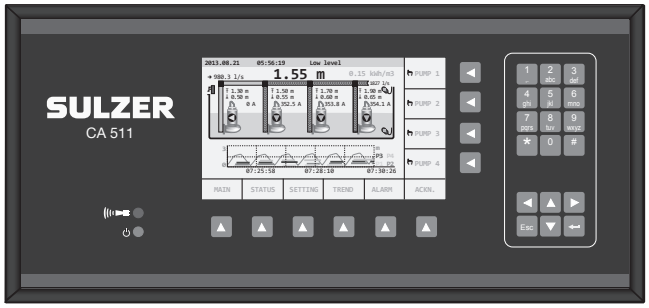
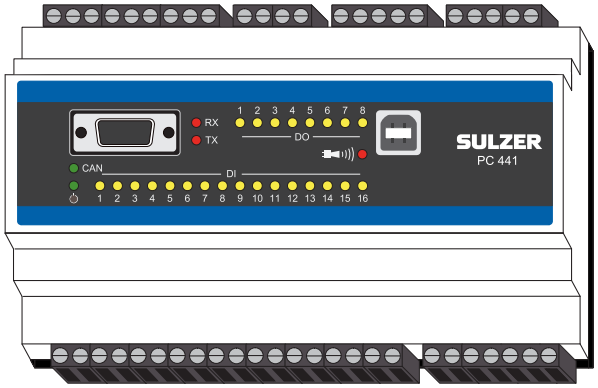
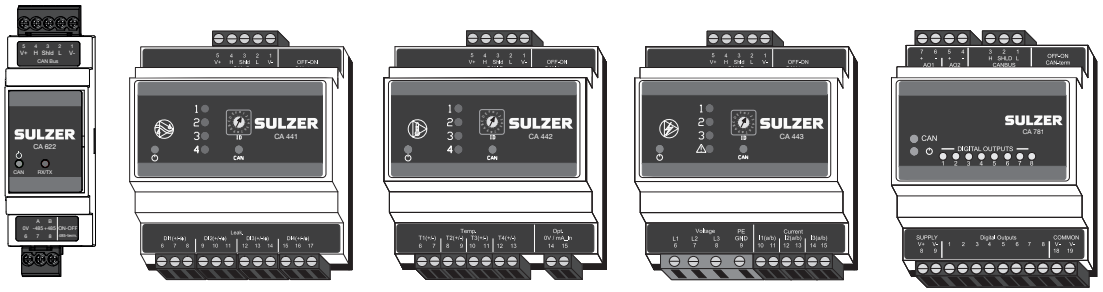
Pump controller type ABS PC 441







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User guide SW 1.70

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ABOUT THIS GUIDE, AUDIENCE AND CONCEPTS

This guide describes the pump controller PC 441 and the operator panel CA 511. The pump controllers can either be used stand-alone or communicate all values and conditions to a central Scada system or a web based alarm and monitoring solution like AquaWeb from Sulzer.

Installation guide

There is a separate document *Installation guide* that describes how to physically install the pump controller (printed document in the installation package, and also a PDF on Sulzer web).

Audience

This guide is intended for system administrators and operators of PC 441 pump controller with operator panel CA 511 or PC program AquaProg.

Prerequisites

This guide assumes that you already are acquainted with those pumps you are set to control and have the sensors and operator panel CA 511 connected to PC 441.

The system administrator must also know and decide on the following:

1. The pump controller can either use an analog level-sensor, which measures the water level in the pit, for precise control over start and stop levels, or it can use simple float switches placed at start and stop levels.
   - Float switches can be used in addition to an analog level-sensor, as a backup, and as an additional alarm input.
   - An analog level-sensor has several advantages over float switches: it is more robust (can not get stuck or be mechanically jammed); it is more accurate; it is more flexible (you can easily change the start and stop levels); you can get readings of the water level in the pit, the inflow, overflow and the pump capacity; you can optimise the pump performance in various ways, including exercising, alternative stop levels, tariff control etc.
   - It is also possible to employ an alternative stop level, usually a lower level than normal, that is effective once after a number of pump starts. This can be useful if it is desirable to “completely” empty the pit once in a while.
2. You need to know if the pump(s) should be exercised in case of long idle periods. If the installation has two pumps or more, you need to decide if the pumps should alternate.
3. If the electricity has daily varying tariffs, you must know the times of high/low tariffs.
4. You must know how overflow will be measured: if it will be measured using both an overflow detector (to detect the start of the overflow) and a level sensor (to measure the actual flow), you must know the parameters (exponents and constants) to be entered as settings so that the overflow can be accurately measured by a calculation in PC 441.
5. You need to know which alarm class, A-alarm or B-alarm (see Glossary and conventions), to assign each alarm.

Reading guide

For installation, see the separate documents *Installation guides* for respective product, PC 441, CA 511, CA 44x, CA 622 and CA 781, which can be found on Sulzer home page. Before you make any settings, or use the control panel, read chapter 1 Overview of functions and usage —it describes the general functionality and the meaning and usage of the controls on the panel.

The system administrator must ensure that all settings according to chapter 6 Settings are suitable for your application.

NOTE!

The default settings are listed in the *Installation guide*.

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Text appearing and declaration in this guide

Text in *italic* is a description of text in the display of CA 511 or a description how you find your way through the menus by key strokes. Texts in **bold**, is how you have to do a change of the settings in the CA 511 menu.

Most settings in chapter 6 only apply to the system administrator, but the following also apply to those who only operate the controller: language selection, date and time settings, units, backlight time-out, buzzer, operator pass code, start/stop levels.

Glossary and conventions

To designate a menu item in a hierarchy, an angle bracket is used to separate the levels. Example: *Settings* > *System* means the menu item you reach by first choosing the menu item *Settings*, which has a number of submenus, where you choose the menu item *System*.

Text in blue indicates a hypertext link. If you read this document on a computer, you can click on the item, which will take you to the link destination.

Pump exercising: Long idle periods in a corrosive contaminated environment are not good for pumps. As a countermeasure, they can be “exercised” at regular intervals, which will reduce corrosion and other detrimental effects.

Cos* j*: Cosine of the phase angle j between the motor current and the voltage.

Alarm class: The alarm class can be either A-alarm or B-alarm. A-alarms are those that require immediate action, so operational staff in the field should be alerted regardless of the time of day. B-alarms are less important, but should be taken care of during normal work hours.

Digital in means a signal that is either *on* or *off* (*high* or *low*), where *high* is anything between 5 and 24 volts DC, and *low* is anything below 2 volts.

Digital output An output signal that is either *on* or *off*.
At *on* condition output current is sourced from the power supply and the output is high (~V+). At *off* condition the output is low (no output current).
Are typically connected to relays.

Analog outputs An output signal in the range 4-20 mA or 0-20 mA.
Sourced from power supply.

Analog inputs are for sensors, and these inputs sense current in the range 4-20 mA or 0-20 mA.

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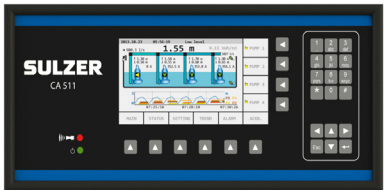
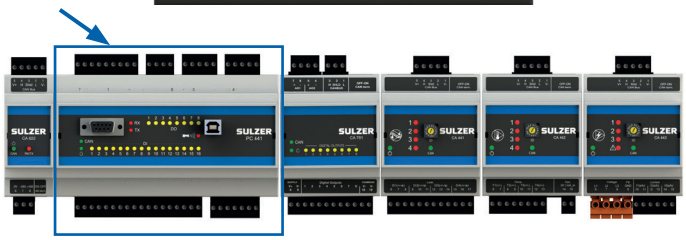
1 OVERVIEW OF FUNCTIONS AND USAGE

PC 441 is designed to control 1-4 pumps. It can operate a pump station stand alone and/ or as a pump monitor. For configuration and operator interaction the graphic operator panel CA 511 may be used. With the AquaProg software (evaluation version available) a PC can be used for configuration and back up of settings. By adding a modem, a full remote alarm and monitoring solution can be achieved with just an AquaWeb rental contract or by most SCADA systems. Optional monitoring modules for leakage, temperature and electrical parameters gives a highly scalable solution for optimal cost and performance.

The PC 441 can work standalone or together with extension modules, but the extension modules cannot work without the PC 441.

PC 441 is the heart of the system! Other modules are optional.





As a pump monitoring device the PC 441 offers the market a combined standard solution for submersible pump and pump station surveillance. Can be set up for full-scale monitoring of one or up to four submersible pumps plus ancillaries.

As a pump controller the PC 441 controls the start/stop of the pumps, offering a standardized solution for sewage pump stations with up to four pumps. A variety of solutions from standard on/off control up to advanced VFD support including pump capacity calculation.

As a combined control and monitoring device the PC 441 can be offered as a solution supporting both the areas above in a single unit.

Modules:

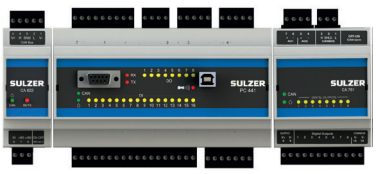
1. CA 511 - Graphical operator interface
Max 1 of this unit per system

1.

2. CA 622 - RS 485 Communication interface module
Max 1 of this unit per system

3. PC 441 - Pump monitoring and/or controller

4. CA 781 - Analog and digital out expansion module
Max 1 of this unit per system

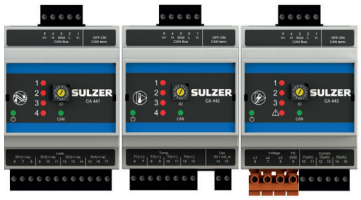


2. 3. 4.

5. CA 441 - Moisture monitoring module
Max 4 of this unit per system

6. CA 442 - Temperature monitoring module
Max 6 of this unit per system

7. CA 443 - Motor and supply power monitoring module
Max 5 of this unit per system



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8. Sulzer wireless modem
Max 1 unit per system

The base unit, PC 441, communicates with the extension modules via CAN communication.
See the installation guide how to connect the extension modules. A fully extended system can look like this:

Up to 4 pumps via 16 Din, 16 Dout, 5 Ain, 4 Aout
3 moisture and 5 temperature inputs per pump

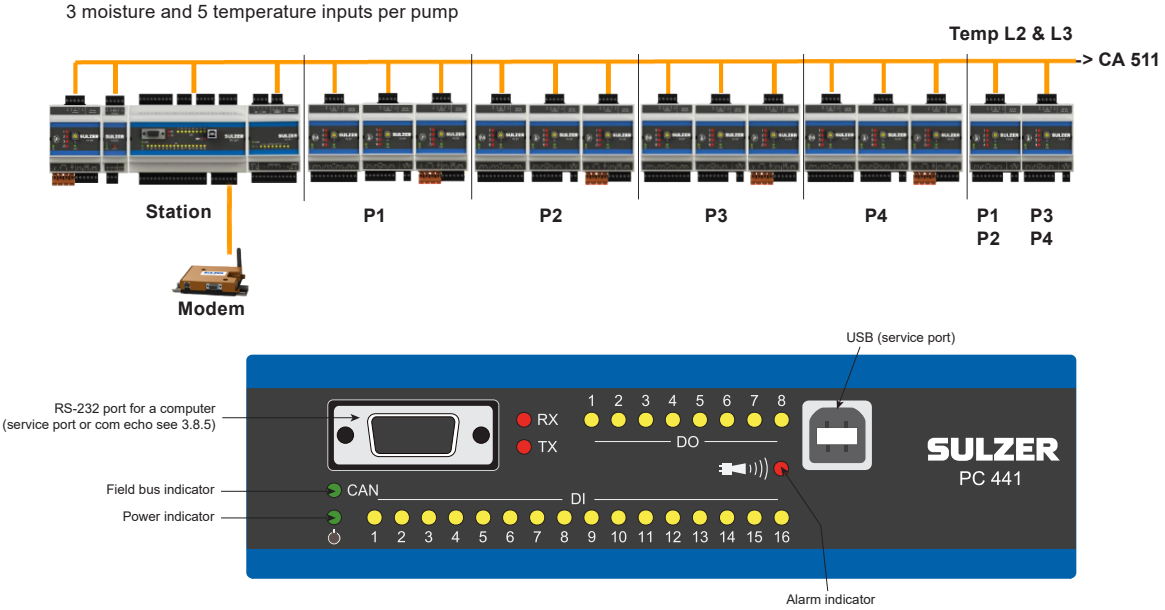

Figure 1-1 A green lamp at the very left indicates that the unit is powered (either battery or mains). The red alarm indicator will blink whenever there is an unacknowledged alarm.

1.1 *Field bus status indicator*

Pump controller, operator panel and monitoring modules communicates via a CAN bus.

Fixed green light = connected OK
Flashing green light = searching for modules
Flashing red light = Invalid ID set on module

1.2 *CA 511 operator panel*

You navigate the menus by the arrow buttons. Press either the *Up* or *Down* arrow button to switch to the menu view. You confirm an operation with the *Enter* button, or acknowledge an alarm. Pressing the *Escape* button will cancel the current operation.

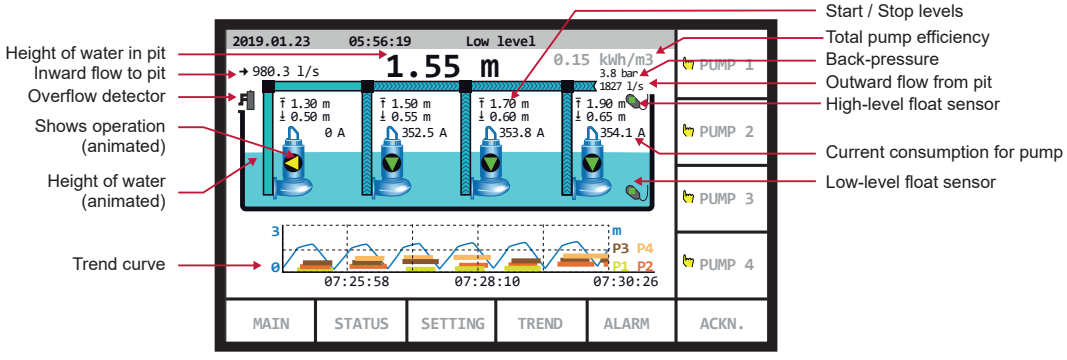

Figure 1-2 The display and its information fields in the default top-level view.

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The default (top-level) view of the display dynamically shows the operating status of the pumps and conditions in the pit. Figure 1-2 shows the symbols and explains their meanings. The unit will always revert to this view after 10 minutes of inactivity in any other view (such as showing menus).

When PC 441 is set to use less than 4 pumps, the view adapts to show actual number of pumps.

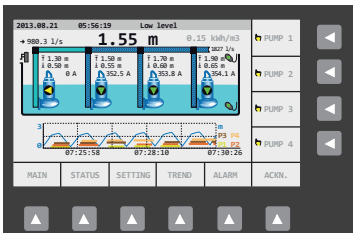
Power and alarm indicator

The two leftmost symbols on the CA 511 panel are for power and alarm indication:

- Green light is the power LED.
- The red alarm indicator flashes whenever there is an unacknowledged alarm, and the display tells you the type of the alarm. When the alarm is acknowledged, the light turns steady red, and remains lit until there are no active alarms, this functions the same as the PC 441 alarm indicator LED.

Direct functions, bottom and right displays

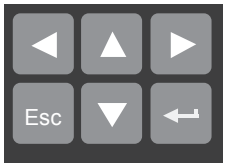
The buttons at the bottom and to the right of the display have the following functions:



- Buttons at bottom gives direct access to the most common menus.
- Bottom right most “Ackn.”. Button will acknowledge the most current alarm displayed on status row at top of display.
- Right buttons will start or stop the pump. (Toggle actual state.) By keeping button pressed, forced pump run below stop level is possible.

Right-hand buttons

The buttons to the lower right of the display have the following functions:



- To leave the overview image of the pump pit and go into the menus, press either the *Up* or *Down* arrow button.
- You go “into” a menu item by pressing either the *Right/Forward* button or the *Enter* button.
- You confirm (or perform/execute) an operation with the *Enter* button (↵).
- To exit the current operation, or leave the menus and go back to overview image of the pump pit, press the *Escape* button.

Main menu

Figure 1-3 shows the Main menu, which you reach from the overview image by pressing either the *Up* or *Down* arrow or shortcut key *Main* below display:

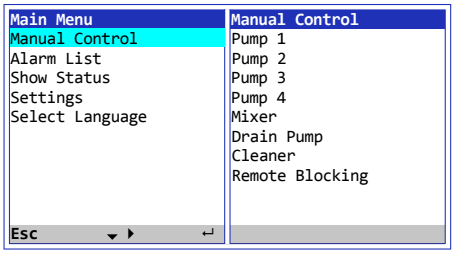


Figure 1-3 The top-level menu of the PC 441 graphical display.

How to select language and make all settings (menu items *Select language and Settings*) are described in chapter 6 Settings.

How to enter values and strings

Press Enter to enable editing of a value.

Use the *Left/Right* buttons to choose the insertion point.

Use the *Up/Down* buttons to increase/decrease a value or letter. Values and strings can also be altered through the alphanumeric keyboard.

An asterisk (*) gives = a dot (.).

Finish the editing by pressing enter.

Passcodes

There are three security levels:

1. Daily operations, such as acknowledging an alarm or stopping a pump, do not require any passcode or authorization.
2. Operational settings, such as setting the start or stop levels for the pump, require a passcode at the level of *Operator*;
3. Configuration settings that affect the basic functionality or access, such as the type of level sensor, require a passcode at the level of *System*.

The factory default passcodes are 1 and 2 respectively, but the codes can be changed under the menu item *Settings* > *System*. Whenever a passcode for Operator is requested, you may supply either the passcode for Operator or System.

Personal alarm, and how to reset it

When the pump station is manned, a personal alarm can be issued if the maintenance person hasn't shown activity within a certain period of time. For details about settings related to this, see section 6.3 System settings (assigning ***Alarm type, Alarm delay*** and ***Max time to reset***), section 6.12 Settings for digital inputs (assigning *Staff in station* to a Digital in), and section 6.13 Settings for digital outputs (assigning *Personal alarm* alert to a digital output).

After the specified ***Max time to reset***, the assigned output is activated so a visual or audio signal can alert the maintenance person that the alarm timer must be reset. If the alarm timer is not reset within *Alarm delay*, a personal alarm is sent out.

To reset the timer, just push any button on the control panel.

1.2.1 *Status view*

One of the useful functions in PC 441 is *Status view*. In the status view shows *Pump running time, Number of starts, Capacity* and *Energy consumption*. In those cases there CA 441, CA 442 and CA 443 are in the system, you will be able to see *Temperatures* in the different bearings, monitoring the *Vibrations*, *Power absorbed* and *Motor current*. You will also see the power supply voltage *L1 – L3* if the is a CA 443 in the system. All the pump alarms will show up here in the graphic.

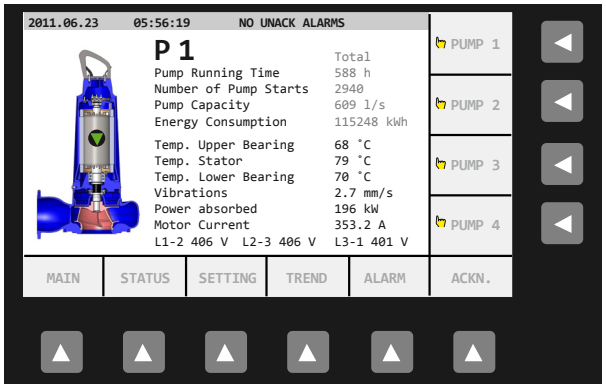


Figure 1-4 Status view

1.2.2 *How to access the status view*

Status view is easy to be accessed by pushing the "*Status*" below the display, and then "*Pump 1*" – "*Pump 4*" on the right side of the display. See picture below.

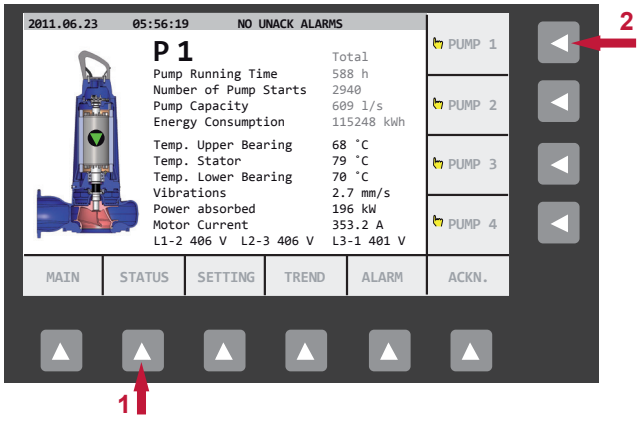


Figure 1-5 How to access *Status view*

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It's possible to use the left and right arrow keys at the numeral key board to step to the other pumps.

Use *up and down arrows* to step between days.
Up to 7 days back can be displayed.

Leave the Status view by **ESC.**

1.2.3 *Pump alarms under status view*

If the *Field bus modules CA 441* and *CA 442* are attached to the PC 441 and pump alarms appears, when under *Status view* you will be able to see an indication where the fault is physically located in the pump.

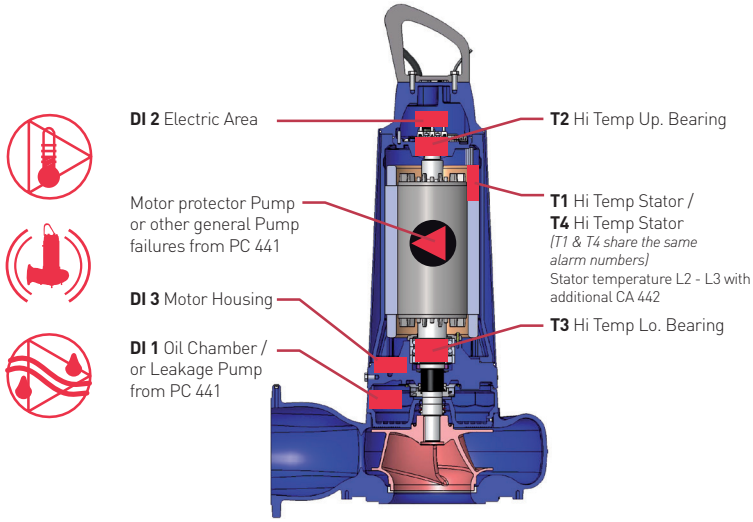


Figure 1-6 Pump sensor indications in *Status view*

1.2.4 *Trend curve*

Another useful function in PC 441 is *Trend curve*. Here you can get an overview of pit level, inflow and outflow or any other parameter you choose over time. Four different trend curves can be displayed at the same time. There is also a possibility to adjust the interval sampling for the curves. Default setting is 1 sample per second.

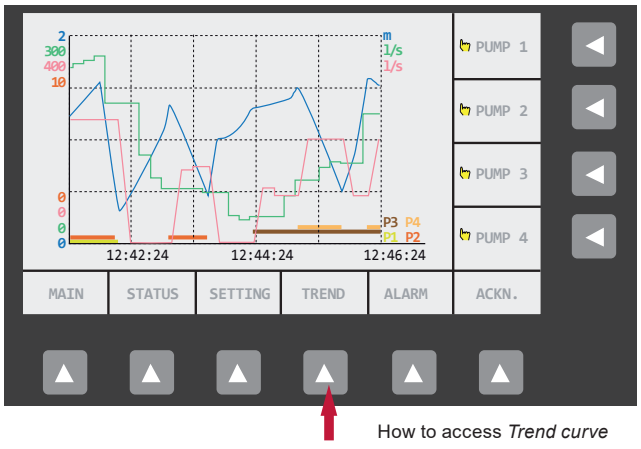


Figure 1-7 Trend curve

To get a presentation of the curve titles in the menu *Trend curve*, then push **Enter** then you have the *Trend curve* picture on the display, the picture will appear with the description as below:

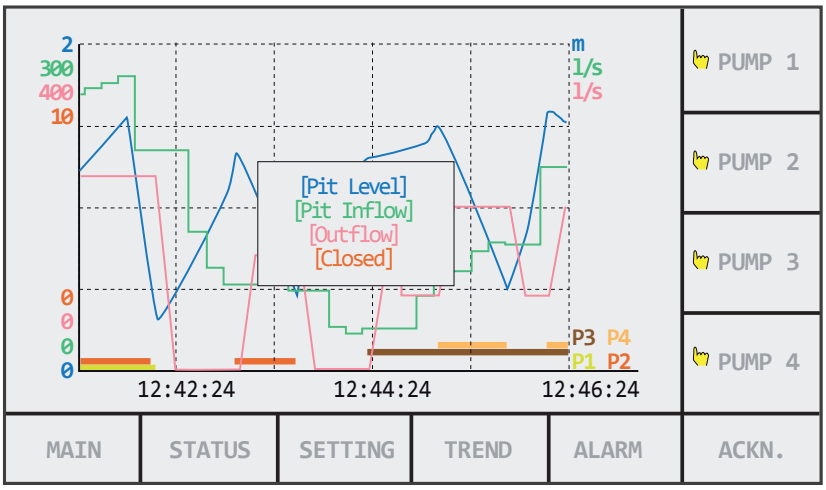


Figure 1-8 Description of the curves in *Trend curve*

The presentation will disappear after a few seconds.

