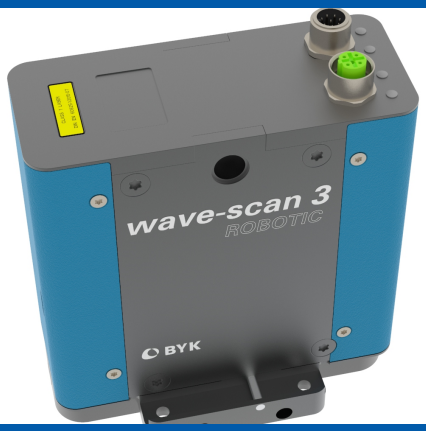
Measure what you see

wave-scan 3 ROBOTIC



Operating Instructions

A member of ALTANA

BYK

Table of Contents

1 Introduction

This instruction manual is an important part of this instrument. It contains essential information about setting up, placing in service and use. If you pass the device on to another user, please ensure that the instruction manual is included with the instrument. The manual must be studied carefully before working with the equipment. Please contact your regional service office if you have any questions or require additional information about the device.

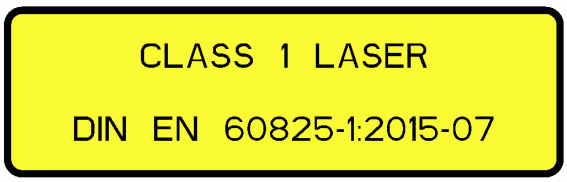
The technology and fittings are based on state-of-the art optic and electronic technology. New developments and innovations are constantly being integrated into the equipment. Thus, the diagrams, dimensions, and technical data used in this manual may have changed as a result of adapting the device to new information and improvements.

www.byk-instruments.com

1.1 Safety Instructions

No claims of product liability or warranty can be honored if the device is not operated in accordance with the operating instructions and the instructions on the instrument.

The measurement unit is a class 1 laser product. The label shown below is on the base of the measurement unit.



Caution!

Since the laser beam used for sampling can penetrate your eye and cause injuries, never dismantle the instrument and never look directly into the measurement aperture when the device is turned on.

If you use the unit and accessories properly, there are no hazards to fear – none of a mechanical nature and none caused by electrical shock.

The following paragraphs contain information about the safe use of the device.

Use only original accessories provided by the manufacturer. See “Delivery Notes” and “Technical Data” for further information.

Avoid exposure to continuous humidity and condensation. See “Technical Data” for further information. Avoid splashing with water, chemicals or other liquids.

Never attempt to make any repairs to the instrument, neither mechanical nor electrical. Please consult our Technical Customer Service.

Only devices that meet the requirements for low-voltage safety may be connected to the control interface (green).

For operation with the external power supply, care should be taken to ensure the nominal voltage of the power supply unit (see the manufacturer's plate on the power supply unit) matches the voltage supplied by the power outlet.

The measurement device may be disconnected from the power supply as follows:

By disconnecting the power plug (black) from the device.

You will find the technical data on the manufacturer's plate and in the section "Technical Data".

Defects and extraordinary loads

If safe operation can no longer be presumed, shut down the device and secure it against unintended operation.

The device must be presumed unsafe to operate:

- if visible damage is evident,
- if the instrument is no longer working,
- if it has been stored for long periods under adverse conditions,
- after harsh treatment during shipping.

Additional information on disposal

This symbol means: Do not dispose of this product together with your household waste. Please refer to the information of your local community or contact our dealers regarding the proper handling of end-of life electric and electronic equipment.

Recycling of this product will help to conserve natural resources and prevent potential negative consequences for the environment and human health caused by inappropriate waste handling

1.2 Declaration of Conformity

We,

BYK-Gardner GmbH

Lausitzer Strasse 8

D-82538 Geretsried

declare, that this instrument complies with the requirements of the following EU directives:

- 2014/30/EU - Electromagnetic Compatibility
- 2014/35/EU - Low Voltage

The following harmonized standards were applied:

- EN 60825-1:2007
- EN 61010-1:2010
- EN 61326-1:2013

Geretsried, November 13, 2019

Frank R. Wagner

Managing Director

1.3 Handling Instructions

The measurement unit contains sensitive precision optical and electronic parts. Do not drop it and protect it from being bumped or jostled!

Do not hold the unit by the measurement aperture or allow any foreign objects to get into this opening.

Do not expose the unit to direct sunlight for extended periods of time. Do not store it in a hot or dusty environment. The case that comes with the unit offers the best protection when the unit is being stored.

Avoid prolonged exposure to high relative humidity and do not allow water to form from condensation, see Technical Data [▶ 31].

Protect the measuring unit from moisture, chemicals and corrosive vapors.

1.4 Prerequisites

In order to operate the instrument basic understanding of following topics is recommended:

- Instrument **wave-scan 3 / 3 dual** for manual measurements (option)
- Software **smart-process** to monitor the measurement results
- Software **smart-robotic** to configure and control the device

2 Hardware

Before operating the instrument for the first time, please read the **Operating Instructions** and take particular notice of the **Safety Instructions**. Unpack the instrument and check the delivery for completeness.

2.1 Delivery Content

The system comes complete with: Measurement unit, cover, test tile, certificate and safety instructions. Also included are screws and a drawing for the robot mounting board.

The items listed below are contained in the transportation case. Please contact BYK-Gardner, if any item is missing or damaged. See also Delivery Notes [▶ 28].

Illustration 1: Delivery content

1	Safety instructions and retraceable certificate	5	Drawing for mounting board
2	Checking tile for instrument test	6	Cleaning towel for checking tile
3	Screws and tool for mounting board	7	Measurement unit
4	USB cable type A / C for initialization	8	Protective cap

The power and communication cables - see Cabling [▶ 13] - are outside the transportation case, but inside the delivery packaging.

2.2 Mounting Board

A mounting board is required to mount the instrument to the robot arm. This board is not part of the delivery. A drawing, that contains all dimensions for the production of the mounting board, is enclosed with each instrument.

