

Measure what you see.

BYK-mac i BYK-mac i COLOR

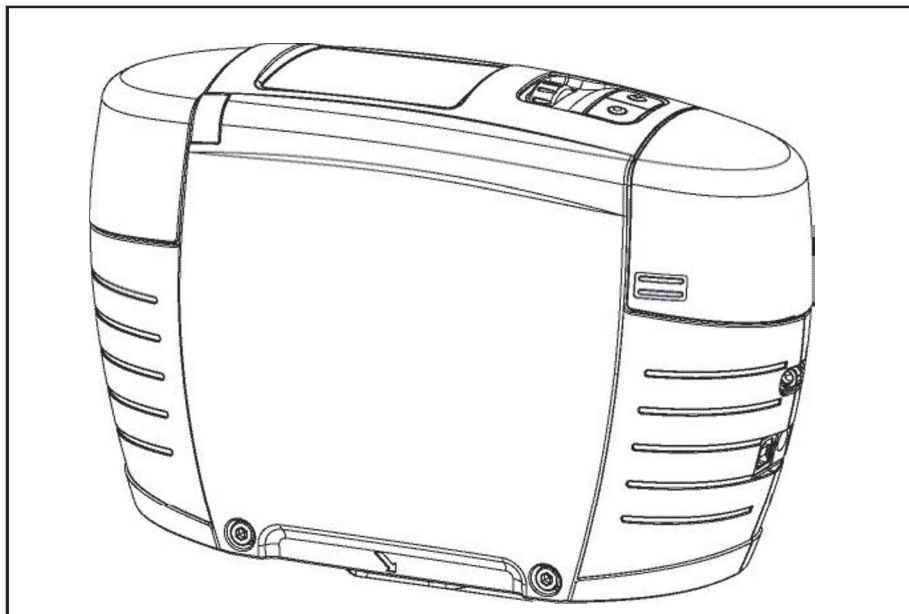


Manual

BYK-mac i
BYK-mac i COLOR

Type No. 345 000 001

Manual



Patent pending

300 000 891 E 2601

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Dear customer,

thank you for having decided for 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 & Application Support
- Application and Technical Seminars
- Repair & Certification Service

BYK-Gardner is part of the Additives and Instrument Division of ALTANA AG, 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

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1. Safety instructions

- Before operating the instrument the first time, please read the operating instructions and take particular notice of the safety instructions.
- If you use the unit and accessories properly, there are no hazards to fear.
- This product is equipped with safety features. Nevertheless, read the safety warnings carefully and use the product only as described in these instructions to avoid accidental injury or damage.
- No claims of product liability or warranty can be honored if the device is not operated in accordance with the operating instructions.
- Keep these instructions for future reference.
- If you pass this instrument to somebody else, make sure to include these instructions.

The following symbols and terms are used.



This symbol warns of the danger of injury.



This symbol warns of the danger of injury caused by electricity.



This sign points out additional information.

DANGER

The term **DANGER** warns of possible severe injuries and danger to life.

WARNING

The term **WARNING** warns of injuries and severe material damage.

CAUTION

The term **CAUTION** warns of slight injuries or damage.

DANGER injuries possible



- 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.
- Safety advices for batteries and rechargeable battery pack: Do not crush or dismantle or apply any other strong impacts or shocks. Do not heat or incinerate. Do not immerse in any liquid. Do not place on or near fires, stoves or other high temperature locations, in direct sunshine or in micro-wave ovens. Do not insert into equipment designed to be hermetically sealed. This may cause explosion or release harmful substances.



- 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.
- Do not perform any repairs on the unit yourself. The unit must be opened by trained professionals only. Please contact our customer service department in such cases.
- The measurement device and accessories may be disconnected from the power supply as follows:
Instrument:
 - a) by removing the battery compartment or
 - b) by removing the rechargeable battery pack or

unit on the docking station

c) by removing the measurement unit from the docking station

Docking station:

a) by disconnecting the plug from the power supply

b) by disconnecting the power supply unit plug from the socket

The power supply unit can be disconnect from the power supply by disconnecting the power connection line plug from the socket. Make certain that the power supply unit plug is easily accessible. Use only the power supply connection line included with delivery.



- When working with the batteries and the rechargeable battery pack, make certain there is no short circuit on the contacts (e.g. due to damaged insulation). Metallic objects must not come in contact with the bare contacts. Immediately discontinue use of the batteries if they emit an unusual smell, feel hot, change color or appear abnormal in any other way.

WARNING severe material damage



- The measurement unit consists of sensitive optical and electronic precision parts. Prevent it from being dropped, bumped or shaken!
- Avoid exposure to continuous humidity and condensation. Avoid splashing with water, chemicals or other liquids.
- Please use only accessories that are available for the unit.
- Only devices that meet the requirements for low-voltage safety may be connected to the USB interface.

CAUTION material damage

- Do not allow any foreign objects to get into the measurement opening.
- Do not expose the unit to direct sunlight for extended periods of time. Do not store it in a hot or dusty environment. Use the instrument case for storage.
- Align the protection cap when the instrument is not in use.
- Avoid prolonged high relative humidity and do not allow condensation water.
- **Do not use any acetone for cleaning the unit!** The unit housing is resistant to many solvents. For cleaning you should use a soft, moist cloth. Excessive dirt and dust can be removed with ethanol or cleaning alcohol.
- In case you intend not to use the instrument for a longer period of time, take out the rechargeable batteries.
- Never use different types of batteries.

Additional information on use:

- You will find the technical data for all system components such as the measurement unit and battery compartment on the respective manufacturer's plates and in the section Technical Data



- Batteries and rechargeable batteries are special waste and must therefore not be disposed of with household trash. Make certain to observe the disposal instructions of the battery or rechargeable battery manufacturer. Insulate the terminals of the batteries with adhesive tape or similar materials before disposal.

