ENTROPIC

CONTROL SYSTEM
ENTROMATIC 500

Operating Manual

Contents

LIST OF INSTRUCTIONS

CONFIGURATION SCHEMES

SETUP AND INSTALLATION INSTRUCTIONS

Installation and operating instructions for devices (sensors, actuators, valves) can be found with the equipment manufacturer.

Symbol legend

Important information

Information

Breakdown / alarm sign

Electrical safety sign

Function in automatic mode

Function in manual mode

Press the button

Function is stopped

Function is OFF

No request, mode is OFF

Automatic mode

Grounding

ESC CONTROL SYSTEM

1 Scope of operating instructions

The ESC system is designed to control the following:

1. Deaerator.
2. Cascade of multi-boiler steam units.
3. Condensate tank.
4. Cooler.

The ESC system may be operated only by qualified personnel. Proper installation and thorough inspection in accordance with the requirements will ensure safe operation of ESC. The system consists of software and hardware components, which are to be set up in an integrated manner and shall be compatible. You must only use accessories and spare parts from the manufacturer for ESC.

If any modifications are made in the ESC design and construction without the agreement and permission of the manufacturer, the performance and operating safety of the system cannot be guaranteed. The safety of operating personnel could also be put at risk.

Use in accordance with the rules also includes thorough reading of these operating instructions and observance of the safety regulations.

The system owner, not the manufacturer, is responsible for any injuries, damage, or material loss inflicted as a result of failing to use the system in accordance with the rules and regulations.

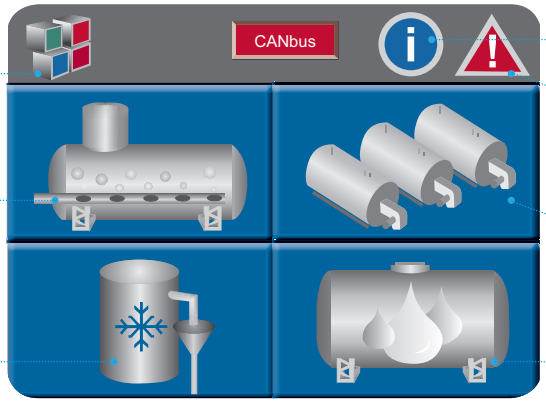
2 Description of the structure and functions/Description of the process

The ESC system uses a controller with touch screen. To call the necessary function, touch the desire area of the screen with your finger. Certain functions will only operate by pressing and holding your finger on the touchpad (for example, increase / decrease of the pump operating speed in manual mode).

Note: Never try to perform several operations at once, so as to avoid setting off functions unintentionally. You should therefore only touch one point on the ESC touchpad at a time.

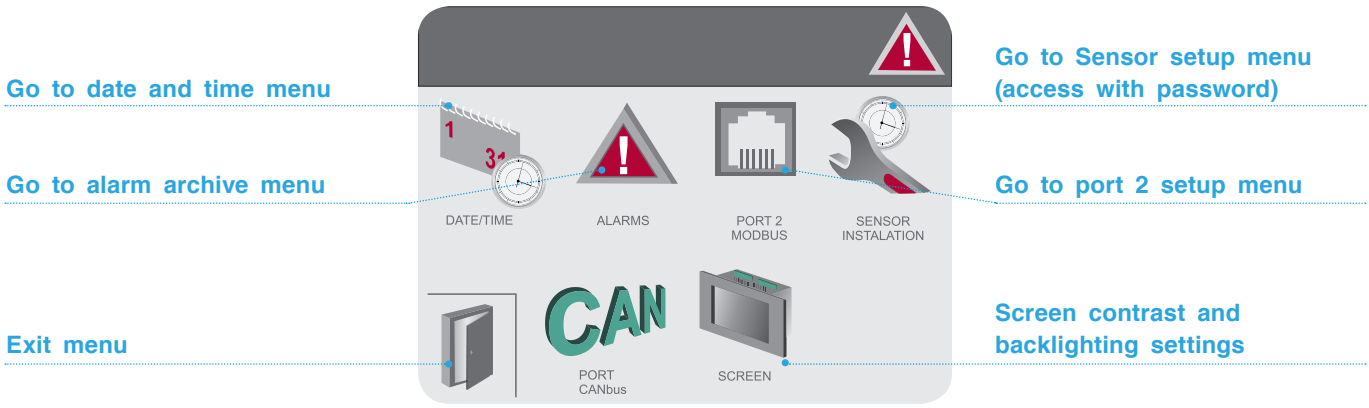
3 Main menu screen

The main menu screen can vary depending on the functions activated.

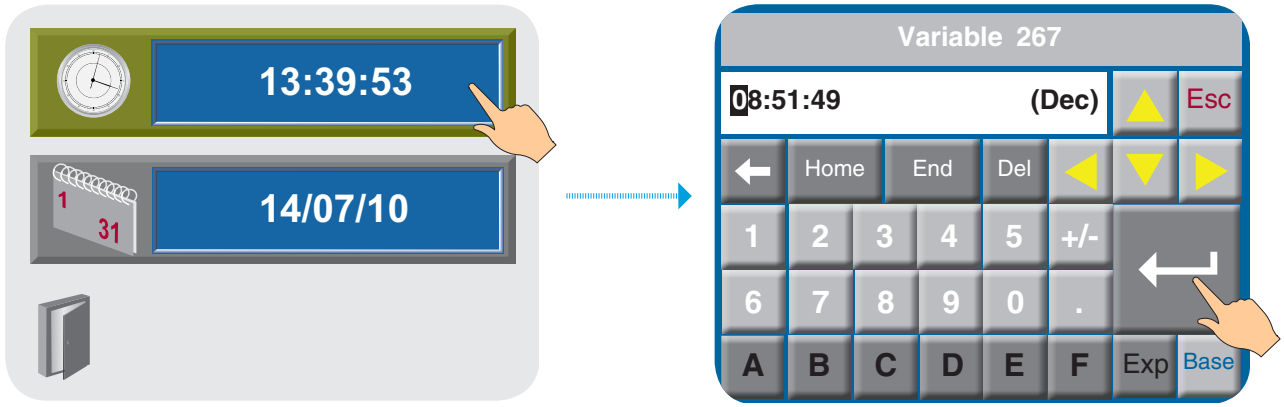


Note: The " " symbol in the navigation bar shows that the corresponding function is not in automatic mode.

4 System settings screen

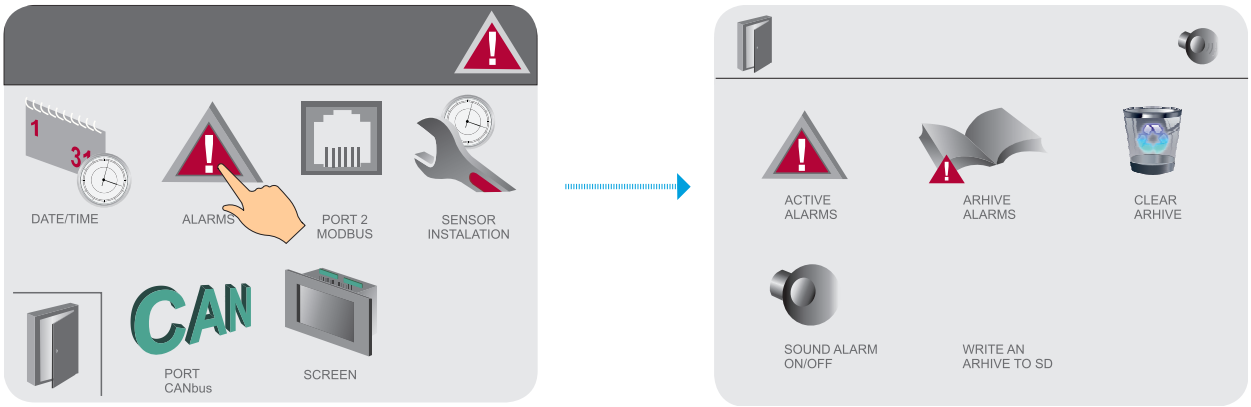


4.1 DATE AND TIME SETUP

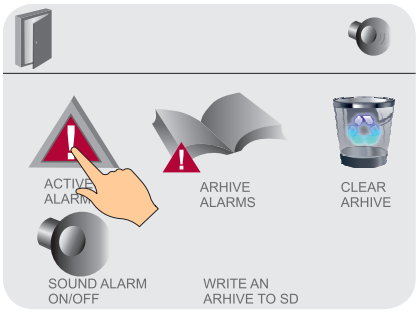


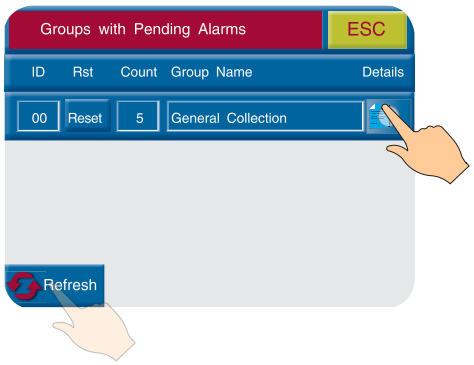
Press the time or date entry box → Enter the necessary value on the keypad and press Enter.

4.2 ALARM ARCHIVE



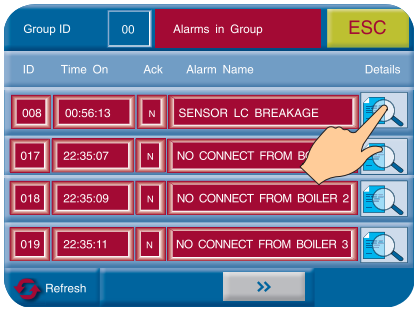
4.2.1 Active alarms





1. Reset inactive alarms.

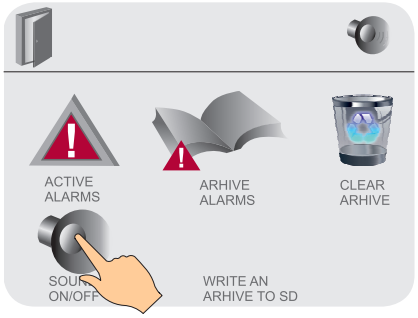
2. Update the status of active alarms.

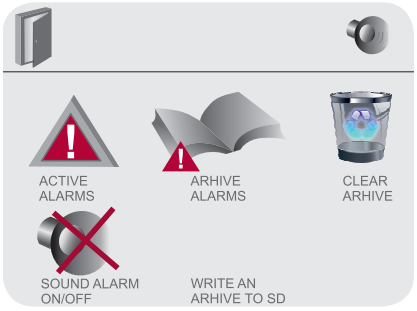


The alarm is unacknowledged → Press to acknowledge

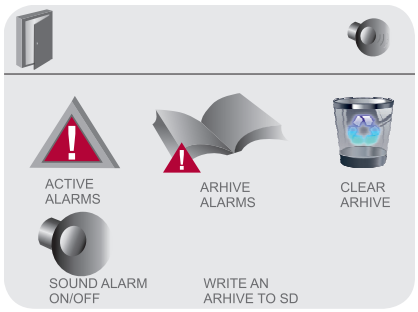
If there are any unacknowledged alarms, a sound alarm will be activated.

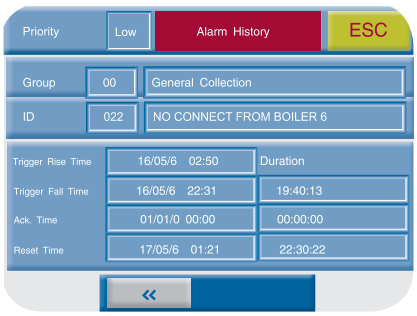
To deactivate the sound alarm, press the speaker icon.





4.2.2 Alarm archive

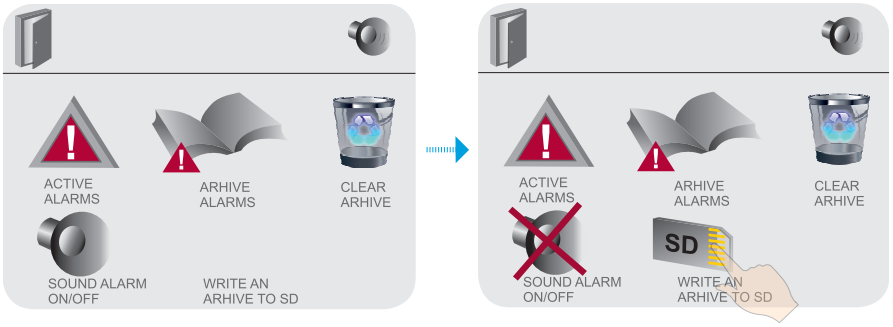




Trigger rise time — the date and time at which the incident occurred.
Trigger fall time — the date and time at which the incident ended.
Accepted — the date and time at which the incident was acknowledged.
Reset — the date and time at which the incident was reset, if no acknowledgement has been made and the incident is not active.

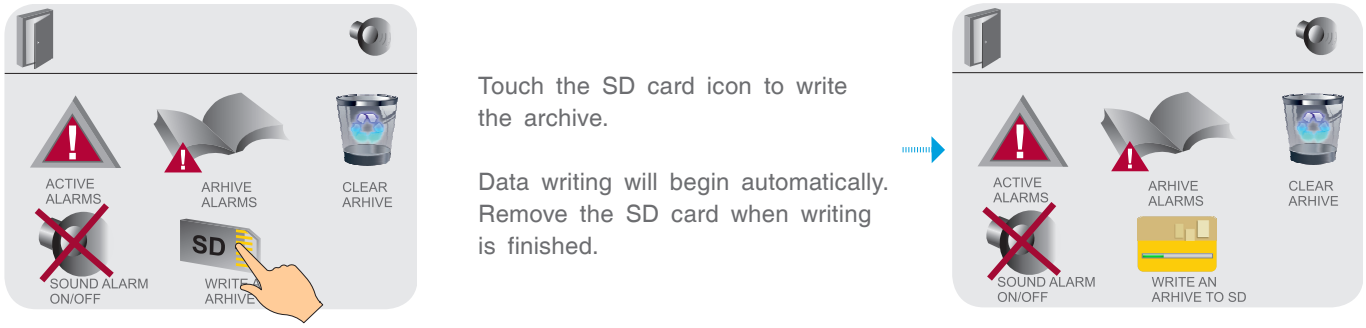
4.2.3 Writing an archive to SD

Insert SD card into controller. The SD card icon will appear on the screen.



Touch the SD card icon to write the archive.

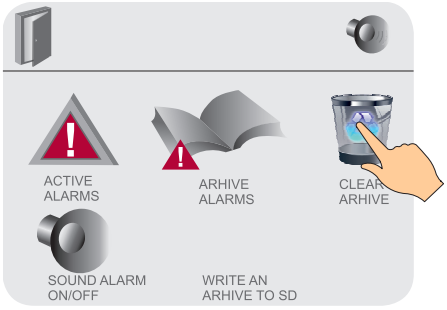
Data writing will begin automatically. Remove the SD card when writing is finished.



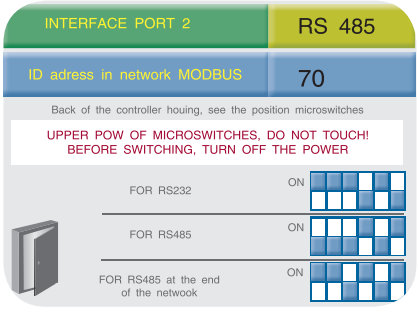
You can view and process data using the Unitronics SD Card Suite program (WWW.UNITRONICS.COM).

4.2.4 Clearing the alarm archive

Touch the wastebasket icon to clear the archive. After clearing the archive, it will be inaccessible.



4.3 SETUP OF PORT 2



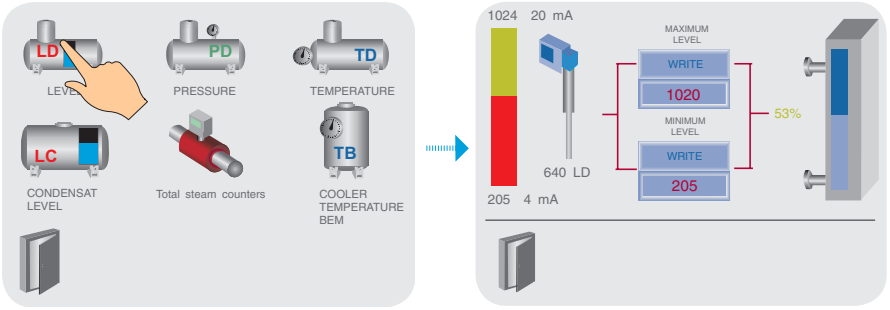
Port 2 is used to connect the ESC to the Modbus network.
The port settings specify the data exchange interface and ESC number in the Modbus network (from 64 to 127).

4.4 SENSOR SETUP

The setup of sensors shall be performed by an experienced specialist in the course of precommissioning activities when the equipment is installed and tested for correct installation.

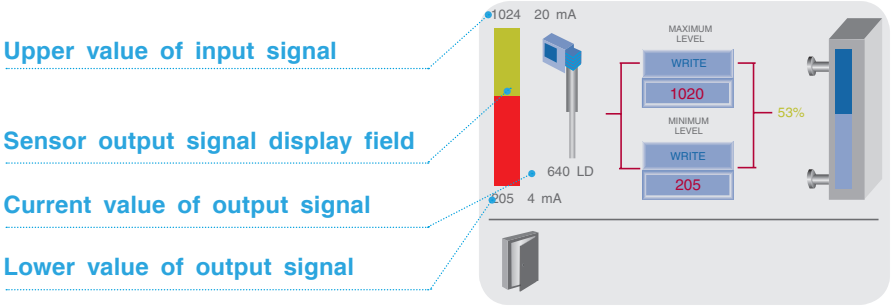
Depending on the ESC configuration, unnecessary sensors will be hidden.

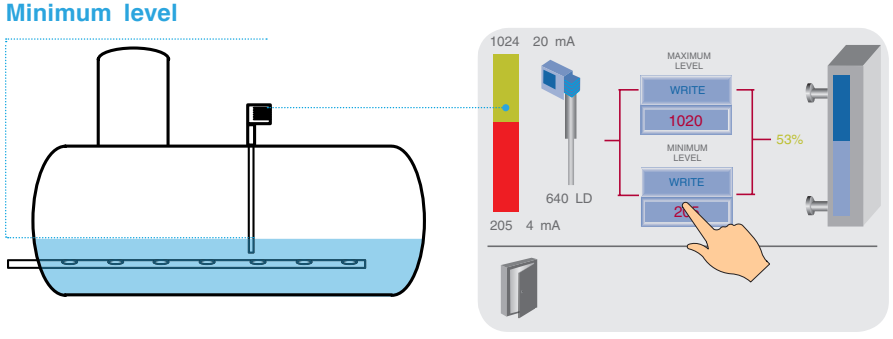
4.4.1 Setup of deaerator level sensor



The level sensor setup is performed after being installed on the deaerator.

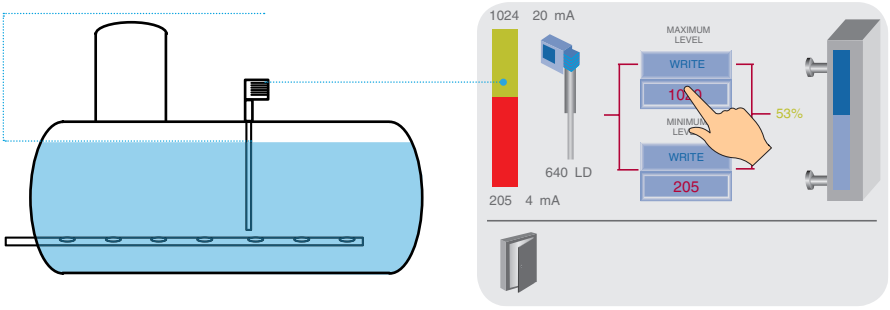
Before filling the deaerator with water, the digital display on the screen must show a value of at least 205+3, which corresponds to the sensor 4 mA current signal.





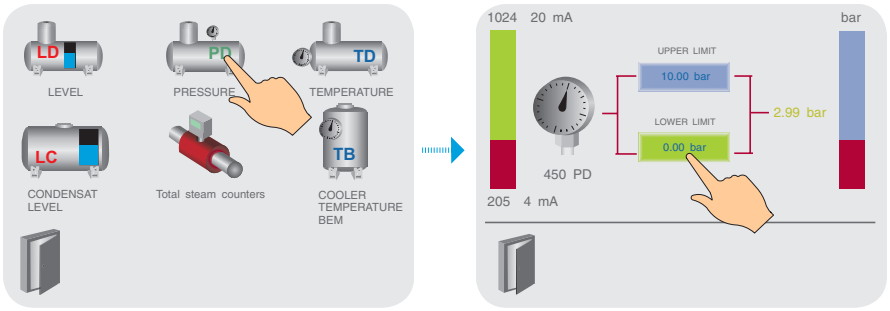
When filling the deaerator with water, bring the deaerator level to the minimum value (according to the deaerator datasheet) and write down the digital value of the minimum level.

Maximum level



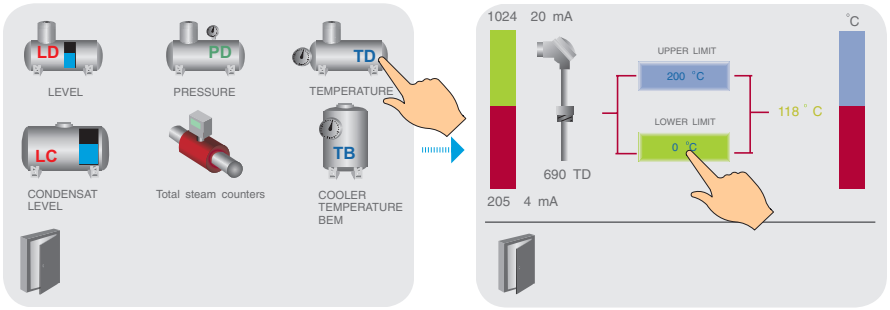
When filling the deaerator with water, bring the deaerator level to the maximum value (according to the deaerator datasheet) and write down the digital value of the maximum level.

4.4.2 Setup of deaerator pressure sensor (option)



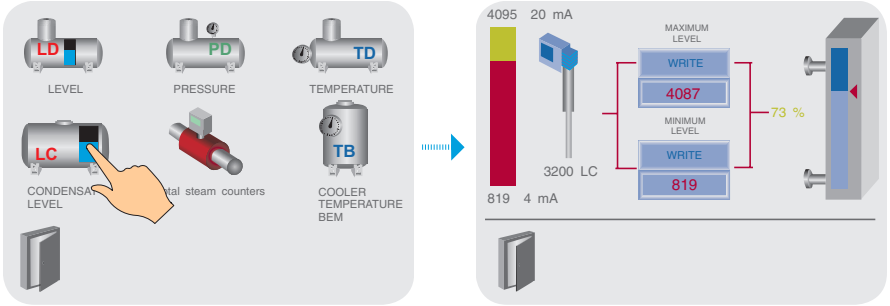
To set up the pressure sensor, enter the values of the sensor's lower and upper limits according to the datasheet.

4.4.3 Setup of deaerator temperature sensor (option)



To set up the temperature sensor, enter the values of the sensor's lower and upper limits according to the datasheet.

