Low limit for process measurement. If the limit is exceeded, an alarm is generated. For eventual delaying of the alarm generation see **Delay** below. **NOTE: Range High ≥ Alarm –Low ≥ Range Low**
Alarm High	High limit for process measurement. If the limit is exceeded, an alarm is generated. For eventual delaying of the alarm generation see **Delay** below. **NOTE: Range High ≥ Alarm High ≥ Range Low**
Hysteresis	Hysteresis is the area over Alarm Low and under Alarm High, which must be passed by process value before the alarm condition will be released. For eventual delaying of the alarm release see **Delay** below.
Delay	The time that an alarm condition must be on continuously before an alarm is generated. (0 to 999 seconds). If the alarm condition goes off before the delay ends the timer is reset. The delay applies to **Low**, **High** and **Deviation** alarms. After a successful alarm generation the delay applies similarly to the release of the alarm.

CONTROL parameters for Air controllers

Output lim Low	Lowest permissible value for the controller output signal when controller is in **AUTO** mode. Note: In **MANUAL** mode the controller output has no limits.
Output lim High	Highest permissible value for the controller output signal when controller is in **AUTO** mode. Note: In **MANUAL** mode the controller output has no limits.
Max ramp	Highest permissible speed for actuator movement (%/s).
PV tracking	Select if the control loop setpoint follow the process values when the controller is in **MANUAL** mode. At change to AUTO mode the setpoint retains it's latest value thus having the same value as the process measurement. This ensures a bumbles operation of control output when changing to **AUTO** mode.
Deadband	Area around the controller setpoint (above and below). If the measurement is inside this area no action is forwarded to the controller output. The purpose of this function is to eliminate unnecessary control actions due to minor process measurement fluctuations. (0 to 99%)
Deviat lim	Limit for the difference between the controller setpoint and the process measurement value. If the limit is exceeded a deviation alarm will be generated. (0 to 100%, 0 = alarm disabled)

CURRENT STATUS of Air controllers

	Control loop is in **AUTO** mode.
	Control loop is in **MANUAL** mode.
SP	Current controller setpoint. **NOTE: Alarm High ≥ SP ≥ Alarm Low**
PV	Current process measurement value.
Output	Current controller output value. **NOTE: Output-lim High ≥ SP ≥ Output-lim Low**

Other parameters

SP increment	The setpoint increment/decrement value of one click of **Up** and **Down** arrows in Operator Interface **Air Control** displays.
Norm factor	Normalizing factor for Air measurements i.e. compensation factor to convert Air measurements to normal volume and temperature.

3.4 Level and Air PID parameters

The control loop PID parameters are individual for each of the Level and Air1 to Air3 controllers. Clicking any of the PID buttons on the CONFIGURATION TOOLS display the respective controller's PID display will open. These displays are identical to the respective Operator Interface displays except that the SP and Output buttons have been replaced by PID parameter buttons. For further details see the corresponding control display in Operator Interface section of this document.

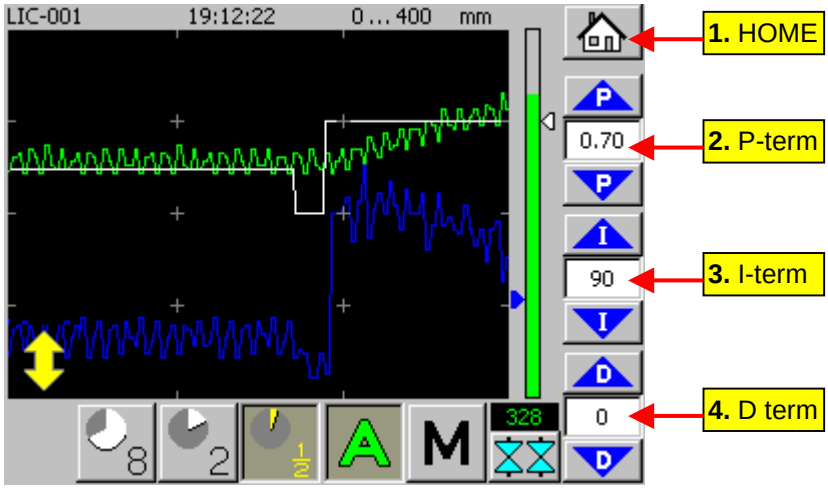
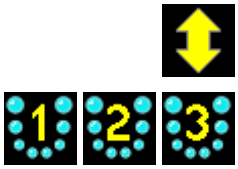


Figure 3.4: Level Control PID display.