2. System description and delivery notes

BYK-mac i COLOR measures color traditionally at five aspecular angles (15°/25°/45°/75°/110°) with a 45° illumination. Additional color measurement "behind" the gloss for color travel of interference pigments is implemented at -15°. Besides color, the **BYK-mac i** uses additional illuminations to simulate sparkle under 15° /45° and 75°. Diffused illumination for graininess evaluation is created by two white coated hemispheres. Detection is performed by a high resolution camera situated perpendicular to the surface.

Additonal out-of-plane sensors detect fluorescent light excited in the visible range and quantify it by the Intensity Emissiion Value.

The instrument is operated by the operate button and the mode-scroll wheel. Functions described in this manual in regards to effect measurement are only available with **BYK-mac i**.

The instrument complies with the following standards: DIN 5033, 5036, 6174, 6175-2, DIN EN ISO 11664, SO 7724; ASTM D2244, E308, E2194, E 1164, SAE J1545.

BYK - mac i 23mm*	7030
BYK - mac i 12mm*	7034
BYK - mac i Sensor 23mm	7031
BYK - mac i Sensor 12mm	7035

Comes complete with:

Multi-angle spectrophotometer, black calibration standard, white calibration standard with certificate, color and effect checking reference, protective cap, cleaning set for bottom plate, two light protection covers, seal replacement kit, *smart-chart software, docking station with USB cable for memory transfer, instrument interface cable for online data transfer, 2 rechargeable Li-ion battery packs, battery holder, 4 AA batteries, short instructions, operating manual via download, carrying case, training.

BYK - mac i COLOR*	7032
BYK - mac i COLOR Sensor	7033

Comes complete with:

Multi-angle spectrophotometer, black calibration standard, white calibration standard with certificate, color checking reference, protective cap, cleaning set for bottom plate, two light protection covers, seal replacement kit, *smart-chart software, docking station with USB cable for memory transfer, instrument interface cable for online data transfer, 2 rechargeable Li-ion battery packs, battery holder, 4 AA batteries, short instructions, operating manual via download, carrying case, training.

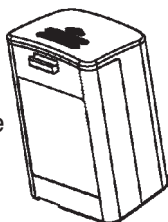
Accessories and spare parts

Black calibration standard	7044
Protective cap 23mm Ø aperture	6336
Protective cap 12mm Ø aperture	6399
Docking station	6360
USB interface cable, instrument	6337
Interface cable, online	6413
Battery pack	6359
Cleaning set for bottom plate	6364
Seal Replacement Set	6348
Light Protection Cover	6414
smart-process BYK-mac i	4888
smart-lab BYK-mac i	4897

3. Power supply

Before operating the instrument for the first time, please read the operating manual and take particular notice of the Safety Instructions.

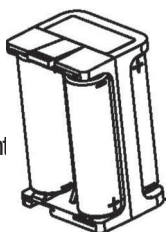
Rechargeable
battery
pack



Powering the instrument

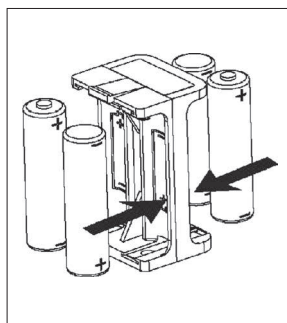
The measurement unit can be operated either with a rechargeable battery pack or with AA (LR6) alkaline batteries.

Battery
compartment



Battery:

To operate the instrument using batteries, the battery compartment must be fitted with four 1.5-V AA(LR6) batteries

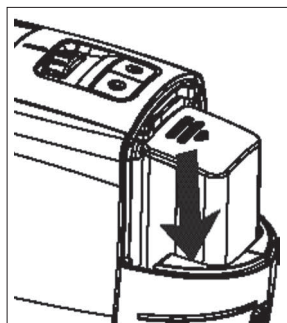


 Ensure that the batteries are correctly oriented in the compartment according to the (+) and (-) marks.

Use only alkaline batteries (AA /LR6)!

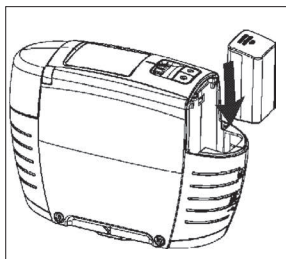
When the battery voltage falls below the required operating voltage, the following message appears on the display:

“Battery Low !”



Insert the battery box into the battery compartment and press it down so that the strap moves into the cut-out of the housing.

Set the battery compartment cover in the slot again. Lock the cover by sliding it downwards until it snaps.



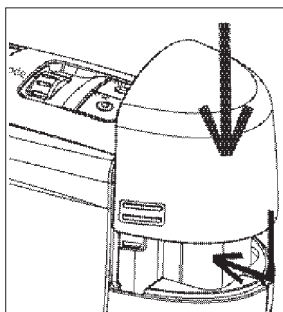
Rechargeable battery pack

To operate the instrument with the rechargeable battery pack, make sure it is inserted until it locks in place.

When inserting the rechargeable battery pack, ensure that its contacts are aligned with those of the instrument. See adjacent figure.

The capacity of the rechargeable battery pack included with delivery is sufficient for about 1000 measurements. When the voltage of the rechargeable battery pack falls below the required operating voltage the following message appears on the display:

“Battery Low !”



Set the battery compartment cover in the slot again. Lock the cover by sliding it downwards until it snaps.

Note: To ensure uniform utilization, the rechargeable battery packs should be exchanged regularly between instrument and docking station (weekly recommended).

Docking station power supply

Power is supplied to the docking station through the external power supply unit. Connect the external power supply unit to the docking station. Connect the appropriate end of the power connection line to the power supply unit and the plug end of the power connection line to the power outlet. Please verify that the specifications of the power supply unit match the power source in terms of current and voltage.

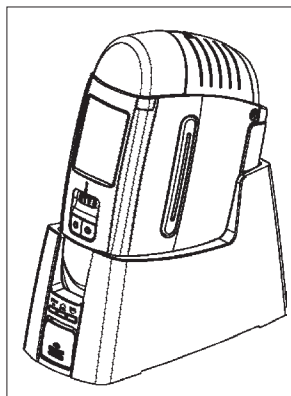
Charging the rechargeable battery pack

The rechargeable battery pack is charged in the docking station. Charging time is approx. 2 hours.

