DOC342.52.90554

BOD-System
BOD Direct plus

11/2015, Edition 1

Instruction Manual



IMPORTANT !

Read this entire manual carefully before use!

Carefully read and follow the SAFETY INSTRUCTIONS at the beginning of this manual!

The system may only be used by qualified persons!

Keep this manual for later reference!

Also observe important notices in order to avoid malfunctions and faults.

If possible, save the complete transport packaging for later transport.



Important information

In compliance with the European Directive 2012/19/EC, your electronic device may not be disposed of in the normal household waste! Hach can dispose of your electrical device in a professional and environmentally-responsible manner. **This service (excluding transport costs) is free of charge.** This service is only valid for electrical devices purchased after August 13, 2005. Send the Tintometer devices you want to dispose of freight-paid to your suppliers.

Importance notice for disposal of batteries

In compliance with the battery directives (2006/66/EC), all consumers are obligated by law to return all used batteries and rechargeable batteries. It is forbidden to dispose of batteries in the household waste. Products from our range include batteries and rechargeable batteries in the scope of delivery which is why we point out the following information: Used batteries and rechargeable batteries should not be disposed of in the household waste. They can be taken to the public collection points in your area and to all locations that sell these types of batteries and rechargeable batteries. The end consumer is also entitled by law to return the batteries and rechargeable batteries to the vendors who sold the product (take-back obligation).

Safety instructions

Follow the safety instructions listed here for your own safety!

The safety instructions draw your attention to potential dangers. They also contain information for how you can prevent danger with appropriate conduct.

Use is only permitted for qualified persons.

 **DANGER!**	**DANGER of electric shock!** Only handle the mains adapter with dry hands! Protect the mains adapter from moisture Do NOT open the mains adapter! Do not subject the mains adapter to great force! Do NOT use the mains adapter if there is damage to the housing or the connection contacts! Only use the mains adapter with an appropriate socket intended for this purpose! Ensure that this socket is in fault-free condition! The mains voltage and the mains frequency must always lie within the specified range of the mains adapter.
 **DANGER!**	**DANGER of chemical burns and damage to the eyes!** The KOH accessory is a chemical reagent and is packaged, labelled, and provided with the legally required documents in accordance with the applicable legal regulations. When unpacking, make sure that the bottle is in fault-free condition! Use appropriate protective equipment! Do NOT use damaged bottles! Dispose of the contents in accordance with local legal regulations. When handling this material, observe the safety instructions in the safety data sheets.
 **WARNING!**	**Health hazard** The allylthiourea accessory is a chemical reagent and is packaged, labelled, and provided with the legally required documents in accordance with the applicable legal regulations. When unpacking, make sure that the bottle is in fault-free condition! Use appropriate protective equipment! Do NOT use damaged bottles! Dispose of the contents in accordance with local legal regulations. When handling this material, observe the safety instructions in the safety data sheets.

 **WARNING!**	Reagents are intended for chemical analysis only and must be kept out of the hands of children!
 **WARNING!**	**DANGER due to magnetism!** The magnetic fields can influence parts that are sensitive to magnetic fields, magnetic parts, or metal parts (e.g. data carrying media, pacemakers, watches, etc.). Keep these parts away from the stirrer drive and magnetic stir bars.
 **CAUTION!**	**Breakage of glass. Danger of cutting injuries.** Breakage of glass. Danger of cutting injuries. Despite protection from the transport packaging, breakage of glass can occur during transport. The resulting broken shards may have sharp edges and could cause cutting injuries when handled carelessly. Look out for broken glass when unpacking, and wear protective gloves. When handling the system, always ensure a firm grip in order to avoid breakage of glass! Do not strike the test bottles against edged during transport of the system!
 **CAUTION!**	**The device may not be operated in explosion-prone rooms.** **Health hazard!** Observe the required protective measures when handling the sample! **Health hazard!!** Do not handle depleted batteries or leaking material with bare hands! Wear protective gloves! Avoid contact with the eyes and skin!
ATTENTION!	Only use the supplied mains adapter! If an incorrect mains adapter is used, the EMC protective goals may not be achieved.
ATTENTION!	Please do only use the provided power supply. A wrong power supply can lead to non-compliance with the EMV goals.
ATTENTION!	Never use fats or other lubricants for the BOD sensors or the rubber gasket. Such products can contain solvents that damage the body of the sensors. This might result in heavy damages at the plastic body, and can cause failure of the sensors. We cannot make any guarantee for the usage of sealing greases.

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1 Important information

ATTENTION!

The tolerances / measurement precision specified here only apply for use of the devices in EMC environments in compliance with the basic requirements in accordance with DIN EN 61326-1:2013.

Only use the supplied mains adapter!

Use of an incorrect mains adapter can result in damage to the measurement system and/or the stirrer drive.

Unauthorised modifications of the system can result in measurement errors, danger, and electromagnetic interference. The manufacturer bears no responsibility for the consequences of such modifications.

Do not place hot stirring containers on the stirrer drive. Maximum temperature: 56°C. The stirrer drive can be damaged if this is disregarded.

The device may only be opened by an authorised service location in the case of a repair. Disconnect from the mains before opening!

The test bottles are contained in the measurement system during transport. Make sure that they do not fall to the floor during unpacking.

IMPORTANT INFORMATION!

Do not leave a magnetic stir bar in an alternating magnetic field when it cannot rotate. It can be exposed to a powerful opposing magnetic field. It could be demagnetised as a result.

Observe the permissible environmental conditions as specified in the technical data (see section 12 Technical data).

Avoid extreme temperature changes.

Do not use the mains adapter in damp rooms and do not use it in areas subject to spray water.

If the mains adapter has become wet or damp, do not touch it or the system. De-energise the socket.

Only use the mains adapter for the power supply of a stirrer drive and a measuring unit. If more devices are connected, the system can malfunction.

The length of the magnetic stir bars should not exceed 40 mm. Do not use elliptical stir bars with a round cross-section.

Place the stirrer drive on a horizontal surface with sufficient bearing capacity to support the weight of the stirrer drive and the measurement system with filled bottles. The measurement system can slide off the stirrer platform if it is in an inclined position. Bottles and the system can fall to the floor.

To disconnect the mains adapter, only pull out the secondary cable (15V DC) from the measurement system and and the stirrer drive at the plugs! Otherwise, the cable can be damaged.

Remove the depleted batteries from the device soon in order to avoid leakage.