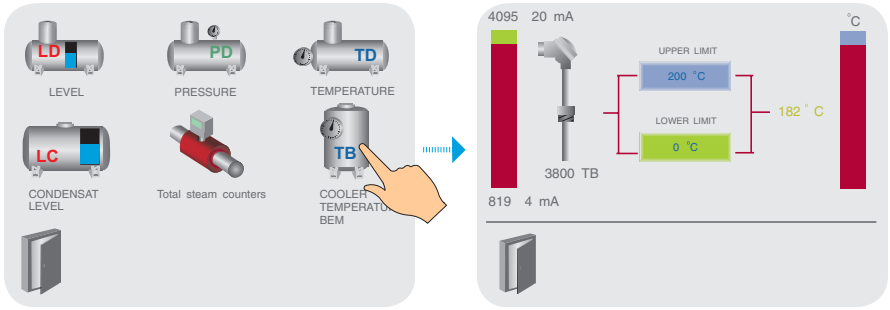
4.4.4 Setup of condensate tank level (option)



The level sensor setup is performed after being installed on the tank. Before filling the tank with water, the digital level indication on the screen shall display a value of no less than 205+3, which corresponds to the sensor 4 mA current signal.*

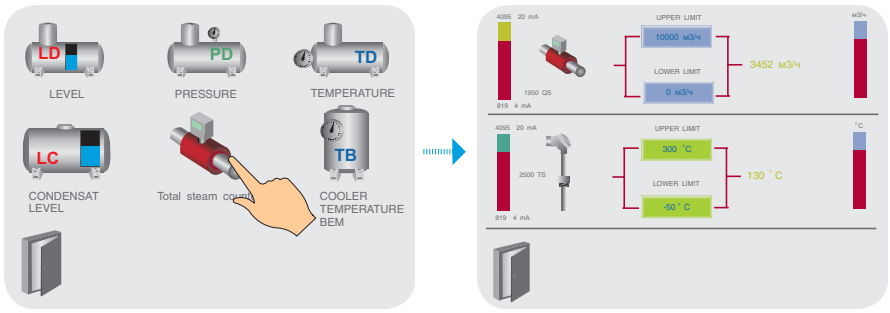
**The setup procedure is similar to the setup of the deaerator level sensor.*

4.4.5 Setup of the cooler temperature sensor (option)



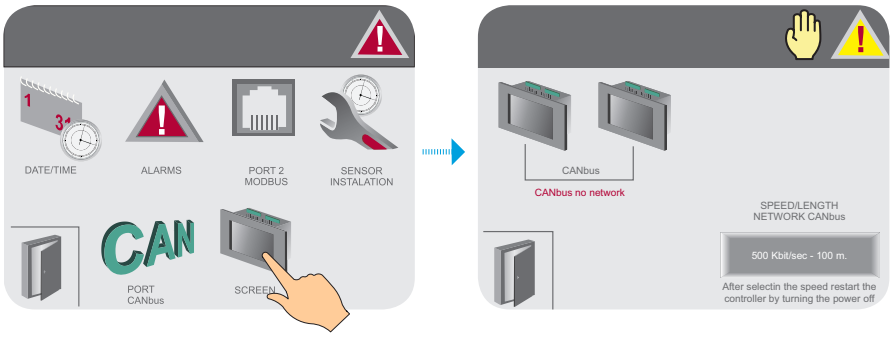
To set up the temperature sensor, enter the values of the sensor's lower and upper limits according to the datasheet.

4.4.6 Setup of steam assembly (option)

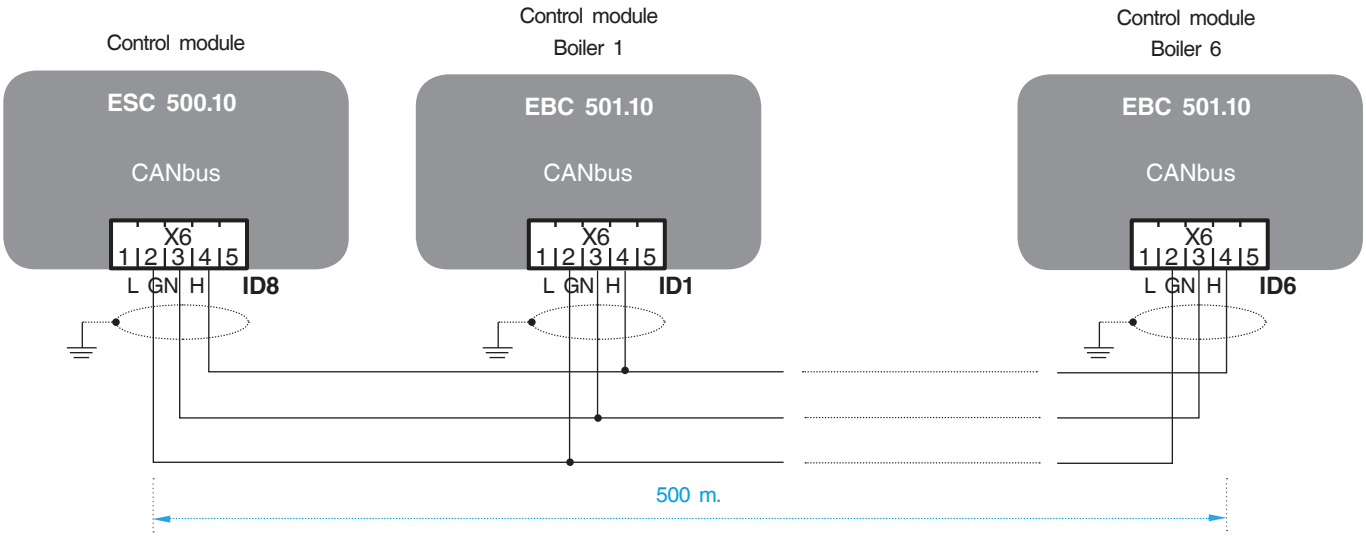


To set up the temperature sensor and the flow-meter, enter the values of the sensor's lower and upper limits according to the datasheet.

4.5 SETUP OF CANBUS NETWORK (ONLY FOR ESC500.10)



The CANbus network is designed for cascade control of steam boilers. The network setup consists of selecting the data transfer rate, which shall be the same for all systems connected to this network. The transfer rate itself depends on the extent of the network, which is determined by the route length of the network cable laid from the two outermost control systems as shown in the figure below.



Transfer rate vs. CANbus network length	
Transfer rate	Network length
50 Kbps	700 m
125 Kbps	500 m
250 Kbps	250 m
500 Kbps	100 m

CANbus network status	
CANbus	CANbus is not active
CANbus	CANbus network is missing
CANbus	CANbus network is busy
CANbus	CANbus network is in operation

The CANbus network wire shall be laid separately from other wires (cables) in order to avoid electromagnetic interference and electrical interference, which can cause damage to CANbus controller ports. The wire shall be shielded, and winding of screens shall be grounded.

MODULATED PRESSURE CONTROL

Description of the structure and functions / Description of the process

The pressure sensor measures the deaerator pressure and converts it into an electrical signal (4–20 mA). This signal is processed by ESC (see Operating Manual IE400ESC, Page 3) and is evaluated depending on the selected control type.

Before releasing the controller, the dearation control of the water supply system must be in the ON position. The steam supply solenoid valve regulates pressure within the range of settings for switching on and off (mean working pressure PD) to be specified on the ESC screen.

In order to avoid malfunctions during operation and damage during deaeration of the water supply system, the pressure adjustment ranges are limited. These values can be set only within the allowable limits.

Error message:

- If the operating excessive pressure PD falls below the minimum value (set up at 0.05 bar) for more than 10 seconds because of insufficient warming-up and steam supply, a message will appear on the ESC touchpad and the incident will be recorded in the memory. The error message is accompanied by a periodic sound signal. A potentially free contact also informs that the working pressure PD has dropped below minimum.

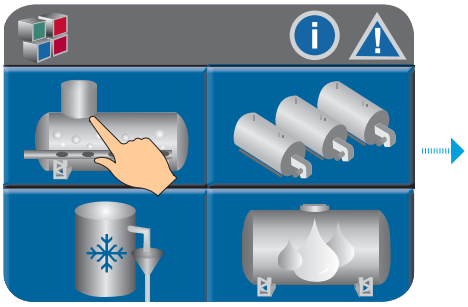
- If the system is powered up in the cold state, there is usually no steam access during the first start-up of the boiler-house. For this reason, the alarms are not activated for up to one hour after the water deaeration system has been switched on.

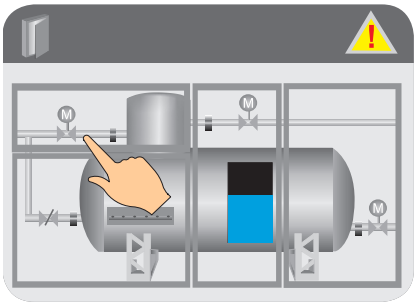
Deaerator makeup pressure PP control (option)

The pressure sensor is installed in the supply line before the dearator makeup valve. This sensor measures pressure in the supply pipeline and converts it into an electrical signal (4–20 mA). This signal is processed and evaluated in the ESC system (see operating instructions for IE400, Page 3).

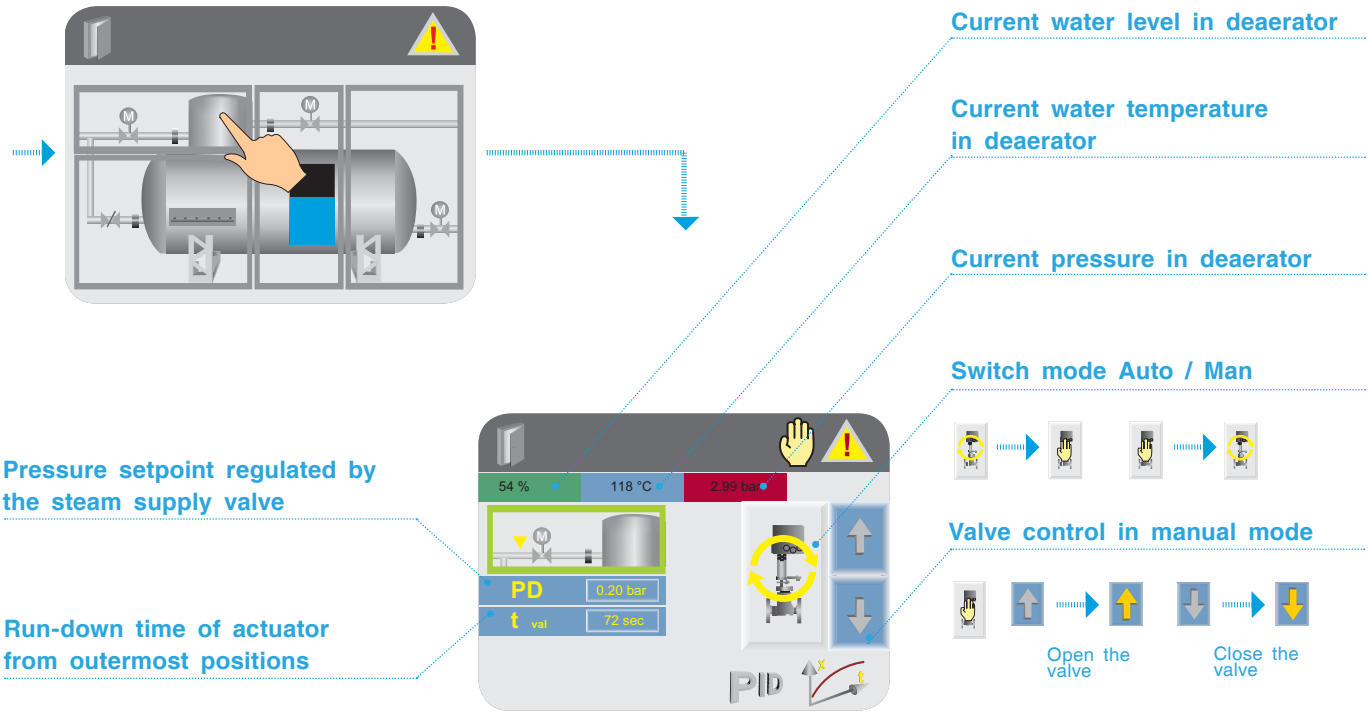
If the cold water pressure PP falls below the minimum setpoint (setpoint at 0.5 bar) and the control valve for deaerator makeup with water is open, the error message will appear with a 10 second delay and the incident will be recorded in the alarm archive.

Functioning

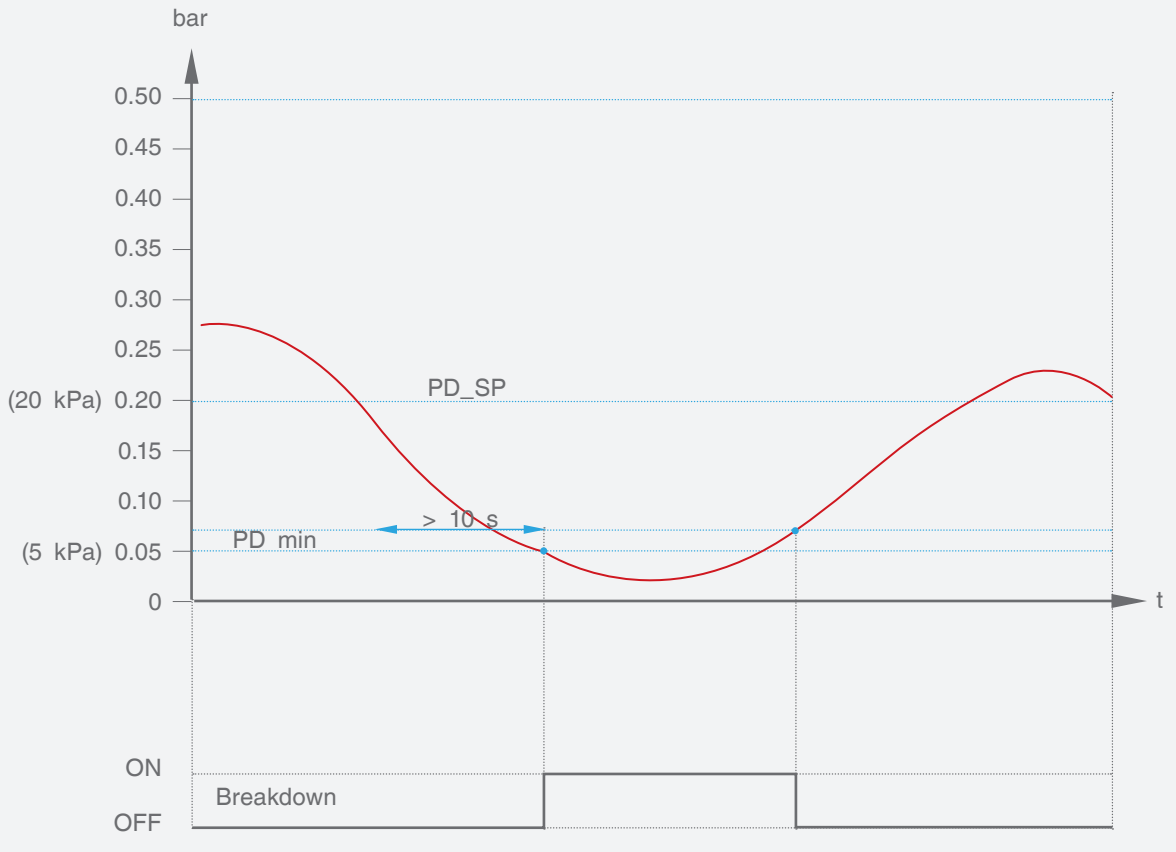




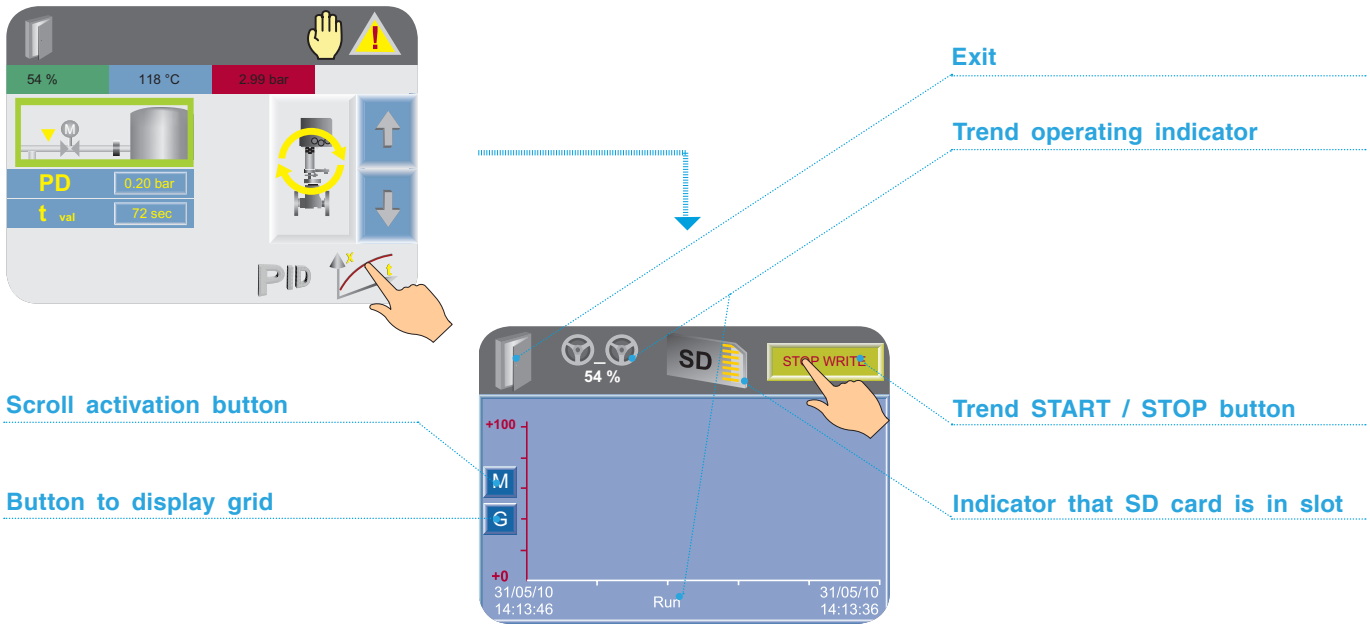
To go to the feed water deaeration control system from the main menu screen, press the Deaerator icon.



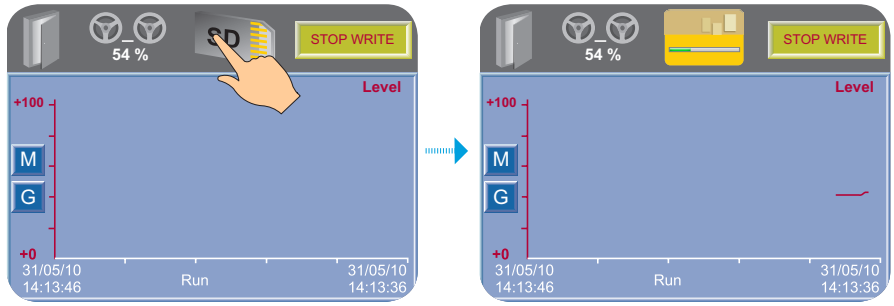
Pressure regulation in deaerator



Pressure trend in dearator PD

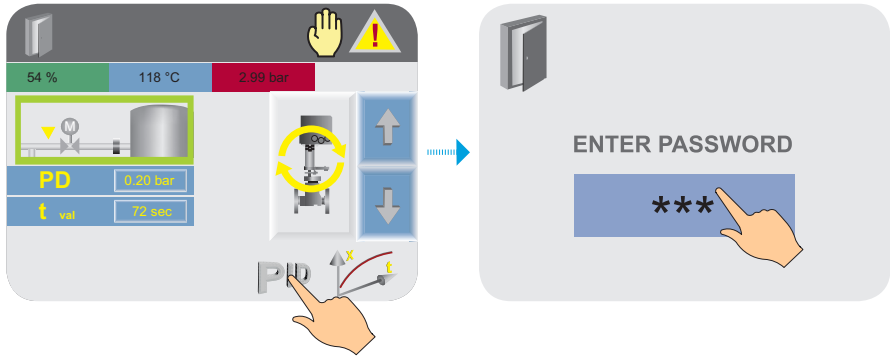


Write trend to memory card



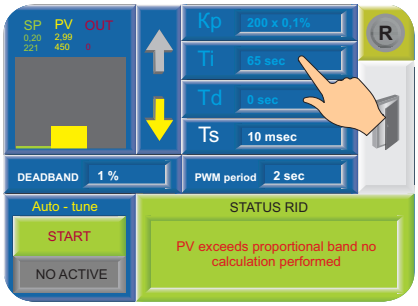
Insert the memory card into the slot. Run the trend by pressing START button and then press the memory card icon — the trend will begin to write to the SD card. If the trend is deactivated, writing to the SD card will be stopped automatically.

PID controller settings



Enter password to go to PID settings.

Set coefficients manually



SP — Setpoint.
PV — Process Variable (current temperature).
OUT — Control output (design PID value).
R — Reset to factory settings.
Deadband — determines the range from the setpoint within which the primary controller will allow the process variable (PV) to deviate without exerting any correction.
PWM (pulse width modulation) period — determines the sampling frequency of the control output.

Kp — proportional band is the established range near the setpoint. It is expressed as a percentage of the PD pressure range. If the boiler pressure is within the limits of this range, PID function is active. The set range is from 0 to 1,000 where 1 = 0.1 %, for example, for a pressure sensor with operating range from 0 to 0.5 bar.

The value of the pressure range in which the PID controller can be operated is equal to 0–0.5 bar (pressure sensor range).

The proportional band is set at 10 %. This means that the proportional band is 0.15–0.25 bar. If the level value is outside the proportional band, the PID will not function.

The proportional band can exceed 100 %. In the event of this, PID control shall be applied to the entire operating range.

A wide proportional band range increases system stability but at the same time increases oscillations during the stable phase.

A proportional band range that is too narrow will make the system respond as when operating in ON / OFF mode and either move past the setpoint or fail to reach it.

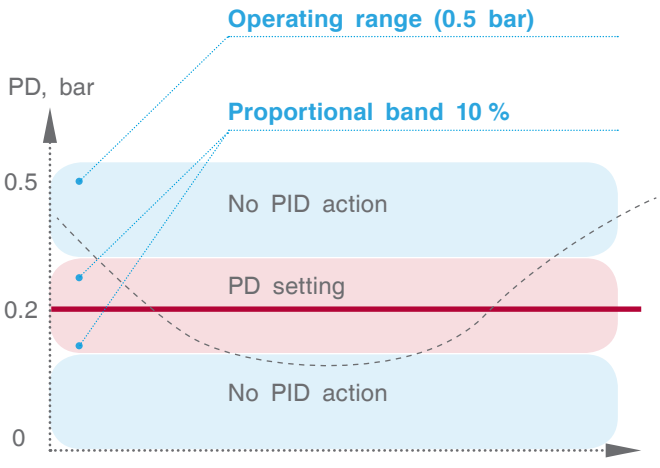
It is possible to increase the proportional band or increase the integral time in order to reduce overshoot and stabilize the system.

Ti — Integral time. This is the amount of time needed (calculated by the controller) for the process to reach the specified level setpoint. Note that if you set a short integral time, the function will respond quickly and can jump past the setpoint. Setting a greater integral time will lead to a slower reaction. As a rule, the integral component value is equal to the burner servo drive run-out. Specified range: from 0 to 1,000 s.

Td — Derivative time. Derivative action conforms to the rate and direction of the change in error (current level value minus setpoint). This means that a quick change in error provokes a strong reaction from the controller. The action on the derivative "anticipates" the value of the current pressure in the boiler with respect to the setpoint and regulates the controller output value accordingly, thereby shortening the PID function reaction time. Specified range: from 0 to 1,000 s.

The sample time Ts is the frequency of the PID control loop calculation. The result of each calculation is a new control output value. Use this parameter to determine the intervals between PID function updates in measurement units equal to 10 m/s.

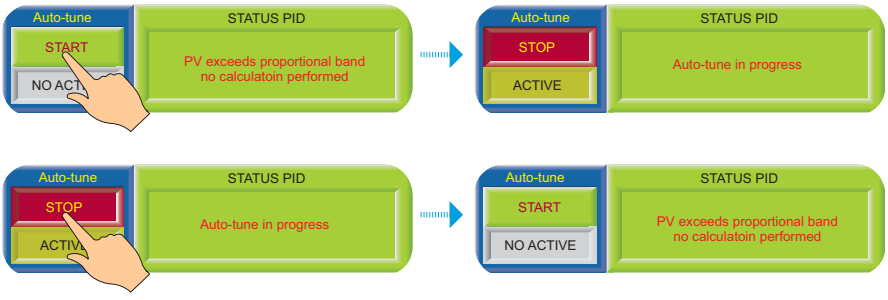
Example



Changes that affect the loop settings shall only be made by authorized personnel who have expert knoweldge of all aspects of the process. Using loop auto-tune procedures affects the process, in particular, causing large variations of the control output. To minimize the risk of injury or equipment damage, make sure that the consequences of any changes you wish to make have been thoroughly analyzed. Auto-tuning in ESC also requires thorough knowledge of the process.

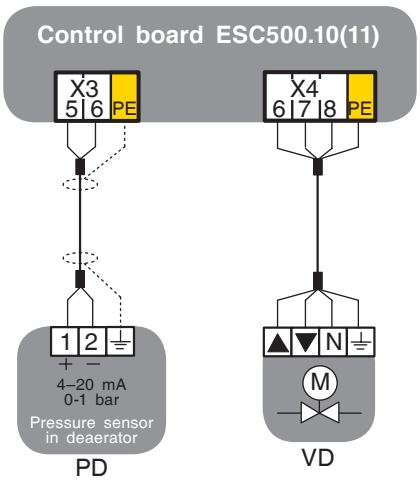
PID controller status

Message
PID without errors
Auto-tune in progress
PID is active
Change setpoint
Integral "round-up"
De-escalation of impact by integral
PV is below the proportional band
PV is above the proportional band
Non-conformance of auto-tune parameters. Run auto-tune repeatedly or write down the parameters manually
Kp coefficient is equal to zero
Incorrect range of PV input signal
Incorrect range of output signal OUT
Integral overflow is equal to 100,000. PID will not allow to further increase the integral value
The setpoint is less than the lower limit in terms of input or is greater than the upper limit
Auto-tune error, failure to calculate PID parameters
Interference is more than 5 % of PV input signal



Auto-tune can only be performed with the burner being in operation. Press the START button on the screen to begin the auto-tune process. Press the STOP button to stop the auto-tune process.

