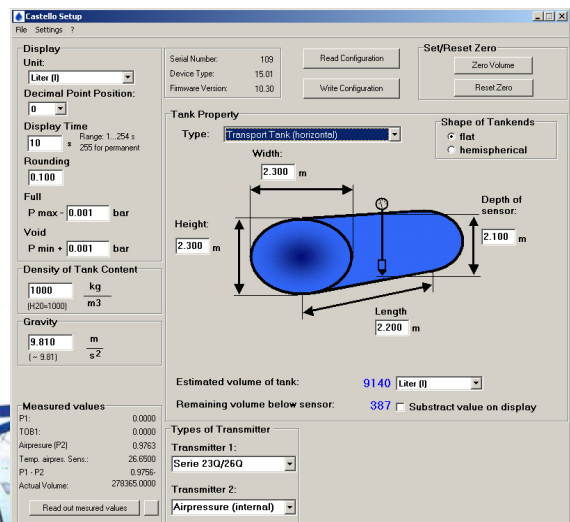




OPERATING MANUAL

CASTELLO & CASTELLO SETUP





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1 Castello Overview

Castello provides a user-friendly way of showing the pressure measurement at the bottom of a tank as the remaining quantity of liquid. At the push of a button, the microcontroller performs calculations based on information about the tank's shape and dimensions so that the remaining tank content (liters, gallons etc.) is shown on the easy-to-read 5-digit LED display.

The unit is configured using a PC and user-friendly software, so the level (which determines the pressure) can be converted into the relevant quantity in the tank (in liters, gallons etc.). The tank shape is selected first, and then the tank dimensions and the liquid's specific density are entered. The program contains the most common tank shapes, but also allows users to generate any tank shape by entering its parameters in a specification table.

The Castello system makes exclusive use of absolute pressure transmitters, so capillary vented cables are eliminated, thus making the Castello very rugged and suitable for reliable applications in humid and wet environments.

An air pressure sensor (range: 0.8 bar to 1.2 bar absolute [abs]) is integrated in the Castello housing. The transmitters to measure hydrostatic pressure at the bottom of the tank are calibrated from 0.8 to 1.8 bar abs for tanks up to 5 m in height, and from 0.8 to 2.3 bar abs for tanks up to 10 m in height. The pressure difference, calculated by the microcontroller, is the relative hydrostatic pressure.

The content of a pressurized tank is determined from the difference between the measurements taken by two absolute pressure transmitters located at the top and bottom of the tank.

The system achieves overall accuracy of 2 mbar thanks to a computerized calibration and compensation procedure for the pressure transmitters Series 23Q and 26Q. The coefficients for this calculation are stored in EEPROMs in the transmitters. These are retrieved by the microprocessor when each measurement is taken, and are used in the equations to calculate the pressure values. Because these coefficients are stored in the transmitter, the Castello housing and the hydrostatic transmitter can be exchanged at will with no need for additional configuration or data entry.

It is also possible to connect a standard 3-wire transmitter with voltage output (0...5V), or a high-precision digital transmitter (series 3X) that can be configured to an accuracy of 0.02% FS over a range of 0 to 50°C; this transmitter is read by Castello via the RS485 interface.

The power supply to the system (8 to 28 VDC) can be provided externally, or internally with a 9 V battery. Castello's display is powered for a configurable duration by pressing the button on the front of the Castello. The Castello has two switch outputs with configurable functionality and threshold values. An external power supply must be provided if the switch outputs are to be used.

Installation

The housing has two holes to mount the unit. The transmitters are easily installed by removing Castello's cover plate, leading the cable through the PG screw connections, and then connecting the transmitter wires to the appropriate screw terminals. The Castello is programmed via the connector on the side, which equally serves as external power supply and switch output connections. Once the cover plate is installed and the cable lead through connections are properly tightened, the extremely robust housing is watertight to IP65.

PC Configuration Software

The software to configure Castello can be downloaded from our website or ordered on CD (handling charge payable). Castello can be connected to the PC via KELLER converter cables K-107 (RS232) or K-104B (USB) with adapter. The software contains the calculations (pressure/content curves) for several tank shapes. The dimensions of the tank, the density of the liquid and the measuring unit of the display are set in the software for the selected tank shape.



2 Castello Hardware

2.1 "On" Button

Press and release the button to switch the display on for a few seconds.






Press and hold the button down while the display is on to show a command or function on Castello's display.

If Castello is configured to use switch outputs, the display will be continuous and will not turn off.





2.2 Commands and Functions ("On" Button)

The "Standard Version"

Standard Version	
	Press and hold the button down for ~5 seconds; the Castello display shows "1d 00".
	Increase the counter up to 22 (Password = 22) by clicking on the button. When the display shows 22, press and hold the button down for ~5 seconds until the display shows the first command, "Z Set".
	"Z Set" - If you want to set the tank content display to zero, press and hold the button down for ~5 seconds until the display shows "donE." *Note: A "Z rES" command should be performed before executing the "Z SEt" command. To go to the next command, click on the button.
	"Z rES" - If you want to reset the tank content display to the factory setting, press and hold the button down for ~5 seconds until the display shows "donE." To go to the next command, click on the button.
	"End" – press the button for ~5 seconds to exit command mode and return Castello to tank content display mode. To go back to the first command, click on the button.

The "Ullage version"

Ullage version	
In this sample, the tank size is 10,000 liters.	
	If the button is not pressed, the display shows the tank content.
	With the button pressed, the display shows the "Ullage" (used tank content).



2.3 Display

➤ Software Version

On startup (when power is applied / when the battery is connected), the Castello displays its software version for 2 seconds.



➤ Content

"18435" The digits show the content of the tank.



➤ Void

"Void" Means the lowest level has been reached (no liquid over the transmitter); the tank is empty.



➤ Full

"FULL" The tank is totally full.



➤ E-Tr1

"Error Transmitter 1" Transmitter 1 has returned an incorrect value; check the connection.



➤ E-Tr2

"Error Transmitter 2" Transmitter 2 has returned an incorrect value; check the connection.