One screen of *Trend curves* covers 300 samplings and that corresponds to 5 minutes in default settings of 1 second.

2 CONFIGURE THE PC 441

Overview of settings

Each station has an unique configuration setup, but the procedure is similar to setup these. This chapter will guide you through the basic settings in PC 441. Note: This does not cover all configurations, you must consider your prerequisites.

The menu item *Settings* has 21 submenus with many settings that need to be entered by the system administrator (although they all have sensible default values). The following 9 notes below are a recommended procedure to setup PC 441.

2.1. Set general configuration, system- and communication settings

2.2. Configure designated IO functions at DI, DO, AI and AO according to the electrical wiring drawing

2.3. Configure I/O modules, CA 441, CA 442, CA 443, CA 622, CA 511 and CA 781

2.4. Pump pit parameters and alarms

2.5. Set pump 1 - 4 settings and their alarms

2.6. Common P1-P4

2.7. Set log settings and events

2.8. Set up communications to surrounding units (VFD, soft starters and/or energy meters (if used)

2.9. Set up cleaner, mixer or drain (if used)

Each of the 21 submenus under settings are described in separate tables in section 6.

To enter the settings area:

Press *down arrow* once and you are in the menus, continue to press down arrow to *Settings*, press Enter.

The majority of settings require a passcode for *System* except some settings under the sub- menu *System* and the start/stop levels under submenus *Pump 1-4* which only require a passcode for *Operator*.

All the settings can be done locally form the menus or by AquaProg. The advantage of AquaProg is you can save the configuration at your PC and easily restore the controller if needed.

2.1 *Set general configuration, system, ID and communication settings*

Setup the basic system parameters and communication parameters by using the menus in CA 511:

Basic system parameters

- From the base screen, press the key for *Setting* under the display, press Enter twice and give the password (default **2**). Scroll on the left part of the screen to your language by using the up/down arrow keys, press Enter at your choice.
- Use the down arrow key to *Station application* and press Enter. Select *Pump controller* or *Pump monitor* by using the up/down arrow in the left part of the screen, press Enter at your choice. Use the down arrow key to *Main graphics* and choose the base screen (*Pump pit status* or any pump)
- Use the down arrow key to *Select units*, metric or US units, press Enter at your choice.
- Use the down arrow key to *Date format*, press Enter. Choose your date format.
- Use the down arrow key to *Set date*, *Set time*, and all other settings under this parameter.
- Set *System alarms* according to your preferences.

Communication parameters

- From the base screen, press the key for *Setting* under the display, scroll down by using the down arrow key to *Communication* and press Enter. Press enter again and select *Protocol* (Modbus/Comli/ Modbus TCP) and press Enter at your choice. Press left arrow key to go back to the left part of the screen. Use the down arrow to *Com port* and press Enter. Select *Station ID*, Press Enter. Type in your *Station ID* by using numeral keys or up/down arrow keys, required for AquaWeb or any other surveillance system. Select *Baudrate*, *Parity* and *Handshake*. Use the left arrow key to go back to the left part of the screen and select *Service port*, press Enter. Select *Baudrate* for the service port.
- Select modem type

Now it's possible to connect to AquaProg through service port or USB.

In AquaProg:

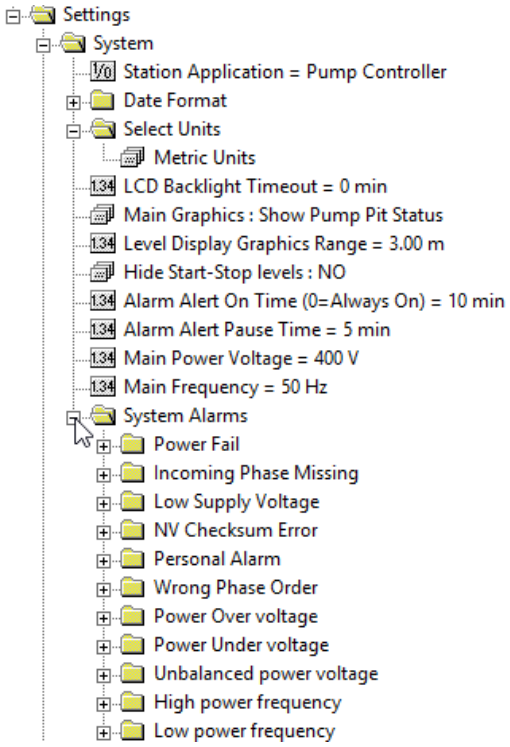


Figure 2-1 System settings

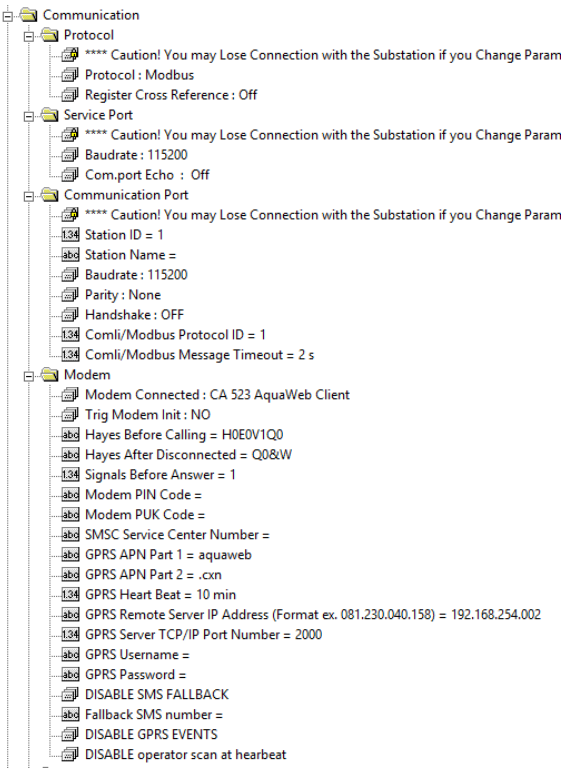


Figure 2-2 Communication

2.2 *Configure the digital inputs, digital outputs, analog inputs and analog outputs*

Set designated IO-functions according to the electrical wiring drawing. See your drawings of the station.

Under *Settings, Digital inputs*; choose for each input according to table 2-1 and *Digital outputs* to table 2-2.

Table 2-1:

Digital inputs
OFF
Pump run indication
Manual pump start
Pump not in auto
Start float
Pump failure
Motor protector
High temperature
Leakage
Stop float P1-P4
Low level float
Overflow sensor
High level float
Drain pump float
Run indicator Drain pump
Motor protector Drain pump
Run indicator Mixer
Motor protector Mixer
Staff in station
Alarm reset
Power fail
DI pulse channel 1-4
Block PID controller
Alarm input
Mixer block + Alarm input
Drain pump block + Alarm input
Block remote data

Table 2-2:

Digital outputs
OFF
Pump control
Reset motor protector
Pump fail
Too many pumps blocked
One pump fail
Master reset motor protector
Mixer control
Reset motor protector Mixer
Drain pump control
Reset motor protector Drain
Cleaner control
Modem control
Remote control
Personnel alarm
High level
Alarm alert
Not ackn. A-alarm
Not ackn. A/B-alarm
Active A-alarm
Active A/B-alarm
Pump reversing
Active B-alarm
Logic IO
Data register set point
Extern reset alert

Under *Settings, Analog inputs*, choose for each input according to table 2-3. Analog input 1 is fixed to level and cannot be changed.

Table 2-3:

Analog input 2-5
OFF
Motor current P1-P4
Back-pressure
Vibrations
Free choice
Vibrations P1-P4
Xylem MiniCas Sim P1-P4
Outflow meter

Note
Analog 1 is predefined to level sensor and cannot be changed.

Table 2-4:

Analog outputs
OFF
Pit level
Pit inflow
Pit outflow
Pit overflow
Pulse channel 1
Pulse channel 2
Pulse channel 3
Pulse channel 4
PID controller
Data register

In AquaProg:

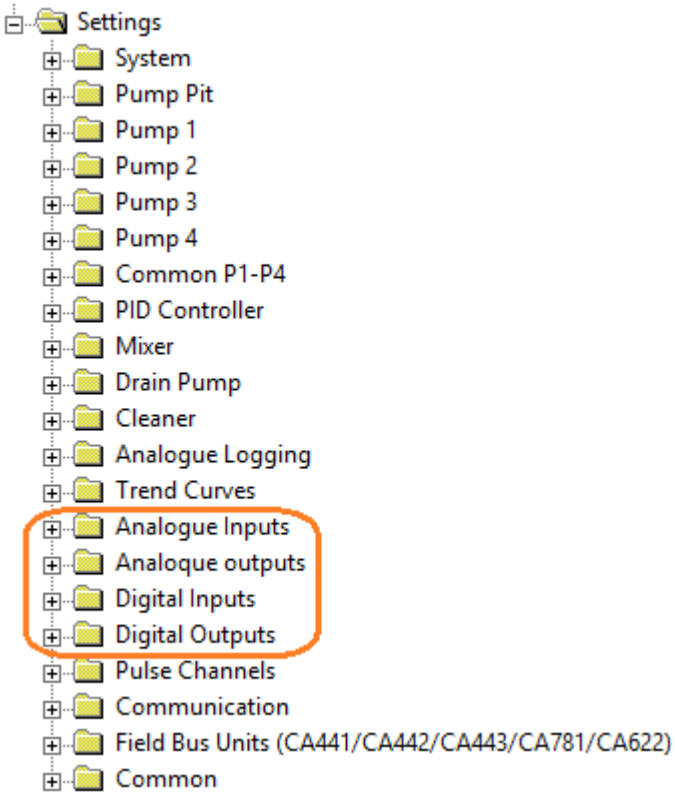
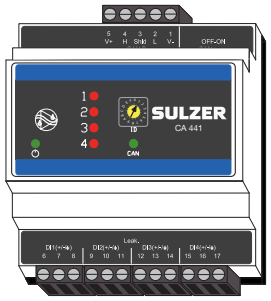


Figure 2-3 Analog and digital inputs / outputs

2.3 *Configure the field bus unit modules*

All the extension modules to PC 441 are optional. The communication is done by the CAN-bus. See *Installation guide CA 441, CA 442, CA 443* (P/N:81307058) on Sulzer home page for more detail information to setup *Leakage, Temperature* and *Power monitors*. Installation guides to CA 511 (P/N 81307061), CA 622 (P/N 81307133) and CA 781 (P/N 81307132) can also be found at Sulzer home page.

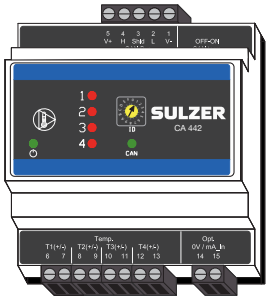
CA 441 Leakage module



A system with PC 441 can contain up to four CA 441 modules. One CA 441 module can monitor leakage in one or four pumps depending on the setting of the address knob on the front of the module, see *Installation guide CA 441, CA 442, CA 443* (P/N: 81307058) for more information. If using one module to four pumps, there is one input for each pump. If using one CA 441 module for each pump, there are four inputs to each pump.

In the settings, you must specify that the module(s) are connected and which type of sensor type your pumps have. Default is *ABS standard* and can be changed to *Xylem (ITT Flygt)*.

CA 442 Temperature module



PC 441 supports up to six units of CA 442. One CA 442 module can monitor temperatures in one or four pumps depending on the setting of the address knob on the front of the module, see *Installation guide CA 441, CA 442, CA 443* (P/N: 81307058) for more information. If using one module to four pumps, there is one input for each pump. If using one CA 442 module for each pump, there are four inputs to each pump. In the settings, you must specify sensor types (Klixon/Pt100/PTC).

Each module from CA 442-1 ("**-1**" refers to the address on the knob) to CA 442-4 has a 4-20 mA *Vibration* input, one for each pump. The vibration inputs are disabled in units CA 442-5 and CA 442-6.

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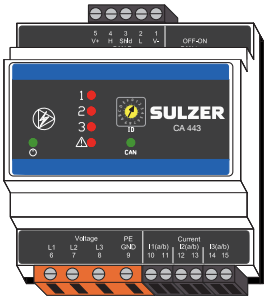
CA 443 Power monitor module

PC 441 supports up to five CA 443 modules, one module for each pump and one for whole system. CA 443 modules cannot be used together with VFD. The CA 443 modules must be connected before pump contactor so the inputs L1-L3 never get powerless. If the inputs get powerless, the phase alarm go on, and the pump will not start, see *Installation guide CA 441, CA 442, CA 443* (P/N:81307058) for more information.

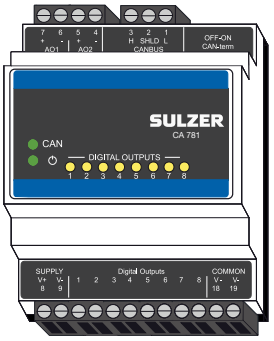


CA 511 Graphical operator interface panel

PC 441 supports one CA 511. It is not possible to use one CA 511 to several PC 441s. CA 511 is connected to PC 441 via CAN-bus and has a CAN-bus termination on the back. The firmware version in CA 511 must conform to the version in PC 441. Always use the latest firmware to ensure full functionality.

CA 781 Output expansion module

CA 781 is a module which gives you eight extra digital outputs and two extra analog outputs. CA 781 module must be powered from the same source as PC 441 and cannot be powered from the CAN-bus because of its higher power consumption. PC 441 supports one CA 781 module. See *Installation and user guide* (P/N 81307123) on Sulzer home page for more information.



CA 622 RS 485 communication module

PC 441 can communicate directly to VFDs, energy meters and soft starters via CA 622 module. CA 622 acts as Modbus master, communicating with attached Modbus slave devices. See the *Installation and user guide* (P/N 81307133) on Sulzer home page for more information and which VFD, energy meters and soft starters PC 441 and CA 622 support. If missing your model -contact Control & Monitoring at Sulzer and we might be able to add the new model. PC 441 support one CA 622 in the system.

When using CA 622 in the system, the values from many parameters can be readout by the RS 485 bus direct from VFD/ soft starters or energy meters and stored in the controller. These values can also be logged. PC 441 together with CA 622 can also control the on/off, speed and reversing of the pumps. Consult the Installation and user guide CA 622 (P/N 81307133) on Sulzer home page for more information about which VFD/soft starters/ energy meters PC 441 and CA 622 supports.

2.4 *Configure the pump pit parameters*

Table 2-5:

Pit settings
Level sensor type
Max number of pump running
Min time between relay change
Alternation
Alternative stop level
Start/stop on fast change
Station flow*
Calculation of pump capacity*
Overflow
Backup running
Pit alarms
Pump blocking
Level sensor check
Tariff control
Level above sea

* ***MUST*** *for accurate pump capacity calculation*

Level sensor type (required parameter, default level sensor)

Analog sensor or start/stop floats. Analog sensor is recommended if you want to track the capacity of the pumps and pumping volume.

Max number of pumps running (optional parameter)

If your pipe system cannot handle too high flows/pressure or your power grid has limitations, reduce number of pumps running at the same time. See section 3.4.1

Alternation (optional parameter)

Normal or asymmetrical

Normal: The pumps start in sequence from 1-4. There is always one pump start at the first (lowest) start level.

Asymmetrical: The pumps are divided in two groups there one group is working more frequently than the other group. See also section 3.4

Alternative stop level (optional parameter)

This function is to aid reduction of sediments in the pit and avoiding floating crust

Start/stop on fast change (optional parameter)

For example: If the pump station is pumping clear water and a heavy rain fills the pit very fast, the pump can start before the level reach the start level.

Station flow (recommended parameters)

Under *Meas. parameters* set the *Inflow calculation=ON* and your pit shape, also the function *Emptying* or *Filling the pit* must be set. *System curve at duty point* is used if there isn't any *Outlet pressure sensor*.

Recommended is to setup the *Pit area* under *Station flow*. That's because the pump calculations shall preform as accurate as possible. This are bound to *Energy calculation*, *Pump capacity* and *Outlet calculations*. Best accuracy of pump capacity calculations and pumped volume is when an *Outlet pressure sensor* is used. See section 3.2 for more information.

Calculation of pump capacity (recommended parameter)

Recommended to set *Calculation=ON*. The level must be in the span of minimum and maximum during the calculations. Make sure that the all times together in *start delay/calculation time/stop delay* in total must be in one and the same pump sequence. See section 3.2 and forward.

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Overflow (optional parameter)

Overflow can be detected by an overflow detector (MD 137) or by the certain level. See more information about overflow in section 3.3.

Backup running (optional parameter)

Backup running start when a *High-level float* gets activated. You can specify which pumps shall participate in backup run, and how long the pump shall run.

Pit alarms (some parameters are recommended)

There are several alarms which can be set under *Pit alarms.* Each alarm is configurable to be A- or B-alarms. Consult your drawings and verify which are important for your installation.

Pump blocking (optional parameter)

The pump can be blocked on remote. There is a time out which releases the blocking after a certain time. Blocking on *Low level float* and/or *High pressure* can be set here.

Level sensor check (optional parameter)

Level sensor check It is possible to check the level sensor reading compared to the installed floats. See the settings under *Level sensor* check set this up.

Tariff control (optional parameter)

This function is to reduce energy consumption in hours of high cost of energy. You can set this up for separate days in the week.

Level above sea (optional parameter)

If you type in a value here, this value will be added in the pit level but not affect the start/stop levels.

In AquaProg:

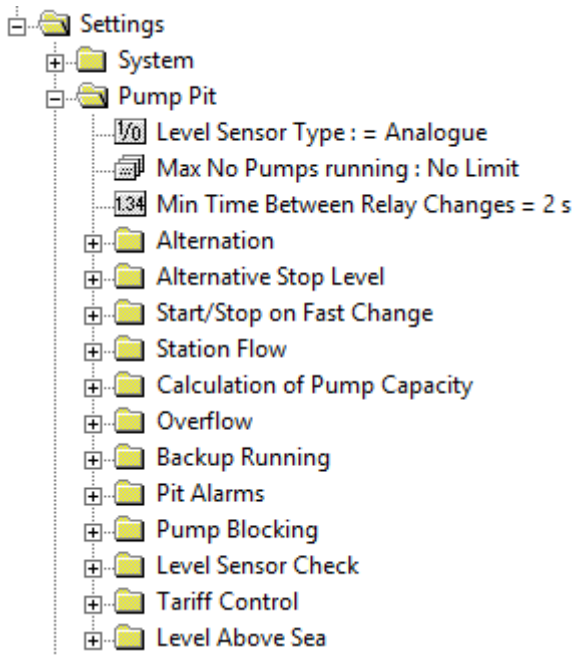

Figure 2-4 **Pump pit settings**

2.5 *Settings for pump 1 to pump 4 and their alarms*

Here you can give the pump a tag name (max 20 characters). Installed pumps must have *Relay control pump=YES,* otherwise the pump will not show up in CA 511 graphics. Alternately; if pump 3 and pump 4 are not installed; *Relay control pump=NO* that pump disappears from the graphics.

Important parameter to setup for each pump:

Type of pump (fixed or VFD)
Running indication (digital input, motor current or field bus module CA 622)
Start/stop level
Pump alarms
Pump curve

Optional parameters:

Time settings
Pump blocking
Pump blocking on alarms
Dry run detection

Type of pump:

- Fixed pumps
  A digital output starts the pump
- Speed controlled pump (PID/VFD)
  Start a VFD which has predefined frequency

Pump parameters:

- Set the nominal current for the pump
- Set the power factor for the pump

Useful parameters to detect dry run and heavy load

Select run indication:

- Digital input
- Motor current
  Require current transformers connected to an analog input
- Modbus CA 622
  RS 485 communication to/from VFD or soft starter

Start/stop levels for each pump

Recommended to have different start levels for all the pumps. Same stop level for all the pumps is fine.

Time settings (optimal parameter)

Set the maximum runtime for the pumps

QH curve (pump curve)

To get accurate values for pump capacity and pumped volume, this parameter is important. See chapter 5 for more information about pump curve.

Mixer prestart

If Mixer function is selected and the PC 441 is acting as a [**Pump controller**], the Mixer will be started before the first pump is started. This allows the mixer time to speed up before any pump is started.

This is true if the Mixer is pump start count controlled.
If the Mixer is time controlled, it will start independent of pump start.
In both cases min and max level for mix start must be performed.
Configure the pump start delay in menu:

Settings / Pump x / Time settings/ Threshold on delay.
You must set this delay on the pump with the lowest start level.

Pump alarms

There are several pump alarms to configure. Each alarm is configurable to be A- or B-alarms. The first part, table 2-6 below, is to setup the types of alarm (A- or B) and alarm delay.

Table 2-6:

Pump alarms
Phase missing
Dry run
No run confirmation
Fallen motor protector
Motor protector reset error
High motor current
Low motor current
Leakage
High temperature
High vibration
Low pump capacity
Pump not in auto
Pump error
Max continuous runtime
Alarm blocked
Max reverse attempts

Pump blocking (auto or manual reset)

All alarms here must be acknowledged on site or remotely for the pump to start again.

Pump blocking on alarms (pump blocked until alarm acknowledge)

All the alarms here will block the pump when the alarm is active. When the criteria for the alarm have returned to normal state, the pump starts automatically again.

Dry run detection

Parameters which must be set if dry run shall be detected.

In AquaProg:

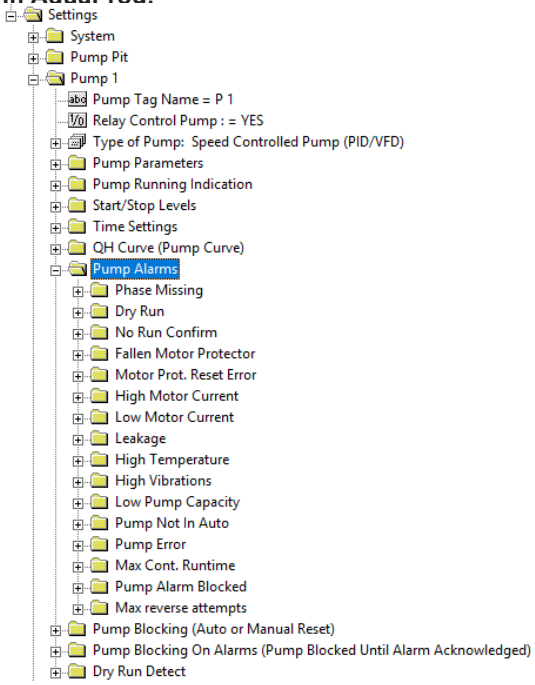

Figure 2-5 Pump alarms

2.6 *Common P1 – P4*

In this option are many useful functions to avoid future problems, like *Motor protector auto reset*, *Pump exercising*, *Pump reversing*, and different scenarios for blocking when using *Power monitor*.

Motor protector auto reset

Can be done "*Conventional*" or by CA 622 "*Motor drive*". Conventional needs a digital output which controls an external solenoid to reset the motor protector.

Motor drive requires CA 622 and the reset is sent to the VFD via software

Pump exercising

It is possible to exercise some pumps if required.
A maximum pump off time can be set and exercising time. The level must be within the parameters.

Note

During Pump Exercising, If the pit level is above the pump's "Stop Level", the pump will continue to run until the stop level is reached. If the level is below the pump's "Stop Level", the pump will run for the duration specified in the "Running Time" parameter.