Connection


Control board ESC500.10(11)
X3
5 6 PE
X4
6 7 8 PE
1 2
+ –
4–20 mA
0-1 bar
Pressure sensor
in deaerator
PD
N
M
VD

TWO-POSITION LEVEL REGULATION

Description of the structure and functions / Description of the process

Level transducer measures the water level in the deaerator and converts it into a standard electrical signal (4–20 mA). This signal is processed in ESC (see operating Manual IE400) and evaluated depending on the selected control type.

Before releasing the controller, the control of the water deaeration system must be in the ON position. LBC opens and closes the makeup water control valve via regulated switchover points:

Upper water level LDC: 70 % (the valve closes).

Decrease of water level LDO: 65 % (the valve opens).

If the ESC system configuration includes a condensate tank, the condensate pump activation points must also be specified (if no condensate tank is present, these settings are hidden).

Preset values:

Water level LPO: 75 % (condensate pump is disactivated).

Water level LPC: 70 % (condensate pump is activated).

The settings range for the upper water level and lower water level and activation of condensate pump has been limited at the manufacturer's factory in order to avoid operational errors and damage to the water deaeration system. The values can be set within the limits of the specified range.

The water makeup valve (full deaeration shutoff valve) can be operated manually. The level regulation is not active in manual mode.

Note: In manual control mode, the system can be operated by qualified personnel in order to prevent the feed water tank from overflowing or draining and the corresponding implications of this.

High level of pre-alarm

In the event of an excess level of water level (LDH, set at 85 %), a pre-alarm will be activated and the incident will be recorded in the ESC incident memory. Eventually, the incidents will be recorded at values below the high pre-alarm level.

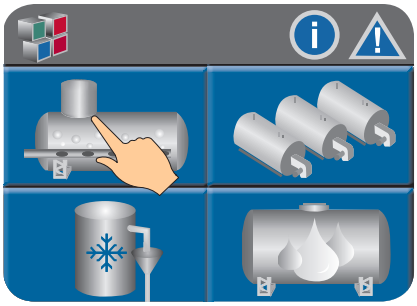
Full deaeration

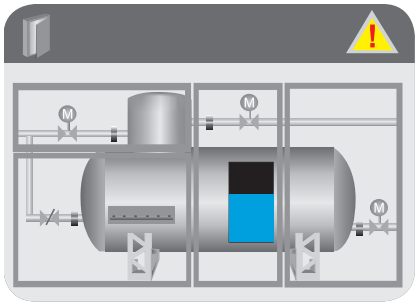
The system will open the blowdown valve at the maximum water level (LH set at 95 %). When this level drops below the maximum water level by 5 %, i.e. to 90 %, the system will close the shutoff valve again. The blowdown valve can be opened and closed in manual mode. The high level function will be activated in manual mode. The system does not issue an error message. **Error message:** when the maximum water level is reached, an error message will appear on the EBC screen and the incident will be recorded in the memory. The alarm is accompanied by a sound signal.

Protection against dry run

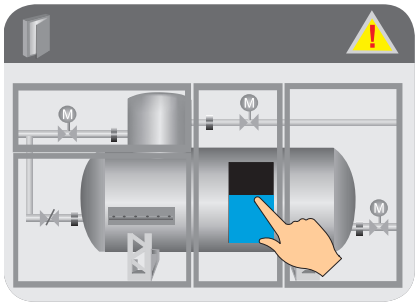
If the level drops below the minimum water level LDL (setpoint = 20 %), the control signal will deactivate the feed pumps to prevent dry run. If the level rises above LDP (setpoint = 25 %), the feed pump will be activated. **Error message:** when the minimum water level is reached, an error message will appear on the ESC screen and the incident will be recorded in the memory. The alarm is accompanied by a sound signal.

Functioning





To go to the feed water deaeration control system from the main menu screen, press the Deaerator icon.



Deaerator makeup valve closing level setpoint

Current water temperature in deaerator

Current pressure in deaerator

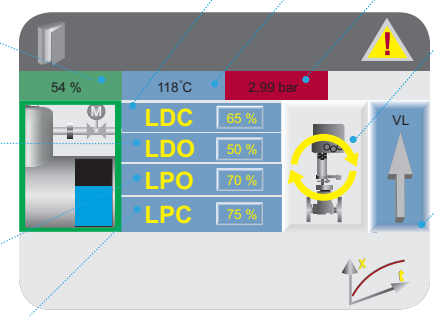
Switch mode Auto / Man

Current water level in deaerator

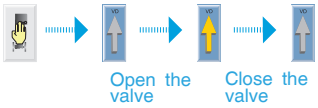
Deaerator makeup valve opening setpoint

Condensate pump activation setpoint (option)

Condensate pump deactivation setpoint (option)



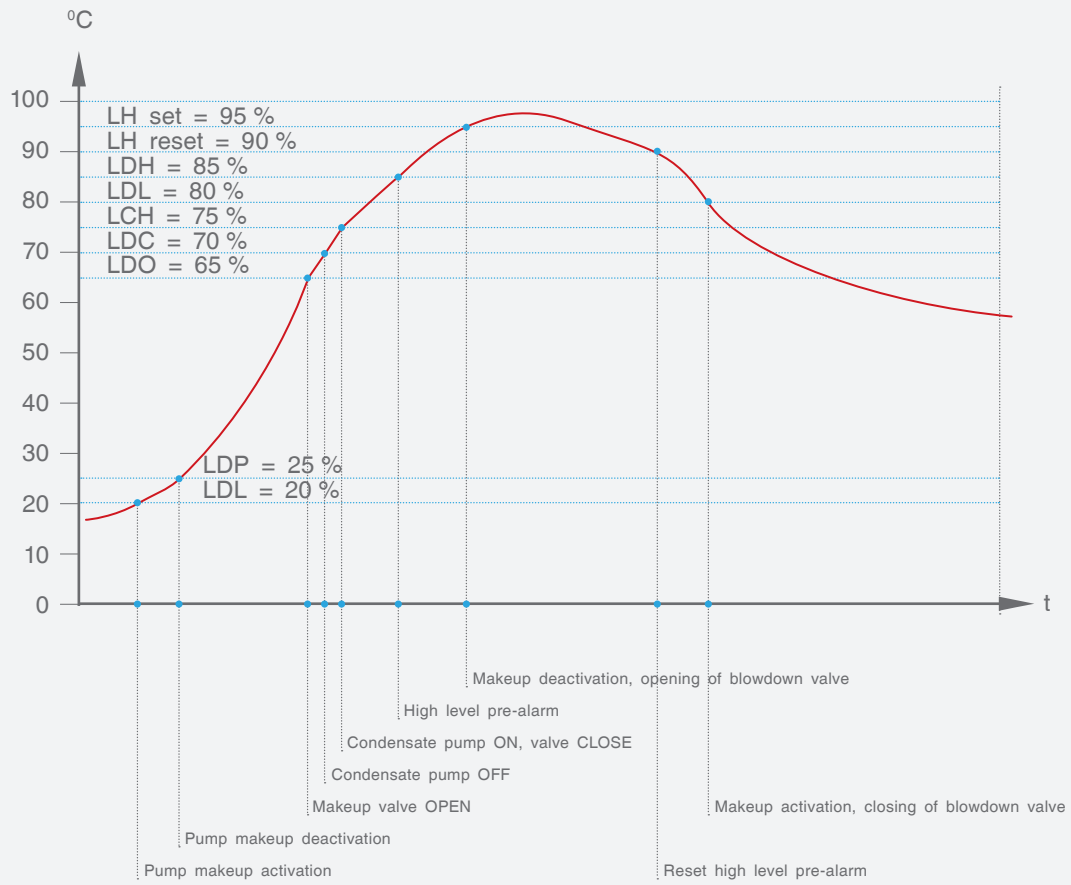
Valve control in manual mode



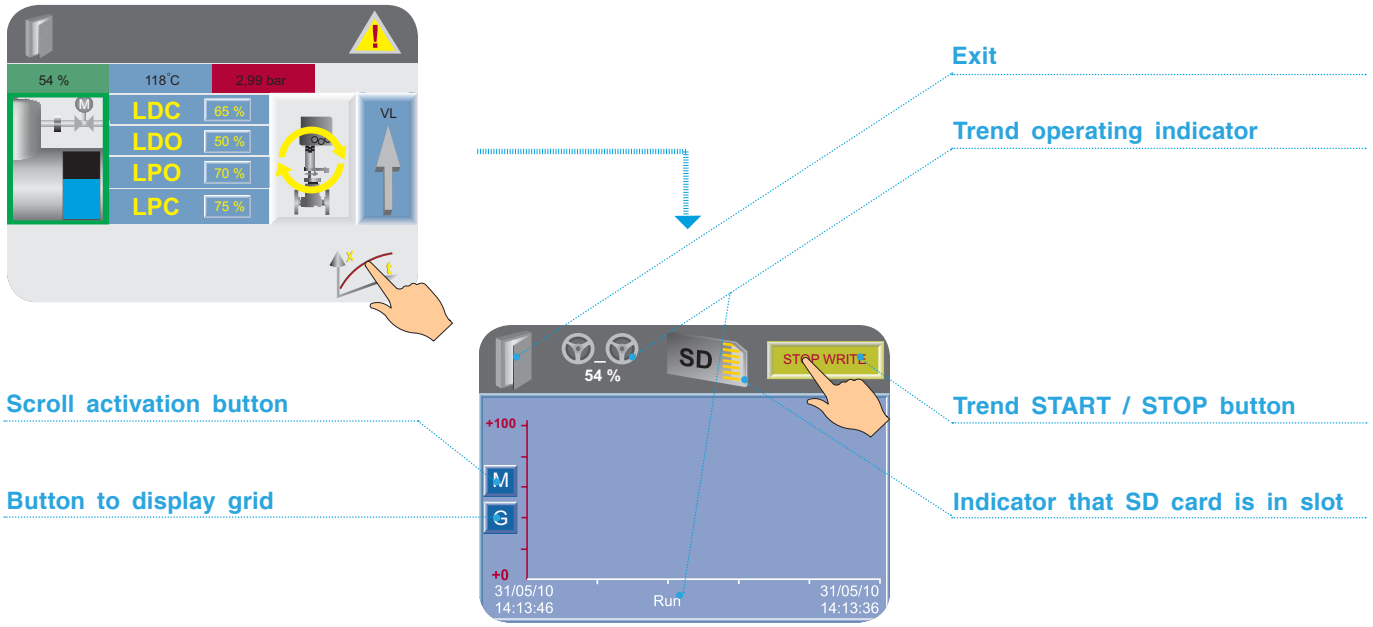
Open the valve

Close the valve

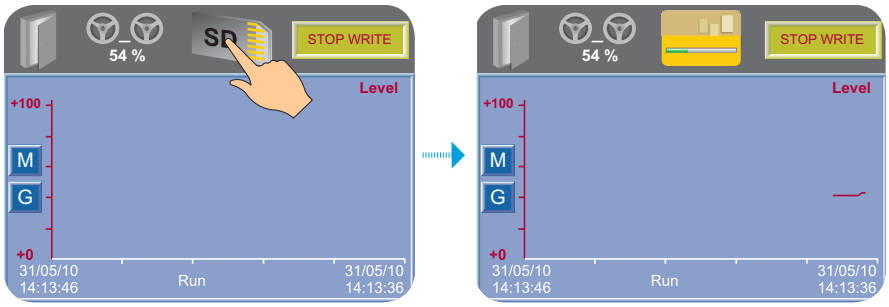
Deaerator makeup valve control



Deaerator temperature trend TD

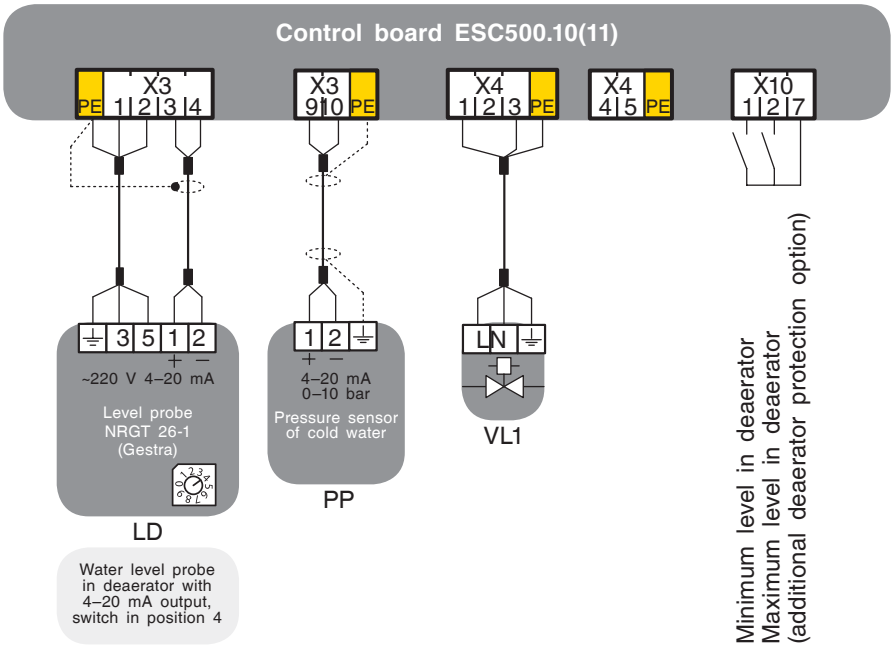


Write trend to memory card



Insert the memory card into the slot. Run the trend by pressing the START button and then press the memory card icon — the trend will begin to write to the SD card. If the trend is deactivated, writing to the SD card will be stopped automatically.

Connection



TWO-VALVE LEVEL REGULATION

Description of the structure and functions / Description of the process

Level transducer measures the water level in the deaerator and converts it into a standard electrical signal (4–20 mA). This signal is processed in ESC (see operating Manual IE400) and evaluated depending on the selected control type.

Before releasing the controller, the control of the water deaeration system must be in the ON position. LBC opens and closes the makeup water control valve via regulated switchover points:

Upper water level LDC: 70 %(the valve closes).

Decrease of water level LDO: 65 % (the valve opens).

If the ESC system configuration includes a condensate tank, the condensate pump activation points must also be specified (if no condensate tank is present, these settings are hidden).

Preset values:

Water level LPO: 75 % (condensate pump is disactivated).

Water level LPC: 70 % (condensate pump is activated).

The settings range for the upper water level and lower water level and activation of condensate pump has been limited at the manufacturer's factory in order to avoid operational errors and damage to the water deaeration system. The values can be set within the limits of the specified range.

The water makeup valve (full deaeration shutoff valve) can be operated manually. The level regulation is not active in manual mode.

Note: In manual control mode, the system can be operated by qualified personnel in order to prevent the feed water tank from overflowing or draining and related implications.

High level of pre-alarm

In the event of an excess level of water level (LDH, set at 85 %), a pre-alarm will be activated and the incident will be recorded in the ESC incident memory. Eventually, the incidents will be recorded at values below the high pre-alarm level.

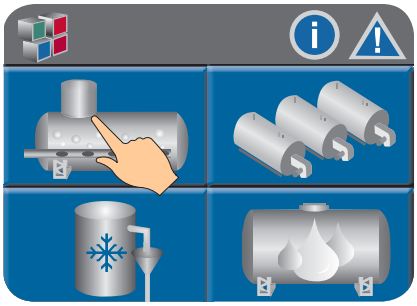
Full deaeration

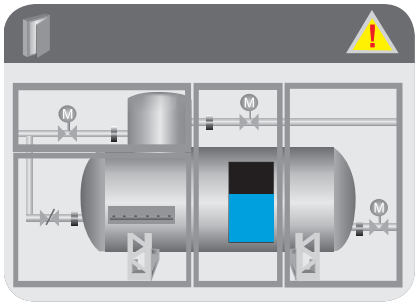
The system will open the blowdown valve at the maximum water level (LH, set at 95 %). When this level drops below the maximum water level by 5 %, i.e. to 90 %, the system will close the shutoff valve again. The blowdown valve can be opened and closed in manual mode. The high level function will be activated in manual mode. The system does not issue an error message. **Error message:** when the maximum water level is reached, an error message will appear on the EBC screen and the incident will be recorded in the memory. The alarm is accompanied by a sound signal.

Protection against dry run

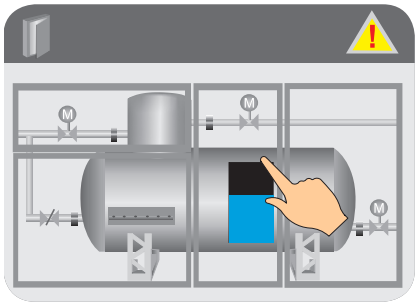
If the level drops below the minimum water level LDL (setpoint = 20 %), the control signal will deactivate the feed pumps to prevent dry run. If the level rises above LDP (setpoint = 25 %), the feed pump will be enabled. **Error message:** when the minimum water level is reached, an error message will appear on the ESC screen and the incident will be recorded in the memory. The alarm is accompanied by a sound signal.

Functioning





To go to the feed water deaeration control system from the main menu screen, press the Deaerator icon.



Closing setpoint for deaerator makeup valves

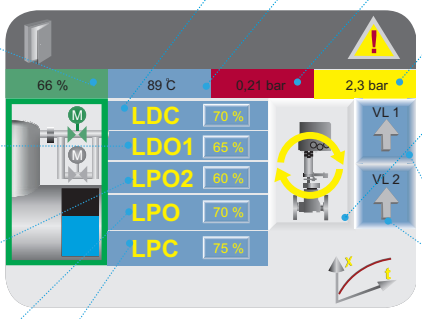
Current water temperature in deaerator

Current pressure in deaerator

Current pressure of cold water for makeup

Current water level in deaerator

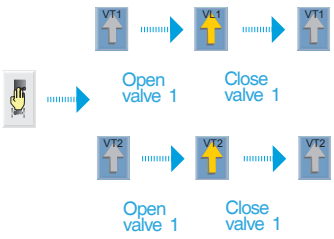
Switch mode Auto / Man



Opening setpoint of deaerator makeup valve 1

Opening setpoint of deaerator makeup valve 2

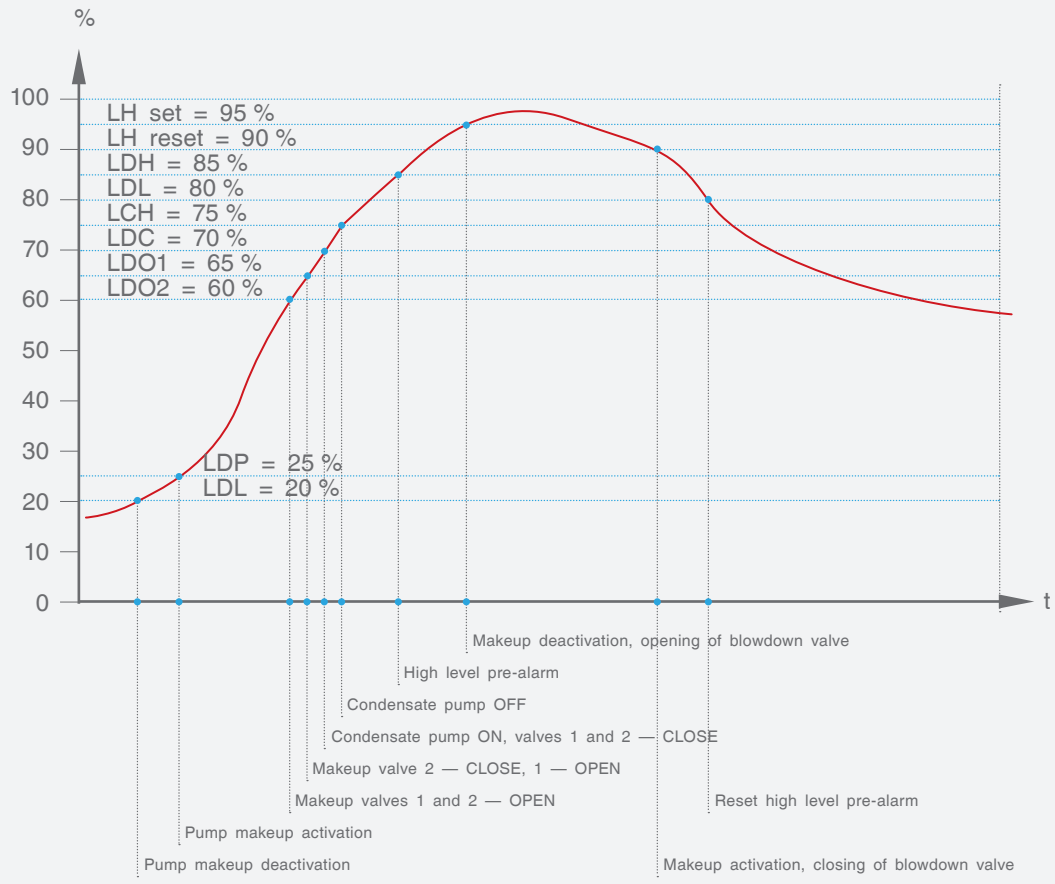
Valve control in manual mode



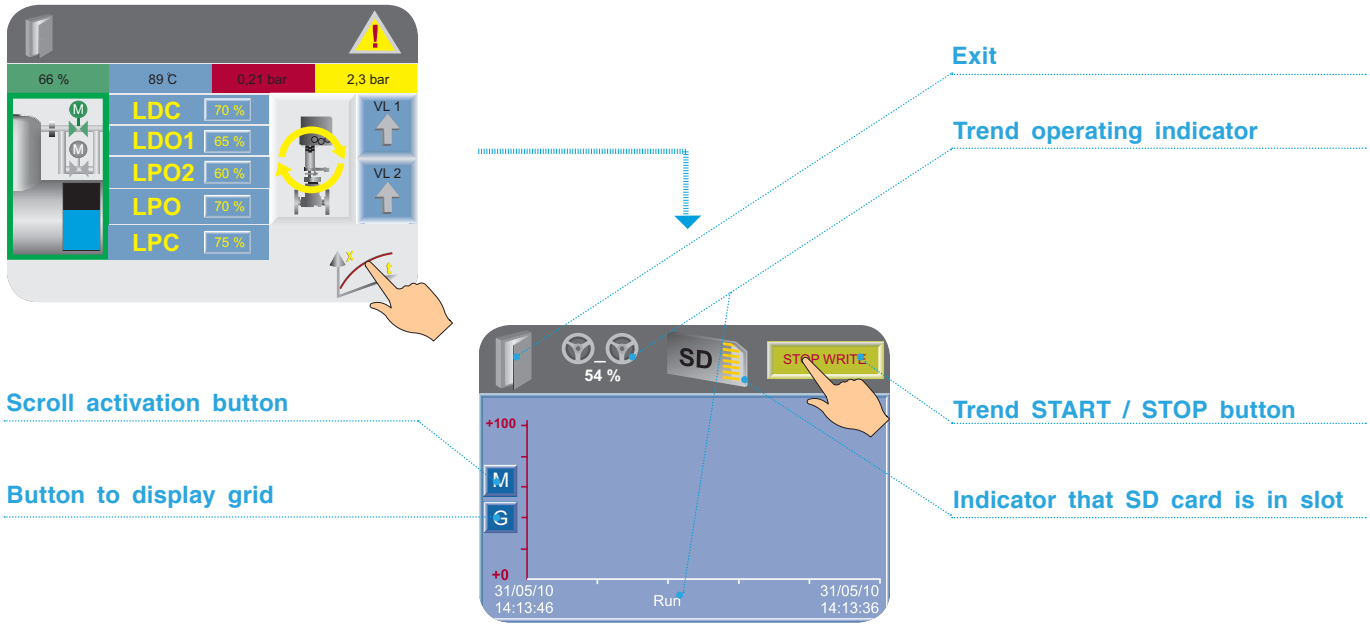
Condensate pump activation setpoint (option)

Condensate pump deactivation setpoint (option)

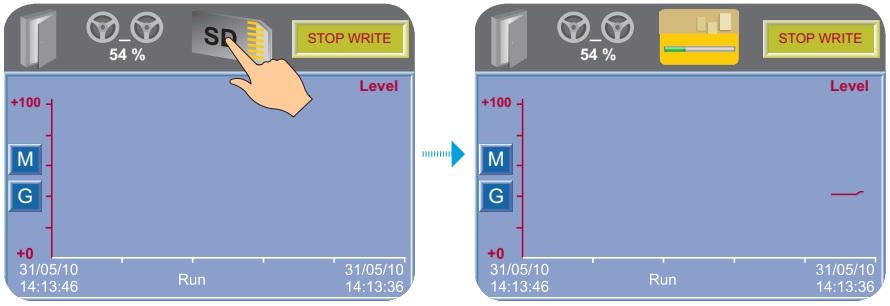
Deaerator makeup valve control



Deaerator temperature trend TD

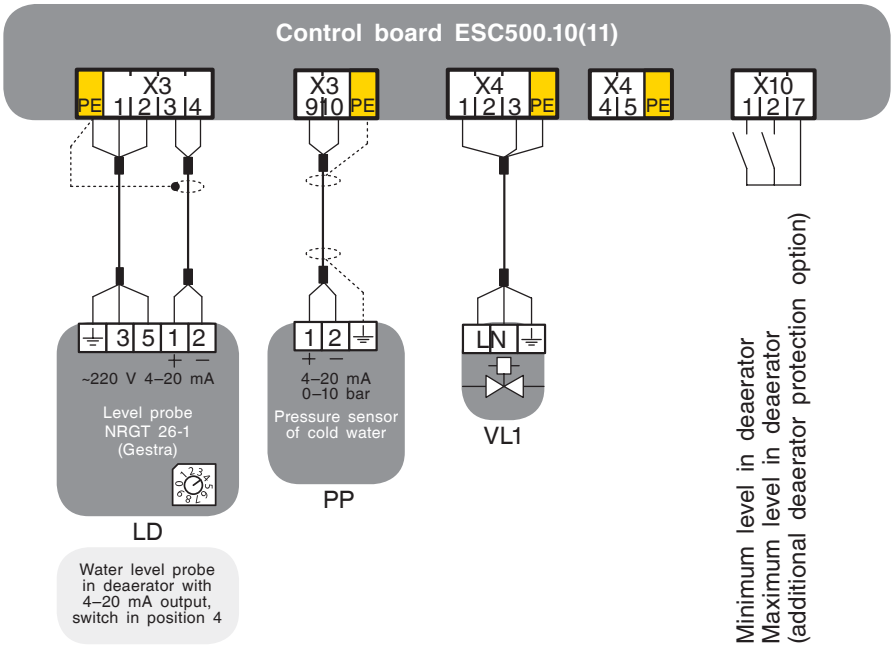


Write trend to memory card



Insert the memory card into the slot. Run the trend by pressing the START button and then press the memory card icon — the trend will begin to write to the SD card. If the trend is deactivated, writing to the SD card will be stopped automatically.