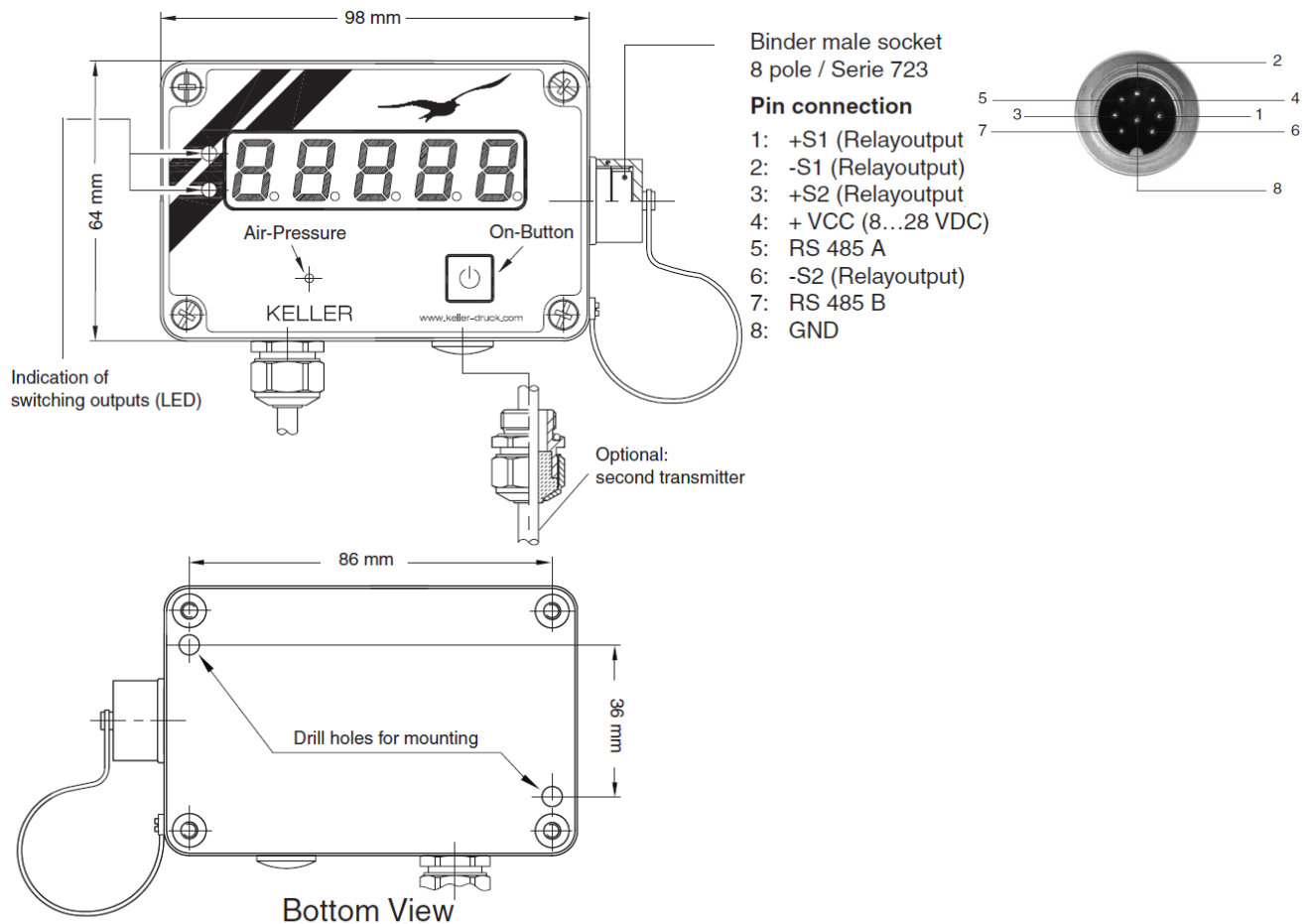
➤ OFL

"Display Overflow" The value is larger than 99,999 and exceeds the display capability.





2.4 Castello Housing Dimensions and Interface



Transmitter Connection

A maximum of two transmitters can be connected to Castello via a cable gland (PG connector).

Air Pressure Sensor

The built-in air pressure sensor can be used to compensate air pressure changes when an absolute pressure sensor is used to measure the content of a vented tank.

Display of Switch Outputs (LED)

The LEDs show the current state of the switch outputs (if they are activated).

External Supply

The device can be supplied from an external power source. If the switch outputs are used (activated), the instrument must be supplied with an external DC voltage of 8 ... 28 volts.

Switch (Relay) Outputs

The relay outputs can handle up to 28VDC / 0.4A. The built-in relays have insulated inputs and outputs.

RS485 Interface

The RS485 interface allows the user to configure and communicate with the Castello (i.e. read current values).

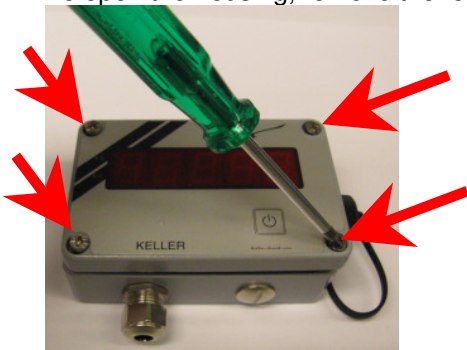
Up to 128 instruments can be addressed via the KELLER BUS protocol.

Please consult our website for a description of the BUS protocol to create custom software, as well as the PC software for graphic display of the current measurement values.



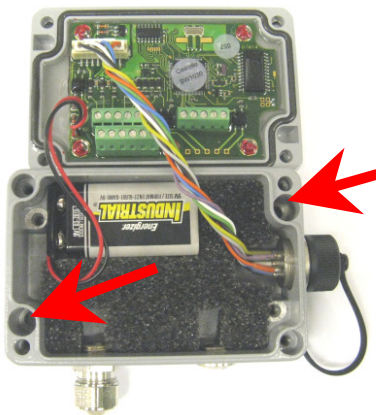
2.5 How to Open the Castello Housing

To open the housing, remove the four screws.



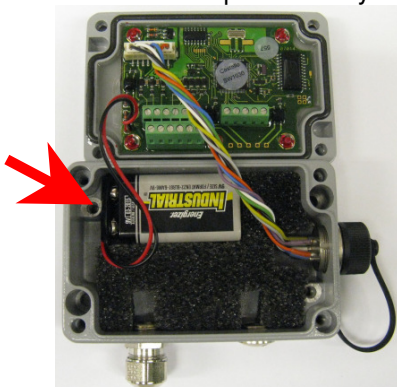
2.6 How to Affix the Castello

The two holes indicated by the red arrows below can be used to affix the Castello to the desired area.