Level and Air PID parameters

1		Go to **Home** display
2		Each click on the **Up** arrow increases the Proportional Gain term by 0.1. Clicking the numerical field in the middle opens the numerical input display for entering the Proportional Gain term numerically (-9.9 to +9.99). Each click on the **Down** arrow decreases the Proportional Gain term by 0.1.
3		Each click on the **Up** arrow increases the Integral term by 1 second. Clicking the numerical field in the middle opens the numerical input display for entering the Integral term numerically (0 to 999 seconds). Each click on the **Down** arrow decreases the Integral term by 1 second.
4		Each click on the **Up** arrow increases the Derivative term by 1 second. Clicking the numerical field in the middle opens the numerical input display for entering the Derivative term numerically (0 to 999 seconds). Each click on the **Down** arrow decreases the Derivative term by 1 second.
5		Return to **CONFIGURATION TOOLS** display when any **PID** display is open.

4. MAINTENANCE TOOLS

CellStation Device parameters must be defined using Maintenance Tools displays of the station's Operator Panel. In case an Operator Panel is not available most of the device parameters can also be set from the DCS via Profibus connection provided the connection is enabled.

To gain access to MAINTENANCE TOOLS the Maintenance Password must be given. If the Engineering Password is given the CONFIGURATION TOOLS display will open. In case the password is not correct the display will not change and the password must be given anew.

Only persons with proper knowledge and training on CellStation should use these tools. Improper setting of these parameters may render the CellStation unoperational.