Connection



MODULATED LEVEL CONTROL

Description of the structure and functions / Description of the process

Level transducer measures the water level in the deaerator and converts it into a standard electrical signal (4–20 mA). This signal is processed in ESC (see operating Manual IE400) and evaluated depending on the selected control type.

Before releasing the controller, the control of the water deaeration system must be in the ON position. LBC opens and closes the makeup water control valve via regulated switchover points:

Upper water level LDC: 70 % (valve closes).

Decrease of water level LDO: 65 % (the valve opens).

If the ESC system configuration includes a condensate tank, the condensate pump activation points must also be specified (if no condensate tank is present, these settings are hidden).

Preset values:

Water level LPO: 75 % (condensate pump is disactivated).

Water level LPC: 70 % (condensate pump is activated).

The settings range for the upper water level and lower water level and activation of condensate pump has been limited at the manufacturer's factory in order to avoid operational errors and damage to the water deaeration system. The values can be set within the limits of the specified range.

The water makeup valve (full deaeration shutoff valve) can be operated manually. The level regulation is not active in manual mode.

Note: In manual control mode, the system can be operated by qualified personnel in order to prevent the feed water tank from overflowing or draining and related implications.

High level of pre-alarm

In the event that the water level is exceeded (LDH, set at 85 %), a pre-alarm will be activated and the incident will be recorded in the ESC memory. Eventually, the incidents will be recorded at values below the high pre-alarm level.

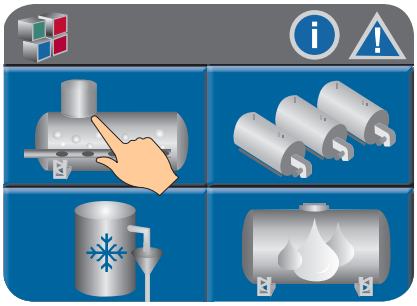
Full deaeration

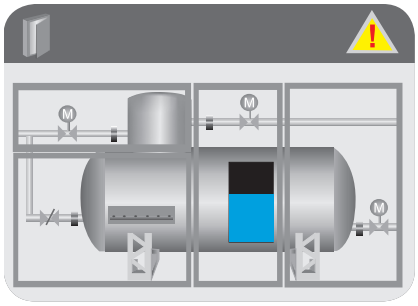
The system will open the blowdown valve at the maximum water level (LH set at 95 %). When this level drops below the maximum water level by 5 %, i.e. to 90 %, the system will close the shutoff valve again. The blowdown valve can be opened and closed in manual mode. The high level function will be activated in manual mode. The system does not issue an error message. **Error message:** when the maximum water level is reached, a message will appear on the EBC screen and will be recorded in the memory. The alarm is accompanied by a sound signal.

Protection against dry run

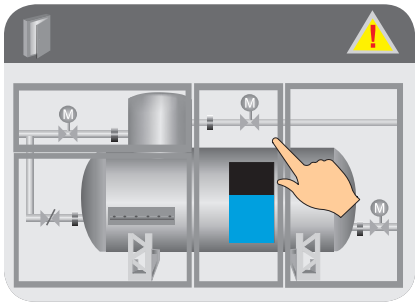
If the level drops below the minimum water level LDL (setpoint = 20 %), the control signal will disable the feed pumps against dry run. If the level rises above LDP (setpoint = 25 %), the feed pump will be enabled. **Error message:** when the minimum water level is reached, a message will appear on the EBC screen and the incident will be recorded in the memory. The alarm is accompanied by a sound signal.

Functioning





To go to the feed water deaeration control system from the main menu screen, press the Deaerator icon.



Setpoint of water level in the deaerator

Current water temperature in deaerator

Current pressure in deaerator

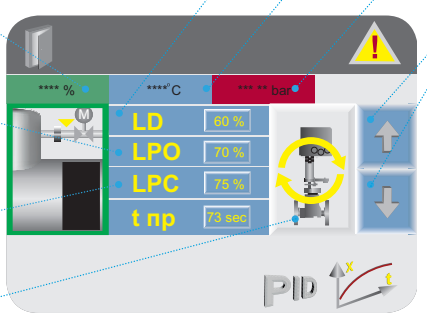
Valve control in manual mode

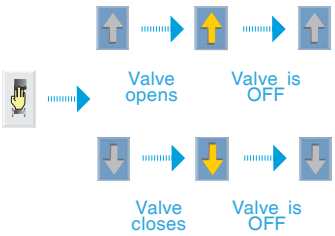
Current water level in deaerator

Condensate pump activation setpoint (option)

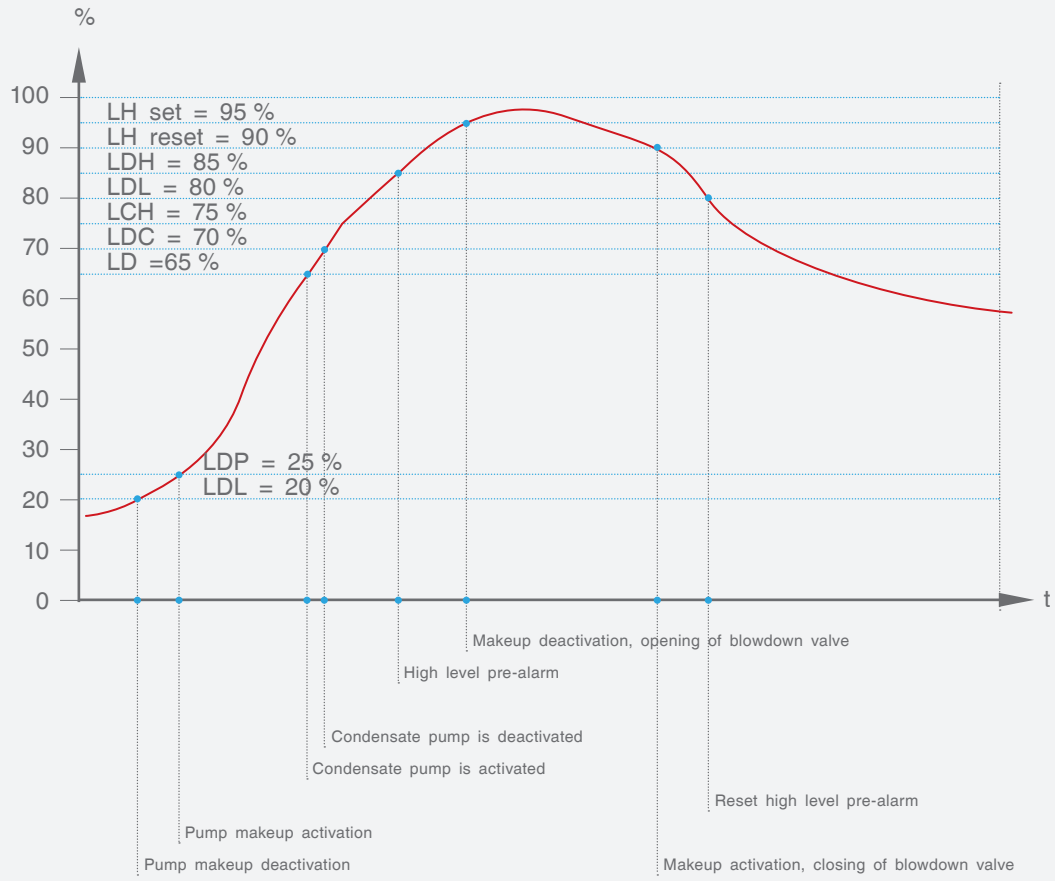
Condensate pump deactivation setpoint (option)

Switch mode Auto / Man

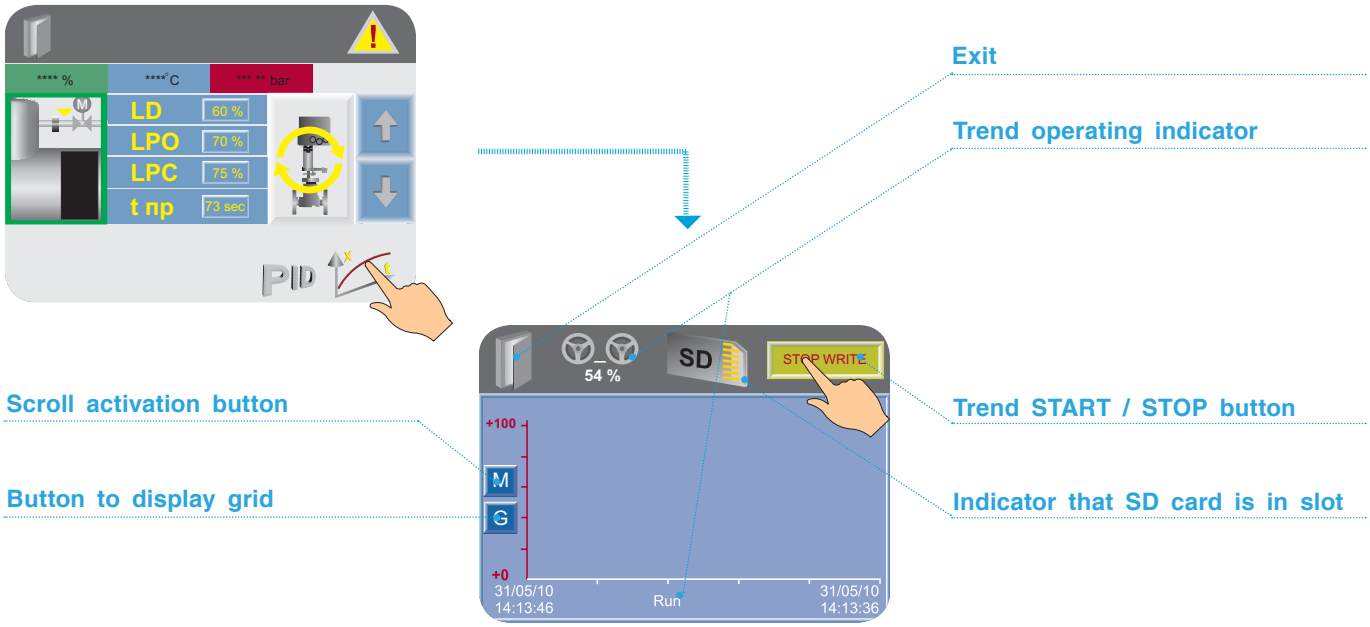




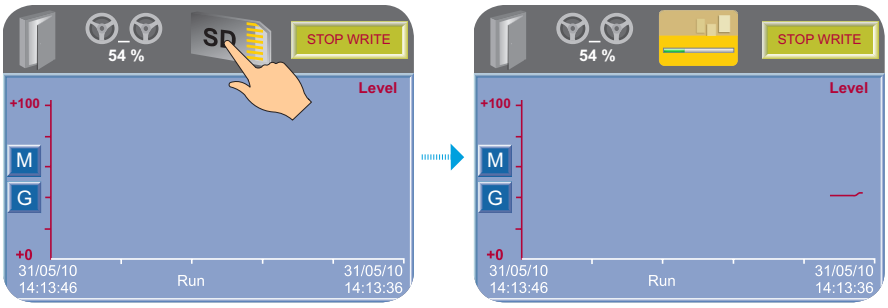
Deaerator makeup valve control



Deaerator temperature trend TD

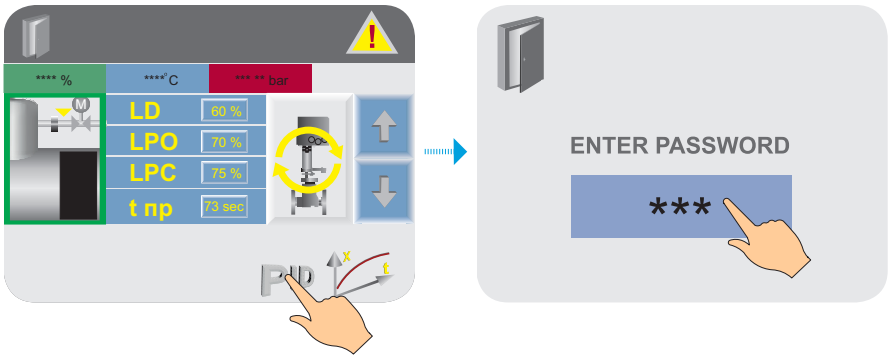


Write trend to memory card



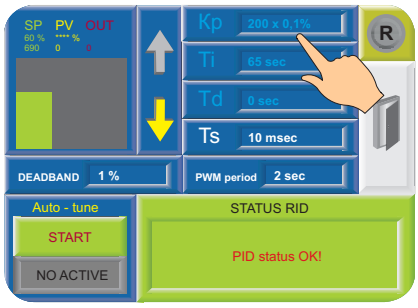
Insert the memory card into the slot. Run the trend by pressing the START button and then press the memory card icon — the trend will begin to write to the SD card. If the trend is deactivated, writing to the SD card will be stopped automatically.

PID controller settings



Enter password to go to PID settings.

Set coefficients manually



SP — Setpoint.
PV — Process Variable (current temperature).
OUT — control output (design PID value).
R — Reset to factory settings.

Kp — proportional band is the established range near the setpoint. It is expressed as a percentage of the PD pressure range. If the boiler pressure is within the limits of this range, PID function is active. Specified range — from 0 to 1,000 where 1 = 0.1 %.

The value of the pressure range in which the PID controller can be operated is equal to 0–0.5 bar (pressure sensor range).

The proportional band is set at 10 %. This means that the proportional band range is 0.15–0.25 bar.

If the level value is outside the proportional band, the PID will not function.

The proportional band can exceed 100 %. In the event of this, PID control shall be applied to the entire operating range.

A wide proportional band range increases system stability but at the same time increases oscillations during the stable phase.

A proportional band range that is too narrow will make the system respond as when operating in ON/OFF mode and either move past the setpoint or fail to reach it.

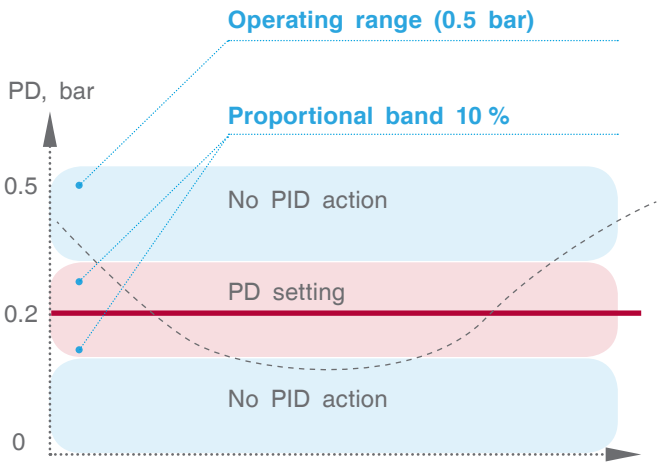
It is possible to increase the proportional band or increase the integral time in order to reduce overshoot and stabilize the system.

Ti — Integral time. This is the amount of time needed (calculated by the controller) for the process to reach the specified level setpoint. Note that if you set a short integral time, the function will respond quickly and can jump past the setpoint. Setting a greater integral time will lead to a slower reaction. As a rule, the integral component value is equal to the burner servo drive run-out. Specified range: from 0 to 1,000 s.

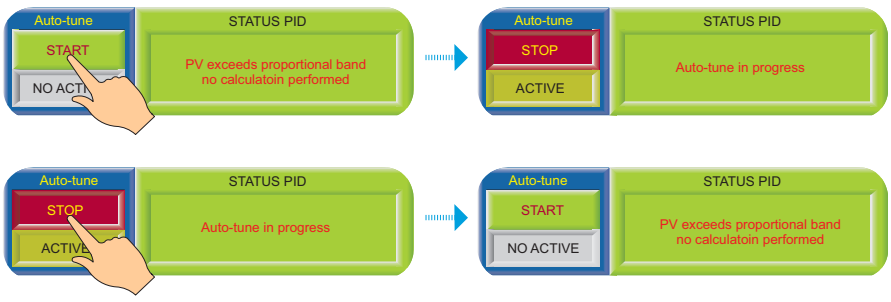
Td — Derivative time. Derivative action conforms to the rate and direction of the change in error (current level value minus setpoint). This means that a quick change in error provokes a strong reaction from the controller. The action on the derivative "anticipates" the value of the current pressure in the boiler with respect to the setpoint and regulates the controller output value accordingly, thereby shortening the PID function reaction time. Specified range: from 0 to 1,000 s.

The sample time Ts is the frequency of the PID control loop calculation. The result of each calculation is a new control output value. Use this parameter to determine the intervals between PID function updates in measurement units equal to 10 m/s.

Example



Changes that affect the loop settings shall only be made by authorized personnel who have expert knoweldge of all aspects of the process. Using loop auto-tune procedures affects the process, in particular, causing large variations of the control output. To minimize the risk of injury or equipment damage, make sure that the consequences of any changes you wish to make have been thoroughly analyzed. Auto-tuning in ESC also requires thorough knowledge of the process.

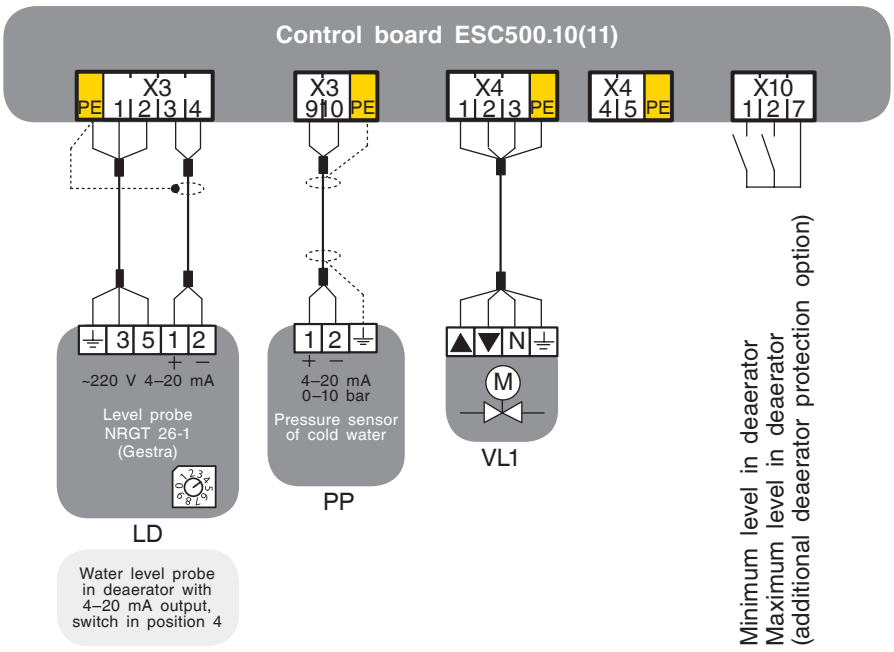


Auto-tune can only be performed with the burner being in operation. Press the START button on the screen to begin the auto-tune process. Press the STOP button to stop the auto-tune process.

PID controller status

Message
PID without errors
Auto-tune in progress
PID is active
Change setpoint
Integral "round-up"
De-escalation of impact by integral
PV input value is below the proportional band
PV input value is above the proportional band
Non-conformance of auto-tune parameters. Run auto-tune repeatedly or write down the parameters manually
Kp coefficient is equal to zero
Incorrect range of PV input signal
Incorrect range of output signal OUT
Integral overflow is equal to 100,000. PID will not allow to further increase the integral value
The setpoint is less than the lower limit in terms of input or is greater than the upper limit
Auto-tune error, failure to calculate PID parameters
Interference is more than 5 % of PV input signal

Connection



WATER BLOWDOWN VALVE

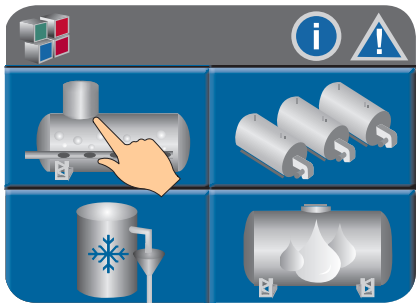
Description of the structure and functions / Description of the process

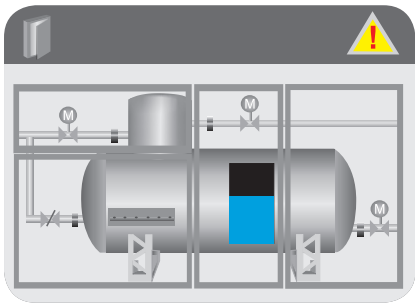
The system will open the blowdown valve at the maximum water level (LH set at 95 %). When this level drops below the maximum water level by 5 %, i.e. to 90 %, the system will close the shutoff valve again. The blowdown valve can be opened and closed in manual mode. The high level function will be activated in manual mode.

Error message:

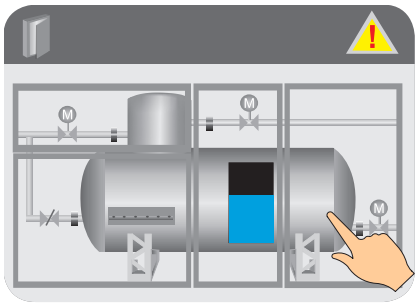
when the maximum water level is reached, an error message will appear on the EBC screen and the incident will be recorded in the memory. The alarm is accompanied by a sound signal.

Functioning





To go to the feed water deaeration control system from the main menu screen, press the Deaerator icon.