For periods of extended non-use, remove the batteries from the device as a precautionary measure.

The battery status should be checked regularly, even if the device is normally supplied externally (mains adapter plug), in order to prevent leaks from empty batteries.

The sample may not come into contact with KOH. Otherwise the measurements will be falsified.

The stirrer drive starts automatically as soon as the power supply is connected. Any magnetic stir bars or other magnetic parts nearby can move unexpectedly as a result.

2 Disposal

Disposal of consumable materials, batteries, and, if applicable, the entire system must take place in accordance with local legal regulations.

3 The Measurement System

3.1 Principle of the method

BOD measurement by means of pressure differential in a closed system (respirometric BOD measurement). The measurement system records a measurement every hour on the first day, every other hour on the second day, and once every 24 hours starting on the third day.

3.2 Area of application

BOD_5 measurement, BSB_7 measurement, OECD 301F / biological degradabilty / further bio-technical applications in aqueous solutions. Use by qualified personnel only.

The measuring time is adjustable in daily increments from 1 to 28 days.

3.3 Device view and scope of delivery



Figure 1

- 1 x BOD base unit with integrated bottle rack
- 6 x BOD sensor (material ABS)*
- 6 x BOD bottles
- 6 x seal cup
- 6 x magnetic stir bar
- 3 x battery, alkali manganese (C / LR14)
- 1 x retaining tube for batteries
- 1 x stirrer drive
- 1 x mains adapter + primary adapter plug
- 1 x Y-cable
- 1 x USB cable
- 1 x nitrification inhibitor
- 1 x potassium hydroxide solution (KOH solution)
- 2 x overflow volumetric flasks (157 ml, 428 ml)
- 1 x Allen key
- 1 x operating manual
- 1 x EC Declaration of Conformity

* for non-aqueous samples: check material compatibility with the sample prior to use.

4 Information about the method

4.1 Biochemical Oxygen Demand (BOD)

The biochemical oxygen demand (BOD) in water (e.g. waste water, surface water) is the amount of oxygen that is consumed during the degradation of organic substances through biochemical processes.

4.2 Measuring principle

The BOD measuring unit, comprising test bottle and BOD sensor, is a closed system. With the filled sample quantity, there is a gas compartment with a defined quantity of air in the test bottle. The bacteria in the waste water filled in the bottle (the sample can be used diluted or undiluted) consume the oxygen dissolved in the sample over the course of the BOD measurement. It is replaced by air oxygen from the gas compartment of the test bottle. The simultaneously developing carbon dioxide is chemically bound by the potassium hydroxide in the seal cup of the test bottle. As a result, a pressure drop occurs in the system, which is measured by the BOD sensor and shown in the directly in the display as a BOD value in mg/l O_2.

4.3 Sample preparation / brief summary

WARNING! Observe the SAFETY INSTRUCTIONS at the beginning of the manual!

- Estimate the measurement range of the sample to be tested and the sample volume as indicated in section 6.1.
- If necessary, pre-treat the sample as indicated in 6.2 (e.g. adjust pH value, filtrate)
- Measure the sample volume precisely with the overflow volumetric flask and pour into the BOD bottle (use a funnel, if necessary)
- If necessary, add the nitrification inhibitor as indicated in section 6.1
- Place the magnetic stir bar in the BOD bottle
- Fill the seal cup with 3 - 4 drops of KOH solution and place the seal cup in the test bottle
- Screw the BOD sensors on the test bottles
- Hang the sample in the bottle rack
- Start the test (see section 5)
- Incubate the sample according to specifications (e.g. BOD_5 at 20 °C).

5 Operation

5.1 Keys

① Arrow keys

They are provided mainly for navigation through the menus.

② Head keys

Individual measurement points and/or heads can be selected in the submenus with the head keys.

③ Function keys

The function keys have a different meaning in each menu. Info text above the keys indicates their meaning. If no text is shown above the key, it has no function.

④ Quick selection keys

The quick selection keys take you directly to the corresponding menu each submenu:

Quick selection key 1 ‚Start' --> ‚Start measurement series'

Quick selection key 2 ‚List' --> ‚Display current values'

Quick selection key 3 ‚Graph' --> ‚Display measurement series'

⑤ Number keys

The number keys are used for entering the date, time, and file and head names.

⑥ ON/OFF key

This key is used for switching the device on and off.

⑦ Backspace

Characters which have been entered can be deleted with the backspace key.

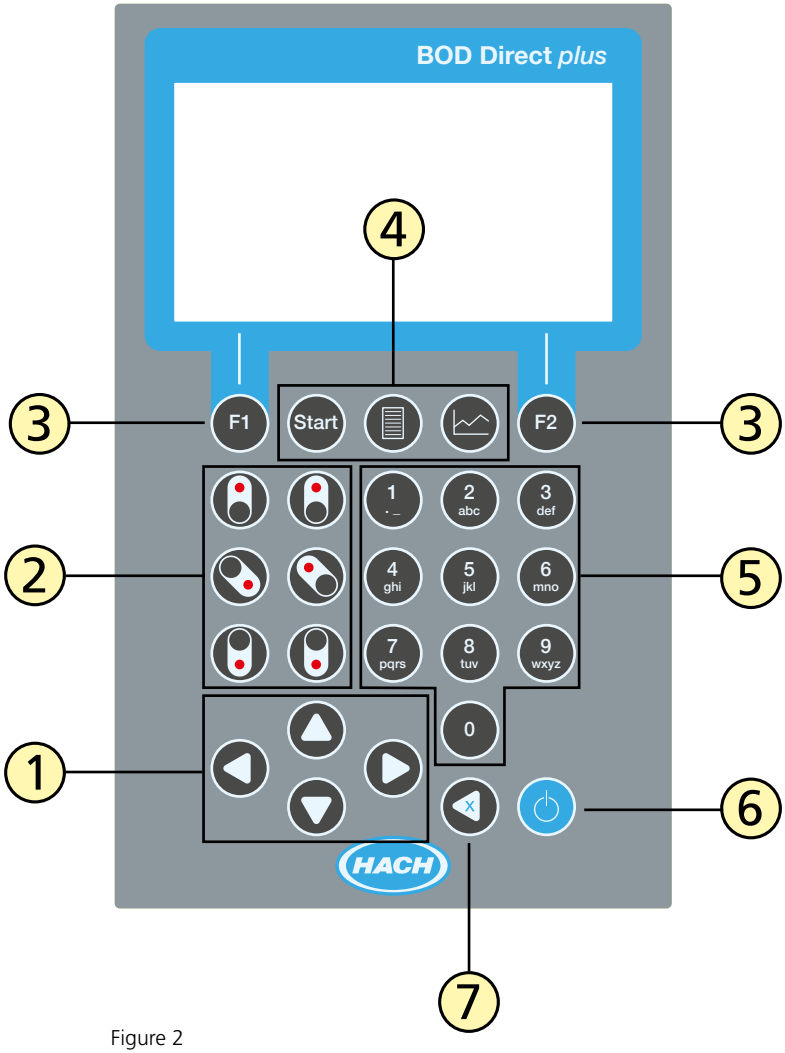
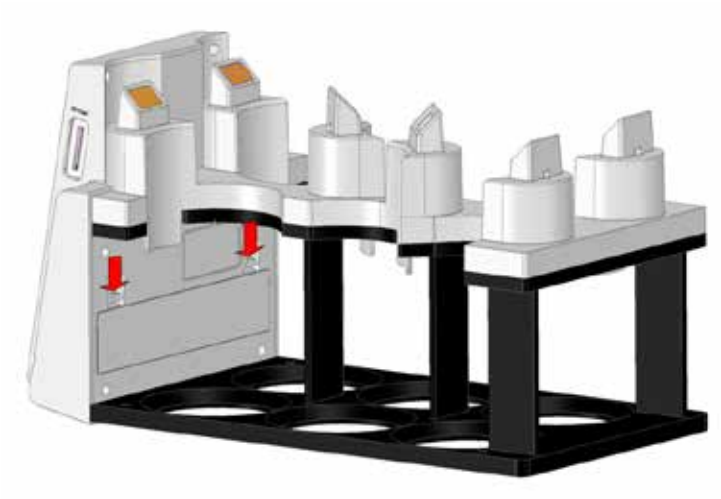