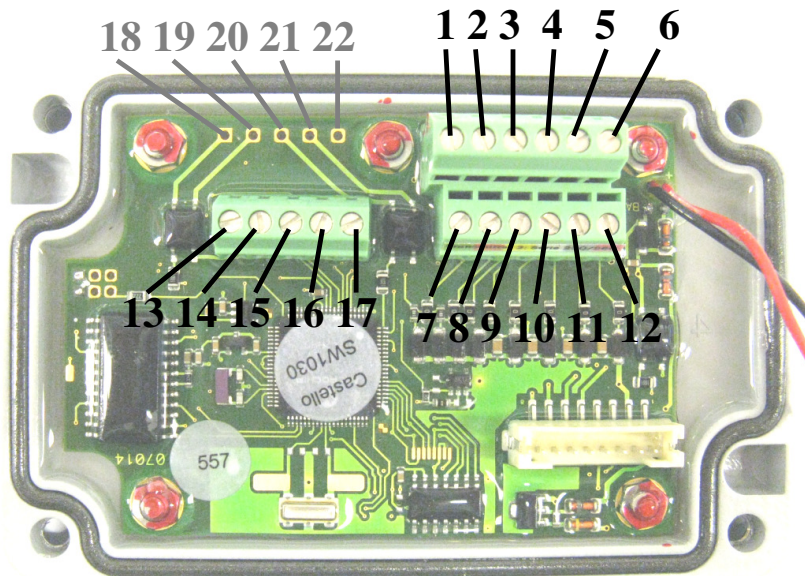
2.7 Connect / Replace Battery

Open the Castello housing and connect the 9V battery (*type: 6LR61 / 604LC*) to the corresponding battery contact. Then push battery into the battery holder.





3 Connection Terminal for Transmitters



3.1 Pin Table

1. GND
2. Transmitter supply, 5 volts
3. I2C DATA
4. I2C CLK
5. Temperature voltage input (TOB2) (Input 0...5V)
6. Pressure voltage input (P2) (Input 0...5V)

7. GND
8. Transmitter supply, 5 volts
9. I2C DATA
10. I2C CLK
11. Temperature voltage input (TOB1) (Input 0...5V)
12. Pressure voltage input (P1) (Input 0...5V)

13. RS485-A
14. RS485-B
15. Transmitter supply 18 volts
16. GND
17. CASE

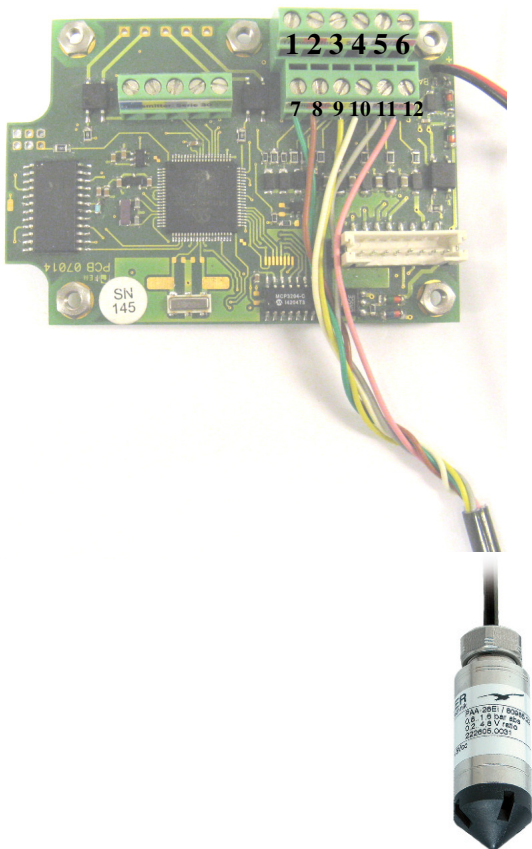
18. Relay 1 +
19. Relay 1 -
20. Relay 2 +
21. Relay 2 -
22. n.c. (not connected)



3.2 Transmitter Supply

The Castello contains two different internal voltage supplies for transmitter supply. The voltage sources are 5 volts and 15...20 volts (use the corresponding clamp). The supply is turned on while the Castello reads the signal from the connected transmitters.

3.3 Connecting Series 23Q and 26Q Transmitters



Transmitter 2

Connect the transmitter to clamps 1..6

- 1 green (GND)
- 2 brown (Transmitter supply, 5 volts)
- 3 yellow (I2C DATA)
- 4 white (I2C CLK)
- 5 gray (TOB2 voltage)
- 6 pink (Pressure voltage)

Transmitter 1

To connect a second transmitter, use clamps 7..12

- 7 green (GND)
- 8 brown (Transmitter supply, 5 volts)
- 9 yellow (I2C DATA)
- 10 white (I2C CLK)
- 11 gray (TOB1 voltage)
- 12 pink (Pressure voltage)



3.4 Connecting Series 3x Transmitters with the RS485 Interface

The RS485 interface enables communication with Keller digital instruments (transmitters, data loggers etc.). Connect RS485 A (**Pin 1**) and RS485 B (**Pin 2**) to the Castello.

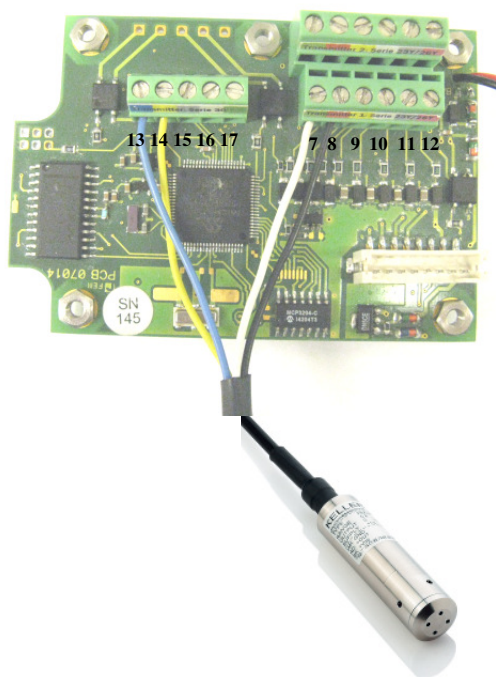
A maximum of two Series 3x transmitters can be connected to the Castello by selecting "Series 30" in "Types of transmitter settings" (Castello Setup). If two S30 transmitters are to be used, each transmitter's address must be configured with a unique address (use Prog30 Software to configure the bus address): Set transmitter 1 to bus address 1, and set transmitter 2 to bus address 2.

