BYK

byko-visc RT

Rotational Viscometer

Operating Manual

A member of ALTANA

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Introduction

Dear customer,

Thank you for deciding to use a BYK-Gardner product. BYK-Gardner is committed to providing you with quality products and services. We offer complete system solutions to solve your problems in areas of color, appearance and physical properties. As the basis of our worldwide business, we strongly believe in total customer satisfaction.

Therefore, in addition to our products, we offer many VALUE-ADDED services:

- Technical Sales Force
- Technical and Application Support
- Application and Technical Seminars
- Repair and Certification Service

BYK-Gardner is part of ALTANA AG and a direct subsidiary of BYK, a leading supplier of additives for coatings and plastics. Together, we offer complete and unique solutions for you, our customer.

Thank you for your trust and confidence. If there is anything we can do better to serve your needs, do not hesitate to let us know.

Your BYK-Gardner Team

https://www.byk-instruments.com

1.1 For Your Safety

CAUTION: Familiarization with safety instructions necessary

Failure to read and understand the safety instructions threatens your health and can damage the instrument. Read the safety instructions before you use the instrument the first time.

The safety instructions are part of the delivery content. You find the safety instructions in the dedicated booklet enclosed to the instrument carrying case.

The safety instructions also include information about disposal, liability and copyright.

WARNING: Injuries possible

This manual cannot address all of the safety considerations associated with its use. It is the responsibility of the user to consult this manual and establish appropriate safety practices for use with this equipment and the individual material being tested.

The byko-visc viscometers are designed and intended for the use described in the manual. Using the viscometer for other purposes for which it was not designed may reduce or eliminate the protection offered by the features of the device. Serious injury may result.

This instrument is not intended for use in a potentially hazardous environment or with materials that may release toxic or flammable gases at the temperatures encountered during testing.

Never defeat the ground conductor or operate the equipment in the absence of a suitably installed ground conductor. Contact the appropriate electrical inspection authority or an electrician if you are uncertain that suitable grounding is available.

WARNING: Severe material damage

Only devices meeting the requirements for low voltage safety may be connected to the USB interface.

1.2 Symbols

The label on the instrument contains the following symbols.

Do not dispose of this product together with your household trash. Please refer to the information of your local community or contact our dealers regarding the proper handling of end-of-live electric and electronic equipment. Recycling of this product will help to conserve natural resources and prevent potential negative consequences for the environment and hum health caused by inappropriate waste handling.

Read the instruction manual before operation.

The manufacturer or importer affirms the good's conformity with European health, safety, and environmental protection standards. Details see Declarations 11.

This symbol denotes the TUV certification mark for the United Kindom and the European Union.

This symbol denotes the TUV certification mark for Canada and the United States.

1.3 Disclaimer

Exclusion of Liability

No liability other than as provided by law is assumed for direct or indirect damage sustained in association with the use of the instrument, the software or documentation.

BYK-Gardner precludes all liability claims if the usage described in "Intended Use" is disregarded. Any other usage than described in "Intended Use" is not according to the purpose of the instrument and leads to termination of liability claims.

See also

- Intended Use 13

1.4 Copyright

Specific properties and structural characteristics of the instrument are intellectual property of BYK-Gardner. The copyright of this manual remains with BYK-Gardner.

This document must not be reproduced fully or in party, published or used for any other competitive purposes, no matter whether against payment or not, without prior written authorization from BYK-Gardner.

BYK-Gardner reserves the right to update the instrument, software and written documentation without prior notice.

1.5 Declarations

1.5.1 Declaration of Conformity (EU)

We,

BYK-Gardner GmbH

Lausitzer Strasse 8

D-82538 Geretsried

declare, that the instrument **byko-visc RT** complies with the requirements of the following directives:

- 2014/30/EU - Electromagnetic Compatibility (EMC)
- 2014/35/EU - Low Voltage

The following harmonized standards were applied:

- EN 61010-1:2010/A1:2019 - Safety Requirements
- EN 61326-1:2013 - EMC Requirements

Geretsried, July 2024

Dr. Jörg Krames

President • BYK-Gardner GmbH

1.5.2 Declaration of Conformity (UK)

Hereby,

BYK-Gardner GmbH

Lausitzer Strasse 8

D-82538 Geretsried

declares, that the products of type **byko-visc RT** comply with the requirements of the following directives:

- S.I. 2016/1091 - Electromagnetic Compatibility (EMC)
- S.I. 2016/1101 - Low Voltage

The following harmonized standards were applied:

- EN 61010-1:2010/A1:2019 - Safety Requirements
- EN 61326-1:2013 - EMC Requirements

Geretsried, July 2024

Dr. Jörg Krames

President • BYK-Gardner GmbH

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System Description

The byko-visc RT is a benchtop viscometer which is operated by the touch screen. The power button - used to switch on the instrument - is located on the rear of the instrument above the power connector. Using the touch screen display icons and functions can be selected directly. The instrument can be used to repeatably measure viscosity of many types of liquid samples in the laboratory and in production.

2.1 Intended Use

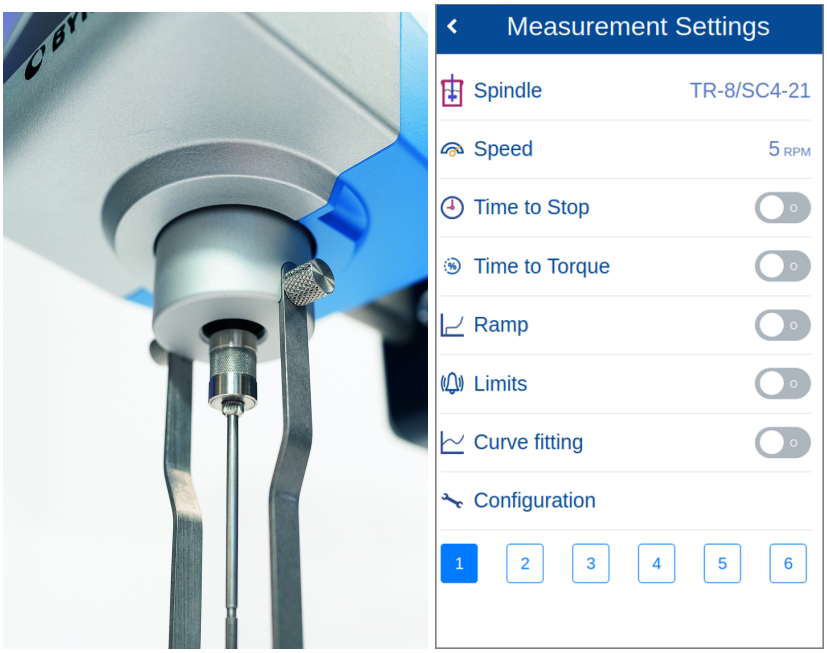
Thank you for acquiring your new byko-visc RT viscometer from BYK-Gardner.

The byko-visc RT is a rotational viscometer, based on the measurement of the torque of a rotating spindle in a sample at a specified velocity. Three different available spring torques, as well as various accessories, allow it to cover a wide range of viscosity measurement.

The instrument is designed for indoor use. For supported functions see Feature Matrix 15.

2.2 Measurement Principle

The instrument uses a precise stepper motor drive to rotate a specially designed spindle at a specific RPM in a sample of liquid. A torque spring is connected between the spindle immersed in the sample and a sensor system to determine the amount of torque required to rotate the spindle through a sample. The torque requirement can then be used to calculate the viscosity of the sample.



The touchscreen display allows user interaction with the instrument and the display of measurement results. Results can also be saved and transferred to a USB thumb drive for importation into Microsoft Excel on a PC for further data analysis.

2.3 Feature Matrix

The BYK-Gardner byko-visc RT product family offers a wide range of high quality benchtop viscometers. For every purpose the best instrument is available. The byko-visc RT product group offers the premium models. The byko-visc RT Lite product group offers the economic models.

	byko-visc RT	**byko-visc RT Lite**
Low viscosity Regular viscosity High viscosity	8356: byko-visc RT L 8357: byko-visc RT R 8358: byko-visc RT H	8350: byko-visc RT Lite L 8351: byko-visc RT Lite R 8352: byko-visc RT Lite H
Measurement range	Low: 1(*) - 6,000,000 cP Regular: 5(*) - 40,000,000 cP High: 300 - 320,000,000 cP (*) With Low Viscosity Adapter (LVA) accessory	Low: 1(*) - 2,000,000 cP Regular: 5(*) - 13,000,000 cP High: 300 - 106,000,000 cP (*) With Low Viscosity Adapter (LVA) accessory
Spindles included	byko-visc RT L: 4 byko-visc RT R: 6 byko-visc RT H: 6	byko-visc RT Lite L: 4 byko-visc RT Lite R: 6 byko-visc RT Lite H: 6
Speed range	0.1 to 250 rpm	0.3 to 200 rpm in 21 steps
No. of speeds	Freely selectable within speed range	21
Repeatability	0.2%	0.2%
Accuracy	1.0% of full-scale range	1.0% of full-scale range
Preset memory	6 memory locations for measurement settings presets	-
Measurement mode	Multi-point	Single-point
Measurement features	Curve Fitting, Multi-Step Ramp, QC Limits, Time to Stop, Time to Torque	Time to Stop, Time to Torque
Data display features	Current viscosity, torque, temperature, graph and table over time	Current viscosity, torque, temperature
Temperature measurement	PT100 temperature probe	PT100 temperature probe (optional)
Product image		

For more product details see Technical Data 68 or on our website: https://www.byk-instruments.com/c/1535#1896.

3

Getting Started

The entire system consists of instrument, power supply and a set of spindles.

3.1 Delivery Content

The items listed below are contained in the packaging:

- Rotational viscometer instrument mounted to adjustable stand
- 4 spindles for L spring models, 6 spindles for R and H spring models
- Temperature probe (standard on RT, optional accessory on RT Lite)
- Documentation: Safety Instructions and Short Instructions
- Certificate with instrument calibration data
- External power supply
- Spindle storage rack
- Spindle guard

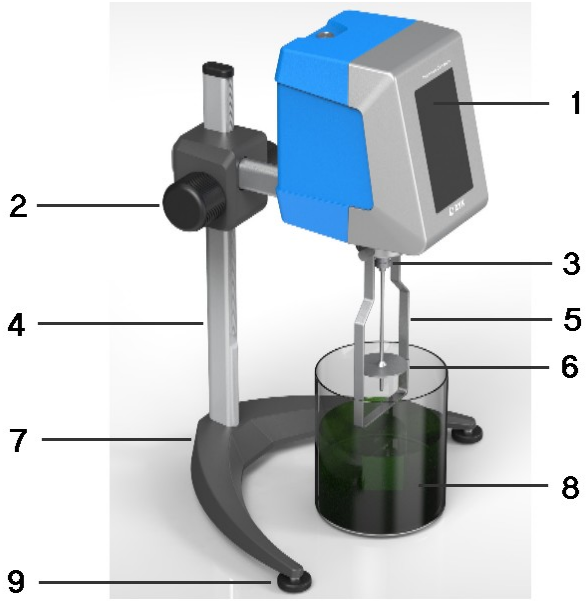
Please contact BYK-Gardner if any item is missing or damaged.

NOTICE

Retain the packaging in case you want to ship the instrument at a later date.

3.2 Control Elements

Control of the instrument is provided by following elements.



1 Touch-screen display

2 Adjustable stand:

- Knob for vertical adjustment
- Lock for horizontal adjustment

3 Spindle attachment (protective cap removed)

4 Support rod for stand

5 Spindle protector (form depends on model)

6 Spindle

7 Base for stand

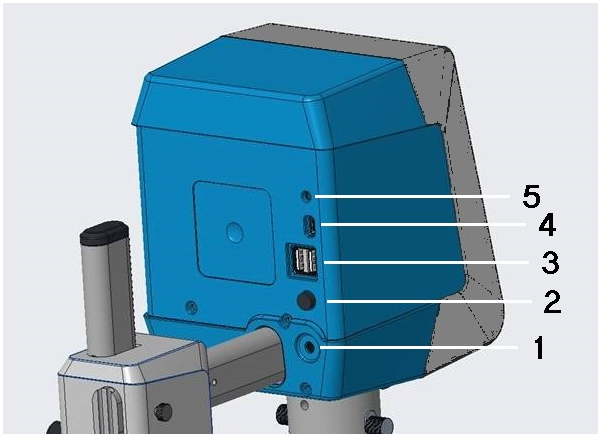
8 Sample container(*)

9 Adjustable feet (3x)

(*) Not included, recommended: 600 mL low form glass beaker (see Spare Parts 67)

3.3 Viscometer Head

On the back of the viscometer head following controls / connectors are provided.