BOD Direct plus
4
3
F1
Start
F2
3
2
1
2 abc
3 def
4 ghi
5 jkl
6 mno
5
7 pqrs
8 tuv
9 wxyz
0
1
6
HACH
7

Figure 2

5.2 Initial commissioning

The device can be supplied with power via the accompanying mains adapter or batteries. If the mains adapter is connected and batteries are inserted, the device is supplied via the mains adapter and the batteries are not used. If the mains adapter is removed during operation, a seamless transition to battery operation takes place automatically.



Remove all bottles from the rack in order to insert the batteries. Open the battery compartment and insert three size C alkali-manganese cells (LR14 / ‚baby cell') in the tubes provided for this purpose. These tubes make it easier to insert the batteries and prevent the batteries from jumping out again when you attempt to close the compartment.

ATTENTION! Insert the batteries in these tubes such that a positive pole always faces a negative pole.



Otherwise, if the battery polarity is reversed it can be damaged and leak and damage the device.

Then insert the batteries with tubes into the battery compartment (ensure correct polarity).

ATTENTION! The device is not designed for rechargeable batteries. Therefore, they must not be used. Rechargeable batteries can be damaged, leak, and damage the device.

The socket provided for the mains adapter (15V DC) is located on the bottom right of the front part of the housing (see also 5.7. ‚Interfaces')

WARNING! Danger of electric shock! Observe the SAFETY INSTRUCTIONS at the beginning of the manual!

Insert the mains adapter in the socket and connect it to the side of the device. The mains adapter can supply the BOD Direct plus measurement system and the stirring device with power via the supplied Y-adapter.

We recommend supplying the device with power via the mains adapter in order to ensure a long battery life.

Press the On/OFF key.

A language selection menu appears for the initial commissioning. Choose the desired language with the up ▲ and down ▼ arrow keys. The selection is confirmed with function key F2 (adopt). You adjust the time and date in the next menu. The four arrow keys and number keys 0 to 9 are used for this purpose. The entry is confirmed with function key F2 (adopt). Now, as with each further start-up, the main menu is displayed. The language and date can be changed hereinafter under options.

5.3 Switching on and off

If the device is switched off, it can be switched on with the ON/OFF key. If the ‚Auto-off' option is activated and no keys/keys are pressed for an extended time, the device switches off automatically in two stages. First the background lighting is switched off and then it switches off completely (if any measurements are still pending, the device is automatically activated at the given time). The device can also be switched off manually with the ON/OFF key.

5.4 Replacing batteries

Switch off the device with the ON/OFF key. Before it switches off, the next menu item is shown, if provided. By this time, the device must be supplied with power via the batteries or the mains adapter; otherwise measurements are lost. Replace the batteries as described under 5.2 ‚Initial commissioning'. Place the samples back in the rack and then switch on the device so that the heads are recognised and the measurements in progress are continued.

5.5 General menu information

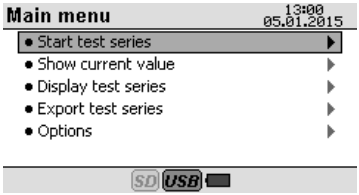


Figure 4

The name of the submenu which the device is currently activated is shown to the left in the header.

The date and time are displayed to the right. The display format for date and time can be adjusted under ‚Options'.

The display area is reserved for the open menu.

Depending on which menu is open, the meaning of function keys F1 and F2 is shown in the footer. If nothing is displayed, the corresponding key has no function.

Three symbols can be seen in the middle. The first two symbols indicate whether the device has recognised an SD card or a USB stick. If the corresponding symbol is grey (e.g. Figure 4, SD), no medium was recognised. The third symbol shows a battery symbol for battery operation (Figure 4) and a plug symbol replaces the battery symbol for mains operation (Figure 5).

5.5.1 Main menu

The following five submenus can be opened from the main menu:

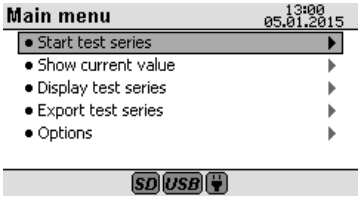


Figure 5

- Start measurement series
- Display current values
- Display measurement series
- Export measurement series
- Options

The preceding or next menu can be selected with the up ▲ and down ▼ arrow keys. The selected submenu is opened with the right ► arrow key.

The first three menu items can be opened from any submenu with the corresponding quick selection key.
Untermenü aufrufen.