1. Battery pack in the instrument:

The lithium ion rechargeable battery will begin charging immediately upon insertion of the instrument into the docking station. To do this, power must be supplied to the docking station through the corresponding power supply unit.

Insert the measurement unit into the docking station as shown in the illustration.

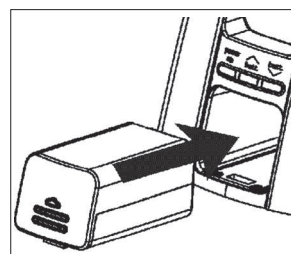


2. Battery pack in docking station:

A second charging shaft is located below the shaft for the instrument. Insert the second battery pack here for charging, so it will be handy at any time to replace the other battery when it is discharged.



The compartment for AA batteries may not be inserted into the charging shaft.



Charging indicator for:

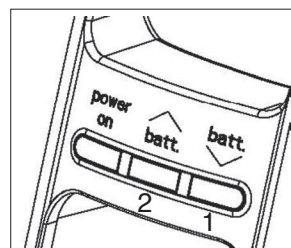
1: additional battery pack

2: instrument

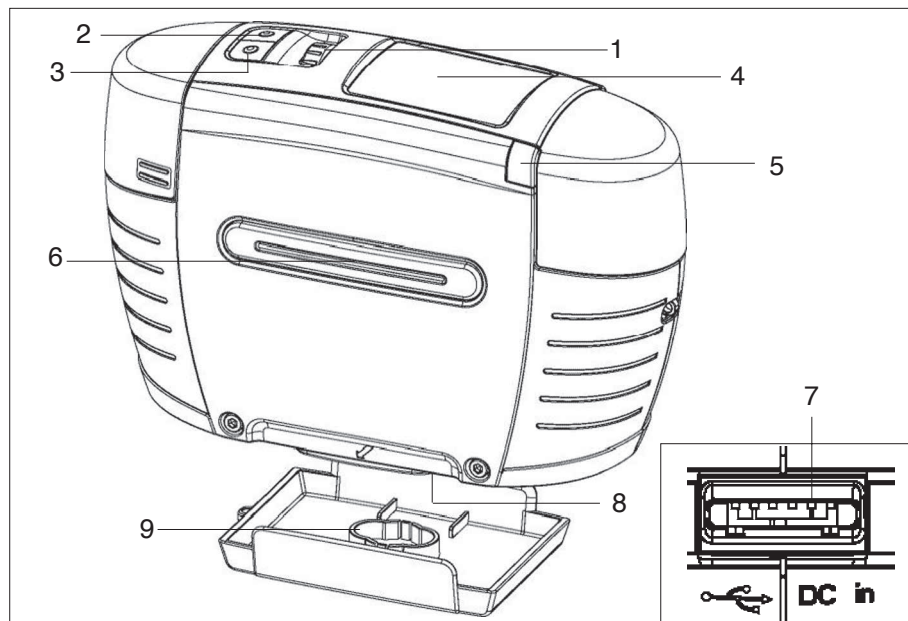
Indication light:

green: ready

red: charging.



4. Controls

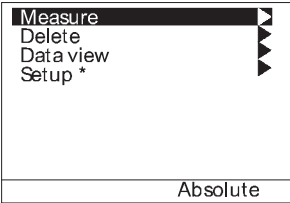


Measurement unit

- 1 Mode scroll wheel: switch on and menu selection
- 2 esc button: changes between main menu and measurement mode
- 3 std button: short-cut to difference mode
- 4 Display for user guidance and measurement values
- 5 Signal lamps
- 6 Operate button (measurement button): switch on and measure
- 7 Docking station and online cable connector
- 8 Pins to detect correct placement on sample surface
- 9 Protective cap

5. Getting started

Turning on the unit



To turn on the unit, press the mode scroll wheel or the operate button.

The main menu appears.

For the first steps select "Absolute" from the "Measure" menu.

D65/10° 1/4			
	L*	a*	b*
-15°	90.92	-56.11	-34.49
15°	87.59	-58.69	-33.76
25°	55.96	-38.01	-31.64
45°	25.76	-11.42	-27.05
75°	12.48	2.81	-24.02
110°	7.75	5.73	-21.78
Absolute X			

Place the instrument on the sample and press "operate". While the reading is in progress, the light diodes are green and "Measuring" is displayed. Keep the instrument stable as long as the green lights are on. According to the preselected number of measurements to be averaged, the instrument is waiting for additional readings.

Having finished all readings the result is displayed.

D65/10° 2/4			
	L*	C*	h
-15°	90.92	65.86	211.58
15°	87.59	67.71	209.91
25°	55.96	49.46	219.77
45°	25.76	29.37	247.10
75°	12.48	24.19	276.67
110°	7.75	22.52	284.74
Absolute X			

To see all measurement data you can switch between the different displays with the scroll wheel. The small black rectangle in the lower left indicates the number of pages.

D65/10° 3/4			
	S _G	S _I	S _q
15°	4.0	7.22	26.07
45°	3.43	5.86	24.98
75°	2.39	9.47	8.78
G 4.69			
Absolute X			

Sparkle and Graininess data is only available when using the BYK-mac i.

D65/10° 4/4	
Int-Em	10.58
Absolute X	

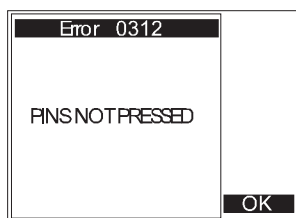
The Intensity Emission value quantifies fluorescent light excited in the visible range.

The amount of fluorescent light is determined for daylight D65 illumination.

The following error messages might appear during measurement.