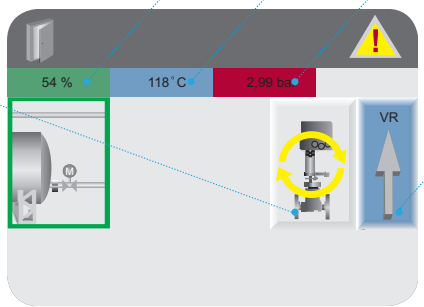


Current water level in deaerator

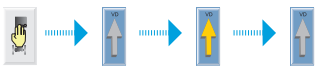
Current water temperature in deaerator

Current pressure in deaerator

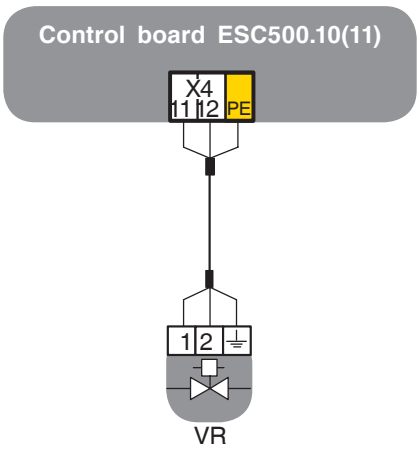
Switch mode Auto / Man



Valve control in manual mode



Connection



CONDENSATE LEVEL REGULATION

Description of the structure and functions / Description of the process

The level transducer measures the water level in the condensate tank and converts it into an electrical standard signal (4–20 mA). This signal is processed in ESC (see operating Manual IE400) and evaluated depending on the selected control type.

Before releasing the controller, the control over the condensate system must be in the ON position, and the condensate level must be below the maximum value. In automatic mode, the activation and deactivation of condensate pumps occurs at specified points:

Upper water level LDO: 45 % feed pump ON.

Decrease of water level LCC: 40 % feed pump is OFF.

The settings range for the upper water level and lower water level has been limited at the manufacturer's factory in order to avoid operational errors and damage. You can set it within the range indicated.

High pre-alarm level

In the event that the water level is reached (LDC, set at 85 %), a pre-alarm will be activated and the incident will be recorded in the ESC memory. When the level decreases to 80 %, the pre-alarm will be deactivated.

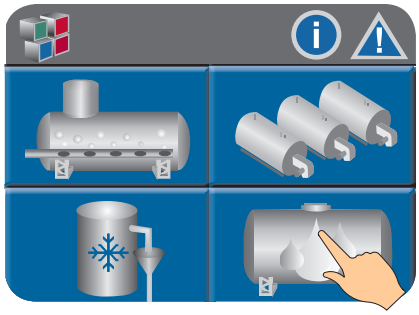
Maximum level

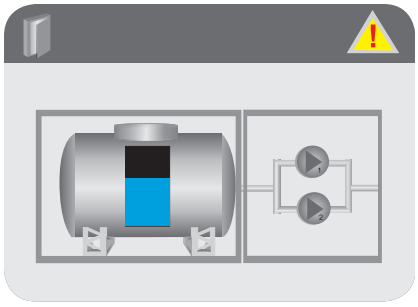
The system will open the blowdown valve VC at the maximum water level (LCH set at 95 %). When this level drops below the maximum water level by 5 %, i.e. to 90 %, the system will close the shutoff valve again. The blowdown valve can be opened and closed in manual mode. The high level function will be activated in manual mode. The system does not issue an error message. **Error message:** when the maximum water level is reached, an error message will appear on the EBC screen and the incident will be recorded in the memory. The alarm is accompanied by a sound signal.

Protection against dry run

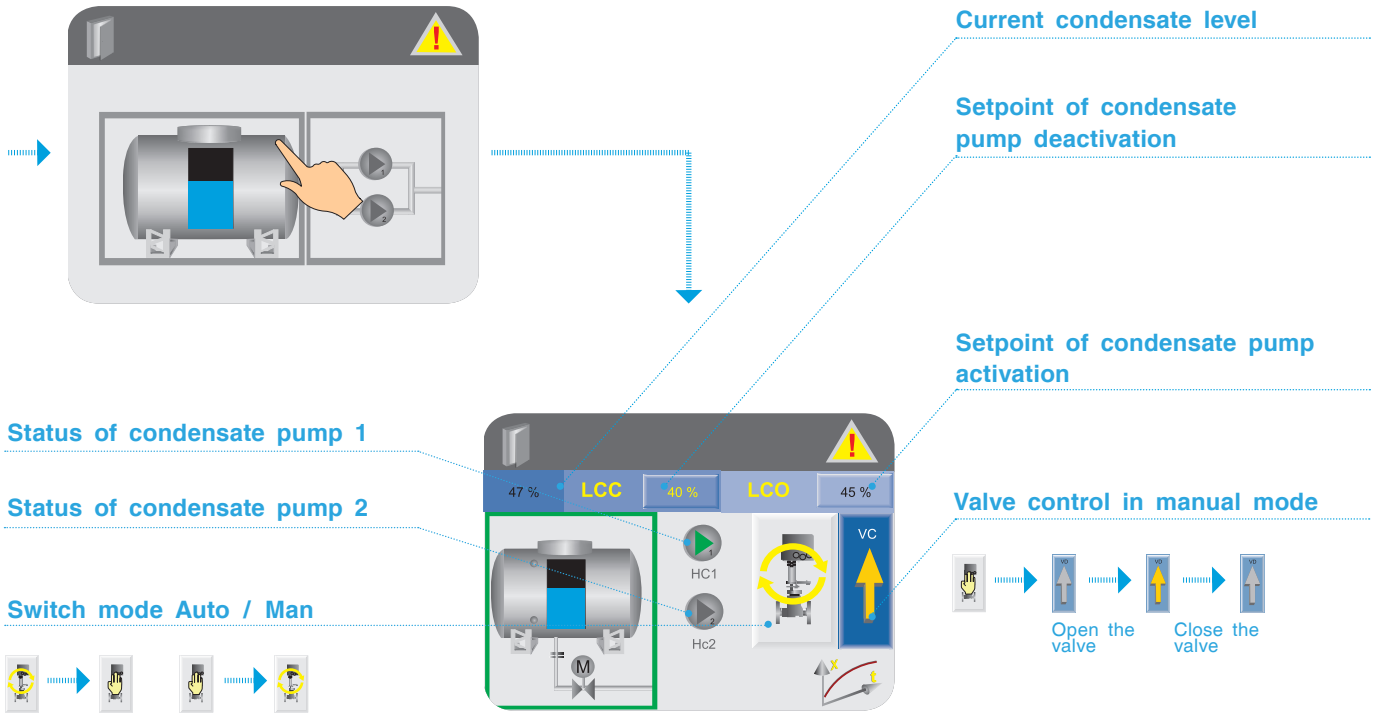
If the level drops below the minimum water level LCP (setpoint = 20 %), the control signal will deactivate the feed pumps to prevent dry run. If the level rises above LC (setpoint = 25 %), the feed pump will be activated. **Error message:** when the minimum water level is reached, a message will appear on the ESC screen and the incident will be recorded in the memory. The alarm is accompanied by a sound signal.

Functioning

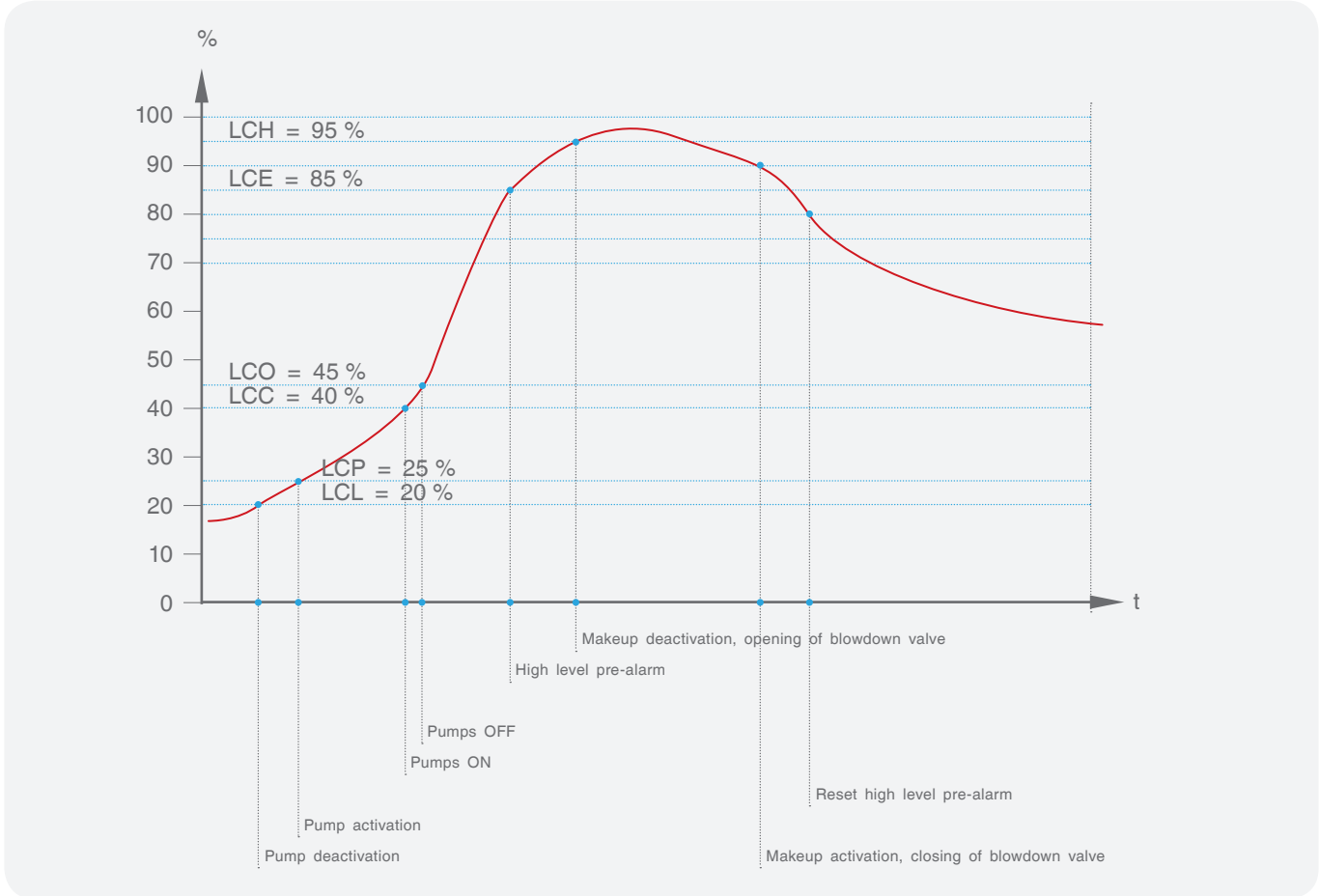




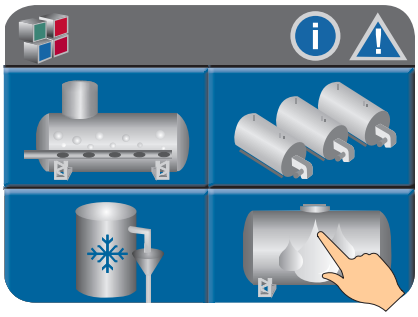
To go to the feed water deaeration control system from the main menu screen, press the condensate tank icon.

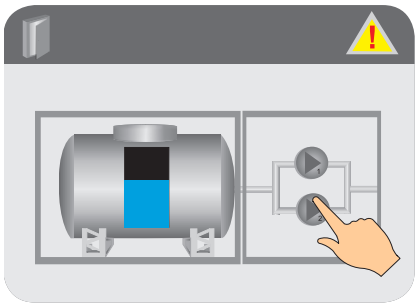


Condensate tank level control

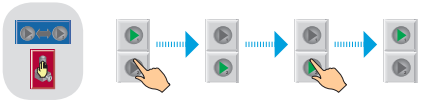


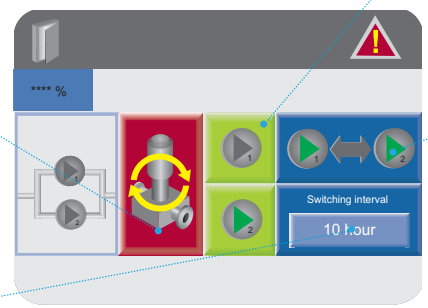
Condensate pump control



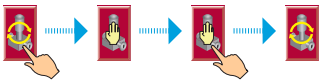


Switchover of pumps in automatic mode occurs according to Tc time or in case of failure of the active pump. If the automatic switchover mode is deactivated, the selection of active pump can be set manually.





Switch mode Auto / Man

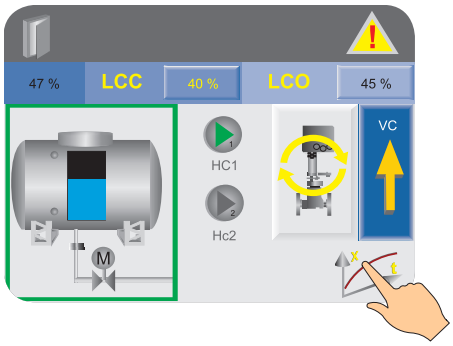


Select mode of automatic switchover by Tc time

Deactivate automatic switchover mode

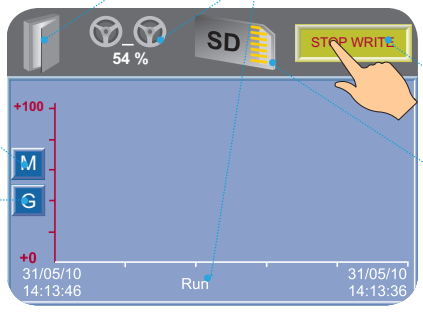
Pump switchover time

Condensate level trend LC



Exit

Trend operating indicator



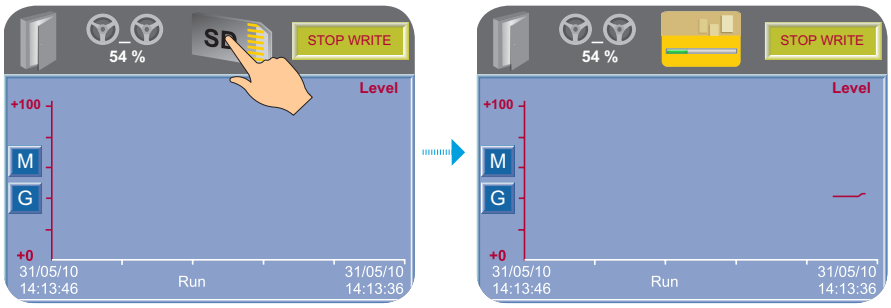
Scroll activation button

Button to display grid

Trend START / STOP button

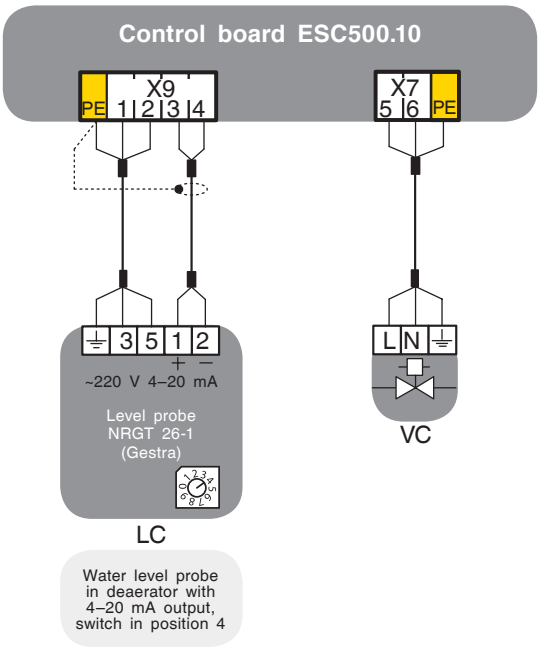
Indicator that SD card is in slot

Write trend to memory card



Insert the memory card into the slot. Run the trend by pressing the START button and then press the memory card icon — the trend will begin to write to the SD card. If the trend is deactivated, writing to the SD card will be stopped automatically.

Connection



COOLER TEMPERATURE REGULATION

Description of the structure and functions / Description of the process

The temperature sensor measures the temperature in the cooler tank (BEM) and converts it into an electrical signal (4–20 mA). This signal is processed by ESC (see Operating Manual IE400ESC, Page 3) and is evaluated depending on the selected control type. The valve for water cooling is controlled via the specified adjustable points for temperature switchover.

ESC opens and closes the control valve for water cooling by means of adjustable points for switchover by temperature:

Activation temperature TBO: 38 °C (the valve opens).
Deactivation temperature TBC: +35 °C (the valve closes).

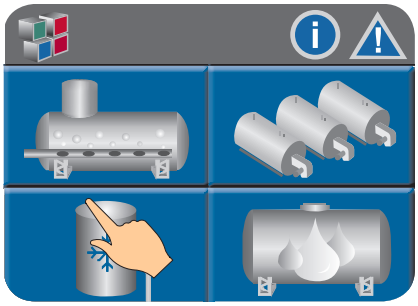
Automatic mode

The temperature range for activation and deactivation is limited in order to avoid malfunctions during operation and damage to the cooler and subsequent systems. You can set the values within the specified range.

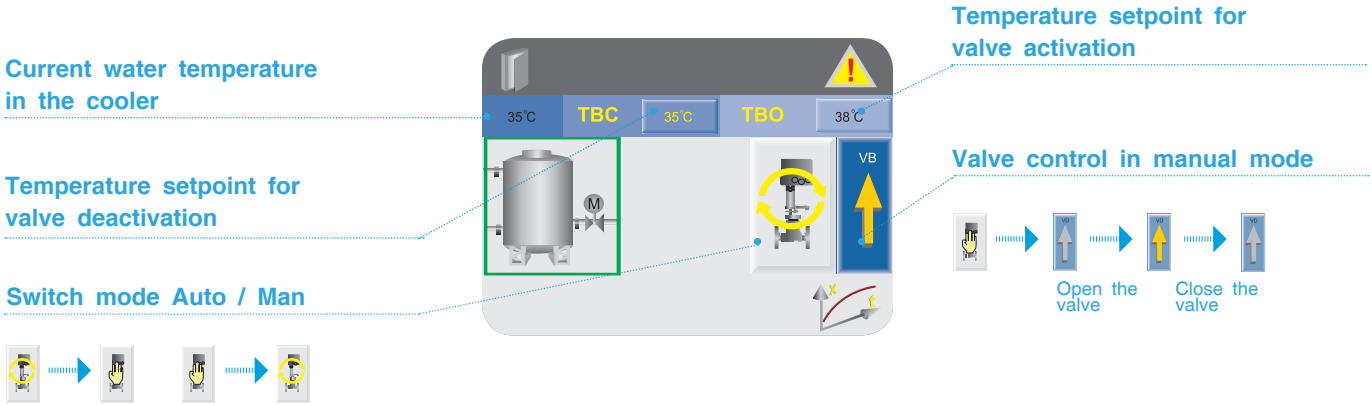
Manual mode

The control valve for water cooling can be open and closed. Temperature monitoring is not active in manual mode.

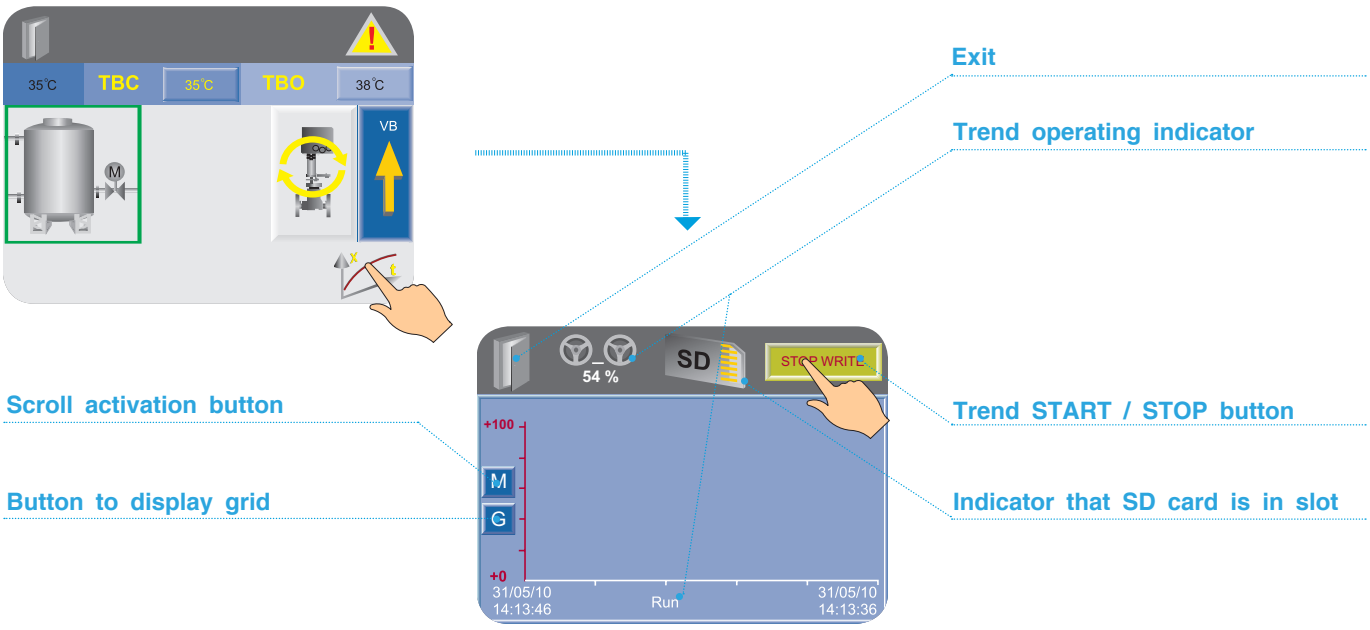
Functioning



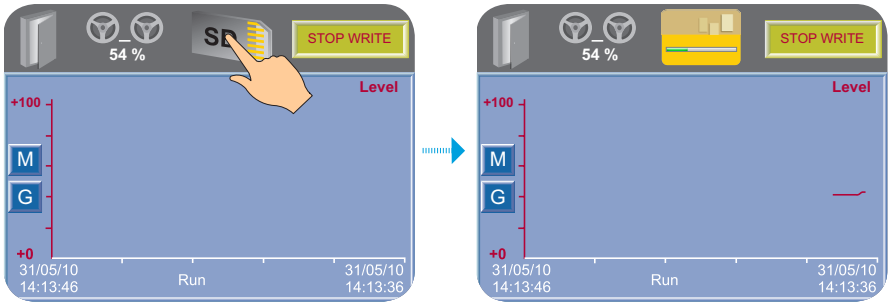
To go to the feed water deaeration control system from the main menu screen, press the Condensate tank icon.



Trend of water temperature in cooler TB

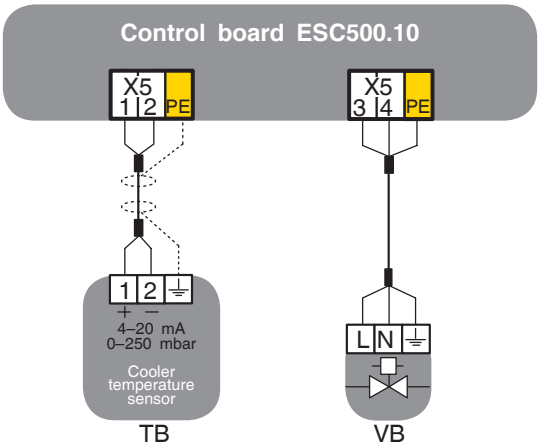


Write trend to memory card



Insert the memory card into the slot. Run the trend by pressing the START button and then press the memory card icon — the trend will begin to write to the SD card. If the trend is deactivated, writing to the SD card will be stopped automatically.

Connection



CASCADE CONTROL BY MASS STEAM FLOW-RATE

Description of the structure and functions / Description of the process

The task of controlling a sequence of boilers is activating the boilers in the amount necessary to cover the current needs for the steam. This can be solved by automatically connecting and disconnecting the boilers to/from the circuit in accordance with the sequential control criteria, thereby ensuring economic efficiency and careful operation of a multi-boiler system.

All boilers connected to sequential control must be separated from each other hydraulically by means of steam shutoff values in order to prevent the boilers interfering with each other in terms of flow-rate or pressure.

The controlled steam shutoff valve shall be installed between the boiler and the general steam network (distributor's steam). Electrical connection of the steam shutoff valve is performed to the corresponding terminals of the ESC boiler control system (see instruction IE540).

Steam volume measurement can be performed in the steam line of each boiler or in the common steam pipeline upstream of the first consumer outlet (this also applies to internal users and to internal boiler-house consumers (deaerator, etc.).

In the first case, the mass steam flow-rate of each boiler measured by the ESC system is transferred to ESC via the CANbus. When adding up all flow-rates, the total mass flow-rate can be transferred over Modbus protocol to the upper automation level.