5.5.2 Start measurement/measurement series

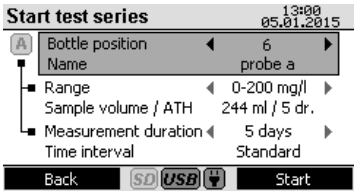


Figure 6

The ‚Start measurement series' menu is divided into three areas ‚Measurement position / name', ‚Measuring range / sample volume / ATH', and ‚Measuring duration / measuring interval'. You can switch between the three areas with the up ▲ and down ▼ arrow keys.

If the A-symbol at the top left of the menu is grey, it means that Autostart mode is deactivated (Figure 6); otherwise it is activated. It can be switched on and off in the ‚Options' submenu (see 5.6 Options, 5.6.1 Autostart).

Measurement position / name: One of the six measurement positions can be selected with the left ◄ and right ► arrow keys or the head keys. The number keys one to six have the same function as the head keys in this menu.

If a head is recognised at the selected measurement position, the measurement parameters and head name are displayed. The LED in the head illuminates continuously.

If you use the arrow keys to switch to the next, measurement positions without heads are skipped.

The displayed measurement parameters and the head name are saved in the head. The parameters of the current and/or last measurement from the selected head are always displayed. The head name can be changed in the ‚Options' menu.

Select the measurement location with the prepared sample.

Measuring range / sample volume / ATH: You adjust the measuring range here. The sample volume required for the measuring range and the quantity of nitrification inhibitor are displayed.

Measuring duration / measuring interval: Specify the measuring duration here.

A measurement is performed with the selected sensor every hour during the first 24 hours, every two hours during the next 24 hours, and once every 24 hours thereafter.

Start the series of measurements with function key F2 (start). The previous measurement results and parameters in the selected head are overwritten in the process.

A corresponding warning message always appears.

Press function key F1 (back) to return to the main menu.

5.5.3 Display current values

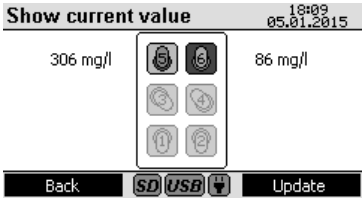


Figure 7

All six measurement positions are displayed with a symbol. The corresponding current value is displayed next to them.

If no head is present, the symbol is completely grey and no current value is displayed (Figure 7, Measurement positions 1 to 4).

If a head is recognised with a completed series of measurements, the symbol is shown as normal and the last measurement value is displayed (Figure 7, Measurement position 5).

If the symbol has a black background, it means that the measurement series is not finished yet (Figure 7, Measurement position 6).

The current value for each measurement position is determined by opening the menu. In order to update all measurements, press function key F2 (update). Alternatively, the head keys can be used to update a specific measurement position.

Press function key F1 (back) to return to the main menu.

5.5.4 Display measurement values

A schematic diagram of all measurement positions is shown to the right in the screen. The grey symbols in Figure 6 for the measurement positions 1 to 4 indicate that no head was found there by the device.

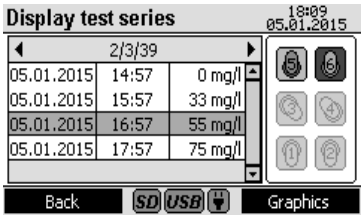


Figure 8

Recognised heads are represented by the symbol for measurement position 5 as shown in Figure 8. In this example, the selected head is in measurement position 8 and its measurements are displayed in the left window.

A different measurement position can be selected with the head keys.

You can switch through the list of measurements with the up ▲ and down ▼ arrow keys.

The information x/y/z, shown in the figure as ‚2/3/39' as an example, can be read in the corresponding header as follows:

x: Selected measurement in the measurement series; the second measurement in this case

y: Number of measurements already performed in the measurement series; three measurements have already been performed in the example

z: Number of total measurements to be performed for this measurement series; 39 in this case

If the warning symbol ⚠ appears here, the measurement series has been ended, although not all measurements have been performed. This can occur for new heads for which a measurement series has not been conducted yet. The eye symbol 👁 indicates that no usable measurement value was recorded for at least one measurement.

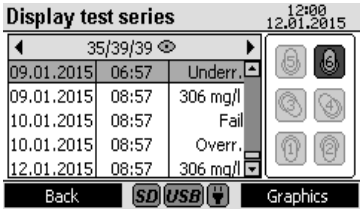


Figure 9

If ‚Underr.' appears instead of the measurement value (abbreviation for underrange, see Figure 9), the recorded measurement value is below the starting measurement value. With ‚Overr.' (abbreviation for overerrange, see Figure 9), the recorded measurement value is outside the measuring range. Fail (see Figure 9) means that no measurement could be conducted for the provided time; e.g. if the sample was removed before the end of the measurement.

Additional information, such as measurement parameters and the head name are displayed in the header with the right ► and left ◄ arrow keys.

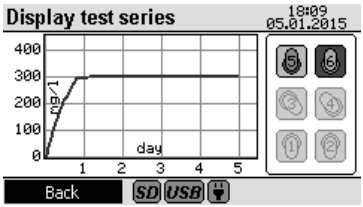


Figure 10

Press function key F1 (back) to return to the main menu.

You can switch to the graphic view with function key F2 (graphic) (Fehler! Verweisquelle konnte nicht gefunden werden.).

Here it is possible to view up to three measurement curves simultaneously. The head keys can be used to select and de-select.

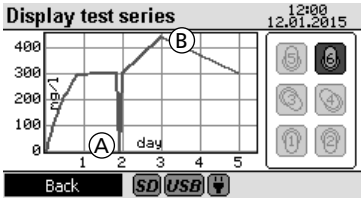


Figure 11

Underrange (A) is shown with zero and **Overrange (B)** is shown with the maximum display value for the measuring range. If a measurement is unsuccessful, the measurement can be ignored, see Figure 11.

You can switch back to the table view with function key F1 (back).

5.5.5 Export measurement series

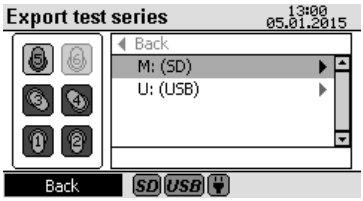


Figure 12

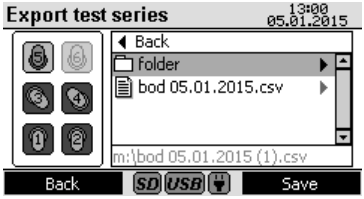


Figure 13

A schematic diagram of the rack can be shown to the left in the screen. Like in the other menus, the grey symbol (Figure 12, measurement position 6) also means that no head was recognised there by the device. In Figure 12 the heads at measurement positions 1 to 4 are selected. A head is present in measurement position 5, but is not selected.