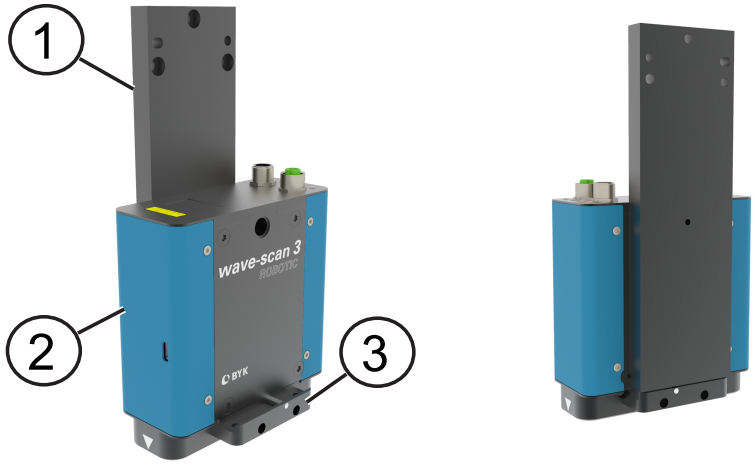


Illustration 2: Mounting board with wave-scan 3 ROBOTIC

1	Mounting board
2	Mounted instrument
3	Fixing bar

The measuring instrument is fixed at the mounting board with three screws (part of the delivery) on the position given below.

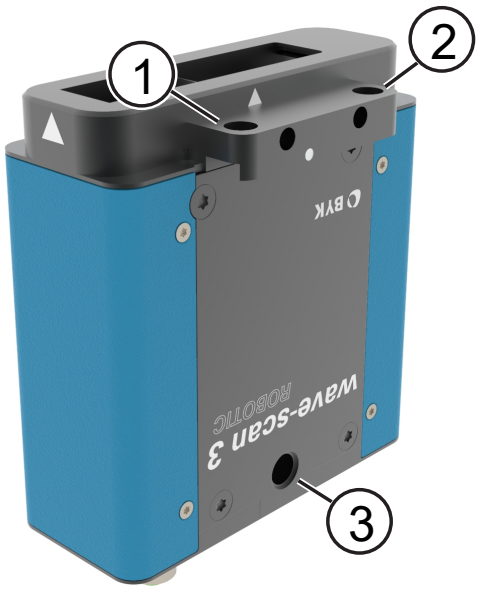


Illustration 3: Mounting of wave-scan 3 ROBOTIC

1	Mounting position 1 - instrument bottom
2	Mounting position 2 - instrument bottom
3	Mounting position 3 - instrument top

The millings at the fixing bar and a pen matching into the deepening provides for a distinctive attachment.

During the measurement, a distance of **15 mm ± 2 mm** to the surface is to be kept.

The angle-deviation of the perpendiculars on the surface can amount to **at most 2°** to all sides.

NOTICE

The mounting can be done on the left or on the right side of the measurement unit. The protruding element on the side not used can be screwed off (two small screws).

2.3 Power Supply

The instrument is supplied by an external AC / DC power adapter, which is not part of the delivery.

Illustration 4: Interface connectors of wave-scan 3 ROBOTIC

1	Power supply is provided via a black 8-pole plug.
2	Data transmission is provided via a green 4-pole plug.

In order to connect the measuring instrument, first check the wiring and the matching of the power supply. Subsequently you plug in the black plug and switch on power.

2.4 Status LEDs

The instruments has four Light Emitting Diodes (LEDs) for status indication.

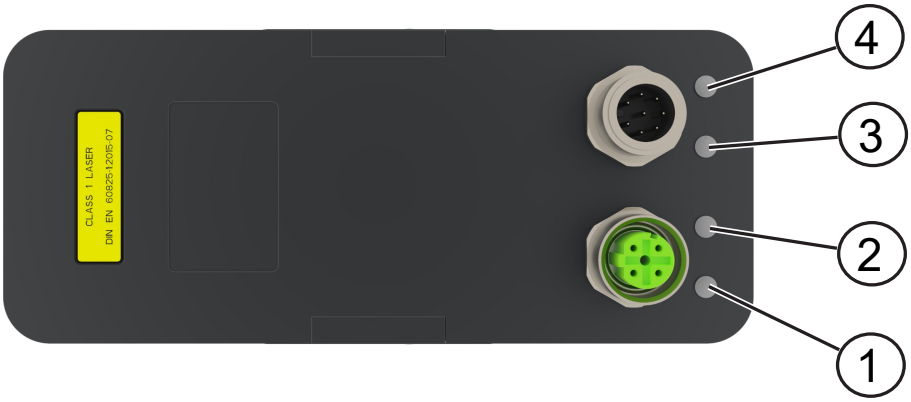


Illustration 5: Status LEDs of wave-scan 3 ROBOTIC

1	Lights in green whenever the device detects a valid link. Blinks in green when CRS is active (high) indicating activity.
2	Lights in blue when the operating speed is 100 Mbps. It is inactive when the operating speed is 10 Mbps or during line isolation.
3	Indicates the status of the measurement: • Lights in green during the measurement. • Lights in red when measurement errors occur.
4	Lights in green when the power supply is connected.

If a mistake should happen during the measurement, it is signaled by a red blinking light-emitting-diode (LED-3). The pertinent error code is shown at the screen.

3 Cabling

The delivery comprises the cables required for initialization and to connect instrument on robot arm with PC:

- Power Cables [▶ 14]
- Data Cables [▶ 16]
- USB Cable [▶ 18]

⚠ WARNING

To avoid instrument damage, only use the cables which are part of the delivery for connecting the instruments!

3.1 Application Example

Following picture gives an example how the cables can be placed in a robot cell.

Illustration 6: Example cabling in a robot cell

Yellow	At robot arm: Torsion capable cable
Green	For track chain: Standard cable
Red	On the floor: Oil resistant cable

These three types of cables are provided for both power and data interface.

3.2 Power Cables

The power interface is a black 8-pole plug. The power supply input is 24 V ⎓ ; max. 0.75 A.

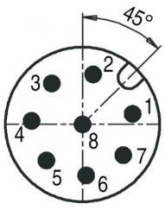


Illustration 7: Polarity diagram for pins M12, 8-pin, A-coded, view pen side

Pin	ROBOTIC Power	Cable Color 4-pin M12-A	Cable Color 8-pin M12-A
1	V_{in}	White	White
2	V_{in}	Yellow	Yellow
3	NC	Green	
4	NC	Brown	
5	NC		
6	GND		
7	GND		Green
8	GND		Brown
M1	Shield		

Following power cables are in the delivery.