1 External power supply

2 Power button: Power on and off

3 USB Type A:

- USB flash drive
- USB printer (or vice versa)

4 USB Type C: PC communication(*)

5 Temperature probe

(*) Not used yet, foreseen for upcoming firmware versions

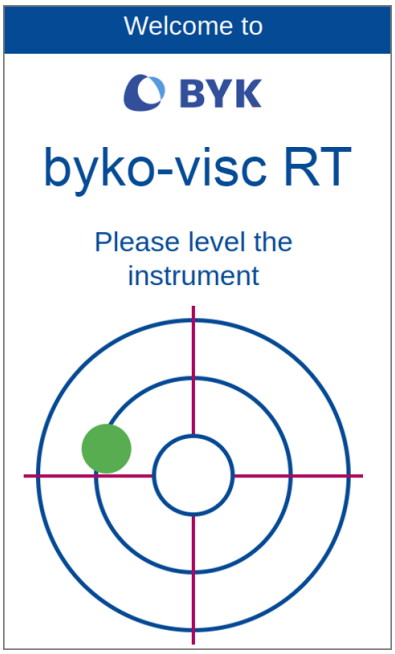
NOTICE

Before switching off the instrument always return to the Main Menu 20 to save all data. In order to turn off the unit press the power button (2) and the unit will shut down. After switch off always wait 30 seconds before you switch on again. To disconnect the unit from the power source unplug the external power supply from (1).

3.4 Instrument Set-up

Perform following steps:

1. Place the viscometer in a suitable location.
2. Turn protective cap clockwise to access spindle attachment.
3. Attach the desired spindle.
4. Plug the power supply into a mains outlet and plug the output cable into the back of the viscometer head.
5. Turn instrument on with the power button located on the back of the viscometer head.
6. A level check takes place; use the adjustable feet to level the instrument.
7. A message appears when instrument is leveled.
8. After a few seconds the main menu is displayed.



CAUTION!

To avoid damage of the precise mechanic: Always remove the spindle and attach the protective cap before moving the instrument.

3.5 System Operation

The instrument is operated using the icons on the touch-screen display to select functions and configure settings.

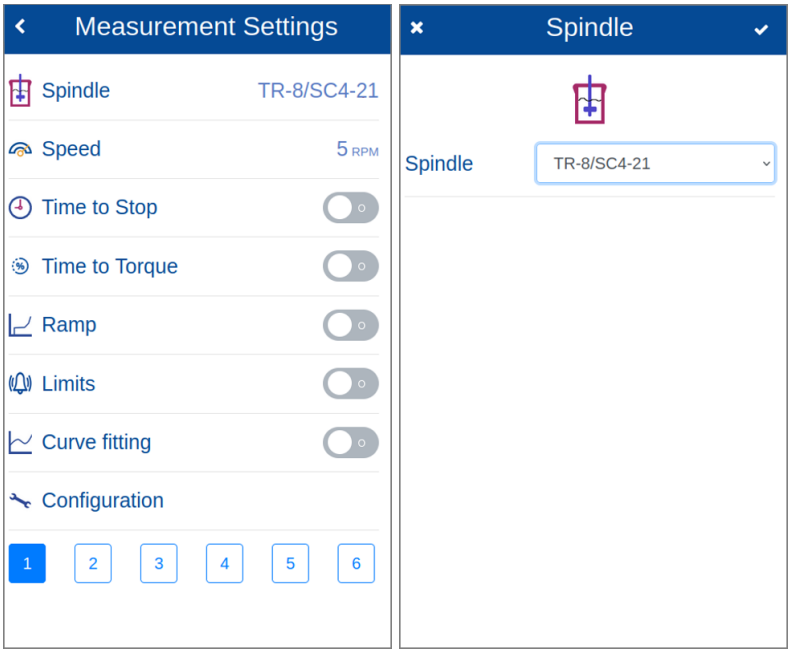
3.5.1 Main Menu

In the main menu the following symbols are displayed.

	**Viscosity Measurement** Perform measurements using existing parameters, change parameters and save results in instrument memory.
	**Browse Measurements** View and manage measurement results saved in instrument memory.
	**Measurement Settings** Change measurement settings and / or instrument configuration.

3.5.2 User Interface

To control the system the following UI elements are available.



	**Activated** The current option or function is active. Tap to deactivate.
	**Deactivated** The current option or function is inactive. Tap to activate.
	**Save** Save your changes and go back to previous screen.
	**Back** Go back to previous screen with existing settings.
	**Close** Go back to previous screen without saving.

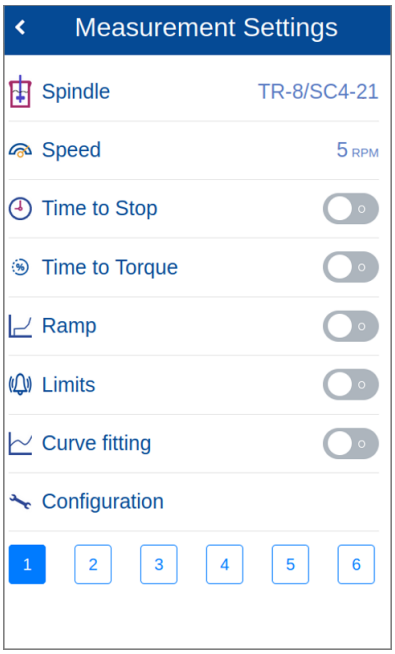
NOTICE

If there is a check mark for **Save** it is to be tapped to save the changes in the current screen. If there is no such check mark all changes are automatically saved.

4

Measurement Settings

Tap the settings icon in the main menu to manage settings that are **often** changed. Before starting with measurements these parameters may have to be controlled.



For settings that are **seldom** changed see System Configuration 33 .

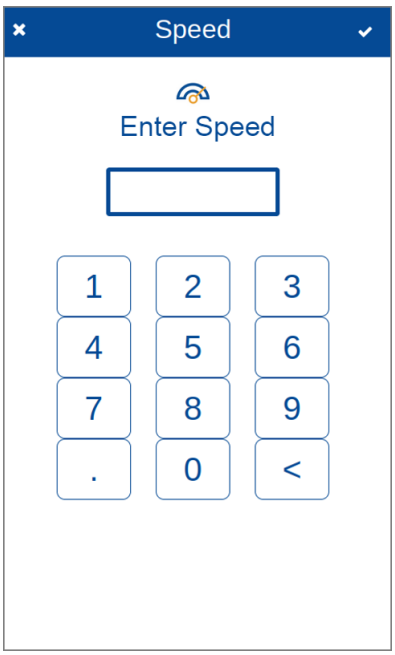
4.1 Spindle

Here the spindle currently mounted can be selected to announce it to the measurement system.

The spindle to be selected depends on the viscometer model, namely the spring torque. Make sure that spindle matches instrument. The spindle type is printed on the head of the spindle.

4.2 Speed

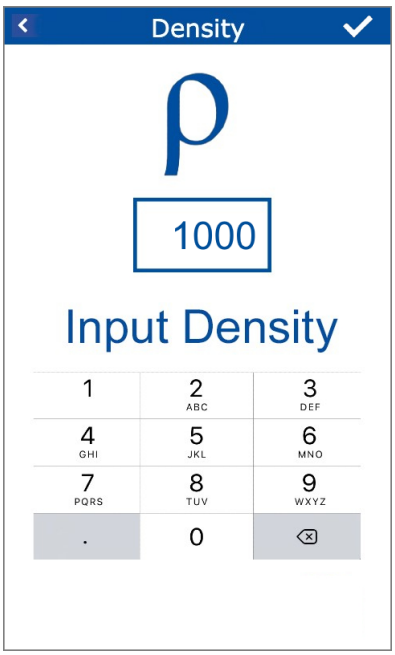
Enter the speed of the spindle in Revolutions per Minute (RPM).



Type in the requested value - between 0.1 and 250 - and save with the check mark.

4.3 Density

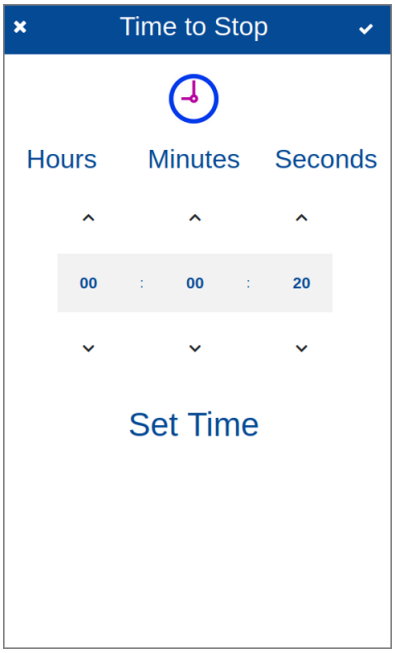
Enter the target density value of the material to be measured.



This option is available, if activated under System Configuration[33] > Density[34].

4.4 Time to Stop

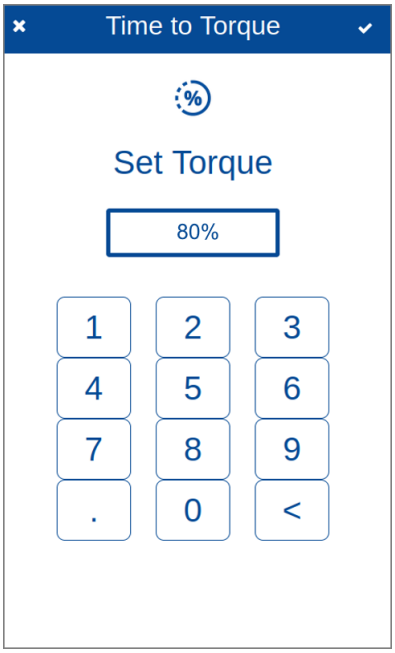
Activate the option to go to the screen **Time to Stop**. Enter the measurement time here.



Use the arrow buttons to enter **Hours**, **Minutes** and **Seconds** and save with the check mark.

4.5 Time to Torque

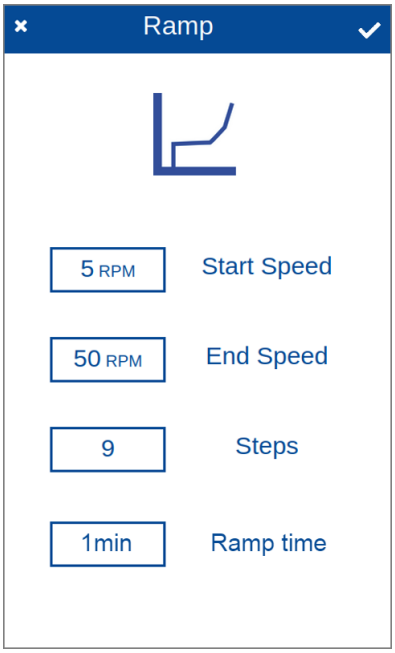
Activate the option to go to the screen **Time to Torque**. Enter the target torque here. Measurement will stop, when the given value has been reached.



Enter the value (in percent) and save with the check mark.

4.6 Ramp

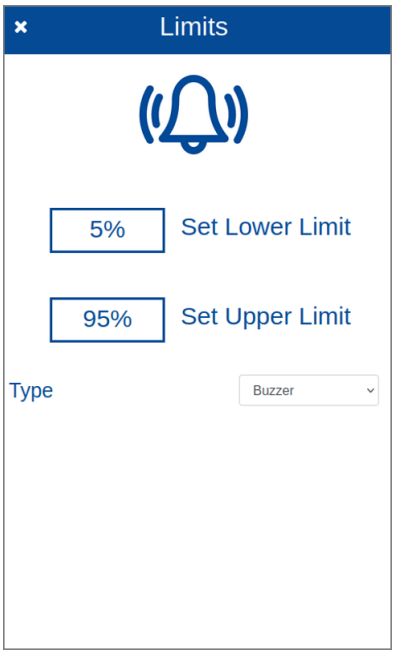
Enter a dynamic speed range here. Instrument will adjust speed accordingly. Activate the option **Ramp** and tap the values to go the details screen **Ramp**.



Enter a **Start Speed** greater Zero (e.g. "5") and an **End Speed** (e.g. "50") and the required **Steps** for increasing / decreasing the speed (e.g. "9"). The measurement time for the ramp-up is calculated by the instrument.

4.7 Limits

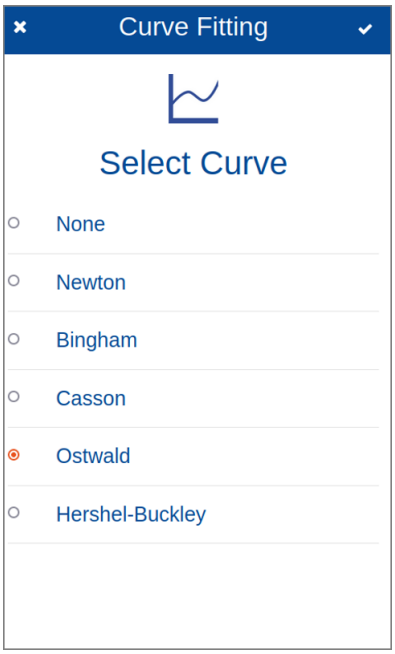
Here you can specify torque values to be observed for quality control. An alarm can be activated if current sample is not within the given range.