In the second case, the mass flow-rate measurement takes place in the common steam pipeline upsteam of the first consumer. The values of steam volume and its temperature are received at ESC in the form of a standard 4–20 mA signal, the pressure value is taken from the digital bus of the master boiler. The total mass flow-rate calculated can be transferred according to Modbus protocol to the upper automation level.

Sequence control structure

Important! Each boiler integrated into the sequential control shall have a permanent number starting from 1.

Manual selection of master boiler

Any boiler can be selected as a master boiler on the ESC touchpad. The master boiler operates continuously (if serviceable) and regulates parameters initialized in its outlet controller. In manual mode it is possible to choose several master boilers which will thereby operate continuously.

Automatic selection of master boiler

In case of automatic selection, the number of operating hours of burners are compared. The boiler whose burner has the least operating hours shall be selected as the master boiler. In order to avoid changing the master boiler too frequently, the change shall not occur until the difference between the boiler with the highest number of burner operating hours and the boiler with the lowest number of burner operating hours exceeds the specified limit.

Slave boiler connection

The slave boiler is deactivated on the basis of the connection criteria specified on the ESC touchpad, i.e. the system will open the boiler steam shutoff valve in the following cases:

- when the total steam volume exceeds the specified value (S1 ON for the 1st slave boiler, F2 ON for the 2nd slave boiler, etc.);
- the specified time interval ts has expired (S1 for the 1st slave boiler, S2 for the 2nd slave boiler, etc.).

Attention! The recommended minimum delay time ts = 60 seconds. A delay time that is too short leads to unwanted connection and disconnection of slave boilers.

After hydraulic connection of boilers to the network

(steam shutoff valve is closed) and identical setup parameters of boiler operation controllers, the steam capacity of boilers in the network will be almost identical after a short period in operation.

In boiler plants with two-stage burners, the identical control of steam supply can function in an unstable manner because of strong load fluctuations. The sequential connection criterion shall be set up so that the slave boiler is connected with the master boiler capacity being at 60 % and over.

Slave boiler sequence

With the master boiler (or several master boilers in manual mode) selected, control over the sequence of other slave boilers is determined by the serial number of these boilers.

- Connection begins from the first slave boiler (with the lowest number) and continues in ascending order to the boiler with the highest number.
- Disconnection occurs in the reverse order.

Example:

- The boiler system consists of five boilers with an integrated system of cascade sequence control: from 1 to 5.
- Boiler 2 has been selected as the master boiler.
- The connection order of slave boilers in cascade control is as follows: boilers 1, 3, 4, 5.
- Disconnection order: boilers 5, 4, 3, 1.

Note: cascade automatic control of boilers is possible when the following conditions are met:

- AUTO mode has been selected on ESC touchpad for cascade operation;
- AUTO mode has been selected on ESC touchpad for steam shutoff valve operation.

Slave boiler connection

A slave boiler is connected to the network on the basis of the connection specified on the ESC touchpad, i.e

the system will close the controlled steam valve of boiler in the following cases:

- when the total steam volume drops below the specified value (S1 OFF for the 1st slave boiler, S2 OFF for the 2nd slave boiler, etc.);
- the specified time interval ts has expired (S1 for the 1st slave boiler, S2 for the 2nd slave boiler, etc.).

When the disconnection condition is met, the control steam valve of the boiler will close.

A slave boiler (limited by low load) is in the hot standby state with mean pressure PM2 until the next activation.

Action in case of boiler failure

In the event of slave boiler breakdown or disconnection, the boiler will be withdrawn from cascade control. The remaining slave boilers (if any) now move up in the cascade control order and are connected to the network by communication criteria as applicable.

If an error occurs in a slave boiler, the boiler will also be withdrawn from cascade control. The slave boiler with the lowest number of operating hours is connected to the network (unless it has already been connected to the network) and becomes a master boiler. Other slave boilers (if any) now move up in the sequence rank. If necessary, one of these boilers will also be connected to the network in accordance with the connection criterion.

Actions in the event of error during data transfer between ESC and EBC

Data exchange between ESC and EBC and everything that exists in the chain are continuously monitored on both sides.

When ESC detects a communication error, the system excludes the corresponding EBC and boiler from cascade control.

When EBC detects a communication error, it will connect the boiler to the steam network and use the boiler setup parameters.

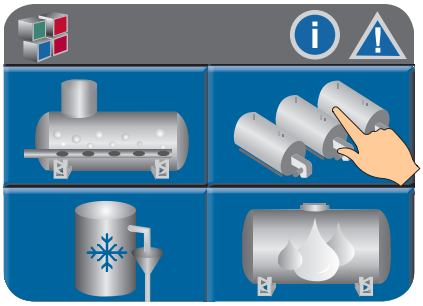
Functioning

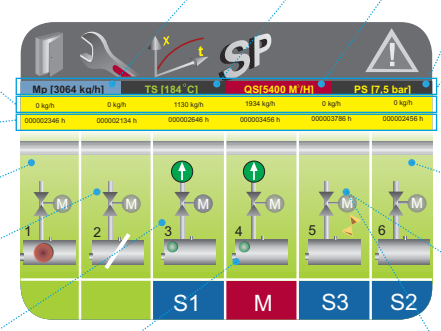
Instructions on how to operate the ESC touchpad are described in Operating Manual IE400 "Description of structure and functions / Description of process".

The exact image on the ESC touchpad depends on the complete set of delivery and the system configuration.

Basic diagram of boiler cascade control

The image below shows the information screen of cascade control:





Total mass flow-rate

Temperature in the common steam pipeline

Steam volume in the common steam pipeline

Pressure in the common steam pipeline

Steam assembly indications

Mass flow-rate by boiler (configuration without steam assembly)

Burner operating time by boiler

The boiler is disconnected from the network because of breakdown

The boiler is disconnected

The boiler is connected to the network, the burner is in operation

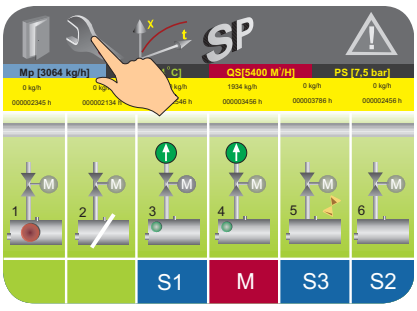
The boiler is connected to the network, the burner is not operating

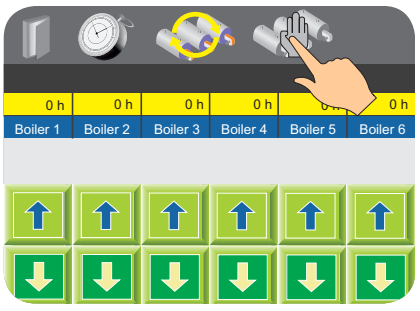
The boiler is disconnected from the network (pressure in the boiler is maintained by boiler automatic devices)

The value of steam mass is above the connection setpoint, the delay time ts is running

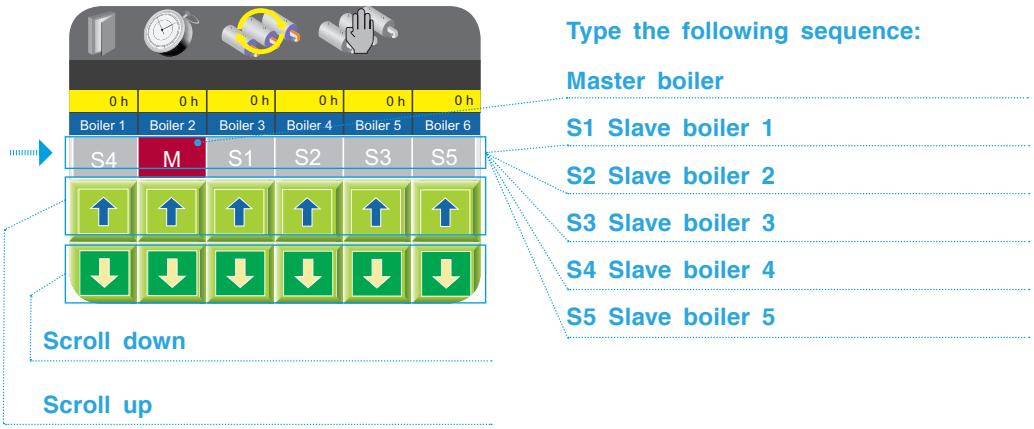
The steam mass value is below the disconnection setpoint, the delay time ts is running

Manual selection of cascade sequence

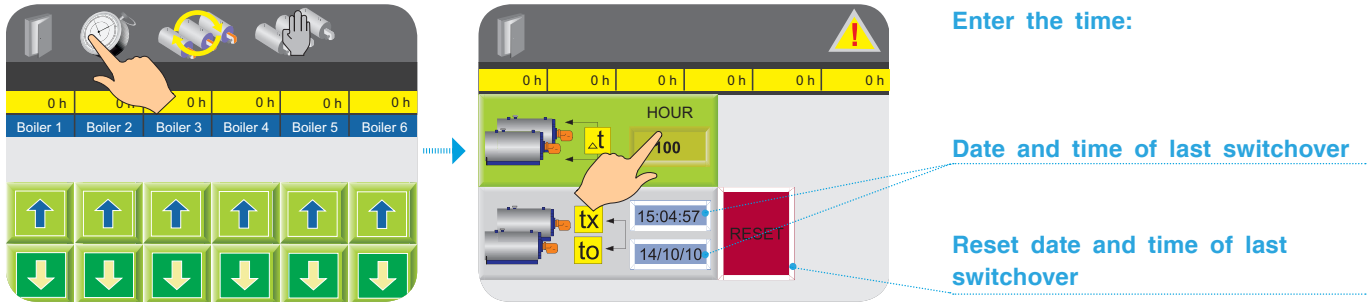




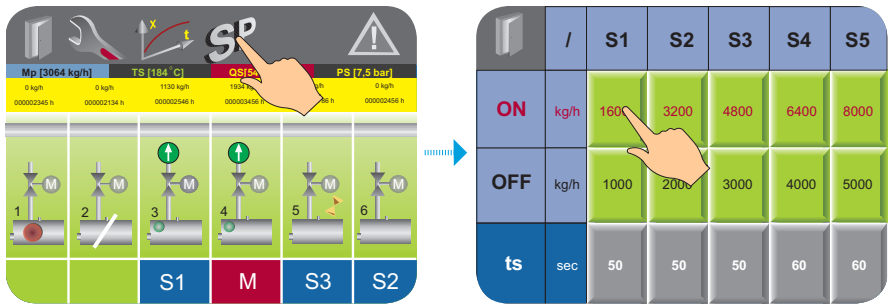
Select manual mode of the cascade



Cascade switchover time (automatic mode only)



Cascade control settings



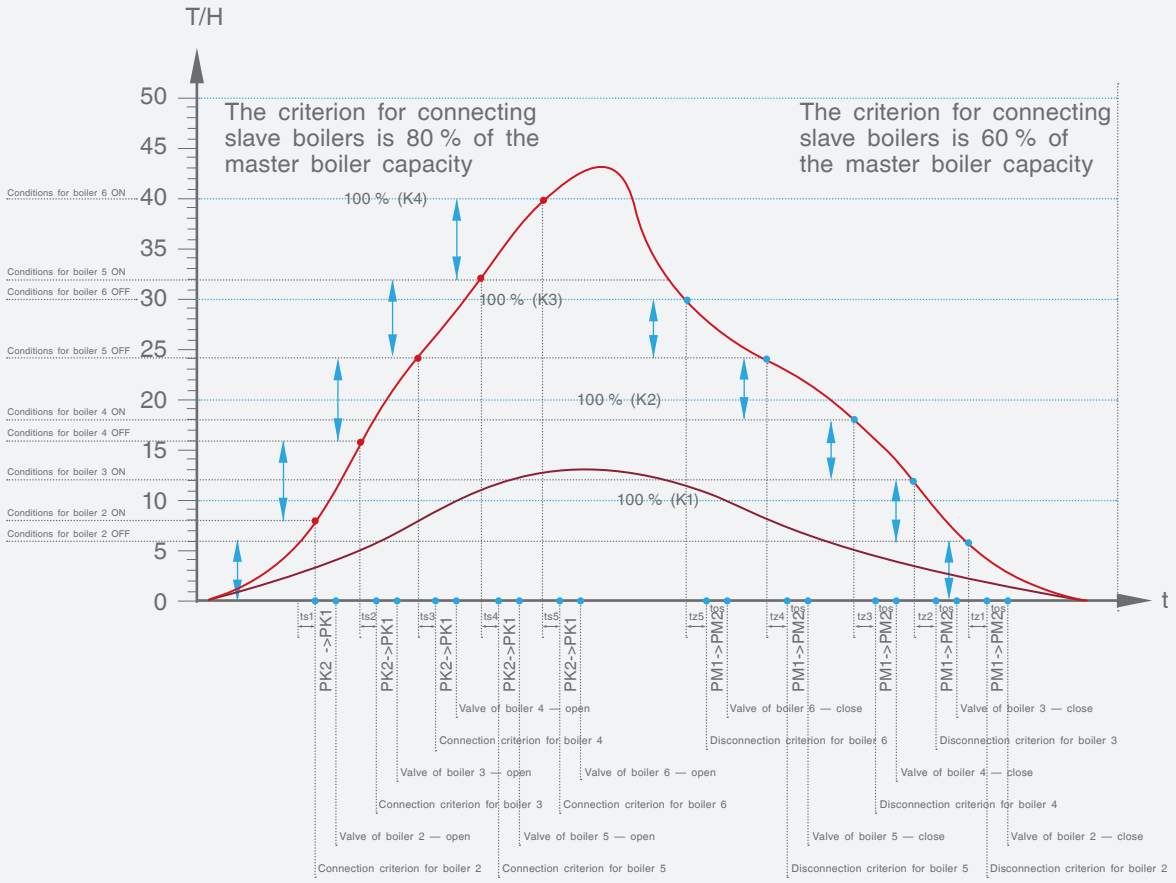
ON: steam volume in kg/h for connection of slave boilers from S1 to S5 (rank in accordance with applicable cascade control sequence).

OFF: steam volume in kg/h for disconnection of slave boilers from S1 to S5 (rank in accordance with applicable cascade control sequence).

ts: time delay of slave boiler connection to / disconnection from the steam network (rank in accordance with applicable cascade control sequence).

CASCADE CONTROL

by variation of steam volume and setpoint value for PM1 and PM2 switchover

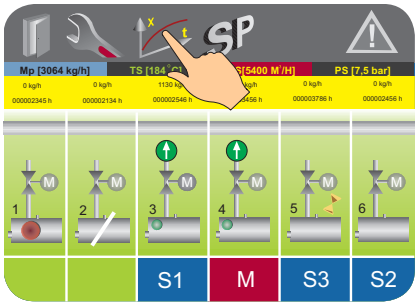


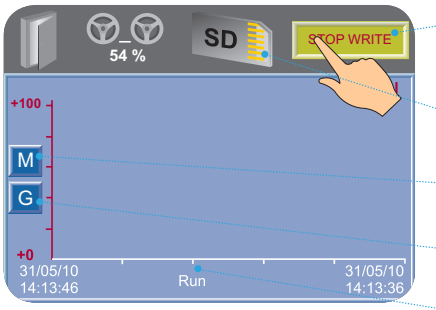
In the event that the criterion condition for disconnection (or breakdown) of the slave boiler is met, the steam shutoff valve will close after time interval ts in order to use the accumulated boiler power and disconnect the slave boiler as smoothly as possible.

The time delay between the slave boiler on/off condition and the slave boiler on/off criterion shall be no less than tz = 60 s so that the boiler isn't being turned on/off too quickly.

PK2 -> PK1 Transition of pressure in the boiler from working setting 2 to working setting 1.
PK1 -> PK2 Transition of pressure in the boiler from working setting 1 to working setting 2.

Trend of water temperature in cooler TB





Trend start / stop button

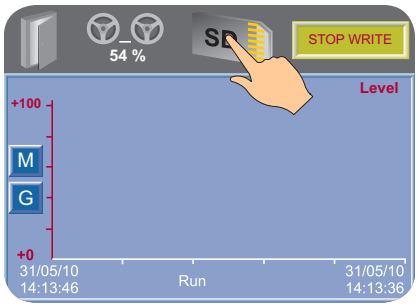
Indicator of SD card in slot

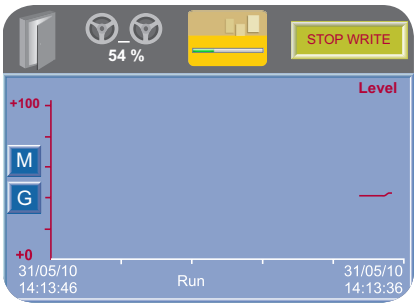
Scroll activation button

Button to display grid

Trend operating indicator

Write trend to memory card

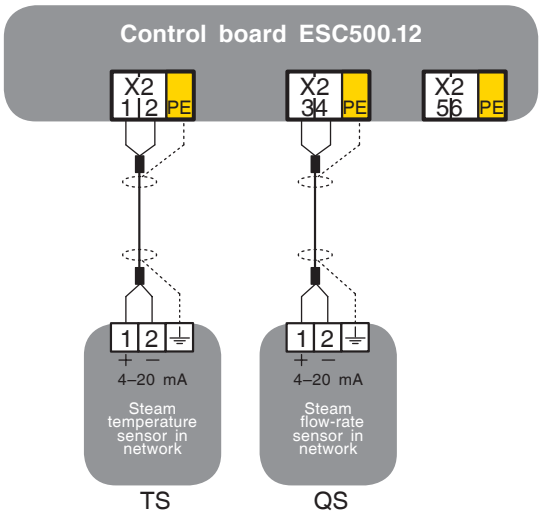




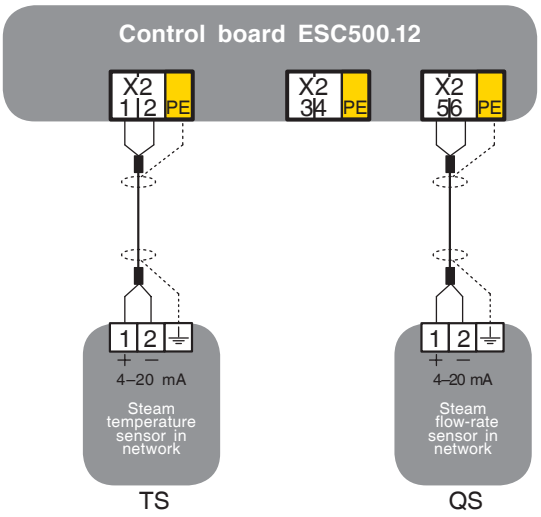
Insert the memory card into the slot. Run the trend by pressing the START button and then press the memory card icon — the trend will begin to write to the SD card. If the trend is deactivated, writing to the SD card will be stopped automatically.

Connection

Option 1
(if the 4–20 mA output of the flow-rate sensor is not active).

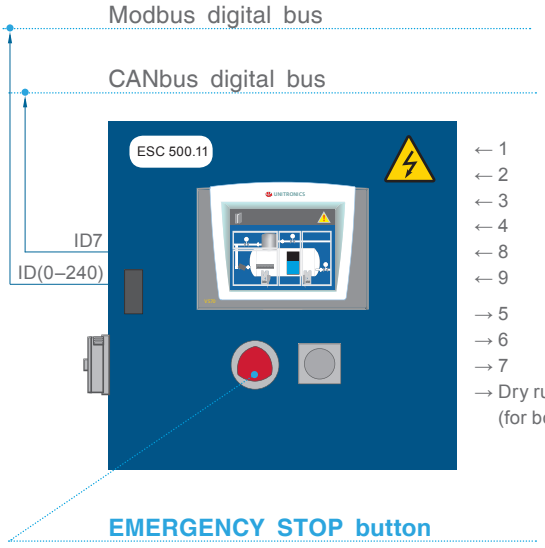


Option 2
(if the 4–20 mA output of the flow-rate sensor is active).



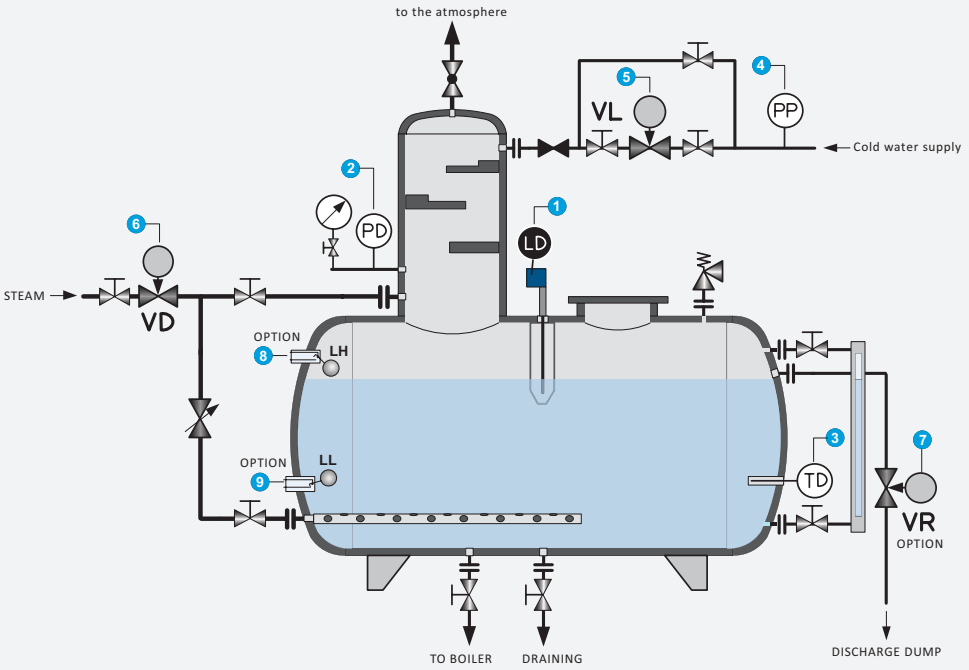
CONFIGURATION SCHEMES
SP200 Deaerator diagram options. Diagram No. 1

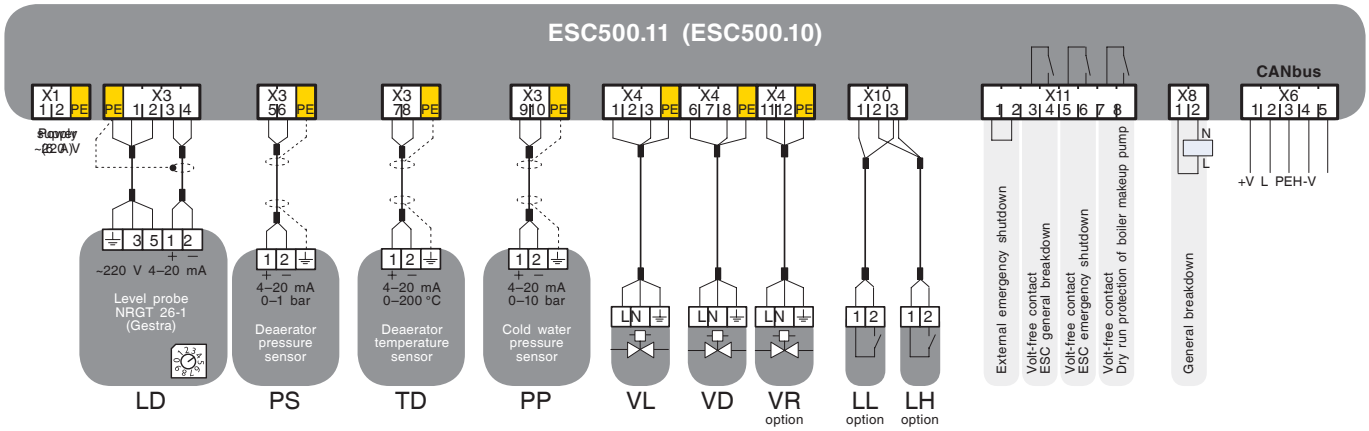
ESC control module 500.11 (ESC 500.10)



LD	Monitoring sensor of water level in the tank (4–20 mA)	
PD	Monitoring sensor of water pressure in the tank (4–20 mA)	
TD	Monitoring sensor of water temperature in the tank (4–20 mA)	
PP	Monitoring sensor of cold water supply pressure (4–20 мА)	
VL	Tank makeup control valve	
VD	Steam supply control valve	
VR	Blowdown control valve	
LH	Maximum level limiter	Additional protection
LL	Minimum level limiter	