Only the selected heads are considered for an export; they can be selected and de-selected with the head keys.

The window in the right section shows the destination drive. It is possible to save the data to an SD card or a USB stick. Connect the appropriate medium to the device and wait until the corresponding symbol appears in the footer of the display. Select the appropriate medium with the up ▲ and down ▼ arrow keys. Now the contents of the data carrying medium can be displayed with the right ► arrow key.

Basically, folder and file names are only displayed in lower-case letters, because entry is only possible in lower-case letters. Folder and file names with special characters are not displayed. In this case, the warning symbol ⚠ is shown in the top right of the window.

The available folders and files can be selected with the up ▲ and down ▼ arrow keys. If a file has been selected, its contents can be shown with the right ► arrow key. Use the left ◄ arrow key to reach the superordinate folder. The path is always displayed together with an automatically generated file at the bottom in the status bar.

With a selected file, on the other hand, you activate the status bar with the right ► arrow key. The automatically generated file name is then replaced with the selected file.

Now you can change the file name.

Individual characters can be deleted with the Backspace key. The cursor can be moved with the right ► and left ◄ arrow keys. New characters can be entered by pressing the corresponding numerical key repeatedly. You can exit the status bar with the up ▲ and down ▼ arrow keys. The first and/or last entry in the list is then selected with the folder name and/or file name.

If you are at the beginning or end of the list, you can also activate the status bar with the up ▲ and down ▼ arrow keys.

Start the data export with function key F2 (save). The export can take some time, depending on the data quantity. The end of the export is indicated by an info box. Press function key F1 (back) to return to the main menu, as accustomed.

The export file is generated in CSV format. A semicolon is used as a separator. The character set is UTF-8 coded. These parameters must be adjusted in the program with which the export file is opened, e.g. Microsoft® Excel®.

5.6 Options

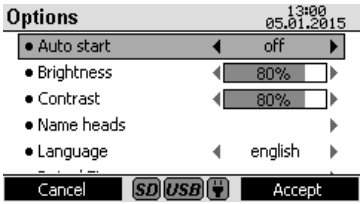


Figure 14

The settings for further submenus, such as ‚Date / time' or ‚Name heads' are saved in the respective submenu. If the menu is exited with function key F1 (cancel), the old settings take effect again. The new settings are permanently adopted with function key F2 (adopt). Pressing the key brings you back to the main menu.

The settings for further submenus, such as ‚Date / time' or ‚Name heads' are saved in the respective submenu.

5.6.1 Autostart

The device's autostart function can be switched on and off here. In order to ensure correct temperature adjustment of the samples, when autostart is activated the device waits until a slight pressure drop in the bottle after start-up. This pressure value is taken as a start value for the later BOD calculation.

In this connection, a maximum wait time of approx. three hours is specified, after which the device automatically uses the current pressure value, even if no pressure drop has been detected.

Use of the autostart function is not a substitute for proper temperature control of the sample before the beginning of the measurement. If BOD samples are tested, whose temperature fluctuates greatly from the setpoint temperature, an error in determining the BOD value arises due to the pressure change.

5.6.2 Brightness

The background lighting for the display is adjusted here in 10% increments from 0% to 100%.

5.6.3 Contrast

The contrast for the display can be adjusted here in 10% increments from 0% to 100%.

5.6.4 Naming heads

An additional submenu can be opened with this menu item (Figure 15).

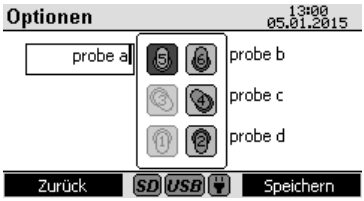


Figure 15

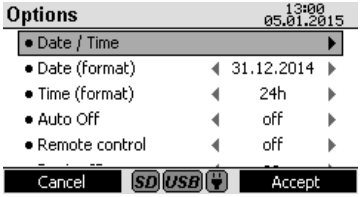
The rack is shown schematically in the middle. In Figure 15 no heads have been recognised at the measurement positions 1 and 3, unlike the other heads. The head at measurement position five is selected. The corresponding names are next to the heads. The name can be changed with the number keys, right arrow ►, left arrow ◄ and backspace. The name of the selected head is saved with function key F2 (save). The head buttons can be used to switch between the heads. Press function key F1 (back) to return to the ‚Options' menu.

5.6.5 Language

The desired language can be set here. The change does not take effect until function key F2 (adopt) is pressed.

5.6.6 Date / Time

ATTENTION. Date and time should not be changed before all measurement series have been completed. Otherwise, the measurement series does not progress correctly under certain circumstances.

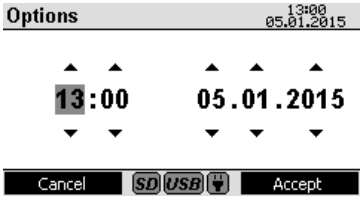


A dedicated submenu is provided to change the date and time (Figure 16).

The four arrow keys and number keys 0 to 9 are used in this case. The changes can be adopted with function key F2 (save). You can reach the ‚Options' menu with function key F1 (cancel) without adopting the changes.

Figure 16

5.6.7 Date (format)



The date format of the header and the ‚Date/time' submenu is adjusted with this menu item. The following variants are possible:

- TT.MM.JJJJ / 31.12.2014
- MM.TT.JJJJ / 12.31.2014
- JJJJ.MM.TT / 2014.12.31

Figure 17

5.6.8 Time (format)

The time format of the header and the ‚Date/time' submenu is adjusted with this menu item. The following variants are possible:

- 12h
- 24h

5.6.9 Auto-Off

The device can be switched off independently after three, five, or ten minutes.

The background lighting is already switched off ahead of time. The times are always based on the last actuation of a key/key. If auto-off is deactivated, the device does not switch off independently.

5.6.10 Update

In this field, the current version number of the operating software can be seen.

You need the ‚bod.hex' file on a USB stick or an SD card for an update. In the process, the file must be in the root directory of the data carrying medium - in other words, it may not be in a subfolder, otherwise it will not be found by the device.

If both an SD card and a USB stick with such a file are inserted, the file on the SD card is used.

For security reasons, updating is only possible in mains operation, so depleted batteries cannot interfere with the update.