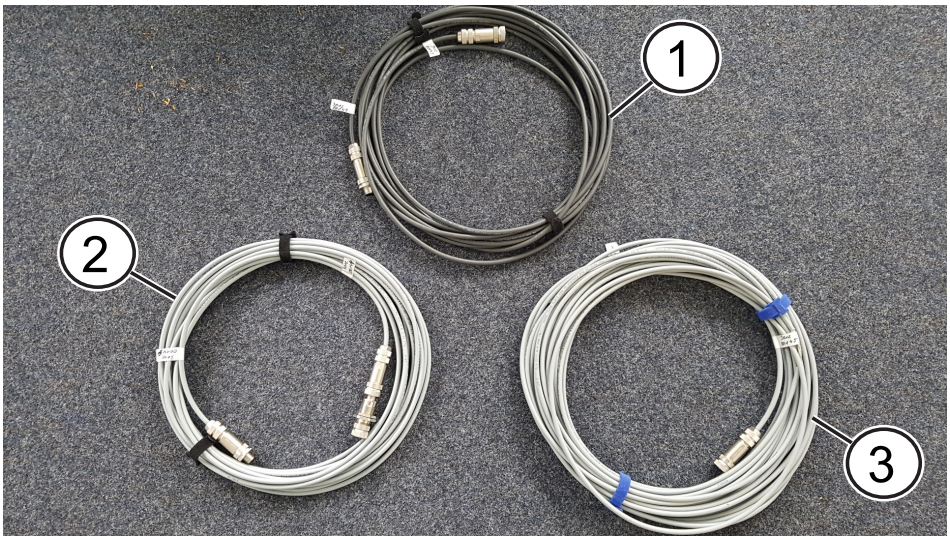


Illustration 8: Power cables

1	301 200 143: 8 m for robot - torsion capable
2	301 200 144: 10 m for drag chain
3	301 200 145: 20 m on floor - oil resistant

The delivery comprises cables and connectors. If necessary, a coupler can be used to attach plugs on both sides to the floor. The product “Binder 0952400004” is recommended.

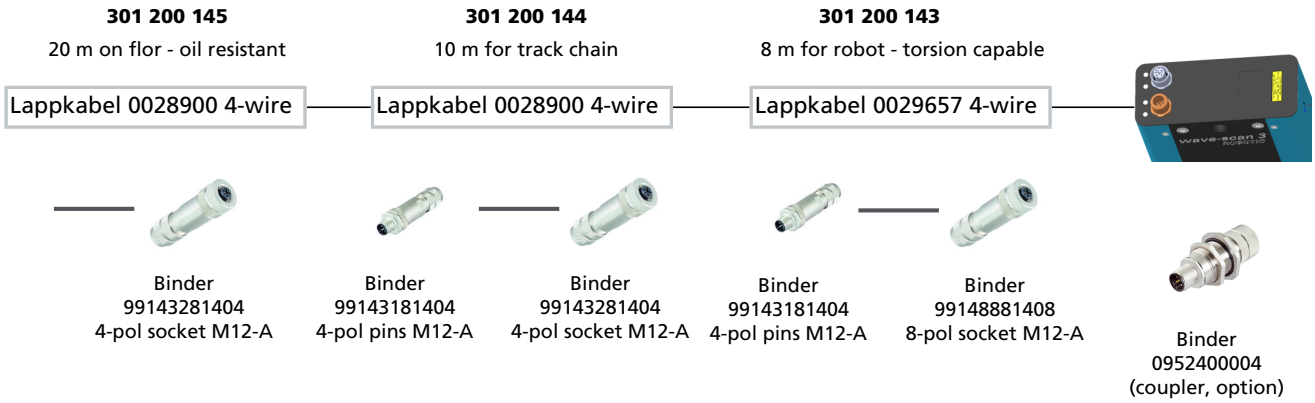


Illustration 9: 301 200 142 Power cable complete for 7410

Products from following vendors are used:

- https://www.binder-connector.com
- https://www.lappkabel.com

Attention: Please heed tension and pin assignment precisely. The instrument can be damaged without functional connection. No product liability and guarantee claims can be put forward if the instrument is not properly power supplied.

3.3 Data Cables

For data communication a proprietary LAN cable is used. The communication interface is a green 4-pole plug.

Illustration 10: Pin assignment M12, 4-pin, D-coded, view socket side

No.	ROBOTIC Data	Cable Color	4-pin M12-D	8-pin RJ-45
1	TX+	Yellow	Pin 1	Pin 1
2	RX+	Orange	Pin 2	Pin 3
3	TX-	White	Pin 3	Pin 2
4	RX-	Blue	Pin 4	Pin 6
M1	Shield			

Following data cables are in the delivery.

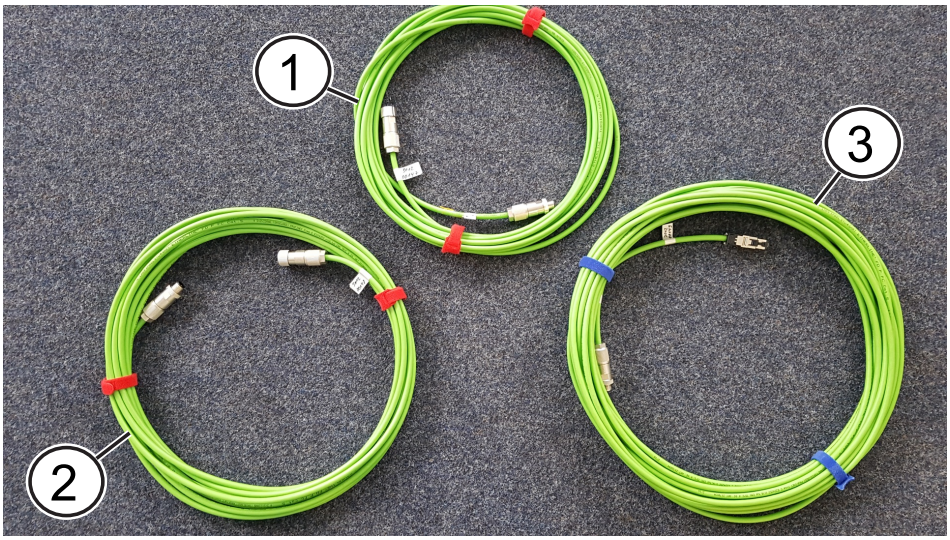


Illustration 11: Data cables

1	301 200 147: 8 m for robot - torsion capable
2	301 200 148: 10 m for drag chain
3	301 200 149: 20 m on floor - oil resistant

The delivery comprises cables and connectors. If necessary, a coupler can be used to attach plugs on both sides to the floor. The product “Binder 0952450004” is recommended.

