bNovate TECHNOLOGIES

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User Manual

BactoSense

Rapid Bacterial Monitoring Systems

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1 Glossary

TERM	EXPLANATION
Cartridge	Refillable container of reagents needed for BactoSense operation
FCS	Flow Cytometry Standard (FCS) is a data file standard for the reading and writing of data from flow cytometry experiments. The FCS specification has traditionally been developed and maintained by the International Society for Advancement of Cytometry (ISAC). FCS used to be the only widely adopted file format in flow cytometry.
FL1	Fluorescence signal 1 (530 nm)
FL2	Fluorescence signal 2 (715 nm)
FSC	Forward scatter, also known as Small Angle Light Scattering. A detector measures the light scattered from microorganisms and other particles at small angles.
Gate	Gates are tools for data analysis of a subset of data points in flow cytometry.
HNA	High Nucleic Acid. Bacteria with a large amount of DNA which produce a strong fluorescence emission.
HNAC	High Nucleic Acid Count. The number of HNA bacteria inside the TCC or ICC gate, and above the HNA / LNA limit.
HNAP [%]	High Nucleic Acid Percentage. The percentage of HNA bacteria relative to the cell count.
ICC	Intact Cell Count. Total number of intact bacteria inside of the ICC gate.
LNA	Low Nucleic Acid. Bacteria with a lower amount of DNA which produce a weaker fluorescence emission than HNA bacteria.
LNAC	Low Nucleic Acid Count. The number of LNA bacteria inside the TCC or ICC gate below the HNA / LNA limit.
Manual Sampling Device	Connection module, allowing manual sampling with the BactoSense Online.
Online Sampling Device	Connection module to a water line, allowing online sampling with the BactoSense Online.
SSC	Side scatter, also known as Large Angle Light Scattering. A detector measures the light scattered from microorganisms and other particles at 90 degrees.
TCC	Total Cell Count. Total number of bacteria detected inside the TCC gate.

2 General User Information

2.1 About this user manual

This user manual provides the user with helpful information about the entire life cycle of the BactoSense and its peripheral devices. Before commissioning and using the instrument, you should be completely familiar with the user manual.

The user manual is intended for all persons who are responsible for the operation and maintenance of the instrument. This document is part of the product. It should be stored in a safe place and always be available to the user.

The most recent version of this document can be ordered from the bNovate representative in your country. A list with all bNovate representatives can be found on our website: www.bnovate.com/distribution-partners.

Additional associated product documentation can be found in the table below.

Table 2-1 Additional documentation

40101	Quick Guide	Basic information needed to operate the BactoSense.
40108	Cleaning Kit User Manual	Usage of the reagent kit to decontaminate the BactoSense.
40107	Validation Kit User Manual	Usage of the reagent kit used to validate proper functioning of the BactoSense.
50115	CE declaration of conformity	Compliance with the underlying directives and standards.
50116	UKCA declaration of conformity	Compliance with the underlying directives and standards.
50117	CB test report	UL/CSA/FCC compliance report, also under CH-12116 on https://certificates.iecee.org

2.2 Compliance and applied standards

The BactoSense has been designed and manufactured to meet or exceed industry-recognized standards to ensure the safety, performance, and reliability of the product.

The device meets all applicable requirements for carrying the CE mark.
For more details, please refer to the separate declaration of conformity.

The device meets all applicable requirements for carrying the UKCA mark.
For more details, please refer to the separate declaration of conformity.

This Class B digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations (CAN ICES-001 (B) / NMB-001 (B)).

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

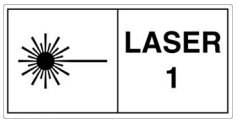
This device is protected from total dust ingress and from low pressure water jets from any direction (IP65).

This device complies with FCC, UL/CAN/CSA-C22.2/IEC 61010-1 and JIS C 1010-1.
For more details refer to the CB test report. (https://certificates.iecee.org: CH-12116).

The following standards have been applied to guarantee compliance with regulatory requirements:

Table 2-2 Applied standards

APPLIED STANDARDS	
Safety (General) (Heating Element) (Laser)	 IEC 61010-1:2010 IEC 61010-1:2010/A1:2016 CAN/CSA-C22.2 No. 61010-1 + A1 UL 61010-1, 3rd Edition A1 JIS C 1010-1:2019 IEC 61010-2-010:2019 CSA C22.2 No. 61010-2-010:19 EN 60825-1:2014 + A11:2021 CAN/CSA-E60825-1:15
EMC	EN IEC 61326-1:2021 EN 61326-1:2013, Class B, Group 1 CISPR 11:2015/A1:2016/A2:2019 EN 61000-3-2:2018 EN 61000-3-3:2013/A1:2017 EN 61000-3-11:2017 EN 61000-3-12:2011 EN 61000-4-2:2008 EN 61000-4-3:2006/A1:2007/A2:2017 EN 61000-4-4:2012 EN 61000-4-5:2014/A1:2017 EN 61000-4-6:2016 EN 61000-4-8:2009 EN 61000-4-11:2020 EN 55011:2016/A1:2017/A2:2021/A11:2020
Ingress Protection	IEC 60529:1989 IEC 60529:1989/A1:1999 IEC 60529:1989/A2:2013 IEC 60529:1989/A2:2013/C1:2019 EN 60529:1991/A1:2000/A2:2013
RoHS	EN IEC 63000:2018



The BactoSense is classified as a Class 1 Laser product according to the standard IEC 60825-1:2014/A11:2021.

2.3 Safety symbols

The safety symbols used in this document are explained below:

DANGER!

Electric shock that may result in serious injury or death

Ignoring this notice may lead to electrical shocks and death.

EXPLOSION HAZARD!

Explosion that may result in serious injury or death

Ignoring this notice may cause explosions resulting in serious property damage and death.

WARNING!

Injury or hazards to health with long-term effects

Ignoring this warning may lead to injuries with possible long-term effects.

CAUTION!

Material damage

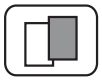
Ignoring this notice may cause material damage to the instrument and its peripherals.

2.4 Pictograms

All pictograms used in this document are explained below:

Additional information about the current topic.

Practical procedures when working with the BactoSense.



The screenshot is an example of the graphical user interface and may be different on your instrument.

2.5 Intended use of the BactoSense

The intended use of the BactoSense is to measure the concentration of microorganisms in water. In particular, the instrument has been developed to count and characterise bacterial populations.

The instrument must be operated by trained technical personnel who have read and understood the content of the user manual.

2.6 Usage restrictions

EXPLOSION HAZARD!

Operation in explosive areas can cause explosions, which can lead to the injury or death of persons in the vicinity.

- It is not permitted to operate the instrument in explosion hazardous areas or rooms.
- It is not permitted to use the instrument with explosive sample substances.

2.7 Improper use

DANGER!

Improper use of the instrument can cause injuries to persons, process-related consequential damage and damage to the instrument and its peripherals.

In the following cases the manufacturer cannot guarantee the protection of persons, the instrument and surrounding equipment, and therefore assumes no legal responsibility:

- The instrument is not used in the described area of application and intended use.
- The instrument is not installed, mounted, set up or transported in accordance with the user manual.
- The instrument is not operated in accordance with the user manual.
- The instrument is operated with accessory parts or consumables which bNovate Technologies SA has not specifically provided, approved or recommended.
- The instrument underwent improper changes or modifications.
- The instrument is operated outside of the specifications, in particular pressure, temperature and power.
- The instrument is operated with a different power supply unit.
- The instrument is exposed to vibrations, shocks, or other mechanical forces.

3 Instrument Overview

3.1 BactoSense overview

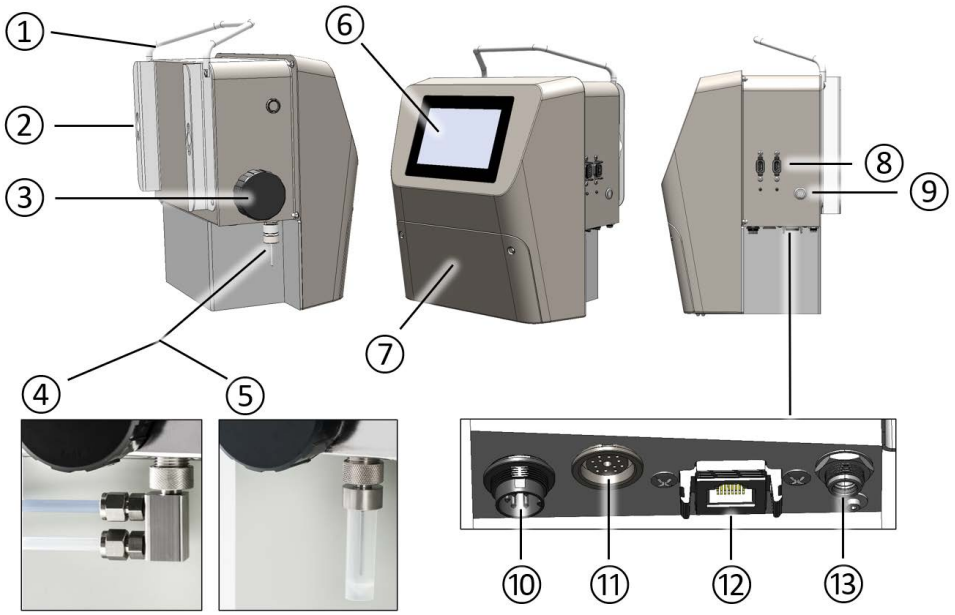


Figure 3-1 BactoSense overview

1	Handle	**2**	Wall mount
3	Desiccant bag compartment cap	**4**	Online sampling device
5	Manual sampling device	**6**	Touchscreen graphical user interface
7	Cartridge compartment door	**8**	USB sockets
9	Power button	**10**	Input connector
11	Output connector	**12**	Ethernet/Modbus TCP interface
13	Power connector		

An overview of the cartridge can be found in section 8.9.3.

3.1.1 Type plate of the BactoSense

The type plate of the BactoSense can be found on the right hand-side of the instrument.

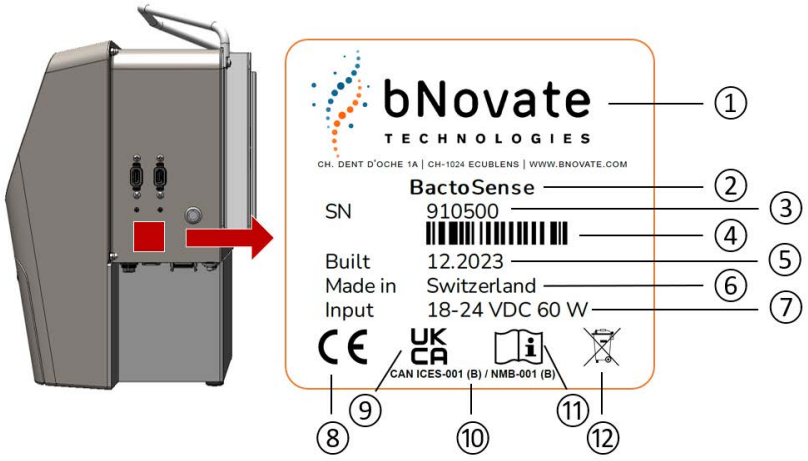


Figure 3-2 Type plate of the BactoSense.

1	Manufacturer	**2**	Product name
3	Serial number	**4**	Barcode
5	Manufacturing date	**6**	Country of origin
7	Voltage and power requirements (see section 5.3)	**8**	CE mark
9	UKCA mark	**10**	Compliance with Canadian EMC and interference standards
11	Read the instructions and operate with caution	**12**	Disposal information

3.1.2 Type plate of the BactoSense power supply

The type plate of the BactoSense power supply can be found on the power supply and has the following elements:

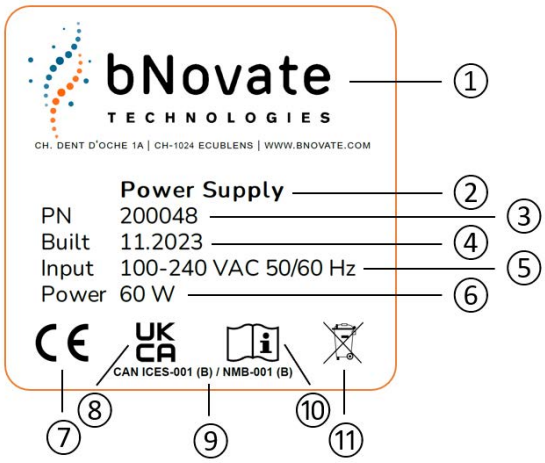


Figure 3-3 Type plate of the BactoSense power supply.

1	Manufacturer	**2**	Product name
3	Part number	**4**	Manufacturing date
5	Service voltage and frequency	**6**	Power consumption
7	CE mark	**8**	UKCA mark
9	Compliance with Canadian EMC and interference standards	**10**	Read the instructions and operate with caution.
11	Disposal information		

3.2 Technical data

Table 3-1 Technical data and specifications

GENERAL	
Operating environment	Indoor use
Operating altitude	Max. 2000 m (6600 ft) above sea level
Operating temperature	5 °C – 30 °C (41 °F – 86 °F)
Operating humidity	10 % – 90 % RH
Storage temperature	10 °C – 30 °C (50 °F – 86 °F)
Storage humidity	10 % – 70 % RH
Ventilation requirements	None
Sound pressure level	< 64 dBA
Protection classes	BactoSense: IP65 Power supply: IP67

PHYSICAL	
Dimension (W x D x H)	361 x 270 x 424 mm (14.2 x 10.6 x 16.7“)
Weight	With cartridge 14.3 kg (31.5 lbs) Without cartridge 11.1 kg (24.5 lbs)
Power supply dimension (W x D x H)	230 x 80 x 65 mm (9.0 x 3.1 x 2.6“)
Power supply weight	0.9 kg (2.0 lbs)

ELECTRICAL	
Installation category	II
Pollution degree	2
Power supply	Power supply unit: 100 – 240 VAC +/-10 %, 50 / 60 Hz, 1.4 A BactoSense: 18 – 24 VDC, 60 W (see section 5.3)
Power consumption	Avg. 20 W, max. 60 W
Recovery after power interruption	Configurable auto-restart

INTERFACES, CONNECTIVITY AND REMOTE ACCESS

USB	2 x USB 3.1, 5 V 1 A per port
Ethernet	1 x RJ45 Gigabit Ethernet
Ethernet protocols and options	Web interface Remote desktop (VNC) Modbus TCP HTTP / HTTPS FTP
Digital inputs	4 x digital inputs, optocoupler input: forward voltage 1.2 VDC with 3 kΩ in serial, cathode connected to COMMON, max. 30 mA, max. 50 mW
Analogue and digital outputs	Analogue outputs: 2 x 0/4 – 20 mA, recommended 250 Ω load Digital outputs: 4 x digital outputs, freely configurable, SSR output: max. 48 VDC, max. 300 mW, ON-resistance 2 Ω
Display	WVGA, 7.0"capacitive touchscreen
Mobile connectivity	BactoLink connectivity module (optional)
Advanced data analysis	FCS 3.1 file export
Data storage capacity	128 GB

MEASUREMENT

Measuring principle	Flow cytometry
Detection range	0 – 5´000´000 cells/mL
Quantification range	TCC: 1000 – 2'000'000 cells/mL ICC: 100 – 2'000'000 cells/mL
Laser type and wavelength	Laser diode 488 nm
Fluorescence	530/50 nm FL1 715 LP nm FL2
Forward scatter (FSC)	488 nm (optional depending on instrument)
Side scatter (SSC)	488 nm (optional depending on instrument)
Result parameters	TCC/mL, ICC/mL, LNAC/mL, HNAC/mL, HNAP (%), Gate+, depending on cartridge used.
Automatic measuring interval	From every 30 min to every 6 hours

SAMPLING	
Sampling type	Online or manual
Online sampling device	Flow through device: 200 – 400 mL/min (0.05 – 0.10 gal/min) Pressure in device: Max. 0.5 bar (7.3 psi) Aspirated volume: 260 µL Measured volume: 90 µL Inlet tubing • Material: PFA (transparent) • Outer diameter: 6.35 mm (1/4") • Inner diameter: 4.35 mm • Max. length: 2 m (6.5 ft) Outlet tubing • Material: FEP (blue) • Outer diameter: 6.35 mm (1/4") • Inner diameter: 4.83 mm • Max. length: 2 m (6.5 ft)
Manual sampling device	Sample container: 5 mL screw-cap tube Sample volume: 2 – 5 mL Aspirated volume: 260 µL Measured volume: 90 µL
Sample conditions	Temperature: 5 °C – 40 °C (41 °F – 104 °F) Turbidity: 0 – 10 FTU, 0 – 10 FNU Conductivity: 0 – 100'000 µS/cm at 20 °C pH-value: 5 – 12 Chlorine: max. 3 mg/L Iron: max. 200 µg/L Manganese: max. 50 µg/L

CARTRIDGE	
Capacity	Up to 1000 measurements
Validity	9 months
Storage temperature	15 °C – 25 °C (59 °F – 77 °F) ideally at 15 °C (59 °F)
Storage humidity	20 % – 60 % RH

MAINTENANCE	
Preventive maintenance	After 3 cartridges, at least yearly.
Calibration	Factory calibration only

COMPLIANCE	
Applied standards and certifications	Please refer to section 2.2.

4 Safety

4.1 Dangers

DANGER!

Damaged instrument or cabling

Touching damaged cables may lead to electrical shocks or death.

- The instrument may be operated only when the cables are intact.
- The instrument may be operated only if it has been properly installed or repaired.

DANGER!

Dangerous voltage inside the supplied mains device

Touching a wet or damaged mains device may lead to electrical shocks or death.

- Do not position the mains device in moist locations.
- Do not operate the mains device if its housing is damaged.

DANGER!

Damage due to incorrect service voltage

If the instrument is connected to an incorrect service voltage, the instrument can be damaged.

- The instrument must only be connected to voltage sources as specified on the type plate.
- The instrument must only be operated with the supplied power supply unit, as described in section 5.3.

WARNING!

Missing user manual

Operating the instrument without following the procedures indicated in the user manual may lead to injuries to persons and damage to the instrument.

- If the instrument changes hands, always include the user manual.
- If the user manual is lost, you can contact bNovate to request a replacement at www.bnovate.com/contact.

CAUTION!

Moisture or condensation on the electrical components

If moisture enters the instrument, the BactoSense can be damaged.

- The covers and lids must always be attached during operation.
- Service inside the instrument must only be performed by trained personnel in a dry room and at room temperature. The instrument should be at operating or room temperature (avoid condensation on optical and electrical surfaces).

Use of aggressive chemicals

Use of aggressive chemicals can cause damage to instrument components.

- Do not use aggressive chemicals or cleaning agents.
- Should the instrument come in contact with aggressive chemicals, clean it thoroughly with a neutral cleaning agent.
- Use a damp cloth (water only) to clean the exterior of the device.

4.2 Safe handling of chemicals

Improper handling of chemicals

Please observe the following instructions for safe handling of chemicals:

- Wear the recommended personal protection (safety goggles, protective gloves, protective clothing).
- Wash your hands thoroughly after working with chemicals.
- Study the MSDS (Material Safety Data Sheet) before working with chemicals. If an accidental release happens, please follow the instructions of the MSDS.
- Never smoke or store food or beverages in the working environment.

4.3 Residual risk

Residual risk

According to the risk assessment of the applied safety directive DIN EN 61010-1, there remains the risk of the displayed measurement values being incorrect. This risk can be reduced with the following measures:

- Use an access code to prevent unauthorized persons from changing parameters.
- Perform the specified servicing duties.

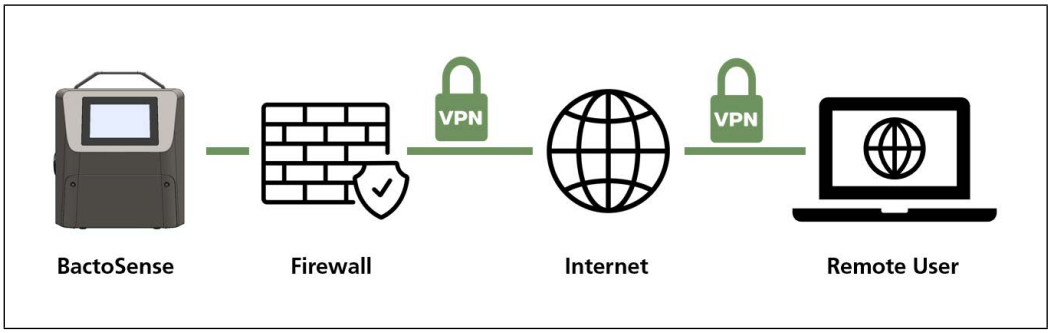
4.4 Warning and danger symbols on the instrument

No warning or danger symbols on the instrument

Users must ensure that they observe the safety measures as specified in the user manual at all times when working with the instrument and its peripheral equipment, even if no warning or danger symbols are attached to the instrument.

- Observe safety points when performing the described procedures.
- Observe local safety regulations.

4.5 Preventing unauthorized online access



CAUTION!

BactoSense is equipped with an integrated web user interface. If directly connected to the internet without appropriate protection, unauthorized internet users can access your instrument.

Please follow these recommendations:

- Never expose the instrument's network ports unprotected to the internet.
- Operate it behind a firewall and block access to the instrument.
- Connect to branch offices only via VPN.
- Change the standard password on commissioning.
- Always keep up-to-date with the latest changes regarding internet security.
- Immediately install the latest updates (also for the router and firewall).

5 Installation

DANGER!

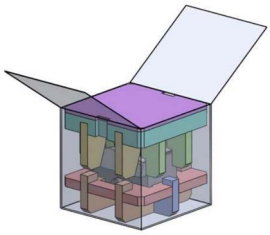
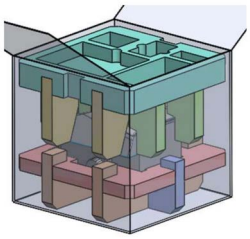
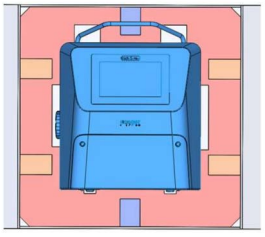
Attention

Before working on the instrument, carefully read the safety points.

- It is forbidden to modify or repair the BactoSense.
- Perform the work steps in the exact order instructed.
- When replacing parts, use only genuine original parts supplied or recommended by bNovate.

5.1 Unpacking the BactoSense

Carefully follow the procedure below to unpack the BactoSense instrument from its packaging.

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	Open the box and remove the lid.	
2.	Remove the compartments with accessories.	
3.	Carefully remove the BactoSense from the box.	
4.	Keep the packaging and foams for future use.	

5.2 Placement of the BactoSense

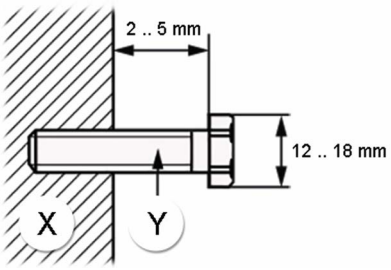
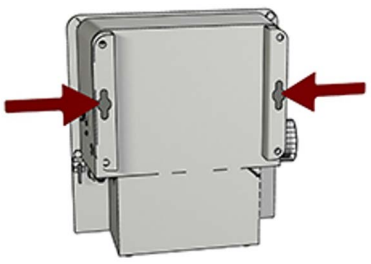
The BactoSense can be operated as a bench top instrument on a flat surface, or mounted to a wall or panel.

Note the following points for selecting an appropriate operating location:

- The BactoSense shall be installed in a vibration-free environment.
- The power supply must be stable, without spikes or interruptions.
- The BactoSense should not be exposed to direct sunlight during operation.
- In case of electromagnetic interference from a nearby object affecting the touchscreen (not responsive or flickering), relocate the BactoSense.

5.2.1 Mounting the BactoSense on a wall

The following procedure describes the mounting of the BactoSense to a vertical wall or panel:

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	Install two M8 screws at the same height, separated horizontally by 265 mm (10.4”) on a wall. The screw head diameter needs to be between 12 mm and 18 mm (0.47” – 0.71”)	CAUTION! The fixation must carry at least 60 kg (132 lbs).
2.	Adjust the distance of the screws head and the wall according to the picture on the right. X: Wall Y: Screw	
3.	Mount the BactoSense on the wall using its wall mounting system (red arrows). Tighten the two screws such that the BactoSense is firmly attached to the wall.	

5.3 Connecting the BactoSense to power

DANGER!

The BactoSense must be operated using the supplied original power supply unit to ensure:

- Compliance with the applicable standards for safety, EMC, ingress protection and RoHS, as listed in section 2.2.
- Instrument performance according to bNovate instrument validation protocols.
- Warranty coverage.

Operation with alternative power supply units requires specific evaluation and permission by bNovate.

CAUTION!

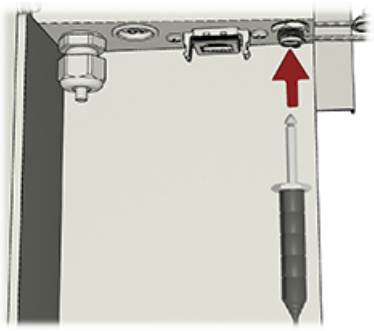
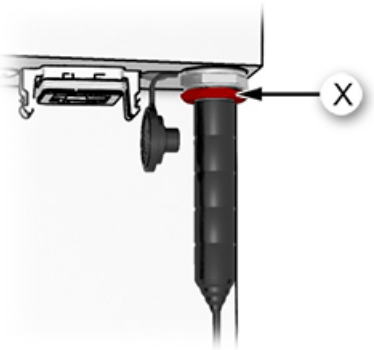
An uninterrupted and stable power supply as specified in the technical information in section 3.2 must be guaranteed.

The power supply comes in an IP67 enclosure and a cable with either a plug type J, type E or type G. For connecting the BactoSense to power using one of these plugs supplied by bNovate, follow the instructions in section 5.3.1.
For the connection using a different plug or power connectors, use the procedure described in section 5.3.2.

- The electrical plug or an additional circuit breaker should always be accessible to disconnect the main supply.
- The circuit breaker should respect the standards IEC60947-1 and IEC60947-3 and should protect a current of 10 A to 16 A.

5.3.1 Connecting using the standard plug of the power supply unit

The following procedure describes how to connect the BactoSense to power using the standard power supply unit and power plug of type J, E or G.

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	Make sure the power supply unit is dry and does not show any signs of damage.	
2.	Plug the J, E or G-type plug of the power supply unit to a power source supplying the indicated voltage.	
3.	Remove the cover of the power connector socket on the BactoSense.	
4.	Insert the power connector plug into the power connector socket.	
5.	Fasten the power connector plug lock ring (X). If the power connector is connected correctly and the instrument is powered, the instrument power button starts blinking.	