Ensure that both conditions are met and start the update with the right arrow ► key. A security query follows. Confirm this with function key F2 (OK). Now the boot loader which performs the update starts up. The device then restarts.

5.7 Interfaces



Figure 18

① **SD card holder**

② **USB host interface**

NOTE! The USB host interface is only intended for USB sticks. USB hubs, external hard disks, and adapter sticks (e.g. USB SD card adapters) are not supported. Battery operation entails the limitation that the host interface can only provide 200 mA.

③ **USB device interface**

The USB device interface is located under the USB host interface on the side of the front section of the housing. It makes it possible to access data saved on the SD card with a PC.

For this purpose, connect the device to a PC via the appropriate USB cable. The device must be switched on. If necessary, deactivate the auto-off option. If there is an SD card in the card holder, the device appears as mass storage on the PC.

④ **Connection jack for the mains adapter**

5.8 Error messages and notices

Message in the display	Meaning
RTC Error! Please set the date and time again.	The message appears when the device is switched on and the RTC (real-time clock) has forgotten its time. Adjust the time in the following menu and then check all pending measurements.
LOBAT!	This appears just before the device switches off on its own. Replace the batteries.
USB-Host overcurrent! Remove the USB device.	This message appears if a short-circuit has occurred at the USB host port. Remove the USB device.
Incorrect head ID! The measurement series was not started!	This appears at the start of a new measurement series when a different head was found at the selected measurement position than for the reading of measurement parameters.
Communication error! The measurement series was not started!	This appears when a new measurement series is started, if there is no head available at the selected measurement position.
The battery level is low!	This appears when a new measurement series is started, if the batteries are nearly depleted. Replace the batteries or connect the mains adapter. The measurement series can still be started.
The current measurement series will be overwritten!	The current measurement series will be overwritten!
Internal processing error! The measurement series was not started!	This appears when a new measurement series is started, if the displayed measurement parameters cannot be correctly interpreted. Change the measurement parameters back to the previous parameters. Then restart measurement series.
Start error! Please restart the measurement series!	This appears when a new measurement series is started, if the measurement could not be started. Check the contacts at the head and the measurement position. Restart the measurement series.
The measurement series was started.	Note. This appears if a measurement series was started successfully.

Updates are only possible in mains operation.	This appears if an update is started from the Options menu and the mains adapter is not connected.
The update file ‚bod.hex' was not found.	This appears if an update was started from the Options menu and the file ‚bod.hex' cannot be found on the SD card or the USB stick.
Do you really want to start the update?	Security query. This appears if an update is started from the Options menu and no errors have occurred.
No head was selected!	This appears on data export, if the export is started and no head was selected.
The medium is write-protected!	This appears on data export to the SD card, if it is write-protected. Remove the write protection.
The path or file name is invalid!	This appears on data export if the path or file name is invalid. Enter a new path and/or file name.
The file already exists. Would you like to replace it?	This appears on data export when an attempt is made to overwrite an existing file.
The file was saved.	Note. This appears after a successful data export.
Communication error! Error when saving!	This appears after an unsuccessful data export. Carry out the export again. Ensure that there is sufficient memory available on the medium and that the device may write to the folder.
Incorrect head ID!	This appears when saving the head name, if a different head was found at the selected measurement position than for the reading of measurement parameters.
Communication error! The name was not saved!	This appears when saving the head name, if there is no head available at the selected measurement position.
The name was saved.	Note. This appears if the head name was saved successfully.
Adjusting the time while measurement series are in progress can falsify the correct measurement times!	This appears as a warning if you attempt to adjust the date and time in the options, because errors can occur when measurement series are in progress.
Communication error! Error when saving the options!	This appears when options are adopted, if they could not be saved successfully. Switch off the device, wait at least 10 seconds, and then switch on the device again. Repeat the settings and attempt to adopt the options. If the message appears again, there is a defect in the device. In this case, contact customer service.

6 Determining the BOD

WARNING! Observe the SAFETY INSTRUCTIONS at the beginning of the manual. DANGERS can arise from the sample, the KOH, and the nitrification inhibitor!

6.1 Selection of sample volume

The BOD value of the sample to be expected determines the volume used. A BOD measurement range (without dilution of the sample) from 0 – 4000 mg/l arises from this.

BOD range in mg/l	Sample volume in ml	Nitrification inhibitor ATH dosage
0 – 40	428	10 drops
0 – 80	360	10 drops
0 – 200	244	5 drops
0 – 400	157	5 drops
0 – 800	94	3 drops
0 – 2000	56	3 drops
0 – 4000	21,7	1 drops

The measurement range should be chosen such that the results to be expected are in the upper half of the measurement range. If the BOD value to be expected is unknown, it can be assumed for the household waste water that the BOD5 value to be expected corresponds to approximately 80% of the COD value.

6.2 Preparation of the water sample

1. Test the pH value of the waste water sample. The ideal pH value lies between pH 6.5 and 7.5. Any greater deviation provides a lower BOD value. If a pH value is too high, it can be neutralised with diluted hydrochloric acid (1 molar) or diluted sulphuric acid (1 molar), and if the pH value is too low, it can be neutralised with a sodium hydroxide solution (1 molar).
2. Depending on the specifications, the water sample must be mixed well, briefly allowed to settle, and filtered or homogenised.
3. Measure the exact necessary sample quantity (see 6.1) with the appropriate overflow volumetric flask and add to the test bottle (use a funnel as necessary). Specified sample volumes must be filled very precisely. Otherwise major measurement errors can occur. IN the process, ensure the even distribution of particulate matter. We recommend performing a double or triple test for each sample. Different results can be expected for the same samples with different shares of particulate matter. The measurements should be repeated if there are greater variations.
4. For the suppression of nitrification, we recommend adding nitrification inhibitor B. This should especially be taken into consideration in the low measurement range of 0 - 40 mg/l, e.g. for final effluent. The recommendation for an optimal dosage of nitrification inhibitor B (=allylthiourea / ATH) depends on the measurement range (see 6.1 Selection of sample volume).

Comment: Nitrifying bacteria also consume oxygen. This consumption can already occur within the first five days, especially in samples with low BOD values. For the BOD testing the oxygen consumption of nitrifiers is not normally recorded. With nitrification inhibitor B, the activity of these bacteria can be suppressed by means of enzymatic suppression such that only the degradation of organic substances constitutes the BOD of a sample. If the oxygen consumption in the course of the nitrification (N-BOD) should be determined, a comparison of the sample with and without nitrification inhibitor can be The difference between BOD values then corresponds to the oxygen requirement of the nitrifying bacteria.