Pump reversing

Several parameters can trigger reversing.
See also chapter 5

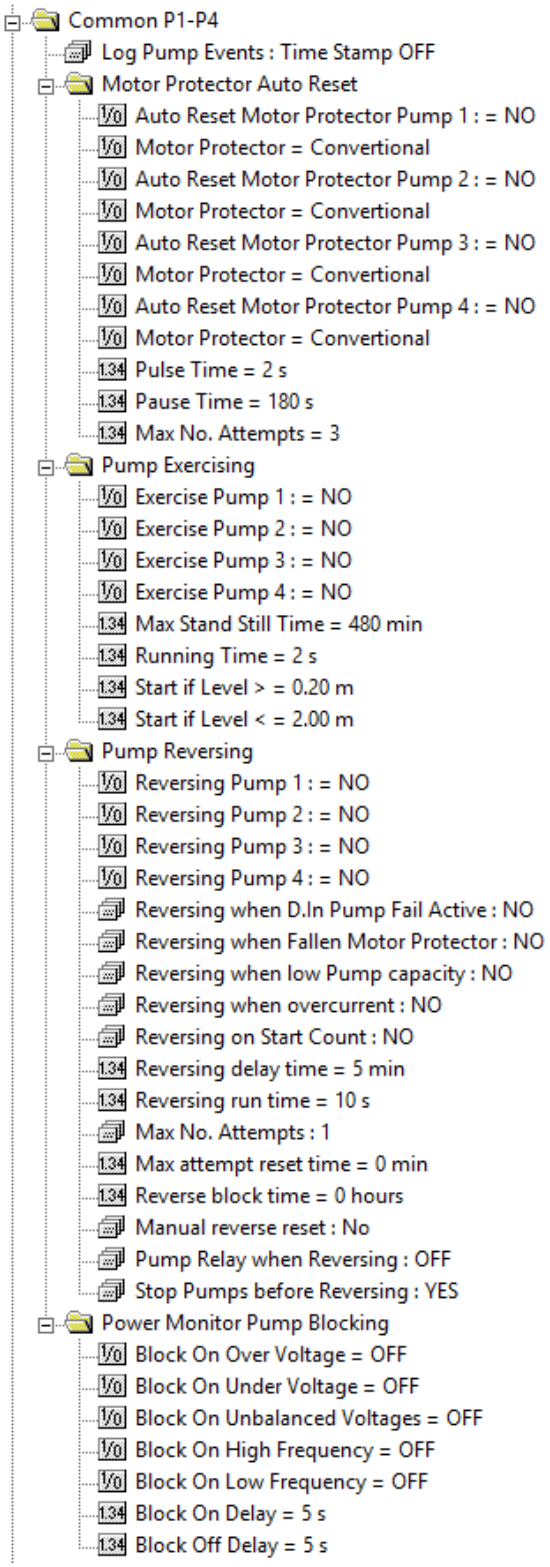

Figure 2-6 AquaProg view of common P1-P4

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2.7 *Set log settings and events*

There are 16 analog log channels which can be allocated to 26 log functions. Recommended to use the log channels in order from channel 1 and upwards. To have one or more log channels disabled between active channels will cost data traffic to the surveillance system.

The logs are kept in the controller for 15 days and the oldest will be deleted when the memory is full.

The settings are:

Log signal
Log function
Log interval

There are 34 *Log signals* which can be logged.

The *Log functions* can be set as follows:

Closed
Actual value
Average value
Min value
Max value

Closed:	No logging
Actual value:	A momentarily value will be stored at the log sequence.
Average value:	An average value during the log interval will be stored.
Min and max value:	The min or the max value in the interval will be stored.

The log interval can be set from 1 minute to 1440 minutes.

Table 2-7:

Log functions
Level in pump pit
Inflow
Outflow
Overflow level
Overflow flow
Back-pressure
Motor currents P1-P4
Pump capacity P1-P4
Power factor (Cos)
Temperature stator wiring
Temperature upper bearing
Temperature lower bearing
Vibration
Main voltage
Main frequency
AI free choice
Supply voltage
Pulse channel
Temperature stator wiring L2
Temperature stator wiring L3
PID controller output
Data register
Data register (2-compl)
Actual VFD frequency
Measured pump head
Actual pump head

Events

Event list stores individual events such as *Pump starts/stops*, *Alarms*, alarm types and when the alarms occur and when it was acknowledged. The controller stores 4096 time-stamp events.

The event list is always active for alarms. To activate event list for pump starts/stops,

Go into *Settings – Common P1-P4 – Log pump events - Yes*

2.8 *If using CA 622; set up communications to surrounding units VFD, soft starters and energy meters*

See installation guide for CA 622 how to connect the surrounding units. Note: All the surrounding units must have unique Modbus ID's and same communication parameters.

2.9 *Set up cleaner, mixer or drain (if used)*

If using cleaner, mixer or drain pump, a digital output must be set as corresponding.

Cleaning

The settings for cleaner are to be found:

Settings – Cleaner

The cleaning can be done at *pump start* or at *pump stop*.
Flushing time in second
Number of *Starts to flush* set the interval to how many starts/stops before cleaning starts.

Mixer

The settings for mixer is to be found:

Settings – Mixer control

The mixer can be started after a certain number of regular pump starts or after a time interval. There is also a criteria to set the level to be within a certain span. The mixer run time must also to be set.

The settings are:

Stop pump when mix [Yes/No]
Run indication [Yes/No]
Mixer run time
Pump starts to mix
Time interval to mix
Max level for start
Min level to start
Motor protector
Mixer alarms

Drain pump

Drain pump requires a start float connected to a digital input which is set as *drain pump float*. The settings for drain pump is to be found:

Settings – Drain pump

The drain pump runs only on time settings, there is no stop float for the drain pump.

3 DETAILED DESCRIPTION OF THE FUNCTIONS

3.1 *Pump controller and/or monitor*

PC 441 can be used as a controller with monitoring capability or solely as a monitoring device.

Setup PC 441 as pump controller:

- In *Settings* / *System menu*:
Set *Station application* to [**Pump controller**] (=default).

The PC 441 monitor and control the pumps.

Setup PC 441 as pump monitor:

When the PC 441 is configured as a *Pump monitor*:
All pump control functions (start/stop pumps) are disabled only monitoring functions are active. If a level sensor is connected inflow, outflow, pump capacity and pumped volume can be calculated. Pumps can be blocked in case of error conditions.
Alarms can be generated and then trigger alarm calls (GSM/GPRS/SMS).
PC 441 can control a Mixer/Cleaner/Drain pump at the same time as it monitors pumps.

- In *Settings / System menu*: Set *Station Application* to [**Pump monitor**].

For monitor function to work you need to connect some kind of pump running indicator. Motor current or a digital signal can be used as run indicator.

First select type:

- In *Settings / Pump x /.* Set *Pump run Indication* to [**Digital input**] or [**Motor current**]

If [**Motor current**]:

- In *Settings / Analog inputs*; Set *Input function* to [**Current pump x**]
(if there is no CA 443 in the system)

If [**Digital input**]:

- In *Settings / Digital inputs*; Set *Input function* to [**Run indicator**] and select pump number.

If you want to block pumps in case of errors:

- In *Settings / Digital outputs*; Set *Output function* to [**Pump fail output**] and select pump number.

Connect the output to the external pump control logic as blocking signal. The signal will go active when PC 441 detects an error condition for the pump.

If you want to have the possibility to manually start a pump from the CA 511 panel:

- In *Settings / Digital outputs*: Set *Output function* to [**Pump relay**] and chose pump number.

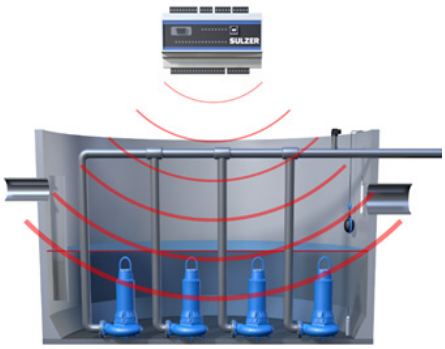
Connect the output to the external logic to force the pump to run when the signal is active. The signal will go active when you press the manual button on the panel and stay active until it's released.

3.2 *Pump capacity and in/outflow of the pit*

In-/outflow and pump capacity calculation

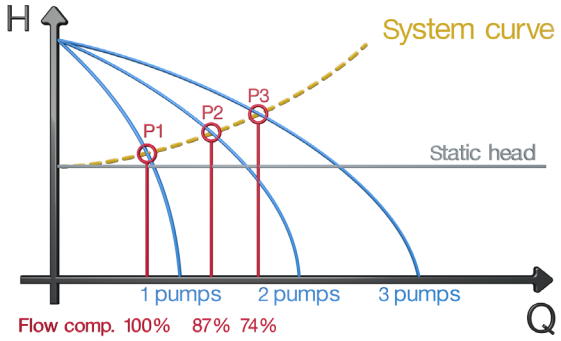
Function

- Calculates the inflow using level change per time unit and surface area.
- Calculates the pump capacity every time a pump runs by itself.
- Pump and system data can be entered for a more exact calculation.
- An even higher flow calculation accuracy is obtained if a pressure sensor is mounted on the mains outlet.
- Outflow calculation compensation for rpm.
- Outflow can be taken from a flow meter.



Value

- Service the pump before breakdown, avoiding/reducing overflows.
- Avoid wasting energy using pumps with degraded efficiency.
- Service can be planned to occur during normal working hours.
- No external flow meter required.
- Accurate overflow measurement



The PC 441 supports several approaches to flow calculation and combinations thereof

1. Flow is based on manually entered capacity values for each pump. This data is then used to theoretically calculate the pumped volume by multiplying capacity data with running hours.
   Pros: Simple set-up
   Cons: No actual pump or system health check
2. Flow is based on a flow measuring device mounted on the mains.
   Pros: Simple set-up with accurate flow measurement if mounting criteria are met
   Cons: No information on inflow and collection system behaviour

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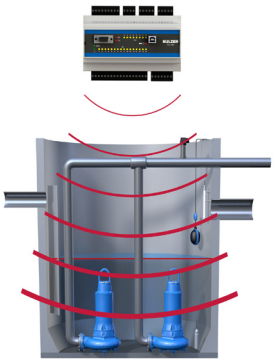
3. Volume is based on inflow calculation in combination with a flow measurement on the mains.
   Pros: An accurate flow measurement if mounting criteria are met
   Collection system behaviour can now be monitored
   Cons: Some more system set-up is required

4. A volume-based inflow and outflow calculation also considering pump and system curves.
   Pros: A cost effective flow monitoring solution also enabling collection system flow monitoring
   Cons: Access to basin, pump and system curves data required

5. A volume based inflow and outflow calculation in combination with a pressure monitoring of the mains.
   Pros: A cost effective flow monitoring solution also enabling collection system Monitoring with an even higher accuracy and less system set-up required
   The mains pressure reading also simplifies the flow calculation times set-up
   No system curve information has to be set-up
   Cons: Access to basin and pump curves data required

Parameter settings for an accurate in-/outflow and pump capacity calculation

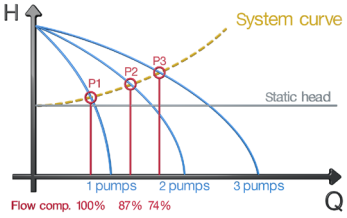
Function



- Calculate the inflow using level change per time unit times surface area
- Calculate the pump capacity every time one pump runs by itself
- Pump curves, rpm compensation and system data can be entered for more exact calculation
- A pump monitoring sequence can be manually initiated via the pump status menu

Value

- Avoid wasting energy using pumps with degraded efficiency
- Service pump before breakdown
- Service can be planned to occur during normal working hours
- No external flow meter required



Pump and system curves

- Pump curves can be entered
- The system curve is calculated from the online measurement together with given data for static head, total head and flow at given duty point.
- The system curve does **not** need to be entered if a mains pressure sensor is mounted, only the height difference between pump inlet and pressure sensor has to be entered!

Pump capacity monitoring and pumped volume recording via an external flow signal

Function

- Pumped volume and pump capacity calculation can be done using an external flow meter
- The internal level/volume based calculation for inflow can be combined with the external flow signal

Logging of pumped volume

- Continuous accumulation over time
- Day total for last 7 days
- Can be combined with energy measurement for pump efficiency calculations
- Can be used for comparing flows between stations in a collection network, pinpointing possible problems of water ingress or overflows within the collection system

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Calculation of pumped volume

Function

- Pumped volume = *Calculated pump capacity* times *Pump running hours*
- Pumped volume calculation takes in consideration the pump curves, system curve as well for the rpm and mains pressure. (if applicable)

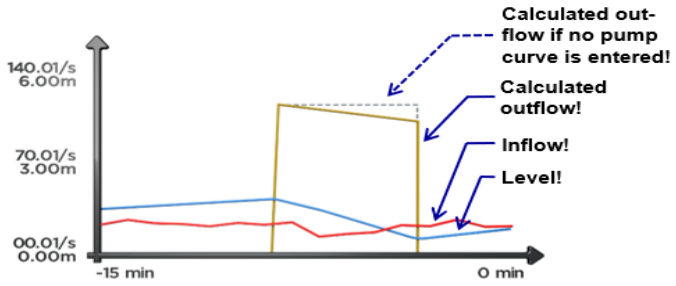


Figure 3-1 Calculated flow with and without pump and pump system curve entered

Logging of pumped volume

- Continuous accumulation
- Totalized values per day and seven days back in time
- Flow calculations based on volumetric calculations adjusted to pump curves, system curves rpm and mains pressure depending on configuration

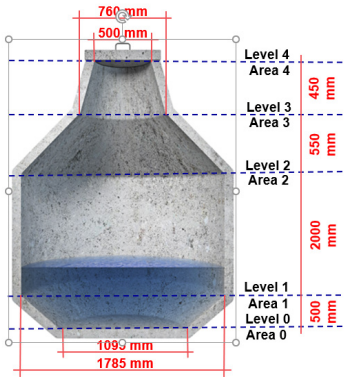
Continuous volumetric calculations

By entering the shape and size of the pump pit, together with an accurate level measuring device, the unit will always know the momentary volume in the pit.

A new pump capacity calculation is performed every time the pump starts alone with no other pump running. If one or more pumps are already running, the controller will use the existing nominal pump capacity for the outflow calculation.

Inflow is calculated at a preset interval. Outflow is recalculated every second and the values are presented and updated according to the parameters set.

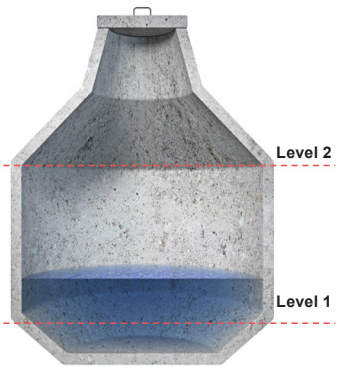
If an analog input signal is set as “Outflow meter” this signal will be used for calculations of outflow and pump capacity.



Level boundaries can be entered for the pump capacity calculation.

Level 2:
Above this level it is not useful or maybe not even possible to calculate the flow.
For instance due to the volume in the incoming mains.

Level 1:
Below this level it is not useful or maybe not even possible to calculate the flow.
For instance, depending on the level for the pumps suction point.



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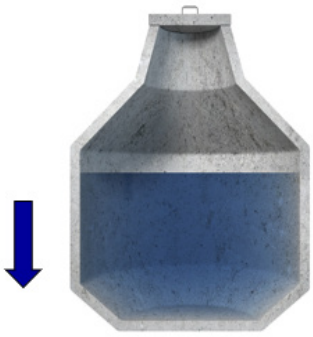
Logic used to calculate the pump capacity



First pump starting.

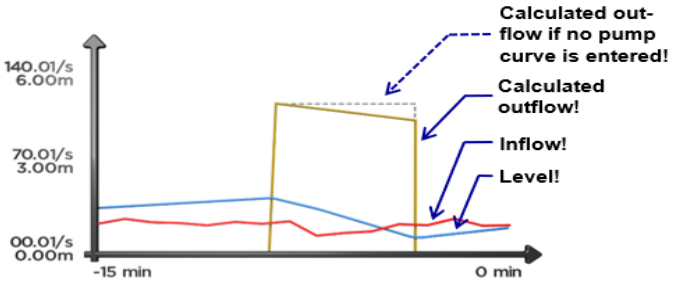
When the start level of the first pump is reached, the last known filtered value of the inflow is stored in the memory.

After an adjustable time-delay the actual pump capacity measured by calculating the speed of level decreasing times the station pit. The time delay is there to enable the pump and system to reach full capacity before conducting the measurement.

The pump capacity calculation time is also a value that can be set/ adjusted. The time needed to achieve an accurate value will depend on parameters like for instance: size of basin, type of pump and the collection network design to mention a few.

Logic used to calculate the outflow during a pump cycle

The outflow calculation is based on the calculated pump capacity times the running hours of the pump. To enhance the accuracy even further the pump curve for each pump can be entered. The curve is then used to adjust the calculated value to match the actual head. When the level drops the head increases and mostly also the pump capacity. This will then be adjusted in accordance to the pump curve data entered. If connected to a VFD, the rpm can also be used to compensate the outflow calculation.



Logic used to re-calculate the inflow during a pump cycle

As earlier mentioned the inflow is continuously calculated based on the level change per time unit when no pump is running.

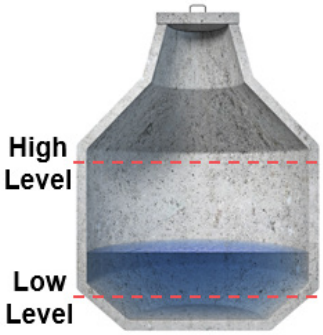
When one or several pumps are running the controller knows the assumed outflow based on the calculated pump capacity and if entered also adjusted to the pump curve, system curve and rpm. This now means that the controller knows with what rate the level should decrease based on the pump capacity already calculated.

If the level decreases with a slower rate it is then assumed that the inflow has increased to balance the calculation.

The calculated outflow is also a function on number of pumps running.

Calculation scenarios when a new pump capacity value is NOT accepted

Basic calculation rules



1. The level must be between the high and low level set-points.
2. The pump capacity calculation sequence starts when the pump start signal is given. The level value after a conducted measurement must be below that point.

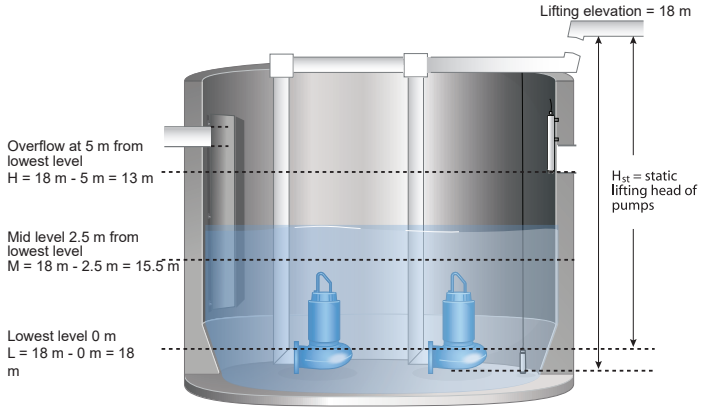
Basis for the calculation of indicated pump capacity

1. Five rolling measurements are continuously performed, where the two with highest deviation is deleted.
2. Based on three values left is an average capacity value calculated.
3. Shown are the following calculated values:

   - Nominal capacity (average of the 3 out of 5 calculations). The nominal value is used for the alarm handling.
   - Last pump capacity (last performed calculation)
   - Average capacity today to seven days ago

The important parameters for a level-based flow measurement are easily entered in the software.

NOTE!! If a pressure sensor is mounted on the mains no system curve information needs to be entered. For correct monitoring the level difference between pump suction point and pressure sensor on the mains must be given.



- Calculation of Pump Capacity
  - Calculation : = ON
  - Min Level for Calculation = 0.50 m
  - Max Level for Calculation = 2.00 m
  - Start Delay = 10 s
  - Calculation Time = 10 s
  - Stop Delay = 10 s

- Station Flow
  - Meas. Parameters
    - Inflow Calculation : = ON
    - Pit Shape : = Regtangular
    - Pump Function : = Emptying Pit
    - Calculation Interval Inflow = 10 s
    - System curve at duty point (1 pump running)
      - Static Head at duty point = 0.00 mvp
      - Total Head at duty point = 0.00 mvp
      - Flow at duty point = 0.0 l/s
    - Flow compensation
  - Pit Area
    - Level 0 = 0.00 m
    - Area 0 = 3.1 m2
    - Level 1 = 1.00 m
    - Area 1 = 3.1 m2
    - Level 2 = 2.00 m
    - Area 2 = 3.1 m2
    - Level 3 = 3.00 m
    - Area 3 = 3.1 m2
    - Level 4 = 4.00 m
    - Area 4 = 3.1 m2
    - Level 5 = 5.00 m
    - Area 5 = 3.1 m2
    - Level 6 = 6.00 m
    - Area 6 = 3.1 m2
    - Level 7 = 7.00 m
    - Area 7 = 3.1 m2
    - Level 8 = 8.00 m
    - Area 8 = 3.1 m2
    - Level 9 = 9.00 m
    - Area 9 = 3.1 m2

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Settings

Valuable pump performance information is given in the pump technical data sheet.

Total head from sensor zero level is an old setting actually referring to the static head. This only needs to be set if no system curve information is entered or no mains pressure sensor is configured.

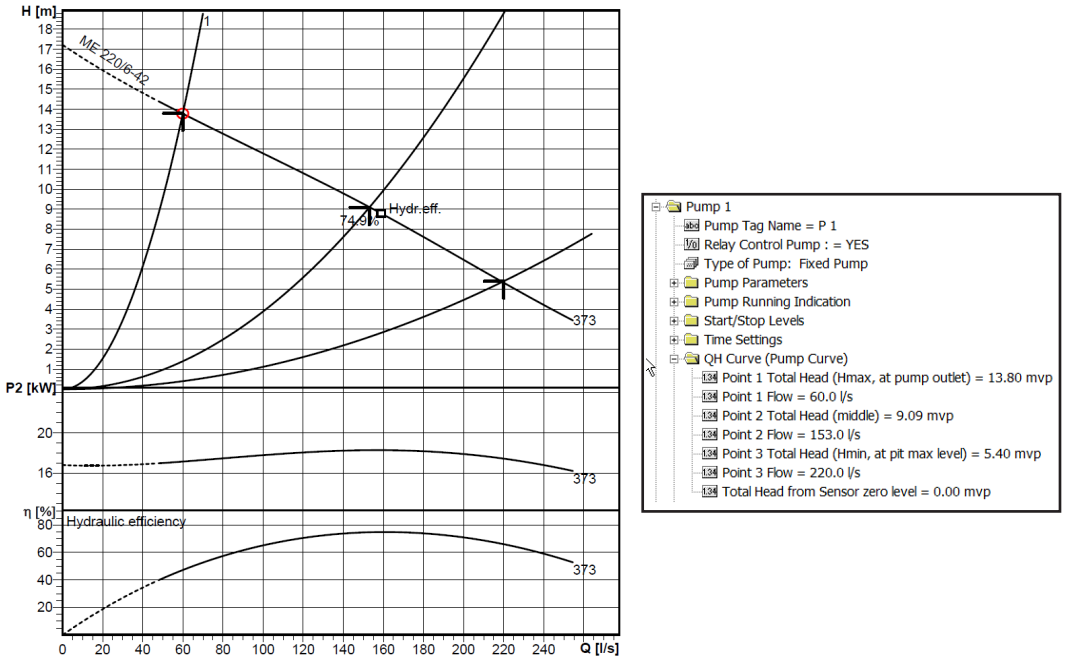


Figure 3-2 Example of pump curve

Operating data specification			
Flow	153 l/s	Head	9.09 m
Static head	7 m	Efficiency	74.7 %
Shaft power	18.3 kW	NPSH	2.8 m
Fluid	Water	Temperature	4 °C
Nature of system	Single head pump	No. of pumps	1
Pump data			
Type	AFP 2571 50 HZ	Make	ABS
Series	AFP M4-M9 (18,5kW-1MW)	Impeller	Contrabloc impeller, 2 vane
N° of vanes	2	Impeller size	373 mm
Free passage	120 mm	Suction port	--
Discharge port	DN250		
Motor data		Station Flow	
Rated voltage	400 V	Meas. Parameters	50 Hz
Rated power P2	22 kW	Inflow Calculation : = ON	970 rpm
Number of poles	6	Pit Shape : = Regtangular	90 %
Power factor	0.822	Pump Function : = Emptying Pit	42.9 A
Starting current	154 A	Calculation Interval Inflow = 10 s	217 Nm
Starting torque	390 Nm	System curve at duty point (1 pump running)	IP68
Insulation class	F	Static Head at duty point = 7.00 mvp	
		Total Head at duty point = 9.09 mvp	
		Flow at duty point = 153.0 l/s	

Figure 3-3 Technical data in data sheet

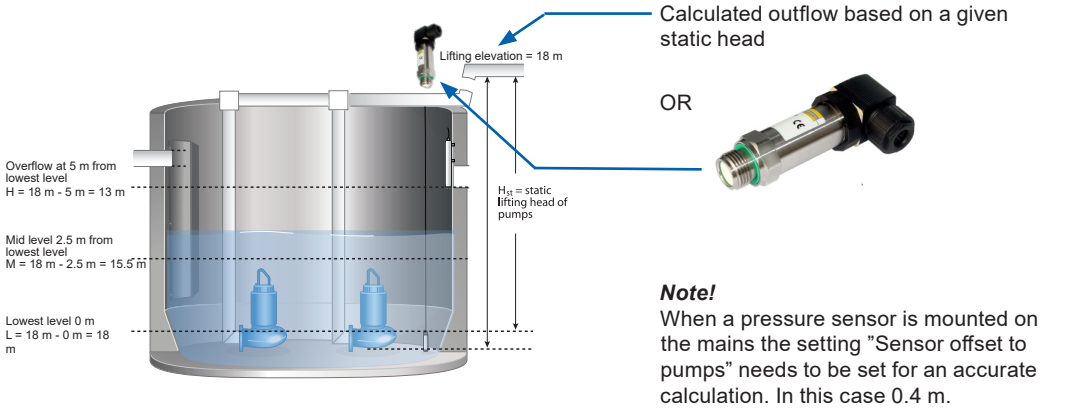
Level based flow solution with a pressure sensor mounted on the mains for actual head compensation

Use either a given static head or mount a pressure sensor on the outgoing mains to get the actual head. If a pressure sensor is mounted in the mains discharge pipe, the controller will automatically compensate for any variances in the head. Having a pressure sensor mounted on the mains can also warn for potential problems with a high mains pressure.