CAUTION!

To disconnect the BactoSense from power, first switch the instrument off. Then unplug the power supply unit from the mains power source, before unplugging the power supply plug from the BactoSense.

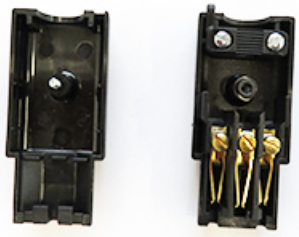
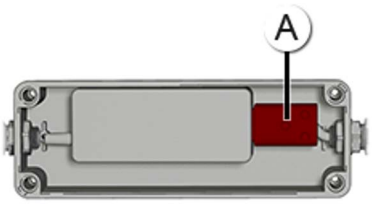
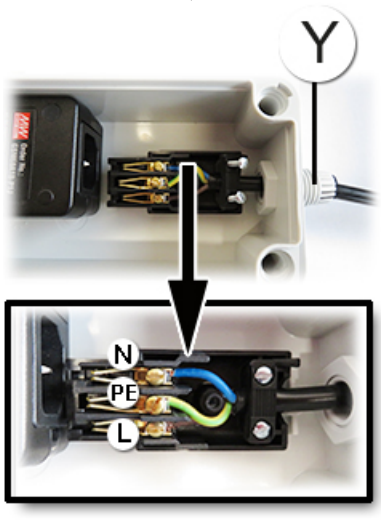
5.3.2 Modifying the standard power supply unit with a different connector

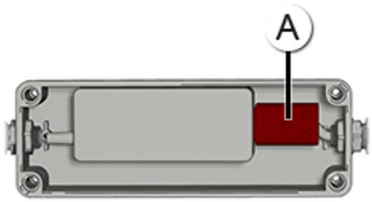
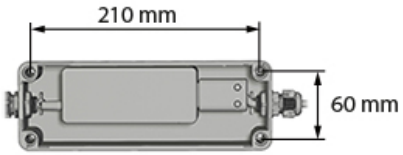
The following procedure only applies, if the BactoSense shall be connected to a power source with a different plug than what has been delivered together with the standard power supply unit (J, E or G). In that case, the power supply unit is opened and the new connector installed manually.

DANGER!

- Only professional electricians are authorized to modify the power supply unit.
- It is forbidden to modify or repair the BactoSense instrument.
- Perform the work steps in the exact order instructed.
- Always use a plug with Protective Earth (PE).

- If the power supply cable is longer than 2 m, label it near the plug with the name of the device.
- If the power supply cable is longer than 20 m, the impedance of PE needs to be smaller than 0.2 Ω.

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	DANGER! Ensure that the power supply is not connected to power. Remove the cover of the enclosure by unscrewing the four screws (circles).	
2.	Remove the C13 connector (A) and unscrew it to open. 	
3.	Open the cable connector (Y) and insert the new cable. Cable lengths and wire cross sections: • 0 – 9 m (0 – 30 ft), 1 mm^2 • 9 – 21 m (30 – 69 ft), 1.5 mm^2 (maximal) The cable connector is dimensioned for a cable diameter of 3 – 10 mm (0.12" – 0.39").	
4.	Tighten the 3 wires (N, PE, L) in the electrical terminal and block the cable isolation. DANGER! Ensure, that a plug with Protective Earth (PE) is used and the device is correctly connected to it.	

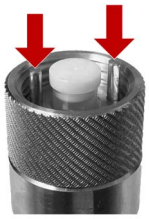
	WORK STEP	ADDITIONAL INFO / IMAGES
5.	Close the C13 connector (A) using the screw and plug it in the power supply. Tighten the cable connector. Try to pull the cable to assess whether the cable connector is tight enough.	
6.	Optional: the power supply can be mounted on a wall. M4 screws should be used with a minimum length of 20 mm. With the cover still removed, place the 4 screws and fix the enclosure to the wall.	
7.	Put the cover of the enclosure back and tighten the four screws to seal it.	
8.	Connect the power supply unit to power and the instrument as described in section 5.3.1.	

5.4 Installation of the manual sampling device

The manual sampling device is intended for measuring individual grab samples, collected in 5 mL screw-cap tubes. The following procedure describes how to install the manual sampling device.

Figure 5-1 Manual sampling device
1: Positioning pins, 2: Plug, 3: Fixation ring, 4: 5 mL screw-cap tube.

Avoid contamination of the equipment. Wear nitrile gloves when handling samples, sampling devices and any components which come in contact with them.

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	Inspect the manual sampling device • Make sure it is free of dust and fibers. If not, clean it with a lint-free tissue wetted with sterile water or ethanol • Make sure the white sealing plug is sitting tightly in the connector	
2.	Attach an empty 5 mL screw-cap tube or the Washstation at the sampling device.	
3.	Carefully insert the connector of the sampling device into the sampling device port on the left hand-side of the BactoSense by inserting the metallic positioning pins located inside of the sampling device connector into the openings on the BactoSense sampling device port.	

	WORK STEP	ADDITIONAL INFO / IMAGES
4.	Then tighten the knurled fixation ring until the sampling device is installed tightly. CAUTION! Finger-tightening only. Do not use any tools.	
5.	It is recommended to clean the sampling device after installation. If a Washstation is available, follow the procedure in section 14.2.2, otherwise the procedure in section 14.2.3.	
6.	After the cleaning, it is recommended to perform a Prime prior to measuring the first sample. Follow the procedure in section 10.7.3.	

5.5 Installation of the online sampling device

The online sampling device is intended to measure samples continuously at predefined measurement intervals, and it is therefore directly connected to a water source and drain using an inlet and outlet tubing. The following procedure describes how to install the online sampling device.

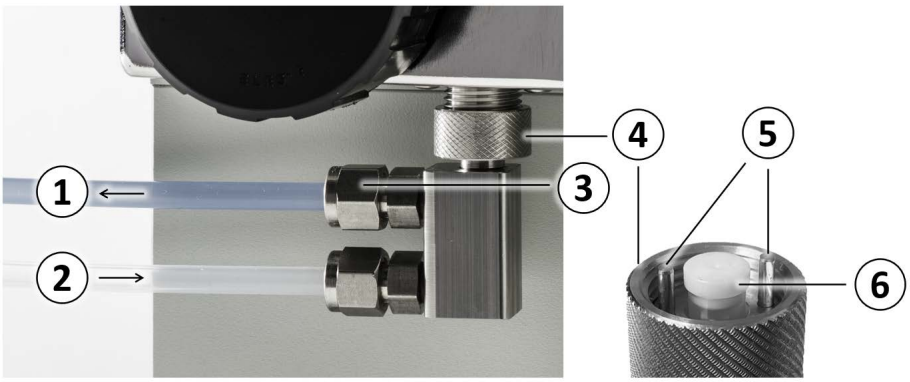


Figure 5-2 Online sampling device
1: Outlet tubing connected to a drain, 2: Inlet tubing connected to a water source, 3: Connector nut, 4: Fixation ring, 5: Positioning pins, 6: Plug.

Avoid contamination of the equipment. Wear nitrile gloves when handling samples, sampling devices and any components which come in contact with them.

CAUTION!

Firmly attach tubings and sampling device

If the plumbing, tubings or sampling device are not tightly assembled or mounted, liquid can flood surrounding areas and cause material damage to nearby objects or infrastructure. All tube junctions must be carefully secured and tightened. The connections should be checked periodically after installation.

WARNING!

Connect outlet tubing to a drain

In drinking water installations, connect the outlet tubing to a drain to make sure that water which has been diverted from the drinking water pipe system is not returned after flowing through the additional fittings, tubings and BactoSense sampling device.

5.5.1 Attaching the tubings to the online sampling device

The following instructions describe how to attach the inlet and outlet tubings to the body of the online sampling device.
Specifications of the tubings can be found in the technical data in section 3.2.
The exchange of tubings in case they are contaminated or damaged is described in section 14.2.4.

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	Make sure the sampling device is not installed at the BactoSense.	
2.	Unscrew the nuts of the two connectors on the sampling device. If necessary use a spanner. Be careful not to lose the ferrules located inside the nut.	
3.	Inspect the two tubings for contamination and damage. Only use clean and intact tubings with straight cuts.	
4.	For both tubings, insert one end through a nut and a ferrule as illustrated.	
5.	Attach the blue tubing (outlet) to the connector closer to the attachment port of the sampling device. Attach the transparent tubing (inlet) to the more distant connector to the attachment port of the sampling device. Use a clamp to fasten the nuts.	
6.	If you want to attach the sampling device, proceed with section 5.5.2.	

5.5.2 Installing the online sampling device at the BactoSense

In this section, the installation of the online sampling device with attached inlet and outlet tubings is described.

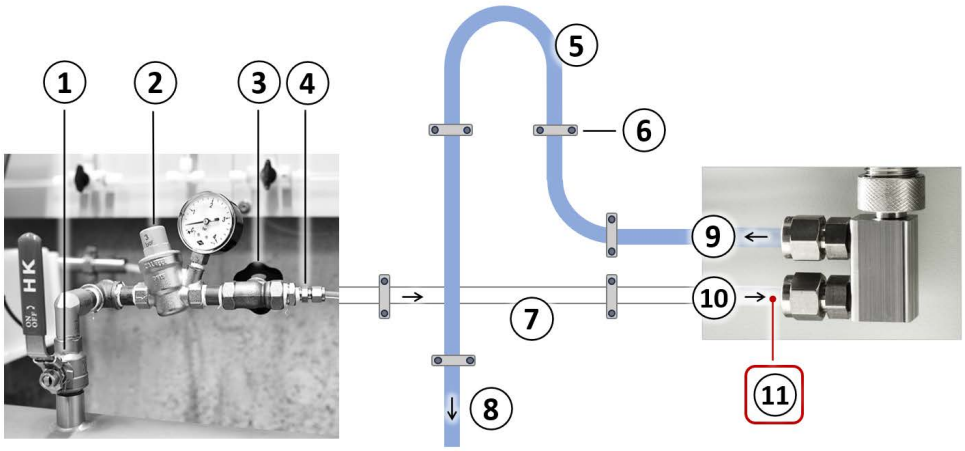
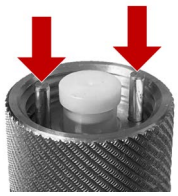
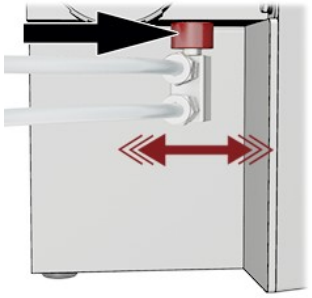


Figure 5-3 Typical installation for the online analysis mode using the online sampling device.

Flow and pressure adjustment	
1	On-off valve
2	Pressure valve with gauge
3	Flow valve
4	Reduction fittings
In and outlet tubings	
5	Backpressure loop
6	Tubing fixation
7	Horizontal inlet tubing
8	Outlet tubing connected to drain
Online sampling device	
9	Outlet tubing
10	Inlet tubing
11	Inlet conditions • Continuous flow • 200 – 400 mL/min (0.05 – 0.10 gal/min) • Max. 0.5 bar (7.3 psi)

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	Make sure the inlet and outlet tubings are firmly attached to the online sampling device.	
2.	Carefully insert the connector of the sampling device into the sampling device port on the left hand-side of the BactoSense by inserting the metallic positioning pins located inside of the sampling device connector into the openings on the BactoSense sampling device port.	
3.	Then tighten the knurled fixation ring (red) until the sampling device is installed tightly. CAUTION! Finger-tightening only. Do not use any tools.	

	WORK STEP	ADDITIONAL INFO / IMAGES
4.	Carefully connect the free ends of the tubings to the inlet water source and outlet drain. • Level the inlet tubing with the water source to prevent trapping of air bubbles • Shorten the length of the tubings as much as possible • Install the outlet tube with a loop in high position • Minimize the amount of connectors to reduce potential sources of contamination • To prevent any damage to the sampling device and BactoSense, make sure no force is exerted via the tubings. Fixate the tubings to a solid structure in the proximity of the sampling device (30 – 50 cm) if possible. CAUTION! In drinking water installations, connect the outlet tubing to a drain to make sure that the water diverted from the drinking water pipe system is not returned after flowing through the additional fittings, tubings and BactoSense sampling device.	See figure 5-3.
5.	Open the water supply carefully and check the appliance for leaks.	
6.	Adjust the flow rate coming from the water supply. Flow rate range: 200 to 400 mL/min (0.05 – 0.10 gal/min) CAUTION! If the flow rate is not within the specified limits, results may be inaccurate or the BactoSense may be damaged. CAUTION! Make sure the pressure in the sampling device does not exceed 0.5 bar (7.3 psi). Install a pressure reducer if needed.	See figure 5-3.

5.6 Connectivity options

The BactoSense offers several options for integration and online data access.

Table 5-1 BactoSense connectivity options

Connectivity Option	Documentation
I/O Box	Chapter 9
Modbus TCP	Section 7.1
FTP	Section 12.2
HTTP and HTTPS	Section 12.3
Virtual network computing (VNC) user interface relay (remote control)	Section 12.4
Web user interface	Chapter 13

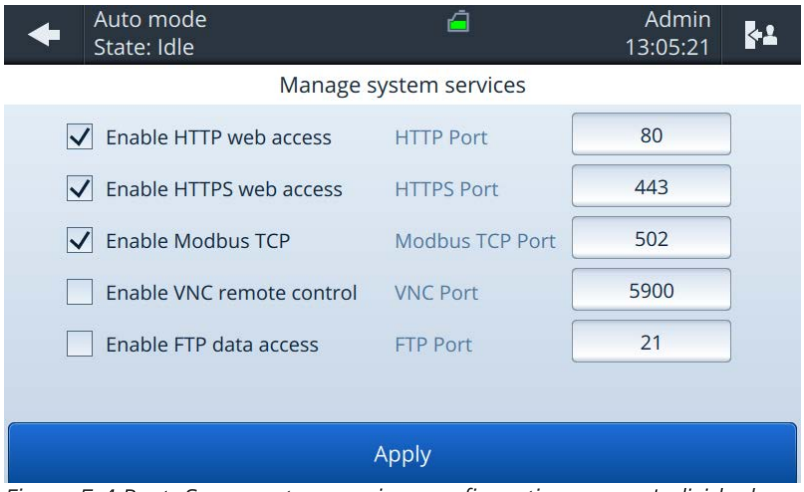


Figure 5-4 BactoSense system services configuration menu. Individual services can be enabled and communication ports configured.

6 I/O-Box

The IO-box is an accessory to the BactoSense. It can be used to connect the in- and outputs of the BactoSense to a PLC/SCADA system.

As an alternative to the I/O-Box, Modbus TCP can be used. Details can be found in section 7.1

6.1 Technical specifications

Carefully read the technical specifications before preparing the integration.

6.1.1 Digital inputs

- Use: 4 digital inputs referenced to Common allow the instrument to be controlled by an external voltage (e.g. voltage coming out of a PLC).
- Specifications: optocoupler input: forward voltage 1.2 VDC with 3 kΩ in serial, cathode connected to COMMON, max. 30 mA, max. 50 mW.

Additional notes

- The Common (port 18) must be connected to the reference voltage of the input voltage (e.g. 0 V / Ground of the external power source).
- The digital inputs (ports 14 - 17) voltage range is between 5 - 30 V to produce a logic high level or "1". Otherwise it produces a logic low level or "0".
- If any of the digital inputs is at a logic high level or "1", the BactoSense enters "PLC-mode".

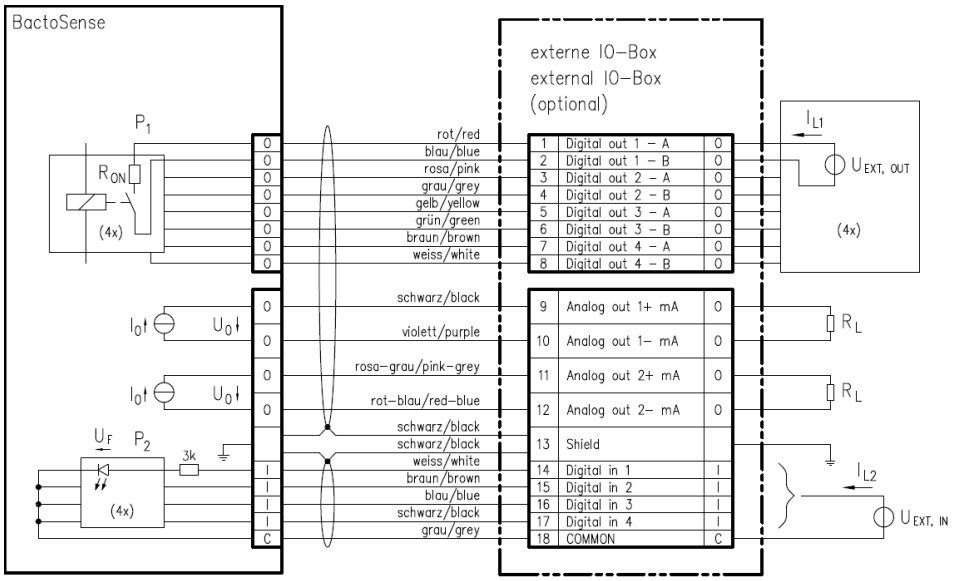
6.1.2 Digital outputs

- Use: 4 digital outputs allow the reporting of 4 different logic states, e.g. errors or alarms. As the output terminals are the output of a MOS-based solid-state relay (LH1540AAB), there is no polarity. Terminals A and B can be used in either direction and can be swapped. Terminals A and B are either in high-impedance (disconnected) or low-impedance (connected) state.
- Specifications: freely configurable, SSR output: max. 48 VDC, max. 300 mW, ON-resistance 2 Ω.

6.1.3 Analogue outputs

- Use: 2 analogue outputs (4 – 20 mA) allow the reporting of two analogue values, e.g. Total Cell Count and HNAP. Note: For the transmission of precise results, the use of Modbus TCP is recommended. See section 7.1
- Specifications: 2 x 0/4 – 20 mA, recommended 250 Ω load

6.1.4 IO-box schematics



Parameter	min.	typ.	max.	Unit
I_0	0		21	mA
U_0		15		VDC
R_L		250	500	Ω
$U_{EXT, OUT}$	–48		48	VDC
$U_{EXT, IN}$	0		30	VDC
I_{L1}	–500		500	mA
I_{L2}	0	7.5	30	mA
R_{ON}		1	2	Ω
P_1			300	mW
P_2			50	mW
U_F	1.1	1.27	1.4	VDC

Figure 6-1 BactoSense IO-box schematics.

6.1.5 IO-box overview

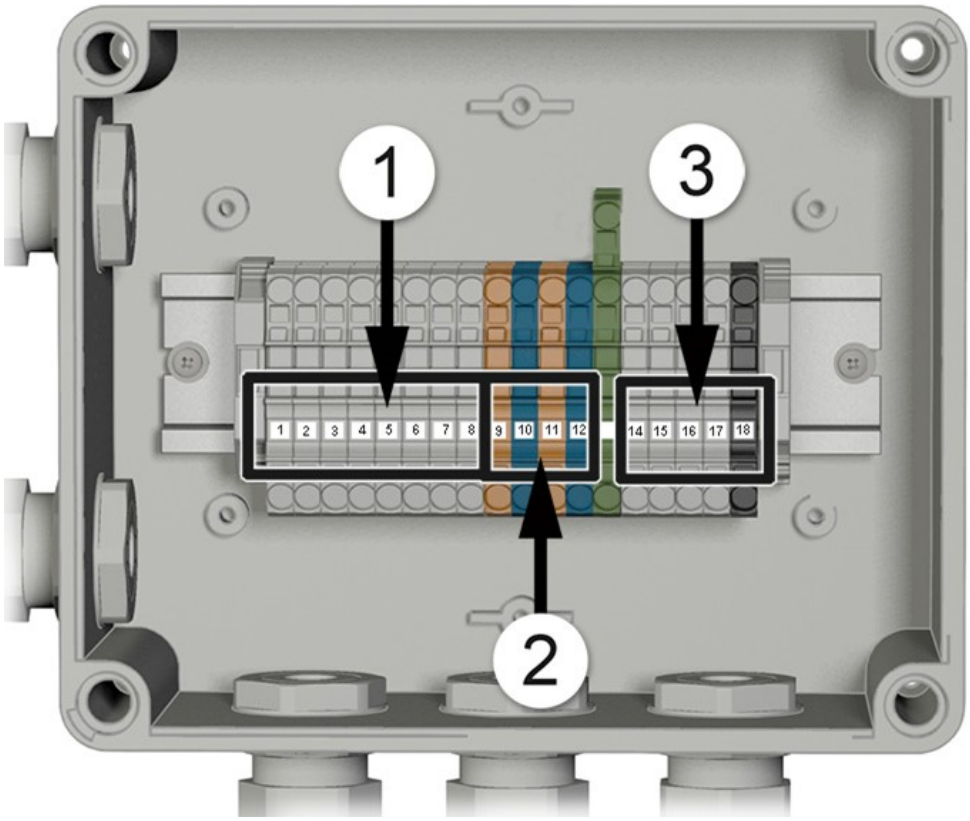


Figure 6-2 Overview of the BactoSense IO-box

①	Position of the *digital outputs* Terminals 1 – 8 Cable requirements: • AWG 12 – 22 • Cross section: 0.25 – 2.5 mm2	②	Position of the *analogue outputs* Terminals 9 – 12 Cable requirements: • AWG 12 – 22 • Cross section: 0.25 – 2.5 mm2
③	Position of the *digital inputs* Terminals 14 – 18 Cable requirements: • AWG 12 – 22 • Cross section: 0.25 – 2.5 mm2		

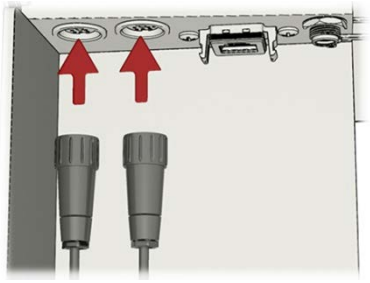
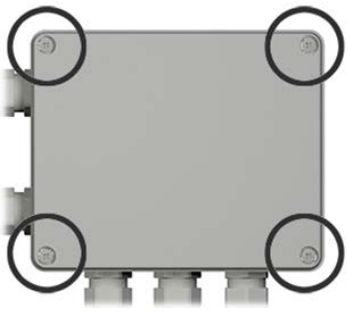
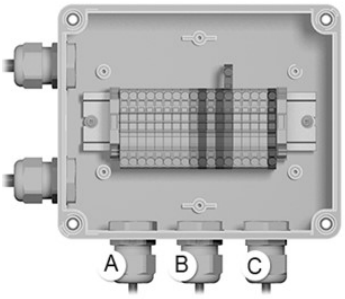
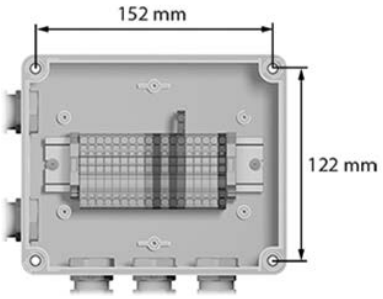
6.1.6 IO-box reference table

Table 6-1 IO-box reference table

Terminal	Function	Terminal Color	Cable Color
1	Digital output 1 - A	Grey	Red
2	Digital output 1 - B	Grey	Blue
3	Digital output 2 - A	Grey	Pink
4	Digital output 2 - B	Grey	Grey
5	Digital output 3 - A	Grey	Yellow
6	Digital output 3 - B	Grey	Green
7	Digital output 4 - A	Grey	Brown
8	Digital output 4 - B	Grey	White
9	Analogue 1+ mA	Orange	Black
10	Analogue 1- mA	Blue	Purple
11	Analogue 2+ mA	Orange	Pink-Grey
12	Analogue 2- mA	Blue	Red-Blue
13	Shield	Green/Yellow	
14	Digital input 1	Grey	White
15	Digital input 2	Grey	Brown
16	Digital input 3	Grey	Blue
17	Digital input 4	Grey	Black
18	Common	Black	Grey

6.2 Connecting the IO-box

Review the technical specifications in sections 6.1.1 to 6.1.3 and the schematics in section 6.1.4 to ensure correct installation.

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	Insert the two M16 plugs of the IO-box on the right-hand side of the instrument.	
2.	Remove the cover of the enclosure by unscrewing the four screws (circles).	
3.	Insert cable through the cable gland (A, B or C) and connect the wires to the corresponding terminal according to the IO-Box reference table in section 6.1.6.	
4.	Tighten the cable gland. Try to pull the cable to see if the cable gland is tight enough.	
5.	Optional: the IO-box can be mounted on a wall. M4 screws should be used with a minimum length of 20 mm. With the cover still removed, place the 4 screws and fix the enclosure to the wall.	
6.	Put the cover of the enclosure back and tighten the four screws to seal it.	

6.3 Connecting the outputs without IO-box

The BactoSense exposes the outputs on a 12 pin M16 female connector. The use of an IO-box is recommended however. The pinout of the connector is given below.

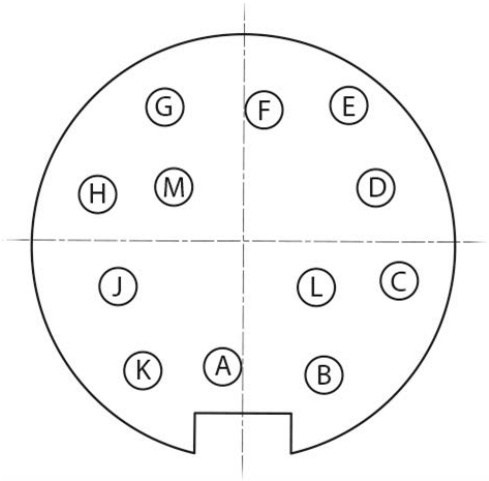


Figure 6-3 Overview of the output connector pinout

A	Digital output 4 - B	G	Digital output 1 - B
B	Digital output 4 - A	H	Digital output 1 - A
C	Digital output 3 - B	J	Analogue 1+
D	Digital output 3 - A	K	Analogue 1-
E	Digital output 2 - B	L	Analogue 2+
F	Digital output 2 - A	M	Analogue 2-

6.4 Connecting the inputs without IO-box

The BactoSense exposes the inputs on a 5 pin M16 female connector. The use of an IO-box is recommended. The pinout of the connector is given below.