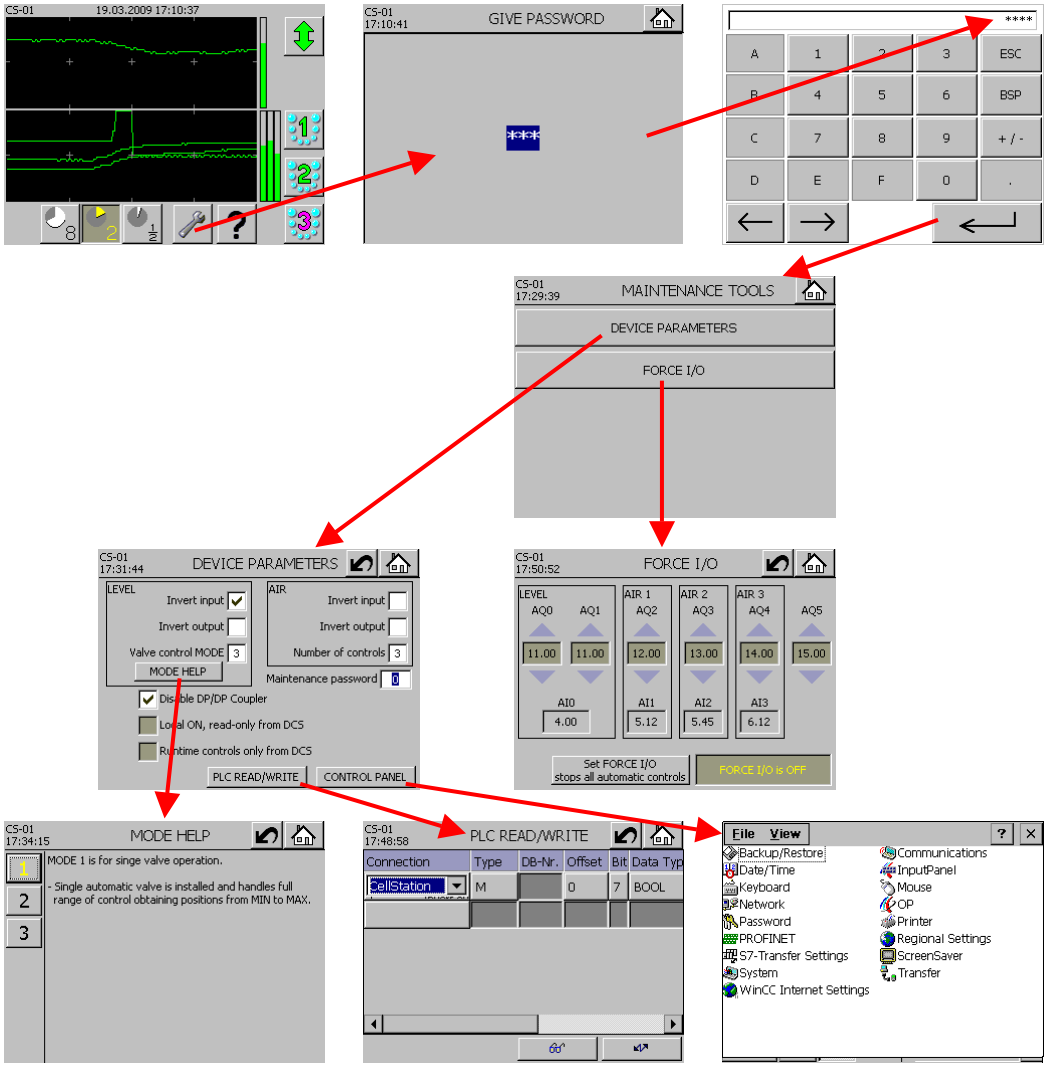


Figure 4: MAINTENANCE TOOLS display hierarchy.

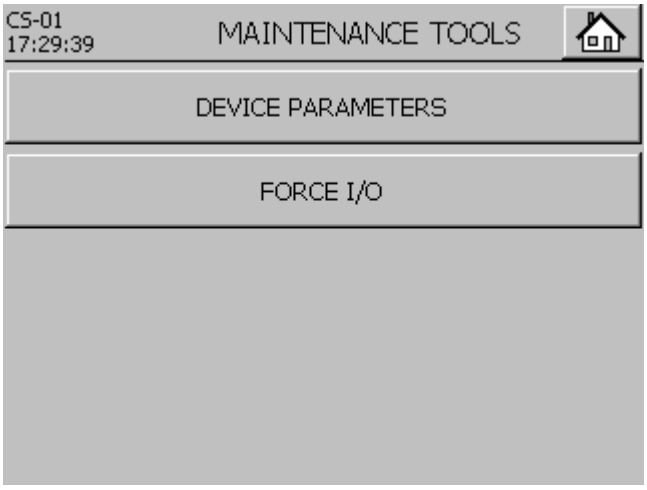


Figure 4.0: MAINTENANCE TOOLS display

The MAINTENANCE TOOLS consist of two main sections.

With DEVICE PARAMETRS you can define the basic functionality of the CellStation (I/O connection detail, number of controllers, networking details etc.).

FORCE I/O can be used for monitoring and testing the I/O connections.

The next sections describe the details of MAINTENANCE TOOLS parameters.

4.1 DEVICE PARAMETERS

CellStation Level and Air Controls device parameters are defined using the Device Parameters display of the station.

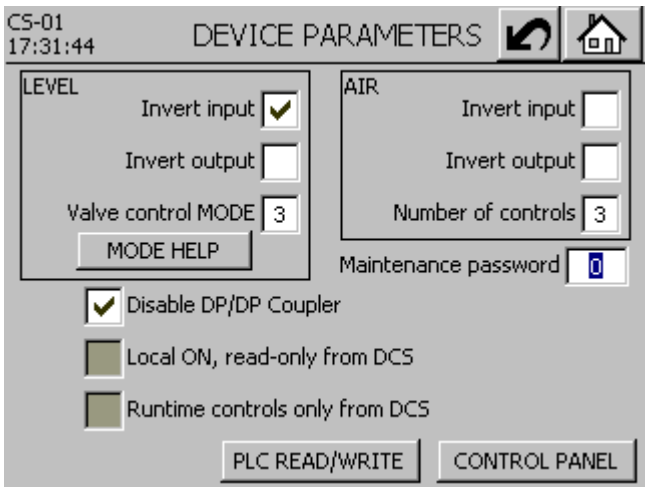


Figure 4.1: DEVICE PARAMETERS display

Each CellStation controls the flotation machine's slurry level by means of 1 or 2 discharge valves. Slurry level is normally measured downwards from top of cell.