If only one S30 transmitter is connected, it is not necessary to set the bus address.

We recommend using Series 30 transmitters from Keller with the low power and low voltage option to reduce battery consumption (in this case, connect the transmitters to the 5 V power supply).

Connect Series 3x Low Power / Low Voltage transmitters

The picture below shows the connection for a Series 3X transmitter with the low power / low voltage option. These transmitters can be supplied with a voltage range of 4V ... 12V. The transmitter supply should be connected to the 5V clamp.



Transmitter 1

Connect the transmitter to clamps 7 & 8 & 13 & 14.

If only one transmitter is connected to the relevant clamps, the BUS address does not have to be set.

13 blue	(RS485-A)
14 yellow	(RS485-B)
7 white	(GND)
8 black	(Transmitter supply, 5 volts)

Transmitter 2

The second transmitter is connected using the same clamps as transmitter 1 (connect them in parallel).

Both transmitters must have been configured with BUS addresses 1 and 2.

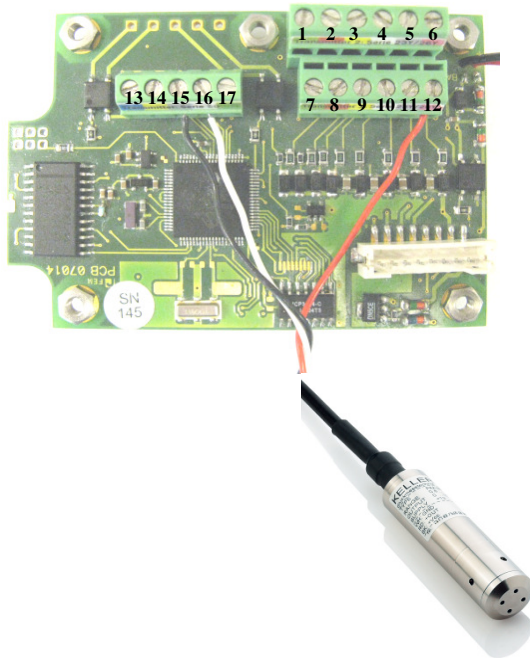
13 blue	(RS485-A)
14 yellow	(RS485-B)
7 white	(GND)
8 black	(Transmitter supply, 5 volts)

Connect Standard Series 3x Transmitter

The standard Series 3X transmitters have a supply in the range from 8V to 28 V. In this case, you should connect the transmitter supply to clamp 15 (transmitter supply: 18 volts).



3.5 Connect Standard Transmitters with Voltage Output (0.5 ... 4.5 Volts)



Transmitter 1

Connect the transmitter to clamps 12 & 15 & 16.

16 (white)	GND
15 (black)	Transmitter supply 18 volts
12 (red)	Pressure voltage input (P1)

Transmitter 2

Connect a second transmitter to the same clamps as transmitter 1 for supply and ground (connect them in parallel). The voltage output of the transmitter is connected to P2, clamp 6.

16 (white)	GND
15 (black)	Transmitter supply 18 volts
6 (red)	Pressure voltage input (P2)



4 Step by Step Installation

This section shows how to install and configure the Castello. This is a standard configuration which is suitable for most applications:

- Castello with one level sensor (Series 26Q) connected @ 5 volts supply.
- Absolute – absolute measurement (tank height = Series 26Q – air pressure sensor).
- Cubic tank, dimensions 1m x 1m x 10m, tank content = 10,000 liters

1 Open the Castello housing



Remove the four screws on the front panel.

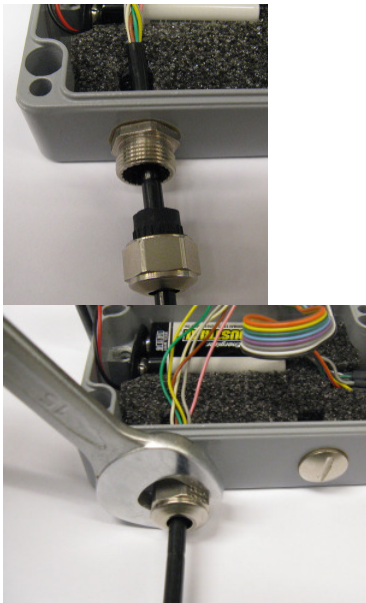
2 Connect the battery



Connect the battery and push it into the battery holder.

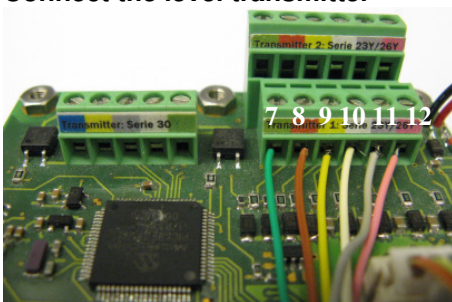


3 Feed in the level transmitter cable



Feed the transmitter cable through the sleeve and tighten the cable gland.

4 Connect the level transmitter



Connect the cable ends to the terminal strip (transmitter 1).

Example with PA-23Q level transmitter :

Connect the level transmitter as follows:

- 7 green: GND
- 8 brown: Transmitter supply, 5 volts
- 9 yellow: I2C DATA
- 10 white: I2C CLK
- 11 gray: Temperature voltage input (TOB1) (Input 0...5V)
- 12 pink: GND

5 Close the Castello housing



Close the housing and install the four screws.



6 Connect the Castello to the PC



Connect the Castello to the PC using converter cable K104-B (USB) or K107 (RS232). Cable option 5 must be used between the Castello and the converter cable.