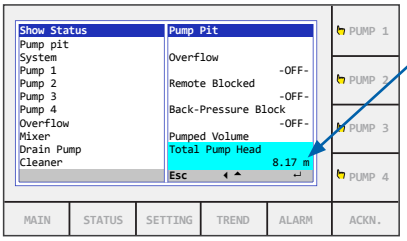
Such a problem can occur due to:

Air entrapment in the mains
High load from other stations

This will then naturally have an impact on the calculations but more importantly on the cost of pumping.

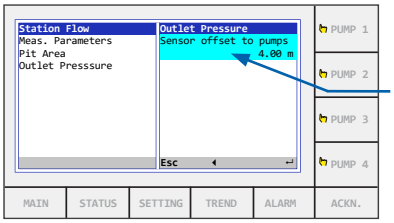


Note!
When a pressure sensor is mounted on the mains the setting ”Sensor offset to pumps” needs to be set for an accurate calculation. In this case 0.4 m.

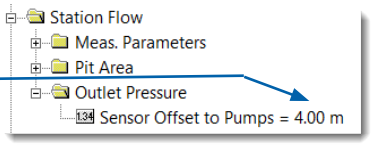


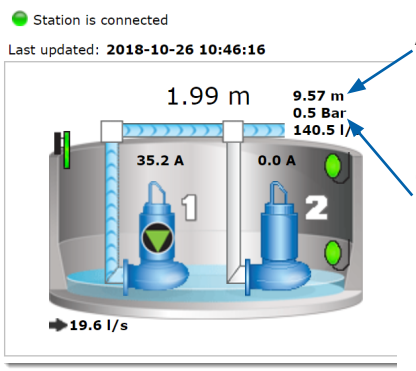
Indication of current total pump head

When a pressure sensor is mounted on the outgoing mains, the offset between the pressure sensor and the intake of the pump has to be entered to get the correct actual head.



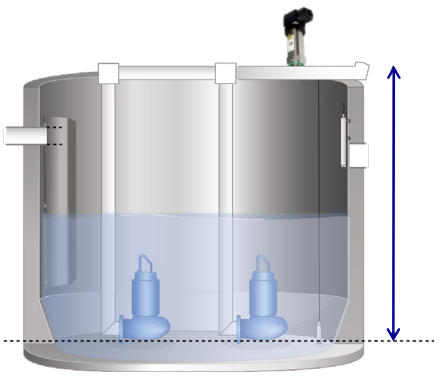
Distance between pressure sensor and suction point of pump





Actual current pump head

Current mains pressure



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Example of calculation cycle:

1. No pump is running, level increasing due to inflow that is then calculated based on the area/level and time settings.
2. Start level reached.
3. Current inflow stored.
4. Time delay before pump capacity measurement, this to enable the flow to pick up speed depending on size of pit, pump, head and collection network design.
5. Measure speed of level reduction during a preset time to a pump capacity value is now obtained.
6. This capacity value is now adjusted to the pump curve (if entered).
7. Release the inflow calculation.
8. The inflow is now a function of the pump capacity and entered pump curve.
9. If yet a pump starts the outflow and inflow is then also adjusted according to the system curve.
10. If a pump is running and there is a stable level reading, this would indicate that the inflow matches the outflow.
11. If the level increases it indicates that the inflow is higher than the pump capacity.

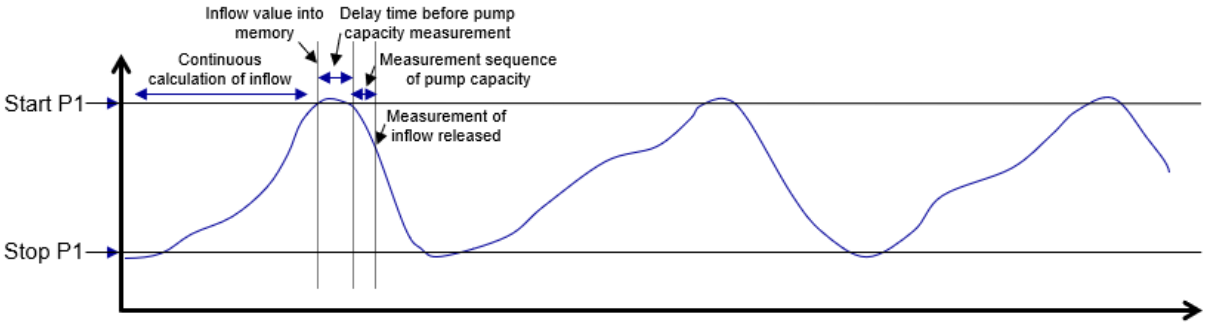
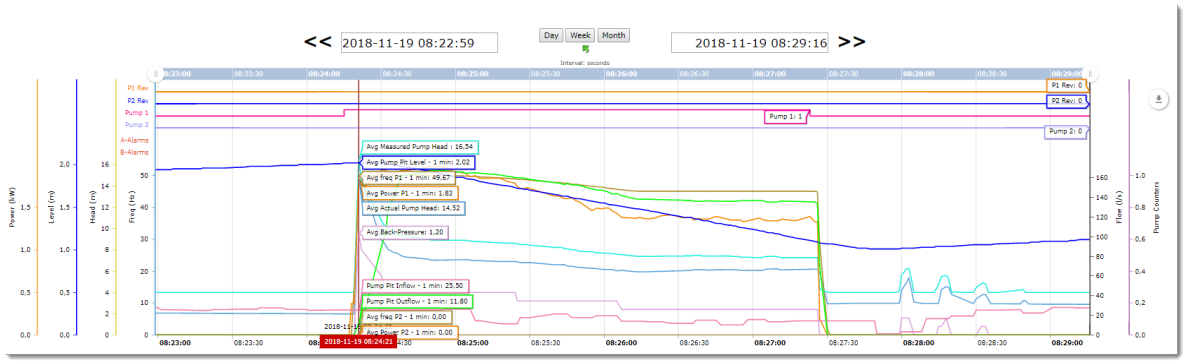
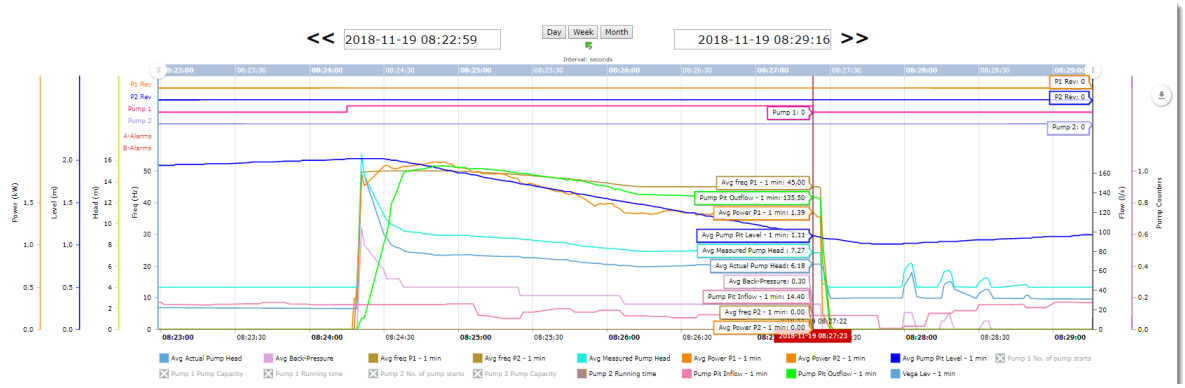


Chart example is based on a full run cycle for P1.
Charts like these are available through the Sulzer AquaWeb tool.





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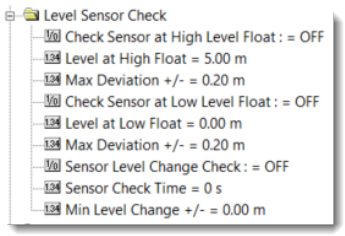
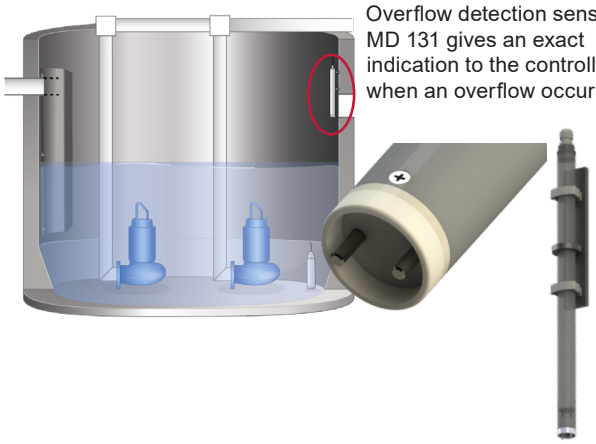
Calculation functionality check routines

1. The level reading stays on a constant value - PC 441 has a built-in level deviation monitoring feature.
2. The level reading is on a constant level due to a overflow situation - A specially designed overflow detection sensor type MD 131 can be used to detect this.
3. The actual level for the high level alarm from a float can be entered, this level can then be used to compare with the level sensor reading. If a certain deviation from this set-point is detected a sensor failure alarm can be raised.

Point 1 and 3 are covered in the below settings



Point 2 is covered by installing the MD 131 sensor



Overflow detection sensor MD 131 gives an exact indication to the controller when an overflow occurs.

Calculation

Compilation of above

When one pump starts alone:

- The actual inflow value when the pump starts is temporarily stored and the indicated inflow value frozen.
- The outflow value is now ramped up for a configurable time frame. “Start delay”
- The pump capacity is calculated during a configurable time frame. “Calculation time”
- The inflow indication lock is released. The inflow is now a function of pump capacity, level and if entered, the pump curve.
- The outflow is ramped down for a configurable time frame after pump stop. “Stop delay”

Pump capacity calculation rules

- The level must be over “Min Level for Calculation”
- The level must be under “Max Level for Calculation”
- The level after calculation must be lower than when the calculation started.

Increased calculation accuracy

To improve the calculation accuracy and alarm handling, especially with varying start levels, we recommend that the pump curves are entered.

For a more accurate outflow calculation, the stations system curve can be entered! In this case the controller will recalculate and adjust the Outflow calculation based on the momentary level!

Presentation of the Pump Capacity calculation

The pump capacity is presented as a Nominal and Last Sample value.

Nominal

- The nominal value is re-calculated from five values to point 1 in the “Pump curve” setting. Of these, five values are filtered by taking off the two most divergent and calculate an average of the three remaining.

Last Sample

- As it sounds, the last calculation, unfiltered.

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3.2.1 *Auto-set limit low pump capacity alarm*

This feature to auto-set the low capacity alarm threshold to 80% of detected pump capacity. The auto-set sequence takes 5-8 pump starts with pump capacity calculations.

Detect pump ramp-up time and Forced pump capacity calculation logic

During detection of low pump capacity threshold is possible to manually activate a “Detect pump ramp-up time” and/or “Force pump capacity calculation” in the menus for each pump.

Settings – Pump X – Pump X Alarms – Low pump capacity – Autoset limit

Option: **Detect pump ramp-up time**

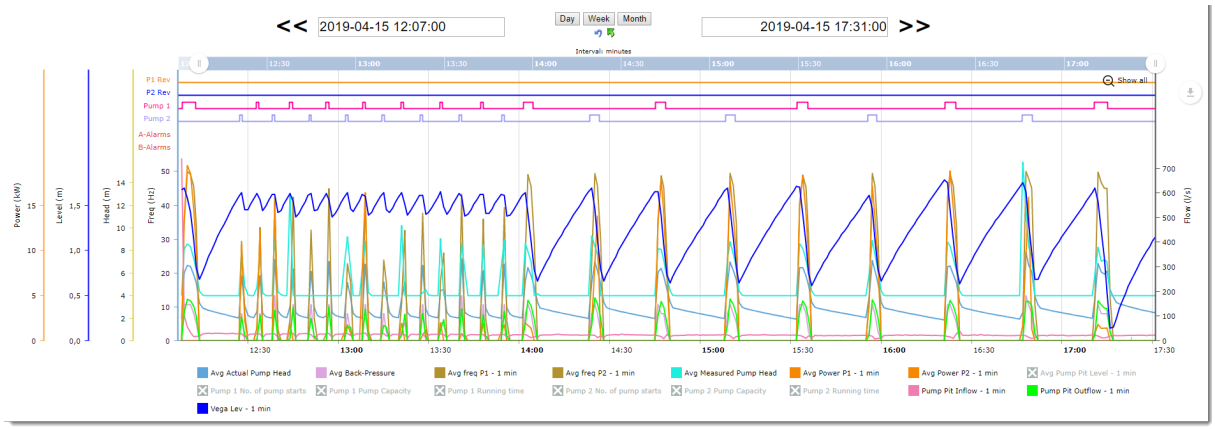
The controller calculates the time it takes from the pump start until full flow is reached. The pump capacity calculation is delayed during this time + the common setting “start delay”.

Option: **Forced pump capacity calculation**

Will stop the pump after calculation of pump capacity before stop level is reached.

Start Auto set

Select **Yes** to start the sequence, **No** to interrupt ongoing sequence.



3.2.2 *Pit shape*

The continuous flow measurement is based on the fact that the PC 441 can calculate the volume by measuring the level difference during a set calculation time. For this calculation is to exact it is necessary that the area / level should be always known. This can be achieved by setting the level and area for all level where the pit changes shape, up to 9 break points + the area at zero point can be set.

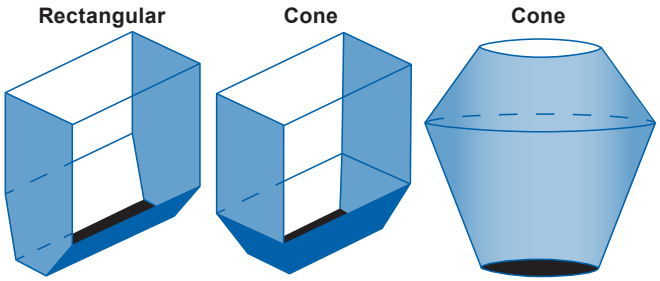
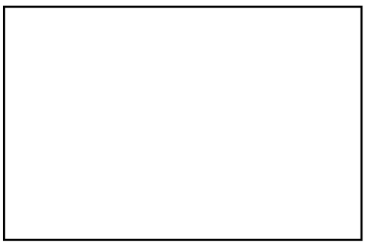


Figure 3-4 Example of pit shapes.

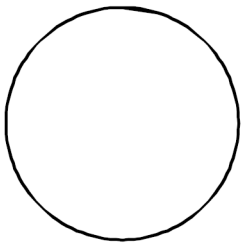
To get a correct calculation at all levels even the pit shape has to be set as the calculation is different for different geometrical shapes. A shape that ends in a point is set as conical, if it ends as a wedge (2 parallel sides) it is set as rectangular shape, see figure above.

Example for area calculation:

Rectangle



Circle



A = L * W	**Ex.**	**A = pi * r²**	**Ex.**
A = Area **L** = Length **W** = Width	**A** = ? **L** = 2.20 Meter **W** = 1.75 meter	**A** = Area **pi** = 3.14... **R** = Radius = D/2	**A** = ? **D** = 2.50 meter **R** = 2.5 / 2 = 1.25 meter
	A = 2.2 * 1.75		**A** = 3.14 * $(1.25)^2$
	A = 3.85 m^2		A = 4.91 m^2

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3.2.3 *Pump curve*

The outflow of the pit is calculated when the pumps are running. It is based on the capacity for the pumps and is accumulated to a pumped volume. If a level difference in the pit, during pumping, gives changes in the pump capacity according to the pump curve, this should be set in the PC 441. The outflow will in this case be compensated with the actual level in the pit according to the pump curve, which gives a more accurate accumulated volume.

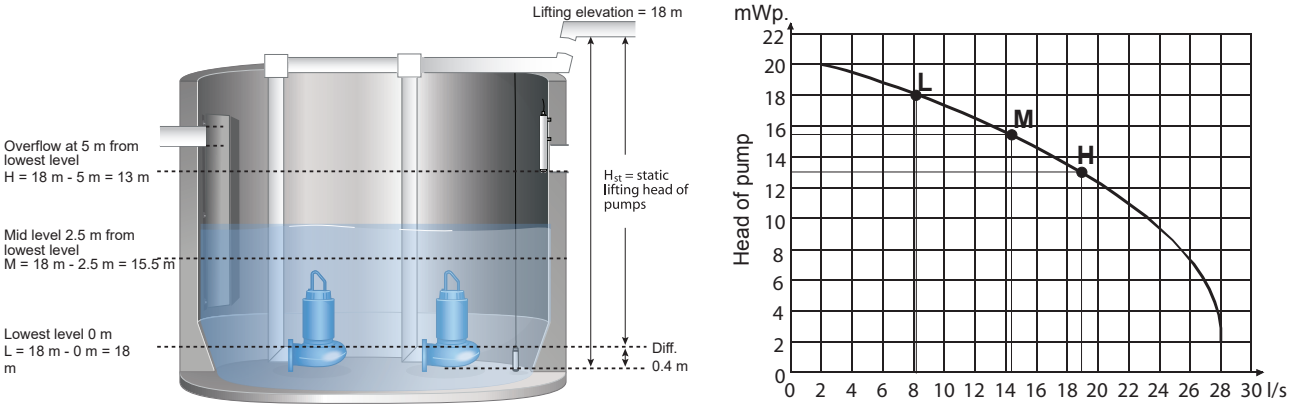

Figure 3-5

Actual head of pump = Total head of pump - actual level

Above pump curve figure 3-5 gives following flows and settings.

In menu Pump 1-4 > Pump Curve.

(L) *Point 1 Hmax tot. head*	18.0 m (ft.)	*Point 1 flow*	8.2 l/s (GPM)
(**M**) *Point 2 Hmid tot. head*	15.5 m (ft.)	*Point 2 flow*	14.4 l/s (GPM)
(H) *Point 3 Hmin tot. head*	13.0 m (ft.)	*Point 3 flow*	19.0 l/s (GPM)

If sensor is mounted according to Ex 1 (Sensor 0-level = Pump outlet) set parameter *Total head sensor zero* = *18 m.*

If sensor is mounted according to figure 3-5, 0.4 m below pump outlet set parameter *Total head sensor zero* = 18 + 0.4 = 18.4 m.

NOTE! If possible add the dynamic head (pipe losses) to the total head for the pumps; this may increase the accuracy of the evaluations tremendously, especially when frictional losses of the pipes are relatively high.

As a simple approach you can find the heads acquainted to the measured flows by using the QH curve of the pump performance chart. This performance chart you can obtain from ABSEL software.

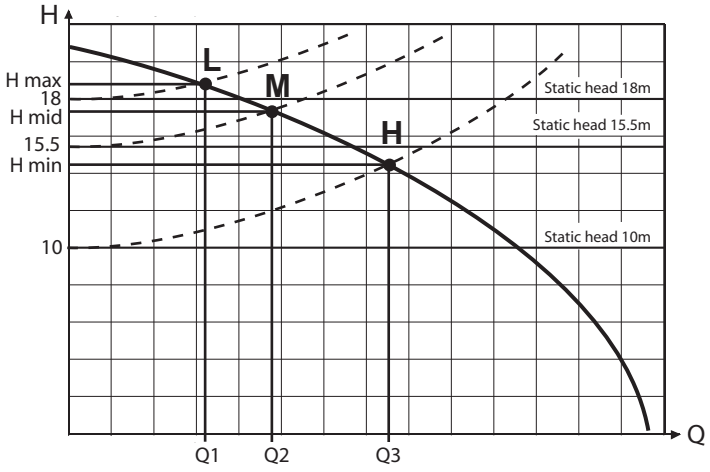

Figure 3-6 Pump curve with dynamic head added

3.2.4 *System curve*

A pump is almost always seen in a system of pipelines and valves. These give losses that the pump must overcome for a specific flow. With the system curve is the sum of the static height and pipeline system losses at a specific flow (*total head*). You may think that if two equal pumps parallel coupled are running the outflow will increase by a factor of 2. Sometimes it turns out, however, that the outflow will only increase a little. This is because the pipeline losses increase with increased flow and thus the total lift height. If you do not compensate for this, the calculation of the output flow and pumped volume will be incorrect in the case of several pumps running. This is especially true when we have great pressure losses in the pipe in relation to the static height PC 441 has two different ways to compensate for this.

1. One way is to manually set the parameters in the menu *Flow compensation* under menu ***Station flow > Meas. parameters***.
   Specifies the factors as a percentage of the pump capacity measured when the one pump is running (1 pump running = 100%). Set factors for 2, 3 and 4 pumps running. Set the parameters in the menu *System curve* to zero, which turns off automatic calculation (see 2 below).

   It can be difficult to estimate how much capacity decreases at the different operational cases.

2. Enter the duty point of the system curve for a pump.
   In menu *System curve* under ***Station flow > Meas. parameters*** set the duty point for a pump.
   System curve and duty point can be calculated manually or by using any calculation programs such as ABSEL PRO from Sulzer.
   Set the static and total lifting height (static and *total head*) at the specific flow. PC 441 can use this to calculate compensation factors for the outflow when more than one pump is running.
   After calculation menu *Flow compensation* shows the calculated factors.

NOTE! For this to work, each pump must have their pump curve entered in the following menu(s), *Menu pump 1-4 > Pump curve.*

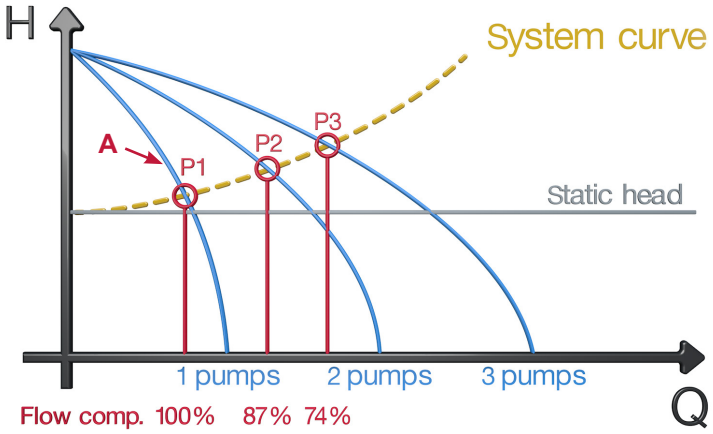

Figure 3-7 Flow compensation 3 pumps.
Enter the point “A” to the system curve menus.