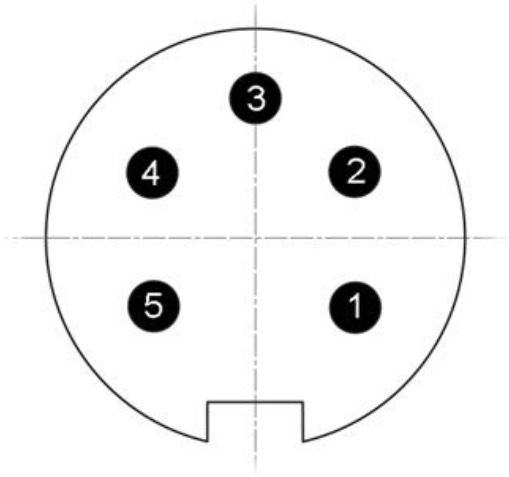


Figure 6-4 Overview of the input connector pinouts

1	Digital input 1	2	Digital input 2
3	Digital input 3	4	Digital input 4
5	Common		

6.5 Digital inputs configuration and PLC mode

The instrument can be controlled from an external Programmable Logic Controller (PLC). In order to avoid any conflicts when starting a process, the PLC first locks the instrument into "PLC Mode", in which the instrument acts as a slave to the PLC. In this mode, all functions of the GUI related to running protocols and other processes are blocked. Once in PLC mode, protocols can be started and aborted from the PLC, using the Instrument's digital inputs. The digital outputs then provide feedback to the PLC for safe operation.

The PLC mode is a remote-controlled Auto mode: the PLC can request a single measurement, or start the scheduler to run protocols at predefined intervals. Measurements started from the PLC also appear in the Auto mode results.

When no wires are connected to the digital inputs, their state is 0000.

Table 6-2 Overview of digital inputs states and associated functions.

DESCRIPTION	DIGITAL INPUTS			
	1	**2**	**3**	**4**
Force PLC mode: The instrument is idle but a slave to the PLC.	1	0	0	0
Run configurable protocol / measurement interval	1	0	0	1
Run configurable protocol / measurement interval	1	0	1	0
Run configurable protocol / measurement interval	1	0	1	1
Run configurable protocol / measurement interval	1	1	0	0
Run configurable protocol / measurement interval	1	1	0	1
Run configurable protocol / measurement interval	1	1	1	0
Abort current protocol	1	1	1	1
Slave mode deactivated. End of PLC mode.	0	0	0	0

To run a protocol several times, either use the scheduler option, or trigger a new measurement from the PLC by resetting the inputs state to 1000, then back to the corresponding "Run" state.

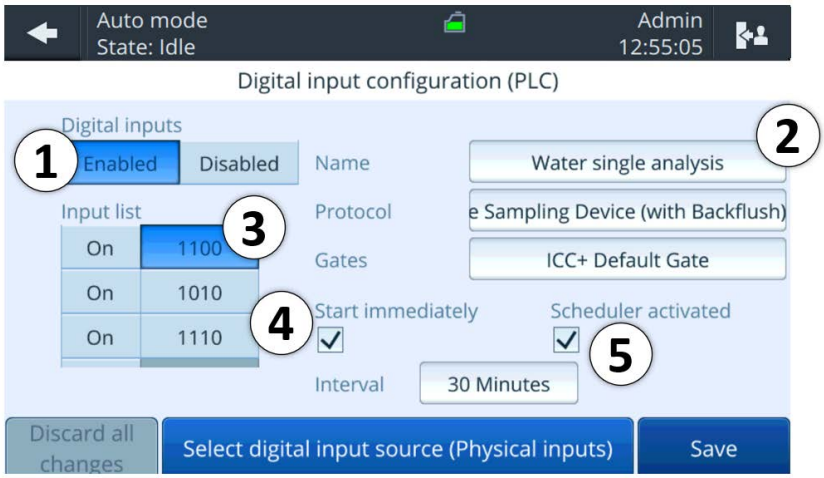


Figure 6-5 Digital inputs configuration

1	Enable or disable digital inputs. If disabled, PLC mode is never active.	**2**	Protocol parameters: Name, Protocol, and Gates.
3	Select the inputs state you wish to configure. When the state selected in (3) is applied to the DI, the protocol defined in (2), (4) and (5) will be executed	**4**	If enabled, start the protocol immediately after the inputs state has changed. If not, wait for the duration of the scheduler interval before starting.
5	Scheduler settings: if the scheduler is activated, the protocol will be repeated at the selected interval, until the inputs state is changed. If the scheduler is disabled, the protocol will run only once.		

To configure the configurable digital inputs states, follow these steps:

	WORK STEP	**ADDITIONAL INFO / IMAGES**
1.	Navigate to the **Home menu** of the BactoSense user interface.	
2.	Press the **Auto mode settings** button.	
3.	Press the **Digital inputs** button.	
4.	Make sure the toggle button is set to **Enabled**.	
5.	Switch on and select the state you wish to configure in the Inputs list, enter a name for the sample, choose a protocol and choose a gate.	

	WORK STEP	ADDITIONAL INFO / IMAGES
6.	If you want the protocol to repeat automatically, enable the "Scheduler activated" check box, and choose an interval.	
7.	In the above case, choose if you want the protocol to execute immediately or at the end of the first interval with the "Start immediately" check box.	This option is only useful if the scheduler is activated.
8.	Press the **Save** button.	

6.6 Digital output configuration

The values of digital outputs are modified in the following situations:

- When the instrument is powered off, all outputs are set to 0.
- When the instrument is powered on, the outputs show the current error state: none / critical / non-critical.
- At the end of a measurement in Auto mode, the outputs are changed to indicate errors and alarms, according to user-defined settings.
- When Reset is clicked on the output test screen or when Save is pressed on the digital output settings, the outputs are updated to show the error state only (alarms are ignored).
- After manually clearing the errors, the outputs are automatically reset (and therefore show the new error state and no alarms).
- At specific times during the measurement, extra signals can be relayed. By default, neither of them is relayed to the outputs. These are:
  - Process running. Active when a protocol is running.
  - Sampling device in use. Active when the sampling device is being used. It drops back to inactive after the sample preparation step of measurement protocols.
  - Low cartridge. Active when the cartridge level is below 15 %, or if the cartridge is estimated to be empty within a month based on the current measurement frequency.
  - Expired cartridge. Active when the cartridge is expired.

The digital output state at the end of a measurement is defined according to these default values, which can be changed in the settings:

- If there are no errors and no alarms, all terminals are set to the user-defined base state. By default, this is 1 everywhere.
- In case of a critical error, the first output is set to 0.
- Non-critical errors set the second output to 0.
- Alarms set the third and fourth output to 0.
- In case of conflict in the output settings, priority is given to:
  - 1. Critical errors
  - 2. Non-critical errors
  - 3. Cartridge states
  - 4. Alarm

Only Admin users can change the output settings, as these can critically affect external PLC systems.

The following procedure describes how to adjust the digital outputs.

<table>
<tr><th></th><th>WORK STEP</th><th>ADDITIONAL INFO / IMAGES</th></tr>
<tr><td>1.</td><td>Navigate to the Home menu of the BactoSense user interface.</td><td></td></tr>
<tr><td>2.</td><td>Press the Auto mode settings button.</td><td></td></tr>
<tr><td>3.</td><td>Press the Digital outputs button.</td><td></td></tr>
<tr><td>4.</td><td>Choose the base state, i.e. the output state when everything is fine:
<table><tr><td>Output</td><td>1</td><td>2</td><td>3</td><td>4</td></tr><tr><td>Base state</td><td>1</td><td>1</td><td>1</td><td>1</td></tr></table></td><td>1: The switch is closed.
0: The switch is open.</td></tr>
<tr><td>5.</td><td>Choose which output the critical error state should be signaled on:
<table><tr><td>Output</td><td>1</td><td>2</td><td>3</td><td>4</td></tr><tr><td>Critical error</td><td>0</td><td>/</td><td>/</td><td>/</td></tr></table></td><td>By default, a critical error opens output 1.
1: The switch is closed.
0: The switch is open.
/: The switch is not affected by this error.</td></tr>
<tr><td>6.</td><td>Choose which output the non-critical error state should be signaled on:
<table><tr><td>Output</td><td>1</td><td>2</td><td>3</td><td>4</td></tr><tr><td>Non-critical error</td><td>/</td><td>0</td><td>/</td><td>/</td></tr></table></td><td>By default, a non-critical error opens output 2.</td></tr>
<tr><td>7.</td><td>Assign alarms to the remaining outputs:
<table><tr><td>Output</td><td>1</td><td>2</td><td>3</td><td>4</td></tr><tr><td>Alarm 1</td><td>/</td><td>/</td><td>0</td><td>0</td></tr><tr><td>Alarm 2 ...</td><td>...</td><td>...</td><td>...</td><td>...</td></tr></table></td><td>You can only assign alarms that are enabled.
You can assign several alarms to the same output.</td></tr>
<tr><td>8.</td><td>Press the Save button.</td><td></td></tr>
</table>

6.7 Analogue output configuration

The analogue current output is changed in the following situations:

- When the instrument is powered off, both outputs are set to 0 mA.
- When the instrument is powered on, both outputs are set to 2 mA.
- When a measurement in Auto mode terminates after cell counting, the value is set between 4 and 20 mA, according to range and source definition of the analogue output settings. If the measurement fails due to an error before cell counting begins, the output remains at its previous value.
- When a user manually tests the output, the current is set to whatever value the user has chosen. The reset button sets them to 4 mA.

For the transmission of precise results, the use of Modbus TCP is recommended. See section 7.1

Only **Admin** users can edit the analogue 4 .. 20 mA outputs.

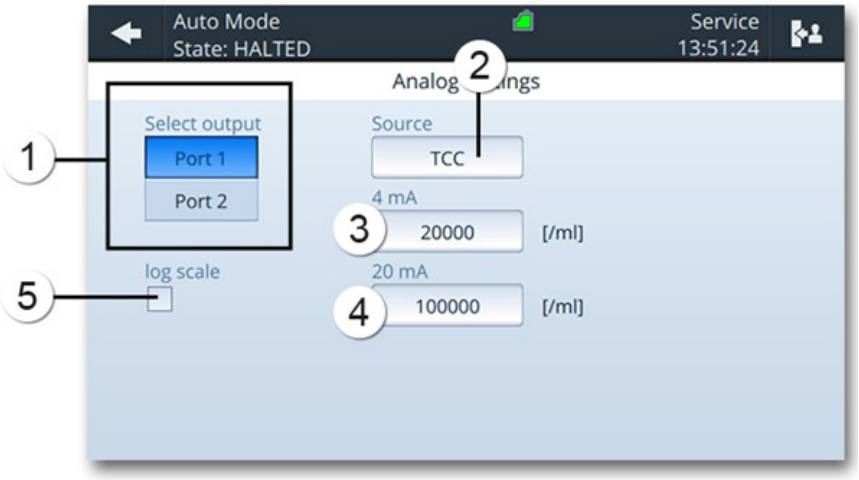


Figure 6-6 Analogue output settings

1	Output port selection	**2**	Source: Defines which measurement result is transmitted by this output port.
3	Lower limit 4 mA: Which value of the measurement result should correspond to 4 mA.	**4**	Upper limit 20 mA: Which value of the measurement result should correspond to 20 mA.
5	If selected, interpolates the chosen cell count value range with a logarithmic scale as follows: $\text{ratio} = 1 + 9 \times \left(\frac{\text{counts} - \text{low}}{\text{high} - \text{low}}\right)$ $\text{output} = 4\text{mA} + \log_{10}(\text{ratio}) \times 16\text{mA}$ counts: Measured cell count low: Lower cell count limit high: Higher cell count limit output: Current amplitude in mA		

The following procedure describes how to adjust the analogue outputs.

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	Navigate to the **Home menu** of the BactoSense user interface.	
2.	Press the **Auto mode settings** button.	
3.	Press the **Analog outputs** button.	
4.	Choose **Port 1** or **Port 2** (figure 6-6)	
5.	Choose the source (figure 6-6, position 2).	
6.	Define the lower limit of the range (figure 6-6, position 3).	When the source is equal to this value, 4 mA will be output on the selected port.
7.	Define the upper limit of the range (figure 6-6, position 4).	When the source is equal to this value, 20 mA will be output on the selected port.
8.	Press the **Save** button.	

6.8 Digital and analogue output testing

CAUTION!

The Test outputs interface allows to generate a physical output signal for testing purposes. Make sure that such tests do not generate an alarm on your control system.

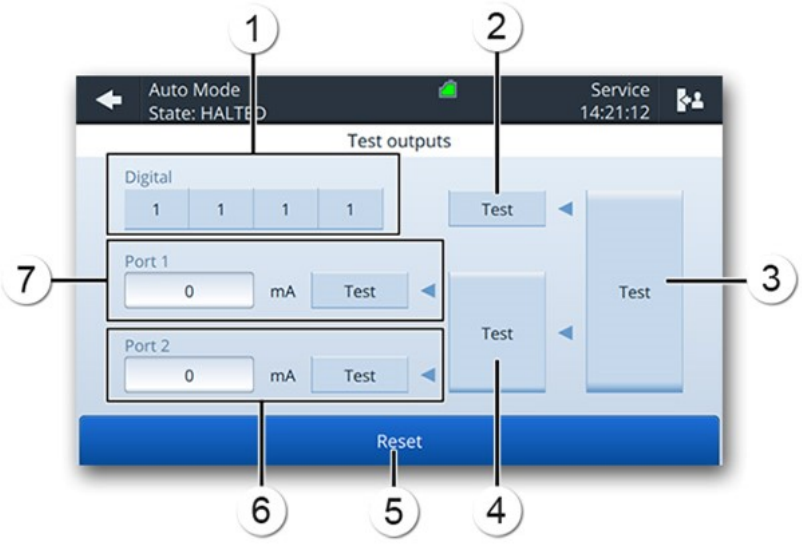


Figure 6-7 Testing analogue and digital outputs

1	Define state of digital outputs for test.	**2**	Set digital outputs to the state defined in (1).
3	Set all digital and analogue outputs at once.	**4**	Set current on both analogue outputs.
5	Reset outputs to their state before the tests.	**6**	Set current on port 2.
7	Set current on port 1.		

The following procedure describes how to test the analogue and digital outputs.

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	Navigate to the **Home menu** of the BactoSense user interface.	
2.	Press the **Auto mode settings** button.	
3.	Press the **Test outputs** button.	

	WORK STEP	ADDITIONAL INFO / IMAGES
4.	Enter the test values that you wish to send to the PLC.	For digital outputs: 1: The switch is closed. 0: The switch is open.
5.	Tests can be triggered individually or together (see figure 6-7): • Testing only the digital outputs on the terminals 1 – 4. • Testing only the analogue outputs on ports 1, 2 or both. • Testing all outputs.	The output signals can be measured on the terminals.
6.	Press the **Reset** button.	

7 Field Bus Interface

7.1 Modbus TCP

7.1.1 General information for operating with Modbus TCP

The BactoSense can be operated via the Modbus Transmission Control Protocol (TCP). The following requirements must be met:

- The computer and/or the management or control system must be compatible with Modbus TCP.
- The computer and/or the management or control system must have software that can properly process the data provided by the BactoSense.
- The BactoSense must have the Modbus TCP service activated in the System settings / System services menu.
- The BactoSense must be connected to the bus system.
- To be able to work with the Modbus TCP, the network settings must be set correctly.

Additional information

- The Modbus TCP interface is integrated by default in the BactoSense.
- The Ethernet socket is located at the right-hand side of the instrument.
- The address table necessary for programming can be found separately in the section 7.1.2.
- All registers are encoded big-endian.
- Modbus TCP communication runs on port 502.
- The error code list can be found in section 15.2 (non-critical errors) and section 15.3 (critical errors).
- Modbus TCP can be used for time synchronisation. Follow the instructions in section 8.7 and select *Modbus TCP* as a sync source.

7.1.2 Address list on Modbus TCP:

The following values can be read with Modbus function 3 or 4 and written with Modbus function 16.

REGISTER NO	ADDRESS (OFFSET)	DATA TYPE	FUNCTION	VALUES
300201 400201	0x00C8	Unsigned integer bits 0-15	Digital Inputs	Bit 0: Input 1 Bit 1: Input 2 Bit 2: Input 3 Bit 3: Input 4
300202 400202	0x00C9	Unsigned integer bits 0-15	Power control	Bit 0: Power off Bit 1: Reboot
300203 400203	0x00CB	Uint16	Watchdog	Write setpoint in seconds to activate or reset countdown. After the value is written, a countdown decrements it by 1 every second. During countdown, reading the register returns the setpoint. If countdown reaches 0, any ongoing protocol is aborted. Reading the register returns 0 Write 0 to disable countdown.
300204 400204	0x00CC	Uint16	Test register	Write 1 to display a message on DI source page of GUI. Resets to 0 at startup.
300211 400211	0x00D2	UInt16: Year	Get/Set Date and Time. Time is changed as soon as write is finished. Only the fields where registers were written are changed: if only month is written, only the month is updated.	
300212 400212	0x00D3	UInt16: Month		
300213 400213	0x00D4	UInt16: Day		
300214 400214	0x00D5	UInt16: Hour		
300215 400215	0x00D6	UInt16: Minute		
300216 400216	0x00D7	UInt16: Second		

The following values can be read with Modbus function 3 or 4.

REGISTER NO	ADDRESS (OFFSET)	DATA TYPE	FUNCTION	VALUES
300001 400001	0x0000	UInt16 (individual bits)	Digital Outputs	Bit 0: Output 1 Bit 1: Output 2 Bit 2: Output 3 Bit 3: Output 4
300002 400002	0x0001	UInt16 (individual bits)	Instrument Status 0 = No 1 = Yes	Bit 0: Process running Bit 1: Critical Error Bit 2: Non-critical error Bit 3: PLC mode active Bit 4: Rapid heating (in winter mode) Bit 5: Background heating (winter mode) Bit 6: Sampling device in use
300003 400003	0x0002	UInt16 (individual bits)	Alarm status, i.e., alarms raised during last measuremen t.	Bit 0: Alarm 1 Bit 1: Alarm 2 Bit 2: Alarm 3 …
300004 400004	0x0003	UInt32 MSB (individual bits)	Warning status, i.e. warnings raised during last measuremen t.	Bit 0: Warning W01 Bit 1: Warning W02 … Bit 31: Warning W32
300005 400005	0x0004	UInt32 LSB (individual bits)		
300006 400006	0x0005	UInt16	Error code	See error code list. Note: E00 (unhandled software error) is renamed to 999 to avoid confusion with "no error". Non-critical error codes remain until either cleared automatically by a successful protocol or cleared manually.
300007 400007	0x0006	UInt16	Heartbeat	Seconds of the clock. The value changes every second, use this to monitor responsiveness of the system.

REGISTER NO	ADDRESS (OFFSET)	DATA TYPE	FUNCTION	VALUES
300008 400008	0x0007	UInt16	Measurement stage	IDLE 0 INITIALIZING 1 HEATING 2 FILLING 3 PRIMING 4 MIXING 5 INCUBATING 6 ANALYZING 7 CLEANING 8 FLUSHING 9 PROCESSING 10 VALIDATING 11 MOVING 12 EJECTING 13 EXPORTING 14 RENAMING 15 DELETING 16 SAVING 17 SELFCHECK 18 ABORTED 19 UNKNOWN 98 ERROR 99
300011 400011	0x000A	UInt16	Measurement Progress	[0, 100] 0 .. 100 %
300012 400012	0x000B	Float 32 MSB	Temperature of IO board	Celsius
300013 400013	0x000C	Float 32 LSB		
300014 400014	0x000D	UInt16	Humidity at IO board	[0, 100] 0 .. 100 %
300015 400015	0x000E	UInt16: Year	Date and time of last sampling	
300016 400016	0x000F	UInt16: Month		
300017 400017	0x0010	UInt16: Day		
300018 400018	0x0011	UInt16: Hour		
300019 400019	0x0012	UInt16: Minute		
300020 400020	0x0013	UInt16: Second		
300021 400021	0x0014	UInt16	Cartridge percentage	[0, 100] 0 .. 100 %

REGISTER NO	ADDRESS (OFFSET)	DATA TYPE	FUNCTION	VALUES
300022 400022	0x0015	UInt32 MSB	Cartridge serial no	
300023 400023	0x0016	UInt32 LSB		
300024 400024	0x0017	UInt32 MSB	Fill serial no	
300025 400025	0x0018	UInt32 LSB		
300026 400026	0x0019	Uint16	Cartridge type	1 = TCC-D 1002 = ICC-A
300027 400027	0x001A	UInt16: Year	Cartridge expiration date	UTC date
300028 400028	0x001B	UInt16: Month		
300029 400029	0x001c	UInt16: Day		
300031 400031	0x001E	UInt32 MSB	Instrument Serial number	
300032 400032	0x001F	UInt32 LSB		
300033 400033	0x0020	String char 1-2	Software version	When shorter than 16 characters, the string is padded with null characters. Example: '1.4.0-BS\0\0\0\0...'
300034 400034	0x0021	String char 3-4		
300035 400035	0x0022	String char 5-6		
300036 400036	0x0023	String char 7-8		
300037 400037	0x0024	String char 9-10		
300038 400038	0x0025	String char 11-12		
300039 400039	0x0026	String char 13-14		
300040 400040	0x0027	String char 15-16		
300041 400041	0x0028	UInt16	Memory remaining	Approx measurements remaining before disk is full

REGISTER NO	ADDRESS (OFFSET)	DATA TYPE	FUNCTION	VALUES
300042 400042	0x0029	UInt16	Lifetime of valve remaining	[0, 100], percentage of movements remaining before service.
300043 400043	0x002A	UInt16	Lifetime of plunger remaining	[0, 100], percentage of movements remaining before service.
300044 400044	0x002B	UInt16: Year	Next service due date	UTC date
300045 400045	0x002C	UInt16: Month		
300046 400046	0x002D	UInt16: Day		
300101 400101	0x0064	UInt32 MSB	TCC	
300102 400102	0x0065	UInt32 LSB		
300103 400103	0x0066	UInt32 MSB	ICC	Always 0 if cartridge does not provide ICC
300104 400104	0x0067	UInt32 LSB		
300105 400105	0x0068	UInt32 MSB	Gate+	Always 0 if cartridge does not provide Gate+
300106 400106	0x0069	UInt32 LSB		
300107 400107	0x006A	UInt32 MSB	HNAC	
300108 400108	0x006B	UInt32 LSB		
300109 400109	0x006C	UInt32 MSB	LNAC	
300110 400110	0x006D	UInt32 LSB		
300111 400111	0x006E	Float 32 MSB	HNAP	
300112 400112	0x006F	Float 32 LSB		
300121 400121	0x0078	UInt32 MSB	Live TCC	Same as TCC, but the value is updated live during a measurement.
300122 400122	0x0079	UInt32 LSB		

REGISTER NO	ADDRESS (OFFSET)	DATA TYPE	FUNCTION	VALUES
300123 400123	0x007A	UInt32 MSB	Live ICC	Same as ICC, but the value is updated live during a measurement.
300124 400124	0x007B	UInt32 LSB		
300125 400125	0x007C	UInt32 MSB	Live Gate+	Same as Gate+, but the value is updated live during a measurement.
300126 400126	0x007D	UInt32 LSB		
300127 400127	0x007E	UInt32 MSB	Live HNAC	Same as HNAC, but the value is updated live during a measurement.
300128 400128	0x007F	UInt32 LSB		
300129 400129	0x0080	UInt32 MSB	Live LNAC	Same as LNAC, but the value is updated live during a measurement.
300130 400130	0x0081	UInt32 LSB		
300131 400131	0x0082	Float 32 MSB	Live HNAP	Same as HNAP, but the value is updated live during a measurement.
300132 400132	0x0083	Float 32 LSB		
300151 400151	0x0096	UInt16: Year	Date and time of last abrupt shutdown	
300152 400152	0x0097	UInt16: Month		
300153 400153	0x0098	UInt16: Day		
300154 400154	0x0099	UInt16: Hour		
300155 400155	0x009A	UInt16: Minute		
300156 400156	0x009B	UInt16: Second		
300157 400157	0x009C	UInt16	Power off time	In seconds

8 General Operations and Configurations

8.1 Switching on and off

The power button of the BactoSense is located on the right hand-side of the instrument.

Figure 8-1 Power button of the BactoSense

CAUTION!

Before switching the BactoSense on, make sure that the instrument is connected to a stable power supply meeting the requirements described in section 5.3.

Switching on

To switch the BactoSense on, shortly press on the power button. The power button LED lights up constantly and after a few seconds, the welcome screen is displayed on the user interface.

Switching off

If you are logged in and want to switch the BactoSense off, tap on the logout button on the top right corner of the user interface and select *Power off*. If you want to switch off from the login page itself, press the power button for 10 seconds.

CAUTION!

To disconnect the BactoSense from power, first switch the instrument off. Then unplug the power supply unit from the mains power source, before unplugging the power supply plug from the BactoSense.

8.2 Login, user roles and permissions

BactoSense operation requires users to log in. Different user roles with different permissions are available. The user role permissions are listed in section 8.2.4. All logins are password protected.

Login and logout can be performed using the login button displayed in the top right corner of the user interface. The currently active user role is displayed next to that button.

8.2.1 Login

	WORK STEP
1.	Press the login button on the top right corner of the user interface, or the login bar at the bottom in case you switched on the instrument.
2.	Select one of the user profiles *Basic*, *Advanced* or *Admin*.
3.	Enter the password and press *OK*. If you don't know the password, ask your Admin user. In a new instrument no passwords are set. In that case, follow the procedure described in section 8.2.3.
4.	After logging in, you see the BactoSense user interface.
5.	To log out, follow the procedure described in section 8.2.2.

8.2.2 Manual logout

	WORK STEP
1.	Make sure all processes (e.g. measurements or cleanings) have completed. The idle state of the instrument is indicated on the left hand-side of the top bar of the BactoSense user interface.
2.	Press the logout button in the top right corner of the user interface.
3.	Select *Log out Lock screen*.
4.	To log in again, follow the procedure described in section 8.2.1.

8.2.3 Setting and changing user role passwords

Each user role is password protected.

Setting a password at first login
Upon initial login with any user role, click *OK* when being prompted for a password. This action will initiate the guided process for configuring your password. The only exception is the service password, where a preset password is provided.

Setting and changing a passwords
Each user profile can change its own password. Admin users are allowed to change passwords from other user profiles. The following procedure describes how to change passwords.

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	Navigate to the BactoSense *Home menu* and press on *System settings*.	
2.	Press on *Users* and then select the user profile you want to edit. Press *Edit* after selecting one check box.	Admin users are allowed to change passwords from other user profiles.
3.	Press on *Change PIN*, enter the new pin twice and press *Save*.	