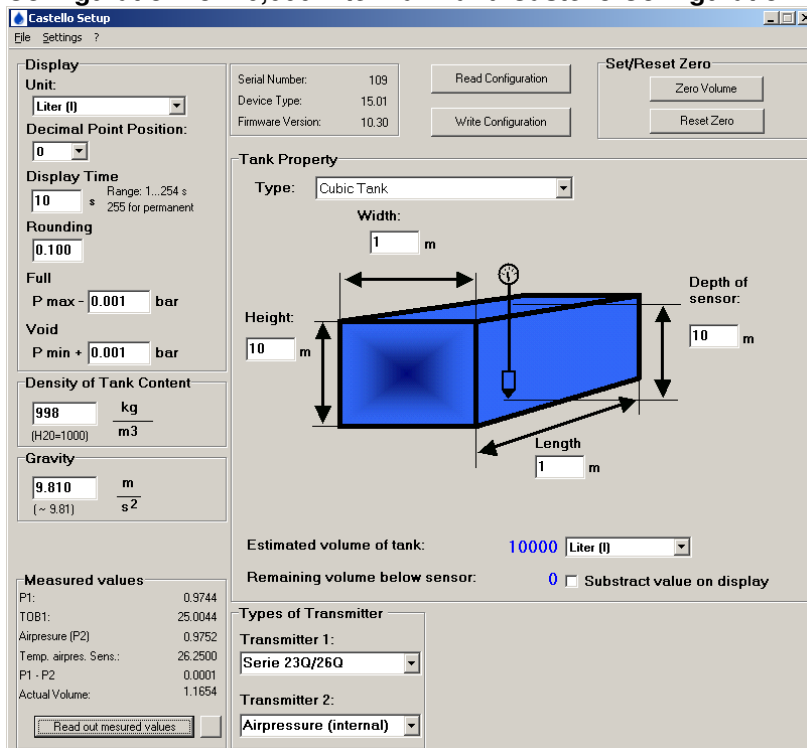
7 Start the Castello Setup Software



Start the Castello Setup Software and configure the Castello. The settings for a tank containing 10,000 liters are listed below.

1. Select Comport
2. Press "Read Configuration"
3. Enter settings as in the example screenshot below
4. Press "Write Configuration"
5. Castello is now configured, and will display the tank content for 10 seconds when the button is pressed.

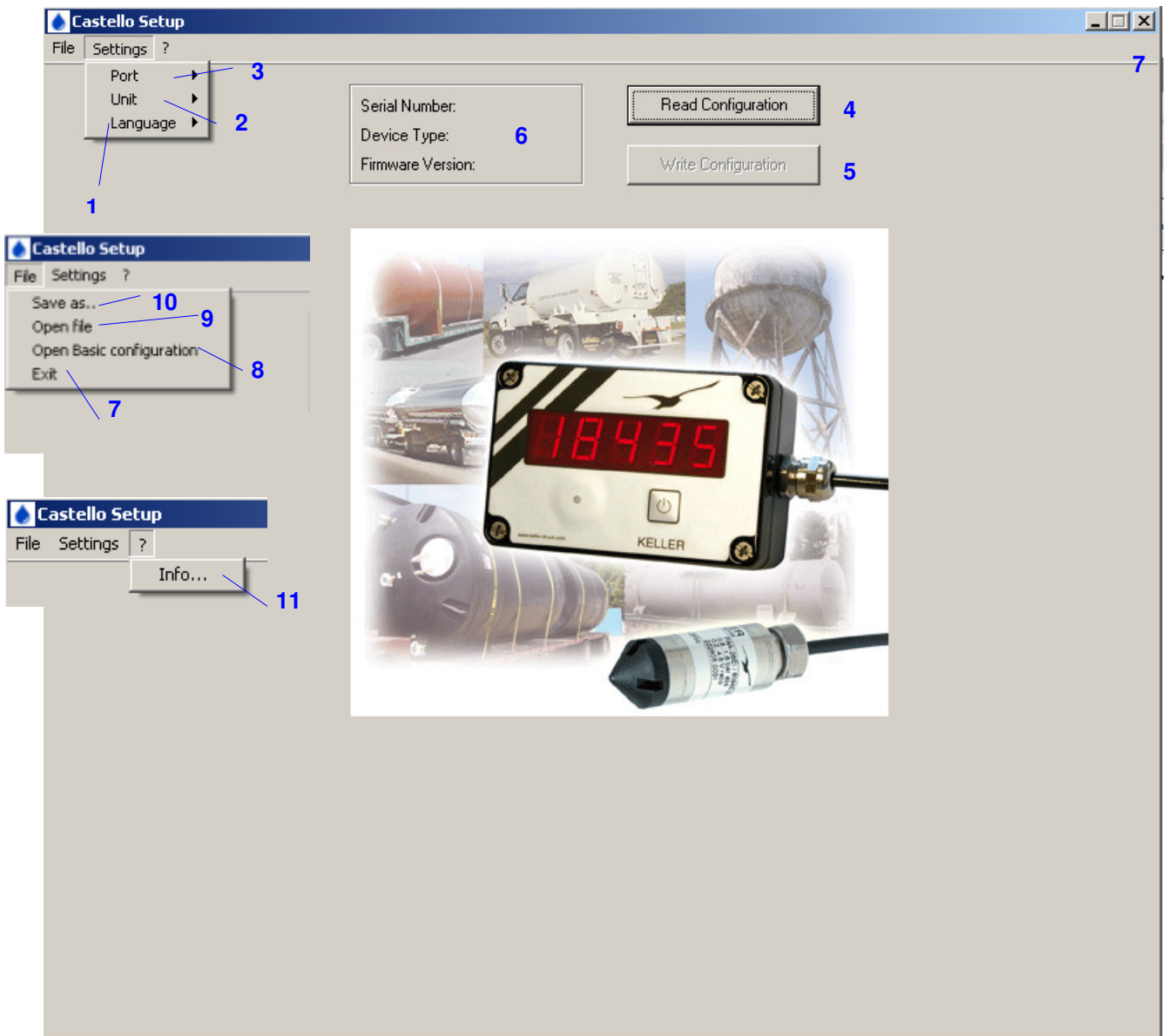
Configuration for 10,000 Liter Tank and Castello Configuration with Level Transmitter 26Q





5 Description of "Castello Setup" Software

5.1 Overview





Number	Description	Explanation / Function
1	Language Selector	Select the preferred language
2	Unit Selector	Select the length unit (meters or feet) for the Setup program
3	Serial Communication Port	Select the appropriate COM port number
4	Read Configuration Button	Read the current configuration from the connected device
5	Write Configuration Button	Write the current configuration to the connected device
6	Device Information	Display the device information for the connected device
7	Exit Program	Exit the application
8	Open Basic configuration	Open a Basic Configuration for the Castello (Sample)
9	File	Open an existing (previously saved) configuration file
10	Save Configuration	Save all settings to a configuration file to be named
11	Info	Retrieve the software version of the Castello Setup Program



5.2 Main Castello Settings

Castello Setup File Settings ?