NOTE! The easiest and most reliable way to obtain the system curve and the operating points for solo and multiple pumps operating at varying static head is to use a combined pipe work losses and pump selection simulation software package, e.g. Sulzer ABSEL. If the system curve and (if applicable) the variation of the static head are known from studies of the consulting engineers, the relevant values can directly be entered into the program. ABSEL also allows, to perform a very detailed pipe work friction loss analysis. The relevant pump and its impeller diameter are selected and all resulting duty points as intersection of pump (pumps in parallel) curves can be shown and transferred into the PC 441 pump curve input. See the example on the next page.

Example Figure 3-8 shows how the PC 441 handles the calculations when the pump curves and system curve are set:

4 pumps in parallel selected for 2000 l/s @ 10 m

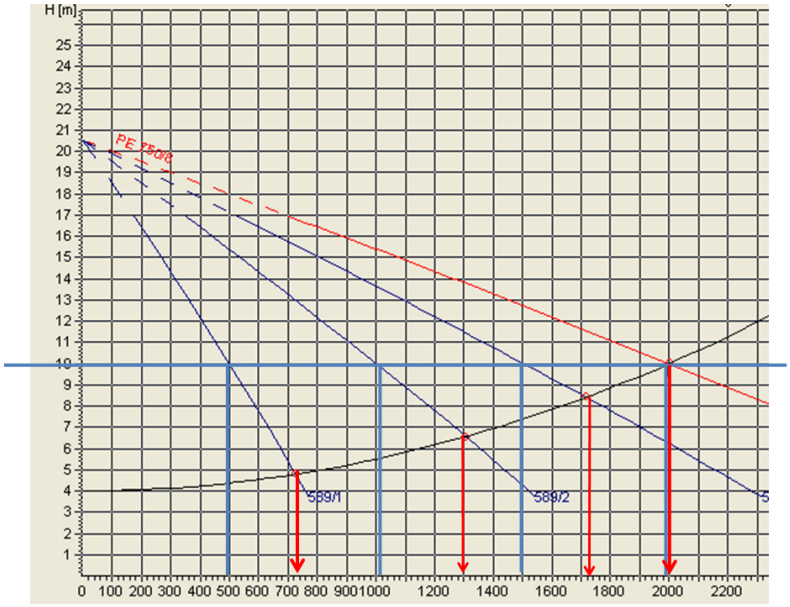

Figure 3-8

System curve
(Settings – Pump pit – Station Flow – Meas. Parameters – System Curve:
[When one pump is running])

Static Head Duty Point: ***4.00 meters***

Total Head Duty Point: ***4.8 meters***

Flow at Duty Point: ***740 l/s***

1 pump running

For this pump 740 l/s

When only 1 pump is running there is no need for any compensation factor, gives **100 %**.

2 pumps running

Total flow 1300 l/s

Meaning 1300 - 740 = 660 l/s more than 1 pump operating.
For the individual pump 1300 / 2 = 650 l/s.
That gives a compensation factor of **88 %**.

3 pumps running

Total flow 1720 l/s

Meaning 1720 - 1300 = 420 l/s
For the individual pump 1720 / 3 = 573 l/s.
That gives a compensation factor of **77 %**.

4 pumps running

Total flow 2000 l/s

Meaning 2000 - 1720 = 280 l/s
For the individual pump 2000 / 4 = 500 l/s.
That gives a compensation factor of **69 %**.

3.2.5 *Energy efficiency: kWh/volume unit*

Energy efficiency (kWh/volume) is a calculated value, from accumulated power consumption and accumulated outflow. Power consumption is available when a power monitor is attached to the system. Correct volume accumulation requires setup of pump capacity calculation (e.g. providing pit area), see section 3.2 regarding flow calculation.

Energy efficiency and all other accumulated values are kept in PC 441 as a grand total and as daily values, seven days prior. The energy efficiency value shown in main display, is today's value, that resets at midnight and updates on actual pump performance. This average day value gives a good reflection of actual pump energy usage and station performance.

3.3 *Overflow flow calculation*

There are several methods that can be used to measure and calculate overflow flow:

1. Use a conventional flow meter.

Advantage In most cases for standard PLC-systems this will increase the accuracy on the measurement.

Drawbacks Expensive and can suffer from detritus drying onto the sensor causing measurement issues, when the pit is operating in normal conditions. The sensor has to be cleaned regularly to ensure correct measurements.

2. Use the same sensor that is used for the level measurement in the pit and a weir and start the flow measurement on analog set point.

Advantage The investment cost is low and the sensor will not need to be cleaned regularly.

Drawbacks The system must have a very good resolution on the input to be able to measure the overflow correctly and a very accurate 0-point otherwise the measurement will be inaccurate.

3. Use the same level sensor that is used for the level measuring in the pit and a weir, and use a level switch to start the overflow measurement.

Advantage The Investment cost is low and the sensor not require regular cleaning. The accuracy of the 0-point does not affect the measurements due to the switch being used as a 0-point.

Drawbacks: The analog input needs to have a very good resolution to be able to measure the signal. The PC 441 has no problem with this, e.g. for a sensor with a range of 10 m, the PC 441 has the resolution of < 0.7 mm.

The third method is preferred and used in the PC 441

A digital overflow switch, like Sulzer MD 131 connected to a digital input indicates if an overflow is occurring independent of what the level signal shows. The PC 441 locks this actual level and the PC 441 starts calculating the overflow level / flow from this value.

This means that the level is measured with a very high accuracy from the correct 0 - point. If an exact flow measurement is needed a weir or channel should be used.

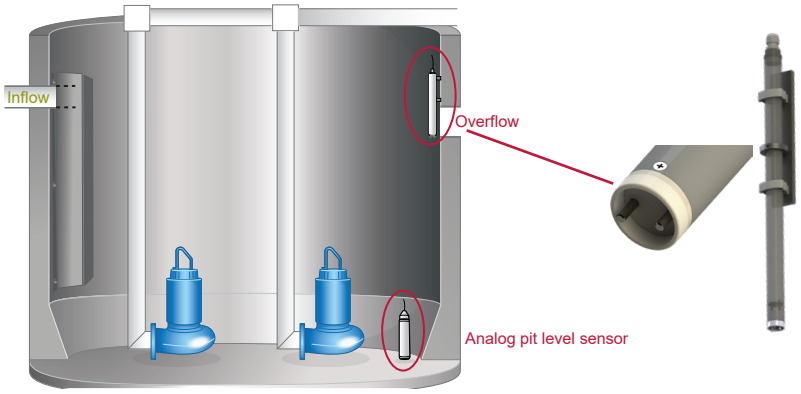

Figure 3-9 Overflow switch MD 131

The PC 441 program has all the functions required for calculating flow in weirs and channels. The overflow is measured separately for each pump pit. Number of overflows, overflow time, overflow level and the flow are logged.

The levels sensor is used as the actual level signal when the switch is activated it sets the 0 - point for the flow measurement. If no level switch or MD 131 is connected to the PC 441 the 0- point for the overflow can be set in "*Settings / Pump pit / Calc. overflow / Overflow detect* "manually. Overflow will be registered when the level exceeds preset overflow level on the level sensor.

NOTE! This set point has no function if a digital input (overflow switch) is set for overflow indication in the pump pit.

A delay can be set to prevent disturbances or waves triggering the switch. After this delay the flow measurement starts and the time of the overflow is recorded. A counter keeps track of how many times the pit has overflowed. The overflow time is only trigged when the level is higher than the stored (set) 0- point . If a float sensor is used for a pump pit, which has no level sensor, the overflow time counts all the time the float is active.

The overflow alarm will stop after the float goes back to normal and the stop delay to avoid errors in the counter and to compensate for the start delay.

NOTE! Overflow *alarm* and *counter* is only activated if alarm is enabled.

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3.3.1 *How to calculate overflows by using constants and exponents*

- In *Settings / Pump pit / Calc. overflow/* you can type in the constant and exponents manually.

There are two different exponents and two constants which can be set in PC 441, depending on the manufacturer and nature of the weir.
Those constants shall normally be provided by the manufactures. If you don't have the e2 and c2 values, you can set e2 and c2 to 0 (zero), only use the left side of the equation. For the basic weir types the c2 constant can be set to 0 (zero).

Overflow = = $h^{e1}c_1 + h^{e2}c_2$ $[m^3/s]$

Type of weir	Exp	Constant
Thompson 30°	2.5	0.373
Thompson 45°	2.5	0.569
Thompson 60°	2.5	0.789
Thompson 90°	2.5	1.368
Straight weir 1 m	1.5	1.76

For straight weirs with a width other than 1 m, multiply the constant with the width in meters. Ex. c = b * 1.76 (b in meters)

NOTE! If "*Locked on inflow*" is chosen, the PC 441 take the overflow to be the last calculation of inflow in the pit minus the capacity of the pumps which are running.

3.4 *Pump alternation*

PC 441 has several different methods in order to alternate pumps.

1. **Normal alternation**
   Pumps are started alternately according to a rotating schedule. The pump that started first in the pump cycle, will start last on the cycle. In this way the running time is divided equally between alternating pumps. Pumps that are not activated for alternation start and stop on their own start and stop levels.
   One can choose between alternation at each pump stop or when all pumps are stopped.
   Alternate at each pump stop method is preferred if the normal inflow to the pit is so high that the pumps don't have the capacity to empty it. If alternate when all pumps stop method is selected in this situation, the issue could arise that one pump is always running, hence no alternation will take place.
   Alternate when all pumps stop method is preferred if the pumps have the capacity to empty the pit at normal inflow. Then all pumps stop and the start/stop levels alternate.

Example 1 **Continuous high inflow. A single pump can't empty the pit.**

Start level pump 1 = 2.0 m
Start level pump 2 = 3.0 m
Stop level pump 1 = 1.0 m
Stop level pump 2 = 1.5 m

Method used:	Alt. each pump stops	Alt. when all pumps stop
Pit level increase At level 2.0 m	Pump 1 start	Pump 1 start
At level 3.0 m	Pump 2 start	Pump 2 start
Pit level decrease At level 1.5 m	**Pump 2 stop**	Pump 2 stop
Pit level increase At level 3.0 m	Pump 2 start	Pump 2 start
Pit level decrease At level 1.5 m	**Pump 1 stop**	Pump 2 stop
Pit level increase At level 3.0 m	Pump 1 start	Pump 2 start

If alternate when all pumps stop method is used, pump 1 will never stop

Example 2 **Temporary high inflow.**

Start level pump 1 = 2.0 m
Start level pump 2 = 3.0 m
Stop level pump 1 = 1.0 m
Stop level pump 2 = 1.5 m

Method used:	**Alt. each pump stops**	**Alt. when all pumps stop**
Pit level increase		
At level 2.0 m	Pump 1 start	**Pump 1 start**
At level 3.0 m	Pump 2 start	Pump 2 start
Pit level decrease		
At level 1.5 m	Pump 2 stop	Pump 2 stop
At level 1.0 m	Pump 1 stop	Pump 1 stop
Pit level increase		
At level 2.0 m	Pump 1 start	**Pump 2 start**
At level 3.0 m	Pump 2 start	Pump 1 start
Pit level decrease		
At level 1.5 m	Pump 2 stop	Pump 1 stop
At level 1.0 m	Pump 1 stop	Pump 2 stop

If alternate each pumps stop method is used, pump 1 always starts first.

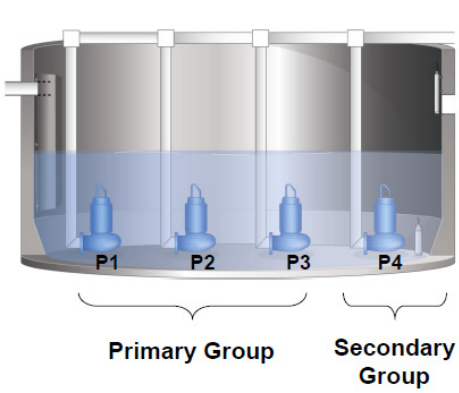
2. Asymmetrical alternation

The difference between asymmetrical and normal alternation is that the pumps are divided in to two alternating groups, primary and secondary group. Within each group the pumps are alternating as in normal alternation.
Normally pumps in primary group start first. After a adjustable number of pump stops in primary group pumps in the secondary group start first. The stop counter resets and at next pump cycle primary pumps start first again. If the pumps in the primary group do not have the capacity to pump down and the pit level continues to increase, the pumps in the secondary will start independent of the stop counter.

- Pumps divided in two alternation groups, primary and secondary.
- A group can have 1 to 3 pumps within.
- Adjustable number of starts in primary group before secondary group start.

Example:

Primary group contains pump 1 –3, and starts twice before secondary group starts which only contains pump number 4.



Function:

- Uneven running times
- Jog runs of spare pump
- Run pumps that has a tendency to block more often

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Value

- Spare pump in good condition when main pump/s breaks down
- Extend the service intervals and lower the maintenance costs
- Reduces the risk for overflow!
- Increased availability

	Pump 1	Pump 2	Pump 3	Pump 4
Start Sequence	1	2	3	
	4	5	6	7
	8	9	10	
	11	12	13	14

3. Runtime alternation
In addition to above, pump can be alternated dependent on there runtime. At exceeded maximum run time the pump will stop and an alternative pump will be started. The pump will only stop if there is at least one alternative pump that is ready to run.

3.4.1 *Max number of pumps running*

If the piping system cannot take the pressure when all pumps are running there is the possibility to set the max number of pumps that are allowed to run at the same time. This feature could also be used when there is a limit for the power load in the station.

If max number of pumps are running the system will not allow any other pumps to start

A pump is running when the relay of the pump is activated or there is a run confirmation from the pump.

If max numbers of pumps are running and the run confirmation is lost or some other errors that block the pump occur. The following will happen.

- Alarm for the error will be indicated.
- The faulty pump will be stopped.
- If alternation is active, after a delay a new pump will be started.
- If alternation is not active a new pump will start at the next start level.

If **Start Level Tracking** is activated the pump controller uses the start levels of the pumps to decide which pump to start. The pump with the highest start level exceeded has highest priority and will be started first. Alternating pumps have the same priority and alternate as usual.

Above can be used if the pumps have different capacities and one pump with high capacity shall pump alone at high pit levels and a pump with low capacity at lower levels.

Example 1

Start level tracking = On
Alternation = Off
Max Pump Running = 1
Start level pump 1 = 1.0 m
Start level pump 2 = 2.0 m
Start level pump 3 = 3.0 m

At level 1.0 m pump 1 start.
At level 2.0 m pump 1 stop and pump 2 starts
At level 3.0 m pump 2 stop and pump 3 starts

Above is valid for pumps that empty the pit. If the pumps are filling the pit the function is inverted.

Example 2

Start level tracking = On.
Max Pump Running = 1
Start level pump 1 = 1.0 m Alternation On
Start level pump 2 = 2.0 m Alternation On
Start level pump 3 = 3.0 m Alternation Off

At level 1.0 m pump 1 or pump 2 starts depending of which one started last pump cycle.
At level 2.0 m nothing happens.
At level 3.0 m pump 1 or pump 2 stop (the one running) and pump 3 starts.

This example show the possibility to have a number of pump alternating at low inflows and to start a powerful pump when the inflow is high

3.5 *Pump reversing*

In the *Settings / Common P1-P4 / Pump reversing* specifies which pump or pumps shall use the reversing function.

The reversing can be triggered on:

- Digital input “Pump Fail”
- Tripped motor protector (after auto reset)
- High motor current
- Low pump capacity
- Preset number of pump starts

If more than the set threshold for number of reverse triggers occurs within a preset time frame (default 5/60 minutes), no further reverse attempts are done within the set block time (default 24h), if manual reset not is required. Acknowledge of the Max reverse attempts alarm or a manual reverse from local control panel clears potential reverse block conditions.

Reversing when digital in pump fail active

If set to **YES**; Reverse cycle starts when digital input signal Pump Fail goes active. The signal must go back to inactive state before the pump start reversing. If not reversing cycle is aborted.

Reversing when Fallen motor-protector

If set to **YES**; Reverse cycle starts when the digital input signal Motor Protector goes active. Motor protector will be reset before the pump starts reversing. You must enable auto reset motor protector function for the pump. Set the cold down time and pulse time in the auto reset menu. If the motor protector reset fails reversing cycle is aborted.

Reversing when Low pump capacity

If set to **YES**; Reverse cycle starts on alarm for low pump capacity. For this function to work you need to enable the low pump capacity alarm in the pump alarms menu. After reversing, the function is disabled until a minimum of 10 new pump capacities calculations have been completed. When enabling the pump capacity calculation, the user must set the nominal capacity for the pump:

- In menu *Status / Pump X / Pump capacity*

Reversing on overcurrent

Reverse cycle starts when alarm for high motor current is activated. For this function to work you need to enable the alarm in the pump alarm menu. Use the alarm delay time to delay the start of reversing (don’t trigger on pump start current).

Reversing on start count

The revers cycle can be trigged after specified number of starts for each pump to eliminate clogs and ensure proper function. If this function is set to **YES**, the sub menu appears, and selectable number of starts can be specified for each pump. In this sub menu, the current start counters are displayed.

3.5.1 *Other settings regarding pump reversing:*

In menu *Settings / Common P1-P4 / Pump reversing*

- Set [**Reversing pump x**] to [**Yes**].
- Set [**Start rev. delay time**]. The time to hold the pump in off position before the start of pump reversing
- Set [**Rev. run time**]. The reversing run time.
- Set [**Max no. attempts**] After the reversing, the pump will start again. If the pump fails again, a new reversing cycle will begin. Here you set max number of attempts.

Pump reverse is considered successful when the pump has been running for the set time [**Start rev. delay time**] without any pump error.
On success the attempt counter is reset.
If the attempts counter reaches max number of attempts, an alarm will be generated and all further reversing stopped until motor protector alarm or pump fail alarms has been reset manually.

- Set [**Stop pumps before rev.**] to [**Yes**] if you want the other pumps to stop and stay blocked when reversing cycle run.

If [**Pump rel. when rev**] is set to [**ON**], the pump relay will be activated 1 sec after the reversing relay and will be deactivated 1 sec before the reversing relay is deactivated. Here pump relay is used to control the pump (on/off) and reversing relay is used to shift two phases before reversing.

If [**Pump rel. when rev**] is set to [**OFF**] only reversing relay is activated during reversing. Pump relay is always off during the reversing process.

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3.6 *Speed controlled pumps (VFD)*

PC 441 can control pumps connected to VFD in two ways, by the Analog outputs or by the optional RS-485 module CA 622. The module CA 622 offers a lot of advantages over running the VFD by use of the analog signals. The installation time and cost will be reduced and the accuracy in pump calculations will increase.

To control the pumps from the analog outputs

PC 441 main unit can control max two pumps on VFD because there are only two analog outputs on the PC 441. With the expansion unit CA 781 comes two additional analog outputs which make it possible to control two extra VFD pumps, four pumps in total, at the same time.

VFD pumps are mainly controlled by start/stop level and the digital outputs like fixed speed pumps. The analog output signals control the speed in the VFD unit(s) which drives the pumps. Normal start and stop levels are used to start and stop the VFD pump(s).

The built-in PID controller is used according to the constant level control method and outputs frequency set points to the VFD. The PID controller will raise the frequency when the water level rises above the set level and lower the frequency when the water level falls below the set level. In some cases, the control logic will override the output signal from the PID controller.

To control the pumps via the CA 622 module

CA 622 communicate with the VFDs by RS 485 field bus. The CA 622 unit is connected to the system via CAN bus. CA 622 is fitted with a galvanically isolated RS 485 communication port for communication with peripheral products such VFDs, soft starters and energy meters. CA 622 is always the Modbus master with all peripherals acting as Modbus slaves.

PC 441 has many predefined VFDs, the correct one must be chosen in the menus. All the predefined VFDs are options in the firmware of PC 441 and CA 622. If you can not find your brand and model of VFD; make sure that you have the latest firmware version in PC 441 and in CA 622. On Sulzer home page you can find the *Installation and user guide CA 622* (P/N 81307133) there you can see if your model of VFD is supported.

Configure the CA 622 module in PC 441 under – Settings – communication – Field bus units – CA 622 – YES

At start level the pump will start at max frequency, if the start level is higher than set point. Output signal is kept at max freq. until the set level is reached. If calculation of pump capacity is enabled the pump will run at max frequency, until the calculation is completed. If the pump is running at min frequency for an adjustable time you can set a force speed for pumping out the pit. The pump will go on force speed until stop level is reached (or set level).

If the pump is exercised, the pump will run on max frequency. When reversing the pump the specified Reverse Speed value will be used (50% default). In high tariff pre-pump down mode the pump will run on the same force speed as specified for min freq. time out.

If there is more than one pump connected to VFD, the pumps will be synchronized. The output signals will always be the same if the scaling is the same. The VFD is responsible for speeding up and slowing down the pump. PC 441 doesn't handle ramp times. The min and max frequency for the pump normally is set on the VFD.
The PID Controller also has adjustable min and max value for the output signal that can be used.

There is a possibility to run VFD pumps with two different *Set Points*, connected to day and night settings. PID operator settings are found under *Status*: ***Status / PID controller***.

3.6.1 *Configure PC 441 for VFD pump(s)*

- In *Settings / Pump x* menu: Set *Type of pump* to [**Speed controlled VFD**]
  If a second VFD pump is used. Set the same type for that.

- On the next level in the menu, [**Pcap comp. at min Freq**] (Pump capacity at minimum frequency), the pump capacity is always calculated when the pump is running at max speed. When the pump is at lower speed the capacity will be lower. Enter the compensation for that here.
  Setting this parameter to 50 % means that the capacity at min speed (freq.) is half of the max speed capacity.

NOTE! This is important for outflow and pumped volume calculation.

- In *Settings / Pump x* menu: Set the **start** and **stop** level for the pump, the start level should be higher than the set level on the PID controller. The stop level should be lower than the set level.

- In *Settings / Analog outputs / Analog output 1* menu:
  Set *Output function* to [**PID controller**].
  The same for Analog output 2, if a second VFD pump is used, the output should be connected to the frequency input on the VFD

- In *Settings / Digital outputs*; Set *output function* [**Pump relay**] as for fixed pumps. The output should be connected to the "*Run input*" on the VFD.

3.6.2 *PID settings*

- In *Show status/PID controller* menu, Set the *Set point* value according to your set level.
- In *Settings / PID controller / Set point* menu:
  You can set **max** and **min** levels for the set point and a **start set point**.
- In *Settings / PID controller / Output signal* **menu**:
  Here you can set the **max** and **min** values for the output signal (min/max freq).
  0 % = 4 mA and 100 %=20 mA., with the frequency being dependent on the setting of the VFD.
- In *Settings / PID controller / PID parameters* **menu**:
  Here you set the parameters that control the behaviour of the PID Controller, the setting of these parameters are outside the scope of this document.
- In *Settings / PID controller / Speed control VFD* menu
  If the pump is running at min frequency for an adjustable time you can set a **force (lock) speed** for pumping out the pit. Here you set the **Min pump speed, Lock speed delay** and **Lock speed** for the function.
  If locked speed **delay = 0** the function is disabled.

3.6.3 *Variable frequency drive auto reset*

As of firmware version 1.70, the "Auto reset motor protector" functionality has a selection for "*Conventional*" or "*Motor drive*" protection.

See *Settings – Common P1-P4 – Motor protector auto reset*

If [**Motor drive**] is selected, trip detection and drive reset is done over field-bus (in parallel with optional discrete motor protector input and reset output).

If reset fails more than "Max no attempts" (default 3 times), an alarm for "Motor protector reset error" is generated and pump is blocked until alarm is acknowledged.

The [**Max no attempts**] error counter is reset when the auto reset sequence is considered successful. This happens when the pump runtime reaches the set [**Pause time**] (cooling time) before auto reset.

4 FURTHER EXPLANATIONS ABOUT SOME DIGITAL/ANALOG OUTPUT/INPUT TYPES

4.1 *Digital output: Logic IO*

One of the options in the functions of *Digital out* is **Logic IO**. This function is especially useful if you want to trigger an output signal when more then one criteria or events are needed to be for filled for an output signal. There are up to four different criteria that can be used to trigger the output signal. Those IO bits can interact as a *True OR, Inverse OR, True AND* and *Inverse AND* functions or as a combination of these for one and the same output. The output signal can be set to *Normally closed* or *Normally open* (NC/NO).