8.2.4 User roles and permissions

Table 8-1 User roles and permissions

RIGHT	BASIC	ADVANCED	ADMIN
View last result	✓	✓	✓
View all results and export	✓	✓	✓
Start, stop, and schedule measurement	✓	✓	✓
Switch between Auto and Manual mode	✓	✓	✓
View error and warning log	✓	✓	✓
Rename results	✓	✓	✓
Validate device	✓	✓	✓
Change their own password	✓	✓	✓
View system info	✓	✓	✓
See network settings	✓	✓	✓
View last self-check	✓	✓	✓

RIGHT	BASIC	ADVANCED	ADMIN
Change cartridge	✓	✓	✓
Clear errors	✓	✓	✓
See intervention log	✓	✓	✓
See validation results	✓	✓	✓
Delete results		✓	✓
Re-gate results		✓	✓
Adjust alarms		✓	✓
Adjust gates		✓	✓
Reboot		✓	✓
Run a self check		✓	✓
Delete old measurements		✓	✓
Export all		✓	✓
See intervention info		✓	✓
Export diagnostics		✓	✓
Change analogue and digital outputs			✓
Test analogue and digital outputs			✓
Change the passwords of other users			✓
Create other users			✓
Change authentication settings			✓
Set device name			✓
Set date and time			✓
Change network settings			✓
Change services settings			✓
Activate Modbus with key or deactivate			✓
Change language			✓
Switch to demo mode			✓
Reset settings			✓
Full factory reset (except intervention log)			✓
Import settings			✓
Change automatic power-on settings			✓
Activate optional FSC detector with code			✓

8.3 Basic configurations

8.3.1 Language of the user interface

The language can only be changed by admin users.

	WORK STEP
1.	Navigate to the *Home menu* of the user interface.
2.	Press on *System settings*, then press *Language*.
3.	Choose the language and press the *OK* button.
4.	A message appears requesting a reload of the user interface. Confirm the message.

8.3.2 Date and time

Date and time can only be changed by admin users.

If time synchronization is enabled, either with NTP servers or through Modbus TCP, your manual date and time settings will be overridden during the next synchronization. Settings can be found under *System settings* > *Date & Time* > *Time synchronization settings*. For setting up NTP server, please refer to section 8.7.

	WORK STEP
1.	Navigate to the *Home menu* of the user interface.
2.	Press the *System settings* button.
3.	Press the *Date & Time* button.
4.	Enter the date and time.
5.	Select the *Time zone.*
6.	Press the *Set* button.

8.3.3 Device name

The device name can only be changed by admin users.

	WORK STEP
1.	Navigate to the *Home menu* of the user interface.
2.	Press the *System settings* button.
3.	Press the *System configuration* button.
4.	Press the *Device name* button.
5.	Enter your individual device name in the input field.
6.	Press the *Save* button.

8.3.4 Automatic power-on

The BactoSense has a built-in auto-restart functionality to automatically recover from temporary power interruptions. Depending on the configuration, the instrument can simply restart, but also return to operation by performing a self-cleaning process and restarting an auto mode series.

	WORK STEP
1.	As an Admin user, navigate to the *Home menu* of the user interface.
2.	Press the *System settings* button.
3.	Press the *System configuration* button.
4.	Select your automatic power-on preferences. Note: Self-cleaning only occurs if the power has been interrupted during a measurement.
5.	Press the *Save* button.

8.3.5 Sound notifications

You can turn on audible notifications to indicate the end of a manual measurement or maintenance process, alarm or error. The notification is one or several beeping sounds from the instrument.

	WORK STEP
1.	As an Admin user, navigate to the *Home menu* of the user interface.
2.	Press the *System settings* button.
3.	Press the *System configuration* button.
4.	Activate the *Sound notifications* option.
5.	Press the *Save* button.

8.4 Alarm configuration

The following rules apply to alarms:

- Only **Advanced** and **Admin** users can change the alarm settings.
- Alarms are only active in the **Auto mode**.

BactoSense records alarms in the following ways:

- A popup is displayed in the graphical user interface
- An alarm bell icon appears in the top bar if the last measurement exceeded the alarm threshold. The alarm is shown in the measurement summary when viewing a result.
- A signal can be sent out to a PLC through digital outputs (configurable).

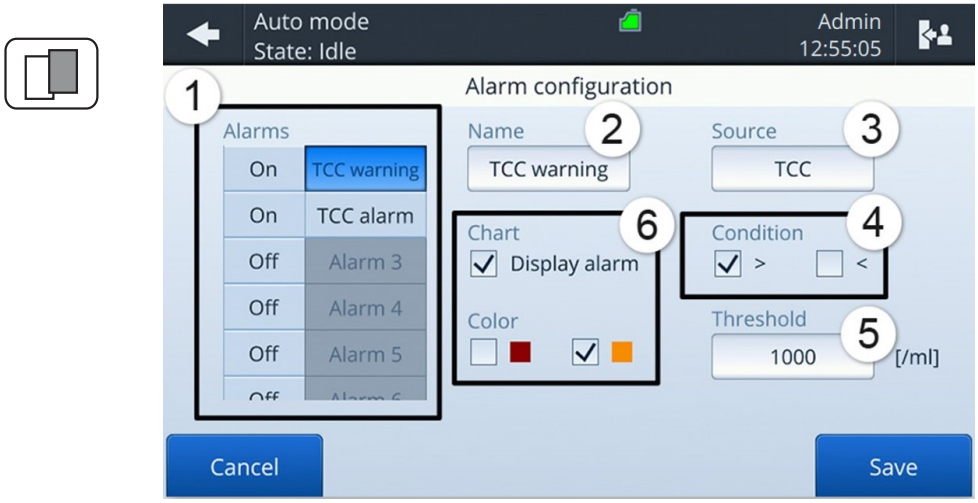


Figure 8-2 Alarm configuration in the BactoSense graphical user interface.

1	Select, enable or disable alarms. Users can configure up to 9 alarms.	**2**	Name of the currently selected alarm.
3	Source of the alarm: Which measurement result should be evaluated. See figure 8-3.	**4**	Condition: Trigger the alarm when the measured parameter is larger than (>) or smaller than (<) the threshold.
5	Threshold	**6**	Display: If checked, a line will be shown on the Auto mode plot, in the selected color.

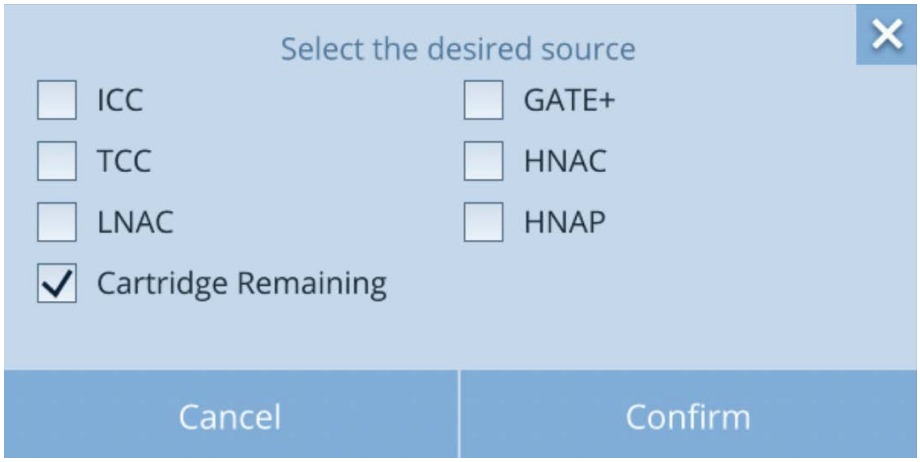


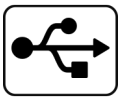
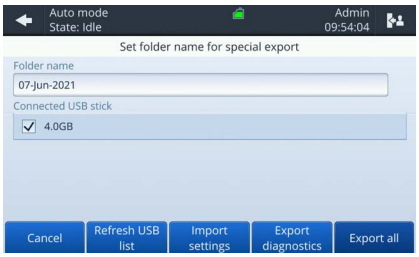
Figure 8-3 BactoSense alarm sources. For a selected source, a condition and a threshold are set. In the example above, an alarm is triggered on a certain cartridge filling level.

The following procedure describes how to configure the alarm:

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	Navigate to the **Home menu** of the BactoSense user interface.	
2.	Press the **Auto mode settings** button.	
3.	Press **Alarms**.	
4.	Activate, select and configure the alarms (according to figure 8-2 and figure 8-3).	By default, no alarms are active.
5.	Press **Save** to save the alarm configuration.	

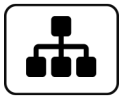
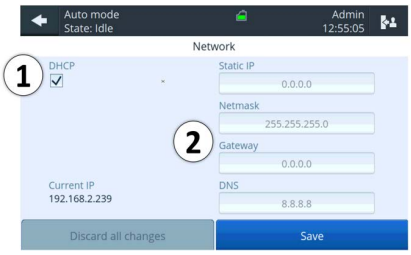
8.5 Import / export settings

Settings are exported to a USB drive as per section 12.1.1. The settings are compiled to a timestamped file ending with ***.bnv**. In order to import the settings in a new instrument, or as a backup, it is necessary to copy the ***.bnv** file at the root of the USB drive, or in the directory the file was exported to. If multiple copies of the settings are located in one USB drive, the system will use the most recent one.

	WORK STEP	ADDITIONAL INFO / IMAGE
1.	Navigate to the **Home menu** of the BactoSense user interface.	
2.	Press the **Maintenance** button.	
3.	Press the **Special export import** button.	
4.	Connect a USB drive. If needed, press the **Refresh USB list** button until the drive is detected.	Make sure the ***.bnv** file is at the root of the USB drive. The USB drive should be formatted in FAT32, which is the common standard.
5.	Press **Import settings**	
6.	Select the settings you want to import. Measurement settings include gate sets, IO settings, alarms, and date and time settings. Network settings include IP, DNS, and NTP addresses	
7.	Press **Import settings** and wait until the device reboots	

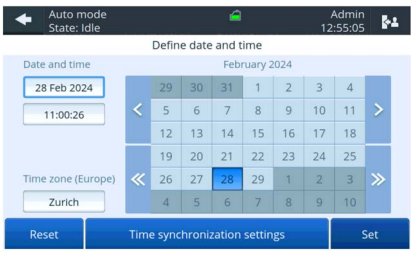
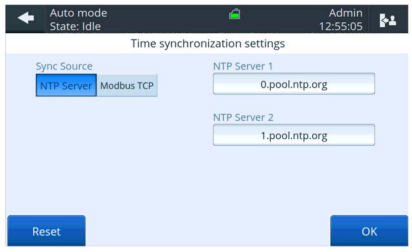
8.6 Network configuration

Ask your network administrator for the correct settings.

	WORK STEP	ADDITIONAL INFO / IMAGE
1.	Navigate to the **Home menu** of the BactoSense user interface.	
2.	Press the **System settings** button.	
3.	Press the **Network** button.	
4.	A: For **Dynamic IP** check the **DHCP** check box (1). Note: This is the preferred configuration for most cases when the BactoSense is connected to a router or switch. B: For **Static IP** uncheck the **DHCP** check box (1) and enter the desired network configuration (2). Note: This is the preferred configuration when the BactoSense is directly connected to a laptop via Ethernet. Make sure to also adjust the network configuration on the laptop accordingly.	
5.	Press the **Save** button.	
6.	Press the **Reboot now** button.	

8.7 Set NTP Servers

Network Time Protocol (NTP) is a computer network protocol which is used to synchronise time on computers across a network. By default, these are set to synchronise to the Network Time Foundation servers (ntp.org). You have the possibility to set custom NTP servers in the *Date and Time* menu.

	WORK STEP	ADDITIONAL INFO / IMAGE
1.	Navigate to the **Home menu** of the BactoSense user interface.	
2.	Press the **System settings** button.	
3.	Press the **Date & Time** button.	
4.	Press **Time synchronization settings** button.	
5.	Select the desired **Sync Source.**	Time synchronisation can be done via NTP server or Modbus TCP. More information about Modbus TCP can be found in section 7.1
6.	Update NTP servers.	
7	Press the **OK** button.	By editing and changing a server address and pressing **OK**, it will automatically ping the server and update the date and time.

8.8 The BactoSense user interface

8.8.1 General structure and home menu

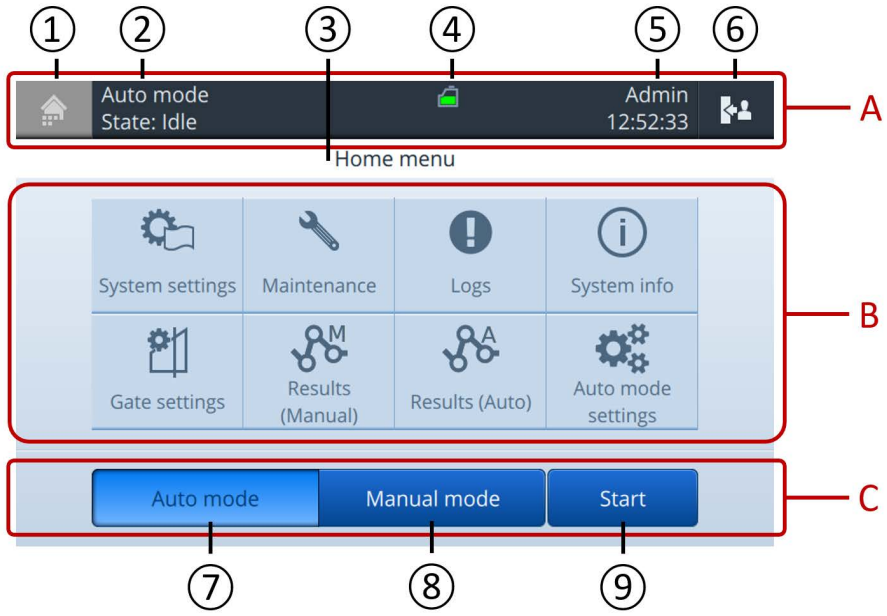


Figure 8-4 The Home menu of the BactoSense user interface.

The BactoSense user interface is divided into 3 main sections:

A	Top bar
B	Content view
C	Action bar

The main elements of the user interface are:

1	Home or return button. To navigate through the menu.	**2**	Operation mode (manual or auto) Instrument status (currently active process)
3	Current view	**4**	Top bar status icons, see 8.8.2.
5	User Role Current time	**6**	Logout or power off
7	Auto mode (continuous measurements using the online sampling device)	**8**	Manual mode (measuring grab samples using the manual sampling device)
9	Go to the list of analysis protocols.		

Depending on the user role, some options may not be visible or disabled.

8.8.2 Top bar status icons

Top bar icons are displayed in the bar in the top of the display. They indicate the status of the instrument.

Table 8-2 Top bar icons

ICON	DESCRIPTION	ICON	DESCRIPTION
	Process running		Demo mode activated
	Cartridge almost empty		Service required (see chapter 14)
	Cartridge almost expired		Cartridge level indication
	Cartridge not correctly initialized or no cartridge		Cartridge empty
	Critical error (section 15.3)		Cartridge expired
	Alarm on last measurement (Auto mode only, see section 8.4)		Non-critical error (section 15.2)

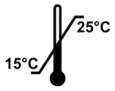
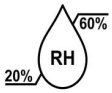
8.9 Cartridge management

The BactoSense cartridges contain the reagents required for measuring and maintaining the instrument clean. The BactoSense can be operated with different cartridge types. In the following sections, the handling of the cartridge is explained. Cartridge storage, transportation and refill are described in chapter 16.

8.9.1 General instructions for cartridge handling

When handling the cartridge, the following instructions must be followed:

Table 8-3 Cartridge handling instructions

	Follow the procedures described in this manual.		Store and ship between 15 °C – 25 °C (59 °F – 77 °F). The optimal temperature is 15 °C (59 °F).
	Wear nitrile gloves when handling the cartridge.		Store and ship between 20 % and 60 % relative humidity.
	Wear safety glasses when handling the cartridge.		The cartridge is intended for refill.
	Ship, install and store in the indicated orientation		Do not throw the cartridge into the trash.

8.9.2 Checking the filling level and expiration date of a cartridge

The cartridge filling levels and expiration date can be retrieved from several sources.

- The cartridge icon shown in the top bar of the user interface constantly indicates the approximate cartridge filling level. In case the cartridge is about to expire, the cartridge icon displays this too. Explanations of the different icons can be found in section 8.8.2.
- If you need more information, navigate to the *Home menu*, and then press *System info*. Under *Cartridge capacity remaining* you see how full the cartridge still is (in percent), and under *Cartridge expiration date* you see when the cartridge expires. The same information can also be retrieved from the web interface (see chapter 13)

8.9.3 Cartridge overview

The BactoSense cartridge is installed in a dedicated cartridge compartment of the instrument. A door closes the cartridge compartment. The cartridge door must only be opened for removing and installing cartridges.

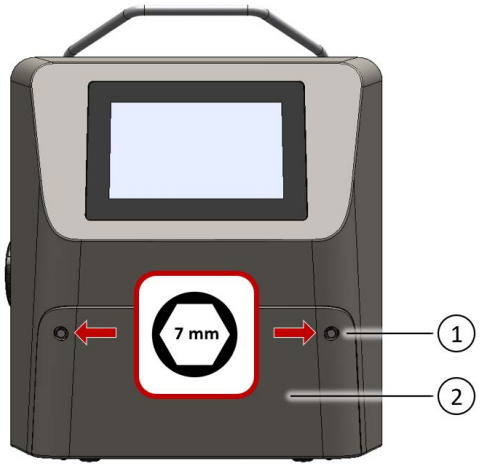


Figure 8-5 The BactoSense cartridge compartment can be opened by removing two 7 mm hex nuts using the supplied hex nut driver.

1	7 mm hex nuts to secure cartridge compartment door	**2**	Cartridge compartment door

CAUTION!

Open and close the cartridge compartment door only with the dedicated 7 mm hex nut driver.

After opening the cartridge compartment door, the user has access to the cartridge and the connectors which connect the cartridge to the BactoSense.

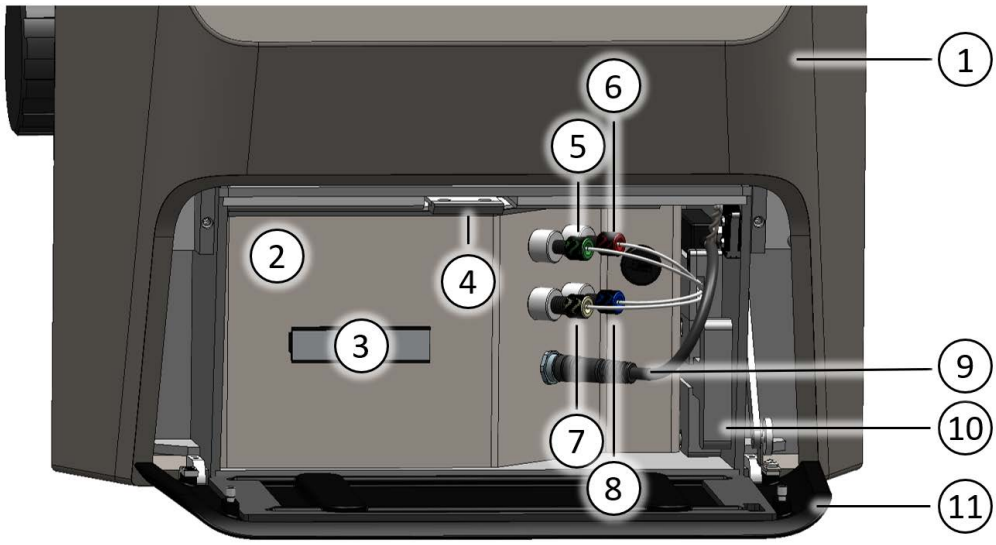


Figure 8-6 Overview of an installed cartridge. The mobility of the cartridge is secured with a fixation latch on top (4), and the cartridge is connected to the instrument with multiple fluidic (5 - 8) and one electronic connector (9). When no cartridge is inserted, the fluidic and electronic connectors can be secured using the removable connector rack (10).

1	BactoSense instrument	**2**	Cartridge
3	Cartridge handle	**4**	Cartridge fixation latch
5	Dye connector (green)	**6**	Bleach connector (red)
7	Waste connector (black or beige)	**8**	Rinse connector (blue)
9	Electronic connector	**10**	Removable connector rack
11	Cartridge compartment door		

CAUTION!

The BactoSense has five fluidic connectors. Depending on the cartridge type, only four or all five fluidic connectors are needed. In case of TCC or ICC cartridges, make sure the unused fifth connector is always mounted to the connector rack to prevent contamination.

8.9.4 Change cartridges

The following procedure describes the exchange of cartridges. Use this procedure if you want to remove and directly install another cartridge. If you only want to remove a cartridge and not install another one, follow the instruction in section 8.9.5.
The duration of the cartridge exchange is approximately 35 min.

CAUTION!

Strictly follow the procedure in the on-screen wizard.
Do not remove or install cartridges without this procedure.

	WORK STEP	ADDITIONAL INFO / IMAGE
1.	Have the replacement cartridge ready and adjusted to ambient temperature.	
2.	Navigate to the *Home menu* of the user interface.	
3.	Press the *Maintenance* button.	Basic users skip this step.
4.	Press the *Cartridge change* button.	
5.	Select the *Change cartridge* option.	
6.	Confirm to follow the instructions of the on-screen wizard. WARNING! Only open the cartridge compartment door when instructed. WARNING! Adhere to the general cartridge handling instruction in section 8.9.1. Wear nitrile gloves and safety glasses. WARNING! Tightly seal the fluidic connectors of the old cartridge with the attached plugs before removing it. WARNING! Make sure the cartridge compartment door is tightly closed and secured at the end.	WARNING! Only very experienced users mastering safe cartridge operations are allowed to skip the on-screen instructions. WARNING! In case of TCC or ICC cartridges, make sure the unused fifth connector is always mounted to the connector rack to prevent contamination.
7.	Handling the removed cartridge • If you wish to store the removed cartridge, refer to the storage instructions in section 16.1.3. • If you wish to refill the removed cartridge, refer to the refill instructions in section 16.3.2.	

8.9.5 Removing a cartridge

This procedure is intended for the removal of a cartridge, without immediate installation of another cartridge. If you want to exchange cartridges, follow the procedure described in section 8.9.4.
The duration of the cartridge removal is approximately 5 min.

CAUTION!

Strictly follow the procedure in the on-screen wizard.
Do not remove or install cartridges without this procedure.

	WORK STEP	ADDITIONAL INFO / IMAGE
1.	Navigate to the *Home menu* of the user interface.	
2.	Press the *Maintenance* button.	Basic users skip this step.
3.	Press the *Cartridge change* button.	
4.	Select the *Remove cartridge* option.	
5.	Confirm to follow the instructions of the on-screen wizard. WARNING! Only open the cartridge compartment door when instructed. WARNING! Adhere to the general cartridge handling instruction in section 8.9.1. Wear nitrile gloves and safety glasses. WARNING! Tightly seal the fluidic connectors of the old cartridge with the attached plugs before removing it. WARNING! Make sure the cartridge compartment door is tightly closed and secured at the end.	WARNING! Only very experienced users mastering safe cartridge operations are allowed to skip the on-screen instructions.
6.	Handling of the removed cartridge • If you wish to store the removed cartridge, refer to the storage instructions in section 16.1.3. • If you wish to refill the removed cartridge, refer to the refill instructions in section 16.3.2.	The top bar of the user interface indicates that no cartridge is connected. The *Maintenance* button in the *Home menu* is now displayed in orange.

8.9.6 Installing a cartridge

This procedure is intended for the installation of a cartridge, when no other cartridge is installed in the BactoSense. If there is already a cartridge and you want to exchange cartridges, follow the procedure described in section 8.9.4.
The duration of the cartridge installation is approximately 30 min.

CAUTION!

Strictly follow the procedure of the on-screen wizard.
Do not remove or install cartridges without this procedure.

	WORK STEP	ADDITIONAL INFO / IMAGE
1.	Have the new cartridge ready and adjusted to ambient temperature.	
2.	Navigate to the *Home menu* of the user interface.	
3.	Press the *Maintenance* button.	The *Maintenance* button is highlighted in orange in case no cartridge is installed. Basic users skip this step.
4.	Press the *Cartridge change* button.	
5.	Select the *Install cartridge* option.	
6.	Confirm to follow the instructions of the on-screen wizard.  Only open the cartridge compartment door when instructed.  Adhere to the general cartridge handling instruction in section 8.9.1. Wear nitrile gloves and safety glasses.  Make sure the cartridge compartment door is tightly closed and secured at the end.	 Only very experienced users mastering safe cartridge operations are allowed to skip the on-screen instructions.  In case of TCC or ICC cartridges, make sure the unused fifth connector is always mounted to the connector rack to prevent contamination.
7.	After following through all steps of the on-screen wizard, the new cartridge is properly initialized.	The cartridge status is indicated with a cartridge symbol in the top bar of the user interface, see 8.8.2.

8.10 Switching between sampling devices

The BactoSense can be operated with either the manual or the online sampling device. The following procedure describes the exchange of sampling devices. Sampling device storage information can be found in section 16.1.2.

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	Remove the mounted sampling device according to the instructions in section 8.10.1 (online sampling device) or 8.10.2 (manual sampling device)	
2.	Install the new sampling device according to the instructions in section 5.5 (online sampling device) or 5.4 (manual sampling device).	

8.10.1 Removal of the online sampling device

When switching to the manual sampling device, the online sampling device has to be removed. Follow the procedure below to safely remove the device and prepare it for storage.

Avoid contamination of the equipment. Wear nitrile gloves when handling samples, sampling devices and any components which come in contact with them.

	WORK STEP
1.	Terminate any ongoing measurement series, as described in section 10.2.2.
2.	Stop the water flow through the sampling device tubings and sampling device.
3.	Carefully unscrew the knurled sampling device fixation ring until the sampling device can be removed.
4.	Remove the online sampling device. Make sure the white sealing plug still sits tightly in the connector of the sampling device. If not, it may have remained in the BactoSense sampling device connector. In this case carefully remove it with tweezers and place it back in the sampling device.
5.	Disconnect and drain the inlet and outlet tubings from the water source and the sampling device body.
6.	Inspect the inlet and outlet tubings for contamination and damage. Only reuse clean and intact tubings.
7.	If you want to store the sampling device, place the device and the tubings separately in a clean and dry plastic bags and follow the storage instructions in section 16.1.2.
8.	To mount now the manual sampling device, see section 5.4.

8.10.2 Removal of the manual sampling device

When switching to the online sampling device, the manual sampling device has to be removed. Follow the procedure below to safely remove the device and prepare it for storage.

Avoid contamination of the equipment. Wear nitrile gloves when handling samples, sampling devices and any components which come in contact with them.