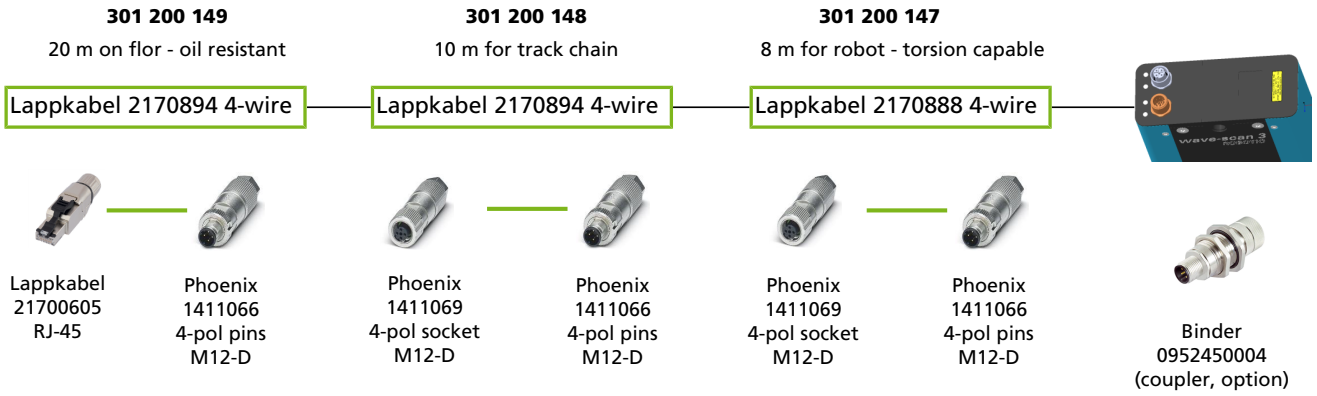


Illustration 12: 301 200 146 Data cable complete for 7410

Products from following vendors are used:

- https://www.binder-connector.com
- https://www.lappkabel.com
- https://www.phoenixcontact.com

3.4 USB Cable

For initialization the instrument provides an additional USB port.

Illustration 13: Interfaces on wave-scan 3 ROBOTIC

1	Power interface (black)
2	Data interface (green)
3	USB type C interface

Perform following steps:

1. Connect the instrument via the USB cable in the delivery with your PC.
2. Provide power to the instrument via power cables and black interface.
3. Start software **smart-robotic** for initialization and configuration.

Details for instrument initialization see Device Configuration [▶ 20]. After initialization and configuration the USB cable can be disconnected. In the productive environment the green data interface is used for communication.

4 Operation

The **wave-scan 3 ROBOTIC** is configured and operated completely via the software **smart-robotic**, which is installed along with smart-chart:

1. Software Installation [▶ 19]
2. Firmware Update [▶ 19]
3. Device Configuration [▶ 20]
4. Productive System [▶ 24]

The complete configuration usually takes place in a test environment. After successful test the configuration is transferred to the productive system.

4.1 Software Installation

Install the software **smart-chart** as described in:

- Operating Instructions **smart-robotic**: 300 003 099 – E - 2010

The installation will create following folders:

- Program **smart-chart**
- Program **smart-robotic**
- Setup for device drivers
- Updates for firmware

After successful installation the software **smart-robotic** can be started. It is used to configure and test the BYK-Gardner robotic instruments.

NOTICE

The software **smart-robotic** also includes a robot simulation. Using the simulator the configuration can be tested outside the robot cell.

4.2 Firmware Update

The firmware of the instrument is updated by BYK-Gardner service team during regular service. The current firmware is also installed along with **smart-chart** in the folder “C:\Program Files (x86)\BykWare\smart-chart3\Firmware”. Perform following steps:

1. Close smart-robotic / smart-chart.
2. Connect the device via USB cable to your PC.
3. Start the program “Update wave-scan3 <Version-No.>”.

The update program compares the firmware in the update (**Package Version**) with the firmware in the device (**Main Version**).

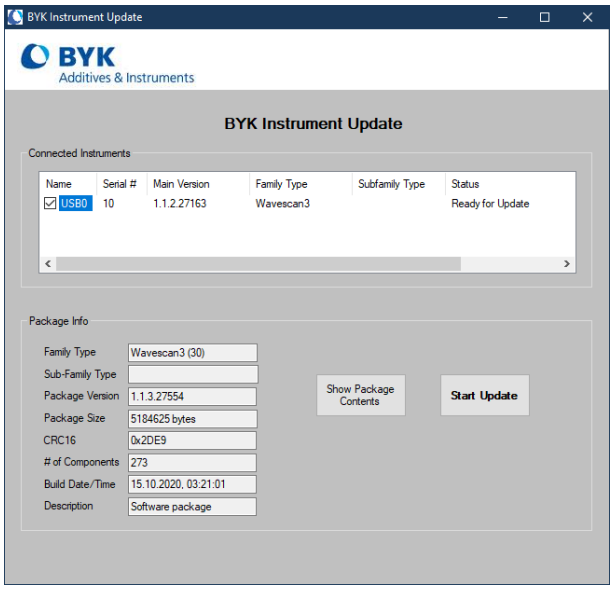


Illustration 14: Firmware update for wave-scan 3 ROBOTIC

Click the **Start Update** button. When the update has finished, close the program.

4.3 Device Configuration

Before the **wave-scan 3 ROBOTIC** can be put into operation, following steps have to be performed:

1. Driver Installation [▶ 20]
2. Device Connection [▶ 22]
3. Device Test [▶ 23]

4.3.1 Driver Installation

Perform following steps:

1. Install the device driver.
2. Connect the device via USB cable to your PC.
3. Check the device in the Windows Device Manager.

For the **wave-scan 3 ROBOTIC** the driver in "C:\Program Files (x86)\Byk-Ware\smart-chart3\Tools\USBBulkDriver" is required.

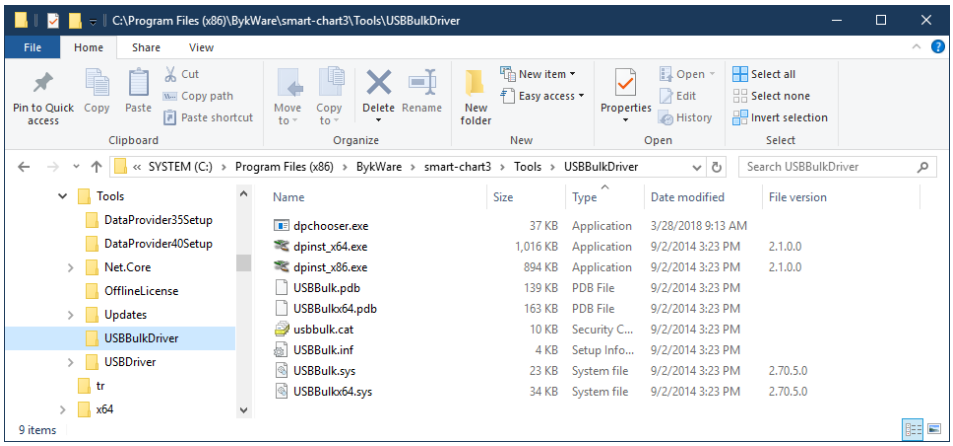


Illustration 15: USB bulk driver for wave-scan 3 ROBOTIC

After driver installation the USB cable is to be connected to activate the device detection in Windows.