This IO can be used to get a specific output signal for one or several indicators from CA 441 or CA 442 e.g. high temperature, leakage, or any others IO-bits of your choice.

- An example of where this function can be useful is when you want to have one digital output signal to be active for a specific alarm in any pumps, for example High temperature alarm.

The following diagram is an example how three IO-bit interact with each other in the function of Logic IO:

IO-bit 1 "OR"	IO-bit 2 "OR"	IO-bit 3 "AND"	Output
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

In this example there are only three IO-bits involved. But you have the option to use up to four IO-bits.

See the *Comli/Modbus register manual* regarding the IO-bit list.

Example In the example below, DO 1 in PC 441 will be activated if any of the temperature alarms connected to CA 442 trips.

To configure, first refer to the IO-bits in *Comli / Modbus manual* for PC 441 and further to *Pump status* on chart 1.2;there you find IO-bit 28, 29 and 30 which are for the different IO-bits for temperature alarms on pump 1:

IO-Bit P1	IO-Bit P2	IO-Bit P3	IO-Bit P4	Function	Note
18	50	82	114	Pump blocked	DI not in auto
19	51	83	115	Pump alarm blocked	Alarm ackn. required
20	52	84	116	Pump fail	DI Pump fail
21	53	85	117	Fallen motor protector	Remote reset possible
22	54	86	118	Fallen temperature protector	DI Temp. protector
23	55	87	119	DI Leakage	DI Leakage
24	56	88	120	Pump blocked Field Bus Error	Com. Failure (CAN)
25	57	89	121	Leakage 1 (oil chamber)	CA 441
26	58	90	122	Leakage 2 (connect chamber)	CA 441
27	59	91	123	Leakage 3 (motor housing)	CA 441
28	60	92	124	High temp 1 (stator wiring)	CA 442 T1 and / or T4
29	61	93	125	High temp 2 (upper bearing)	CA 442
30	62	94	126	High temp 3 (lower bearing)	CA 442
31	63	95	127	High vibrations	CA 442
32	64	96	128	Wrong phase order	CA 443
33	65	97	129	Phase missing	CA 443
34	66	98	130	Dry run	CA 443

Figure 4-1 Above chart is an extract from the Comli/Modbus manual for PC 441 - Pump status.

Then in the menu in CA 511 go into:

- *Settings / Digital outputs / Digital output 1* to [**Logic IO**] and type in according to picture below:

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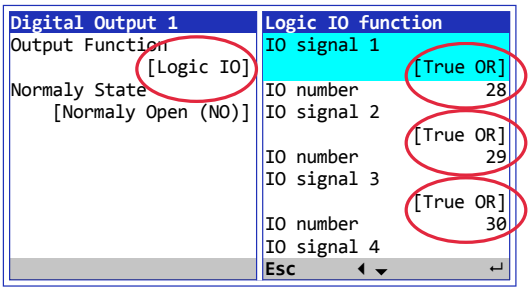


The result will be that DO 1 will be activated if any of the alarms for temperature are triggered.

4.2 *Digital output type: data reg. setpoint*

With the Digital Output Type "*Data reg. Setpoint*" a set point can be tied to any analog signal, internal or external. By using the registers defined in the Modbus manual and entering them in the function as in the example below, you can achieve this function.

Example We have a sulphuric gas monitoring device connected to an analog input signal. We use A.IN5 for the sulphuric meter. In this case we want a switch on DO 1 when the concentration of gas is or above 10.0 ppm. We also want the output signal to switch back at 1.0 ppm (a hysteresis of 9 ppm). This digital output 1 controls a fan which evacuates the gas from the station.

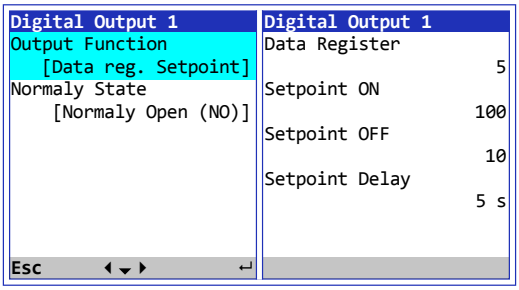
NOTE! According to *Comli/Modbus reference manual* (p/n 81307126) we find that the register for analog input 5 is to read on **register 5**; see figure 4-2 below. We note as well that the scale factor is 0.1 (*i.e. the value in reg.5 is multiplied by 0.1 to get actual value in engineering units*).

Reg. no	Description	Scale factor	Unit / Note
1	A.IN 1. Pit level	0.01	m or ft
2	A.IN 2. Current P1/User	0.1	A / User defined
3	A.IN 3. Current P2/User	0.1	A / User defined
4	A.IN 4. Current P3/User	0.1	A / User defined
5	A.IN 5. Current P4 / Pressure / User	0.1	A / bar / User defined
6	Inflow	0.1	l/s or GPM
7	Outflow	0.1	l/s or GPM
8	Overflow level	1	mm or Inch
9	Overflow flow m3/h	0.1	m3/h or GPM

Figure 4-2 Above table is an extract from the Comli/Modbus manual for PC 441 – *Analog inputs/Output in engineering units*.

The function is configured in the menu of CA 511 as follows: Under *Settings / Digital outputs / PC 441 Main (**or** CA 781 Exp.-) Module / Digital output 1* to **[Data reg. setpoint]** according to picture below.

And then type in the set point value 100 for ON state and the value 10 for OFF state



The *Setpoint ON=100* correspond to the value of 10 engineering units and *Setpoint OFF=10* correspond to 1.

Above is an example of how to get an analog sensor signal to change state on a *Digital Output* signal via ***Data reg. setpoint*** function.

4.3 *Digital output type: external reset alert*

External reset alert is active during the configured *Pre alert time* before an automatic reset of motor protector is performed, or alarms are reset from a digital input type **Alarm reset** with reset delay > 0.

Example: The pumps are blocked because one or several alarms.

A remote alarm reset may cause a blocked pump to start. If service staff are nearby they could be notified by a siren or flashing light connected to the digital output, that a possible pump start is pending.

4.4 *Digital input type: block remote date*

When this digital input is activated, all changes in the settings made remotely through the modem port by AquaProg or any SCADA system is blocked. Changes made locally by AquaProg via the service port are not blocked. This is for a safety precaution to block any changes done remotely.

Option: Allow set clock: Yes/No

4.5 *Digital input type: mixer and drain pump blocking*

There is a function where you can set a digital input to block the mixer or drain pump. It is possible to set an alarm with free alarm text for each input. When the signal is activated the mixer/drain pump will stop and block. If an alarm is enabled, it will be come active.

In menu *Settings / Digital Inputs / Digital In x*

Set Input function to [**Mixer block**] or [**Drain pump block**]. In the same menu set user alarm text and alarm priority.

4.6 *Analog output type: data register*

With the Analog Output Type *Data register*, any analog signal, actual or calculated can be used as a 0/4-20 mA output signal. By using the registers defined in the Modbus manual, you can achieve this function.

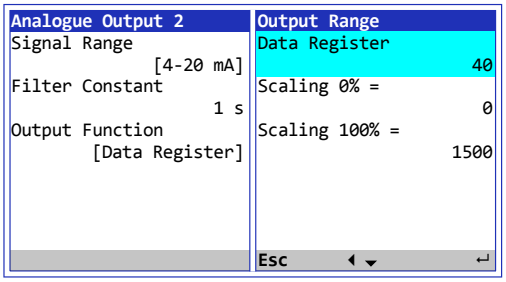
Example We want to have a 4-20mA analog output signal tied to stator temperature 1 on pump 1. We also want the output signal to be 4mA at 0°C and 20mA at 150°C.

NOTE! According to *Comli/Modbus reference manual* (p/n 81307126) we find that the temperature stator pump 1 is in register **40**; see figure 4-3 below. We note as well that the scale factor is 0.1 (*i.e. the value in reg.40 is multiplied by 0.1 to get actual value in engineering units*).

Reg. no	Description	Scale factor	Unit / Note
40	Temperature 1 P1	0.1 °C or °F	Normally Stator Pt 100
41	Temperature 2 P1	0.1 °C or °F	Normally upper bearing
42	Temperature 3 P1	0.1 °C or °F	Normally lower bearing
43	Temperature 4 P1	0.1 °C or °F	Normally Stator
44	Vibrations P1	0.1 mm/s or 0.01 Inch/s	
45	Temperature 1 P2	0.1 °C or °F	Normally Stator Pt 100
46	Temperature 2 P2	0.1 °C or °F	Normally upper bearing
47	Temperature 3 P2	0.1 °C or °F	Normally lower bearing
48	Temperature 4 P2	0.1 °C or °F	Normally Stator Pt 100
49	Vibrations P2	0.1 mm/s or 0.01 Inch/s	Normally Stator

Figure 4-3 Above table is an extract from the Comli/Modbus manual for PC 441 – Analog inputs/Output in engineering units

The function is to setup in the menu of the CA 511 under; *Settings / Analog outputs / PC 441 Main (**or** CA 781 Exp.-) Module / Analog output 2* to **[Data register]** according to picture below.



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Scaling 100% should correspond to the data value at 20mA, in this case 1500 for 150°C.

Above is an example of how to configure a Pt 100 Stator temperature transmitted output as a 4-20 mA signal via Analog output.

4.7 *Analogue input: Secondary pit level sensor*

This input is a comparison to the actual level sensor. Useful in dual communicating pits. A pit-alarm can be set as deviation from the actual level sensor and the secondary pit level. This level sensor is only for comparison.

5 COMMUNICATION AND AQUAPROG

5.1 *Communication*

There are three ports for communication. One USB and two RS 232, of these two RS 232 there is only one which can be connected to a modem. The protocols are Modbus (RTU or TCP) or Comli. Other protocol could be available if there is an external converter from Modbus or Comli to requested protocol.

5.1.1 *Com port (screw terminals 48 – 52)*

This port is designed for modem communication and supports Modbus (RTU or TCP) or Comli protocols. Other protocol such as TCP/IP can be used by using modem which converts the signal. The port is configured as Modbus RTU default with baud rate: 115200, parity: None, Handshake: Off, and Protocol ID: 1, Message time out: 2 s Optional: Station name.

On this port there are possibilities to change the properties of baud rate (300 – 115200), protocol ID (1 – 255) and station ID (1 – 65535), Parity (None, Odd, Even) and handshake (on/off) as well. Necessary for AquaWeb connection is the **Station ID** set correctly and that the protocol ID is set to **1**!

5.1.2 *Service port (9-pols D-Sub in the front)*

This port follows "***Com port***" in protocol and has always protocol ID:1 there are however possibilities to change the properties of baud rate separate from *Com port*. This port is considering to be used for download configuration and updating the firmware by using AquaProg.

5.1.3 *USB port (USB type B in the front)*

This port is following the protocol from "***Com port***" and is only for upload/download configuration by using AquaProg.

5.1.4 *Modem*

Only the port at the screw terminals (Com port) is supporting modem.
There are several different modems which can be used on PC 441. Normally is a GSM modem connected to the PC 441 which calls by GSM to a SCADA trigged by an event or that a SCADA calls up for catching log values. If PC 441 is connected to AquaWeb, then must the Sulzer CA-modem be working as a *AquaWeb client* modem. It's also possible to connect a TCP/IP or analog modem.

Analog modem For fixed telephone line. Signals before answer, minimum 1. Hayes settings normally works with default. Settings under *Communication – Modem – Modem connected* in the PC 441 shall be **[Analog modem]**.

GSM modem For GSM connection, signals before answer, minimum 1.
Hayes settings normally works with default. Set PIN code if SIM card is equipped with one. Settings under *Communication – Modem – Modem connected* in the PC 441 shall be set to **[GSM modem]**.

NOTE! The PIN code can be deleted with a cell phone.

GPRS modem Based on internal TCP/IP stack in Cinterion (former Siemens) GSM/GPRS modules. All data access is via the Hayes commands defined by Cinterion. Most common is dynamic IP addressing. GPRS default is the pump controller connects to TCP server in Sulzer AquaWeb system. If Scada system should connect to station see TCP-server section. Communication via GSM and GPRS uses the same network. If subscription allows, both can be used one at a time. Set PIN code if SIM card is equipped with one (deleted on AquaWeb SIM cards).

AquaWeb client Used only when a subscription on AquaWeb exist or when the customer has a different APN. If use a different APN, the SCADA system must handle the Heartbeat.

Heart beat interval 10 min (default). Can be adjusted but can raise costs if set to low.
Server TCP port; Must be the same as in GPRS Server (default 2000 for AquaWeb).
Servers IP address; The Public/global IP (normally in fire wall/router) address to the GPRS Server must be a static IP address.
APN is provided by SIM card supplier. GPRS APN part 1 and GPRS part 2. If APN string is long it can be divided between the two parts. (Default APN is aquaweb.cxn). SMS fallback: 0046708728550 for AquaWeb only!

Settings under *Communication – Modem – Modem connected* in the PC 441 shall be set to [**CA 52x AquaWeb Client**]. Set GPRS User name and Password if required by the subscription provider. GPRS Event Log and Heart beat operator scan for error search only. Default off.

TCP/IP converter For fixed TCP/IP line. Communication through RS 232 to external IP converter. This is comparable to a direct line and in the settings under *Communication – Modem – Modem connected* in the PC 441 shall be **[Modem connected NO]**.

TCP-Server If you have a SIM card subscription with a fixed IP address, then you can connect the station by GPRS on a local network by using a Sulzer modem and set the function in modem settings to *FIX IP TCP LISTEN* – TCP-server.

FIX IP TCP LISTEN requires a SIM with fixed IP address from the provider on the station so that an external SCADA can contact remotely.

Settings under *Communication – Modem – Modem connected* in the PC 441 shall be set to [**FIX IP TCP LISTEN**].

Other types of modem Profibus gateway and radio modems etc.

Connect a modem according to figure 4-4 to the Com port on PC 441. On CA 511 press *Arrow down/Settings/ Arrow right/Communication/Enter.*

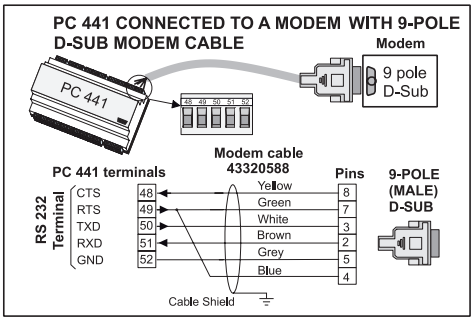

Figure 5-1 Connect PC 441 to 9-Pole D-Sub. Cable can be ordered, item no 43320588.

5.1.5 *Com Echo PC 441*

When communication with multiple units over RS 232 port there is a possibility to activate communication echo between communications ports, all data on Com:1 are echoed to Com:2 and vice versa. All units must have unique Comli/Modbus ID.

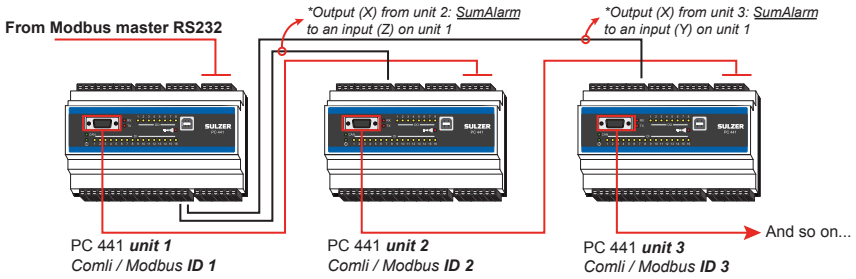

Figure 5-2

If dial-up modem is used; it has to be on unit 1. This unit is the only unit which can initiate modem to dial-up alarms. That means in a combined alarm from additional controllers to generate alarm dial-up has to go through unit 1. Unit 1 needs a separate alarm input signal from each unit to trigger the alarm call up. Likewise, an alarm output from each unit has to be connected to a separate input on unit 1, see figure 4-5. When using direct communication; these feedback signals are not needed.

Activate Com Echo in the menu of CA 511:

Settings – Communications – Service Port – Com. Echo – Yes

5.1.6 *Alarms*

There are mainly two ways to handle alarms from PC 441; through modem or direct communication. Most common is a GPRS/GSM modem solution. The alarms can be transferred to a SCADA system or as a SMS to a mobile phone.

When using the GSM functionality to send SMS, there are possibilities to set up four attempts to call out. These attempts can be set as parallel calls; call multiple numbers in a sequence. Or as back up call; call first number in the attempt list and then wait for acknowledgement before trying with same number again in total three times, and then call next number in the attempt list. As soon as the substation gets an acknowledgement of an alarm call out; it will terminate the outgoing calls. Alarms will be sent out at ON/OFF state and A-alarms or A+B-alarms depending of settings.

5.2 *AquaProg*

AquaProg is Windows based software specially designed for setting and monitoring of Sulzer substations. Communication with the controller is established via RS 232, USB or Modem (analog or GPRS) connection between substation and computer. To communicate to PC 441 there has to be AquaProg version 4.86 or later.

Features

- Configuring substation PC 441 together with CA 441 - 443
- Checking and acknowledging alarms
- Checking events
- Collecting log data
- Showing the display and LED of the substation
- Showing the status of the in- and outputs of the substation
- Collecting and sending the configuration data of the substation
- Substation software upgrade

5.2.1 *How to set up AquaProg*

A detailed description of AquaProg is outside the scope of this document, please see AquaProg manual P/N 81300037 on www.sulzer.com.

PC 441 communicates by default with **Modbus RTU** and has **Comli ID 1** and **Station ID 1**. The baud rate is **115200**, **8 data bits** and **No Parity**.

To create a new substation follow the text below.

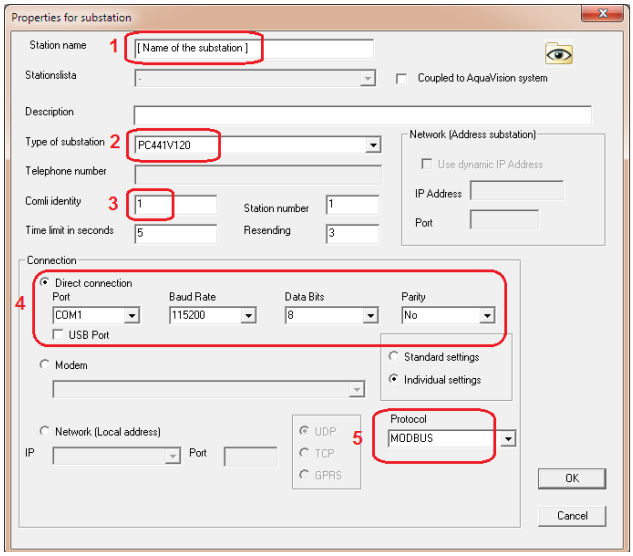

Figure 5-3 Create a new substation in AquaProg.

1. Give your station a name
2. Choose “Type of substation” – PC441V1xx
3. Comli ID is critical for AquaProg, default is 1. If there is wrong station ID – AquaProg can handle that, but **not** wrong Comli ID. If you use the ***Service Port*** or the ***USB*** –then it’s always ***Comli ID = 1***.
4. C your com port and the properties according to your substation
5. Modbus is default
6. Press OK

After this configuration, you can call the substation and change the properties as normal.

5.3 *Cross reference table*

Cross reference is available in firmware 1.22 or later and in AquaProg version 4.90 or later.

Cross reference table can be set-up in AquaProg to optimise the data flow in Comli/Modbus to the supervisory system. Register 0-254 (telegram type 0 and 2) can be defined to hold preferred data by a cross reference table and can be set for data of any register. See further information in *Comli/Modbus register manual.*

There is the possibility for certain rescaling of data, e.g. *Running time* in seconds can be rescaled to minutes with the factor 60. The scale factor can be between 0-32767. With the factor 0 no rescaling is done.

Certain supervisory systems only handle positive values when using the Comli protocol. Settings can be selected for 2's compliment +/-32767 or pure integers 0-65535. If positive numbers are used will 0 be returned for negative values.

The extended Comli telegram (max 65535 reg.) is not affected by the cross-reference.

Together with the cross reference table there is a possibility to set an individual scale factor between 0 and 32767, for each position in the cross-reference list. When reading data, the value is divided with corresponding scale factor. When writing data the value will be multiplied with corresponding scale factor. Scale factor is ignored when set to 0.

For data in double registers (32 bits), the highest register number should be used together with scale factors. Writing to the highest double register number will also set data in the lower register number if scale factor is set. If scale factor is set to zero, each register is handled individually.

Many registers allow negative values (signed 2-complement data). This can cause some systems to treat negative data as large positive numbers (ex. –1 is read as 65535 by the system).

To avoid any issues there is a possibility to individually set cross reference registers to only positive data. Negative values will give zero readout.

NOTE! Cross reference table are only available to set up in AquaProg. In the menus of CA 511 you have possibility to activate or deactivate the table.

IO-bits IO 0-255 can be redirected to any IO number when cross reference table is enabled.
IO-bit 0-255 is also available in register 312-327. Cross reference enabled is useful in systems that optimise data screens into single messages.

To activate the cross reference table in menu:

- *Settings / Communication / Protocol / Register Cross Ref*; Set to ON [or OFF]

By using AquaProg you can also save and download your cross reference table to other PC 441 units.

6 SETTINGS

6.1 *Select language*

1. Choose the menu item *Select language* and press *Enter* twice.
2. Enter the pass code *Operator* (default is 2). Press *Enter*.
3. Scroll to the language of your choice by using the *Up/down* buttons.
4. Press *Enter* and then the *Left/backward* arrow.

6.2 *Overview of settings*

The menu item *Settings* has 21 submenus with a large number of settings that need to be entered by the system administrator, although they all have sensible default values. The following are the 21 submenus:

All settings require a pass code for *System* except some settings under the submenu *System* and the start/stop levels under submenus *Pump 1, Pump 2, Pump 3* and *Pump 4*, which only require a pass code for *Operator*.

Each of the 21 submenus are described in separate tables. The exact procedure how the tables should be interpreted is exemplified below for the settings under the menu item *Settings* > *System* > *System alarms* > *Power fail* in Table 6-1.

1. Choose the menu item *Setting* (or choose *Main*, select *Settings* by using the *Up/down* buttons and press *Enter*).

The topmost menu item *System* will be selected. Press *Enter* again.

2. Select the menu item *System alarms* by using the *Up/down* buttons, press *Enter*.
3. Select the menu item Power fail, press *Enter*.
4. Select the menu item A*larm type*, press *Enter* and enter the pass code for *System*. Choose one of (*Inactive, B-Alarm, A-Alarm*) and press *Enter*.
5. Select the menu item *Alarm Delay*, press *Enter* and give the pass code for *System*. Set the number of seconds and press *Enter*.

The pass code will be valid as long as you stay in the setting menus, for step 5 above, you may not need to enter the pass code. How the buttons on the panel are used is described in Chapter 1 Overview.

6.3 *System settings*

Table 6-1 shows the complete list of system settings.