LEVEL device parameters

Invert input	Inverts the signal from level measurement sensor (default = YES).
Invert output	Inverts the signal to discharge valve actuator (default = NO).
Valve control mode	Valve control mode is selected depending on how many discharge valves are installed and how they should be controlled (default = 3).
MODE HELP	See descriptions for the possible control modes of Discharge Valve(s).

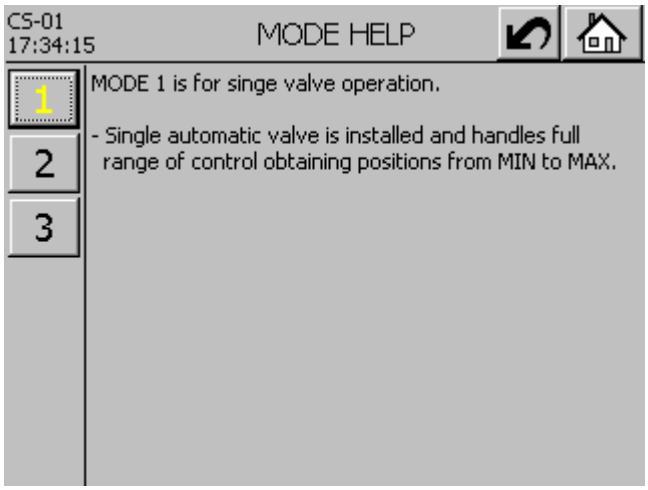


Figure 4.1.1: Level Valve control MODE HELP display

To see the details of flotation cell discharge valve control modes push the numbered buttons to switch between different MODE HELP descriptions.

Each CellStation can be configured for 1 to 3 flotation air controls. For each air control loop there is a separate flow measurement device and control valve. The device parameters are common for all the air controllers.

AIR device parameters

Invert input	Inverts signal from air measurement sensor (default = NO).
Invert output	Inverts signal to air valve actuator (default = NO).
Number of controls	Number of air controls (1-3) that are defined on the CellStation (default = 3).

CellStation can be connected to a Distributed Control System (DCS) using the built-in Profibus-DP/DP Coupler. The rights of the DCS to access the data on the CellStation are defined by the common device parameters. Also the Maintenance password can be changed from this display.

Other device parameters

Disable DP/DP Coupler	Define whether CellStation DP/DP Coupler hardware is enabled or disabled. The Coupler must be enabled in order for the connection to DCS to be possible using the Profibus DP/DP Coupler (default = OFF i.e. DP/DP Coupler is NOT DISABLED and communications is thus possible).
Local ON, read-only from DCS	Define the access rights of the DCS to read-only or read/write CellStation data (default = NO i.e. CellStation is NOT in “Local ON” mode and thus DCS is allowed both to read and write CellStation data).
Run-time controls only from DCS	Define what kind of data the DCS is allowed to write to CellStation (default = NO i.e. DCS is allowed both to read and write all CellStation data). All data on CellStation that can be accessed via DCS communications is categorized to 2 groups i.e. “Run-time controls” and “Parameter data”. The “Run-time controls” contain basically everything that is needed for a Process Operator on the DCS to set in order to control the flotation process via CellStation control loops. Examples of the “Run-time controls” are: • Date and time • Control loop Setpoints • Selection of controller MANUAL/AUTO modes • Setting control output values (0-100%) when in MANUAL mode • Control loop PID parameters • Selection of ACTIVE/STAND-BY slurry valve (in case there are 2 slurry valves installed) • Level control Feedforward ON/OFF • Feedforward gain For connection details see document “CellStation Connection to Automation System” (document code 10000005690).
Maintenance password 	The password to open the MAINTENANCE TOOLS display (default = 3589). If you change this password, be sure to remember it later. If you loose the password, you must reload the CellStation from the distribution image and thus all parameters will get their default values.

4.2 FORCE I/O

The FORCE I/O display may be used for monitoring and manually testing the analog inputs and outputs of CellStation.