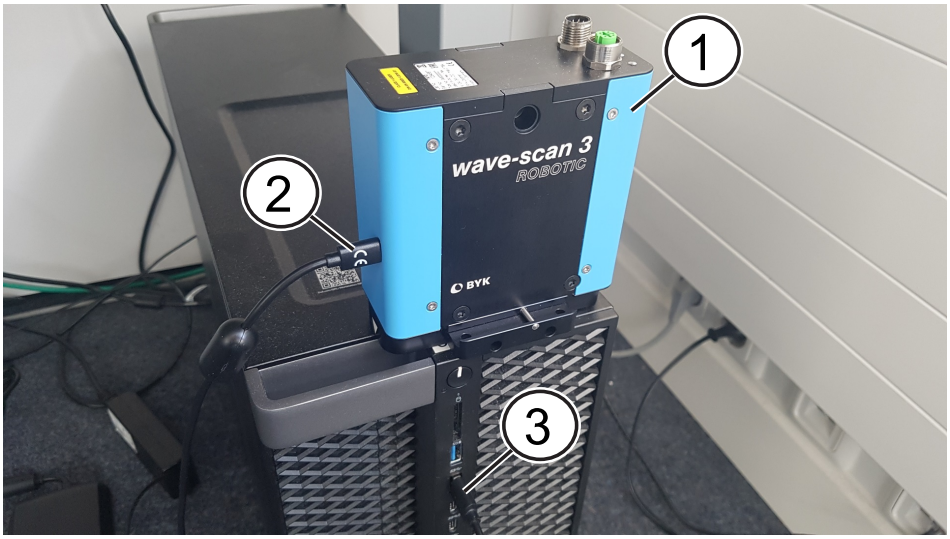


Illustration 16: Cabling for USB driver installation

1 Instrument wave-scan 3 ROBOTIC	2 USB port on instrument
3 USB port on PC	

For the installation of the device in the Windows system the USB connection is sufficient. With an active USB connection the instrument appears in the Windows **Device Manager**.

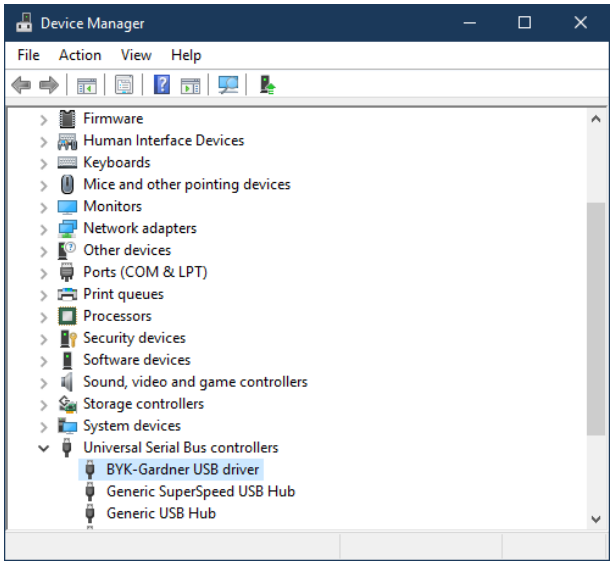


Illustration 17: Instrument in Windows Device Manager

The required entry is **BYK-Gardner USB driver**. The instrument can now be added as a new device in **smart-robotic**.

4.3.2 Device Connection

To access the device via **smart-robotic**, the instrument has be connected to the power supply too.

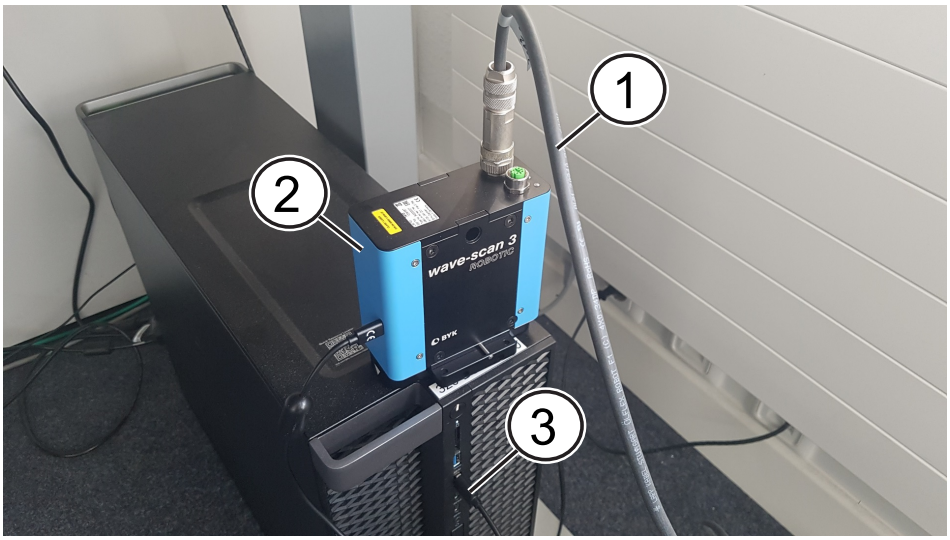


Illustration 18: Cabling for connection test

1	Instrument wave-scan 3 ROBOTIC	2	USB port on instrument
3	USB port on PC		

With power supply and USB connection the instrument can now be accessed in **smart-robotic** in the **Devices** > **Connection** tab.

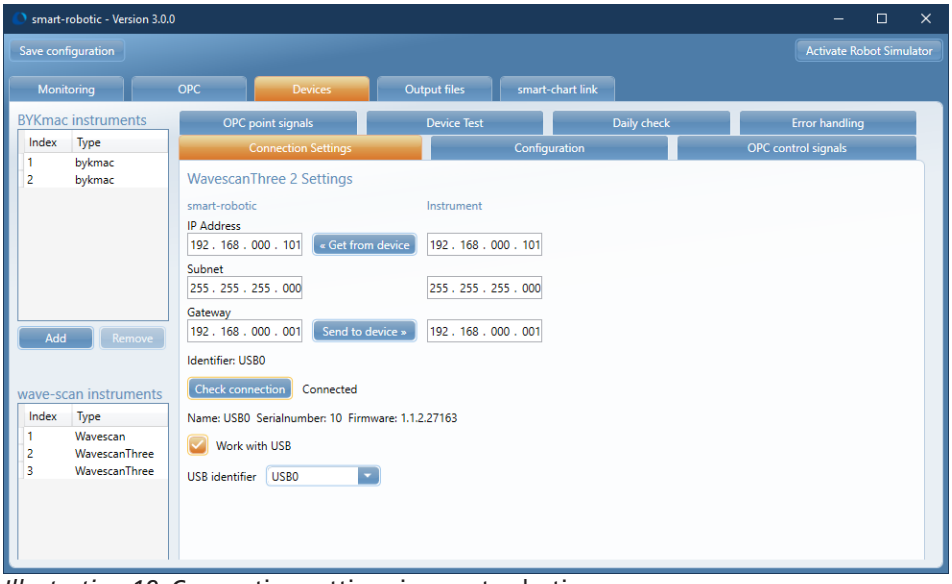


Illustration 19: Connection settings in smart-robotic

Perform following steps:

1. Activate the option **Work with USB**.
2. Select the **USB identifier** from the list.
3. Click the button **Check connection**.
4. Check if the status is **Connected**.