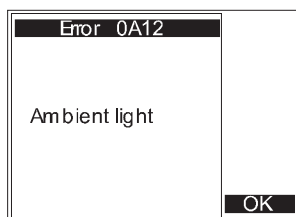
A warning signal is heard and the light diodes flash red. At the same time, a message appears in the display indicating the type of error.

"Pins not pressed"



Not all of the pins have been pressed thoroughly on the sample surface (e.g. curvature too high, instrument has been moved during measurement). Confirm the message by pressing the scroll wheel or the operate button and repeat the reading.

"Ambient light"



Appears when ambient light enters the measurement aperture. Confirm the message by pressing the scroll wheel or the operate button and repeat the reading.

This warning can also appear when measuring bright colors (white and light silver) in direct sunlight. Very bright light adds to the internal reflection of the coating.

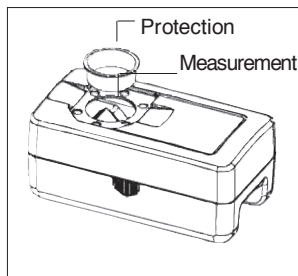


In that case please use the light protection cover which is supplied with the instrument. It is a black, flexible foam attachment that snaps on the bottom plate of the instrument. You will find it in the carrying case under the black trap.

6. Calibrate

Calibration Information

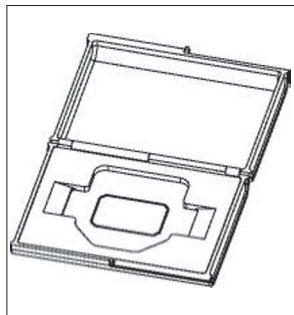
Standards



Black trap

The instrument comes with 2 calibration standards.

The black trap is used to perform the zero reflectance calibration (black calibration). Always store the black trap with the protection cover in place when not in use.

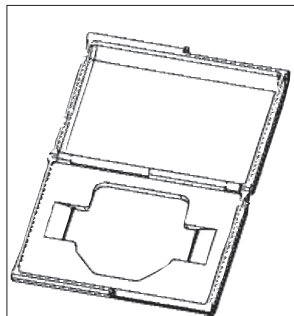


White Standard

The white standard is fixed in a case that has a hinged cover. It is used to perform the 100% reflectance calibration and to calibrate the camera. Additionally two checking standards are supplied to audit instrument performance:

A color reference for color and an effect reference for sparkle and graininess (only with BYK-mac i).

When calibration is required, the device will display a message.



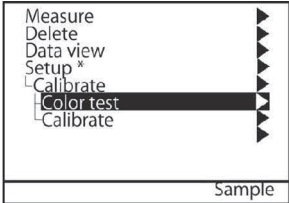
Color reference, effect reference

The color test on the color reference must be accomplished every 30 days. Black and white calibration must be accomplished every 3 months. It is recommended to perform the effect check also once per month.

Calibration Notes

- Dirt or dust in the optics area will cause an inaccurate calibration reading. Therefore, always use the protective cap, if no readings are taken.
- The standards and black trap should be cleaned periodically. For cleaning procedure see section "Cleaning and Maintenance". Please make sure that the standards are not scratched.
- The color reference is to some extent temperature dependent. Therefore, make sure to perform calibration and color test in laboratory environment: temperature (20 – 25°C) and humidity (30 – 60%) controlled.
- Do not move the instrument while taking a calibration measurement. If motion is detected, an error message will be displayed and calibration is aborted.
- When moving from cold to warm environment, there is a danger of condensation. For this reason, you should wait for an appropriate amount of time to allow the optical components to adjust before calibrating and using the unit.

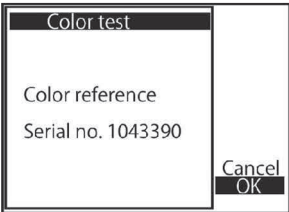
6.1 Color test



Choose “Color test“ from the "Calibrate" menu.

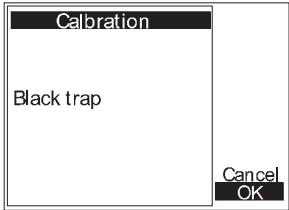
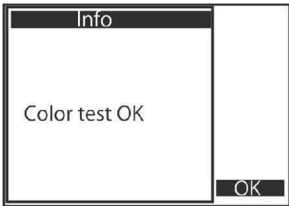
Open the cover of the color reference and position the instrument on the standard. The instrument snaps into the indentation of the standard and can only be positioned in one direction.

Choose "OK" with the scroll wheel.



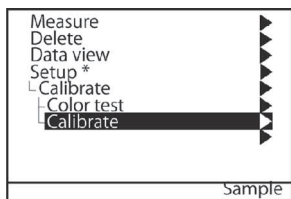
When the color test is completed, an affirmation is shown in the display.

Confirm by pressing the operate button or the wheel to return to the main menu.



If the reading of the color reference was out of tolerance, a black and white calibration is necessary. The instrument leads you directly to the calibration display.

6.2 Calibrate

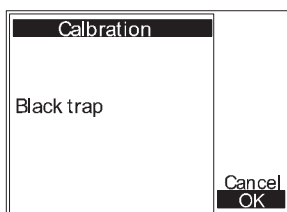


Turn the unit on by pressing either the menu scroll wheel or the operate button.

Choose the menu item Calibrate from the Calibrate menu.



Remove the protective cap. Place the instrument on the **black trap**. Make sure that the instrument fits into the indentation of the black trap.



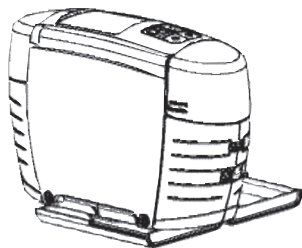
Choose OK with the wheel and press the operate button to perform the black trap reading.

Black trap

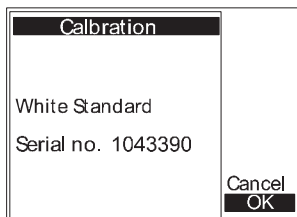
The reading process is indicated on the display.



Choosing Cancel will abort the calibration procedure and calibration will not be updated.