5. Add a clean magnetic stir bar to each test bottle and fill the dry seal cup with 3-4 drops of 45% potassium hydroxide solution (for binding of the carbon dioxide). Then place the seal cup in the test bottle.

ATTENTION! The sample may never come into contact with the potassium hydroxide solution. This could result in falsified measurement values.

ATTENTION! Never use greases or other lubricants as an additional sealing aid for the seal cups for the BOD sensors. Such products can contain solvents which corrode the body of the sensors. This can result in severe damage to the plastic housing or even complete destruction of the sensors. No warranty is accepted for damages resulting from the use of sealing grease!

6. The prepared sample must be brought to ± 1 °C of the desired temperature before the start of the measurement. (e.g. 20 °C ± 1 °C). This can be take place, for instance, with constant stirring of the sample on the inductive stirring system in the thermostat cabinet.

   The BOD Direct plus has an optional autostart function which allows the use of samples with a temperature of 15 to 21 °C. With the autostart function switched on, the system checks in specific intervals whether a pressure drop has taken place in the BOD bottle and then starts the time measurement (the time begins running no later than three hours after the BOD sensors is started, regardless of whether a pressure drop has been detected or not).

7. Place the BOD sensors on the test bottles and carefully screw them in place. This is especially important, because the system must be absolutely tight. Then place the BOD bottle with sensor screwed on in the bottle rack. This can take place directly in the thermostat cabinet. Alternatively, due to the user-friendly design of the BOD Direct plus, it is also possible to remove the entire BOD base unit with the integrated bottle rack from the thermostat cabinet, while the inductive stirring system remains in the cabinet. In the process, it may be necessary to disconnect the mains power supply from the BOD Direct plus.

ATTENTION! Do not pull on the cable.

   After the rack has been loaded with BOD bottles, it must be positioned on the inductive stirring system such that the 4 adjusting screws engage in the corresponding recesses on the stirrer drive.

8. Start the test (see section 5.5.2 Start measurement/measurement series)
9. Incubate the sample according to specifications (e.g. BOD5 at 20 °C for 5 days).

7 Instructions for evaluation of results

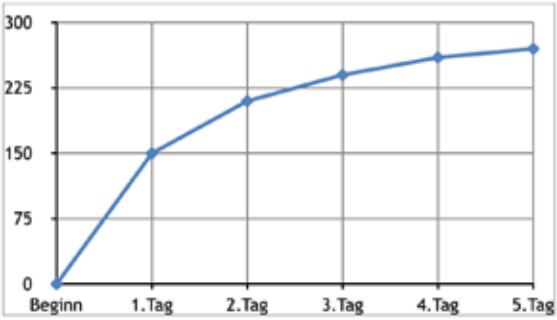


Figure 21, typical BOD curve

1. The BOD measurement values must always be higher than on the preceding day.
2. The BOD measurement values do not increase linearly. The increase is always smaller than on the preceding day.
3. If the BOD measurement values increase linearly, the sample has a higher BOD value than was to be expected when the sample was prepared.
4. If the BOD measurement values should suddenly rise drastically during the measurement, it may be an indication of nitrification.
5. If the BOD measurement values fall during the measurement, the system may have become leaky.

   The previous specifications and explanations always relate to regular samples (municipal waste water) and normal behaviour of the bacteria over the course of a BOD measurement. However, special cases are always possible and occur on the basis of the respective circumstances. For instance, a zero indication after 5 days may be indicative of a leaky system or heavy suppression. Industrial waste water is often subject to special circumstances. For instance, it may contain toxic substances. These must be entirely eliminated from the sample or the sample must be diluted; otherwise the measurement results are too low. Nutrients (nitrogen, phosphate), and trace elements (e.g. iron) must also be available in a sufficient concentrations; otherwise growth limitations of the bacteria and thus false low BOD readings can occur. Insofar as such problems occur during the BOD measurement, they must be addressed and resolved on an individual basis.

8 Maintenance and care

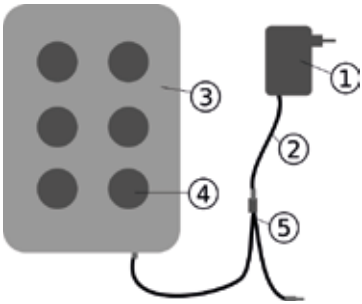
High-quality metal alloys are used for the contacts between the BOD sensors and the bottle rack. Carefully clean the contacts as necessary with a soft cloth.

To smooth out any unevenness, for optimisation of the contact between the BOD sensor and bottle rack, and for optimisation of the stirrer position, the BOD base unit has 4 adjusting screws on the bottom.

Carefully clean the BOD base unit (including bottle rack) and the BOD sensors as necessary with a dry cloth.

The parts coming into contact with the samples (BOD bottle, seal cup, magnetic stir bar) must be carefully cleaned after each test. Empty the bottles after the testing is complete – observe local regulations in the process – and rinse out repeatedly with hot water. **Rinse thoroughly after using cleansers!** Residue from cleansers can destroy the BOD test.

9 Inductive stirring system



① Mains adapter
② DC connection cable
③ Stirrer drive
④ Stirring position
⑤ Y-cable

Figure 22, stirrer drive, mains adapter, Y-cable

9.1 Device description and functional description

The inductive stirring system is designed for the stirring of liquids in special BOD bottles. It comprises a super-flate stirrer drive with 6 stirring positions and the mains adapter. The inductive stirrer drive does not have a motor and is thus wear-free. It is especially well-suited for stirring during continuous operation in thermocabinets. It is completely protected from dripping water due to its hermetically sealed encapsulation. It can be used in harsh environmental conditions.

The wide recess between the stirring positions also ensures greater ventilation of the containers in the thermocabinet. The stirrer drive is supplied with power via the mains adapter and has integrated control electronics. When switched on, a soft-start at reduced speed assures an even start-up and centring of the magnetic stir bars.

The electronically controlled automatic monitoring unit reduces the speed about every 40 seconds. In the process, each magnetic stir bar is re-centred in the bottle for a few seconds. Therefore, you can easily exchange individual bottles while the unit is switched on.

Due to the synchronous operation, mutual interference of the magnetic stir bars can be practically ruled out altogether.

10.2 Commissioning

WARNING! Observe the SAFETY INSTRUCTIONS at the beginning of the manual.