With an active USB connection the IP data – used in the productive environment for the LAN connection – can be sent to the device.

4.3.3 Device Test

With USB connection and power supply the device can be tested. During the test a measurement is performed. The wave-scan ROBOTIC performs a non-contact measurement. A possible test setup is shown below.

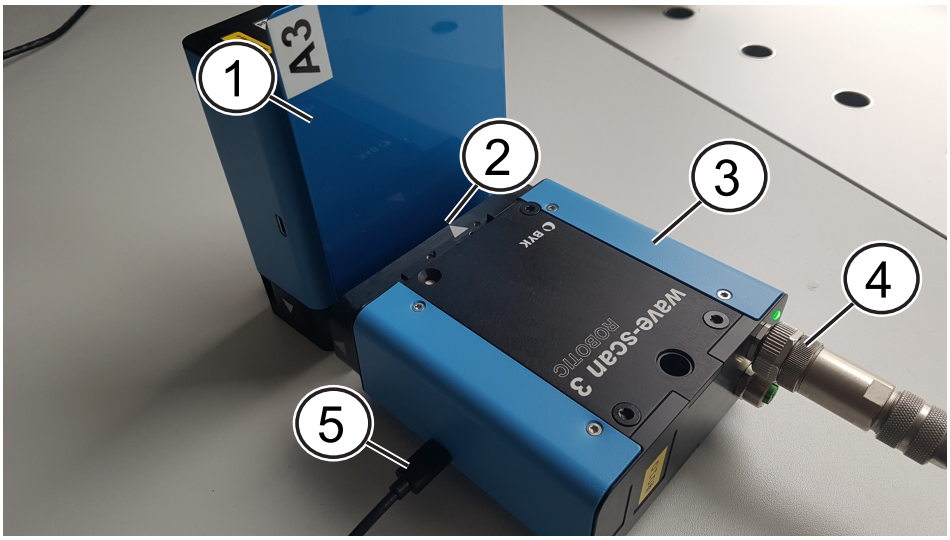


Illustration 20: Setup for device test

1 Sample to be measured	2 Measurement distance 15 mm Measurement angel 2°
3 Instrument wave-scan 3 ROBOTIC	4 Power cable
5 USB cable	

Go to the tab **Device Test**.

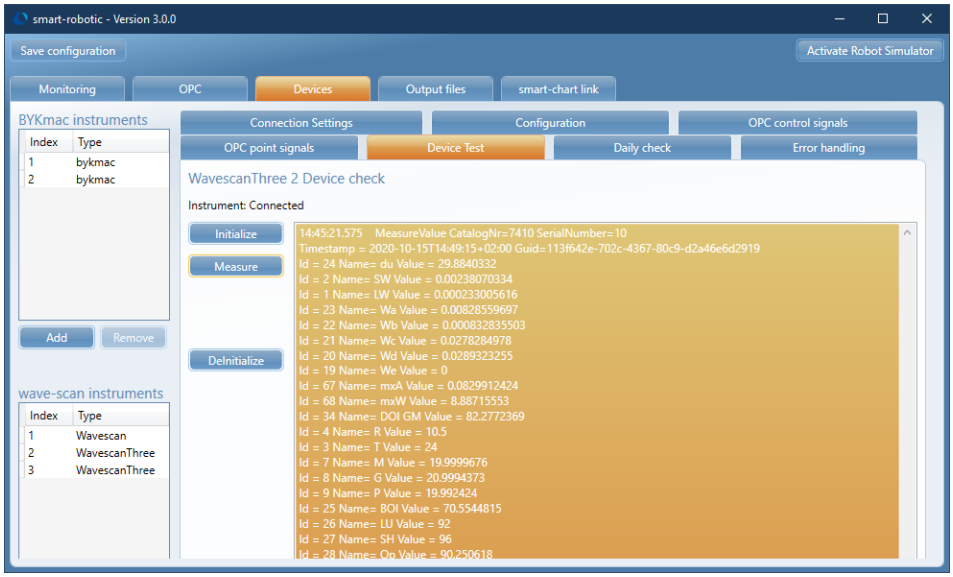


Illustration 21: Device test in smart-robotic

Perform following steps:

1. **Initialize**: Load device driver.
2. **Measure**: Get measurement data.
3. **De-Initialize**: Unload device driver.

With static sample only the dullness can be measured. To measure the values for the wavelength slowly move the sample (or the instrument) during measurement.

4.4 Productive System

The instrument is designed to measure in full automatic mode. Only requirement is to configure the instrument(s) and the data output interface(s) in **smart-robotic**. After are successful testing the configuration can be copied from the test system to the productive system and adapted.

Illustration 22: Robot cell with two robots / Robot arm with two instruments

When the robotic instruments are configured and mounted, the measurements will be done automatically by the robot according to the programming in the PLC.