When black trap calibration is completed, the instrument must be placed on the **white standard**.

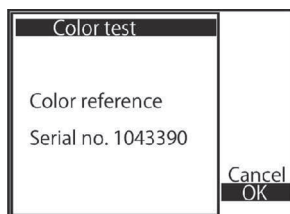


Position the instrument as thoroughly on the **white standard** as it is described for the black trap and press the operate button.

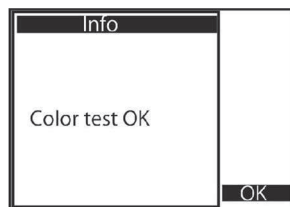
White Standard



The reading process is indicated on the display. When calibration is complete, an affirmation is shown in the display. Confirm by pressing the Operate button or the wheel to proceed to the color test.



Choose "OK" with the scroll wheel.

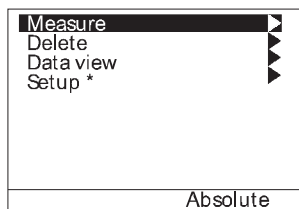


When the color test is completed, an affirmation is shown in the display. Confirm by pressing the operate button or the wheel to return to the main menu.



If an error occurs during calibration, try to read the plaque again. If the error message still occurs, refer to section "Errors and warning messages".

6.3 Effect test



Choose "Absolute" from the "Measure" menu. The basic configuration is the average of three measurements.

Open the cover of the effect checking standard and position the instrument on the standard. The instrument snaps into the indentation of the standard and can only be positioned in one direction.

	D65/10°			3/3
	S _G	S _I	S _q	
15°	4.0	7.22	26.07	
45°	3.43	5.86	24.98	
75°	2.39	9.47	8.78	
G				4.69
Absolute				⊗

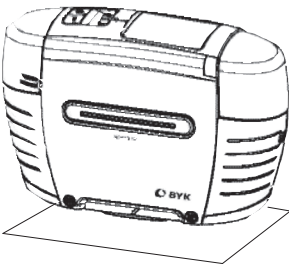
Perform three measurements.

Compare the average of the measurements with the range indicated on the lid.

If the values measured on the effect standard are within the printed tolerance range, the requirements are met.

If the mean value is not within the desired tolerance range, try carefully cleaning the effect standard. If this produces no improvement, please contact our Customer Service department.

7. Measurement techniques

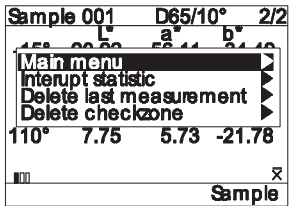
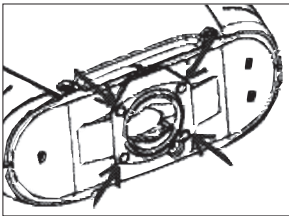


In order to obtain accurate and repeatable measurements, the bottom of the instrument must be aligned flat on the sample surface. Do not move the instrument while measuring.

To perform a measurement, press the operate key or set-up the instrument to automatically perform a measurement when the four pins are pressed down (see chapter "Setup/Instrument").

You can adjust the number of readings in "Setup/Measurement parameters/Sample/Statistic/Number of measurements". When using an Organizer, the number of readings is predefined.

You can adjust the sensitivity of the pins to the sample curvature. Refer to the paragraph "Sample curvature" in chapter "Setup/Instrument".

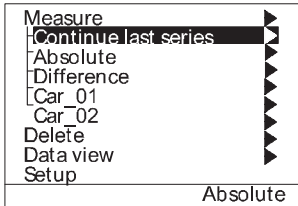


Pressing the mode wheel while being in measurement mode opens a submenu:

- Main menu
- Interrupt statistic
- Delete last measurement
- Delete checkzone.

By pressing the "esc" button you can switch between measurement mode and the main menu.

8. Measure



Select the menu item Measure by pressing the operate button/scroll wheel.

A selection menu appears.

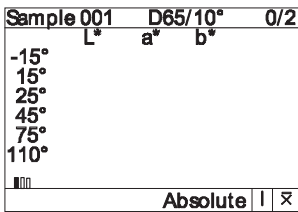
”Continue last series”: To continue the last test series. If no series is stored, it will be created.

”Absolute”: To measure absolute data.

”Difference”: To measure differences. Select an existing standard, create a new one or use the function „Auto Standard“.

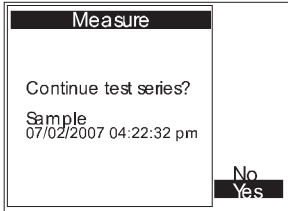
”car_01”: To take readings according to a predefined measurement sequence (organizer).

8.1 Continue last series



”Continue last series” leads you directly to the measuring sequence of the last series. Press operate to start the reading.

8.2 Absolute



You are asked if you like to continue the test series.

Sample 004	D65/10°		2/2
	L*	a*	b*
-15°	90.92	-56.11	-34.49
15°	87.59	-58.69	-33.76
25°	55.96	-38.01	-31.64
45°	25.76	-11.42	-27.05
75°	12.48	2.81	-24.02
110°	7.75	5.73	-21.78
Absolute ↗			

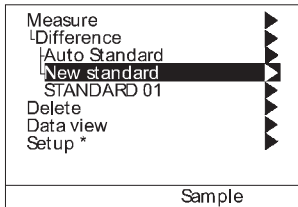
Confirm by pressing the scroll wheel leads you to the last test series.

You can continue to take readings by pressing "operate".

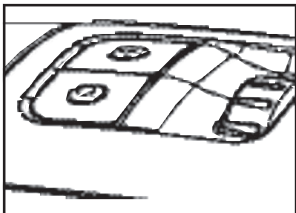
Sample 001	D65/10°		0/2
	L*	a*	b*
-15°			
15°			
25°			
45°			
75°			
110°			
Absolute ↗			

Choosing "No" opens a new test series, starting with Sample 001. Press operate to continue.