	WORK STEP
1.	Perform a cleaning of the manual sampling device: If a Washstation is available, follow the procedure in section 14.2.2, otherwise the procedure in section 14.2.3.
2.	After finishing, attach a clean and empty 5 mL screw-cap tube or the Washstation to the sampling device.
3.	Carefully unscrew the knurled sampling device fixation ring on top of the device until the sampling device can be removed.
4.	Remove the manual sampling device. Make sure the white sealing plug still sits tightly in the connector of the sampling device. If not, it may have remained in the BactoSense sampling device connector. In this case, carefully remove it with tweezers and place it back in the sampling device.
5.	If you want to store the sampling device, place it in a clean and dry plastic bag and follow the storage instructions in section 16.1.2.
6.	To mount now the online sampling device, follow the procedure in section 5.5.

8.11 Qualification

Qualification is a process to ensure the BactoSense operates as intended. Different options are available.

To do a fully automated quick check of the instrument status, perform the self-check procedure described in section 15.6. This test does not require any reagents or user interaction, is very quick and checks the integrity and communication between the different modules of the BactoSense.

To assess the cleanliness of the BactoSense and rule out a contamination, perform the cleanliness verification procedure in section 8.11.1.

For operational environments requiring system suitability testing, use the *System Suitability Test Kit (SST Kit)* and follow the procedure in its user manual.

For other environments, an instrument qualification using the *Validation kit* is recommended in the following situations:

- After shipping the instrument or other long-distance transport, exposing the instrument to vibration or shock.
- After storing the instrument for more than one month.
- If there are indications that measurement results could be erroneous.

8.11.1 Cleanliness verification

	WORK STEP
1.	Make sure the manual sampling device is tightly installed as described in section 5.4.
2.	Perform a cleaning of the sampling device with two replications: If a Washstation is available, follow the procedure in section 14.2.2, otherwise the procedure in section 14.2.3.
3.	Prepare the blank sample in a 5 mL screw-cap tube. There are two options: A) Use cell-free water, e.g. a sterile solution aliquot from the Validation Kit. If you use the sterile solution aliquot from the Validation Kit, remove the cap of the aliquot and place the aliquot in an empty 5 mL screw-cap tube, as described in the user manual of the Validation Kit. B) Take a still mineral water and filter twice using a membrane filter with a pore size of 0.22 µm or smaller.
4.	In the BactoSense user interface, navigate to the *Home menu*.
5.	On the action bar at the bottom, select *Manual mode* and press *Start*.
6.	Choose the *Prime* protocol from the list of available protocols.
7.	Press the *Next* button.

	WORK STEP
8.	Remove the tube or Washstation from the manual sampling device and attach the blank sample.
9.	Press the *Start* button to run the Prime protocol.
10.	After completion of the Prime, press the *New* button to navigate back to the list of protocols.
11.	Select the *Water Analysis* protocol from the list of available protocols.
12.	Configure two replications.
13.	Enter a sample name by tapping into the *Sample name* text field, entering the name and pressing *OK*.
14.	Verify that the ICC or TCC default gate is configured and change it otherwise by pressing into the *Gates* field.
15.	Press the *Next* button.
16.	Press the *Start* button and wait for the two measurements to complete.
17.	After finishing, press the *Next* button to review the results.
18.	Look at the results and compare them to the reference values indicated below. The BactoSense is clean if the following criteria are fulfilled: • For TCC cartridges: **TCC [/mL] < 300** • For ICC cartridges: **ICC [/mL] < 100**
19.	If the cell concentrations are higher than the specified limits, apply the following procedure: • Repeat the procedure with a freshly prepared blank sample. • Repeat the procedure after a decontamination using the Cleaning Kit (see section 17.3). • If the test keeps failing, contact bNovate support or your local service representative.
20.	After finishing, attach a clean and empty 5 mL screw-cap tube or the Washstation to the manual sampling device.

8.12 Demo mode

Demo mode can be used when demonstrating the device or when learning how to navigate the menus and use the functions. When it is activated, the instrument reboots into a special mode that displays demonstration data (the owner's measurement results are hidden). All the instrument's functions are replaced by simulations that never move the hardware or modify the results database. This means protocols can be started without needing to load a sample, and users can pretend to delete or re-gate results without ever changing the data. If the demo mode is activated, the message ***Demo*** is displayed in the upper middle of the screen.
When the instrument is reverted to normal mode, the owner's data is shown again, and all functions are active again.

	WORK STEP	ADDITIONAL INFO / IMAGE
1.	Navigate to the **Home menu** of the BactoSense user interface.	
2.	Enter the **System settings** button, and then the **Demo mode** button.	 
3.	Select the **Activate demo mode** box.	
4.	Press the **Save and restart** button.	
5.	The device reboots automatically.	

To return into normal mode, follow the same procedure, but uncheck the **Activate demo mode** box.

8.13 Factory reset

Factory reset reverts most of the instrument settings to the factory values: Gating limits, measurement interval, default protocol names, users, language and network settings. This option is accessible only by the Admin and Service users.

The following procedure describes how to perform a factory reset:

	WORK STEP	ADDITIONAL INFO / IMAGE
1.	Navigate to the **Home menu** of the BactoSense user interface.	
2.	Press the **System settings** button, then the **Factory reset** button.	 
3.	Use the check boxes to select which parameters you wish to reset: • Instrument settings • Measurements incl. errors and logs • both	Service logs, validation results and the software update history are not deleted.
4.	Then press the **Reset the device and reboot** button.	

9 Optional Features

Depending on the BactoSense model, some functionalities are optional and can be activated with a license key.

9.1 Scientific package

The *Scientific Package* is intended for water research professionals to perform advanced data analysis.
It contains the following features:

- Additional gate: Apply an additional configurable polygon gate to the FL1 / FL2 data directly in the user interface.
- Light scattering data: Record and display forward and side scatter data for each detected event. Retrieve data in FCS files for post-processing.

Additional polygon gate
The freely configurable additional polygon gate has the following properties:

- It is available for TCC and ICC cartridges.
- The result parameter is a cell concentration named "Gate+".
- The gate can be adjusted similar to the TCC or ICC default gates. Please refer to section 11.4.

Forward and side scatter detector
The Forward Scatter (FSC) detector measures light that is scattered by bacteria or other particles. The detector is placed at a small angle to the laser beam's direction, thus measuring light signals in "forward" direction.
In contrast, the Side Scatter (SSC) detector is placed at 90 degrees from the beam's direction, measuring light scattered towards the side.
The combination of fluorescence and scattering information provides high content data, enabling applications like microbiological fingerprinting, profiling or anomaly detection.

Scattering data is available in the following ways:

- in the flow cytometry standard (FCS) files. For more information about this file format please refer to section 11.5.
- on the BactoSense user interface as a FSC / SSC dotplot
- on the web interface as a FSC / SSC dotplot
- when downloading the dotplots as images

Activation of the *Scientific Package*

	WORK STEP	ADDITIONAL INFO / IMAGE
1.	Contact your bNovate Sales representative to purchase an activation key.	
2.	After receiving the activation key, log in as *Admin* user on the BactoSense.	
3.	Navigate to the *Home menu* of the BactoSense user interface.	
4.	Press the *System settings* button.	

	WORK STEP	ADDITIONAL INFO / IMAGE
5.	Press the *Upgrades* button.	
6.	Press the *Upgrade* button.	
7.	Enter the activation key and press *OK*.	

9.2 Management package

The *Management Package* is intended for instrument operation in environments with stronger traceability requirements.
It contains the following features:

- Advanced user management (role-based access control)
- Audit trail

Advanced User Management
With the *Advanced User Management* feature, the instrument owner can create different users and assign different user roles (Basic, Advanced, Admin). This allows to give different permissions to individual users, and log their activity for the audit trail.

Audit Trail
The *Audit Trail* is a record of all relevant operations or changes that have been made with the instrument. It provides a detailed history of actions taken by the user or the instrument itself.
The *Audit Trail* can be accessed in the following ways:

- On the user interface. In the *Home Menu*, press on *Logs* and then *Audit Trail*.
- When exporting all data to a USB drive, see section 12.1.
- From the web user interface. The access to the web user interface is described in chapter 13.

Activation of the *Management Package*

	WORK STEP	ADDITIONAL INFO / IMAGE
1.	Contact your bNovate Sales representative to purchase an activation key.	
2.	After receiving the activation key, log in as Admin user on the BactoSense.	
3.	Navigate to the *Home menu* of the BactoSense user interface.	
4.	Press the *System settings* button.	
5.	Press the *Upgrades* button.	
6.	Press the *Upgrade* button.	

	WORK STEP	ADDITIONAL INFO / IMAGE
7.	Enter the activation key and press *OK*.	Note: The advanced user management feature is not activated yet. If you wish to activate the advanced user management, follow the next steps.
8.	Navigate to the *Home menu* of the BactoSense user interface.	
9.	Press the *System settings* button.	
10.	Press the *System configuration* button.	
11.	Check the *Advanced user management mode* check box.	
12.	Press *Save*.	

10 Measurements

10.1 Samples

The BactoSense can measure manually collected grab samples using the manual sampling device, and also sample automatically from a connected water source using the online sampling device.

Sample types and pretreatments:

- Raw waters and especially surface waters must be filtered with a 20 µm filter. Particles can block the internal filters and damage the instrument. Clear water expected to be potable usually does not need filtering.
- Sparkling water and soft drinks cannot be measured by the instrument.
- Water with a high concentration of chlorine can affect the results of the measurement.
- The sample and operating conditions listed in the technical data in section 3.2 must be fulfilled.

10.2 Measuring automatically in online mode

Measuring in online (also called *automatic* or *auto*) mode describes a configuration, in which the BactoSense is connected to a water source using the online sampling device, and automatically draws and measures a sample at predefined intervals.

If you want to measure manually collected grab samples instead, refer to section 10.3.

10.2.1 Configuring and starting automatic online measurements

The following instructions show how to configure and start automatic online measurements using the online sampling device.

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	Make sure the online sampling device is tightly installed as described in section 5.5.	If you have the manual sampling device installed and want to change to the online sampling device, refer to section 8.10.2 to remove the manual sampling device and section 5.5 to install the online sampling device.
2.	In the BactoSense user interface, navigate to the *Home menu*.	
3.	On the action bar at the bottom, select *Auto mode* and press *Start*.	
4.	Press the *Start* button.	
5.	Under Protocol, make sure the check box for *"Online Sampling Device (with Backflush)"* is checked.	
6.	Enter a sample name by tapping into the *Sample name* text field.	

	WORK STEP	ADDITIONAL INFO / IMAGES
7.	Select the desired gate to be applied to the measurements by tapping into the *Gates* text field.	Generally, default TCC and ICC gates are used. Use user-defined gates if your application requires it. Creating and adjusting gates is described in chapter 11.
8.	Press the *Next* button.	
9.	Select the measurement interval using the wheel on the right hand side.	The measurement interval describes the time between different measurements and can be as short as 30 min and as long as 6 hours.
10.	If needed, you can delay the starting time by unchecking the *Start immediately* box and choose a specific time to start.	The time setting of the BactoSense is described in section 8.3.2.
11.	Press the *Start* button.	During the measurement, the current estimate of the cell concentration is displayed in the action bar under "Last".
12.	After each measurement, the time series graph is updated.	For more details press the *View results* button.
13.	If you want to stop an online measurement series, refer to section 10.2.2.	

10.2.2 Terminating automatic online measurements

Follow the steps below to terminate a measurement series in auto mode.

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	Press the *Stop* button on the user interface.	
2.	Confirm the message to stop the auto mode measurement series.	
3.	If a measurement is running, you can select whether you want to abort it immediately, or wait for completion.	
4.	If you don't continue with another measurement series within the next hours, proceed with removing the online sampling device as described in section 8.10.1 and installing the manual sampling device as described in section 5.4.	
5.	If you want to view your data, refer to section 10.2.3. If you want to retrieve your data, refer to section 10.6.	

10.2.3 Reviewing automatic online measurements

The home screen in Auto mode shows a line plot of the measurement results over time.

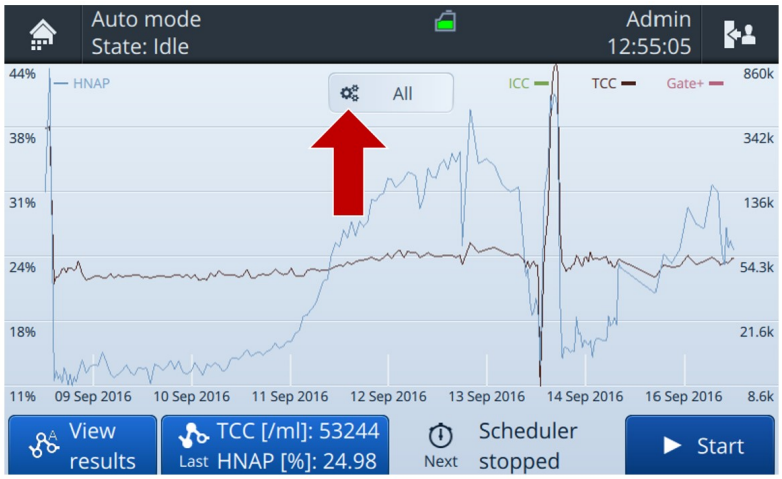


Figure 10-1 Auto mode results overview plot

By tapping the button with a gear icon (arrow in figure 10-1), users can change the scales and which metrics are displayed (see figure 10-2). To display alarms on the plot, create an alarm and enable its "Display alarm" setting (see section 8.4).

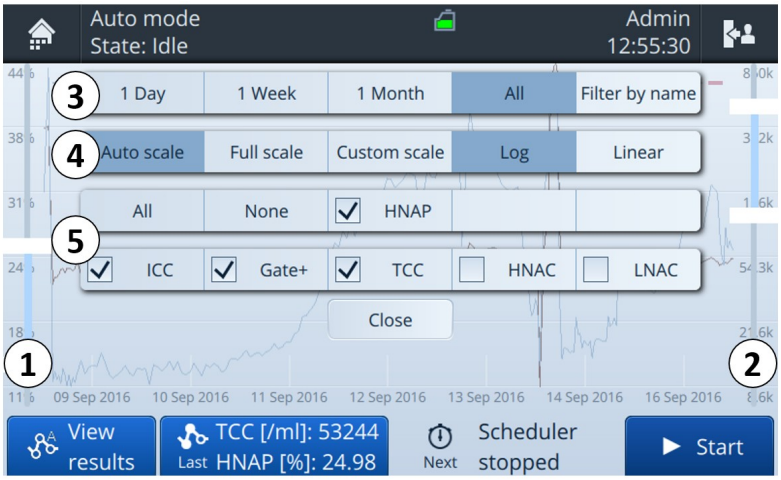


Figure 10-2 Auto mode plot settings

1	Adjust the percentage scale. Touch the upper half of the scale bar to move the upper limit. Touch the lower half to move the lower limit.
2	Adjust the counts scale. Touch the upper half of the scale bar to move the upper limit. Touch the lower half to move the lower limit.
3	Choose the display interval or filter by name (see section 10.5).
4	Choose the vertical scale: • Auto scale adapts to the current data • Full scale shows the full range of the instrument • Custom scale is adjusted with sliders 1 and 2. Log and Linear control the counts scale (right-hand-side scale).
5	Choose which metrics to display on the graph.

10.3 Measuring in manual mode

Measuring in manual mode describes a configuration, in which the manual sampling device is connected to the BactoSense, and the operator attaches individual grab samples collected in 5 mL screw cap tubes to the instrument.

10.3.1 Performing a measurement in manual mode

The following instructions show how to configure and start a measurement in manual mode.

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	Make sure the manual sampling device is tightly installed as described in section 5.4.	
2.	If the manual sampling device has been newly installed or the instrument has been switched off or idle for more than 3 days, it is recommended to clean the sampling device. If a Washstation is available, follow the procedure in section 14.2.2, otherwise the procedure in section 14.2.3.	
3.	If a cleaning of the manual sampling device has been conducted (see previous step), it is recommended to perform a prime prior to measuring the sample. Follow the procedure in section 10.7.3.	
4.	In the BactoSense user interface, navigate to the *Home menu*.	
5.	On the action bar at the bottom, select *Manual mode* and press *Start*.	
6.	Choose the *Water Analysis* protocol from the list of available protocols.	If you want technical replicates, select the number of replicates in *Replications* column. By default, one sample is measured. If more replicates are configured, multiple samples are drawn from the same sample tube.
7.	Enter a sample name by tapping into the *Sample name* text field, entering the name and pressing *OK*.	
8.	Check whether your desired gate is configured in the *Gates* field. If you wish to use another gate, tap into the *Gates* field and select the desired gate from the available options (depending on the cartridge installed).	Generally, default TCC and ICC gates are used. Use user-defined gates if your application requires it. Creating and adjusting gates is described in chapter 11.
9.	Press the *Next* button.	

	WORK STEP	ADDITIONAL INFO / IMAGES
10.	Attach a 5 mL screw-cap tube containing 2 – 5 mL of sample to the manual sampling device.	
11.	Press the *Start* button.	The estimated protocol duration and expected termination timepoint are displayed. The current state of the measurement is indicated in the top bar (e.g. Initializing, Mixing...)
12.	After finishing the measurement, view the results. Results are explained in section 10.3.2.	
13.	If you want to proceed with the next measurement, press the *New* button.	
14.	If you want to see previous measurement results, press the *View results* button.	
15.	If you want to rename, regate or export the measurement, refer to the instructions in following sections.	
16.	If you don't want to measure more samples and the instrument will be idle or switched off, perform a cleaning of the manual sampling device. If a Washstation is available, follow the procedure in section 14.2.2, otherwise the procedure in section 14.2.3.	

10.3.2 Reviewing manual measurement results

This page shows a measurement result. From here, the user can delete a measurement, look up older results or export results. Expert users can re-gate the measurements. Some actions are bound to specific roles (Basic, Advanced or Admin).

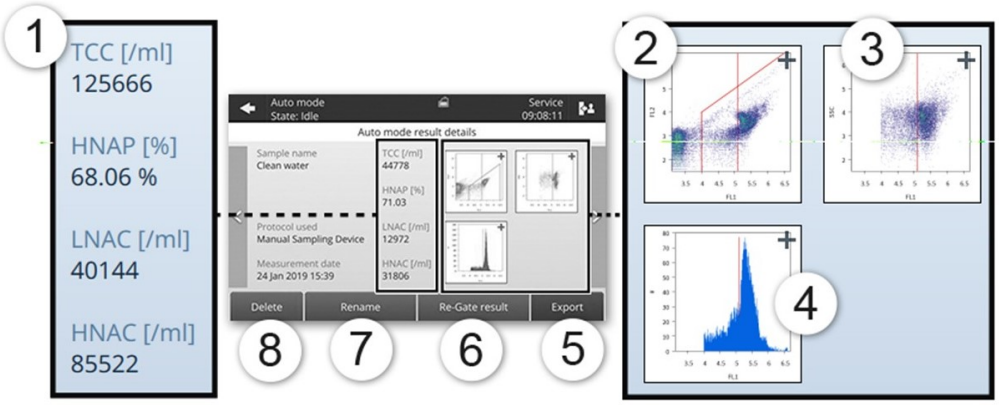


Figure 10-3 Display of a single measurement result, using a TCC cartridge.

1	Measured parameters are displayed. For details refer to section 11.3.
2	The FL2 vs FL1 dotplot shows all detected events according to the amplitude of their fluorescence signals FL1 (530 nm, X-axis) and FL2 (715 nm, Y-axis). The red polygon defines the gate. For details refer to section 11.3.
3	The SSC vs FL1 dotplot shows only cells inside the gates, according to their fluorescence signal FL1 (530 nm) and scattered light signal SSC (488 nm).
4	The FL1 histogram shows all cells inside the gates, binned according to their fluorescence in FL1.
5	*Export* saves this result to a USB stick (section 10.6.1). To export all data or diagnostic data, refer to section 12.1.1.
6	*Re-Gate result* allows you to move the gates and recalculate cell counts. You can optionally save the new gates for future measurements. For details refer to section 11.4.1.
7	*Rename* allows to rename the measurement (section 10.3.3).
8	*Delete* allows to delete the measurement permanently.

10.3.3 Renaming measurements

Measurements can be renamed from their result details view.

	WORK STEP
1.	Navigate to the *Home menu* and press *Results (Manual)* or *Results (Auto)*.
2.	In the results list, select the measurement you want to rename. Exception: If you want to rename a group of replicates (see section 10.3.4), long-press on the group of replicates and then press the rename button.
3.	In the result details view, press the *Rename* button (see section 10.3.2).
4.	A keyboard and text field with the current sample name will appear. Use the keyboard to change the sample name and press *OK*.

10.3.4 Working with measurement replicates

When working in manual mode, analysis protocols can be repeated. This is particularly useful for generating technical replicates of a single sample.

- The number of replicates can be selected when configuring a manual measurement, as described in section 10.3.1.
- In the manual mode results list, replicates are grouped into one entry, and the number in brackets next to the sample name indicates the number of replicates. In this view, the results shown for the replicate group consist of average and standard deviation. Individual replicate measurements can be accessed by pressing on the replicate group.
- Replicate groups can easily be renamed, deleted, exported or regated after a long-press on the replicate group in the manual mode results list.

10.4 Regating measurements

Adjusting the gates of individual measurements or a set of measurements is described in section 11.4.

10.5 Filtering measurements

Filtering can be applied to display a subset of the measurement results. Filtering by text and date range is possible.

	WORK STEP
1.	Navigate to the *Home menu* and press *Results (Manual)* or *Results (Auto).*
2.	In the results list, press the *Filter* button.
3.	Specify your filter by applying one or both of the following options: • Define a date range by specifying start and end date • Define a text string to filter by measurement name
4.	Press *OK*. The result list will be refreshed showing filtered results.

10.6 Exporting measurements

There are multiple ways to retrieve measurement data. Retrieval via HTTP, HTTPS, FTP and the web interface are described in chapter 12 and chapter 13. In this section, data export to a USB drive is described.

10.6.1 Export to a USB drive

It is possible to export selected or all measurements to a USB flash drive.
Make sure your USB flash drive is formatted in FAT32 format.

	WORK STEP
1.	Navigate to the *Home menu* and press *Results (Manual)* or *Results (Auto)*.
2.	In the results list, • press the *Export series* button to export a set of measurements or all measurements. • select a group of replicates and press the *Export series* button to export this group of replicates. • select a single measurement and then press *Export* to export only a single measurement.
3.	In the *folder name* field, the name of the target folder which will be created on the USB drive is shown. Change the name if desired.
4.	Insert a USB stick with enough available memory. Press *Refresh list* to display the connected USB stick.
5.	Export options • press *Export results* to export only the basic results (see details in the user interface) • press *Export all* to export results, raw data and diagnostic information (see details in the user interface)
6.	Wait for the export to complete and then press *OK*.

10.7 Available analysis and maintenance protocols

10.7.1 Overview of protocols in manual mode

Operators can choose between two analysis protocols in manual mode.

Table 10-1 Analysis protocols for manual mode

PROTOCOL NAME	PROTOCOL DESCRIPTION
Water Analysis	Analyze a water sample and finish with a cleaning cycle. If several replications are executed, the cleaning step is executed only once, at the end. A prime is executed automatically between replicates.
Beads Analysis	This protocol is intended for the analysis of calibration beads and is used with the Validation Kit. The protocol automatically finishes with a cleaning cycle. If several replications are executed, the cleaning step is executed only once, at the end.

Maintenance protocols can be executed before or between analysis protocols, to prepare, flush, or clean the system. In manual mode, the following maintenance protocols are available:

Table 10-2 Maintenance protocols for manual mode

PROTOCOL NAME	PROTOCOL DESCRIPTION
Clean Optics	Launches a cleaning step that washes all components in contact with the sample inside the BactoSense, except the sampling device.
Clean Sampling Device with Washstation	Cleans the manual sampling device such that the outside filter, the needle's interior and exterior can be fully washed between measurements, after a dirty sample or in case of filter blockage. The Washstation device must be mounted on the manual sampling device and a cartridge must be installed for this protocol to appear. This protocol has a higher disinfection power than the *Clean Sampling Device* protocol and should therefore be preferred. Using the Washstation is the best way to keep the manual sampling device clean and to avoid cross-contaminations. Instructions for this protocol can be found in section 14.2.2.
Clean Sampling Device	Cleans the sampling device so that the external filter and the needle’s interior can be washed after an extremely loaded sample or in case of filter blockage. Instructions for this protocol can be found in section 14.2.3.

PROTOCOL NAME	PROTOCOL DESCRIPTION
Fill Tubing	Fills all tubing carrying reagents from the cartridge, to remove bubbles in the tubing. Cleans optics at the end of the process.
Prime and Clean Optics	Fills the tubing with liquid from the sample. Helps to dilute any residues after a clean sampling device for instance. Is finished by the cleaning step.
Prime	Loads sample into the instrument. Instructions can be found in section 10.7.3.

10.7.2 Overview of protocols in auto mode

Operators can choose between two analysis protocols in *Auto mode*.

Table 10-3 Analysis protocols for Auto mode

PROTOCOL NAME	PROTOCOL DESCRIPTION
Online Sampling Device (with Backflush)	This is the standard protocol to be used with the online sampling device. This protocol includes automated cleaning procedures between measurements.
Manual Sampling Device	This protocol is used with the manual sampling device installed.

10.7.3 Performing a Prime

Priming preconditions the BactoSense with the sample. Priming can be used to reduce the carryover of cells or unwanted substances, and takes approximately 5 minutes.

Use a Prime under the following circumstances:

- After a *Clean Sampling Device* protocol (with and without Washstation)
- After measuring a sample with a high chlorine concentration or any other unwanted substance which may affect subsequent measurements

	WORK STEP
1.	Make sure the manual sampling device is tightly installed as described in section 5.4.
2.	In the BactoSense user interface, navigate to the *Home menu*.
3.	On the action bar at the bottom, select *Manual mode* and press *Start*.
4.	Choose the *Prime* protocol from the list of available protocols.
5.	Press the *Next* button.
6.	Attach the sample you want to measure next to the manual sampling device.
7.	Press the *Start* button.

11 Results and Data Analysis

11.1 Measurement results

The figure below shows the result of a selected measurement. From here, the user can delete or rename the measurement, look up older results (and export them), or export the result. Expert users can repeat the cell counting with new gates. Some actions are bound to specific accounts (Basic, Advanced or Admin).