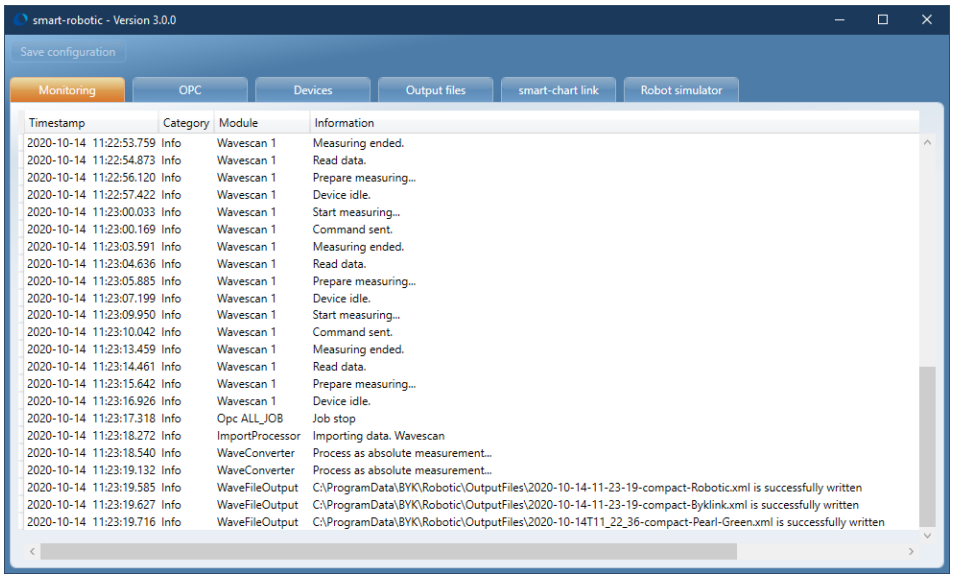


Illustration 23: Monitoring tab in smart-robotic

Only raw data will be measured – no processing and evaluation takes place. This allows very fast measurements by the robot. To store the measurement results:

- If **smart-chart** is used, the measurement results will be written into **smart-chart** database – according to existing configuration of color standards and check-zone organizers.
- If **smart-chart** is not used, the measurement results will be written to files on disk for external processing and evaluation.

For more details on operation in the productive environment see Operating Instructions for **smart-robotic**.

5 Checking

Due to the underlying measurement principle, no calibration of the instrument is required.

5.1 Principle

It is recommended, however, to check the functionality of the instrument at regular intervals (about once every 3 months).

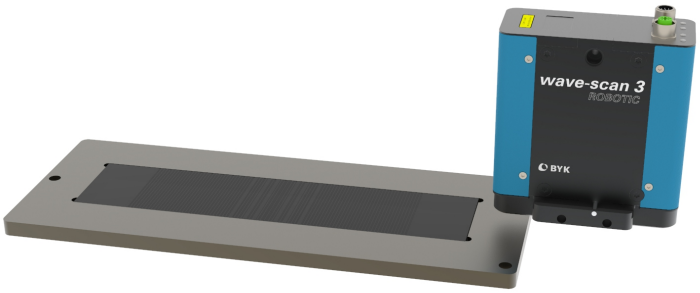


Illustration 24: Instrument and checking tile

The reference tile included with delivery is provided for this purpose.

5.2 Mounting

Mount the test tile near the robot at the position intended for the instrument test. The robot is to be programmed to reach the checking tile.

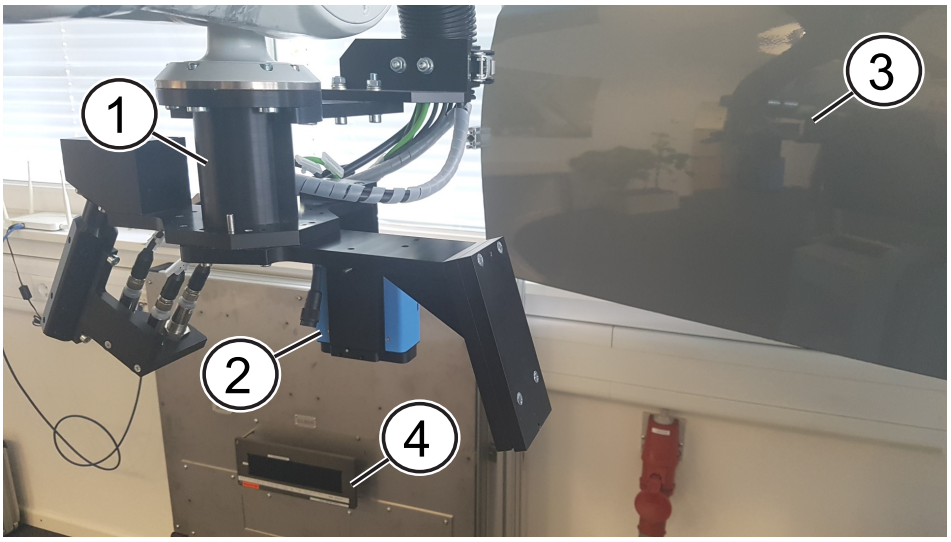


Illustration 25: Mounting of checking tile

1	Robot arm with rotable adapter
2	Instrument on rotable adapter
3	Car body / part in robot cell
4	Checking tile mounted to wall

5.3 Procedure

Perform a measurement with the robot. The values for a correct reading are printed in the retraceable certificate and on the reference tile. These values can be entered in smart-robotic for a pass / fail check.

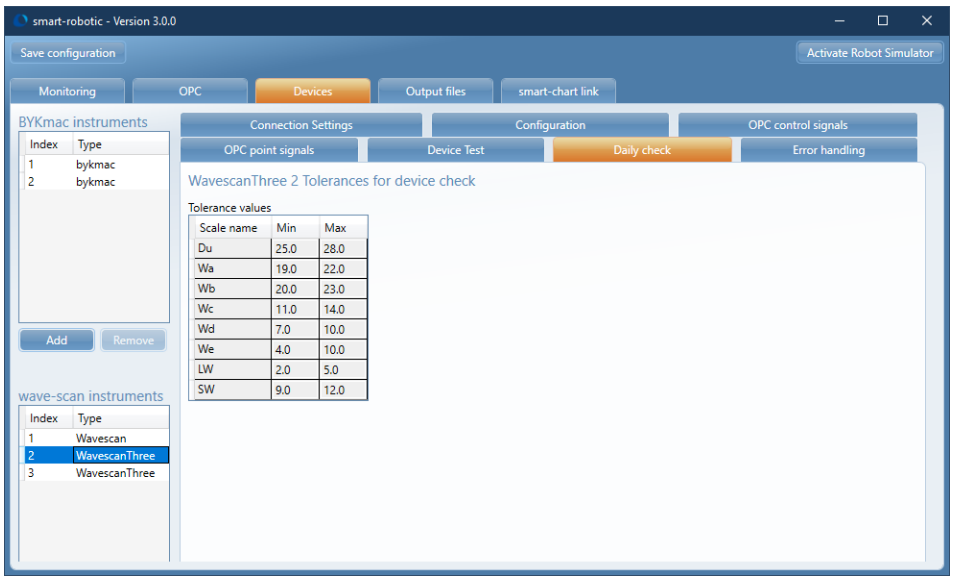


Illustration 26: Daily check in smart-robotic

If the value measured on the reference tile is within the printed tolerance range, the requirements are met.