8.3 Difference



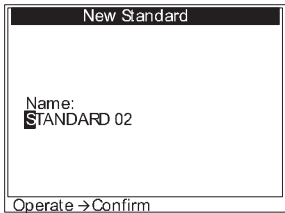
Choosing "Difference" leads you to a selection menu. You can choose an existing standard, create a new standard or use the function „Auto Standard“.



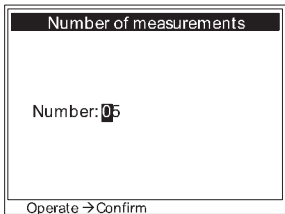
std - Button

You can easily access the "Difference" menu by pressing the std button on top of the instrument. You can choose an existing standard or you can create a new standard as described before.

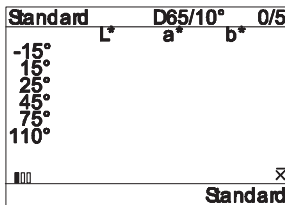
New Standard



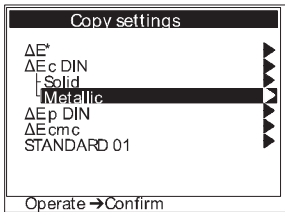
You are asked to input a name. You can accept the predefined suggestion or change the character by turning the scroll wheel. When you press the wheel, the highlighted position moves to the next character. If you did a wrong input, you can move backward with the esc button.



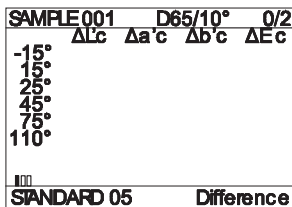
After inputting the name, you can input the number of readings by using the scroll wheel.



Then measure the standard by pressing "operate".

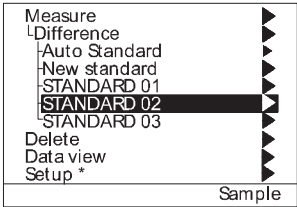


After the readings you are asked to copy settings. You can choose among several predefined settings:
Solid: Displays only 45° angle and no effect parameters.
Metallic: Displays all 6 color angles and effect parameters.

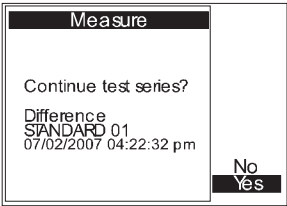


The instrument is now ready to take sample readings.

Existing standard



Choose the appropriate standard from the list.



You are asked to continue the last series.

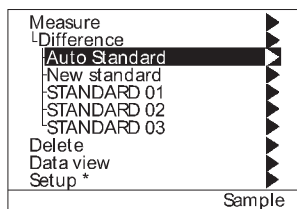
SAMPLE 003		D65/10°		2/2
	ΔL^*	Δa^*	Δb^*	ΔE^*
-15°	-0.55	-0.00	-0.32	0.64
-15°	0.43	-0.16	0.24	0.52
25°	0.27	-0.16	0.21	0.30
45°	0.43	-0.15	0.19	0.49
75°	0.46	-0.13	0.15	0.50
110°	0.77	-0.18	0.21	0.02
STANDARD 02		Difference		

If you choose "Yes", you can directly continue the series by pressing the "operate" button.

SAMPLE 001		D65/10°		0/2
	ΔL^*	Δa^*	Δb^*	ΔE^*
-15°				
-15°				
25°				
45°				
75°				
110°				
STANDARD 02		Difference		

In case you choose "No", a new series is started.

Auto standard



The function „Auto Standard“ is displayed if at least one standard is stored in the memory. When choosing this function the closest standard compared to the sample is automatically recalled.

Auto standard				0/1
	L*c	a*c	b*c	
-15°				
15°				
25°				
45°				
75°				
110°				

}				

Choose „Auto Standard“ from the menu and press operate to start the sample reading.

SAMPLE 003	D65/10°			1/2
	ΔL^*c	Δa^*c	Δb^*c	ΔE_c
-15°	-0.55	-0.00	-0.32	0.64
15°	0.43	-0.16	0.24	0.52
25°	0.27	-0.16	0.21	0.30
45°	0.43	-0.15	0.19	0.49
75°	0.46	-0.13	0.15	0.50
110°	0.77	-0.18	0.21	0.02

STANDARD 02	Difference			

If only one standard is close to the sample, this standard is automatically selected and the initial sample reading is compared to this standard.

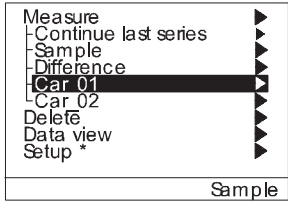
Some Standards close Select Standard	
Smaragd green	
Dark green	
Lake green	
Racing green	

If more than one standard is close to the sample, you have the choice to select from the list of standards.

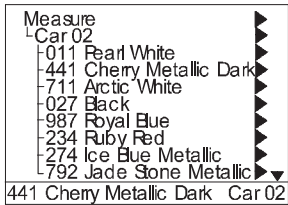
No good match! Select Standard	
New standard	
All standards	
Ruby red	
Dark green	
Deep sea blue	

If no standard is close, the message „No good match“ is displayed and you can either measure a new standard or select from the list of all standards stored in the instrument.

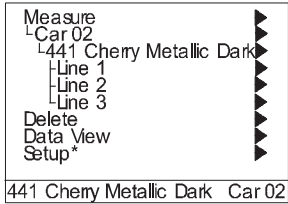
8.4 Organizer



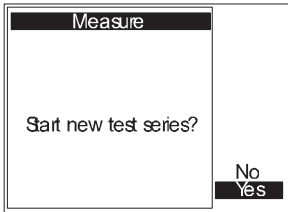
An organizer file defines a measurement sequence for user guidance, e. g. measuring a car body with several checkzones. These files can be generated with the smart-process software and transferred to the instrument.