DANGER! Electric shock.
Only use the mains adapter with dry hands! Only use the mains adapter in dry rooms! Do not use the mains adapter if it is damaged! Only use the mains adapter in undamaged sockets which are suitable for this purpose! Only use the mains adapter with a primary voltage and frequency which match the technical specifications of the mains adapter!

DANGER! Magnetism
The magnetic fields can influence parts which are sensitive to magnetic fields, magnetic parts, or metal parts (e.g. data carrying media, pacemakers, watches, magnetic strips, etc.). Keep these parts away from the stirrer drive and magnetic stir bars.

ATTENTION! The device may not be operated in explosion-prone rooms.

ATTENTION! Observe the permissible environmental conditions.

NOTE! The mains adapter and the stirrer drive do not have an ON/OFF switch. The system is ready for operation as soon as it is plugged into the mains socket.

Connect the DC connection cable of the mains adapter with the supplied Y-cable. Insert on of the Y-cable plugs into the power supply socket of the stirrer drive. The second branch of the Y-cable is intended for power supply of the measurement system. Plug the mains adapter into a suitable socket.

In order to ensure smooth stirring operation, it may be necessary to adjust the screws on the bottle rack.

9.3 Magnetic stir bars

Use the PTFE covered magnetic stir bars included in the scope of delivery.

NOTE: The length of the magnetic stir bars should not exceed 40 mm.

9.4 Stirring

ATTENTION! Do not place hot containers on the stirrer drive; maximum temperature: 56 °C.

Fill the BOD bottles.

Place a magnetic stir bar in each bottle.

Place the BOD bottles in the rack.

9.5 Maintenance and cleaning

The stirrer drive is maintenance-free.

The magnetic drive is installed inside the housing to ensure that it is waterproof.

Clean the surface of the stirrer drive regularly. The stirrer drive can be cleaned with cleansers or disinfecting solutions which are suitable for PVC. Wipe off the surface of the mains adapter with a dry cloth.

ATTENTION! The device may only be opened by an authorised service location in the case of a repair. Disconnect the device from the mains before opening!

9.6 Errors

- **The magnetic stir bars rotate increasingly unevenly.**

  It is possible that the magnetic stir bars age over the course of time. Their magnetisation decreases as a result.

  ATTENTION! Do not leave a magnetic stir bar lying in a magnetically alternating field when it cannot rotate. Do not subject it to a powerful opposing magnetic field. The bar can be demagnetised as a result.

  The magnetic stir bar moves in a rocking motion.

  A rocking motion of the magnetic stir bar may also be due to an irregularly shaped interior bottom of the stirring container. This can arise, for instance in BOD test bottles with a concave bottom, or if the bottom is irregularly or asymmetrically shaped.

  Sort out and replace such stirring containers.

  We recommend the BOD bottles individually (order no. 418644) or in a set of six (order no. 418645).

10 Decommissioning

Disconnect the external power supply from the unit in order to decommission the system. Disconnect the mains adapter plug from the mains supply. Remove batteries from the measurement system. Remove seal caps from the test bottles and clean in the correct manner. Empty and clean test bottles correctly. Clean sensor heads. Store the stirrer drive and magnetic stir bars in a manner such that no hazards arise for parts which are sensitive to magnetic fields.

ATTENTION! Observe the SAFETY INSTRUCTIONS at the beginning of the manual. Observe the local legal regulations for all emptying and cleaning.

11 Technical data

11.1 BOD Measurement System

Type	BOD Direct plus
Measuring principle	Respirometric; electronic pressure sensor
Measurement ranges [mg/l O_2]	0 40, 0 80, 0 200, 0 400, 0 800, 0 2000, 0 4000
Applications	BOD_5, BOD_7, OECD 301 F, etc.
Display	Graphic display, 16 grey levels, 240 pixels wide, 128 pixels high
Automatic measurement buffer	First day - hourly Second day - every 2 hours Third day and later - every 24 hours
Autostart	Can be switched off; controlled by pressure drop in the bottle
Power supply, batteries	3 alkali-manganese cells, type C / LR14
Power supply, external	15 V DC via supplied mains adapter plug, low-voltage barrel connector, max. power requirement 600 mA
Time	Real-time clock, supported by the batteries if the device is not provided with an external power supply
Interfaces	USB host (only for USB stick), USB device, SD card
Dimensions, without stirrer drive, W x D x H	182 mm x 376 mm x 213 mm
Weight, with batteries and empty bottles, without mains adapter plug and stirrer drive	4139 g
Environmental conditions	2 – 40°C, 5 – 80 % relative air humidity, non-condensing
Test approvals, EMC	CE, EMC in accordance DIN EN 61326, basic requirements

11.2 Stirrer unit

Type	Inductive stirring system
Number of positions	6
Stirring output	7 W
Speed	320 rpm, brief centring phase every 40 s
Dimensions (W x D x H) [mm]	270 x 180 x 25
Stirring position spacing	88 mm
Weight (stirrer drive)	1960 g
Housing material	PVC
Environmental conditions	-10°C to +56°C, 95 % relative air humidity
Operating voltage	15 V DC
Protection class	IP 68
Test approvals, EMC	CE, DIN EN 61326:2013

11.3 Mains adapter

Type	SWP1502300P
Design	Mains adapter plug, switching power supply
Input voltage, frequency	100 – 240 V, 50 / 60Hz
Input current	1500 mA
Primary adapter	Europe, UK, Australia, USA
Protection class	II
Output voltage, frequency	15 V, DC
Max. output current	2300 mA
Output protection	Short-circuit-proof
DC cable length approx.	1800 mm
Environmental conditions	0°C to 40°C, with max. 93 % relative air humidity
Energy efficiency class	V
Safety standard	EN 609501
EMC	EN 55022
Dimensions [mm]	62 x 84 x 53
Weight, with EU adapter	258 g
Approval, EMC	CE, EN 55024

12 Accessories and spare parts list

Article	Order code
Spare BOD sensor	LZQ172
Y-cable BOD Direct plus	LZQ173
Mains adapter plug	LZQ079
Inductive stirrer drive, with mains adapter	LZQ077
Potassium hydroxide solution, 50 ml	23032
Nitrificaiton inhibitor B, 50 ml	LZQ087
BOD bottle	LZQ081
Seal cap	LZQ089
Magnetic stir bar	LZQ084
Overflow volumetric flask, 428 ml	LZQ083
Overflow volumetric flask, 157 ml	LZQ082
Thermostat cabinets	LZQ080

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