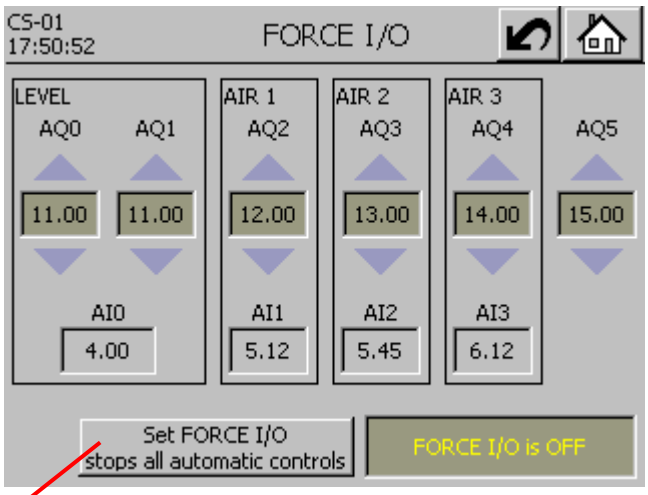


Figure 4.2.1: FORCE I/O display in OFF state.

Setting FORCE I/O stops the CellStation controllers and thus leaves the analog outputs of the valve actuators to their present positions. Use FORCE I/O only for installation, maintenance or repair purposes and make sure no risk is caused of this action.

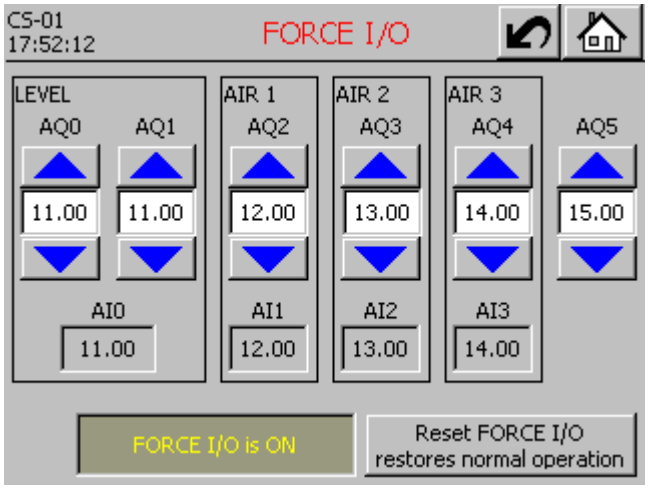


Figure 4.2.2: FORCE I/O display in ON state.

All analog inputs AI1…AI4 and outputs AQ1…AQ5 on this display are shown as raw values (0…4…20mA) and the numerical inputs for AQ1…AQ5 are also given in 0 to 20mA range.

Analog Outputs

AQ0	Level controller discharge valve number 1 analog output. This is the default output for a flotation machine having only 1 discharge valve.
AQ1	Level controller discharge valve number 2 analog output. This is the output for the optional second discharge valve actuator.
AQ2	First air control valve analog output. For single-actuator flotation machines this is the only air control output.
AQ3	Second air control valve analog output. Used only if more than one air-feed control is needed.
AQ4	Third air control valve analog output. Used only if more than 2 air controls are needed.
AQ5	Additional analog output. Not used.
	Each click on the **Up** arrow increases the analog output by 1mA Clicking the numerical field in the middle opens the numerical input display for entering the analog output value numerically (4.00 to 20.00mA). Each click on the **Down** arrow decreases the analog output by 1mA

Analog Inputs

AI1	Level measurement analog input.
AI2	First air measurement analog input.
AI3	Second air measurement analog input.
AI4	Third air measurement analog input.

4.3 PLC READ/WRITE

All PLC program variables can be read and set from **PLC READ/WRITE** display.

Do NOT use **PLC READ/WRITE** display if you are not absolutely sure of the effects of your actions. Improper use of **PLC READ/WRITE** will damage the PLC program of the CellStation and possibly render the station unoperational. If this happens, you must reload the CellStation from the distribution image and thus all user-entered parameters will be lost and replaced with the default values.

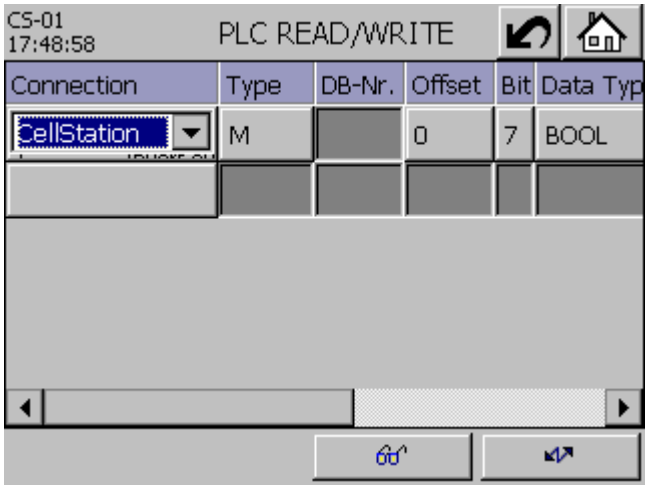


Figure 4.3: PLC READ/WRITE display for maintenance engineer.