Tap on **Set Upper Limit** to enter the maxmium torque values (e.g. "5%"). Repeat for **Set Lower Limit** (e.g. "95%"). Finally select the **Type** for the alarm: **Buzzer**, **Display Flash** or **Both**.

4.8 Curve Fitting

Several curve fitting models are available. Dependent on the type of sample you want to measure different fits will be applied and different curve parameters will be displayed. For every case the correlation factor, R^2, will be displayed. This corresponds to how well the fit matches the measured data. R^2 is always between 0 and 1 with values closer to 1 being better.



Following curves can be selected:

- None
- Newton[28]
- Bingham[28]
- Casson[29]
- Ostwald[30]
- Herschel-Bulkley[31]

Select the required curve from the list and save with the check mark.

4.8.1 Newton

This mode is used only for Newtonian fluids. That means the shear stress of the fluid is proportional to the shear rate. The curve is described by a linear equation:

$$\tau = \eta * \gamma \quad (1)$$

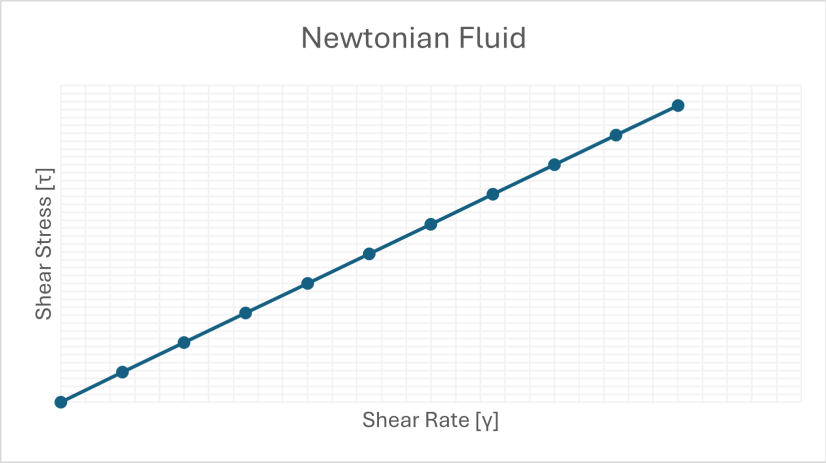


Figure 1: Example of the flow curve of a Newtonian fluid.

Where τ is the shear stress, η the dynamic viscosity and γ is the shear rate.

After the measurement is complete, two values will appear on the screen: R^2 and PV. PV is the plastic viscosity and corresponds to the slope of the curve.

4.8.2 Bingham

This mode is used for plastic fluids. That means, that finite stress must be applied to initiate flow, and that at greater stresses the flow will be linear. The curve of a Bingham fluid must therefore be described by two parameters, the yield value and the plastic viscosity. It is represented via the equation:

$$\tau = \tau_0 + \eta * \gamma \quad (2)$$

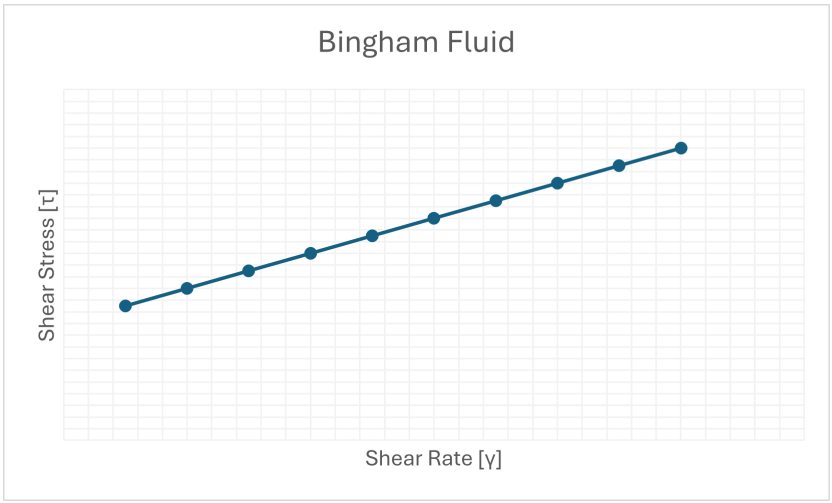


Figure 2: Example of the flow curve of a plastic fluid according to the Bingham model. The yield value corresponds to the point on the y-axis where the liquid begins to flow.

Where τ_0 is the yield value, or the stress where the liquid first begins to flow and the plastic viscosity which corresponds to the slope of the curve.

4.8.3 Casson

This mode is used for plastic fluids. These are similar to Bingham fluids, in that a finite amount of stress needs to be induced on the fluid to initiate flow. It is described by the equation:

$$\sqrt{\tau} = \sqrt{\eta} * \sqrt{\gamma} \quad (3)$$

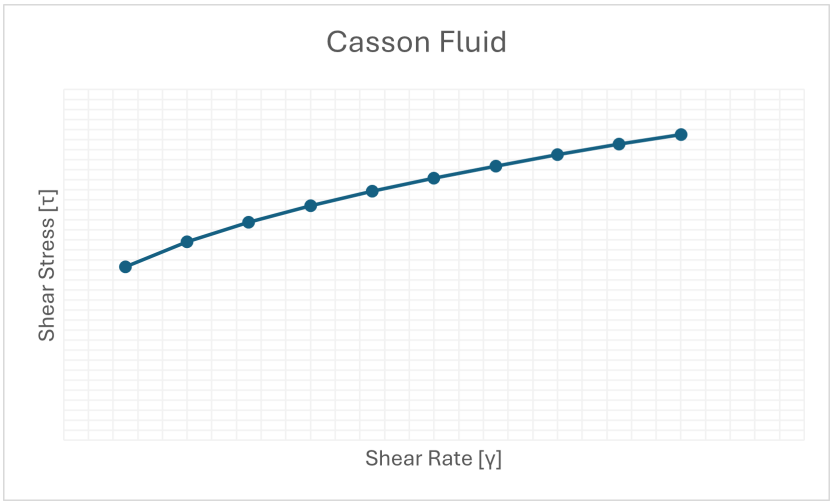


Figure 3 Example of the flow curve of a plastic fluid according to the Casson model. The yield value corresponds to the point on the y-axis where the liquid begins to flow.

The difference to the Bingham model is, that a certain degree of non-linearity is introduced, by utilizing the square root of the slope and viscosity values for fluids that are not quite accurately described by the Bingham model. This is mostly used to indicate shear thinning behavior. As with the Bingham model, the Casson option will display the plastic viscosity as well as the yield value on screen.

4.8.4 Ostwald

Ostwald or power-law fluids describe a generalized fluid equation for which the shear stress is given via a flow consistency index, the shear rate and a flow behavior index. It is described by the following equation:

$$\tau = K * \gamma^n \quad (4)$$

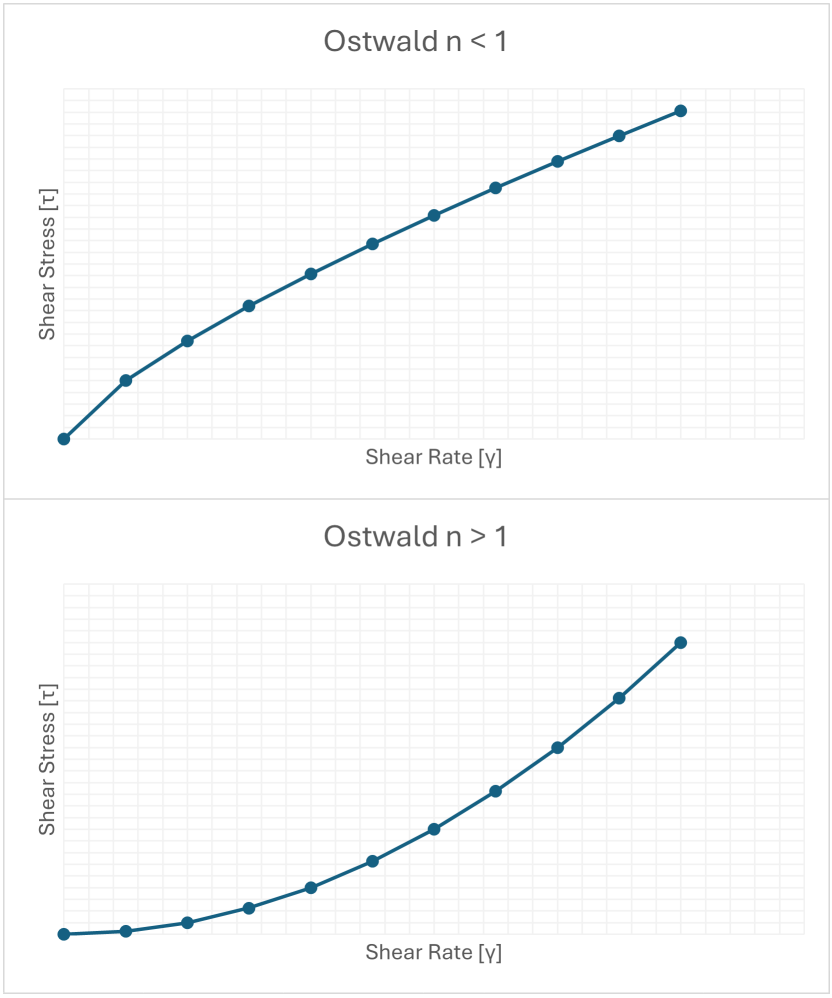


Figure 4: Example of the flow curves of a plastic fluid according to the Ostwald model that shows shear thinning (top) and shear thickening (bottom) behavior.

Where τ is the shear stress, K is the flow consistency index, γ is the shear rate and n is the flow behavior index:

- For n = 1, this equation corresponds to Newtonian fluids.
- For n > 1 this equation corresponds to dilatant (or shear thickening) fluids.
- For n < 1 this equation corresponds to pseudoplastic (or shear thinning) fluids.

The instrument will display the consistency index as well as the behavior index on screen after the measurement is complete.

4.8.5 Herschel-Bulkley

Herschel-Bulkley fluids also follow a generalized power law equation They differ from Ostwald fluids by the introduction of a yield value, similar to how plastic fluids differ from Newtonian fluids. They are described by the following equation:

$$\tau = \tau_0 + K * \gamma^n \quad (5)$$

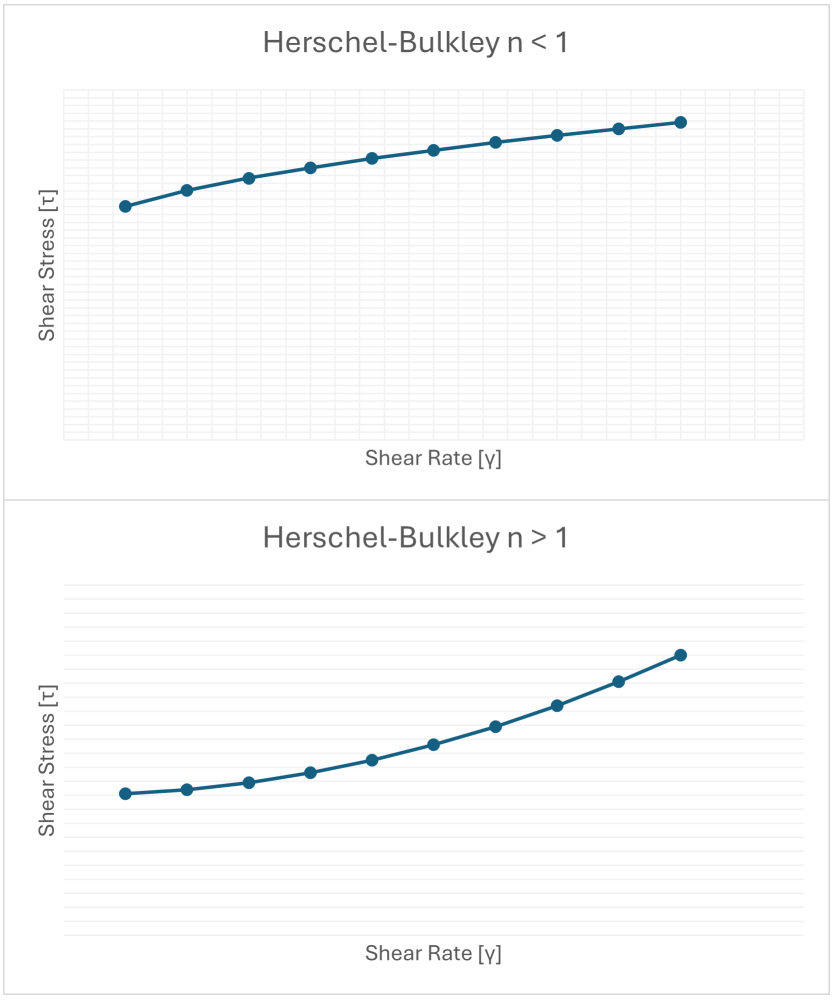


Figure 5: Example of the flow curves of a plastic fluid according to the Herschel-Bulkley model that shows shear thinning (top) and shear thickening (bottom) behavior. The yield value corresponds to the point on the y-axis where the liquid begins to flow