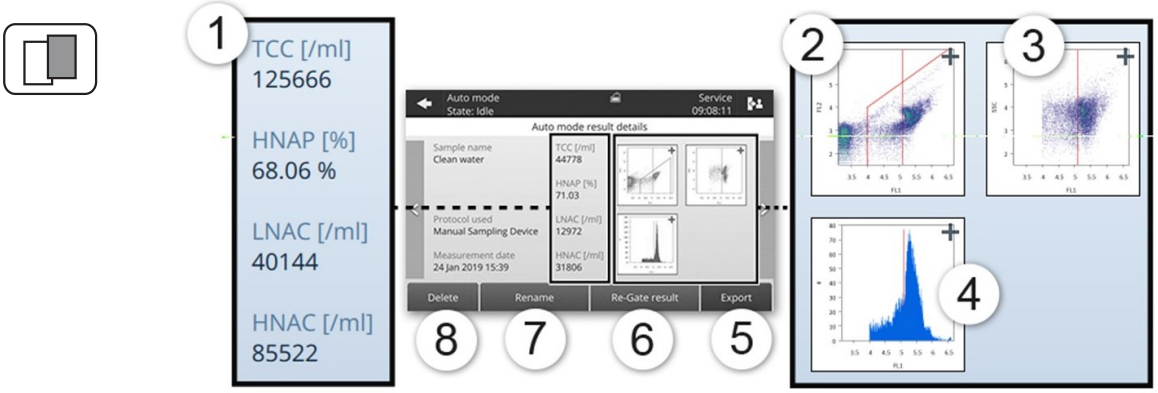


Figure 11-1 : Display of a single measurement result, acquired using a TCC cartridge

①	Result parameters are displayed. For details refer to section 11.3.
②	The FL1 vs FL2 dotplot shows all detected events according to the amplitude of their fluorescence signals FL1 (535 nm, X-axis) and FL2 (715 nm, Y-axis). The red polygon and vertical line define the gates. For details refer to section 11.3.
③	The FL1 vs SSC dotplot shows only cells inside the FL1 - FL2 polygon gate, according to their fluorescence signal FL1 (535 nm) and scattered light signal SSC (488 nm).
④	The FL1 histogram shows all cells inside the FL1 - FL2 polygon gate, binned according to their fluorescence in FL1.
⑤	**Export** saves this result to a USB stick. More information can be found in section 10.6.1.
⑥	**Re-Gate result** allows to apply a different gating to the measurement data. For details refer to section 11.4.1.
⑦	**Rename changes** the measurement name.
⑧	**Delete** removes the measurement permanently (requires confirmation).

Multiple selection & batch operations: In the list of measurements, long-press on one measurement to activate the selection of multiple measurements, then select **Delete / Re-gate** or **Export**.

11.2 Introduction to gates

Following flow cytometry standards, the BactoSense uses gates to count cells in samples.

We define:

- **Gate**: A line or polygon applied to a dotplot to quantify populations of measured cells.
- **Set of gates, or gating set**: A collection of two or more gates, used for the gating strategy. The types of gates are fixed, but users can change the limits of each gate. These are different for TCC and ICC measurements.
- **Gating strategy**: Defines how the gates are combined to count cells. For example, HNAC is the number of cells that are inside the TCC polygon and higher than the HNA lower limit. These strategies are different for TCC and ICC measurements.

Gating sets are specific for a type of cartridge. As an example, only gating sets of type *TCC* can be used with measurements performed using a TCC cartridge.

11.2.1 Default gating sets

The BactoSense has preconfigured gating sets for all available cartridge types. These gating sets are called **Default gating sets**. They have been carefully designed to be applicable to the **vast majority of samples**.

- The default gates on the BactoSense can be found when pressing on **Gate settings** in the **Home menu** of the BactoSense user interface.
- Default gating sets can neither be modified nor deleted.
- New gating sets can be created by editing a copy of an existing gating set, as described in section 11.4.2.

11.2.2 List of available gating sets and operations

A list of all available gating sets on the BactoSense can be found when pressing **Gate settings** in the **Home menu** of the BactoSense user interface.

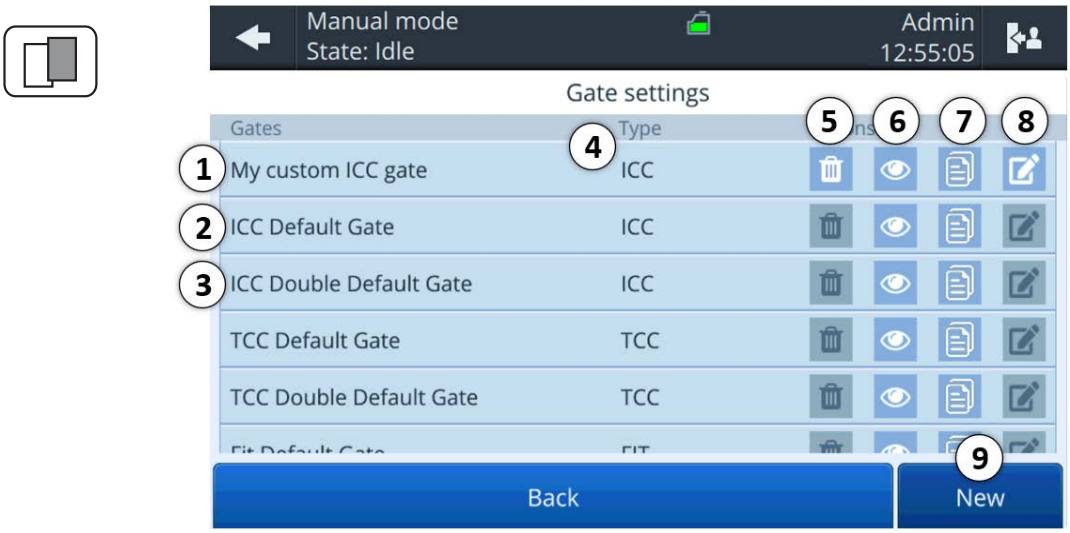


Figure 11-2 List of available gating sets and options to copy and create new sets. Default gates are preconfigured and cannot be deleted or edited.

1	Example of a custom gate for the ICC cartridge.	**2**	ICC default gate. Default gates are preconfigured.
3	ICC double default gate. This gating set contains an additional configurable polygon gate. Note: For some instrument models, an additional feature is needed for using the additional gate (see section 9.1).	**4**	Gate types, to be used with the respective cartridge type.
5	Delete an existing gating set. Default gates can not be deleted.	**6**	Preview the gating set.
7	Create a copy of the gating set.	**8**	Edit the gating set. Default gates can not be edited.
9	Create a new gating set.		

11.3 Cartridges, gates and result parameters

Depending on the cartridge used for a measurement, different parameters are measured. The following sections give an overview over the different cartridge types, their gating sets and result parameters.

11.3.1 TCC cartridge

TCC refers to *Total Cell Count*. The TCC cartridge is therefore used to measure the concentration of all cells.

Table 11-1 Gating set used for the TCC cartridge.

GATE	TYPE	DESCRIPTION
TCC	Polygon	A polygon defined on the FL1-FL2 plane. Points inside this polygon are counted as cells (TCC).
HNA lower limit	Vertical line	A threshold on FL1. Points within TCC but larger than the HNA lower limit in FL1 are counted as HNAC. Points within TCC but smaller than the limit are counted as LNAC.

Table 11-2 Result parameters obtained from the TCC cartridge.

PARAMETER	UNIT	NAME	DESCRIPTION
TCC	1/mL	Total Cell Count	Total number of cells detected inside the TCC gate. It is an addition of HNAC and LNAC: $\mathrm{TCC} = \mathrm{HNAC} + \mathrm{LNAC}$
HNAP	%	High Nucleic Acid Percentage	The percentage of HNA cells relative to TCC: $\mathrm{HNAP} = \frac{\mathrm{HNAC}}{\mathrm{TCC}} \times 100$
LNAC	1/mL	Low Nucleic Acid Count	The number of cells inside the TCC gate, but below the HNA lower limit (vertical line gate).
HNAC	1/mL	High Nucleic Acid Count	The number of cells inside the TCC gate and above the HNA lower limit (vertical line gate).

For further information on how to adjust the gates see section 11.4.

11.3.2 ICC cartridge

ICC refers to *Intact Cell Count*. The ICC cartridge is therefore used to measure the concentration of intact cells.

Table 11-3 Gating set used for the ICC cartridge.

GATE	TYPE	DESCRIPTION
ICC	Polygon	A polygon defined on the FL1-FL2 plane. Points inside this polygon are counted as intact cells (ICC).
HNA lower limit	Vertical line	A threshold on FL1. Points within ICC but larger than the HNA lower limit in FL1 are counted as HNAC. Points within ICC but smaller than the limit are counted as LNAC.

Table 11-4 Result parameters obtained from the ICC cartridge.

PARAMETER	UNIT	NAME	DESCRIPTION
ICC	1/mL	Intact Cell Count	Total number of intact cells inside the ICC gate: $\mathrm{ICC} = \mathrm{HNAC} + \mathrm{LNAC}$
HNAP	%	High Nucleic Acid Percentage	The percentage of HNA cells relative to ICC: $\mathrm{HNAP} = \frac{\mathrm{HNAC}}{\mathrm{ICC}} \times 100$
LNAC	1/mL	Low Nucleic Acid Count	The number of LNA cells inside the ICC gate, but below the HNA lower limit (vertical line gate).
HNAC	1/mL	High Nucleic Acid Count	The number of HNA cells inside the ICC gate and above the HNA lower limit (vertical line gate).

For further information on how to adjust the gates see section 11.4.

11.4 Change gates

11.4.1 Regate measurements

Regating is the process of applying a different gating set to existing measurement data.

- A prerequisite for regating is the presence of such additional gating set. Find all available gating sets for your cartridge type when pressing **Gate settings** on the **Home menu** of the BactoSense user interface.
- The process of modifying an existing gating set is described in section 11.4.3.

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	Navigate to the **Home menu** of the BactoSense user interface.	
2.	Depending on how the measurement was performed, press **Results (manual)** or **Results (auto)** to see the list of results.	
3.	To regate a **single measurement**, select the measurement to see the result details page. To regate **multiple measurements** (batch), long-press on the measurement, until it is highlighted and a check box appears on the left. Then tap on more measurement to also select them for regating.	
4.	Then press the **Re-gate** button.	
5.	Select the desired gating set by checking its box.	
6.	Press the **Confirm** button to start the regating process.	Depending on the number of measurements, regating can take several minutes.
7.	After finishing, press **OK**.	

11.4.2 Create a new gating set

New gating sets can be created either from a copy of an existing gating set, or from scratch.

Creating a new gating set from a copy

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	Navigate to the **Home menu** of the BactoSense user interface.	
2.	Press the **Gate settings** button.	
3.	In the list of available gating sets, identify the gating set from which you want to make a copy to create the new gating set.	Make sure the gating type (e.g. TCC, ICC) matches with your target application.
4.	Press the **Copy icon** to create a copy of the gating set.	
5.	In the newly generated copy, press the **Edit icon** and follow the editing instructions in section 11.4.3.	

Creating a new gating set from scratch

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	Navigate to the **Home menu** of the BactoSense user interface.	
2.	Press the **Gate settings** button.	
3.	In the action bar at the bottom, press **New**.	
4.	In the name field, type a name for the set of gates. In the type field, select for which cartridge type the set of gates will be used.	
5.	Then follow the gate configuration on-screen wizard as describe in the gate editing instructions in section 11.4.3.	
6.	After finishing, you can select the new gating set when creating new measurements, or regate existing measurements, as described in section 11.4.1.	

11.4.3 Edit existing gating sets

Apart from default gating sets, all other gating sets can be modified. Gate editing can comprise renaming, changing the position of the vertical gate, and changing the number and position of the corners of the polygon gate.

In this section, the general process of editing a gating set is described. Section 11.4.4 describes a specific strategy to adjust gating sets for TCC and ICC measurements.

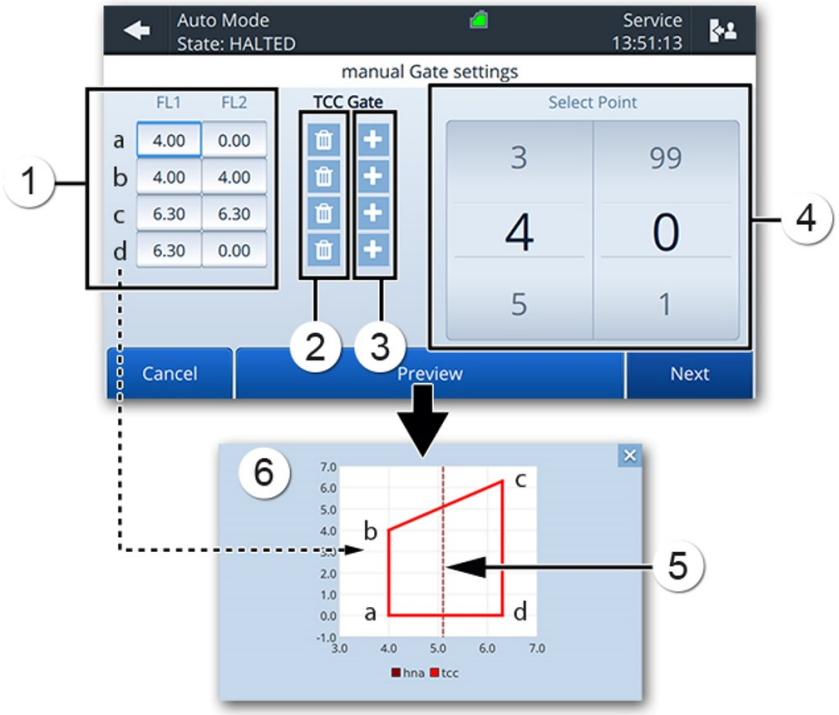
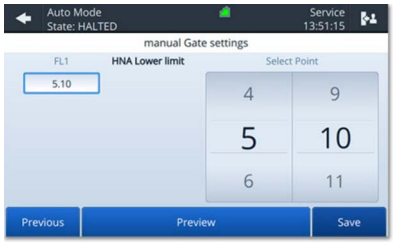


Figure 11-3 Gate settings for TCC

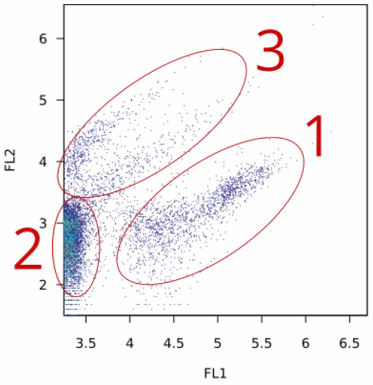
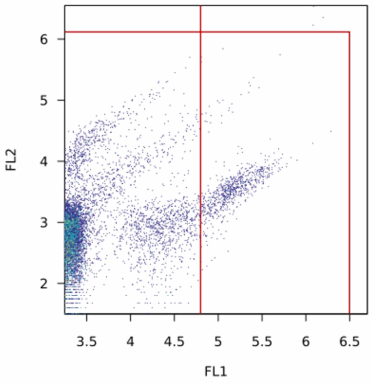
①	Coordinates of the gate's points. a: First point in the gate b: Second point in the gate c: Third point in the gate d: Fourth point in the gate	②	Remove a point from the gate.
③	Add a new point to the gate.	④	Modify the selected coordinate. In this screenshot, the FL1 (a, FL1) coordinate of the first point is selected, so we can move the first point in the gate along the FL1 axis (X-axis).
⑤	HNA lower limit: this gate is defined on the next screen.	⑥	Preview

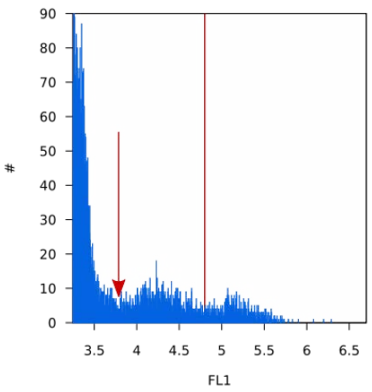
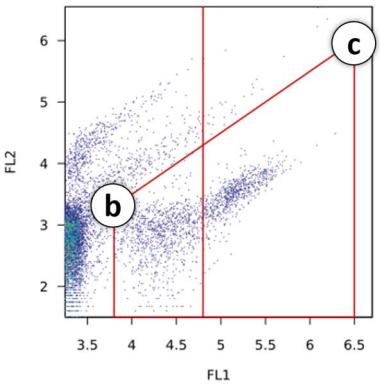
The following procedure describes how to adjust a gate:

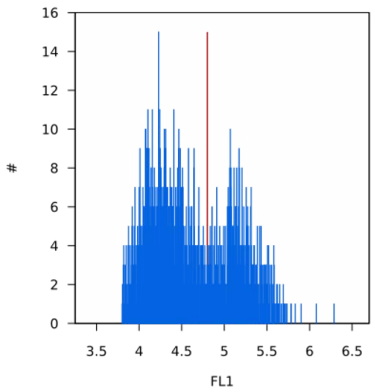
	WORK STEP	ADDITIONAL INFO / IMAGE
1.	Navigate to the **Home menu** of the BactoSense user interface.	
2.	Press the **Gate settings** button.	
3.	Press the **Edit** button of the gate you wish to edit.	
4.	Change the name if desired, then press the **Next** button.	
5.	Adjust the number and position of polygon corners (for TCC and ICC refer to section 11.4.4). A polygon gate can have between 3 and 6 corners.	
6.	Press the **Next** button.	
7.	Enter the HNA lower limit (for TCC and ICC refer to section 11.4.4).	
8.	Press the **Save** button and confirm.	
9.	After finishing, you can select the modified gating set when creating new measurements, or regate existing measurements, as described in section 11.4.1.	

11.4.4 Strategy to adjust gates for TCC and ICC

The BactoSense is delivered with default gate sets that are suitable for the vast majority of samples. If needed however, advanced users have the possibility to adjust the gate.
A general procedure to adjust the gate is explained below and is valid for both TCC and ICC cartridges.

	WORK STEP	ADDITIONAL INFO / IMAGE
1.	Measure a water sample using the standard **Water analysis** protocol. On the Result details page, the FL1 vs FL2 dotplot shows: 1) LNA and HNA cells in the water 2) Electrical noise from the optical detectors 3) Debris/background noise (This can include damaged cells, aggregates or other particles)	
2.	Navigate to the **Home menu** of the BactoSense user interface and press the **Gate settings** button.	
3.	Depending on your needs, perform one of the following: • Create a new set of gates • Edit an existing set of gates • Copy an existing set of gates and edit the copy	
4.	Give a name to this set of gates and press **Next**.	
5.	Place the polygon gate at each extremity (left and right). For example, use these four points: FL1 / FL2 3.0 / 0.0 3.0 / 6.1 6.5 / 6.1 6.5 / 0.0	
6.	Press **Next** and **Save**. Confirm that you wish to Save the new set of gates.	
7.	Navigate to the result view of the water sample you measured previously.	

	WORK STEP	ADDITIONAL INFO / IMAGE
8.	On the result view, press the **Re-gate result** button.	
9.	Select the gate you just created, and re-process the data with the new gate by pressing the button **Confirm**.	
10.	Open the FL1 histogram and locate the first valley after the noise peak, i.e. the first minimum after the peak at the extreme left (arrow in the picture). Write down the FL1 value of this minimum (e.g. 3.8).	
11.	Return to **Gate settings** and again edit your gate. Place the left limits of the gate at the previously determined FL1 value. This will exclude the electrical noise of the optical detectors. If needed, for the FL2 axis, place the points “b” and “c” of the gate just below the debris/background area (generally appearing as straight diagonals).	
12.	Save the adjusted gate.	
13.	Navigate again to the result view of the water sample you measured previously.	
14.	On the result view, press the **Re-gate result** button.	
15.	Select the gate you just created, and re-process the data with the new gate by pressing the button **Confirm**.	

	WORK STEP	ADDITIONAL INFO / IMAGE
16.	To place the HNA lower limit, open again the FL1 histogram and locate the minimum between the LNA and HNA peaks (vertical line on the image). Write down its FL1 value (e.g. 4.8).	
17.	Return to **Gate settings** and again edit your gate.	
18.	Navigate to the HNA lower limit configuration step. Enter the previously identified HNA lower limit to the FL1 field, press **Save** and confirm.	
19.	Regate the water analysis measurement again and verify that the gate is suitable. Further adjust if needed.	

11.5 Advanced data analysis

BactoSense measurement data can be exported in Flow Cytometry Standard (FCS) 3.1 file format. The FCS file format is standardized by the International Society for Advancement of Cytometry (ISAC) to ensure interoperability between different flow cytometry instruments and analysis software. There are different versions of the FCS format with each version introducing improvements and additional features.
FCS data can be used for custom offline postprocessing, such as the application of complex gating strategies, "microbial fingerprinting", automated anomaly detection and many more.

11.5.1 How to retrieve FCS files

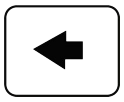
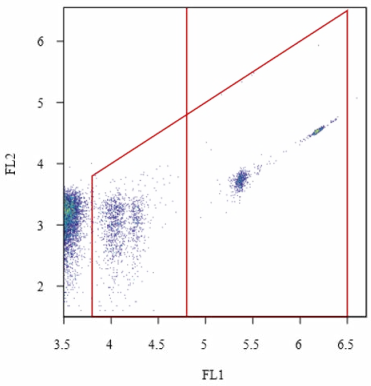
FCS files can be retrieved in the following ways:

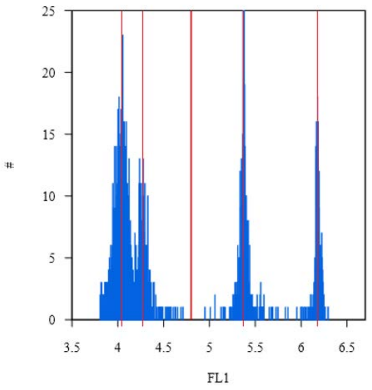
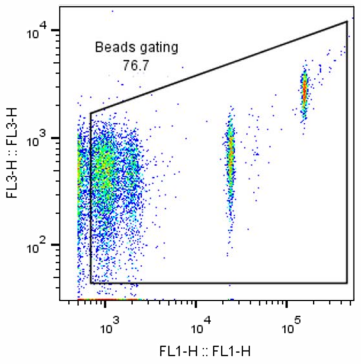
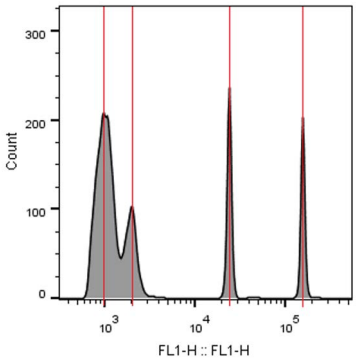
- Download to a USB stick: Using the Export all function (see section 12.1.1)
- Download from the web interface, either as single files (see section 13.4) or multiple files (see section 13.5)
- Access using FTP (see section 12.2)
- Access using HTTPS (see section 12.3)

For help with the setup of an advanced data analysis tool chain, please contact support@bnovate.com.

11.6 Comparison with other flow cytometers

To compare results of the BactoSense to another flow cytometer, a reference solution containing auto fluorescent beads can be analyzed. This method allows the user to compare the measurement scales of different devices.

	WORK STEP	ADDITIONAL INFO / IMAGE
1.	It is recommended to use the Validation Kit which contains a ready to use beads solution.	Read the instructions of the **Validation Kit** for more information.
2.	Install the manual sampling device according to the user manual.	
3.	Take of one of the Validation kit's beads solutions and load it into the sampling device.	Read the instructions of the **Validation Kit** for more information.
4.	Press the **Home** button. ⓘ Press the **Back** button as many times as needed for the **Home** button to appear.	 
5.	Select **Manual mode** and confirm with **Start**.	
6.	Choose the **Prime** protocol from the list.	See section 10.7.3.
7.	Press the **Next** and **Start** button. Let the priming protocol finish.	
8.	Choose the **Beads Analysis** protocol from the list and run it.	
9.	Wait for the results and if necessary, precisely adjust the gate of the FL1 vs FL2 dot plot to count only the 4 populations of beads. It is important to ensure that noise, background, and debris are not counted into the gate.	See section 11.4.3 to adjust the gate. 

	WORK STEP	ADDITIONAL INFO / IMAGE
10.	On the FL1 vs counts histogram, estimate the log value of each peak's center on the FL1 axis. In this example, we obtain approximately (in log): 1st peak = 4.05 2nd peak = 4.3 3rd peak = 5.35 4th peak = 6.2	
11.	Measure the same beads with the other flow cytometer you want to compare and repeat the steps 10 and 11. In this example, we obtain approximately (in log): 1st peak = log(10^3) = 3 2nd peak = log(2*10^3) = 3.3 3rd peak = log(2.4*10^4) = 4.4 4th peak = log(1.6*10^5) = 5.2	 
12.	With the different values obtained for both devices, it is now possible to compare their scales and their measurement windows.	

12 Data Access and Export

12.1 Export data to USB device

To export measurement data, refer to section 10.6.1.

12.1.1 Export settings, diagnostics, or all to USB device

The "Special import/export" function allows users to export either all measurement data from the instrument, or to export only diagnostics data which can be interpreted by service technicians.

	WORK STEP	ADDITIONAL INFO / IMAGE
1.	Navigate to the **Home menu** of the BactoSense user interface.	
2.	Press the **Maintenance** button and then the **Special export import** button.	
3.	Connect a USB mass storage device. The USB flash drive should be formatted in FAT32. If needed, press the **Refresh USB list** button until the device is displayed.	
4.	The name of the folder which will be created on the USB device is displayed in the Folder name field. Enter a new folder name if desired.	
5.	• To export all data, press the **Export all** button. • To export diagnostics data, press the **Export diagnostics** button. • To export settings, press the **Export diagnostics** button. Do not remove the USB mass storage device during the data transfer.	Exporting all data can take several hours. If the available storage capacity of the USB mass storage device is too small, a notification will be shown.
6.	After completion of the export, press the **OK** button and remove the USB device.	

12.2 Retrieve data via FTP

BactoSense data can be remotely accessed using the FTP protocol (RFC 3659).

- FTP authentication uses the username/password pairs used in the GUI of the instrument. Default account names are: basic, advanced, and admin.
- The CSV and Excel files are generated on-the-fly, and thus always contain the latest measurement data.

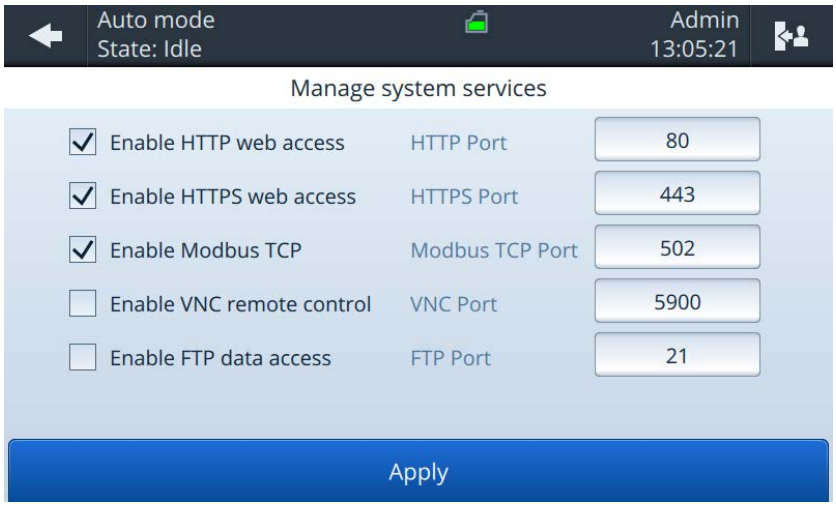


Figure 12-1 The Manage services view of the BactoSense user interface.