If the mean value is not within the desired tolerance range, try carefully cleaning the test tile. If this produces no improvement, please contact our customer service department.

http://www.byk-instruments.com/contact-infos

6 Appendix

6.1 Cleaning and Maintenance

6.1.1 Cleaning the Test Tile

Since the surface of the test tile is highly sensitive, cleaning must be undertaken with great care.

To clean standards, use a new lint-free cloth, dust-free lens paper or an optical cloth as included with the device.

Apply only slight pressure when cleaning, and ensure the cloth is free of dust or other particles that could damage the surface.

For dirt that is difficult to remove, use a pre-moistened optical cloth. Then wipe the surface with a dry optical cloth.

An exact verification is not possible unless the test tile is in perfect condition. If the condition of the test tile seems doubtful because of its appearance or measurement errors, have it checked by the manufacturer.

6.1.2 Usage of Reference Tile

To ensure a precise instrument test, only original test tiles from the manufacturer should be used. Their surface must not be touched and must be protected against scratches.

Due to environmental influences, however, the values of test tiles can change over the course of time even if they are handled gently.

For this reason, have the test tiles checked by the manufacturer at regular intervals (annual checks are recommended).

6.2 Delivery Notes

6.2.1 Product Highlights

- State-of-the-art chip technology with high speed computing power – needed for calculation of scales using e.g. Fast Fourier Transformation
- New LAN interface - today´s industry standard
- New, flexible detachable mount - compatible to predecessor
- New smart-robotic: Interface software with integration ofprevious byk-LINK functions and minimum migration effort

6.2.2 Product Features

- Automatic, non-contact measurement at the line
- Classical LW and SW, modern W_a … W_e and customer specific scales
- Structure spectrum to analyze appearance changes for optimization
- Dullness and DOI measurement independent of the paint system
- Software smart-process for data analysis and documentation
- For flat and curved surfaces (radius > 500 mm)
- Small and light weight sensor

6.2.3 Delivery Content

- Instrument (7410)
- Checking tile (4833)
- Power cable kit (torsion resistant, drag chain, oil resistant)
- Data cable kit (torsion resistant, drag chain, oil resistant)
- USB type C cable for instrument initialization
- Mounting kit (hex key, screws, technical drawing)
- Software **smart-process** (with licenses for 2 PCs)
- Software **smart-robotic** (communication software)
- Retraceable certificate
- Safety Instructions
- Carrying case
- 2-day training

6.2.4 Download Links

6.2.4.1 Instrument Software

- **Smart-process** (including **smart-robotic** and device driver)
- Operating Instructions (**smart-robotic**): 300 003 099 - 2010

https://www.byk-instruments.com/software#wave-scan

6.2.4.2 Instrument Documentation

- Safety Instructions: 301 200 080 - 2004
- Operating Instructions: 301 200 141 - 2010

https://www.byk-instruments.com/p/7410

6.2.5 Accessories List

https://www.byk-instruments.com/c/smart-process/p/4831

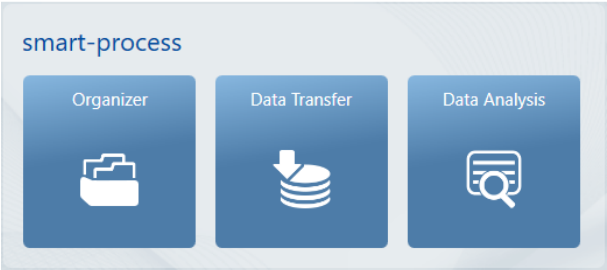


Illustration 27: Additional license for smart-process

https://www.byk-instruments.com/c/p/4833

Illustration 28: Checking tile for wave-scan 3 ROBOTIC

6.3 Error Messages

ID	Message Text
550	Acquired measurement data is not valid
555	Measurement timeout
560	Device temperature too high
561	Device temperature too low
601	Initialization error
614	Component not initialized
1001	Camera capture timeout
1002	Camera initialization timeout
1401	IR laser error detected
1405	Out of linear range - dullness
1406	Not measurable - dullness
1407	Not measurable - dull surface
1408	Out of linear range - dullness > xx, steep slope
1409	Out of linear range - steep slope
1410	Not measurable - dullness > xx, very steep slope
1411	Not measurable - very steep slope
1413	Image saturated
1415	Measurement aborted
1422	Measurement failed

6.4 System Requirements

Operating system	Microsoft Windows® 10 v.1607 or later
Runtime	Microsoft® .NET core 3.1.0 or later
Hardware	i3, 2.5 GHz; i7 recommended, or equivalent
Memory	4-8 GB RAM, 16 GB recommended
Hard-disk capacity	4 GB during installation
Monitor resolution	1280 x 1024 pixel or higher

6.5 Technical Data

6.5.1 Measuring Data

Light source	Laser Diode LED and IR-SLD
Laser diode	Laser Class 1, P ≤ 390 µW, λ=670 nm, DIN EN 60825-1:2015-07
Measure range	Dullness: 1 to 40 LW, SW: 0 to 100 Wa – We: 0 to 100
Structure spectrum	Dullness: < 0.1 mm Wa: 0.1 to 0.3 mm Wb: 0.3 to 1.0 mm Wc: 1.0 to 3.0 mm Wd: 3.0 to 10.0 mm We: 10.0 to 30.0 mm
Scan length	5 / 10 / 20 cm
Scan speed	50 to 150 mm/sec
Repeatability	du < 40: 4% or > 0.4 (standard deviation) du > 40: 6% or > 0.6 (standard deviation)
Reproducibility	du < 40: 6% or > 0.6 (standard deviation) du > 40: 8% or > 0.8 (standard deviation)
Distance to surface	15 ± 2mm
Angle to perpendicular	± 2°
Object radius	> 500 mm
Smallest sample size	35 mm x 150 mm
Resolution	375 pixel per cm
Memory capacity	n/a – immediate data transfer

6.5.2 General Data

Temperature range	Storage: 0° C to 60° C Operation: 10° C to 40° C
Relative humidity	Up to 85% non-condensing at 35° C
Operation altitude	Up to 2000 m (6561 ft)
Dimensions (LxWxH)	112 x 59 x 131 mm (4.4 x 2.4 x 4.8 in)
Weight	Ca. 550 g (1.21 lbs)
Interface	Initialization: USB-C (USB 2.0) Operation: Ethernet LAN (M12-A)
Power supply (input)	Initialization: 5 VDC ; max. 1.75 A (USB-C) Operation: 24 VDC ; max. 0.75 (M12-A)

Download your software from:
https://www.byk-instruments.com/software

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

Find more information on our products and services:
https://www.byk-instruments.com

301 200 141 E 2010