Where τ is the shear stress, τ_0 is the yield value, K is the flow consistency index, γ is the shear rate and n is the flow behavior index:

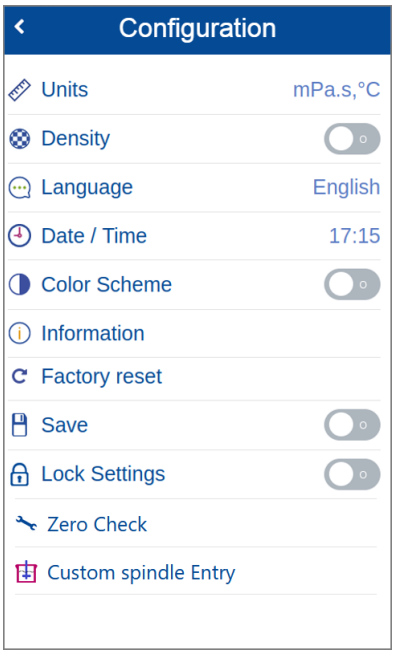
- For n = 1, this equation corresponds to Newtonian fluids.
- For n > 1 this equation corresponds to dilatant (or shear thickening) fluids.
- For n < 1 this equation corresponds to pseudoplastic (or shear thinning) fluids.

The instrument will display the consistency index, the yield value as well as the behavior index on screen after the measurement is complete.

5

System Configuration

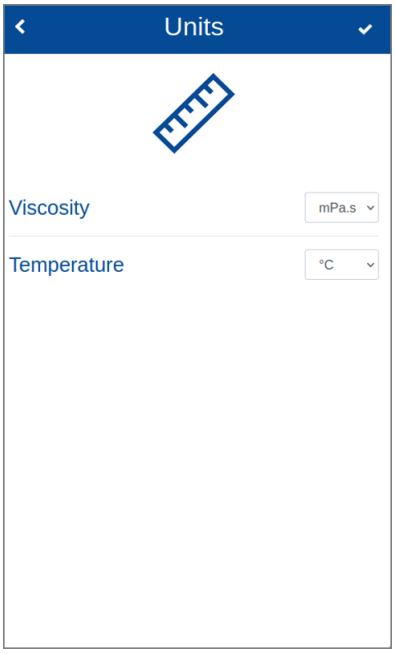
Tap the settings icon in the main menu and tap on **Configuration** to manage settings that are **seldom** changed.



Before starting with measurements the configuration may have to be controlled.

5.1 Units

Select the units used for measurement.



For the **Viscosity** following units are supported:

- Milli Pascal Second: **mPa.s**
- Centipoise: **cP**

For the temperature following units are supported:

- Celsius: **°C**
- Fahrenheit: **°F**

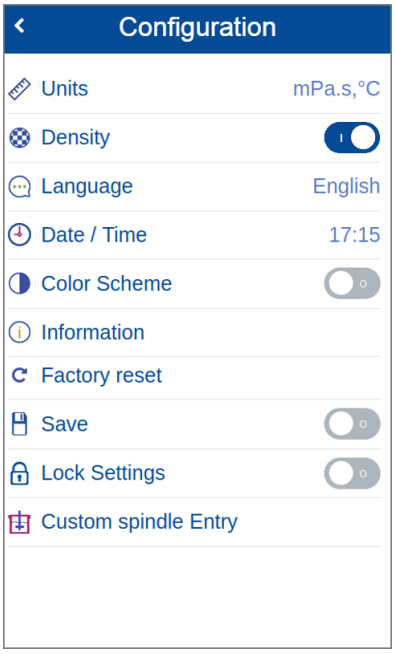
Select the required unit and save with the check mark.

NOTICE

The configuration for **Units** will be used as default and can also be changed directly during measurements.

5.2 Density

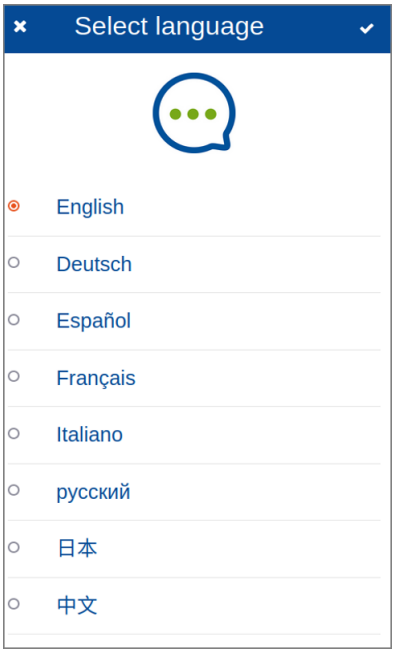
If this option is activated the Density 24 appears in the Measurement Settings 23.



If the option is active, the instrument switches to a special measurement mode, see Density 48.

5.3 Language

Select the language of the user interface here.



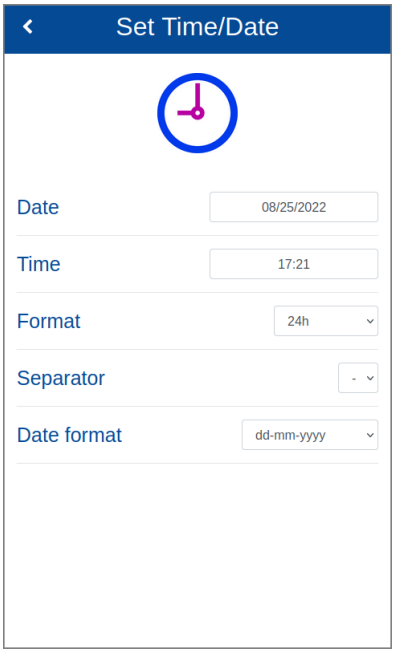
Following languages are supported:

- English: English
- German: Deutsch
- Spanish: Español
- French: Français
- Russian: Русский
- Japanese: 日本語
- Chinese: 中国

Select the required language and save with the check mark.

5.4 Date / Time

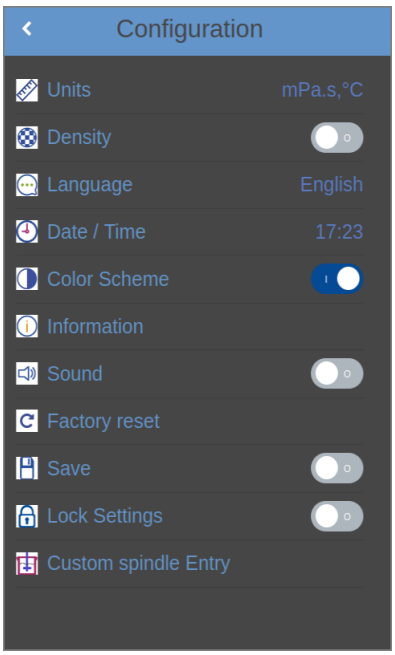
Here you can enter date, time and the format.



The **Time** is entered with **Hour** and **Minute**. The **Date** is entered with **Day**, **Month** and **Year**. For **Date** and **Time** the **Format** to be displayed can be selected.

5.5 Color-Scheme

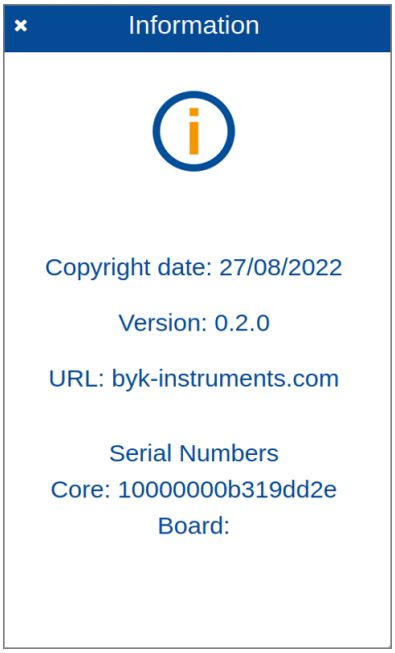
If this option is activated the white background of the display turns to black. This option is preferred in case of darker surroundings.



If this option is deactivated the background turns back to white.

5.6 Information

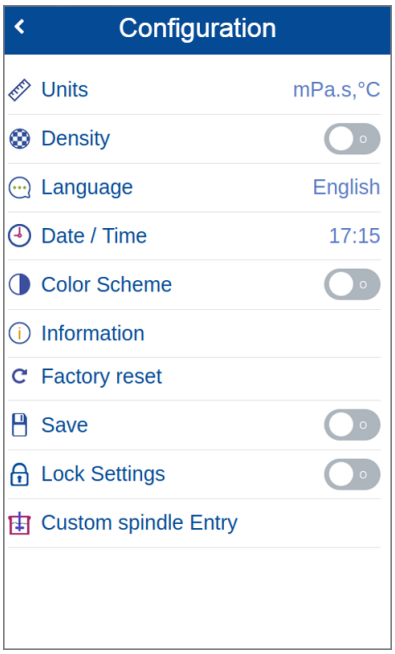
Under this option the details about instrument, firmware version and serial number can be retrieved.



In case you contact your local BYK-Gardner service center please have these data handy.

5.7 Factory Reset

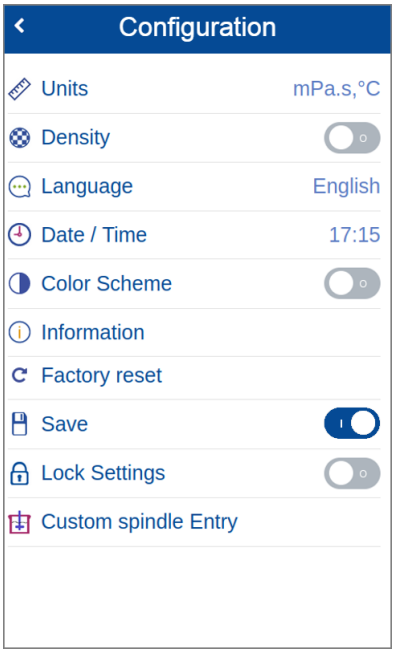
This option can be used to reset instrument to the factory settings.



Tap on **Factory Reset** and follow the instructions on the display to perform the reset.

5.8 Save Results

This option can be used to turn on saving the results of the viscosity measurements, see Browse Measurements 56.



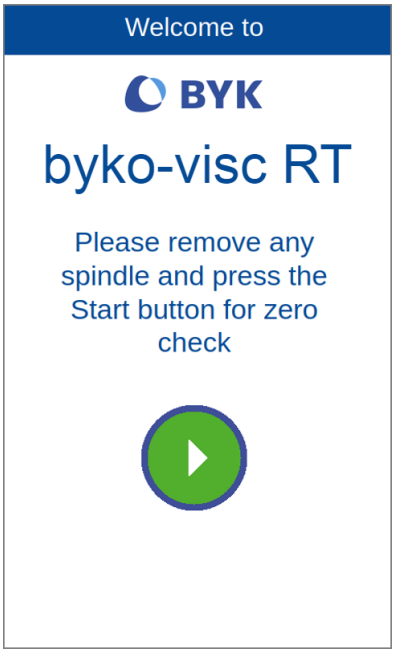
If this option is deactivated the measurements results are not saved and will not be shown in the browse screen.

5.9 Zero Check

A zero check should be run when the Calibration Check 61 has not passed (see Addendum 61). Perform following checks:

1. Make sure, that the unit is properly leveled.
2. In **Configuration** tap **Zero Check** to initiate the procedure.
3. Remove any spindle from the attachment.
4. Press green **Start** button to start the zero check.
5. The zero viscosity point is automatically determined.

After finishing zero check the instrument will automatically go to the main menu.

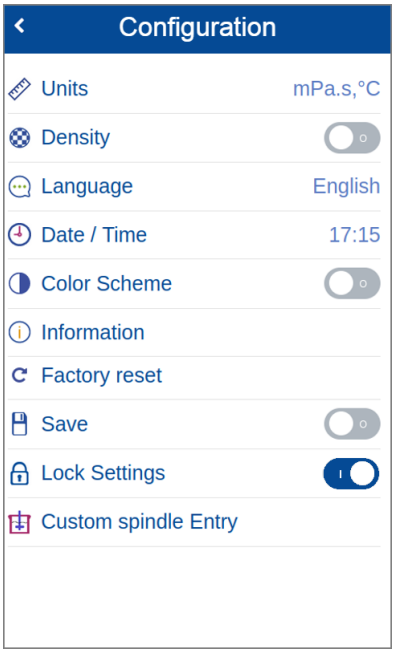


If the zero check passes, repeat the calibration check.