Table 6-1 System settings, under the menu item 'Settings > System'

Submenu	Submenu	Setting	Value	Passcode	Comment
––		Select Language	Select a language	Operator	Same as the setting described in Section 6.1
		Station Application	Pump Controller	System	
			Pump Monitor		Pump Monitor: See Section 3.1
		Select Units	(Metric units, US units)	System	Metric: m, m^2, m^3, Liters/second (liters/s), bar, mm, ºC US: ft, ft^2, gal , GPM (gal/min), psi, ra ºF
		Date Format	(YYYY.MM.DD, DD.MM.YYYY, MM.DD.YYYY)	System	
		Set Date	Date	System	
		Set Time	Time		
		LCD Backlight Timeout	Minutes		If you enter a value of 0, the backlight will always be on.
		Level Display Graphics	m, ft		
		Hide Start - Stop Levels	No, Yes		
		Alarm Alert On Time	Minutes		
		Alarm Alert Pause Time	Minutes		
		Main Power 3~Voltage	Volts		Used as set points for system alarms.
		Main Frequency	Hz		
System Alarms	Power Fail	Alarm Type	(Inactive, B-Alarm, A-Alarm)	System	
		Alarm Delay	Seconds		
	Incoming Phase Missing	Alarm Type	(Inactive, B-Alarm, A-Alarm)		
		Alarm Delay	Seconds		
	Low Supply Voltage	Alarm Type	(Inactive, B-Alarm, A-Alarm)		
		Alarm Delay	Seconds		
		Limit	Volts		
		Hysteresis	Volts		
	NV Checksum Error	Alarm Type	(Inactive, B-Alarm, A-Alarm)		*NV Checksum Error* is issued if the checksum for the nonvolatile memory indicates error.
		Alarm Delay	Seconds		

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Submenu	Submenu	Setting	Value	Passcode	Comment
System Alarms	Personal Alarm	Alarm Type	(Inactive, B-Alarm, A-Alarm)	System	
		Alarm Delay	Seconds		
		Max Time to Reset	Minutes		After this time, the maintenance person must reset the timer (by pushing any button), or a Personal Alarm is sent out after *Alarm Delay*
	Wrong Phase Order	Alarm Type	(Inactive, B-Alarm, A-Alarm)		Signals from main power monitor CA443-0. Limits here are the deviations from the settings in the *Main power* and the *Main frequency* menu. Limits also used as set points for pump blocking.
		Alarm Delay	Seconds		
	Over 3~ Voltage	Alarm Type	(Inactive, B-Alarm, A-Alarm)		
		Alarm Delay	Seconds		
		Limit (+)	Percentage		
		Hysteresis	Percentage		
	Under 3~ Voltage	Alarm Type	(Inactive, B-Alarm, A-Alarm)		
		Alarm Delay	Seconds		
		Limit (-)	Percentage		
		Hysteresis	Percentage		
	Unbalanced 3~ Voltages	Alarm Type	(Inactive, B-Alarm, A-Alarm)		
		Alarm Delay	Seconds		
		Limit (+/-)	Percentage		
		Hysteresis	Percentage		
	High Frequency	Alarm Type	(Inactive, B-Alarm, A-Alarm)		
		Alarm Delay	Seconds		
		Limit (+)	Percentage		
		Hysteresis	Percentage		
	Low Frequency	Alarm Type	(Inactive, B-Alarm, A-Alarm)		
		Alarm Delay	Seconds		
		Limit (-)	Percentage		
		Hysteresis	Percentage		
Set Password		Operator	Integer	Operator	For Operator access. The code may be 1 to 4 digits long. The factory default code is 1.
		System	Integer	System	For System (administrator) access. The code may be 1 to 4 digits long. The factory default code is 2.
Log and Alarm Reset		Analog Log	Cancel	System	
			Reset All		
		Alarm & Events	Cancel		
			Reset All		

6.4 *Pump pit settings*

Table 6-2 shows the complete list of settings under the submenu *Pump Pit*.

Table 6-2 Pump pit settings, under 'Settings > Pump Pit'

Submenu	Submenu	Submenu	Setting	Value	Pass code	Comment
Level Sensor Type			Select Type	(Analog, Start/Stop Floats)	System	
Min Time Relay Changes			Min Time	Seconds	System	To minimize power surges or spikes caused by pumps starting or stopping simultaneously, there should always be a minimum time between two relays switching states.
Max No. Pumps Running			Set Max No. Pumps	(Max 1 Pump, Max 2 Pumps, Max 3 Pumps, No Limit)	System	Set the number of pumps that are allowed to run at the same time.
			Start Level Tracking	(OFF, ON)		If activated the pumps with the highest start level reached have highest priority and will run first.
Pump Alternation	-		Type of Alternation	(OFF, Normal, Asymmetrical)	System	
			Alternate after	(Every Pump Stop, Last Pump Stop)		
			Pump 1 Alternate?	(NO, YES)		
			... ...	... ...		
			Pump 4 Alternate?	(NO, YES)		
			Runtime Alternation?	(NO, YES)		In addition to the normal or asymmetrical alternation, you can set the controller to switch pump when that pump has been running continuously for a certain period of time.
			Runtime to Alternation	Minutes		
	Asymmetrical Altern.		P1 in Primary Group?	(NO, YES)		Will switch to the secondary pumps only after a certain number of stops of the primary pumps.
			... ..	... ...		
			P4 in Primary Group?	(NO, YES)		
			No. Stop to Group Alt.	Integer		
Alternative Stop Level			Function Active?	(NO, YES)	System	Let the pump run below its normal stop level. After the alternative stop level has been reached the stop of the pump can be delayed by setting the *Stop Delay* parameter.
			Pump Stop Level	m, ft		
			After No. Starts	Integer		
			Stop Delay	Seconds		
			P1 Use Stop Level?	(NO, YES)		
			... ...	... ...		
			P4 Use Stop Level)	(NO, YES)		
Level Change Start/Stop			Start Function Active	(NO, YES)	System	If the level increases at least *Level Change to Start* during the time period *Per*, then one pump will start. If the level continues to increase that much, the next pump will start.
			No. Pump Run to Start	(No Limit, Min 1 Pump, Min 2 Pumps, Min 3 Pumps)		
			No. Pump Run to Start	(No Limit, Max 1 Pump, Max 2 Pumps, Max 3 Pumps)		

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Submenu	Submenu	Submenu	Setting	Value	Pass code	Comment
Level Change Start/Stop			Level Change to Start	m, ft	System	If the level increases at least *Level Change to Start* during the time period *Per*, then one pump will start. If the level continues to increase that much, the next pump will start
			Time period (Per.)	Minutes		
			Stop Function Active?	(NO, YES)		If the level decreases more than *Level Change to Stop* during the time period *Per*, then one pump will stop. If the level continues to decrease that much, the other pump will stop.
			No. Pump Run to Stop	(No Limit, Min 1 Pump, Min 2 Pumps, Min 3 Pumps, Min 4 Pumps)		
			No. Pump Run to Stop	(No Limit, Max 1 Pump, Max 2 Pumps, Max 3 Pumps, Max 4 Pumps))		
			Level Change to Stop	m, ft		
			Time Period (Per.)	Minutes		
Station Flow	Meas. Parameters	-	Inflow Calculation	(OFF, ON)	System	
			Pit Shape	(Rectangular, Conical)		
			Pump Function	(Emptying Pit, Filling Pit)		Is the pump filling or emptying the pit?
			Calc. Interval Inflow	Seconds		Time interval between measurements.
		System Curve	Static Head Duty Point	m, ft		Used for outflow calculation if any parameters are set to 0 the function is disabled and normal flow compensation are used. See Section 3.2.3
			Total Head Duty Point	m, ft		
			Flow at Duty Point	Liters/second, GPM		
		Flow Compensation	2 Pumps running	Percentage		100% means that 2 pumps deliver twice as much as a single pump. 50% means that 2 pumps deliver not more than a single pump. See Section 3.2.3
			3 Pumps running	Percentage		
			4 Pumps running	Percentage		
	Pit Area		Level 0	Fixed at 0 m, ft		You can specify the shape of the pit by specifying the area at 10 different levels from the bottom of the pit, level 0, to the top, level 9.
			Area 0	m^2, ft^2		
			... ...	... ...		
			Level 9	Fixed at 9 m, ft		
			Area 9	m^2, ft^2		
Calc. Pump Capacity			Pump Cap. Calculation	(OFF, ON)	System	For submersed pumps, set *Min Level for Calc* to be the top of the pump - it improves accuracy. Calculation starts after *Start Delay*, when pump flows are stabilized, and goes on for *Calculation Time*. *Stop Delay* does not affect pump capacity calculation, but the calculation of the inflow is inhibited during *Stop Delay* after the pump stops as the flow stabilizes.
			Max Level for Calc.	m, ft		
			Min Level for Calc.	m, ft		
			Start Delay	Seconds		
			Calculation Time	Seconds		
			Stop Delay	Seconds		

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Submenu	Submenu	Submenu	Setting	Value	Pass code	Comment
Calc. Overflow			Overflow Detect	(OFF, Overflow Sensor; Level Limit)	System	To detect overflow, an overflow sensor is much more accurate than a threshold from the level sensor. By setting parameters (exponents and constants) the overflow can also be accurately measured by a calculation. 'Lock on inflow' simply uses the historical value of inflow. *Level Limit* is the level at which overflow is expected. Note: not as accurate as using an overflow switch. See Section 3.2
			Level if Limit Used	m, ft		
			Overflow Calculation	(Exp + const, Lock on Inflow)		
Calc. Overflow			Exponent 1	Number	System	Overflow = $h^{e_1}c_1 + h^{e_2}c_2$ (m³/s or ft³/s) h = height of water (m or ft) See Section 3.2.1
			Constant 1	Number		
			Exponent 2	Number		
			Constant 2	Number		
Backup Run			Pump 1 Backup Start	(OFF, ON)	System	If the normal control via start and stop levels fails, this may act as an emergency backup: If the high-level float triggers, pumps 1, 2, 3 and/or 4 may be set to start running for a period of *Running Time*.
			... ...	... ...		
			Pump 4 Backup Start	(OFF, ON)		
			Backup Running Time	Seconds		
Pit Alarms	High Level		Alarm Type	(Inactive, B-Alarm, A-Alarm)	System	
			Alarm Delay	Seconds		
			Limit	m, ft		
			Hysteresis	m, ft		
	Low Level		Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
			Limit	m. ft		
			Hysteresis	m, ft		
	High Level Float		Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Block al. if pump runs	(No, Min 1 pump, Min 2 pumps, ... Min 4 pumps)		If pump(s) running normally when the High Level Float will generate a B-alarm.
			Alarm Delay	Seconds		
	Low Level Float		Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
	High Inflow		Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
			Limit	Liters/second, GPM		
			Hysteresis	Liters/second, GPM		
	Low Inflow		Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
			Limit	Liters/second, GPM		
			Hysteresis	Liters/second, GPM		

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Submenu	Submenu	Submenu	Setting	Value	Pass code	Comment
Pit Alarms	Backup Start		Alarm Type	(Inactive, B-Alarm, A-Alarm)	System	
			Alarm Delay	Seconds		
	Remote Blocking		Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
	High Pressure		Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
			Limit	bar, psi		
			Hysteresis	bar, psi		
	Low Pressure		Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
			Limit	bar, psi		
			Hysteresis	bar, psi		
	Overflow		Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
	High Pressure Block		Alarm Type	(Inactive, B-Alarm, A-Alarm)		The pressure threshold for the alarm is set in the menu below for Pump Blocking.
			Alarm Delay	Seconds		
	Drain Pump Float		Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
	Sensor Error		Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
	To few pumps available		Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
			No. Pumps Available	(Min 1 Pump, Min 2 Pumps, Min 3 Pumps, Min 4 Pumps)		
	M. prot reset error		Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
Pump Blocking	Remote Blocking		Remote Blocking	(OFF, ON)	System	A value of zero for *Block Time out* means that the blocking will never time out.
			Block Time out	Seconds		
	Low Level Float		Block on Float Active	(OFF, ON)		
	Back-Pressure		Block on High Pressure	(OFF, ON)		Note: *Back-Pressure* may be used when a pressure sensor is installed on the outflow side; when it indicates too high pressure for the pump, it can be blocked. A value of zero for *Block Time out* means that the blocking will never time out.
			Block Delay	Seconds		
			Block Limit	bar, psi		
			Block Time out	Seconds		

Submenu	Submenu	Submenu	Setting	Value	Pass code	Comment
Level Sensor Check			Check at High Float	(OFF, ON)	System	Checks that the level sensor is functioning properly. Checks can be made at high float, at low float and to ensure that the output varies. At high/low float, a sensor alarm can be issued if the level sensor gives a vale that is not within *Max Deviation* from the specified level of the high/low float. To ensure that values vary, see below:
			Level at High Float	m, ft		
			Max Deviation +/-	m, ft		
			Check at Low Float	(OFF, ON)		
			Level at Low Float	m, ft		
			Max Deviation +/-	m, ft		
			Level Change Check	(OFF, ON)		A sensor alarm can be installed if the level sensor does not change its output value at least *Min Level Change* in the time period *Check Time*.
			Check Time	Seconds		
			Min Level Change +/-	m, ft		
Tariff Control	-		Tariff Control	(OFF, ON)	System	If tariff control is used, you can set the pumps to start emptying the pit *Pump Prestart Time* before high tariff starts. In this case, it will empty the pit down to *Pump Down Level* (or to a stop level, whichever is triggered first. For each day of the week, you can specify two time periods of high tariff (by specifying its On and Off times).
	-		Pump Prestart Time	Minutes		
	-		Pump Down Level	m, ft		
	Peak Monday to Peak Sunday		Peak 1 On After midn.	Minutes		
			Peak 1 Off	Minutes		
			Peak 2 On	Minutes		
			Peak 2 Off	Minutes		
Level Above Sea			Set Level m.a.s.	m, ft	System	If the display of current levels should be absolute levels above sea, enter the level of the pump pit above sea level.

6.5 *Pump 1 to 4 settings*

Table 6-3 shows the complete list of settings under the submenus *Pump 1, Pump 2, Pump 3 and Pump 2*.

Table 6-3 Pump 1 to 4 settings, under 'Settings > Pump 1','Settings > Pump 2', 'Settings > Pump 3', and 'Settings > Pump 4'

Submenu	Submenu	Submenu	Setting	Value	Passcode	Comment
Relay Control Pump			Pump Connected?	(NO, YES)	System	If a pump is not connected, the relay is still operating according to start/stop levels.
Type of Pump		Fixed			System	
		Speed Controlled VFD	P. Cap Comp at min Freq (Pump Capacity Compensation at minimum Frequency)	Percent		See Section 3.6
Start/Stop Levels			Start Level	m, ft	Operator	Note: These levels are only used during low tariff times if tariff control is used.
			Stop Level	m, ft		
			Random Start Level +/-	m, ft		The start level is randomized ± this range around *Start Level*.
			Hi. Tariff Start Level	m, ft		During high tariff times, these levels are used as the start and stop levels.
			Hi. Tariff Stop Level	m, ft		

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Submenu	Submenu	Submenu	Setting	Value	Passcode	Comment
Pump Parameters			Nominal Current	Amperes	System	
			Nominal Power Factor	Number		
Pump Run Indication			Pump Run Indication	(OFF, Digital Input, Motor Current)	System	The means/sensor by which a pump is regarded as running.
			Current Threshold	Amperes		Pump is regarded as running above threshold.
Time Settings			Threshold On Delay	Seconds	System	Delay before change of set point status.
			Threshold Off Delay	Seconds		
			Max Runtime Stop Pump	(OFF, ON)		
			Max Continuous Runtime	Minutes		Pumps are stopped when *Max Continuous Runtime* is reached. The timer is reset each time a start level is reached.
Pump Curve (QH)			Point 1 Hmax Tot. Head	m, ft	System	Lowest level (pump outlet) Highest head See Section 3.2.2
			Point 1 Flow	Liters/second, GPM		
			Point 2 Hmid Tot. Head	m, ft		Mid level See Section 3.2.2
			Point 2 Flow	Liters/second, GPM		
			Point 3 Hmin Tot. Head	m, ft		Highest level in the pit. Lowest head See Section 3.2.2
			Point 3 Flow	Liters/second, GPM		
			Total Head Sensor Zero	m, ft		Often the sensor 0-point is lower then the outlet of the pump. In this case the difference must be added to the head. See Section 3.2.2
Pump Alarms	Phase Missing		Alarm Type	(Inactive, B-Alarm, A-Alarm)	System	
			Alarm Delay	Seconds		
	Dry Run		Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
	No Run Confirm		Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
	Fallen Motor Protector		Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
	M. Prot. Reset Error		Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
	High Motor Current		Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
			Limit	Amperes		
			Hysteresis	Amperes		
	Low Motor Current		Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
			Limit	Amperes		
			Hysteresis	Amperes		

Submenu	Submenu	Submenu	Setting	Value	Passcode	Comment
Pump Alarms	High Vibrations		Alarm Type	(Inactive, B-Alarm, A-Alarm)	System	
			Alarm Delay	Seconds		
			Limit	mm/s, inch/s		
			Hysteresis	mm/s, inch/s		
	Low Pump Capacity		Alarm Type	(Inactive, B-Alarm, A-Alarm)		An alarm is issued if the measured capacity is below this threshold.
			Alarm Delay	Seconds		
			Limit	Liters/second, GPM		
			Hysteresis	Liters/second, GPM		
	Pump Not In Auto		Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
	Pump Error		Alarm Type	(Inactive, B-Alarm, A-Alarm)		Digital input pump fail activated.
			Alarm Delay	Seconds		
	Max Cont. Run Time		Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
	Pump Alarm Blocked		Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
	Leakage	Digital Input / MiniCas(1)	Alarm Type	(Inactive, B-Alarm, A-Alarm)		Leakage sensor connected to a digital input or MiniCas simulation on *Analog Input.*
			Alarm Delay	Seconds		
		DI1 Oil Chamber	Alarm Type	(Inactive, B-Alarm, A-Alarm)		Signals from CA 441. If one CA 441 is monitoring several pumps only DI1 oil chamber can be used.
			Alarm Delay	Seconds		
		DI2 Electric Area	Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
		DI3 Motor Housing	Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
	High Temperature	Digital Input / MiniCas(1)	Alarm Type	(Inactive, B-Alarm, A-Alarm)	System	Temperature sensor connected to a digital input or MiniCas[1] simulation on *Analog Input.*
			Alarm Delay	Seconds		
		T1/T4 Stator	Alarm Type	(Inactive, B-Alarm, A-Alarm)		Signals from CA 442. Alarms limits are only used for sensor type Pt100. Klixon and PTC use fixed limits. If one CA 442 is monitoring several pumps only T1 stator can be used.
			Alarm Delay	Seconds		
			Alarm Limit (Pt100)	°C, °F		
			Hysteresis (Pt100)	°C, °F		
		T2 Upper Bearing	Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
			Alarm Limit (Pt100)	°C, °F		
			Hysteresis (Pt100)	°C, °F		
		T3 Lower Bearing	Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
			Alarm Limit (Pt100)	°C, °F		
			Hysteresis (Pt100)	°C, °F		

(1) Xylem; **MiniCas** = *External monitoring relay*

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Submenu	Submenu	Submenu	Setting	Value	Passcode	Comment
Pump Alarms	High Temperatur	Temp. Stator L2	Alarm Type	(Inactive, B-Alarm, A-Alarm)	System	From additional CA 442: Same set point are used for Alarm Limit and Hysteresis as T1/T4 (Pt100)
			Alarm Delay	Seconds		
		Temp. Stator L3	Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
Pump Block Auto Reset	Stop On High Temp.		T1/T4 Stator or Digital Input or MiniCas[1] simulation on *Analog Input*	(NO, YES)	System	If activated the pump will be blocked as long the alarm limit is exceeded. Use alarm limits from the pump alarms menu. Independent on alarm type.
			T2 Upper Bearing	(NO, YES)		
			T3 Lower Bearing	(NO, YES)		
			Manual Reset Required	(NO, YES for T1/T4 Digital In, YES for all Temp.)		If setting is YES, the pump will be blocked until the condition is back to normal and thereafter manually reset from the menu *Main Menu – Manual Control – Pump* **x** *– Reset Temp. Protection*
			Block Delay	Seconds		
	Stop On Vibrations		Stop On Vibrations	(NO, YES)		If activated the pump will be blocked as long as the alarm limit is exceeded. Use alarm limits from the pump alarms menu. Independent on alarm type
			Block Delay	Seconds		
	Stop on Leakage		DI1 Oil Chamb. (CA 441) or MiniCas[1] simulation on *Analog In* or Digital Input	(NO, YES)		
			DI2 (CA 441) Electric Area	(NO, YES)		
			DI3 (CA 441) Motor Housing	(NO, YES)		
			Block Delay	Seconds		Block delay works on ON/OFF conditions.
Pump Block On Alarm	-		High Motor Current	(NO, YES)	System	If setting is *YES*, the pump will be blocked until the alarm is acknowledged.
			Low Motor Current	(NO, YES)		
			Fallen Motor Protector	(NO, YES)		
			Low Pump Capacity	(NO, YES)		
			Dry Run	(NO, YES)		
			No Run Confirm	(NO, YES)		
			Pump Error	(NO, YES)		
			High Vibrations	(NO, YES)		
	Block on High Temperature		Digital Input or MiniCas[1] simulation on *Analog Input*	(NO, YES)		
			T1/T4 (CA 442) Stator	(NO, YES)		
			T2 (CA 442) Upper Bearing	(NO, YES)		
			T3 (CA 442) Lower Bearing	(NO, YES)		
	Block on Leakage		Digital Input or MiniCas[1] simulation on *Analog Input*	(NO, YES)	System	If setting is *YES*, the pump will be blocked until the alarm is acknowledged.
			DI1 (CA 441) Oil Chamber	(NO, YES)		
			DI2 (CA 441) Electric Area	(NO, YES)		
			DI3 (CA 441) Motor Housing	(NO, YES)		

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(1) Xylem; **MiniCas** = *External monitoring relay*

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Submenu	Submenu	Submenu	Setting	Value	Passcode	Comment
Dry Run Detect			Low Cos Block Pump	(NO, YES)	System	To detect that the pump is running dry, a threshold on low cos phi is used.
			Block Delay	Seconds		
			Block if Cos <	Number		
			Block Timeout	Seconds		
Pump Tag			Pump name	String		Max 11 characters to name the pump.

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6.6 *Common settings for pump 1, 2, 3 and 4.*

Table 6-4 shows the complete list of settings you can make under the submenu *Common P1-P4*.

Table 6-4 Common settings for pump 1, 2, 3 and 4, under 'Settings > Common P1-P4'

Submenu	Submenu	Setting	Value	Passcode	Comment
Log Pump Events		Default: OFF	(OFF, ON)	System	
Auto Reset M. Protect		Reset Protector P1	(NO, YES)	System	*Pulse Time* is the duration of the reset pulse. *Pause Time* is used for two purposes: (1) the cooling time before a new reset is attempted, (2) the counter for *Max No. Attempts* is reset when the pump has been running for *Pause Time*.
		... ...	... ...		
		Reset Protector P4	(NO, YES)		
		Pulse Time	Seconds		
		Pause Time	Seconds		
		Max No. Attempts	Integer		
Pump Exercising		Exercise Pump 1	(NO, YES)	System	This is used to "exercise" the pumps if they have been standing still for *Max Stand Still Time*. If '*Start if Level* >=' is lower than '*Start if Level* <', this is the window where the pump(s) may run. In the opposite case, the pump(s) may only run outside that window. When the condition is met, the pump(s) will run for *Running Time*.
		... ...	... ...		
		Exercise Pump 4	(NO, YES)		
		Max Stand Still Time	Minutes		
		Running Time	Seconds		
		Start if Level >=	m, ft		
		Start if Level <=	m, ft		
Pump Reversing		Reversing Pump 1	(NO, YES)	System	This is used to reverse the pump when a pump failure has occurred. The start of the reversing can be trigged by the motor protector or the digital input (pump fail) or when low pump capacity is detected. If *Pump Relay When Rev.* is set to *ON* the pump relay will be activated one second after the reversing relay and goes off one second before the reversing relay.
		... ...	... ...		
		Reversing Pump 4	(NO, YES)		
		Rev. On Pump Fail	(NO, YES)		
		Rev. On Fallen M. prot	(NO, YES)		
		Rev. On Low P. Cap	(NO, YES)		
		Rev. On Overcurrent	(NO, YES)		
		Start Rev. Delay Time	MInutes		
		Rev. Running Time	Seconds		
		Max No. Attempts	Integer		
		Pump Relay When Rev.	(OFF, ON)		
		Stop Pumps Before Rev.	(NO, YES)		
Power Pump Blocking		On Over Voltage	(NO, YES)	System	Use alarm limits from the system alarms menu.
		On Under Voltage	(NO, YES)		
		On Unbalanced Voltage	(NO, YES)		
		On High Frequency	(NO, YES)		
		On Low Frequency	(NO, YES)		
		Block On Delay	Seconds		
		Block Off Delay	Seconds		

6.7 *Settings for PID controller*

Table 6-5 shows the complete list of settings you can make under the submenu *PID Controller.*

Table 6-5 Settings for PID controller, under 'Settings > PID Controller'

Submenu	Submenu	Setting	Value	Passcode	Comment
Set Point		External Set Point	(OFF, Analog Input 2, Analog Input 3, Analog Input 4, Analog Input 5)	System	See Section 3.6.1
		Set Point Tracking	(OFF, ON)		
		Startup Set Point	(Last Set Point, Start Value, External Set Point)		
		Set Point Start Value	m, ft		
		Max Set Point	m, ft		
		Min Set Point	m, ft		
Output Signal		Start Up State	(Last State, Auto, Manual, Blocked)	System	
		Output when Blocked	(Freeze Output, Block Signal Value)		
		Block Output	Percent		
		Max Output Signal	Percent		
		Min Output Signal	Percent		
		Max Output Change	Percent/Seconds		
PID Parameters		Controller Direction	(Reverse, Direct)	System	
		P (Amplification)	Number		
		I (Integration time)	Seconds		
		D (Derivation time)	Seconds		
		Output At Zero Dev.	Percent		
Speed Control VFD		Min Pump Speed	Percent	System	
		Lock Speed	Percent		
		Lock Speed Delay	Seconds		
		Reverse Speed	Percent		

6.8 *Settings for mixer*

Table 6-6 shows the complete list of settings you can make under the submenu *Mixer*.