Display

Unit: **Liter (l)** 1

Decimal Point Position: **0** 2

Display Time: **10** s 3
Range: 1...254 s
255 for permanent

Rounding: **0.100** 4

Full
P max - **0.001** bar 5

Void
P min + **0.001** bar 6

Density of Tank Content
998 $\frac{\text{kg}}{\text{m}^3}$ 7
(H2O=1000)

Gravity
9.810 $\frac{\text{m}}{\text{s}^2}$ 8
(~ 9.81)

Measured values

P1: 0.9754
TOB1: 21.8375
Airpressure (P2): 0.9762
Temp. airpres. Sens.: 22.0000
P1 - P2: 0.0001
Actual Volume: **10** 0.1128 10

11

Serial Number: 109 13

Device Type: **12** 15.01 14

Firmware Version: 10.30

Tank Property

Type: **Tank Table** 15

	Pressure [bar]	Displayed Value
1	0.000	0.000
2	0.100	100.000
3	0.200	200.000
4	0.300	300.000
5	0.400	400.000
6	0.500	500.000
7	0.600	600.000
8	0.700	700.000
9	0.800	800.000
10	0.900	900.000
11	1.000	1000.000
12	1.100	1100.000
13	1.200	1200.000
14	1.300	1300.000
15	1.400	1400.000

16

Set/Reset Zero

17

18

Types of Transmitter

Transmitter 1: **9**
Serie 23Q/26Q

Transmitter 2:
Airpressure (internal)

Display

Unit: **Liter (l)** 1

Decimal Point Position: **0**

Display Time: **10** s 3
Range: 1...254 s
255 for permanent

Rounding: **0.100**

Full
P max - **0.001** bar

Void
P min + **0.001** bar

Tank Property

Type: **Tank Table** 15

- Tank Table
- Transport Tank (horizontal)
- Silo Tank (vertical)
- Sphere Tank
- Cubic Tank
- Special silo
- Cylindrical Tank (round Ends)

Types of Transmitter

Transmitter 1: **9**
Serie 23Q/26Q
Serie 23Q/26Q
Serie 30
Analog transmitter
Airpressure (internal)

Types of Transmitter 9

Transmitter 1: **Analog transmitter**

Transmitter 2: **Analog transmitter**

Transmitter 1 type

Pressure-Range: **0.000** bar → **10.000** bar

Voltage-Range: **0.500** V → **4.500** V

Transmitter 2 type

Pressure-Range: **0.000** bar → **10.000** bar

Voltage-Range: **0.500** V → **4.500** V



Number	Description	Explanation / Function
1	Unit Selector	Unit in which the tank content is displayed (software and Castello display)
2	Decimal Point Selector	Number of decimal places (0-4) to be displayed
3	Display Time	Tank content display time (how long the Castello display shows the tank content when the button is pushed). Range is 1 to 254 seconds. For continuous display, set the value to 255.
4	Rounding	Set the rounding for the display. The display will increment the value by the steps that you configure.
5	Full	The Castello display will show "FULL" if value "Pmax-x,xxx" bar is reached, to inform you that the tank is totally full.
6	Void	The Castello display will show "VOID" if value "Pmin+x,xxx" bar is reached, to inform you that the tank is empty.
7	Density of Tank Content	Density of the liquid in the tank to be measured. The tank content will be calculated using this density.
8	Gravity	The tank content will be calculated using this gravity. Standard gravity is 9.81.
9	Types of Transmitter	Transmitter(s) connected to the Castello. Transmitter 1 (P1) is the level transmitter in the tank, Transmitter 2 (P2) is the transmitter to measure the air pressure in the tank. The level is calculated by P1-P2.
10	Measured Values	A display of all measured values, when the "Read out measured values" button is selected. All current values are listed.
11	Read Out Current Values (Online)	Go to the "Read out current values (Online)" window for a graphic display of all values.
12	Device Information	Display the device information for the connected device after a Read Configuration is selected
13	Read Configuration	Read the current configuration from the connected device
14	Write Configuration	Write the current configuration to the connected device
15	Tank Type	Choose the tank type. When a tank type is selected, its properties will be displayed.
16	Tank Table / Tank Property	This window displays the tank type with its properties, or the tank table with its values, which are written to Castello's memory to calculate the tank content.
17	Zero Volume	Set current display to zero.
18	Reset Zero	Set the zero to its factory setting.



5.3 Tank Property

The screenshot shows the 'Castello Setup' software window with the following sections:

- Display:** Unit: Liter (l), Decimal Point Position: 0, Display Time: 10 s, Rounding: 0.100, Full: P max - 0.001 bar, Void: P min + 0.001 bar.
- Density of Tank Content:** 998 kg/m³ (H₂O=1000).
- Gravity:** 9.810 m/s² (~ 9.81).
- Measured values:** P1: 0.9754, TOB1: 21.8375, Airpressure (P2): 0.9762, Temp. airpres. Sens.: 22.0000, P1 - P2: 0.0001, Actual Volume: 0.1128.
- Serial Number:** 109, **Device Type:** 15.01, **Firmware Version:** 10.30.
- Buttons:** Read Configuration, Write Configuration, Set/Reset Zero (Zero Volume, Reset Zero).
- Tank Property:** Type: Tank Table (dropdown menu showing options: Tank Table, Transport Tank (horizontal), Silo Tank (vertical), Sphere Tank, Cubic Tank, Special silo, Cylindrical Tank (round Ends)).
- Types of Transmitter:** Transmitter 1: Serie 23Q/26Q, Transmitter 2: Airpressure (internal).

6	0.500	500.000
7	0.600	600.000
8	0.700	700.000
9	0.800	800.000
10	0.900	900.000
11	1.000	1000.000
12	1.100	1100.000
13	1.200	1200.000
14	1.300	1300.000
15	1.400	1400.000



Supported tank types / properties

Tank Property

Type: **Transport Tank (horizontal)**

Shape of Tankends:
 flat
 hemispherical

Width: 2.300 m

Height: 2.300 m

Length: 2.200 m

Depth of sensor: 2.100 m

Estimated volume of tank: 9140 Liter (l)

Remaining volume below sensor: 387 Subtract value on display

Tank Property

Type: **Silo Tank (vertical)**

Width: 2.300 m

Height: 2.300 m

Depth of sensor: 2.100 m

Estimated volume of tank: 9556 Liter (l)

Remaining volume below sensor: 831 Subtract value on display

Tank Property

Type: **Sphere Tank**

Width: 2.300 m

Depth of sensor: 2.100 m

Estimated volume of tank: 6371 Liter (l)

Remaining volume below sensor: 136 Subtract value on display

Tank Property

Type: **Cubic Tank**

Width: 2.300 m

Height: 2.300 m

Length: 2.200 m

Depth of sensor: 2.100 m

Estimated volume of tank: 11638 Liter (l)