If the zero check fails, please contact your nearest BYK-Gardner service point and we will be happy to assist you further.

5.10 Lock Settings

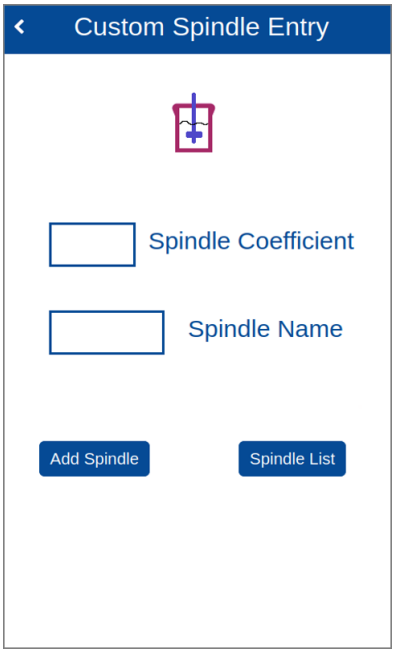
This option can be used to lock the current settings against unintentional changes.



If this option is deactivated the settings can be changed again.

5.11 Custom Spindle

This option can be used to announce custom spindles to the viscosity measurement system.



For custom spindles the specific **Spindle Coefficient** and a **Spindle Name** to identify the spindle is to be entered.

6

Perform Measurements

Tap the measurement icon in the main menu to access the measurement screen. For viscosity measurements perform following steps:

6.1 Attach Spindle

Perform following steps:

1. If protective cap is attached, turn it clockwise to remove.
2. Move spindle attachment upwards, insert spindle and release attachment.
3. To remove the spindle do the same and release the spindle.

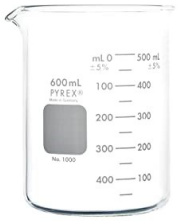
The spindle attachment can be kept with one hand.

The spindle can be attached with the other hand. On the spindle head the type label is available.

The spindle attached has to be selected in Measurement Settings[23] > Spindle[23] - or directly in Measure Viscosity[43].

6.2 Measure Viscosity

To measure viscosity a sample container is necessary (not part of delivery). We recommend a 600 mL low form glass beaker.

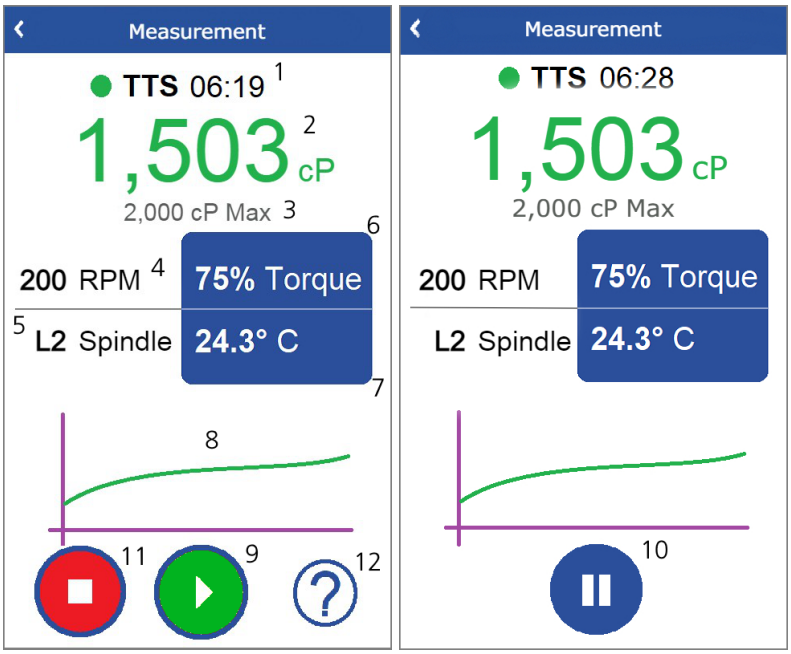


Perform following steps:

1. Go to the main menu.
2. Tap the measurement icon.
3. The measurement screen is displayed.
4. Lower unit into sample and tap the green **Start** button.
5. The measurement is started using the existing settings.

Re-adjust vertical and horizontal position of the instrument head, if required - see Control Elements[18].

The measurement screen displays the following items.

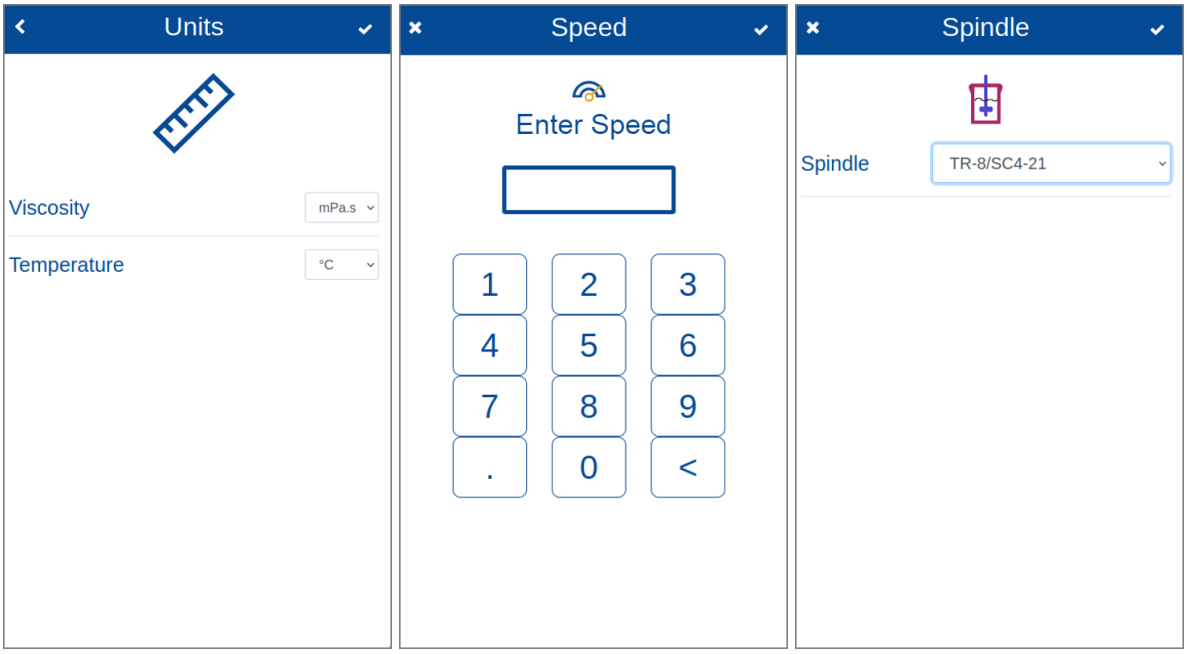


1	TTS / TTT	Counter for Time to Stop or Time to Torque
2	Viscosity	Average of measurements - taken every spindle revolution, tap unit to change
3	Maximum	Maximum possible viscosity value, depending on current spindle and speed
4	Speed	Current spindle speed in rotations per minute (RPM), tap value to change
5	Spindle	Identifier for current spindle, tap entry to change
6	Torque	Current value in percent: Values < 15% or > 95% indicate that speed or spindle settings should be changed (invalid measurement)
7	Temp	Current temperature of sample in °C or °F (if temperature probe is attached)
8	Graph	Live updating graph of viscosity over time
9	Start	Green **Start** button: Start and resume measurement
10	Pause	Blue **Pause** button: Pause measurement
11	Stop	Red **Stop** button: End measurement and save results
12	Help	White **Question** mark: Open context-sensitive help

6.3 Change Parameters

During measurement following parameters can be changed directly:

1. Units[33]: Tap on the unit currently shown.
2. Speed[24]: Tap the speed in RPM currently shown.
3. Spindle[23]: Tap the spindle name currently shown.

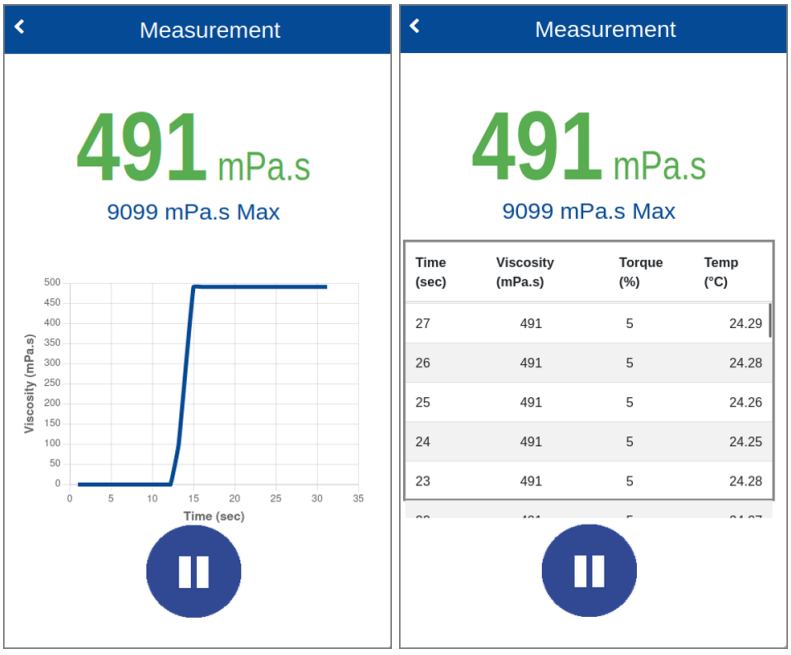


To change all other settings, stop the measurement and go back to the Measurement Settings[23].

6.4 Access all Screens

Swipe left and right to access the other screens:

- Graph: Measurement data in graphical form
- Table: Measurement data in table form



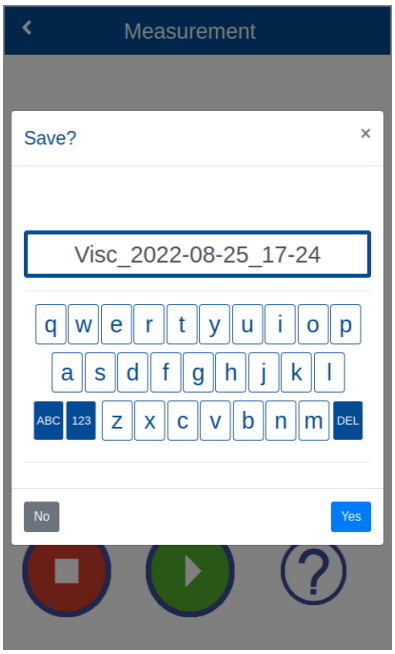
You can also double swipe left and right to access the other screens.

6.5 End Measurement

To end the measurement first tap the blue **Pause** button and than on red **Stop** button.

To end the measurement directly tap the **Back** button in the title row.

A confirmation for saving the data is displayed.



Tap on the file name to change it, if required. For saving you have following options:

- **No**: Current measurement data is not saved, use this to make quick measurements without saving.
- **Yes**: Current measurement data is saved in instrument memory.

NOTICE

The dialog box **Save?** will be displayed, if option Save[38] is active in System Configuration[33].

Go to Browse Measurements[56] to check the results or make a new measurement.

7

Special Measurements

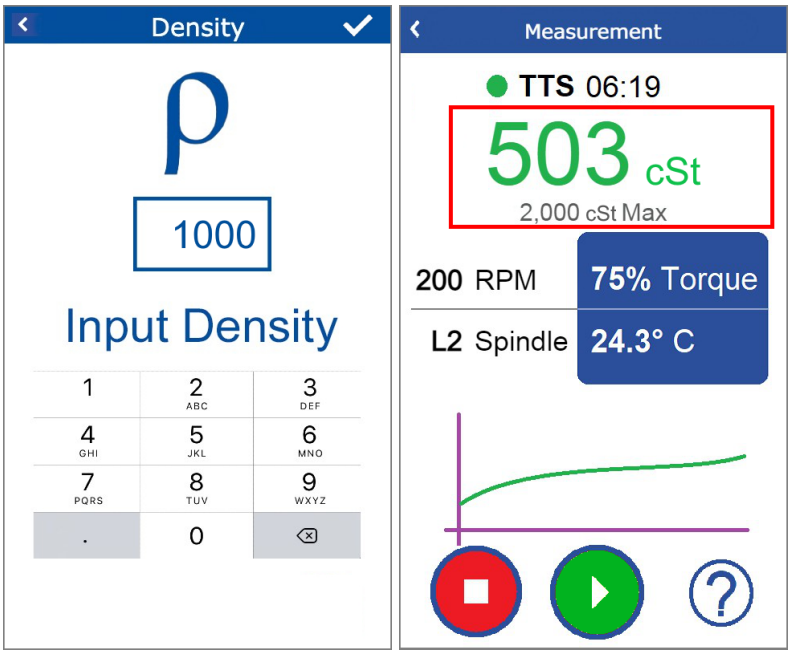
The instrument supports various viscosity measurement modes:

- Density 48
- Time to Stop 49
- Time to Torque 50
- Ramp-Up 52
- QC-Limits 51
- Curve Fitting 53
- Temperature 54

7.1 Density

To use the **Density** feature perform following steps:

1. Go to System Configuration 33 and activate the option **Density**.
2. Go to Measurement Settings 23 and tap on the option **Density**.
3. Enter the target density value of the material to be measured.
4. Perform a measurement and check the results.