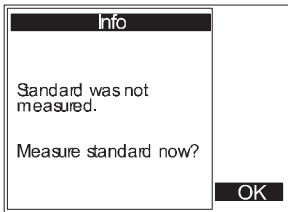
Once an Organizer is selected, a menu appears for Parameter 2 (Color).



After you have selected the appropriate color, a selection menu appears for Parameter 3 (e.g. automotive paint line).



If "Input Comment" is activated in the organizer, you are prompted to enter additional information.
If "Input ID" is activated, you are prompted to enter a code, e.g. the vehicle ID.
After definition of all parameters you are asked to start a new test series.



If the answer is "No", the instrument returns to the main menu.
If the answer is "Yes", the instrument goes to the measurement mode.
In case the standard (color) has not been stored in the instrument, you can measure it now. Please proceed as described at "Measure/New standard".

Hood Center	D65/10°			0/2
	ΔL^*	Δa^*	Δb^*	ΔE_c
-15°				
15°				
25°				
45°				
75°				
110°				
	ΔE_{avg}			
NOI				
011 Pearl White	Car02			

After the standard has been measured, or when it is already stored in the instrument, the name of the checkzone to be measured first, appears on the left side of the display.

The number of performed and predefined measurements (0 of 2) appears in the upper right corner.

Press the operate button to start the reading.

Hood	Center	D65/10°		2/2
	ΔL^*	Δa^*	Δb^*	ΔE_c
-15°	-0.55	-0.00	-0.32	0.64
15°	0.43	-0.16	0.24	0.52
25°	0.27	-0.16	0.21	0.30
45°	0.43	-0.15	0.19	0.49
75°	0.46	-0.13	0.15	0.50
110°	0.77	-0.18	0.21	0.02
ΔE_{avg}				
NOI				
011 Pearl White		Car02		

Once the number of measurements for the checkzone is reached, a double audio signal is heard.

The display shows the results of the measurement and indicates that the measurement of the checkzone is complete (e.g.2/2).

Door Left	D65/10°			0/2
	ΔL^*	Δa^*	Δb^*	ΔE_c
-15°				
15°				
25°				
45°				
75°				
110°				
	ΔE_{avg}			
NOI				
011 Pearl White	Car02			

Pressing briefly the operate button allows the next checkzone to appear in the display.

Once all checkzones have been measured, the instrument returns to the Measure menu.

Pass/Fail Mode

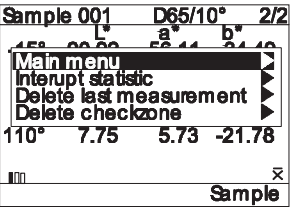
Door Left	D65/10°	1/2
Fail		
011 Pearl White	Car 02)	

In the software smart-process tolerances can be set for each color. If Pass/Fail mode is selected in the organizer and the measurements are within the tolerance range, PASS is indicated in the display. If not, FAIL.

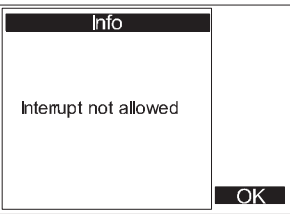
Hood Center	D65/10°			2/2
	ΔL^*	Δa^*	Δb^*	ΔE_p
-15°	-0.55	-0.00	-0.32	0.64
15°	0.43	-0.16	0.24	0.52
25°	0.27	-0.16	0.21	0.30
45°	0.43	-0.15	0.19	0.49
75°	0.46	-0.13	0.15	0.50
110°	0.77	-0.18	0.21	0.02
	ΔE_{avg}			
011 Pearl White	Car 02			

To see which measurement value is out of tolerance, you can scroll through the display pages with the scroll wheel.

The appropriate value will be highlighted.

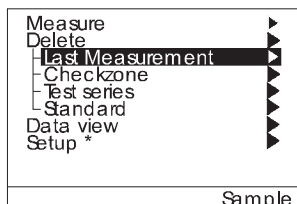


During the measurement you have access to additional functions by pressing the mode wheel. In case you took a false reading, you can delete the last measurement or a complete checkzone.



”Interrupt statistic” must be activated when the organizer is created. If not, you will get an information on the display that it is not allowed.

9. Delete



Select the menu item Delete by pressing the operate button/scroll wheel.

A selection menu appears.

"Last Measurement": To delete the last measurement of a checkzone.

"Checkzone": To delete the whole checkzone.

"Test series": To delete a test series.

"Standard": To delete a standard.

9.1 Last Measurement

Sample 004	D65/10°		2/2
	L*	a*	b*
-15°	90.92	-56.11	-34.49
15°	87.59	-58.69	-33.76
25°	55.96	-38.01	-31.64
45°	25.76	-11.42	-27.05
75°	12.48	2.81	-24.02
110°	7.75	5.73	-21.78
NOO			
Sample			

In case you took a false reading you can delete measurements.

Select the menu item "Last Measurement" by pressing the scroll wheel or the operate button.

Sample 004	D65/10°		1/2
	L*	a*	b*
-15°	90.54	-55.78	-34.62
15°	87.55	-58.23	-33.80
25°	55.12	-38.55	-31.72
45°	25.22	-11.34	-27.44
75°	12.78	2.56	-24.87
110°	7.44	5.67	-21.70
NOO			
Sample			

The last measurement is deleted and the number of the performed measurements in the upper right corner of the display is diminished by one.

9.2 Checkzone

SAMPLE 003	D65/10°			2/2
	ΔL^*c	Δa^*c	Δb^*c	ΔE^*c
-15°	-0.55	-0.00	-0.32	0.64
15°	0.43	-0.16	0.24	0.52
25°	0.27	-0.16	0.21	0.30
45°	0.43	-0.15	0.19	0.49
75°	0.46	-0.13	0.15	0.50
110°	0.77	-0.18	0.21	0.02
ΔE_{avg}				
STANDARD 02				
Difference				

To delete a whole checkzone, choose the menu item "Delete checkzone" and press the mode wheel.

D65/10°			2/2
-15°	ΔL*c	Δa*c	Δb*c
15°			ΔE*c
25°			
45°			
75°			
110°			
	ΔEavg		
STANDARD 02			Difference

The instrument is now ready again to measure the checkzone.