Remaining volume below sensor: 1012 Subtract value on display

Tank Property

Type: **Special silo**

Width of cylinder: 2.300 m

Height of cylinder: 2.300 m

Height of truncated cone: 2.200 m

Width of tube: 3.000 m

Height of tube: 3.000 m

Depth of sensor: 2.100 m

Estimated volume of tank: 42966 Liter (l)

Remaining volume below sensor: 34241 Subtract value on display

Tank Property

Type: **Cylindrical Tank (round Ends)**

Length of cylindrical part: 2.300 m

Diam. of cylinder: 2.300 m

Length of complete Tank: 2.200 m

Depth of sensor: 2.100 m

Estimated volume of tank: 0 Liter (l)

Remaining volume below sensor: 0 Subtract value on display



5.4 Tank Calculation

Tank Property

Type: Tank Table

	Pressure [bar]	Displayed Value
1	0.000	0.000
2	0.100	100.000
3	0.200	200.000
4	0.300	300.000
5	0.400	400.000
6	0.500	500.000
7	0.600	600.000
8	0.700	700.000
9	0.800	800.000
10	0.900	900.000
11	1.000	1000.000
12	1.100	1100.000
13	1.200	1200.000
14	1.300	1300.000
15	1.400	1400.000

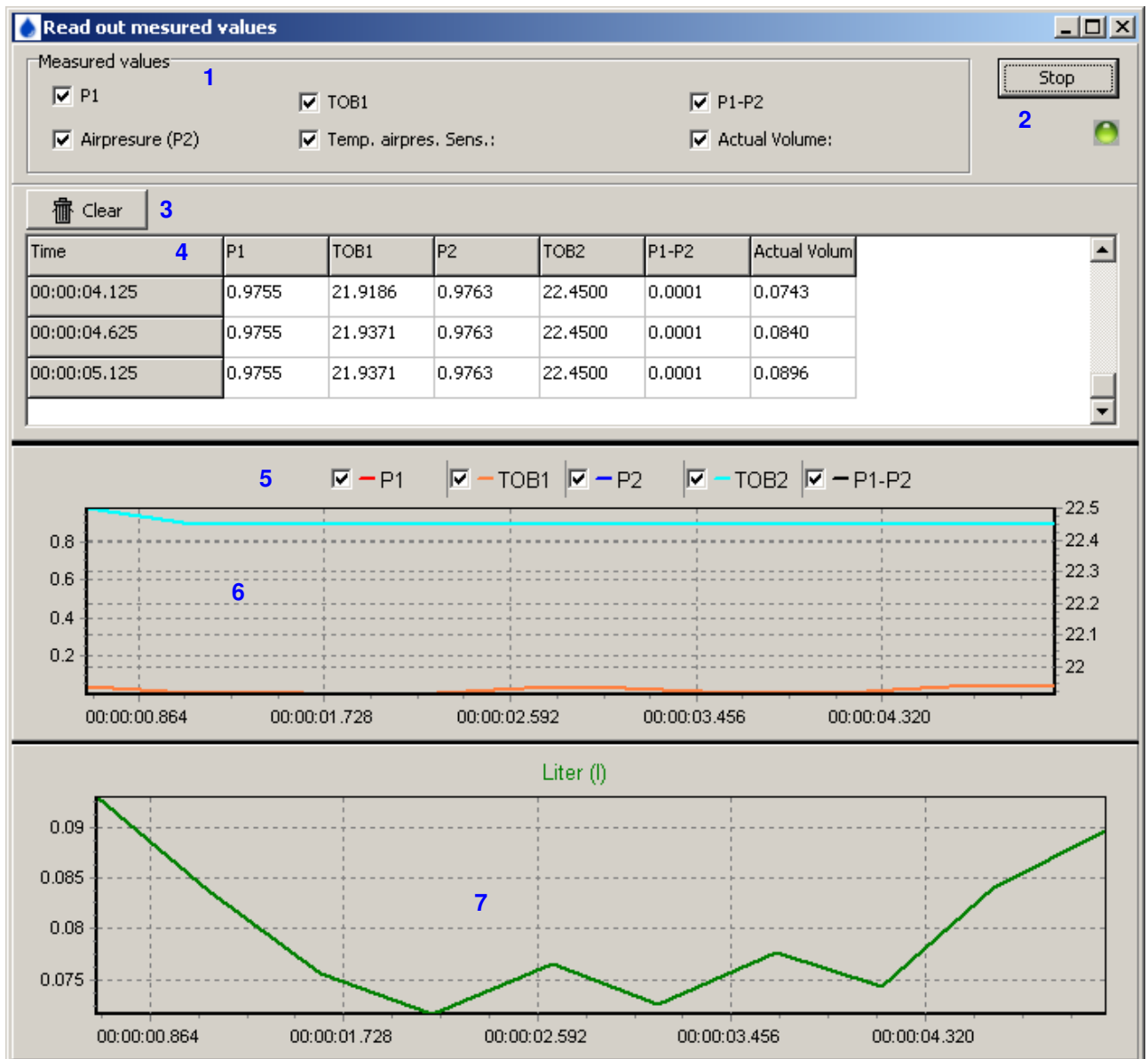
For all the different tank types, properties, and settings, "Castello Setup" calculates a table and writes it to Castello's EEPROM.

The microcontroller then measures the current pressure (level) and searches the table for this value. The microcontroller interpolates a polynomial over 3 measuring points, calculates the tank content and shows it on the display.

Tank settings are also stored in the Castello.