The **PLC READ/WRITE** display is included in the Maintenance Tools for special maintenance purposes only. Special training is needed for any use of this display.

4.4 Control Panel operations

The Operator Panel software is based on Microsoft Windows CE operating system and thus the Control Panel display gives access to the various parameters of the panel. Normally these parameters do not need any changes. Great care should be taken for any parameter changes.

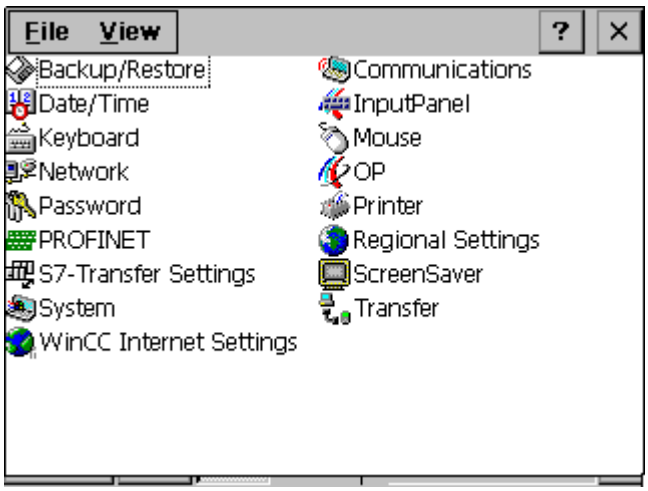


Figure 4.4: Windows CE Control Panel display.

CSP version of the CellStation supports the use of the Operator Interface remotely via an Ethernet network. To gain access to the CSP the IP address must be set using the Windows CE Control Panel's Network Configuration display.

To open the display double-click the Network icon on the Control Panel.

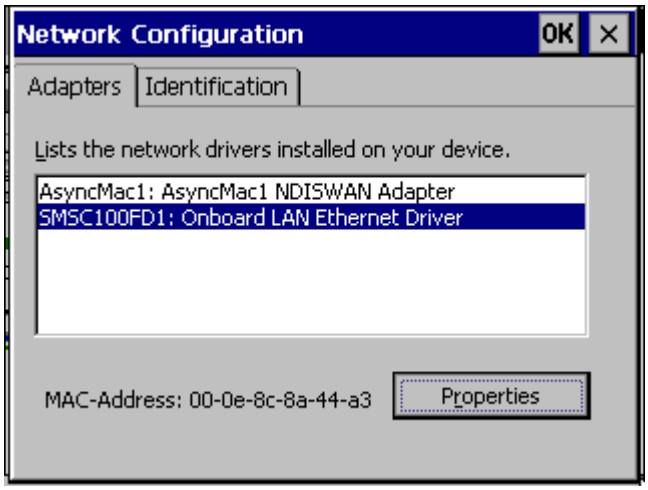


Figure 4.4.1: Network Configuration display.

Select the SMSC100DF1 from the list and click Properties button to open the Onboard LAN Ethernet Driver address definitions.

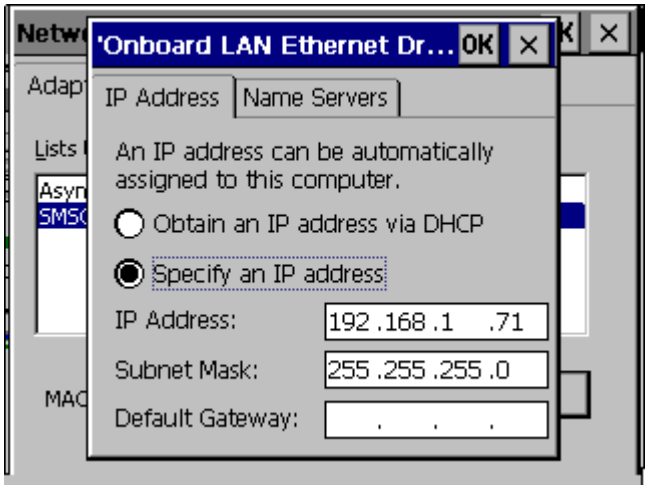


Figure 4.4.2: Onboard LAN Ethernet Driver display.