	WORK STEP	ADDITIONAL INFO / IMAGE
1.	• Install an FTP client on the device you want to use to retrieve data, e.g. your laptop. • Alternatively, the Windows file explorer can be used.	
2.	Connect the BactoSense via Ethernet to a safe network (e.g. LAN). Connect your device to the same network.	For information about network configurations (i.e. static and dynamic IP settings), refer to section 8.6.
3.	Navigate to the **Home menu** of the BactoSense user interface.	
4.	Press the **System settings** button.	
5.	Press the **System services** button.	
6.	Make sure the **Enable FTP data access** check box is checked.	
7.	Choose a port for the FTP server.	The default port is port 21.

	WORK STEP	ADDITIONAL INFO / IMAGE
8.	Press the **Apply** button to reboot the BactoSense.	Only needed in case you changed the configuration.
9.	Retrieve the IP address of the BactoSense by navigating to the **Home menu** of the BactoSense user interface, and pressing the **System info** button.	For information about network configurations (i.e. static and dynamic IP settings), refer to section 8.6.
10.	For FTP client: Open the client and enter the login details. For the Windows file explorer: Enter the following address in the address bar: ftp://user:password@ip:port	• User/username: Username to log in to the BactoSense • Password: Password to log in to the BactoSense • Host/ip: IP address of the BactoSense • Port: Port configured in System services view (see figure 12-1)

12.3 Retrieve files via HTTP or HTTPS

The HTTP and HTTPS servers are enabled by default and available through a web browser or any HTTP request library. Use the following procedure to retrieve specific files via HTTP or HTTPS. As an alternative, consider the web interface (chapter 13) or FTP (section 12.2).

	WORK STEP	ADDITIONAL INFO / IMAGE
1.	Connect the BactoSense via Ethernet to a safe network (e.g. LAN). Connect your device to the same network.	For information about network configurations (i.e. static and dynamic IP settings), refer to section 8.6.
2.	Navigate to the **Home menu** of the BactoSense user interface.	
3.	Press the **System settings** button.	
4.	Press the **System services** button.	
5.	For HTTP: Make sure the **Enable HTTP data access** check box is checked. For HTTPS: Make sure the **Enable HTTPS data access** check box is checked.	
6.	Choose a port for the HTTP or HTTPS server.	The default port for HTTP is 80. The default port for HTTPS is 443.

	WORK STEP	ADDITIONAL INFO / IMAGE
7.	Press the **Apply** button to reboot the BactoSense.	Only needed in case you changed the configuration.
8.	Retrieve the IP address of the BactoSense by navigating to the **Home menu** of the BactoSense user interface, and pressing the **System info** button.	
9.	Open a web browser on your device and enter the target file address into the address field. The file address has the following form: For HTTP: *http://ipaddress:port/export/filename.extension?hash=myhash* Example: *http://192.168.1.2/export/history_auto.xlsx?hash=QWRtaW46MTExMQ* For HTTPS: https://ipaddress:port/export/filename.extension?hash=myhash Example: *https://192.168.1.2/export/history_auto.xlsx?hash=QWRtaW46MTExMQ*	

Name	Description
ipaddress	Local IP address of the instrument
port	Port of the HTTP or HTTPS server (by default 80 and 443, respectively)
filename	Name of the target file. Example: history_auto
extension	File extension (csv, xlsx,pdf)
myhash	Security key containing user identification. The key is unique to any user-password combination. It is possible to find the key in the web interface (chapter 13) by copying the link shown when downloading a file. For example: *hash=QWRtaW46MTExMQ*

12.4 GUI relay using VNC

Virtual Network Computing (VNC) is a graphical desktop-sharing system to remotely control another computer. It transmits the keyboard and mouse input from one computer to another, relaying the graphical-screen updates, over a network.
The embedded VNC server in the BactoSense is capable of sharing the user interface over the local area network (LAN) only (exception: remote access using a VPN).

CAUTION!

VNC is an insecure protocol and is not recommended outside of a local network or with a VPN connection.

A VNC connection can slow down the user interface since it is very taxing in terms of processing power. Be sure to close your VNC connection after use.

	WORK STEP	ADDITIONAL INFO / IMAGE
1.	Install a VNC client on your computer.	
2.	Connect the BactoSense via Ethernet to a safe network (LAN). Connect your computer to the same network.	For information about network configurations (i.e. static and dynamic IP settings), refer to section 8.6.
3.	Navigate to the **Home menu** of the BactoSense user interface.	
4.	Press the **System settings** button.	
5.	Press the **System services** button.	
6.	Make sure the **Enable VNC remote control** check box is checked.	
7.	Choose a port for the VNC server.	The default port is port 5900.
8.	Press the **Apply** button to reboot the BactoSense.	Only needed in case you changed the configuration.
9.	Retrieve the IP address of the BactoSense by navigating to the **Home menu** of the BactoSense user interface, and pressing the **System info** button.	
10.	Open the VNC client on your computer and connect to the BactoSense using the IP address and port identified previously.	Your VNC client may allow you to change connection settings to optimize the speed of the connection if needed.
11.	Disable the VNC connection in the BactoSense System services page after finishing.	The VNC connection can slow down the user interface on the BactoSense.

13 Web User Interface

13.1 General information

- The web interface allows users to browse and export results and other data from a remote computer, as well as monitor the state of the instrument (active process, cartridge level, alerts etc.)
- The BactoSense needs to be connected to the same network as the computer that accesses the web interface.
- The web interface can be loaded on any browser on desktop computers or mobile devices.
- Take care about data and network security with all usual measures.

13.2 Connect to the web user interface

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	Connect the BactoSense via Ethernet to a safe network (e.g. LAN). Connect your device (e.g. computer or tablet) to the same network.	
2.	Navigate to the **Home menu** of the BactoSense user interface. Press the **System info** button.	 
3.	Retrieve the **IP address** of the BactoSense shown on the System info page.	
4.	On your device, open a web browser.	
5.	Enter the IP address of the BactoSense in the address bar and press Enter.	
6.	On the login page, use the same username and password as for the BactoSense and press **Login**.	

13.3 Start page in manual mode

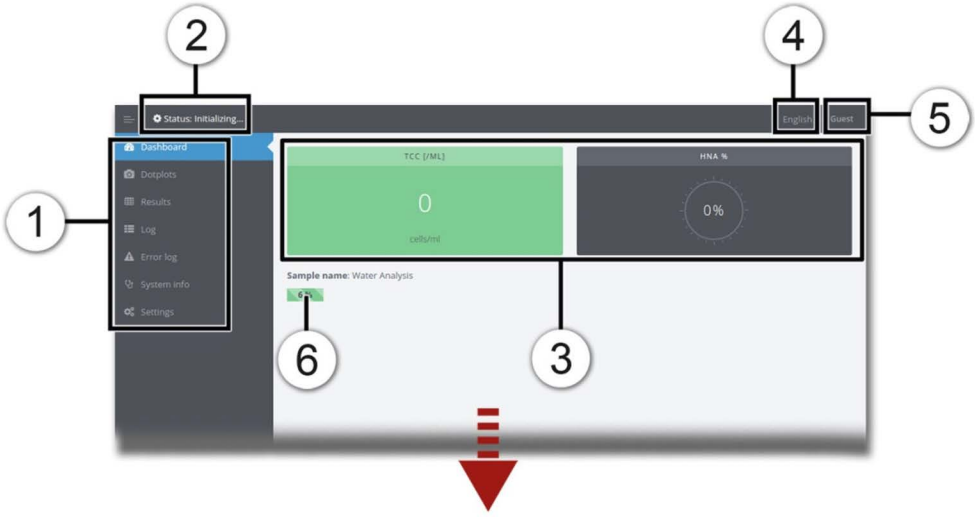
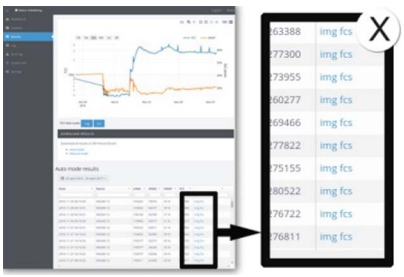


Figure 13-1 Start page on web user interface

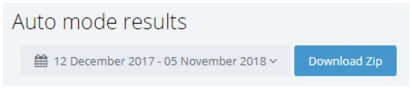
1	Menu	**2**	State of the instrument
3	Dashboard with latest results	**4**	Language: Drop-down menu for changing the language.
5	Logout from Web interface and reboot BactoSense options	**6**	Progress of the current measurement

13.4 Download an FCS-file

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	On the web interface, select the **Results** page on the navigation panel on the left.	
2.	Navigate to the result you wish to export.	
3.	Click on the **fcs** link (Position X).	
4.	Wait for the download to complete.	

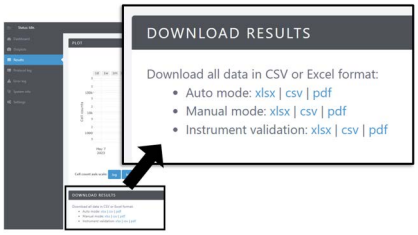
13.5 Download a zip file with multiple results

The results from multiple measurements can be downloaded as a zip file. This zip includes the FCS file and summary plots of each measurement.

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	On the web interface, select the **Results** page on the navigation panel on the left.	
2.	Find the results for the mode you are interested in: **Auto** or **Manual mode** results.	
3.	Select the date range you want and click **Download ZIP**. A progress bar will appear at the top of the browser until the zip starts downloading.	
4.	Wait for the download to complete.	

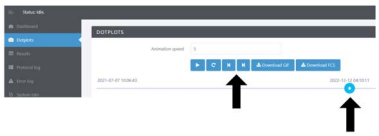
13.6 Download all results as CSV, XLSX or PDF

The list of all results can be downloaded from the web interface in either Excel XLSX, CSV or PDF format. The **Auto mode** results are separated from **Manual mode** results.

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	On the web interface, select the **Results** page on the navigation panel on the left.	
2.	Find the **DOWNLOAD RESULTS** section, just below the top PLOT section.	
3.	Click on the desired file (xlsx, csv or PDF) to start the download.	
4.	Wait for the download to complete.	

13.7 Animate the evolution of dot plots

The web interface can animate dot plots from the **Auto mode**, to help visualize the progression of the measurements. This feature shows static images in rapid succession; therefore the animation can only be exported using screen recording software.

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	On the web interface, select the **Dotplots** page on the navigation panel on the left.	
2.	Use the previous and next arrows or the slider to centre the slider on the desired date range.	
3.	Press the Play button to start the animation.	
4.	Adjust the animation speed if needed using the animation speed field.	
5.	The animation can be downloaded as GIF file when pressing the *Download GIF* button.	

13.8 Change the measurement interval

If the instrument is in **Auto mode**, the measurement interval can be changed from the web interface.

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	On the web interface, select the **Settings** page on the navigation panel on the left.	
2.	Change the duration of the measurement interval.	
3.	Click **Save** to confirm.	

13.9 Take screenshots of the GUI

Take screenshots of the BactoSense GUI from the web interface:

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	On the web interface, select the **System info** page on the navigation panel on the left.	
2.	Press the **Get screenshot** button at the bottom of the page.	
3.	The screenshot is displayed below.	

13.10 Reboot from web user interface

The BactoSense can be rebooted from the web interface according to the following procedure.

The instrument cannot switch on remotely.

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	In the top right corner of the web interface, click on the username to show the drop-down list of options.	
2.	Select **Reboot** and confirm the confirmation request.	
3.	The instrument reboots and a new login is required.	

14 Maintenance

BactoSense maintenance refers to the activities and procedures performed to ensure the proper functioning, accuracy and reliability of the instrument over its life cycle.

CAUTION!

BactoSense service duty

Adhering to the maintenance schedule is important to ensure a long instrument lifetime, safe operation and correct measurement results.

Service duties have to be carried out according to the maintenance schedule and original bNovate spare parts have to be used, otherwise this can lead to damage to the instrument or measurement errors. In case of neglected maintenance, bNovate Technologies accepts no warranty claims made by the customer and is not responsible for any resulting costs.

Importantly,

- Only service-trained and authorized personnel are allowed to carry out BactoSense service operation
- Carry out servicing duties according to the servicing schedule in section 14.1 and 14.2.1.
- When carrying out servicing duties, use original bNovate spare parts. The use of third-party spare parts requires the written approval of bNovate Technologies.
- If the instruments are subjected to heavy use or exposed to adverse environmental conditions, service duties must be carried out more frequently.

DANGER!

Observe the safety points

Before working on the instrument, ensure that you have carefully read the safety points in this user manual.

You should also follow these regulations:

- Only professional electricians are authorized to do the electrical installation of the power plug.
- It is forbidden to modify or repair the BactoSense instrument.
- Perform the work steps in the instructed order.
- When replacing parts, use only genuine original parts listed in the consumables and spare parts list.
- When returning components use the original packaging of the BactoSense
- Be sure to use a plug with Protective Earth (PE) and that the device is correctly connected to it.

14.1 Periodic preventive maintenance by service professional

Preventive maintenance of the BactoSense is a scheduled intervention to replace wear parts, update the software and inspect and validate the instrument. Preventive maintenance is important to prevent failures and optimize the performance and reliability. It can only be conducted by service professionals specifically trained by bNovate.

A preventive maintenance is due after the consumption of either 3 cartridges or 1 year, whichever comes first.

Contact bNovate support or your local service partner to see available options. Contact details can be found in section 18.1.

14.1.1 Retrieve service information

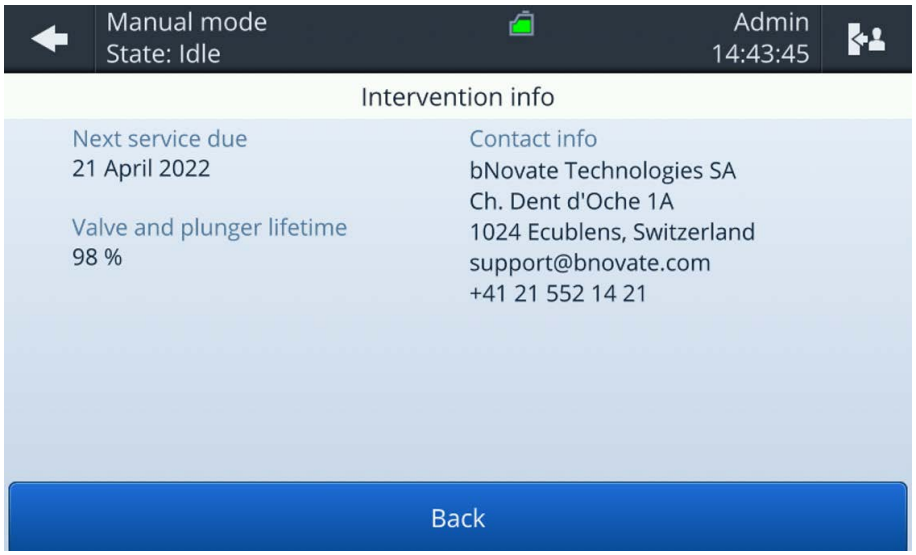


Figure 14-1 Intervention info screen

	WORK STEP	ADDITIONAL INFO / IMAGE
1.	Navigate to the **Home menu** of the BactoSense user interface.	
2.	Press the **Maintenance** button.	
3.	Press the **Intervention info** button.	
4.	If a service is needed, a warning will be attached to the measurement result. Schedule a preventive maintenance before the service due date.	

14.1.2 Review the service intervention log

The following procedure describes how to view details of past service interventions.

	WORK STEP	ADDITIONAL INFO / IMAGE
1.	Navigate to the **Home menu** of the BactoSense user interface.	
2.	Press the **Maintenance** button.	
3.	Press the **Intervention log** button.	
4.	Past service interventions are listed in this log screen.	

14.2 Maintenance by the user

Maintenance by user refers to simple and occasional maintenance activities performed by the user. They are important to maximize the instrument's performance, minimize downtime, and extend its operational life.

14.2.1 Overview of maintenance by user

Table 14-1 Overview of the maintenance activities performed by the user

WHEN	WHAT	PROCEDURE
Cartridge expired or empty	Replace cartridge	See cartridge exchange procedure in section 8.9.4. See cartridge shipping instructions in section 16.3.2.
Manual sampling device is newly installed. Instrument has been or will be idle or switched off for more than 3 days.	Cleaning with Washstation or Basic Cleaning	If Washstation is available, see section 14.2.2. Otherwise see section 14.2.3.
Instrument shows signs of contamination	Decontamination	Requires a Cleaning Kit, see consumables list in section 17.3. See Cleaning Kit user manual.
Online sampling device tubing is damaged or dirty	Replace tubing	See replacement process in section 14.2.4.
Cell concentrations lower than expected or no cells measured	Sampling device inlet filter clogged. Replace the filter.	See section 14.2.6. See consumables list in section 17.3.
Error E08 appears (internal humidity)	Internal humidity is not within specified limits. Replace the desiccant bag	Replace the desiccant bag. See instructions in section 14.2.5. See consumables list in section 17.3.
Error E07 appears (disk full)	Disk space is full. Clear disk space	See instructions in section 14.2.7.

14.2.2 Clean manual sampling device with Washstation

This protocol describes how to clean the manual sampling device using the Washstation. If no Washstation is available, follow the procedure in section 14.2.3.

- This protocol automatically cleans the inner and outer surfaces of the aspiration needle.
- All reagents required come directly from the installed cartridge.
- The protocol takes approximately 15 min.

Figure 14-2 Washstation for cleaning the manual sampling device

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	Make sure the manual sampling device is tightly installed as described in section 5.4.	
2.	Navigate to the *Home menu* of the BactoSense user interface.	
3.	On the action bar at the bottom, select *Manual mode* and press *Start*.	
4.	In the list of available protocols, select *Clean Sampling Device with Washstation*.	
5.	Make sure 1 replication is configured in the *Replications* column.	More replications can be conducted for stronger cleanings.
6.	Press the *Next* button.	
7.	Mount the Washstation by screwing it on the manual sampling device, similar to a sample tube. Make sure you install it to the end of the thread.	
8.	Press the *Start* button and wait for 15 min for the protocol to complete.	
9.	If the instrument will be idle or decommissioned, leave the Washstation attached to the manual sampling device. If you want to keep on measuring, remove the Washstation and close it with a cap from a 5 mL screw-cap tube.	
10.	If the contamination persists, repeat the procedure with more replications. If it still persists, use the Cleaning Kit to decontaminate the instrument (see section 17.3).	

14.2.3 Clean manual sampling device with basic cleaning

This protocol describes how to clean the manual sampling device without the Washstation. If a Washstation is available, follow the procedure in section 14.2.2 instead.
This protocol requires sterile water.

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	Make sure the manual sampling device is tightly installed as described in section 5.5.	
2.	Attach a fresh 5 mL screw-cap tube containing 2 – 5 mL sterile water to the manual sampling device.	
3.	Navigate to the *Home menu* of the BactoSense user interface.	
4.	On the action bar at the bottom, select *Manual mode* and press *Start*.	
5.	In the list of available protocols, select *Clean Optics*.	
6.	Make sure 1 replication is configured in the *Replications* column.	Configure more replications for a stronger cleaning.
7.	Press the *Next* button.	
8.	Press the *Start* button and wait for 5 min for the protocol to complete.	
9.	Then press the *New* button to navigate back to the protocol list. In the list of available protocols, select *Clean Sampling Device*.	
10.	Make sure 1 replication is configured in the *Replications* column.	Configure more replications for a stronger cleaning.
11.	Press the *Next* button.	
12.	Press the *Start* button and wait for 5 min for the protocol to complete.	
13.	Once the protocol is finished, remove the 5 mL screw-cap tube and discard it.	

	WORK STEP	ADDITIONAL INFO / IMAGES
14.	Press the *Home* button on the top left of the user interface to return to the *Home menu*.	
15.	If you want to continue with measurements, perform a Prime prior to the first measurement. The instructions can be found in section 10.7.3. If the instrument will be idle or shut off, attach a fresh sample tube to the manual sampling device.	
16.	If you face a persisting contamination, first repeat the procedure with more replications. If it still persists, use the Cleaning Kit to decontaminate the instrument (see consumables in section 17.3).	

14.2.4 Replacing online sampling device tubings

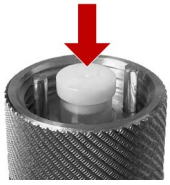
The inlet- and outlet tubings of the online sampling device must be exchanged if they show signs of damage or contamination. The required materials are the inlet and outlet tubing and two ferrules. For specifications refer to the technical information in section 3.2, and for the part numbers to section 17.3.

CAUTION!

Never use a spanner on the sampling device when attached to the BactoSense

Wear nitrile gloves when manipulating the sampling device or any other components which come in contact with the sample.

	WORK STEP	ADDITIONAL INFO / IMAGES
1.	Make sure all protocols (e.g. measurements) have terminated, or terminate them if needed.	
2.	Stop the water flow through the sampling device.	
3.	Disconnect the tubings to the water supply and drain them.	

	WORK STEP	ADDITIONAL INFO / IMAGES
4.	Carefully unscrew the knurled sampling device fixation ring until the sampling device can be removed.	
5.	Make sure the white sealing plug still sits tightly in the connector of the sampling device. If not, it may have remained in the BactoSense sampling device connector. In this case carefully remove it with tweezers and place it back in the sampling device.	
6.	Unscrew the nuts of the two connectors on the sampling device using a spanner.	
7.	Pull the nuts off the old tubings.	
8.	Discard the old tubings with ferrules.	
9.	Take the new tubings and install the nut and ferrule as illustrated. Screw the nut on the online sampling device using a clamp. Make sure the blue FEP tubing is connected to the top fluidic connector (see figure 5-2 in section 5.5).	
10.	Continue with the procedure for installing the online sampling device described in section 5.5.2.	

14.2.5 Replacement of the desiccant bag

The following procedure describes how to replace the desiccant bag. The desiccant bag is a consumable listed in section 17.3.

	WORK STEP	ADDITIONAL INFO / IMAGE
1.	Open the desiccant bag container by unscrewing the large cap on the left-hand side of the instrument.	
2.	Replace the used desiccant bag by a new one.	
3.	Close the desiccant bag container by screwing back the large cap.	

14.2.6 Replacement of the sampling device filter

The sampling device of the BactoSense contains a 25 µm filter which can be replaced by the user. The filter is a consumable listed in section 17.3.

Wear fresh, non-powdered nitrile gloves when handling the samples, sampling device, or any components which come in contact with them.

	WORK STEP	ADDITIONAL INFO / IMAGE
1.	Unscrew the sampling device from the BactoSense, as described in section 8.10.1 for the online sampling device, and 8.10.2 for the manual sampling device.	
2.	Place flat tweezers under the white plug.	
3.	Remove the white plug and mind the transparent filter disc. The filter sometimes stays inside the cavity and sometimes remains attached to the white plug.	
4.	Remove the filter and place a new one. Do not use force, let the filter sink with gravity. Do not push the filter inside with tweezers.	
5.	Re-insert the white plug. Be sure to press it until it reaches the bottom. The force of the white plug will press the filter in the right position.	
6.	Re-install the sampling device as described in section 5.4 for the manual sampling device and 5.5 for the online sampling device.	

14.2.7 Clearing of disk space

When running out of disk space, old data can be deleted.

CAUTION!

Make sure you retrieve all data from other users and your data before deleting it from the BactoSense.

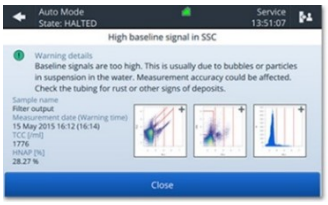
	WORK STEP
1.	Navigate to the *Home menu* in the BactoSense user interface.
2.	Press the *Maintenance* button.
3.	Press the *Delete old measurements* button. This function is only available for the *Admin* role.
4.	If available, choose one of the following measuring modes: *Auto* / *Manual*
5.	Choose the time interval for the measurements to keep. Measurements older than this will be deleted.
6.	Press *Delete measurements* to permanently delete the data.

15 Warnings, Errors and Troubleshooting

If the instrument encounters a problem, it enters a different state, depending on the severity of the issue. There are warnings, noncritical errors and critical errors, each having different implications and requiring different actions.

15.1 Warnings

Warnings appear when unusual behaviour is detected during an otherwise successful measurement. They can indicate reduced accuracy of the measurement results or indicate impending errors. Unlike errors, warnings do not prevent the instrument from functioning, but users should pay attention to them as they can indicate sources of inaccuracies.

WARNING	IMAGE
When unusual behavior is detected, a warning is shown next to the measurement results. More information on the warning can be found by clicking on the corresponding warning entry next to the measurement results or directly in the warning log.	

The following warning messages can be displayed:

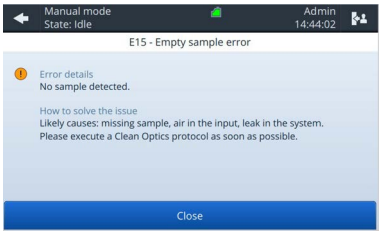
Table 15-1 Warnings

ERROR CODE	NAME	DESCRIPTION	CAUSES / WHAT TO DO
W01	Cartridge expired	Cartridge reagents have expired. Measurement accuracy could be affected.	• Please replace the cartridge as soon as possible.
W02-04	High baseline signal in FL1 / FL2 / SSC	Baseline signals are too high. This is usually due to bubbles or particles in suspension in the sample. Measurement accuracy could be affected.	• Check the inlet tubing for any signs of deposits. • Check the water connections, be sure that they are all tight (no air entry). • If the warning persists, please perform cleaning of instrument with the cleaning kit.
W05	Incubator temperature off target	Temperature during incubation was more than 2 °C off target. Cell counts may be affected. The incubator may be defective.	• If the problem persists, please contact customer service.