5.5 Read Out Current Values (Online)





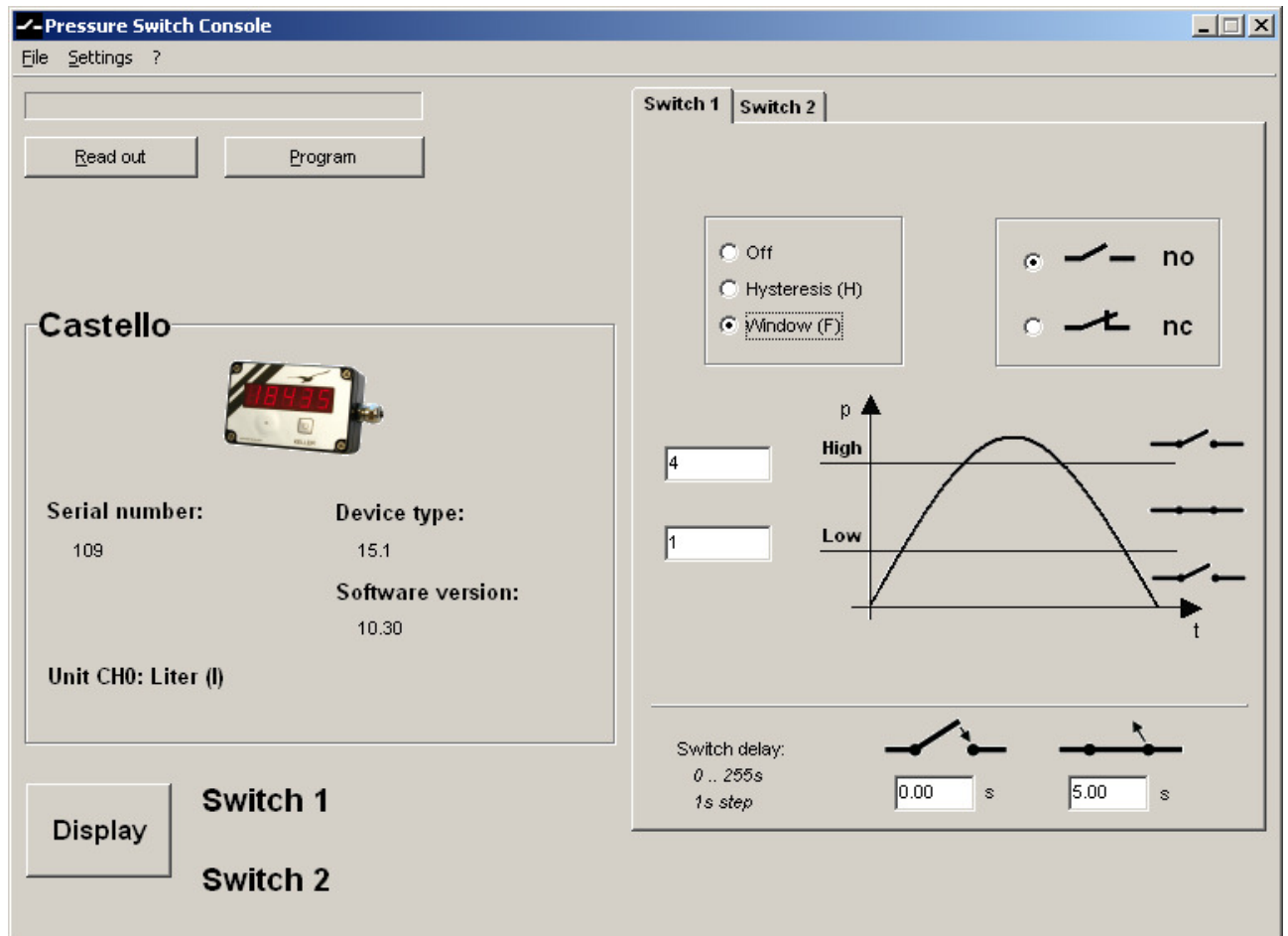
Number	Description	Explanation / Function
1	Enabled Measuring Channels	Activates the desired channels to be measured and displayed. P1 → Level transmitter [pressure / bar] (P2) Second pressure transmitter (air pressure) [pressure / bar] (e.g. for AA measurement as barometric sensor) TOB1 → Temp. sensor of level transmitter P1 [temperature /°C] (temperature over bridge pressure transmitter 1) TOB2 → Temp. transmitter of pressure transmitter P2 [temperature /°C] P1-P2 → Pressure difference between pressure P1 and pressure P2 --> Level Actual Volume → Tank content calculated with current tank property settings. This is the value displayed by Castello.
2	Start and Stop "Online Mode"	To start or stop Online Mode. The green (ok) or red (error) indicator shows the communication status
3	Clear	Clear all charts and the table showing the values
4	Table	Table containing time and values
5	Channel selector for chart	Enables or disables the channels that are displayed in the chart
6	Chart	Chart displays values as function of time
7	Chart (current tank content)	Chart contains values for current tank content



6 Configuring the Switch Outputs

To configure the switch outputs, the separate "Pressure Switch Console" software must be used. If switch outputs are enabled, an external supply should be used to power the Castello, since the display is then in continuous mode and the battery will consequently discharge rapidly.

Disabling the switches (setting them to Off) will return Castello to standard mode (i.e. power down the display after the configured delay).



6.1 Switch Outputs with Switch Time Delay

If a switch delay is set, the corresponding Castello LED switch indicator starts flashing when the switch setpoint is reached and the time delay countdown starts. When the switch time delay is reached, the LED stops flashing and shows the corresponding switch state.







LED on = switch closed

LED off = switch open



LED flashing = switch delay is counting, and switch state is set after the delay



7 Castello Parts and Accessories

DESCRIPTION	PRODUCT NO.	Picture
Castello	310065.0002	
Counter Plug to Binder 723 8 Pole	508405.0006	
Level Transmitter Series 23Q (0.8 ... 1.8 bar abs) 5 mWC / 10 m cable (0.8 ... 2.3 bar abs) 10 mWC / 15 m cable Other ranges and cable lengths are also available	222399.0015 222399.0028	
Level Transmitter Series 26Q (0.8 ... 1.8 bar abs) 5 mWC / 10 m cable (0.8 ... 2.3 bar abs) 10 mWC / 15 m cable Other ranges and cable lengths are also available	222605.0038 222605.0046	
Level Transmitter Series 36XW Only: digital output (RS485) / low power PAA-36XW (0.8 bar ... 1.8 bar) 5 mWC / 5 m cable (0.8 bar ... 1.8 bar) 10 mWC / 10 m cable	233610.0761 233610.0762	
Battery, 9 V Type: 6LR61 / 604LC	557005.0019	



DESCRIPTION	PRODUCT NO.	Picture
<p>K-114B Interface Converter For communication between the PC and Castello.</p> <p>Connection to USB port (USB – RS 485 converter)</p>	309010.0075	
<p>Cable Option 5 Cable adapter 5-pin binder plug Series 723 (m) to 8-pin binder cable socket Series 423 (f)</p> <p>Used for K-114B</p>	309010.0041	
<p>KELLER Software CD CD includes: Configuration software: Castello Setup with operating manual.</p> <p>Free download at: www.keller-druck.com (see "Products" -> "Miscellaneous/Software")</p>	750505.0001	