Set the proper IP Address and Subnet Mask (Gateway is normally not needed). Defaults are as shown in the figure above.

Click the OK button to accept the given parameters and again to accept the Network Configuration changes.

Note: The IP Address and Subnet Mask depend on your local network structure and conventions. Each Ethernet node (i.e. each CSP) must have unique IP address. For details consult your local network specialists.

Appendix A: CellStation specifications

Power specifications

Input voltage	85 – 132 VAC / 187 – 264 VAC, single phase
Input frequency	47 – 63 Hz
Input power (nominal)	15W (CSS version), 35W (CSP version).
Input rush current	12A/115V, 20A/230V, 20 milliseconds
Output power	24 VDC / 3A

Environmental specifications

Operating temperature	-10°C to +45°C
Storage temperature	-10°C to +50°C
Humidity	5% to 85%, non-condensing
Electrical protection	IP65 / NEMA 4X (Electrical box and Mains switch)

Electrical specifications

Analog inputs	4mA to 20mA, connection using 2- or 4-wire layout with common ground
Analog outputs	4mA to 20mA, 2-wire common ground with short-circuit protection

Physical dimensions

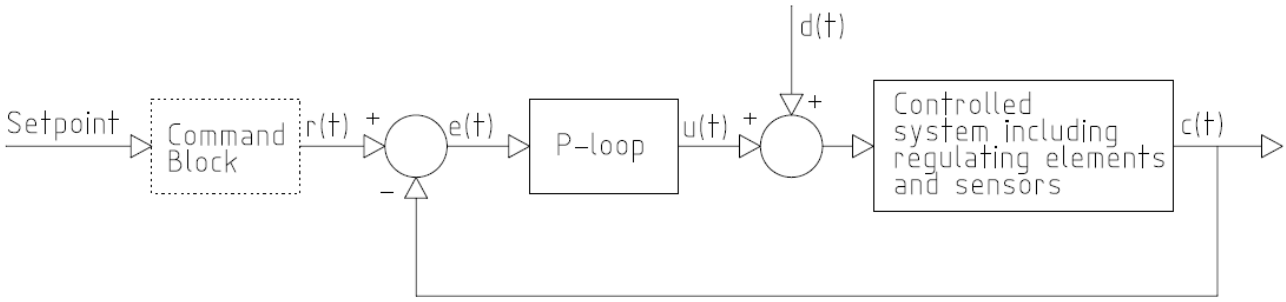
Electrical box length	Box only 210 mm, 302 mm with visor
Electrical box width	600 mm
Electrical box height	600 mm
Electrical box weight	41 kg
Installation base length	210 mm
Installation base width	600 mm
Installation base height	1300 mm
Installation base weight	25 kg
Mains switch	150 x 120 mm (h x w)
Total length	310 mm
Total width	720 mm
Total height	1900 mm
Total weight	66 kg

Appendix B: PID Control Loop Guide

CellStation Level and Air controllers conform to standard ISA-PID algorithm. The following paragraphs give a brief description of the associated algorithm and parameters.

P parameter (Proportional Gain)

P parameter is effectively the gain from process measurement to the controlling variable. The higher the P parameter is the stronger reaction of output when changing the setpoint. If only P parameter is used, the process value will always settle with an offset from the setpoint leaving a static deviation between setpoint and process value. Higher P parameter leaves smaller static deviation.