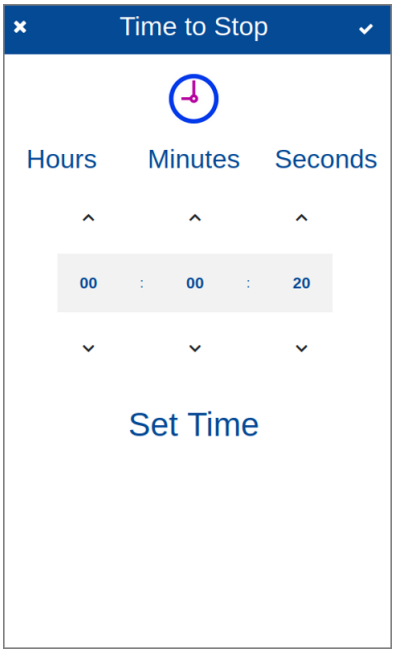


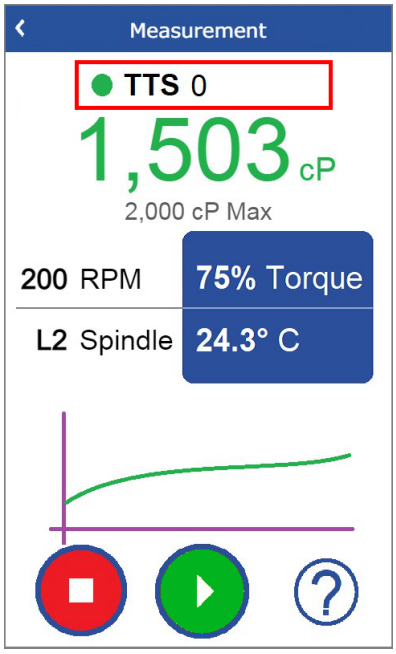
The density is measured in Centistokes (cSt).

7.2 Time to Stop

To use the **Time to Stop** feature perform following steps:

1. Go to Measurement Settings 23 and tap on **Time to Stop**.
2. Enter the time duration the measurement should last.
3. Perform a measurement and check the remaining time.





The measurement is stopped when the time has expired. Press **Play** to restart measurement.

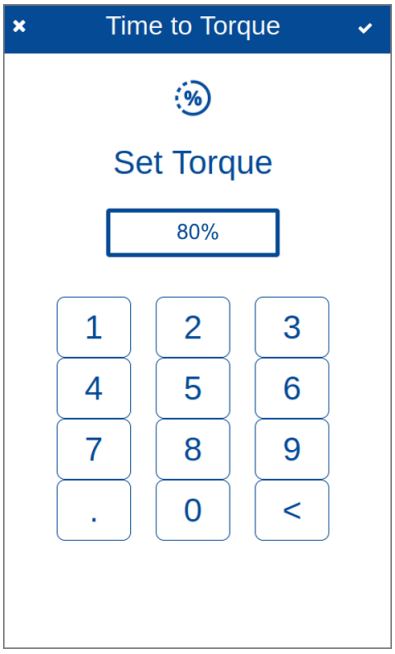
NOTICE

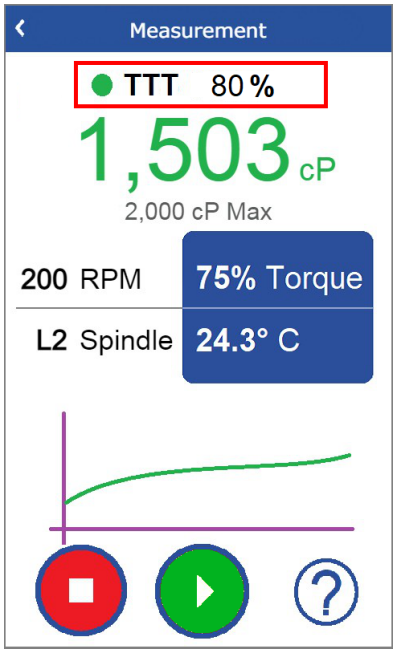
The time feature can be used alternatively to Time to Torque 50.

7.3 Time to Torque

To use the **Time to Torque** feature perform following steps:

1. Go to Measurement Settings 23 and tap on **Time to Torque**.
2. Enter the target torque at which the measurement should stop.
3. Perform a measurement and check the current torque value.





The measurement is stopped when the given torque has been reached. Press **Play** to restart measurement.

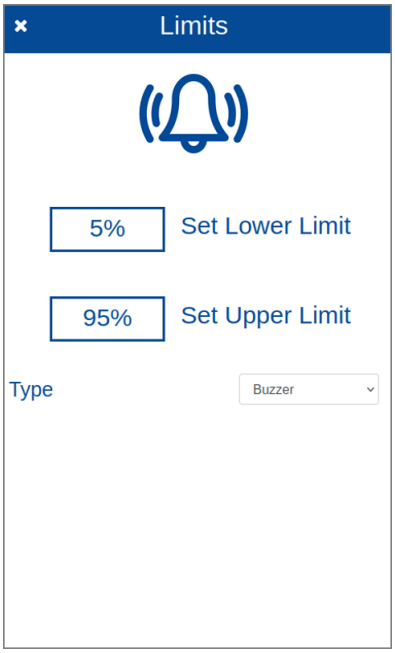
NOTICE

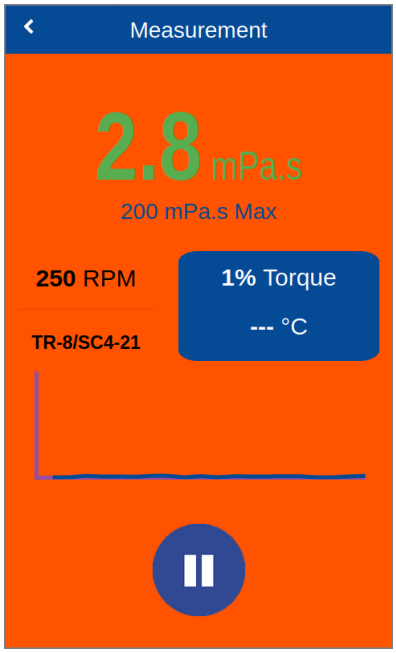
The torque feature can be used alternatively to Time to Stop 49.

7.4 QC-Limits

To use the **QC Limits** feature perform following steps:

1. Go to Measurement Settings 23 and tap on **Limits**.
2. Enter the required values for **Upper** and **Lower** limit.
3. Select the required Alarm type: **Buzzer** or **Flash** or **Both**.
4. Perform a measurement and check the current torque value.





In the given example the display will start to flash if the torque measured is below 5% or above 95% of target value.

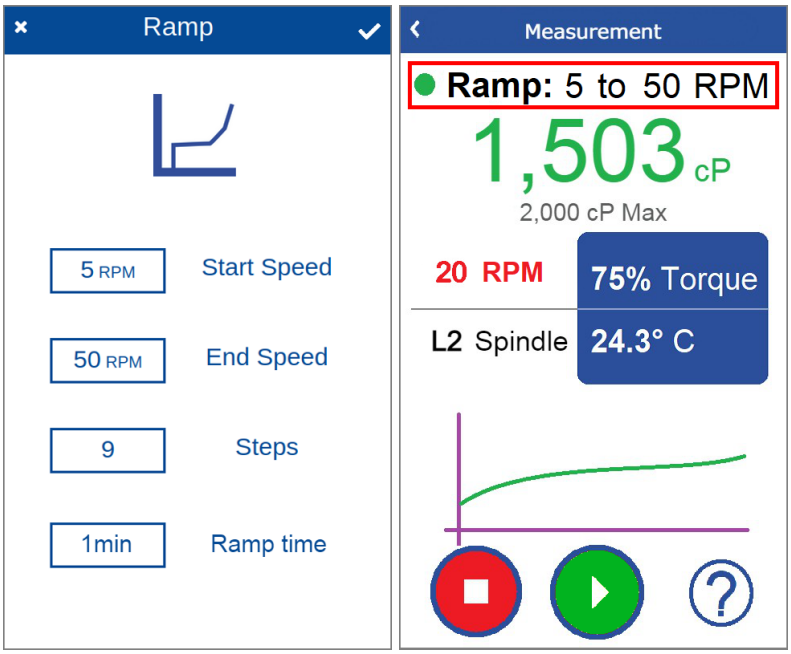
NOTICE

The limits feature can be combined with Ramp 52 and with Time to Stop 49 or with Time to Torque 50.

7.5 Ramp-Up

To use the **Ramp-up** feature perform following steps:

1. Go to Measurement Settings 23 and tap on **Ramp**.
2. Enter the required values for the ramp:
   - **Start speed**: 0.1 ... 150 RPM
   - **End speed**: 0.1 ... 150 RPM
   - **Steps**: 2 ... 500
3. Perform a measurement and check ramp data and current speed in RPM.

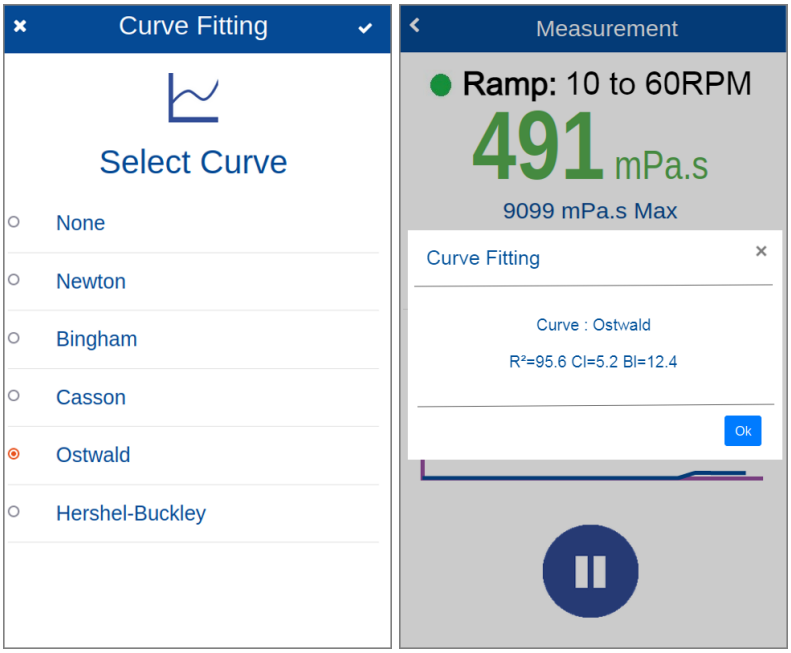


In the given example the instrument will start at 5 RPM, increase to 20 RPM and will end when 50 RPM have been reached. The measurement time for the ramp-up is calculated by the instrument.

7.6 Curve Fitting

To use the **Curve Fitting** feature perform following steps:

1. Go to Measurement Settings[23] and tap on **Curve Fitting**.
2. Select the required curve and save with the check mark.
3. Activating **Curve Fitting** simultaneously activates Ramp-Up[52].
4. Tap on **Ramp** and configure the ramp-up to be measured.
5. Go to Measure Viscosity[43] to start the ramp measurement.