ERROR CODE	NAME	DESCRIPTION	CAUSES / WHAT TO DO
W06	No events detected	No events detected during the measurement.	• If the problem persists, please contact customer service.
W07	TCC out of range	TCC is above the specification limit of BactoSense of 2'000'000 cells/ml.	• Please dilute the sample to ensure accuracy of the measurement.
W08	Air bubbles detected	The sample appears to contain air bubbles.	• Check sampling device is installed properly. • Check the sample for bubbles. • If using online sampling device, check water is supplied at correct pressure.
W10	Enclosure too cold	Enclosure is too cold, rapid heating has been activated before continuing protocol.	• Instrument cannot safely operate if internal temperature is too cold. • Rapid heating attempts to heat the enclosure to ensure safe operations. • Measurements will start once internal temperature is sufficient.
W11	Service required	Service of the instrument is required. Measurement precision can no longer be guaranteed. **Continued operation can lead to leaks, which can damage the instrument.**	• Next service date is overdue. • Valve and plunger have reached end of life. • Please contact your service representative.
W13	Laser end of life	Laser has reached end of life.	• Please contact your service representative.
W14	Non-critical power cut	The instrument was powered off unexpectedly.	• Ensure the cleanliness of the instrument. • If the issue occurs frequently, install an uninterruptible power supply

15.2 Non-critical errors

Non-critical errors prevent a measurement from terminating successfully, but do not prevent the instrument from running another measurement afterwards. These errors do not require human intervention. Some non-critical errors are promoted to critical errors if they repeat three times.

NON-CRITICAL ERRORS	
The protocol stops. The cause of the error is usually fixed by repeating the analysis or waiting. • Another measurement can immediately be started. If it completes successfully, the error state is cleared. • More information on the error can be found in the error log, by clicking on the corresponding error entry.	

The following non-critical error messages can be displayed:

Table 15-2 List of non-critical errors.

ERROR CODE	NAME	DESCRIPTION	CAUSES / WHAT TO DO
E01	Cartridge door open	Cartridge door is open and prevents measurements from running.	• Close door and retry the measurement.
E08	Enclosure too damp	Enclosure humidity is too high for safe operation.	• Replace desiccant bag, by unscrewing the large cap on the left-hand-side of the instrument (see section 14.2.5). • If the problem persists, please contact customer service.
E09	System overheated	Inside temperature is too high for safe operation.	• Reduce ambient temperature or increase measurement interval to allow instrument to cool down.
E14	Laser too hot	Laser temperature is too high for safe operation.	• Reduce ambient temperature or increase measurement interval to allow instrument to cool down.

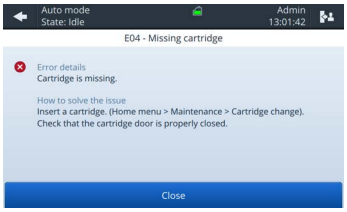
ERROR CODE	NAME	DESCRIPTION	CAUSES / WHAT TO DO
E15	Mixer inflation error	Underpressure detected during mix or dispense.	• Missing sample. • Air in the input. • Leak in the system. • Please execute the Clean Optics protocol (see section 10.7.1).
E18	Pump underpressure error	Underpressure detected during dispense.	• Missing sample. • Air in the input. • Leak in the system. • Please execute the Clean Optics protocol (see section 10.7.1).
E19	System overheated	The inner temperature is too high for operation.	• Reduce ambient temperature, or increase measurement interval to allow instrument to cool down.
E33	Processing memory overflow	Signal processing circuits memory has overflown.	• Please execute the Clean Optics protocol (see section 10.7.1). • Retry the measurement.
E42	Enclosure too cold despite heating	Enclosure temperature remains too cold after heating procedure.	• Ambient temperature is less than 5 °C (41 °F). • Increase ambient temperature.
E44	Pump module startup error	The pump module failed to power on correctly.	• Simply retry the measurement.
E45	Low valid volume ratio error	The valid volume ratio is too low. This can be caused by a too elevated bacterial content in the water or turbidity/debris.	• The accuracy of the measurement is probably very low. Repeat the measurement while diluting the sample with clear water.
E46	Cartridge is still busy	The cartridge was still initializing when the measurement started.	• Non-critical error. Repeat the measurement. If the problem persists, contact a service technician.

ERROR CODE	NAME	DESCRIPTION	CAUSES / WHAT TO DO
E48	Microfluidic subsystem busy	The microfluidic controller is performing another task while the measurement was taken.	• Non-critical error. Repeat the measurement. If the problem persists, contact a service technician.
E49	GPIO Timeout error	The processing board is waiting for another module to respond.	• Non-critical error. Repeat the measurement. If the problem persists, contact a service technician.
E50	Pump motion blocked	The motion of the pump is blocked.	• Non-critical error. Repeat the measurement. If the problem persists, contact a service technician.
E51	Unable to get temperature reading	Unable to get temperature reading. The control loop is thus disabled.	• Non-critical error. Repeat the measurement. If the problem persists, contact a service technician.
E52	Cartridge valve motion blocked	The motion of the cartridge valve is blocked.	• Non-critical error. Repeat the measurement. If the problem persists, contact customer service.
E55	M7 not connected	The acquisition processor cannot be initialized.	• Reboot the instrument. • If the problem persists, contact customer service.
E56	Empty acquisition	No events detected during acquisition	• Clean the sampling device using the Washstation, then perform a measurement of clean water. • If the problem persists, contact customer service.

ERROR CODE	NAME	DESCRIPTION	CAUSES / WHAT TO DO
E57	Cartridge busy (special command busy)	Communication with the cartridge failed.	• Non-critical error. Repeat the measurement. • If the problem persists, contact customer service.
E58	Cartridge busy (timeout)	Communication with the cartridge failed.	• Check the electronic connector between the cartridge and the instrument. • Repeat the measurement. • If the problem persists, contact customer service.
E59	Valve sensor error	Unable to read valve position.	• Please contact customer service.

15.3 Critical errors

Critical errors interrupt the workflows of the instrument and require human intervention. The error source needs to be eliminated and the instrument set to running conditions again. Critical errors need to be cleared.

CRITICAL ERRORS	IMAGE
If a critical error occurs during operation, it has the following effects: • The protocol immediately stops. • The instrument goes into a critical error state, and manual intervention is needed before any new protocol can be launched. • The cause of the error must be solved by an operator. The errors can then be manually cleared from the Error log, as described in sections 15.4 and 15.5.	

The following critical error messages can be displayed:

Table 15-3 List of critical errors.

ERROR CODE	NAME	DESCRIPTION	CAUSES / WHAT TO DO
E00	General error	Unhandled error.	• Please contact customer service
E02	Cartridge empty	Cartridge is empty.	• Replace cartridge (see section 8.9.4)
E04	Cartridge missing	Cartridge is missing.	• Insert a cartridge (see section 8.9.6)
E05	Full waste bag	Cartridge waste bag is full.	• Replace cartridge (see section 8.9.4)
E06	Cartridge communication impossible	Cartridge is disconnected, door is open, or cartridge electronics are damaged.	• Make sure the cartridge's electronic cable is connected properly, and that the door is properly closed. • If that doesn't help, replace the cartridge and inform customer service.

ERROR CODE	NAME	DESCRIPTION	CAUSES / WHAT TO DO
E07	Storage disk full	Insufficient storage space to continue operation.	• Delete old measurements and try again (see section 14.2.7) • This will delete the measurements permanently from the device. • Export measurements as backup solution.
E12	FPGA initialization error	Failed to initialize the signal processing chip.	• Reboot the instrument.
E16	Processing error	An error was discovered while processing the signals.	• The accuracy of the latest result is not guaranteed. Please repeat the analysis.
E17	Overpressure detected	Overpressure detected during dispense.	• Likely cause: The output filter is probably clogged. • Optical flow cell blocked. • Please call customer service.
E20	Abnormal shutdown	Protocol interrupted for unknown reasons, usually due to a power cut.	• Usually indicates a power cut, or other external interruption to the measurement. • Perform a Clean Optics and Clean Sampling Device protocol before starting a new measurement (see section 10.7.1).
E23	Temperature Sensor Communication Error	Communication with temperature sensor on IO board failed.	• Please contact customer service.
E24	Laser Communication Error	Communication with optical unit failed.	• Please contact customer service.
E25	Pump Communication Error	Communication with pump module impossible.	• Please contact customer service.

ERROR CODE	NAME	DESCRIPTION	CAUSES / WHAT TO DO
E26	Power Supply Communication Error	Communication with power supply module impossible.	• Please contact customer service.
E27	Pump Communication timeout	Communication with pump module timed out.	• The cartridge door is open. • A cable is disconnected. • A circuit board is damaged, either in the pump or cartridge.
E28	Empty dye supply	Dye tube connected to cartridge is empty.	• The tube is disconnected. • Cartridge is defective. • Repeat the cartridge change procedure, making sure that all tubes are properly connected.
E29	Empty rinse fluid supply	Rinse fluid tube connected to cartridge is empty.	• The tube is disconnected. • Cartridge is defective. • Repeat the cartridge change procedure, making sure that all tubes are properly connected.
E30	Empty bleach supply	Bleach tube connected to cartridge is empty	• The tube is disconnected. • Cartridge is defective. • Repeat the cartridge change procedure, making sure that all tubes are properly connected.
E31	Cartridge electronics failure	Cartridge level can no longer be determined accurately.	• Replace cartridge and contact customer service.
E32	Incompatible cartridge	Cartridge type is incompatible with this instrument or software.	• Make sure that you have the correct cartridge type for this instrument.
E33	Processing memory overflow	Signal processing circuits memory has overflowed.	• Please execute the Clean Optics protocol (see section 10.7.1). • Retry the measurement.

ERROR CODE	NAME	DESCRIPTION	CAUSES / WHAT TO DO
E38	Cartridge not ready error	The new cartridge has not been initialized correctly	• Execute the "Cartridge Change" procedure (see section 8.9.4).
E39	Laser current limit reached	The laser has reached its upper current limit; indicating end of life.	• The laser needs to be replaced. Contact a service technician.
E40	Set of gates not found	Reference to the set of gates selected for the measurement cannot be found in the instrument settings.	• The set of gates has been deleted. • Change the set of gates and retry the measurement.
E41	Set of gates incompatible	The set of gates selected for the measurement cannot be used with this cartridge.	• Correct cartridge change procedure was not followed. • Incorrect digital input configuration. • Change the set of gates and retry the measurement.
E43	External temperature too low	Ambient temperature is outside of the instrument specifications.	• Increase ambient temperature. • Trying to operate or store the instrument below 5 °C (41 °F) can cause damage to the device.
E47	Unable to find main reference magnet during homing	During initialization, the valve did not home properly.	• Please contact customer service.
E53	Unable to communicate with motor	The communication to the motor controller of the mixer is defective.	• Please contact customer service.
E54	Laser temperature sensor error	Unable to get the laser temperature.	• Please contact customer service.

15.4 Error and warning logs

The error and warning log views can be accessed separately through the user interface **Home menu** when pressing the **Logs** button.

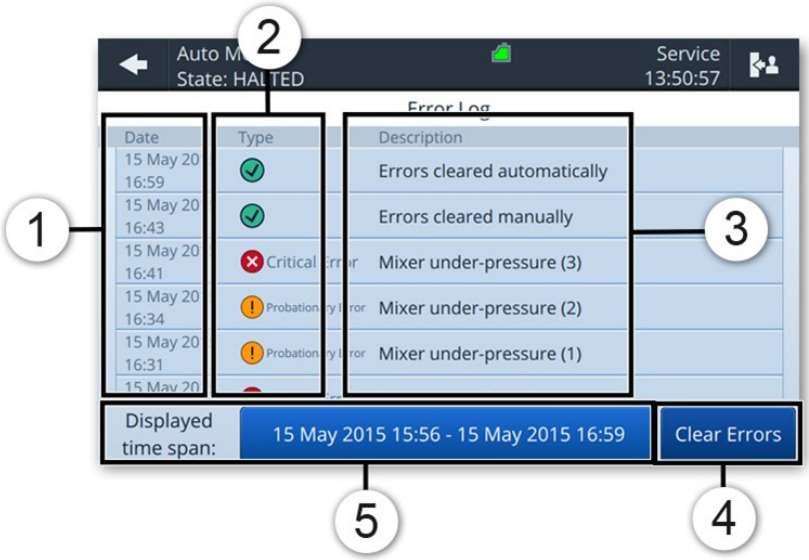


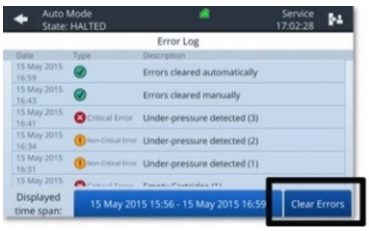
Figure 15-1 : Error logs

①	Date and time of the event	②	Type of the event
			Critical error
			Non-critical error
			Errors cleared
③	Short description of the error or event	④	Button to manually clear errors (only available for **Admin** and **Service** users)
⑤	Date range of displayed events. Click to change the range.		

Selecting any event on the list leads to a page with more information on the cause of the error and recommended resolution steps.

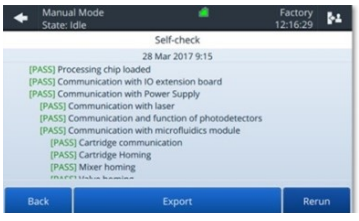
15.5 Clearing errors

Critical errors must be cleared manually. Make sure to first solve the origin of the problem, then manually clear the error with the steps below. Please note that the procedure below does not automatically solve the root cause of the error.

	WORK STEP	ADDITIONAL INFO / IMAGE
1.	Navigate to the **Home menu** of the BactoSense user interface.	
2.	Press the **Logs** button, and then the **Error log** button	
3.	Make sure you have resolved the problem leading to the displayed error(s). Then press the **Clear Errors** button.	
4.	Cleared errors appear with grey error symbols and an “Errors cleared” event is added to the log. The instrument is ready to analyze again.	

15.6 Automatic self-check

The **automatic self-check** tool checks that each component of the BactoSense is functioning correctly and identifies those that are not. It can be used to identify problems with the instrument.

	WORK STEP	ADDITIONAL INFO / IMAGE
1.	Navigate to the **Home menu** of the BactoSense user interface.	
2.	Press the **Maintenance** button.	
3.	Press the **Self-check** button.	
4.	Press the **Run** or **Rerun** button to start the self-check. ⓘ Once execution has terminated, the instrument shows a list of all tests, with a green PASS or red FAIL indicator. Some tests may be skipped: if the system cannot communicate with the cartridge, all the tests that require cartridge communication are skipped.	

15.7 Operation at low temperature

The instrument must be operated within a specific temperature range to prevent damage and ensure reliable and reproducible measurement results (see section 3.2).
At very low and very high ambient temperatures (below 5 °C (41 °F) or above 30 °C (86 °F)), protocols are not executed.
At low ambient temperatures, the instrument automatically warms up prior to a measurement to reach the required temperature. During this heating process, the instrument status shows "Heating...". If the target temperature cannot be reached after several hours, the protocol exits with an error (table 15-2, E42).

Measurements can be delayed if extensive heating is necessary.
To avoid this, keep the instrument temperature above 10 °C (50 °F).

15.8 Troubleshooting

The following table provides an overview of issues and resolutions. If the issue cannot be resolved, please contact your local service representative or bNovate customer service. Contact information for bNovate customer service can be found in section 18.1.

Table 15-4 Troubleshooting instructions

OBSERVATION	INSTRUCTION
Nothing on display	• Check whether the BactoSense is connected to power and switched on.
Unresponsive or flickering user interface	• Potential electromagnetic interference from nearby machine (e.g. pump). Relocate BactoSense.
Error message on the display	• Respond to the error message as described in this chapter.
The measurements appear to be wrong	• Ensure that the sample and operating conditions described in section 3.2 are met. • Check whether the instrument is correctly installed according to chapter 5. • Ensure that the servicing duties have been performed according to the servicing schedules described in sections 14.1 and 14.2. • Perform an instrument cleaning using the Cleaning Kit. • Perform an instrument validation using the Validation Kit.

16 Storage, Transport and Disposal

16.1 Storage

16.1.1 Storage of the BactoSense

Preparations

	WORK STEP
1.	Make sure the manual sampling device is installed
2.	Perform a *Clean sampling device with Washstation* process, as described in section 14.2.2. Alternatively, if no Washstation is available, follow the procedure in section 14.2.3.
3.	Leave an empty tube or empty Washstation attached to the manual sampling device.
4.	Follow the cartridge removal procedure in section 8.9.5 to safely remove the cartridge. Note: Cartridge removal is not required if the storage conditions of the cartridge can also be fulfilled.
5.	Power off the BactoSense.
6.	Unplug the power supply unit from the mains power supply, then unplug the power supply plug from the BactoSense.
7.	Make sure the USB, Ethernet and power sockets are covered with the attached covers.
8.	Pack the BactoSense with attached manual sampling device in its standard cardboard box with foam inserts, or in the transport case.

Storage

Store the BactoSense according to the following storage conditions:

- Temperature between 10 °C and 30 °C (50 °F – 86 °F)
- Relative humidity between 10 % and 70 %
- Non-vibrating, non-corrosive, dark and clean environment

Re-installation

After storage, follow the general installation instructions described in chapter 5.

If the BactoSense has been stored for more than one month, perform an instrument validation using the Validation Kit before the first measurement to ensure proper functioning.

16.1.2 Storage of the sampling devices

Note: The BactoSense should always have a sampling device installed. This procedure refers to storage of additional sampling devices if available.

Preparations

	WORK STEP
1.	Remove and clean the sampling device according to the instructions in section 8.10.2 (manual sampling device) or section 8.10.1 (online sampling device). If the tubings of the online sampling device show any signs of contamination or damage, do not reuse and discard.
2.	Wear gloves and pack the clean sampling device into a clean and dry plastic bag.

Storage

Store the sampling device according to the following storage conditions:

- Temperature between 5 °C and 40 °C (41 °F – 104 °F)
- Relative humidity between 10 % and 70 %
- Non-vibrating, non-corrosive, dark and clean environment

Re-installation

After storage, follow the general installation instructions in section 5.4 (manual sampling device) or 5.5 (online sampling device).

16.1.3 Storage of the cartridge

WARNING!

Wear protective gloves and goggles. Leaking chemicals can cause skin irritation, eye damage and other health hazards.

Make sure the liquid connectors of the cartridge are all tightly sealed with the respective plugs.

Check the expiration date of the cartridge. The expiration date is printed on the handle of the cartridge in the format Day/Month/Year, or can be found on the *System info* page on the user interface, accessible from the *Home menu*.

Preparations

	WORK STEP
1.	Wear protective gloves and goggles.
2.	Follow the cartridge removal procedure in section 8.9.5 to safely remove the cartridge from the BactoSense.
3.	Make sure the liquid connectors of the cartridge are all tightly sealed with the respective plugs.
4.	Pack the cartridge in its original cardboard box with foam inserts.

Storage

Store the cartridge according to the following storage conditions:

- Temperature between 15 °C and 25 °C (59 °F – 77 °F), ideally 15 °C
- Relative humidity between 20 % and 60 %
- Non-vibrating, non-corrosive, dark and clean environment

Re-installation

After storage, follow the general installation instructions in section 8.9.6.

16.2 Transport

16.2.1 Transport of the BactoSense

Refer to the following transportation instructions to safely transport the BactoSense.

- Follow the general preparation steps in section 16.1.1 to prepare the BactoSense for transport.
- Note that the storage conditions for humidity and temperature listed in section 3.2 and 16.1.1 apply.
- Make sure the manual sampling device is installed for transportation.

Table 16-1 BactoSense transportation instructions

MODE	INSTRUCTIONS
Standard shipping	• Remove the cartridge using the *Remove cartridge* procedure in the *Cartridge change* menu. • Pack BactoSense and cartridge in their standard cardboard boxes with foam inserts. • Ship on a pallet or skid. • Perform an instrument self-check (section 15.6) and an instrument validation using the Validation kit when reinstalling the instrument.
Long distance by car or Uneven road by car	• Remove the cartridge using the *Remove cartridge* procedure in the *Cartridge change* menu. • Pack BactoSense and cartridge in their standard cardboard boxes with foam inserts, or alternatively use the transport case (see accessories in section 17.2). • Perform a *Clean sampling device with Washstation* when reinstalling the instrument (see section 14.2.2).
Short distance by car, even road, instrument laying on its backside	• Remove the cartridge using the *Remove cartridge* procedure in the *Cartridge change* menu. • Transport the BactoSense in the transport case (see accessories in section 17.2). • Perform a *Clean sampling device with Washstation* when reinstalling the instrument (see section 14.2.2).
Short distance by car, even road, instrument in upright position	• Transport in the transport case (see accessories in section 17.2), without removing the cartridge. • Perform a *Fill Tubing* process after switching on the instrument again, see section 10.7.1.
Short distance within facility, instrument in upright position	• Transport in the transport case (see accessories in section 17.2) or by hand, without removing the cartridge. • Perform a *Fill Tubing* process after switching on the instrument again, see section 10.7.1.

16.2.2 Transport of the cartridge

Preparations

	WORK STEP
1.	Wear protective gloves and goggles
2.	Follow the cartridge removal in section 8.9.5 procedure to safely remove the cartridge.
3.	Make sure the liquid connectors of the cartridge are all tightly sealed with the respective plugs.
4.	Pack the cartridge in its original cardboard box with foam inserts, or in the transport case if available.

Transportation

Transport the cartridge in normal horizontal position. The cartridge storage conditions listed in section 3.2 apply.

Re-installation

After transport, follow the general installation instructions in section 8.9.6.

16.3 Returning the BactoSense or accessories

In case you return the BactoSense or accessories to bNovate or a distribution partner, please follow the instructions in this section.

WARNING!

Do not return contaminated materials

Instruments that have come into contact with hazardous media must not be sent without prior decontamination and accompanied certificate of decontamination. Contact support@bnovate.com for more information.

CAUTION!

Adhere to shipping instructions

bNovate does not take responsibility for deliveries which do not comply with our shipping regulations and will charge for repairs. Please contact support@bnovate.com if the original packaging is no longer available or you need help with packaging.

16.3.1 Returning the BactoSense

Preparations

	WORK STEP
1.	If the instrument has been exposed to hazardous substances, fully decontaminate it and provide a certificate of decontamination.
2.	Make sure the manual sampling device is installed.
3.	Perform a *Clean sampling device with Washstation* process, as described in section 14.2.2. Alternatively, if no Washstation is available, follow the procedure in section 14.2.3.
4.	Leave an empty tube or empty Washstation attached to the manual sampling device
5.	Follow the cartridge removal procedure in section 8.9.5 to safely remove the cartridge.
6.	Power off the BactoSense.
7.	Unplug the power supply unit from the mains power supply, then unplug the power supply plug from the BactoSense.
8.	Make sure the USB, Ethernet and power sockets are covered with the attached covers.
9.	Pack the BactoSense with manual sampling device but without cartridge in its standard cardboard box and fixate the box on a pallet or skid.
10.	If you ship additional items, label them with the serial number of the BactoSense.
11.	Indicate with stickers that the contents of the parcels are fragile, shall be kept dry, and shall only be transported in the indicated orientation.

Return

Ship the BactoSense to bNovate or distribution partner, adhering to the general storage temperature and humidity requirements listed in section 3.2 and 16.1.1.

16.3.2 Returning a cartridge for refill

Preparations

	WORK STEP
1.	If the cartridge has been exposed to hazardous substances, fully decontaminate it and provide a certificate of decontamination.
2.	Follow the cartridge removal procedure in section 8.9.5 to safely remove the cartridge.
3.	Pack the cartridge in its standard cardboard box.
4.	Indicate with stickers that the contents of the parcels are fragile, shall be kept dry, and shall only be transported in the indicated orientation.

Return for Refill
Ship the cartridge to bNovate, adhering to the general storage temperature and humidity requirements listed in section 3.2 and 16.1.3.

16.4 Recycling and disposal

The disposal of the BactoSense, accessories and consumables has to be carried out in compliance with regional statutory regulations.
The BactoSense contains no environmentally damaging sources of radiation.

Table 16-2 Materials and their recycling or disposal

CATEGORY	MATERIALS	DISPOSAL POSSIBILITIES
Packaging	Cardboard, wood, paper	Reuse as packaging material or dispose for recycling
	Protective foils, polystyrene shells	Reuse as packaging material or dispose for recycling
Electronics	Printed circuit boards, electro-mechanical components	To be disposed as electronic waste. Follow the local legislation.
Optics	Glass, aluminum	Recycling via centers for recycling glass and waste metal
Housing	Styrene butadiene painted, stainless steel, polystyrene painted, Silica beads (Desiccant bag), filters	Local disposal center
Cartridge	CAUTION! Do not disassemble nor dispose the cartridge.	Prepare the cartridge according to section 8.9.5 and return the cartridge with a declaration to bNovate according to section 16.3.2.

17 Supply Scope, Accessories and Consumables

17.1 BactoSense instruments

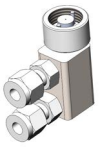
Table 17-1 BactoSense instruments

ART. NO.	NAME	IMAGE
200157	BactoSense Core	
200158	BactoSense Smart	
200159	BactoSense Pure	

17.2 Accessories

Accessories can be ordered upon need, for example if you need spare parts. bNovate Technologies recommends to order a second cartridge with your instrument in order to have a replacement cartridge when required.

Table 17-2 Accessories for the BactoSense

ART. NO.	NAME	IMAGE
200048 200049 200050	Power Supply Unit 200048 CH plug 200049 EU plug 200050 UK plug	
200017	Cartridge TCC	
200053	Cartridge ICC	
200169	Printed User Manual BactoSense English	
200170	Printed User Manual BactoSense French	
200171	Printed User Manual BactoSense German	
200006	Manual sampling device	
200007	Online sampling device	
200145	BactoLink remote instrument access	
200008	Transport Box BactoSense	

ART. NO.	NAME	IMAGE
200009	External IO-Box BactoSense	
200162	Scientific package license key	
200163	Management package license key	
100173	Washstation	
200131	Hex nut driver, 7mm, for cartridge compartment door	

17.3 Consumables

Available consumables are listed below. They can be ordered from your local sales representative.

Table 17-3 Consumables of the BactoSense

ART. NO.	NAME
200003	Screw cap tubes 5 mL, 25 pcs set
200023	Desiccant bag
200025	Set of 5 filters 316L – 25 µm for sampling device
200004	Validation Kit
200005	Cleaning Kit
200019	Refill TCC cartridge
200054	Refill ICC cartridge
200030	Inlet tubing for online sampling device
200029	Outlet tubing for online sampling device
200065	Ferrules for online sampling device

18 Contact

18.1 Contacting customer service

If you have any questions, please contact the bNovate support team under support@bnovate.com, or the service centre responsible in your country or region.
An up-to-date list of all bNovate representatives is available online at www.bnovate.com/distribution-partners.

Please have the following information ready when you contact customer service:

- Serial number of the BactoSense.
- Description of instrument behavior and the work steps when the problem occurred.
- Description of what you did when trying to solve the problem yourself.
- Documentation of the third-party products you use in conjunction with the BactoSense.
- Description of operation conditions (place, power supply, measured medium, temperature etc.).
- This user manual.
- Export of the last measurements when the error occurred, see section 10.6.

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