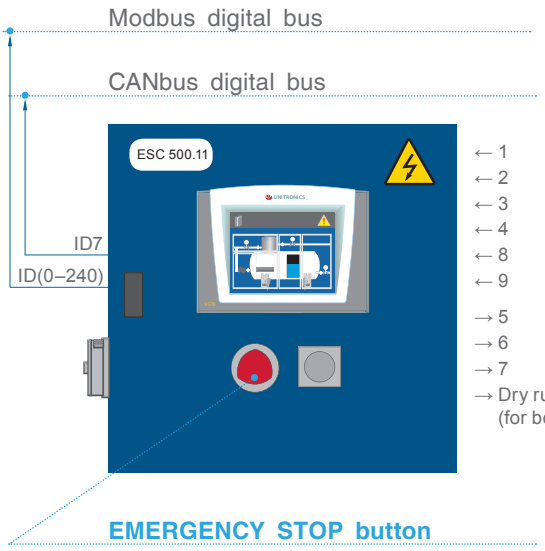
— Solenoid valve





CONFIGURATION SCHEMES
SP200 Deaerator diagram options. Diagram No. 5

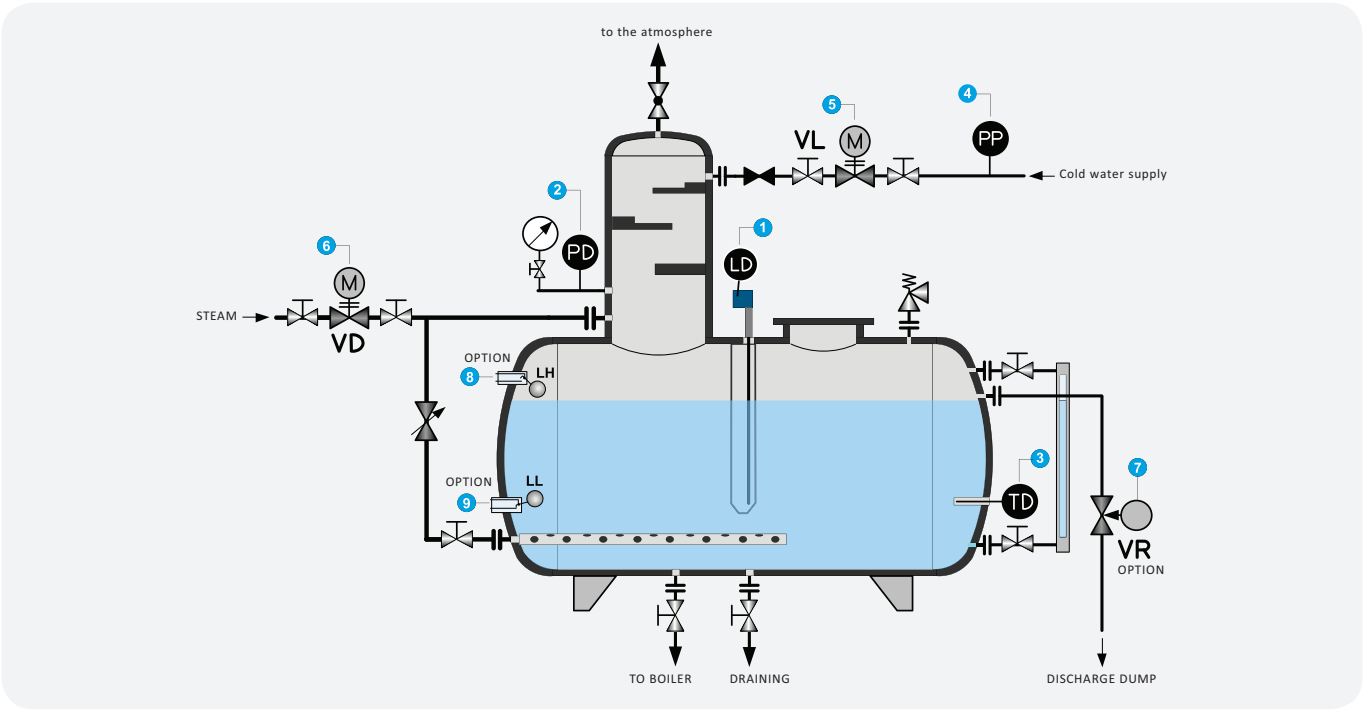
ESC control module 500.11 (ESC 500.10)

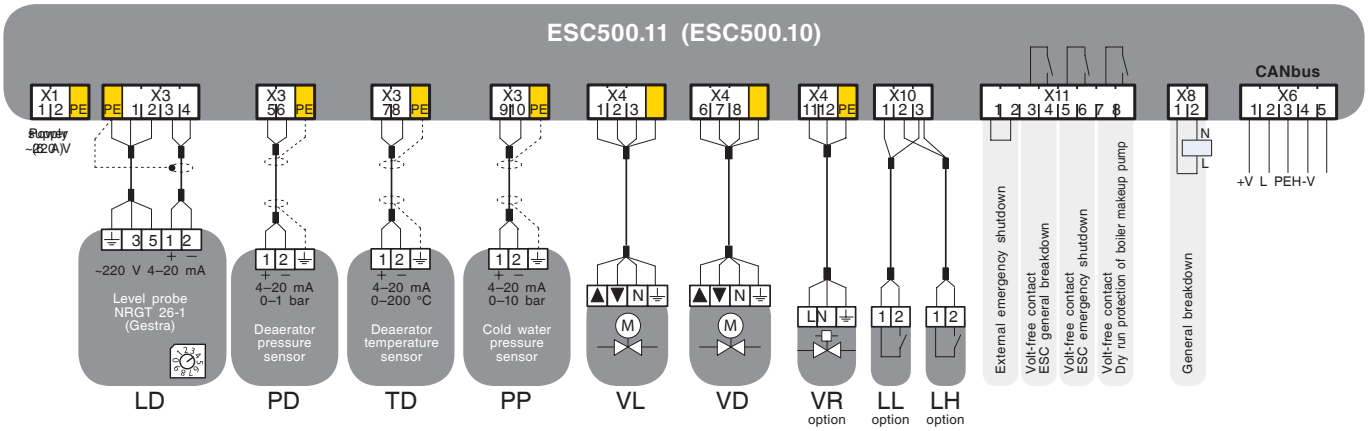


LD	Monitoring sensor of water level in the tank (4–20 mA)	
PD	Monitoring sensor of water pressure in the tank (4–20 mA)	
TD	Monitoring sensor of water temperature in the tank (4–20 mA)	
PP	Monitoring sensor of cold water supply pressure (4–20 мА)	
VL	Tank makeup control valve	
VD	Steam supply control valve	
VR	Blowdown control valve	
LH	Maximum level limiter	Additional protection
LL	Minimum level limiter	

— Solenoid valve

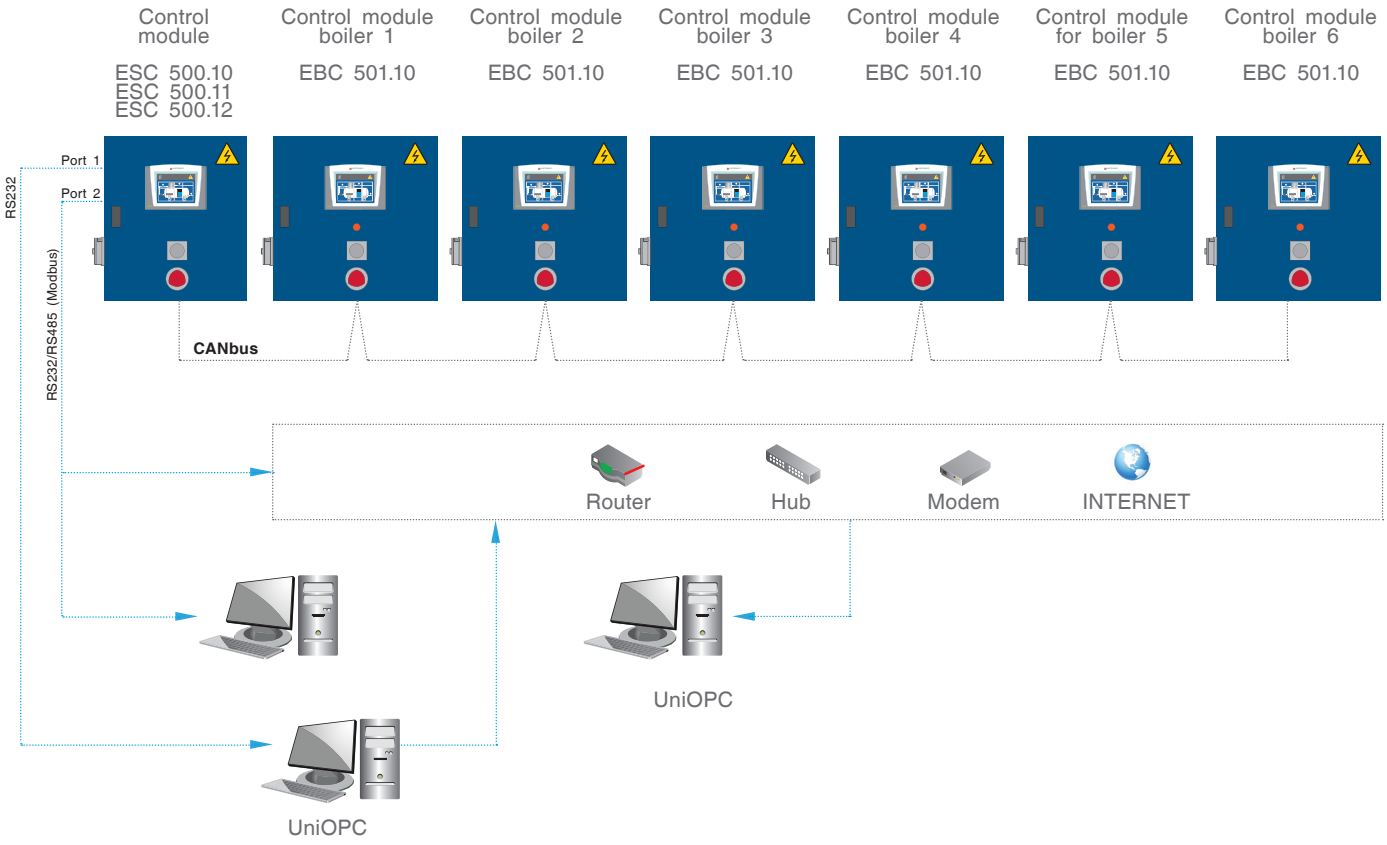
— Valve with actuator

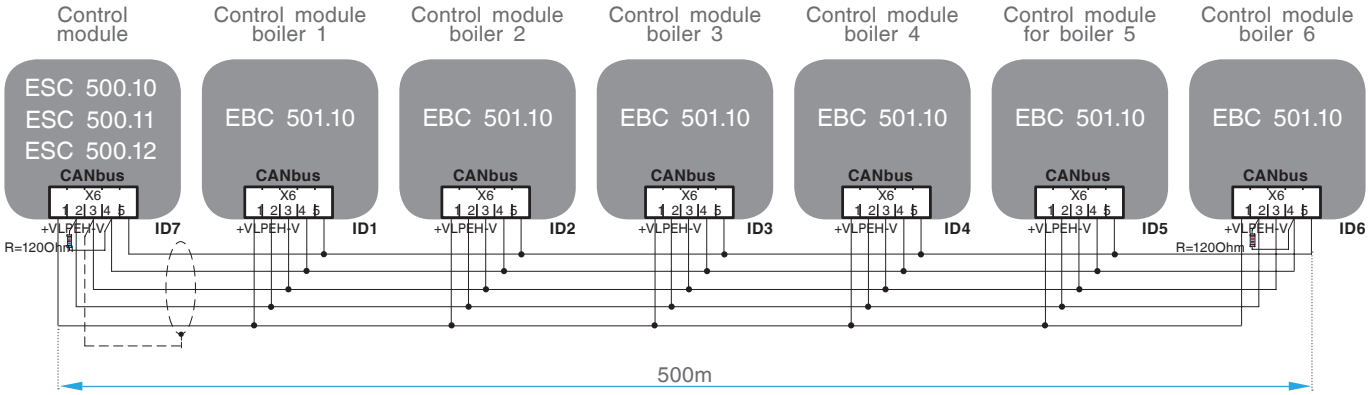




ENTROPIC

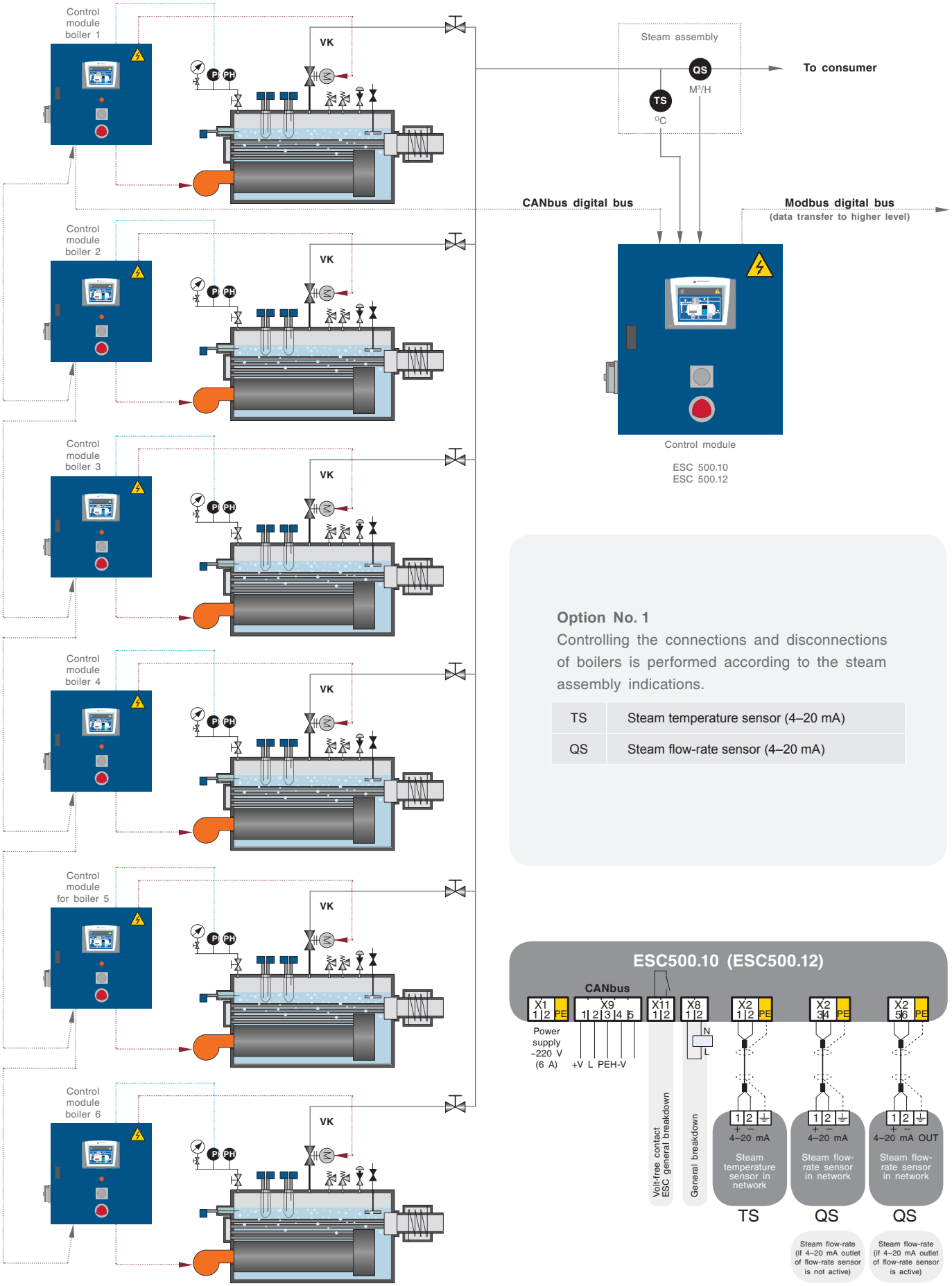
SP201 CANbus network diagram





SP201. CANbus connection diagram ESC 500.10, ESC 500.11, ESC 500.12

SP202 Cascade control diagrams

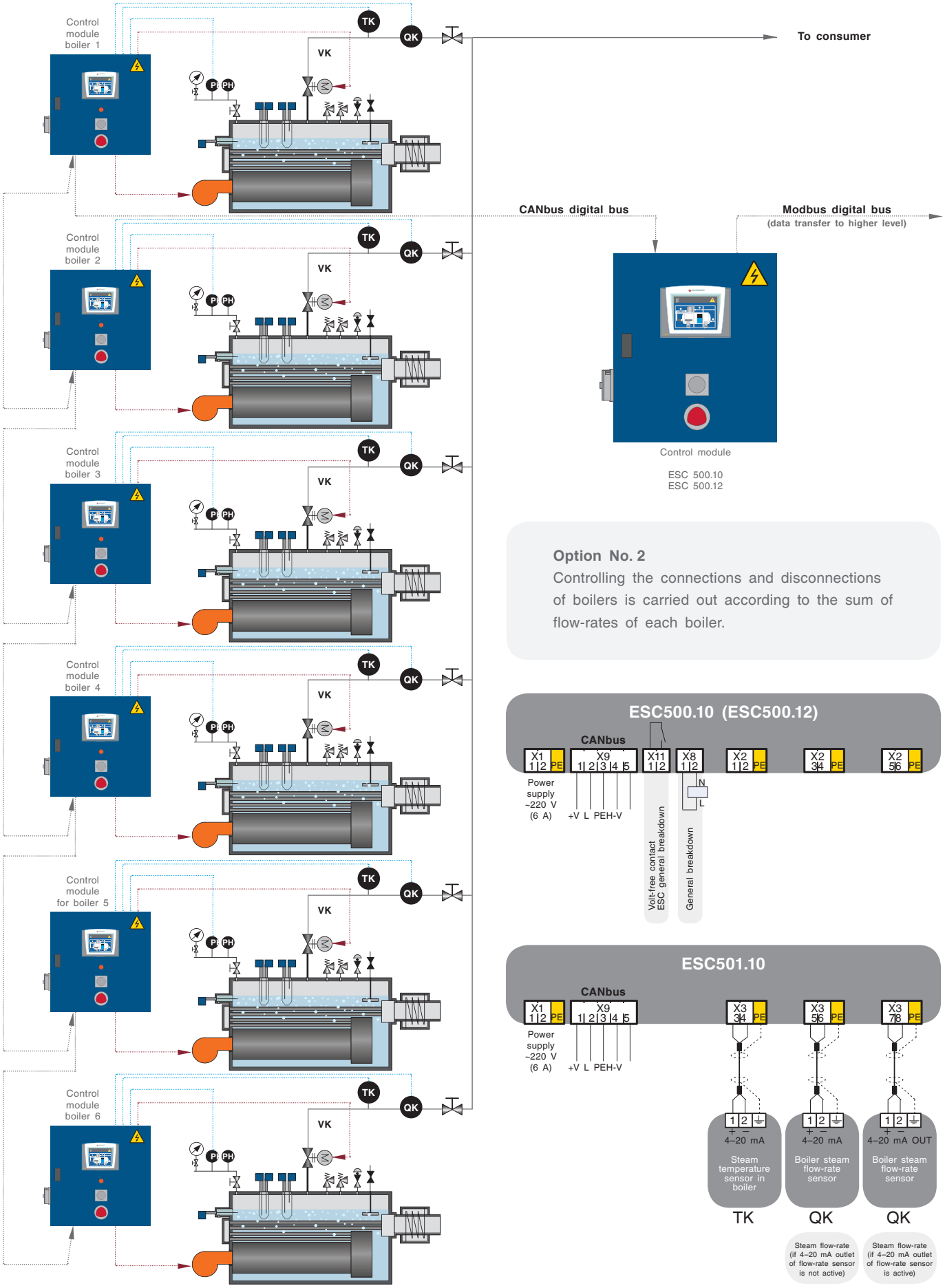


Option No. 1

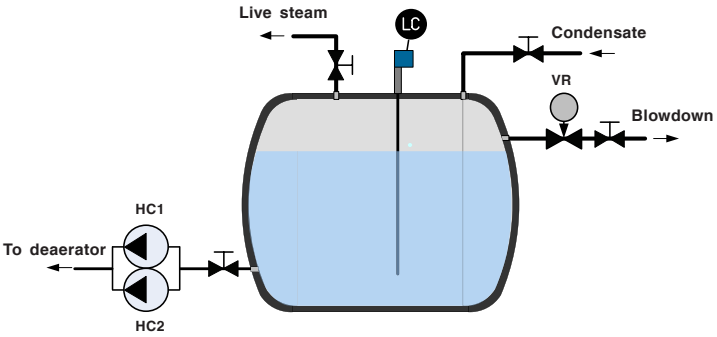
Controlling the connections and disconnections of boilers is performed according to the steam assembly indications.

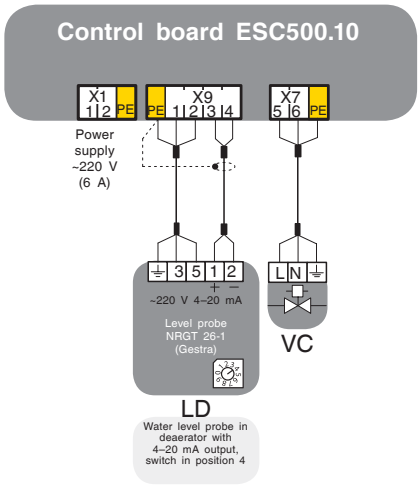
TS	Steam temperature sensor (4–20 mA)
QS	Steam flow-rate sensor (4–20 mA)

SP202 Cascade control diagrams



SP204 Condensate tank diagram

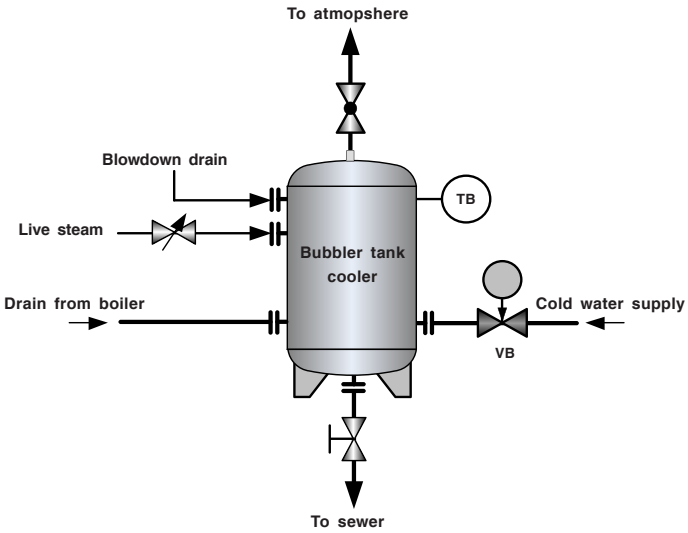


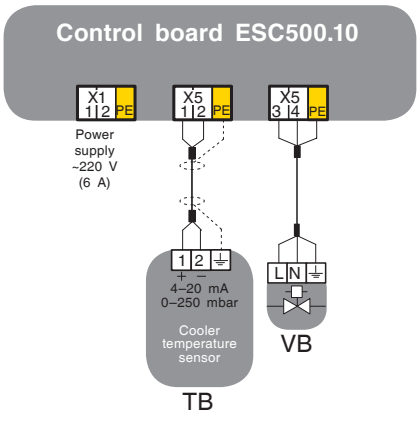


LC	Monitoring sensor of water level in condensate tank (4–20 mA)
VR	Solenoid valve for blowdown by maximum level
HC1	Condensate pump 1
HC2	Condensate pump 1

— Solenoid valve

SP205 Cooler diagram





TB	Cooler temperature monitoring sensor (4–20 mA)
VB	Solenoid valve for cold water supply

— Solenoid valve

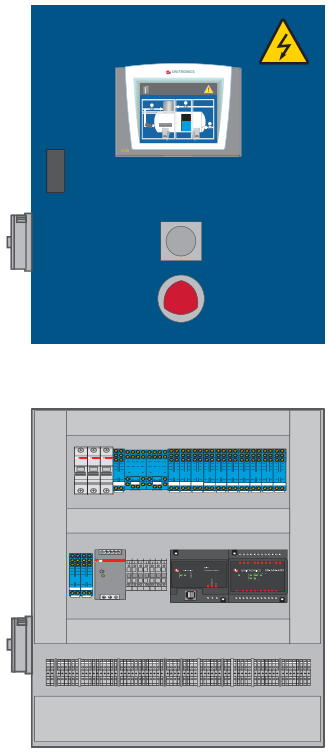
SETUP AND INSTALLATION INSTRUCTIONS IM100 ESC500 Plant

BOARD INSTALLATION

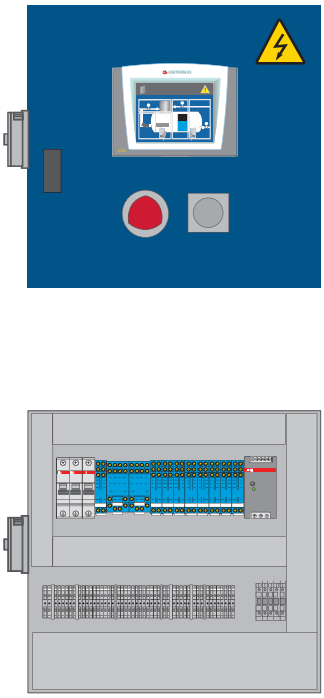
ESC 500 is a board (IP54) with the following equipment installed on it:

- Unitronics V570 controller.
- Safety units and control circuits.
- Switching equipment.
- Extension units.
- Power supply 24 V.