During measurement swipe left or right to access data and table screen. When the ramp has finished, tap on **Back** or **Stop**. The curve fitting results are listed:

- Behavior Index (BI)
- Consistency Index (CI)
- Correlation Factor (R^2)
- Plastic Viscosity (PV)
- Yield Value (YV)

This depends on the curve selected:

- **Newton**: R^2, PV
- **Bingham**: R^2, PV, YV
- **Casson**: R^2, PV, YV
- **Ostwald**: R^2, CI, BI
- **Hershel-Buckley**: R^2, CI, BI, YV

With Export to USB[57] / Print to USB[58] following data will be exported:

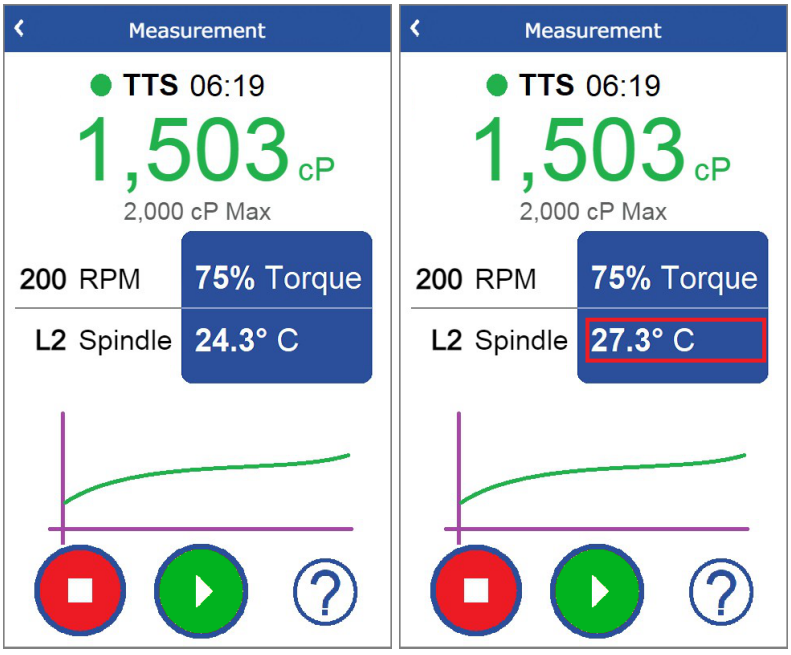
- Name of measurement file
- Curve fitting data
- Ramp data

7.7 Temperature

The temperature probe PT100 is part of the delivery.

To measure the temperature of your sample perform following steps:

1. Attach the temperature probe to the Viscometer Head[18].
2. Fix the cable for the probe on the spindle protector.
3. Insert spindle and temperature probe into the sample.
4. Perform a measurement and observe the temperature.

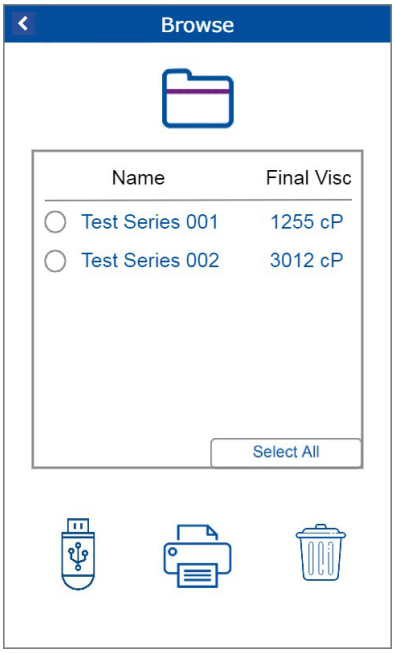


Tap on the temperature value to change the Units[33], if required.

8

Browse Measurements

Using this function you can manage the measured data. Click on icon **Browse**. The final viscosity value for a measurement is displayed here.



Following operations are supported:

- Rename Test Series 56
- Export to USB 57
- Print to USB 58
- Delete Data 59

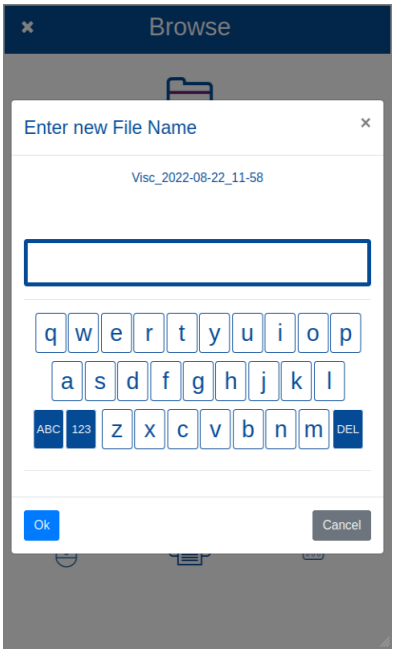
NOTICE

You can select single or multiple test series. Alternatively you can select all test series at once.

8.1 Rename Test Series

You can rename existing test series. Perform following steps:

1. Tap the check box for the series to be renamed.
2. Tap on button **File Name**.
3. Enter the new file name.
4. Tap on **OK** to save name.



NOTICE

The default file name can be configured in Date / Time 36 .

8.2 Export to USB

Export to USB to see all viscosity values measured over time. Perform following steps:

1. Attach USB flash drive to the viscometer head.
2. Select all test series to be exported.
3. Tap on the **Export USB** icon.
4. Wait until process finishes.
5. Connect USB drive to PC.
6. Use MS Excel to view data.

	A	B	C	D	E	F
1	Time(sec)	Viscosity(cP)	Torque(%)	Speed(RPM)	Temperature(°C)	
2	0	0	0	0	-24484	
3	1	0	0	0	-24484	
4	2	0	0	0	-24484	
5	3	0	0	0	-24484	
6	4	0	0	0	-24483	
7	5	0	0	0	-24481	
8	6	0	0	90	-24482	
9	7	0	0	124	-24484	
10	8	0	0	150	-24484	
11	9	0	0	150	-24484	
12	10	2	0	150	-24488	
13	11	2	0	150	-24490	
14	12	220	41	150	-24491	
15	13	532	99	150	-24487	
16	14	532	99	150	-24488	
17	15	532	99	150	-24488	
18	16	532	99	150	-24488	
19	17	532	99	150	-24491	
20						
21	532					
22						

NOTICE

The export format is Comma Separated Values (CSV). In MS Excel create an empty sheet and select **Data** > **Get Data** > **From File** > **From Text/CSV** to convert the data in your file.

8.3 Print to USB

You can directly print a test series to a USB printer. Perform following steps:

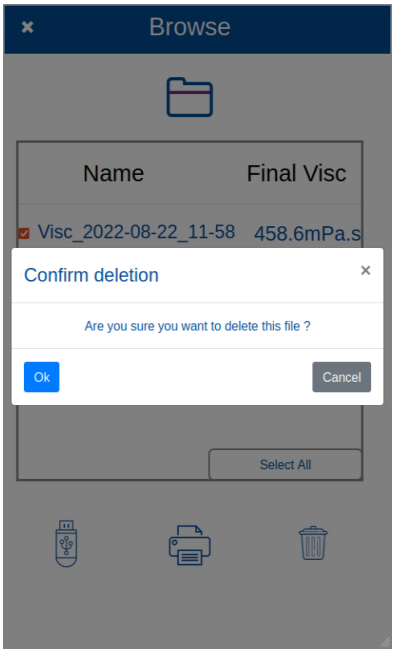
1. Attach USB printer to the viscometer head.
2. Select all test series to be printed.
3. Tap on the **Print USB** icon.
4. Wait until process finishes.

We suggest a USB label printer, for example the Dymo Labelwriter 450 or 550.

Depending on paper role you can print labels for the probes or just paper output.

8.4 Delete Data

Measurement data not required anymore can be deleted from instrument memory. Tap the test series to be deleted - to delete all test series at once tap on button **Select All** - and tap on button **Delete**.



Tap on **Yes** to confirm the request. The selected objects are deleted. To abort the deletion tap on **No**.

9
Appendix

9.1 Addendum

In order to get the best results possible, a number of factors have to be considered when taking measurements with the byko-visc RT. Firstly, there are instrument specific factors. These include the spindle geometry, accuracy and sample volume size. Secondly, there are fluid dependent factors. Is the sample Newtonian or not? If not, is it pseudoplastic or thixotropic?

These factors should be considered before any measurement is made to get the most accurate result possible.

9.1.1 Calibration Check

A calibration check should be run whenever you have data that seems off. Use it to double check, if the measured values are correct. If correct, double check your measurement settings. If not the values are not correct, a Zero Check 38 is recommended (see System Configuration 33).

The byko-visc RT is accurate to one percent of the full-scale range viscosity or FSR. The FSR can be calculated by multiplying the maximum viscosity value (as displayed on the screen) by 0.01. When checking the calibration with a reference oil, the accuracy of this oil (usually 1%) has to be taken into account as well. An example of the allowable error for three speeds with spindle R3 and the reference oil RT500 (4043) can be seen in Table 1.

Table 1: Overview over the 1% full scale range accuracy for three speeds with the R3 spindle and the reference oil RT500. Viscosity of RT500 at 25 °C = 484,7± 4,85 cP.

RPM	Maximum Value [cP]	Torque [%]	1% FSR [cP]	Allowable Error [cP]
25	4005	12.5	40	44.9
50	2003	25.0	20	24.9
100	1000	50.0	10	14.9

Therefore, when operating at 25 rpm, any value between 439.9 and 529.6 cP indicates that the viscometer is operating correctly. Ideally, these measurements shall be done in triplicate to confirm their accuracy. If afterwards your instrument is not reading correct values, first perform a Zero Check and if this fails, please contact your nearest BYK service point and we will be able to assist you further.

In general, measurements at very low torque values (less than 10 %) should be avoided, as the measurement uncertainty is too high compared to the actual measured values. Consider changing the speed and or spindle if you find yourself in this situation.

9.1.2 Spindle Guard

If possible, the spindle guard should always be attached when verifying viscosity values, as it defines the outer boundary of the measurement. The spindle guard is used in the calibration of the internal spindle coefficients of the instrument, and they are used to convert the measured torque values into a centipoise value. Attaching the spindle guard does not change the viscosity of the measured sample, but it does change how the instrument converts torque into centipoise. As such, without the spindle guard the viscosity values will be incorrect. This effect will be more apparent with big spindles like the L1, L2 and R1 and R2 spindles. With smaller spindles this variation is negligible.

We are aware, that using the spindle guard is sometimes not practical for customers. It is absolutely possible to remove it, and or use smaller sample sizes than 500 mL. The instrument will keep measuring accurate torque values. However, these will not translate into accurate viscosity readings, because the boundary conditions have changed. It is possible to do a correction calculation to remedy this issue.

To do this, perform following steps:

1. Measure your sample under perfectly controlled conditions. That means, spindle guard, 600 mL container, 500 mL of certified viscosity standard and temperature control.
2. Perform this measurement in triplicate and note down the viscosity that is displayed.
3. Transfer the viscosity standard into the container that you wish to measure in (for example directly in the bottle).
4. Repeat the earlier measurement with the same spindle and temperature and note the torque reading that is displayed (NOT the viscosity reading).
5. Calculate the correction factor by solving equations 1 to 3.

$$FSR(1) = \frac{\eta}{x} * 100 \quad (1)$$

The adjusted FSR is the ratio of the measured viscosity in step 1 and the measured torque in step 4. (Eq. 1, η = measured viscosity in cP, x = measured torque in %).

$$S = \frac{FSR(1)}{100} \quad (2)$$

The scaling factor S can be multiplied by the measured torque to get the corrected viscosity value. (Eq. 2).

$$\frac{FSR(1)}{FSR(2)} = \frac{Speed(1)}{Speed(2)} \quad (3)$$

To determine the FSR at different speeds than the one it was originally calibrated at, use this formula. (Eq. 3).

Example

We want to measure the viscosity of a sample directly in the bottle. This means, that the scaling factors will not be correct and therefore we have to make an adjustment. We begin by measuring a viscosity standard oil under controlled conditions. We measure a value of 1000 cP with spindle R2 at 10 rpm.

Afterwards we measure the same oil inside the bottle without the spindle guard. We measure a torque reading of 23%.

Next, we calculate the adjusted FSR using equation 1, the torque reading and the measured viscosity. The adjusted FSR(1) equals 4348.

To calculate the FSR at a different speed we use equation 2, the speed from our first measurement and FSR(1) from earlier. For a speed of 20 rpm this yields a FSR(2) of 2174.

The scaling factor S is calculated using equation 3 and FSR(1). Substituting the values yields S1 = 43.5. Multiplied by the measured torque of 23% this gets us to the corrected viscosity reading of 1000.5 cP.

9.1.3 Spindle Geometries

Viscometer readings are dependent on several different factors. Most substances are found to be non-Newtonian. These are dependent on the shear rate and spindle geometry conditions. These factors can be found in the following Tables 2-4. Non-Newtonian fluids change their viscosity values dependent on the shear rate. The shear rate in turn, is dependent on the speed of the rotation. It can be calculated for defined geometry systems like the small sample adapter (SSA) and low viscosity adapter (LVA, Tables 3 and 4) by multiplying the speed by the shear rate constant (SRC).