P algorithm: $u(t) = K_P e(t)$

r(t) = Setpoint

e(t) = r(t)-c(t)

u(t) = Output value calculated in P-loop

d(t) = external disturbance

c(t) = Process value

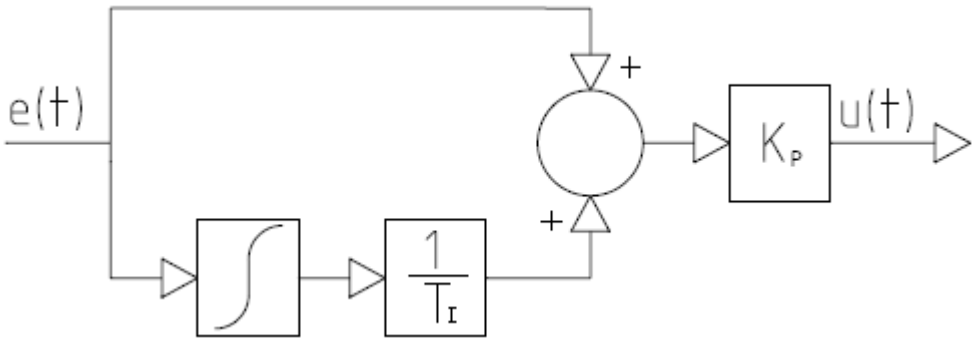
K_P = Proportional gain (P parameter)

If P parameter is set too **high**, the output will oscillate.

To avoid static deviation between setpoint and process value, a non-zero I parameter is needed.

I parameter (Integral term)

I parameter defines how fast the deviation between setpoint and process value will be eliminated when setpoint is changed. Higher I parameter means that it takes longer for the process value to reach setpoint.



PI algorithm: $u(t) = K_P(e(t) + \frac{1}{T_I}\int_0^t e(\tau)d\tau)$

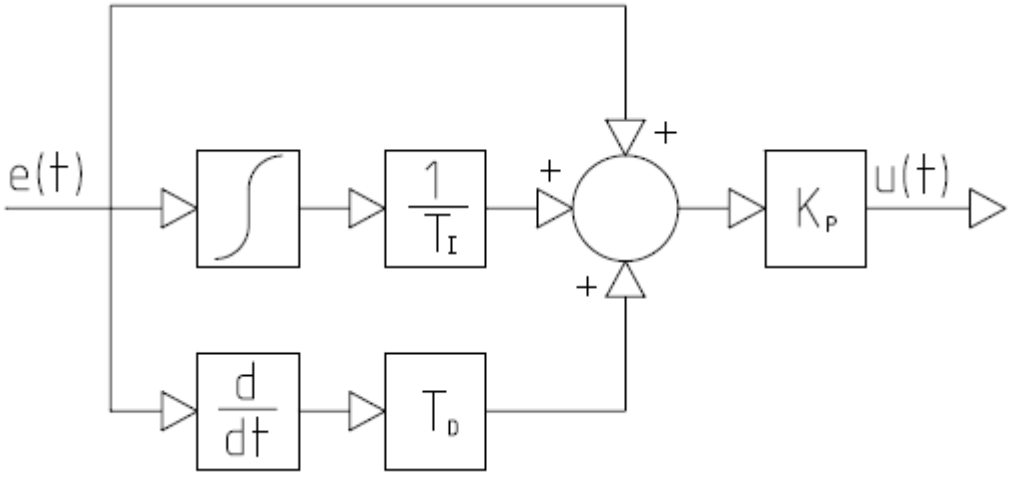
T_I = Integration time (I parameter)

τ = Time constant

If I parameter is set too **low,** the output will oscillate.

D parameter (Derivative term)

D parameter is needed if quick changes in process value are expected. With the D parameter the controller can be set to react quickly to process disturbances by exaggerating the control actions during quick process value changes.



PID algorithm: $u(t) = K_P(e(t) + \frac{1}{T_I}\int_0^t e(\tau)d\tau + T_D\frac{d}{dt}e(t))$

T_D = Derivation time (D parameter)

If D parameter is set too **high**, the output will oscillate.

READER COMMENTS

The design team of Outotec is committed to ensure the quality and usefulness of this manual and the automation products. Your comments, recommendations and suggestions will help us to make our continuous effort more effective.

Please take few moments to write your comments either directly on the form provided or on a photocopy of it.

Your assistance is greatly appreciated.
Thank you for choosing the Outotec automation equipment.

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or e-mail to:	automation@outotec.com
Attn:	Automation Support
From:	_____
	_____
	_____
Product name or Serial Number:	_____
Manual:	CellStation Operating Manual Code 10000005701e Revision 1.00 (Please identify applicable software versions and individual documents)
Comments / recommendations:	_____
	_____
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	_____