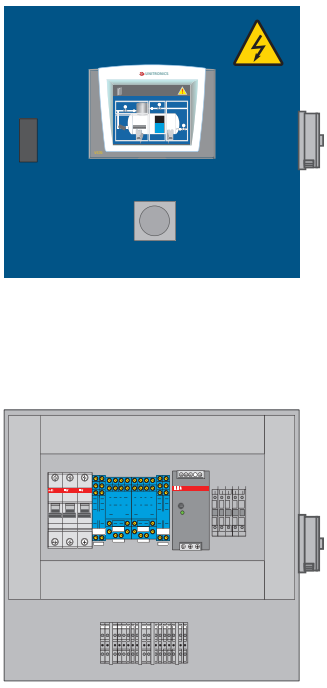
Before installing, check the board for external damage and corrosion. Open the board, check the fastening of all the display and control elements fitted on the board door.



Board ESC 500.10



Board ESC 500.11



Board ESC 500.12

Recommendations for board installation:

- Do not install in places subject to high temperatures, permanent impacts, or excessive vibration.
- Avoid water leaking into the product.
- Do not allow dirt to get into the product during installation.
- Recheck all wiring before turning on the power.
- Stay as far away from high voltage wires and power equipment as possible.
- Leave at least 150 mm of free space for ventilation between the upper and side walls of the board.
- After installing, remove all debris and dust from the board using a vacuum cleaner.

Power supply

ESC 500 is designed for operation in alternating current networks with voltage of 210–230 V. In some cases, the electricity is not always stable where the product is installed, and disturbances can cause voltage surges. Voltage surges and inconsistencies in electrical energy quality can cause the ESC to function incorrectly and can lead to system failure. In order to ensure reliable operation of the control system and protection against voltage surges and electromagnetic interference, it is recommended to install network filters or uninterruptible power supplies without sinusoid rupture during switchover.

Connectors

The connection points of input / outout, safety sensors, and burner control circuits shall be provided with terminal connectors installed on ESC board. They provide screw-type connection points for power supply, inputs and outputs.

For the ESC to function correctly, proper grounding is necessary. One pole of all control circuits and power supply circuits as well as the shield of the flexible screened cable shall be connected to the PE bus of the board.

- To avoid damage to the screw plug connectors and terminals, do not exceed the maximum torque on screws equal to 0.5 N•m (5 kgf•cm).
- We recommend using crimp-type lugs for wires.
- It is not permitted to lay the low voltage cables of the automation system together with the alternating current power cables.

For cables laid parallel, the minimum distance between them must be 100 mm, with 50 mm at intersections.

CONNECTION TO CANbus DIGITAL BUS

The CS ESC500, as MASTER in the multiple boiler system, allows to control a cascade of subordinate EBC control systems via the CANbus digital bus. In this network, CANbus allows data exchange between PLCs.

Technical requirements for CANbus
Requirements for power supply: direct current 24 V (±4 %) 40 mA max. (power supply is connected to ESC500). Galvanic isolation between CANbus and controller: the maximum length of network cable is as follows: 1 Mbps — 25 m, 500 Kbps — 100 m, 250 Kbps — 250 m, 125 Kbps — 500 m, 100 Kbps — 500 m.

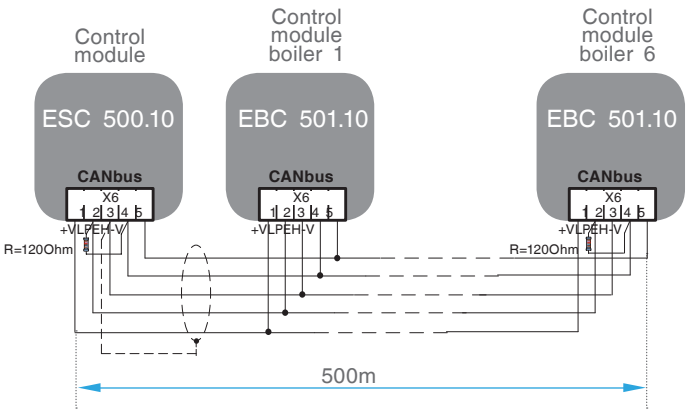
Recommendations for connection
Use twisted pair cabling. It is recommended to use a thick screened cable such as DeviceNet® twisted pair.

COMMISSIONING

Before power-up:

- check that external devices and sensors are connected correctly;
- switch on power supply;
- EOL resistor shall be installed at the beginning and end of the CANbus network;
- the protection shield shall be grounded on the side of the bus power supply (on ESC control system);
- the distance between the first network device and the last device shall not exceed 500 m.

Switch off power supply before connecting communication lines.



Data transfer over RS485 interface, Modbus protocol

General

Data shall be transferred to the upper level via controller port 2 according to Modbus protocol. On the ESC (EBC) touchpad, it is necessary to select which interface will be used for RS232 or RS485 data transfer and specify the ESC (EBC) address in the network (ID from 64 to 127).

Network topology and electrical diagram

The network topology is a multidrop bus. Each RS485 network includes 2 types of nodes; the nodes refer to each device physically connected to the network.

- End nodes: these devices are connected on both physical ends of the network, which contain network terminations.
- A node on the line: all devices connected to the network except end nodes.

To ensure a high data transfer speed over relatively long distances, the wires function as transmission channels. For this reason, network terminations must be installed at the end nodes in order to match impedances. For each device, an individual procedure has been described for installing network terminations.

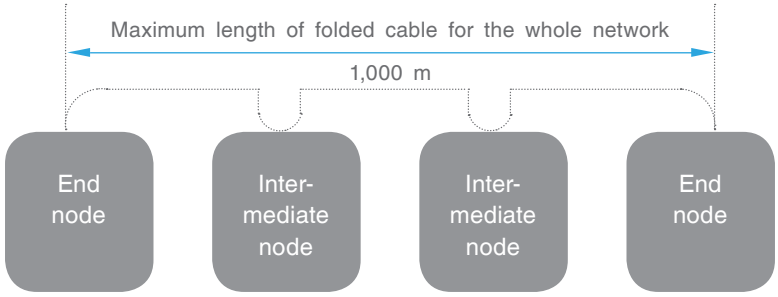
Diagram of wire connections of RS485 network

For network devices, use shielded twisted pair (STP) cables.

Recommended cable types are as follows:

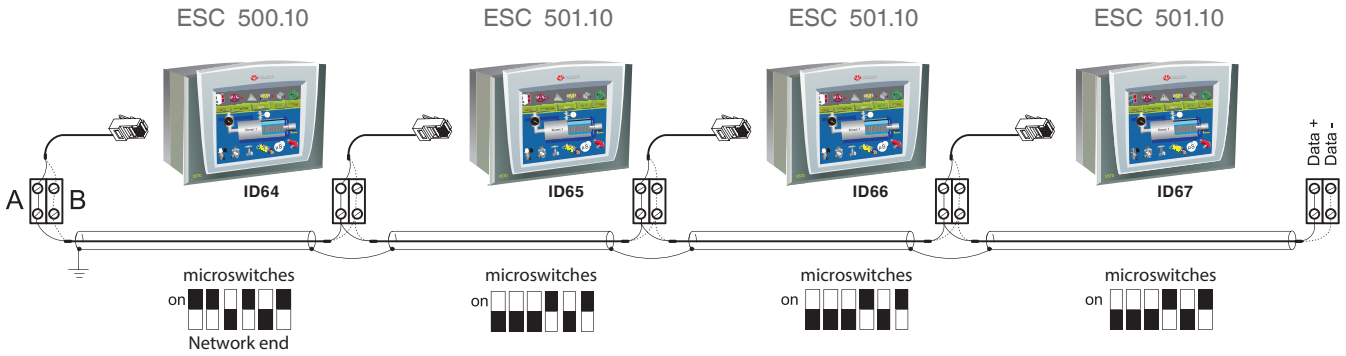
- Twinax Cable H8106. Control cable, standard 4001 (0.5 mm^2, twisted pair).
- Twinax Cable H3094. Control cable, type V45551-F21-B5 (1.5 mm^2, twisted pair).

The total length of all network cables cannot exceed 1,000 meters as shown below.



Principles of laying RS485 cables

- RS485 signals are NOT isolated. It is necessary to avoid a potential voltage exceeding ± 10 V. In order to avoid serious damage to the system, the ports of all non-isolated devices shall be compared to the same signal of 0 V.
- Minimize the length of sleeves (outlets) that lead from each device to the bus. The sleeve length shall not exceed 5 cm. Ideally, the main cable shall be connected and terminated from the device to be combined in the network as shown in the diagram below.

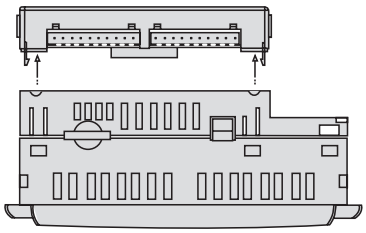


Do not establish conditions where positive (A) and negative (B) signals intersect. Positive outputs shall be connected using positive cables and negative outputs using negative cables.

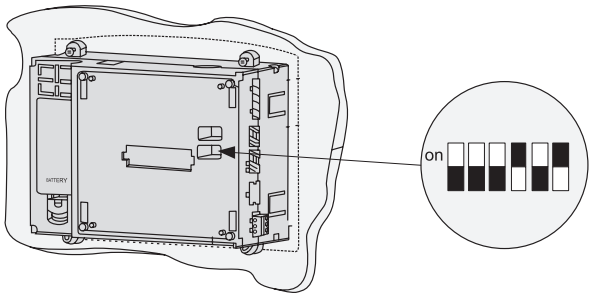
It is necessary to create network connection points by means of two terminal devices built into the network. Terminal devices are set by microswitches.

To install microswitches, perform the following:

1) Turn off ESC (EBC) power supply.
2) Remove the extension unit from the controller.



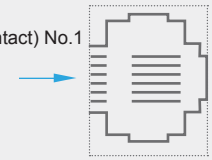
3) Install mocroswitches for port 2 in ON position



The jumper settings shown above determine the controller's ability to perform the functions of the terminal device in the RS485 network. Please note that the default factory setting is YES. If the OPLC (operator's PLC) is not a terminal network device, install both jumpers in the NO position.

4) Install the extension unit.

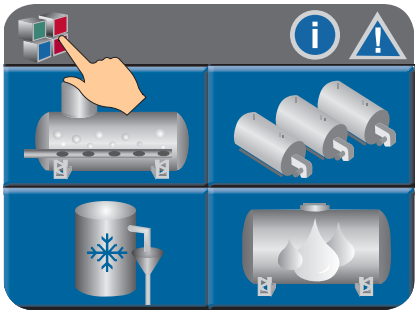
Connection to port

RS485 Port 2		Controller port
Output No.	Description	
1	Signal A (+)	Output (contact) No.1 
2	RS 232 signal	
3	RS 232 signal	
4	RS 232 signal	
5	RS 232 signal	
6	Signal B (-)	

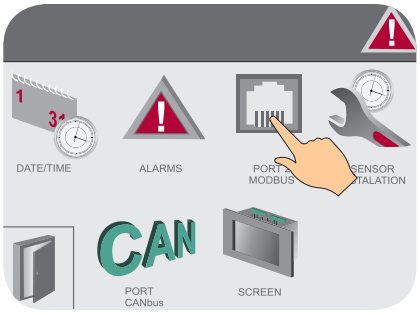
Connection parameters:

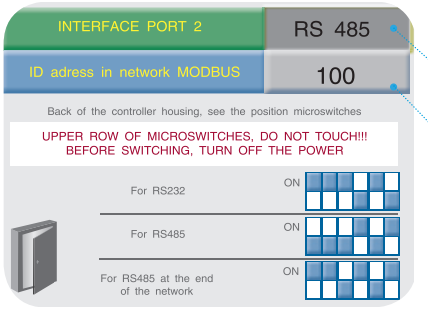
- speed — 9,600
- number of inf. bits — 8
- stop-bit 1
- parity check — NO
- parity — NO

Functioning



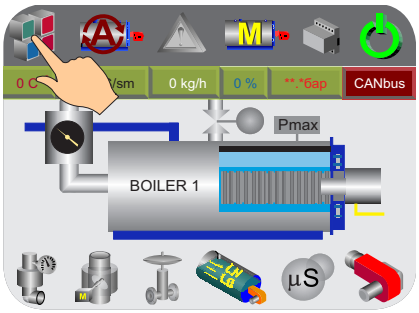
Port setup for ESC500



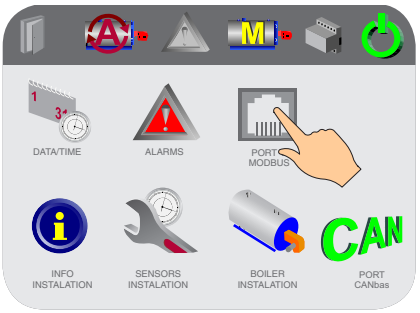


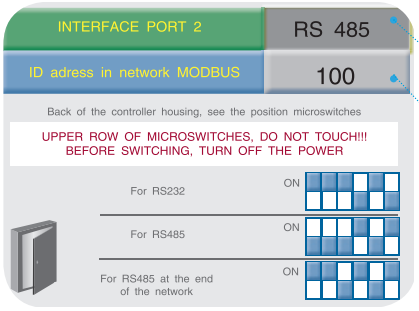
Select interface

Set address in Modbus network



Port setup for ESC501





Select interface

Set address in Modbus network

Database for data to be transferred according to Modbus protocol to ESC500 control system (Port 2)

Parameter designation	Physical INPUT/OUTPUT	PURPOSE	Address Modbus	Data type	Connection
VL_open (VL1-ON/OFF)	00	Deaerator makeup valve OPEN (Valve 1 ON/OFF)	16384	BIT	
VL_close (VL2-ON/OFF)	01	Deaerator makeup valve CLOSE (Valve 2 ON/OFF)	16385	BIT	
VR_ON/OFF	02	Deaerator water blowdown valve	16386	BIT	
VD_open (ON/OFF)	03	Deaerator steam supply valve OPEN (ON/OF)	16387	BIT	
VD_close	04	Deaerator steam supply valve CLOSE	16388	BIT	
	05	Protection of boiler makeup pumps from dry run	16389	BIT	
VT_ON/OFF	06	Deaerator water heating valve ON/OFF	16390	BIT	
VB_ON/OFF	07	Cooler valve ON/OFF	16391	BIT	
HC1_ON/OFF	08	Condensate pump 1 ON/OFF	16392	BIT	
HC2_ON/OFF	09	Condensate pump 2 ON/OFF	16393	BIT	
VC_ON/OFF	010	Condensate blowdown valve ON/OFF	16394	BIT	
Alarm_OUT	016	General breakdown output to speaker	16400	BIT	
LD_PV	AN0	Current water level in deaerator (%)	122	INT	
PD_PV	AN1	Current pressure in deaerator (kPa)	17	INT	
TD_PV	AN3	Current water temperature in deaerator	108	INT	
PP_PV	AI3	Current cold water supply pressure in makeup line (kPa)	128	INT	
TS_PV	AI0	Temperature in the common steam pipeline	15	INT	
QS_PV	AI1	Steam flow-rate in common steam pipeline (m3/h)	16	INT	
PS_PV		Steam pressure in common steam pipeline (kPa)	9	INT	
Ms_PV		Steam mass flow-rate in common steam pipeline (kg/h)	14	INT	
LC_PV	AI4	Current water level in condensate tank (%)	147	INT	
TB_PV	AI2	Current temperature in the cooler	125	INT	
POWER_ESC	I0	ESC board power supply	0	BIT	

STOP_ESC	I1	ESC emergency stop	1	BIT	
LH_IN	I2	Minimum level in deaerator	2	BIT	
LL_IN	I3	Maximum level in deaerator	3	BIT	
HC1_ALM	I4	Breakdown of condensate pump 1	4	BIT	
HC2_ALM	I5	Breakdown of condensate pump 2	5	BIT	
HC1_WOR	I6	Operation of condensate pump 1	6	BIT	
HC2_WOR	I7	Operation of condensate pump 2	7	BIT	
LD_ALM		Break of deaerator level sensor	20	BIT	
TS_ALM		Break of temperature sensor in general steam pipeline	18	BIT	
QS_ALM		Break of flow-rate sensor in general steam pipeline	19	BIT	
LC_ALM		Break of condensate tank level sensor	56	BIT	
PD_ALM		Break of deaerator pressure sensor	119	BIT	
TD_ALM		Break of deaerator temperature sensor	120	BIT	
TB_ALM		Break of cooler temperature sensor	128	BIT	
PP_ALM		Break of cold water supply pressure sensor	130	BIT	
LDH_ALM		Minimum level in deaerator	82	BIT	
LDL_ALM		Maximum level in deaerator	77	BIT	
PDL_ALM		Minimum pressure in deaerator	12420	BIT	
TDL_ALM		Minimum temperature in deaerator	12422	BIT	
CAN_K1_ALM		CANbus_No communication with boiler 1	112	BIT	
CAN_K2_ALM		CANbus_No communication with boiler 2	113	BIT	
CAN_K3_ALM		CANbus_No communication with boiler 3	114	BIT	
CAN_K4_ALM		CANbus_No communication with boiler 4	115	BIT	

CAN_K5_ALM		CANbus_No communication with boiler 5	116	BIT	
CAN_K5_ALM		CANbus_No communication with boiler 6	117	BIT	
REQ_K1		Boiler 1 request	12322	BIT	
REQ_K2		Boiler 2 request	12338	BIT	
REQ_K3		Boiler 3 request	12354	BIT	
REQ_K4		Boiler 4 request	12370	BIT	
REQ_K5		Boiler 5 request	12386	BIT	
REQ_K6		Boiler 6 request	12402	BIT	
STAT_K1		Status of boiler 1 in cascade	3901	INT	
STAT_K2		Status of boiler 2 in cascade	3917	INT	
STAT_K3		Status of boiler 3 in cascade	3933	INT	
STAT_K4		Status of boiler 4 in cascade	3949	INT	
STAT_K5		Status of boiler 5 in cascade	3965	INT	
STAT_K6		Status of boiler 6 in cascade	3981	INT	

Status of boiler in cascade			
Register		Number	Number assigned
3901		0	Master (M)
3917		1	Slave 1 (S1)
3933	=	2	Slave 2 (S2)
3949		3	Slave 3 (S3)
3965		4	Slave 4 (S4)
3981		5	Slave 5 (S5)

Data base for data to be transferred according to Modbus protocol to ESC500 control system (Port 2)

Parameter designation	Physical INPUT/OUTPUT	PURPOSE	Address Modbus	Data type	Connection
HK1_ON/OFF	O0	Pump 1 of boiler makeup (ON/OFF)	16384	BIT	
HK2_ON/OFF	O1	Pump 2 of boiler makeup (ON/OFF)	16385	BIT	
	O2	Interlocking by high salt content in water	16386	BIT	
Alarm_OUT	O4	General breakdown output to speaker	16388	BIT	
VP_ON/OFF	O5	Periodic purge valve (ON/OFF)	16389	BIT	
VE_OPEN/CLOSE	O6	Desalination valve OPEN/CLOSE	16390	BIT	
VE_MIDLE	O7	Desalination valve MIDDLE position	16391	BIT	
VF_open (ON/OFF)	O8	Boiler makeup valve OPEN (ON/OFF)	16392	BIT	
VF_close	O9	Boiler makeup valve CLOSE	16393	BIT	
Ist_ON/OFF	O10	First stage of burner ON/OFF	16394	BIT	
IIst_open (IIst_ON/OFF)	O11	Second stage of burner OPEN (ON/OFF)	16395	BIT	
IIst_close (IIIst_ON/OFF)	O12	Second stage of burner CLOSE (Third stage ON/OFF)	16396	BIT	
VK_open	O13	Boiler steam shutoff valve OPEN	16397	BIT	
VK_close	O14	Boiler steam shutoff valve CLOSE	16398	BIT	
VG_open	O15	Economizer valve (damper) OPEN	16399	BIT	
VG_close	O16	Economizer valve (damper) CLOSE	16400	BIT	
PK_PV	AN1	Current boiler pressure (kPa)	4083	INT	
LK_PV	AN0	Current water level in boiler (%)	4082	INT	
EK_PV	AN2	Current electrical conductivity of water (mS)	4084	INT	
TG_PV	AI0	Current off-gas temperature	4085	INT	
TK_PV	AI1	Steam temperature at boiler outlet	4086	INT	
QK_PV	AI2	Steam flow-rate at boiler outlet (m^3/h)	4087	INT	
MK_PV		Steam mass flow-rate in boiler (kg/h)	4088	INT	

LK_SP		Setpoint of water level in boiler (%)	4089	INT	
PK_SP		Current pressure setpoint in boiler (kPa)	4090	INT	
EK_SP		Setpoint of water conductivity in boiler (mS)	4091	INT	
PK1_SP		Setpoint of pressure in boiler operating mode (kPa)	50	INT	
PK2_SP		Setpoint of pressure in boiler standby mode (kPa)	51	INT	
PKmin_SP		Minimum permissible pressure in boiler (kPa)	12342	INT	
HK_OUT		Value of 4–20 mA output to VSD (variable speed drive) of makeup pump	186	INT	
BR_LIF		Burner operating time (h)	28678	INT	
POWER_EBC	I0	EBC board power supply	0	BIT	
STOP_EBC	I1	EBC emergency stop	1	BIT	
LL1_ALM	I2	Interlocking by sensor 1 for limitation of minimum level in boiler	2	BIT	
LL2_ALM	I3	Interlocking by sensor 2 for limitation of minimum level in boiler	3	BIT	
PH_ALM	I4	Interlocking by limiter of maximum boiler pressure	4	BIT	
SUM_ALM	I5	Safety circuit. External boiler interlocking	5	BIT	
BR_ALM	I6	Burner breakdown	6	BIT	
BR_WOR	I7	Burner operation	7	BIT	
HK1_ALM	I8	Breakdown of makeup pump 1	8	BIT	
HK2_ALM	I9	Breakdown of makeup pump 2	9	BIT	
HK_STOP	I10	Interlocking of pumps by dry run	10	BIT	
HK1_WOR	I11	Operation of makeup pump 1	11	BIT	
HK2_WOR	I12	Operation of makeup pump 2	12	BIT	
LH_ALM	I13	Interlocking by limiter of maximum boiler level	13	BIT	
BRI_REQ		Burner stage I request	12339	BIT	
BRII_REQ		Burner stage II request	12340	BIT	
BRIII_REQ		Burner stage III request	12341	BIT	
BR_MOD		Burner operating mode 0-Auto, 1-Man	40	BIT	

LK30_ALM		Pre-alarm of minimum level in boiler (30 %)	75	BIT	
LK85_ALM		Pre-alarm of maximum level in boiler (85 %)	76	BIT	
LK98_ALM		Interlocking of makeup by level (98 %)	77	BIT	
RELE_ON/OFF		Disconnection of control outputs	39	BIT	
BOL_NET		Request to connect boiler to network	12357	BIT	
CAN_ALM		CANbus_No communication with ESC	12402	BIT	
I/O_EXP		Extension units are not connected	12403	BIT	
LK_ALM		Break of LK level sensor	12404	BIT	
PK_ALM		Break of PK pressure sensor	12405	BIT	
EK_ALM		Break of EK conductivity sensor	12406	BIT	
TG_ALM		Break of off-gas temperature sensor TG	12407	BIT	
TK_ALM		Break of steam temperature sensor TK	12408	BIT	
QK_ALM		Break of steam flow-rate sensor QK	12409	BIT	
EK97_ALM		Pre-alarm of maximum conductivity	12400	BIT	
EKmax_ALM		Interlocking by maximum conductivity	12401	BIT	

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