Table 2: Overview over the recommended volumes and spindle geometries for byko-visc RT models

Model	Spindle	Recom-mended Volume [mL]	Container	Part no.	Shear Rate Constant [sec^{-1}/rpm]	Dia-meter [mm]	Length [mm]
L	L1	500	600 mL beaker	4982	-	18.84	65.1
	L2			4983	-	18.72	6.86
	L3			4984	-	12.6	1.78
	L4			4985	-	3.2	31.01
R+H	R1			4987	-	56.26	22.48
	R2			4988	-	46.93	1.65
	R3			4989	-	34.69	1.65
	R4			4990	-	24.3	1.65
	R5			4991	-	31.14	1.65
	R6			4992	-	14.62	1.65
	R7			4993	-	3.2	50.37

Table 3: Overview over the recommended volumes and spindle geometries for byko-visc RT models using the small sample adapter (SSA) or the low viscosity adapters (LVA)

Model	Spindle	Recom-mended Volume [mL]	Container	Part no.	Shear Rate Constant [sec^{-1}/rpm]	Dia-meter [mm]	Length [mm]
L	TL-5	6.7	SSA	4961	1.32	17.48	31.72
	TL-6	9.0		4962	0.34	11.76	25.15
	TL-7	9.4		4963	0.28	9.39	24.23
L+R	LVA	16.0	LVA	4972	1.225	25.15	90.74
R+H	TR-8	7.1	SSA	4964	0.93	16.76	31.24
	TR-9	10.4		4965	0.34	11.76	33.02

Model	Spindle	Recom-mended Volume [mL]	Container	Part no.	Shear Rate Constant [sec^{-1}/rpm]	Dia-meter [mm]	Length [mm]
	TR-10	11.0		4966	0.28	9.39	32.0
	TR-11	13.5		4967	0.25	7.62	27.18

Table 4: Overview over the recommended container sizes and spindle geometries for byko-visc RT models using vane spindles

Model	Spindle	Recom-mended Volume [mL]	Container	Part no.	Shear Rate Constant [sec^{-1}/rpm]	Dia-meter [mm]	Length [mm]
R+H	V-71	7.1	250 mL beaker	8367	-	34.39	68.78
	V-72	10.4	200 mL beaker	8368	-	21.67	43.33
	V-73	11.0	100 mL beaker	8369	-	12.67	25.35
	V-74	13.5	50 mL beaker	8370	-	5.89	11.76
	V-75	13.5		8371	-	8.03	16.1

We recommend to accurately control and report the following conditions:

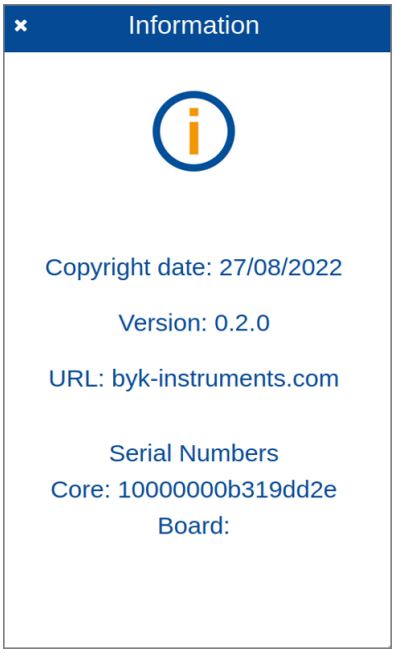
1. Temperature
2. Sample Container Size (Beaker vs. SSA vs. LVA)
3. Sample Volume
4. Spindle
5. Spindle guard attached or not
6. Speed and if applicable shear rate
7. Time to stop
8. Measured value and torque

This way repeatable results can be achieved.

9.2 Firmware Update

To update the firmware of your instrument perform following steps:

1. Go to System Configuration[33] and tap on **Information**.
2. Check the current firmware version.
3. Get the new firmware, it is a compressed file of type "byko_update_x.y.z.tar.gz".
4. Copy the file into root directory of a USB flash drive.
5. Go to the Main Menu[20].
6. Attach the flash drive to the Viscometer Head[18].
7. The new firmware is detected and automatically installed.
8. Do not switch off the instrument during the update!
9. The system performs a reboot to load the new firmware.
10. Check the new version in the information screen.



In case you contact your local BYK-Gardner service center please have these data handy.

NOTICE

The file with the new firmware will automatically be deleted from the USB flash drive.

9.3 Maintenance

9.3.1 Cleaning and Routine Maintenance

Remove the spindle after use to clean. Severe damage to the instrument can occur if the spindle is cleaned while mounted to the viscometer. The stainless steel paddle spindle may be cleaned with solvents required for the material being measured and a non-abrasive cloth.

Remove spilled material from the instrument case and base. Avoid solvents on the faceplate and the color display as they may be seriously damaged by strong solvents.

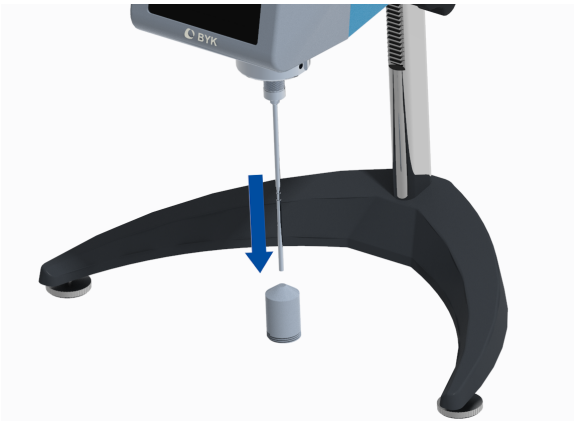
Restart instrument to check both leveling and zero check in regular intervals.

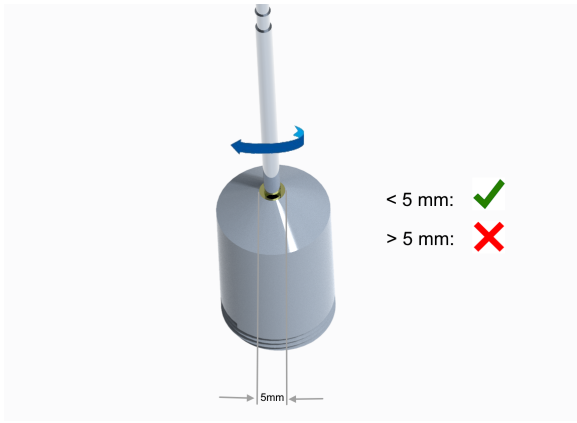
9.3.2 Runout Checking Procedure

Due to the measuring principle - stepper motor and spring mechanism - the rotation of the spindle can cause a certain amount of deflection. However, if the spindle looks bent or runs unevenly, the instrument should be checked.

Perform the following steps:

1. Use spindle L4 for L model; R7 for R and H model.
2. Place the protective cap supplied under the spindle.
3. Set the measurement speed to 50 RPM.
4. Lower the viscometer head to just above the protective cap.
5. Start a measurement so that the spindle rotates.
6. If the spindle rotates within the upper diameter of the cap (5 mm), the amount of deflection is normal and the instrument is OK.





If the spindle exceeds this margin, it may be bent and must be replaced. If all spindles exceed the margin, the viscometer coupling may be bent. In both cases, please contact your local BYK-Gardner representative.

9.3.3 Service and Repairs

Do not perform any repairs on the unit. The unit must be opened by BYK-Gardner authorized repair locations only. Repair as this will void the warranty and affect the safety protection.

9.3.4 Troubleshooting

If problems occur, verify that power is being applied, first to the power supply then from the power supply to the instrument. If the power is good, disconnect the power supply from the back of the instrument for at least 30 seconds, reconnect the power supply and turn on the power switch. If problems persist, please contact your local BYK-Gardner office.

9.4 Spare Parts

For all service and spare parts requirements, please contact your local BYK-Gardner office.

<table>
<tr><th>byko-visc RT L</th><th>byko-visc RT R</th><th>byko-visc RT H</th></tr>
<tr><td>Viscometer with stand (8356)</td><td>Viscometer with stand (8357)</td><td>Viscometer with stand (8358)</td></tr>
<tr><td>Spindle L1 (4982)
Spindle L2 (4983)
Spindle L3 (4984)
Spindle L4 (4985)</td><td colspan="2">Spindle R2 (4988)
Spindle R3 (4989)
Spindle R4 (4990)
Spindle R5 (4991)
Spindle R6 (4992)
Spindle R7 (4993)</td></tr>
<tr><td>Spindle guard L (300003462)</td><td colspan="2">Spindle guard R / H (300003430)</td></tr>
<tr><td colspan="3">Spindle rack (300003438)</td></tr>
<tr><td colspan="3">Temperature probe (8363)</td></tr>
<tr><td colspan="3">Glass beaker, 600ml, low form (8364)</td></tr>
<tr><td colspan="3">Power supply (8360)</td></tr>
</table>

9.5 Technical Data

All technical data are subject to change without notice.

9.5.1 Instrument

Catalog number	8356: byko-visc RT L (Low viscosity) 8357: byko-visc RT R (Regular viscosity) 8358: byko-visc RT H (High viscosity)
Measurement range	byko-visc RT L: 1* - 6,000,000 cP byko-visc RT R: 5* - 40,000,000 cP byko-visc RT H: 300 - 320,000,000 cP * With Low Viscosity Adapter (LVA) accessory
Spindles included	byko-visc RT L: 4 byko-visc RT R: 6 byko-visc RT H: 6
Speed range	0.1 - 250 rpm
No. of speeds	Freely selectable within speed range
Repeatability	0.2%
Accuracy	1.0% of range
Preset memory	6 memory locations for measurement settings presets
Measurement features	Curve Fitting, Density, QC Limits, Multi-point Tests
Programmable features	Time to Stop, Time to Torque, Multi-step Ramp
Temperature measurement	PT100 temperature probe
Display	Capacitive color display
Languages	English, German, French, Italian, Spanish, Russian, Japanese, Chinese

9.5.2 General Data

Usage	Indoor use
Temperature range	10° C to 40° C (50° F to 104° F) for operation 0° C to 60° C (32° F to 140° F) for storage
Relative humidity	Up to 85% non-condensing at 35° C (95° F)
Operation altitude	Up to 2000 m (6561 ft)
Dimensions (LxWxH)	250 x 310 x 470 mm (9.8 x 12.2 x 18.5 in)
Interface	2x USB Type A 1x USB Type C
Weight	6.5 kg (14.3 lbs)
Power supply	24 V ⎓ , max. 1.25 A
Fuse	Bourns SF-1206SA250W-2 rated at 2.5 A
External power supply	Input: 100 - 240 V ~ ; 50 - 60 Hz ; max. 0.7 A Output: 24 V ⎓ ; max. 1.25 A Vendor: Mean Well Model: GE30I24 Safety standards: UL62368-1, CSA C22.2 NO. 62368-1,TUV BS EN/EN62368-1, AS/NZS 60950.1, CCC GB4943,EAC TP TC 004 approved
Overvoltage category	I
Pollution degree	2

9.5.3 Documentation

Safety Instructions	300 003 475	26 languages
Short Instructions	300 003 476	8 languages
Operating Manual	300 003 478 E	English

Download: https://www.byk-instruments.com/p/8356

9.6 Service Points

List of global service centers with ISO / IEC 17025 accredited laboratories		
Headquarter BYK-Gardner GmbH Lausitzer Strasse 8 82538 Geretsried / Germany		
Service Point USA c/o BYK-Gardner USA 9104 Guilford Road Columbia, Suite H, MD 21046 / USA	**Service Point Austria, Hungary, Slovenia** c/o Friedrich W. Bloch GmbH Wagramerstrasse 201, 1210 Vienna / Austria	**Service Point France** c/o Eckart France S.A.S. 31 Rue Amilcar Cipriani, 93400 Saint Ouen / France
Service Point Spain c/o Actega Artística S.A.U. Calle Balmes 8, Suite: 3º2ª 08291 Ripollet / Spain	**Service Point China** c/o BYK (Tongling) Co. Ltd. Shanghai Branch Block 6A, Building A, No 88 Hong Cao Road, Xuhui District, Shanghai 200233 / P.R. China	**Service Point India** c/o IMCD India Private Limited 1101-03, B-Wing, ONE BKC, Bandra Kurla Complex, Bandra East, Mumbai, MH. Pin.: 400 051 / India
Service Point Japan c/o Tetsutani Co. Ltd. Chuo-ku, Osaka Tokuicho 2-2-2 / Japan	**Service Point South Latin America** c/o MAST Comercial e Importadora LTDA Rua Itaporanga, 340-B, Bairro Paraiso, Santo André - SP, 09190-640 / Brazil	
Complete list: https://www.byk-instruments.com/global-service-centers List of authorized agents: https://www.byk-instruments.com/contact-infos		

Notes

A member of ALTANA

Download your manuals from:
https://www.byk-instruments.com/p/8356

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BYK

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