Table 6-6 Settings for mixer, under 'Settings > Mixer'

Submenu	Submenu	Setting	Value	Passcode	Comment
-		Stop Pumps when Mix	(NO, YES)	System	
-		Run Indication	(OFF, Digital Input)		
-		Mixer Run Time	Seconds		
-		Pump Starts to Mix	Integer		The mixer is either started after *Pump Starts to Mix*, or after *Time Interval to Mix*. Entering zero disables the corresponding trigger.
-		Time Interval to Mix	Minutes		
-		Max Level for Start	m, ft		If max > min level, this is the window where the mixer may run. If max < min level, the mixer may only run outside that window.
-		Min Level for Start	m, ft		
Motor Protector		Auto Reset	(OFF, ON)	System	See *Auto Reset M. Protect* Table 6-6.
		Pulse Time	Seconds		
		Pause Time	Seconds		
		Max No. Attempts	Integer		
Mixer Alarms	No run Confirm	Alarm Type	(Inactive, B-Alarm, A-Alarm)	System	
		Alarm Delay	Seconds		
	Fallen Motor Protector	Alarm Type	(Inactive, B-Alarm, A-Alarm)		
		Alarm Delay	Seconds		
	M. Prot. Reset Error	Alarm Type	(Inactive, B-Alarm, A-Alarm)		
		Alarm Delay	Seconds		

6.9 *Drain pump*

Table 6-7 shows the complete list of settings you can make under the submenu *Drain Pump*.

Table 6-7 Drain pump, under 'Settings > Drain Pump'

Submenu	Submenu	Setting	Value	Passcode	Comment
-		Run Indication	(OFF, Digital Input)	System	
-		Start Delay	Seconds		
-		Stop Delay	Seconds		
Motor Protector		Auto Reset	(OFF, ON)		See *Auto Reset M. Protect* Table 6-6.
		Pulse Time	Seconds		
		Pause Time	Seconds		
		Max No. Attempts	Integer		
Drain Pump Alarms	No Run Confirm	Alarm Type	(Inactive, B-Alarm, A-Alarm)	System	
		Alarm Delay	Seconds		
	Fallen Motor Protector	Alarm Type	(Inactive, B-Alarm, A-Alarm)		
		Alarm Delay	Seconds		
	M. Prot. Reset Error	Alarm Type	(Inactive, B-Alarm, A-Alarm)		
		Alarm Delay	Seconds		

6.10 *Cleaner*

Table 6-8 shows the complete list of settings you can make under the submenu *Cleaner*.

Table 6-8 Cleaner, under 'Settings > Cleaner'

Submenu	Submenu	Setting	Value	Passcode	Comment
-		Flush at :	(Pump Start, Pump Stop)	System	
-		Flushing Time	Seconds		
-		No. Start to Flush	Integer		

6.11 *Analog logging*

Table 6-9 shows the complete list of settings you can make under the submenu *Analog Logging*.

Table 6-9 Analog logging, under 'Settings > Analog Logging'

Submenu	Submenu	Setting	Value	Passcode	Comment
Log Channel 1 to Log Channel 16		Log Signal	(Closed, Pit Level, Pit Inflow, Pit Outflow, Overflow Level, Overflow Flow, Back-Pressure, Motor Current, Pump Capacity, Power Factor, Temp. Stator, Temp. Upper Bearing, Temp. Lower Bearing, Vibrations, Main Voltage, Main Frequency, Free Choice, Supply Voltage, Pulse Channel, Temperature Stator Wiring L2, Temperature Stator Wiring L3, Pid Controller output, Data Register, Data Register (2-compl.), Actual VFD frequency P1-P4, Total Head, Actual Head)	System	A total of 16 analog channels whose outputs you can choose from the list. *Pulse Channel* are used for rain, flow and energy values. Temperature signals are only meaningful if you use PT100 sensors. For some signals you have to choose pump number or pulse channel.
		Log Function	(Closed, Actual Value, Average Value, Min Value, Max Value)		
		Log Interval	Minutes		

6.12 *Settings for digital inputs*

Table 6-10 shows the complete list of settings you can make under the submenu *Digital Inputs*.

Table 6-10 Settings for digital inputs, under 'Settings > Digital Inputs'

Submenu	Submenu	Setting	Value	Passcode	Comment
Digital Input 1 to Digital Input 12		Input Function	(OFF, Pump run indication, Manuel pump start, Pump not in auto, Start float, Pump failure, Motor protector, High temperature, Leakage, Stop float P1-P4, Low level float, Overflow sensor, High level float, Drain pump float, Run ind. drain pump, M. prot. drain pump, Run indication mixer, Motor prot. mixer, Staff in station Alarm reset, Power fail, DI pulse channel 1-4 Block PID controller, Alarm input, Mixer block + Alarm input, Drain pump block + Alarm input Block remote data)	System	There is a total of 16 digital (on/off) input channels. The first 12 ones can be chosen from a list of 26 functions. However, we recommend to keep the default configuration, which is listed in the installation Guide. *Pump Not in Auto* is usually a signal from a manual switch that disconnects the pump completely from being controlled from this unit. *Manual Start* may be connected to a manual switch - its function will be identical to that of starting the pump by using the menu.
Digital Input 13 to Digital Input 16		Input Function	(Same as Digital In 1 – 12 above with additional functions: Input Pulse Ch. 1, Input Pulse Ch. 2, Input Pulse Ch. 3, Input Pulse Ch. 4,)	System	The last 4 digital input channels, that are numbered 13-16, can be chosen from a list of 29 functions. However, we recommend to keep the default configuration, where they are used for *Input Pulse Ch. 1*, *Input Pulse Ch. 2*, *Input Pulse Ch. 3* and *Input Pulse Ch. 4* respectively.
		Normally State	(Normally Open (NO), Normally Closed (NC))		

6.13 *Settings for digital outputs*

Table 6-11 shows the complete list of settings you can make under the submenu *Digital Outputs*. The default configuration for DO 1-8 is listed in the Installation Guide.

Table 6-11 Settings for digital outputs, under 'Settings > Digital Outputs'

Submenu	Submenu	Setting	Sub Setting	Value	Passcode	Comment
Digital Output 1 to Digital Output 8	Output Function	(OFF, Pump control, Reset motor prot., Pump fail, Too many pumps blocked, One pump fail, Master reset m.prot., Mixer control, Reset m.prot. mixer, Drain pump control, Res. m.prot drain, Cleaner control, Modem control, Remote control, Personal alarm, High level, Alarm alert, Not ackn. A-alarm, Not ackn. A/B-alarm, Active A-alarm, Active A/B-alarm, Pump reversing, Active B-alarm, External reset alert			System	
		Logic IO, IO 1 – IO 4	(OFF, True OR, Inverse OR, True AND, Inverse AND)			See Section 4.1
		Data reg. setpoint)	Data Register	0-4529		See Section 4.2
			Setpoint ON	Integer		
			Setpoint OFF	Integer		
			Setpoint Delay	Seconds		
	Normally State	(Normally Open (NO), Normally Closed (NC))				

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6.14 *Settings for analog inputs*

Table 6-12 shows the complete list of settings you can make under the submenu *Analog Inputs*.

Table 6-12 Settings for analog inputs, under 'Settings > Analog Inputs'

Submenu	Submenu	Setting	Value	Passcode	Comment
Analog Input 1		Signal Range	(4-20 mA, 0-20 mA)	System	Dedicated for the level sensor.
		Filter Constant	Seconds		
		Scaling 0% =	m, ft		
		Scaling 100% =	m, ft		
		Zero Offset	m, ft		
Analog Input 2 to Analog Input 5		Filter Constant	Seconds		If CA 442 is connected to a pump the vibration input signal from CA 442 will be used instead of the analog inputs in this menu. If CA 443 is connected to a pump the motor current from CA 443 will be used instead of the analog inputs in this menu. (NA= not available)
		Input Function	(OFF, NA, Motor current pump 1, Motor current pump 2, Motor current pump 3, Motor current pump 4, Back-pressure, Vibrations, Free choice, Vibrations pump 1, Vibrations pump 2, Vibrations pump 3, Vibrations pump 4, Xylem MiniCas Sim. P1, Xylem MiniCas Sim. P2, Xylem MiniCas Sim. P3, Xylem MiniCas Sim. P4) Outflow meter		

6.15 *Settings for analog outputs*

Table 6-13 shows the complete list of settings you can make under the submenu *Analog Outputs*.

Table 6-13 Settings for analog outputs, under 'Settings > Analog Outputs'

Submenu	Submenu	Setting	Value	Sub settings	Passcode
PC 441 Main Module	Analog Output 1	Signal Range	(4-20 mA, 0-20 mA)	Scaling 0 % Scaling 100 %	System
		Filter Constant	Seconds		
		Output Function	(OFF, Pit level, Pit inflow, Pit outflow, Pit overflow, Pulse channel 1, Pulse channel 2, Pulse channel 3, Pulse channel 4, PID controller Data Register)	Data Register 0-4529 Scaling 0 % Scaling 100 % See Section 4.3	

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Submenu	Submenu	Setting	Value	Sub settings	Passcode
PC 441 Main Module	Analog Output 2	Signal Range	(4-20 mA, 0-20 mA)	Scaling 0 % Scaling 100 %	System
		Filter Constant	Seconds		
		Output Function	(OFF, Pit level, Pit inflow, Pit outflow, Pit overflow, Pulse channel 1, Pulse channel 2, Pulse channel 3, Pulse channel 4, PID Controller)		
			Data Register	Data Register 0-4529 Scaling 0 % Scaling 100 % See Section 4.3	
CA 781 Exp. Module	Analog Output 1	Signal Range	(4-20 mA, 0-20 mA)	Scaling 0 % Scaling 100 %	
		Filter Constant	Seconds		
		Output Function	(OFF, Pit level, Pit inflow, Pit outflow, Pit overflow, Pulse channel 1, Pulse channel 2, Pulse channel 3, Pulse channel 4, PID Controller)		
			Data Register	Data Register 0-4529 Scaling 0 % Scaling 100 % See Section 4.3	
	Analog Output 2	Signal Range	(4-20 mA, 0-20 mA)	Scaling 0 % Scaling 100 %	
		Filter Constant	Seconds		
		Output Function	(OFF, Pit level, Pit inflow, Pit outflow, Pit overflow, Pulse channel 1, Pulse channel 2, Pulse channel 3, Pulse channel 4, PID Controller)		
			Data Register	Data Register 0-4529 Scaling 0 % Scaling 100 % See Section 4.3	

6.16 *Settings for pulse channels*

Table 6-14 shows the complete list of settings you can make under the submenu *Pulse Channels*.

Table 6-14 Settings for pulse channels, under 'Settings > Pulse Channels'

Submenu	Submenu	Submenu	Setting	Value	Passcode	Comment
Pulse Channel 1 to Pulse Channel 4	Function	Precipitation	1 Pulse	mm, inch	System	The menus adapt to the choice you made for the function of Channel 1 and Channel 2.
			Alarm High Precip.	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
			Limit	l/s/ha, inch/h		
			Hysteresis	l/s/ha, inch/h		
		Energy	1 Pulse	kWh		
			Alarm High Power	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
			Limit	kW		
			Hysteresis	kW		
		Flow	1 Pulse	m^3, gal		
			Alarm High Power	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
			Limit	m^3/h, GPM		
			Hysteresis	m^3/h, GPM		
			Alarm Low Flow	(Inactive, B-Alarm, A-Alarm)		Only available for Channel 1 and Channel 2.
			Alarm Delay	Seconds		
			Limit	m^3/h, GPM		
			Hysteresis	m^3/h, GPM		

6.17 *Settings for trend curves*

Table 6-15 shows the complete list of settings you can make under the submenu *Trend Curves*.

Table 6-15 Settings for trend curves, under 'Settings > Trend Curves'

Submenu	Submenu	Setting	Value	Passcode	Comment
-		Sample Time	Seconds	System	
Trend Curve 1 to Trend Curve 4		Signal	(Closed, Pit Level, Pit Inflow, Pit Outflow, Overflow Level, Overflow Flow, Back-Pressure, Motor Current, Pump Capacity, Power Factor, Temp. Stator, Temp. Upper Bearing, Temp. Lower Bearing, Vibrations, Main Voltage, Main Frequency, Free Choice, Supply Voltage)	System	A total of 4 trend curves you can choose from the list.
		Max Value	Number		The maximum and minimum values are used to set the scales of the graphs.
		Min Value	Number		

6.18 *Communication settings*

Table 6-16 shows the complete list of settings you can make under the submenu *Communication*.

Table 6-16 Communication settings, under 'Settings > Communication'

Submenu	Submenu	Setting	Value	Passcode	Comment
Protocol		Select Protocol	(Modbus, Comli, Modbus TCP)	System	Protocol for both the ports and the USB connections.
		Cross Reference Table	(ON, OFF)		See Section 4.9
Service Port		Baudrate	(OFF, 300 Baud, 600 Baud, 1200 Baud, 2400 Baud, 4800 Baud, 9600 Baud, 19200 Baud, 38400 Baud, 57600 Baud, 115200 Baud)	System	See Section 4.7.2
		Comport Echo	(OFF, ON)		See Section 4.7.5
Com Port		Station Id	Integer	System	Unique number for the station needed for connection to AquaWeb.
		Baudrate	(OFF, 300 Baud, 600 Baud, 1200 Baud, 2400 Baud, 4800 Baud, 9600 Baud, 19200 Baud, 38400 Baud, 57600 Baud, 115200 Baud)		See Section 4.7.1
		Parity	(None, Odd, Even)		
		Handshake	(OFF, ON)		
		Protocol Id	Integer		
		Message Time out	Seconds		
		Station Name	String		
Modem	-	Modem Connected	(NO, Analog Modem, GSM Modem, GPRS Modem CA521, FIX IP TCP LISTEN)	System	Modem is not needed for fixed line connections.
	-	Signals Before Answer	Integer		See Section 4.7.4
	-	Hayes Before Calling	String		
	-	Hayes After Disconnect	String		
	-	Modem PIN Code	String		
	-	Modem PUK Code	String		
	-	SMSC Service Center No	String		

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Submenu	Submenu	Setting	Value	Passcode	Comment
Modem	GPRS Settings	Heart Beat Interval	Minutes	System	See Section 4.7.4
		Server TCP Port No	Number		
		Server IP Address	String		
		GPRS APN Part 1	String		
		GPRS APN Part 2	String		
		SMS Fallback	(OFF, ON)		
		Fallback SMS Number	String		
		GPRS User Name	String		
		GPRS Password	String		
		GPRS Event log	(OFF, ON)		
		H. Beat Operator Scan	(OFF, ON)		
Alarm Call Up		Max No. Calls/ Alarm	Integer	System	The maximum number of attempts to call. It cycles through Call Attempt 1-4 (see settings below) until *Max No. Calls/Alarms* is reached.
		Interval Call Attempts	Seconds		The time between call attempts.
		Alarm Call Acknowledge	(No Ackn., Ring Signal, Write to Reg. 333, All Data Com.)		
		Alarm Ackn. Write R333	(OFF, ON)		This is for the local indication. If YES, it is acknowledged when the central system has taken care of the alarm.
		Connect Id String	String		
Call Attempts	Call Attempts 1 to Call Attempts 4	Alarm Receiver	(OFF, Central System, SMS GSM PDU)	System	Type of alarm receiver. Iff *OFF*, it skips to the next Call Attempt in the list.
		Condition Alarm Call	(A-Alarm ON, A-Alarm ON/OFF), A+B-Alarm ON, A+B-Alarm ON/OFF)		A call is attempted only if the condition is true. On/Off indicates whether the alarm goes on or off. Example: *A+B-Alarm On/OFF* means either A or B alarm that either goes on or off.
		Time out Call Ackn.	Seconds		The time until it skips this attempt and tries the next one.
		Call order	Backup number or Parallel call		See Section 4.7.6
		Phone Number	String		Call Attempt 1-4 assume that a modem is connected. Not needed for fixed line connections. For SMS, the GSM number must be in international format (but the leading '+' character may be omitted).
		Send Id String	(NO, YES)		
		Id String Send Delay	Seconds		The time between the start of the connection until the ID-String is being sent (if set to *YES*).
Communication Alarm	Modem Error	Alarm Type	(Inactive, B-Alarm, A-Alarm)	System	
		Alarm Delay	Seconds		
	Teleline Error	Alarm Type	(Inactive, B-Alarm, A-Alarm)		
		Alarm Delay	Seconds		

6.19 *Settings for field bus modules*

Table 6-17 shows the complete list of settings you can make under the submenu *Field Bus Modules*.

Table 6-17 Settings for field bus modules, under 'Settings > Field Bus Modules'

Submenu	Submenu	Submenu	Setting	Value	Passcode	Comment
Leakage Monitors CA441	CA441-1 P1 or P1-P4	-	Used and Connected	(NO, YES)	System	Only set this to *YES* if the units are connected to Canbus and used as leakage monitor.
		-	Pumps Connected	(4 Pumps P1-P4, Pump 1)		If one pump is selected DI1 - DI3 is used for that pump. At four pumps DI1 corresponds to P1... DI4 to P4.
		-	DI1 Sensor Type	(OFF, ABS Standard, ABS Extended, Xylem)		
		-	... ...	... ...		
		-	DI4 Sensor Type	(OFF, ABS Standard, ABS Extended, Xylem)		
		Alarm Com. Failure	Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
		Sensor Alarms	DI1 Sensor Error	*Alarm Type*: (Inactive, B-Alarm, A-Alarm) *Alarm Delay*: Seconds)		
			... ...	... ...		
			DI4 Sensor Error	*Alarm Type*: (Inactive, B-Alarm, A-Alarm) *Alarm Delay*: Seconds)		
Leakage Monitors CA441	CA441-2 Pump 2 to CA 441-4 Pump 4	-	Used and Connected	(NO, YES)	System	Only set this to *YES* if the units are connected to Canbus and used as leakage monitor.
		-	DI1 Sensor Type	(OFF, ABS Standard, ABS Extended, Xylem)		
		-	... ...	... ...		
		-	DI4 Sensor Type	(OFF, ABS Standard, ABS Extended, Xylem)		
		Alarm Com. Failure	Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
		Sensor Alarms	DI1 Sensor Error	*Alarm Type*: (Inactive, B-Alarm, A-Alarm) *Alarm Delay*: Seconds)		
			... ...	... ...		
			DI4 Sensor Error	*Alarm Type*: (Inactive, B-Alarm, A-Alarm) *Alarm Delay*: Seconds)		

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Submenu	Submenu	Submenu	Setting	Value	Passcode	Comment
Temperature Mon. CA 442	CA442-1 P1 or P1-P4	-	Used and Connected	(4 Pumps P1-P4, Pump 1)	System	Only set this to *YES* if the units are connected to Canbus and used as temperature monitor.
		-	Pumps Connected	(NO, YES)		If one pump is selected T1 - T3 is used for that pump. At four pumps T1 corresponds to P1...T4 to P4.
		-	T1 Sensor Type	(OFF, Klixon PTC, PT100)		
		-	... ...	... ...		
		-	T4 Sensor Type	(OFF, Klixon PTC, PT100)		
		Vibrations	Scaling 0% =	mm/s, inch/s		
			Scaling 100% =	mm/s, inch/s		
			Filter Constant	Seconds		
		Alarm Com. Failure	Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
		Sensor Alarms	T1 Sensor Error	*Alarm Type*: (Inactive, B-Alarm, A-Alarm) *Alarm Delay*: Seconds)		
			... ...	... ...		
			T4 Sensor Error	*Alarm Type*: (Inactive, B-Alarm, A-Alarm) *Alarm Delay*: Seconds)		
	CA442-2 Pump 2 to CA 442-4 Pump 4	-	Used and Connected	(NO, YES)		Only set this to *YES* if the units are connected to Canbus and used as temperature monitor.
Temperature Mon. CA 442	CA442-2 Pump 2 to CA 442-4 Pump 4	-	T1 Sensor Type	(OFF, Klixon PTC, PT100)	System	
		-	... ...	... ...		
		-	T4 Sensor Type	(OFF, Klixon PTC, PT100)		
		Vibrations	Scaling 0% =	mm/s, inch/s		
			Scaling 100% =	mm/s, inch/s		
			Filter Constant	Seconds		
		Alarm Com. Failure	Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
		Sensor Alarms	T1 Sensor Error	*Alarm Type*: (Inactive, B-Alarm, A-Alarm) *Alarm Delay*: Seconds)		
			... ...	... ...		
			T4 Sensor Error	*Alarm Type*: (Inactive, B-Alarm, A-Alarm) *Alarm Delay*: Seconds)		

Submenu	Submenu	Submenu	Setting	Value	Passcode	Comment
Power Monitors CA 443	CA443-0 Main Power	-	Used and Connected	(NO, YES)	System	Only set this to *YES* if the units are connected to Canbus and used as power monitor.
		Current Measuring	Transf. Connected to	(None, L1, L1 and L2, L1, L2 and L3)		All current measuring is done through current transformers.
			TR. Nominal Current	Amperes		
			TR. Secondary Current	Amperes		
			Current Offset	Amperes		
			Current Dead band	Amperes		
			Filter Constant	Seconds		
			Phase Compensations	Value		
		Voltages Measuring	Phases Connected	(None, L1, L1 and L2, L1, L2 and L3, NA, Volt. from CA 443-1)		(NA= not available)
			Ext. Transf. Connected	(NO, YES)		
			Offset Voltage	Voltage		
			Filter Constant	Seconds		
		Alarm Com. Failure	Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
		High-leg Delta		(NO, YES)		
	CA 443-1 Pump 1 to CA 443-4 Pump 4	-	Used and Connected	(NO, YES)	System	Only set this to *YES* if the units are connected to Canbus and used as power monitor.
		Current Measuring	Trans. Connected to	(None, L1, L1 and L2, L1, L2 and L3)		All current measuring is done through current transformers.
			TR. Nominal Current	Amperes		
			TR. Secondary Current	Amperes		
			Current Offset	Amperes		
			Current Dead band	Amperes		
			Filter Con stand	Seconds		
			Phase Compensations	Value		
		Voltages Measuring	Phases Connected	(None, L1, L1 and L2, L1, L2 and L3, Volt. from CA443-0)		If voltage measuring
			Ext. Transf. Connected	(NO; YES: Primary Voltage, Secondary Voltage)		
			Offset Voltage	Voltage		
			Filter Constant	Seconds		

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Submenu	Submenu	Submenu	Setting	Value	Passcode	Comment
Power Monitors CA 443	CA 443-1 Pump 1 to CA 443-4 Pump 4	Alarm Com. Failure	Alarm Type	(Inactive, B-Alarm, A-Alarm)	System	
			Alarm Delay	Seconds		
		High-leg Delta		(NO, YES)		
AO/DO Expantion CA 781		-	Used and Connected	(NO, YES)	System	
		Alarm Com. Failure	Alarm Type	(Inactive, B-Alarm, A-Alarm)		
			Alarm Delay	Seconds		
Field Bus Alarm			Alarm Type	(Inactive, B-Alarm, A-Alarm)	System	
			Alarm Delay	Seconds		

6.20 *Common settings*

Table 6-18 shows the complete list of settings you can make under the submenu *Common*.

Table 6-18 Common settings, under 'Settings > Common'

Submenu	Submenu	Setting	Value	Pass-code	Comment
No. Decimals Flow		Inflow Decimals	(None, 1, 2, 3, 4)	System	
		Outflow Decimals	(None, 1, 2, 3, 4)		
		Pump Capac-ity Dec.	(None, 1, 2, 3, 4)		
		Overflow Decimals	(None, 1, 2, 3, 4)		
		Pulse Flow Decimals	(None, 1, 2, 3, 4)		

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