9.3 Test series

Delete
└ Test series
└└ All test series
└└ Absolute
└└ Difference
└└ Car 01
└└ Car 02
└└ Car 03
└└ Car 04
Data view
Sample

When you choose "Test series" from the menu, a submenu opens.

You can delete all test series or individual test series taken in absolute, difference or organizer mode.

Measure
Delete
└ Test series
└└ Absolute
└└└ 07/09/2007 11:43:23 am
└└└ 07/09/2007 11:47:18 am
└└└ 07/09/2007 11:55:44 am
└└└ 07/09/2007 01:02:31 am
Data view
Setup*
Sample

To delete the test series in absolute mode, choose "Absolute" from the menu.

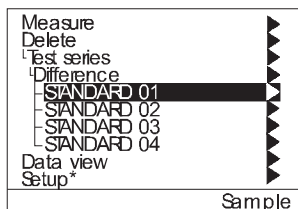
A list of the stored test series is displayed.

Choose the appropriate test series and press the operate button or the mode wheel.

Delete
Absolute
07/09/2007 11:43:23 am
Delete
Cancel

To confirm choose "Delete" with the mode wheel and press the wheel or the operate button.

If you choose "Cancel" the instrument returns to the selection menu.



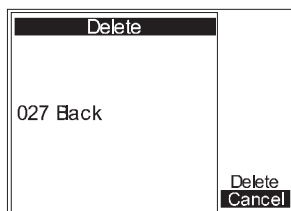
To delete test series in difference mode, you have to choose the appropriate standard first and then the test series to be deleted. Test series in Organizer mode can be deleted accordingly. The organizer itself can only be deleted with smart-process.

9.4 Standard



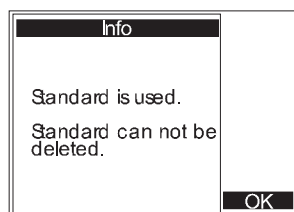
With this function you can delete standards.

Choose the appropriate standard from the list and press the mode wheel or the operate button.



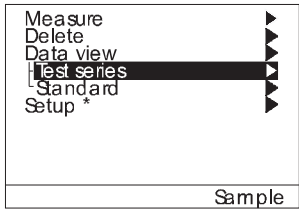
To confirm, choose "Delete" with the mode wheel and press the wheel or the operate button.

If you choose "Cancel" the instrument returns to the selection menu.



If a test series is stored in the instrument, that uses the standard, it can not be deleted. You have to delete the test series first.

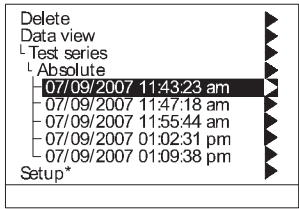
10. Data View



You can use this function to display the readings of measurements stored in the instrument.

10.1 Test series

Absolute



To view the data of readings taken in absolute mode, choose "Absolute" from the menu.

A list of all test series taken in absolute mode is displayed.

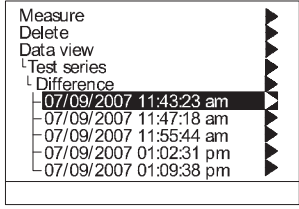
Choose the appropriate test series and press the operate button or the mode wheel.

Sample 004	D65/10°		2/2
	L*	a*	b*
-15°	90.92	-56.11	-34.49
-15°	87.59	-58.69	-33.76
25°	55.96	-38.01	-31.84
45°	25.76	-11.42	-27.05
75°	12.48	2.81	-24.02
110°	7.75	5.73	-21.78
Data view			

The data of the first reading is displayed.

Use the operate button to switch to the next reading.

Difference



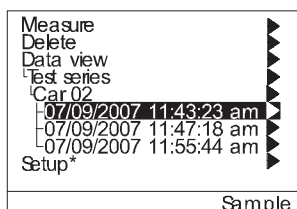
To view the data taken in difference mode, choose "Difference" from the menu.

Then select the standard and the appropriate test series by pressing the operate button or the mode wheel.

Organizer



To view the data of an organizer, choose the appropriate organizer from the list.



Then select parameter 2 (color) and the appropriate test series by pressing the operate button or the mode wheel.

Car 02 Hood		D65/10°		2/2
L*	a*	b*		
-15°	90.92	-56.11	-34.49	
15°	87.59	-58.69	-33.76	
25°	55.96	-38.01	-31.64	
45°	25.76	-11.42	-27.05	
75°	12.48	2.81	-24.02	
110°	7.75	5.73	-21.78	
Data view				

The data of the first checkzone is displayed. You can move through the different displays with the scroll wheel to see all measurement data. The small black rectangle in the lower left corner indicates the number of pages.

Car 02 Door		D65/10°		2/2
L*	a*	b*		
-15°	90.92	-56.11	-34.49	
15°	87.59	-58.69	-33.76	
25°	55.96	-38.01	-31.64	
45°	25.76	-11.42	-27.05	
75°	12.48	2.81	-24.02	
110°	7.75	5.73	-21.78	
Data view				

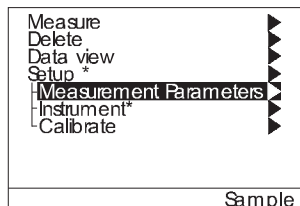
With the operate button you can move to the next checkzone.

10.2 Standard



To view the data of a standard, choose the appropriate standard from the menu.
The data of the standard is displayed.

11. Setup



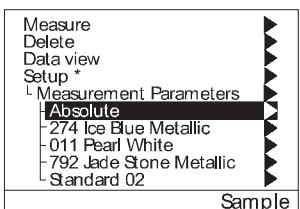
In the Setup menu you find functions to adjust general settings for:

Measurement parameters

Instrument

Calibrate

11.1 Measurement parameters



Measurement parameters can be adjusted for absolute mode or any individual standard. Select the standard you want to change and a submenu opens:

Statistic

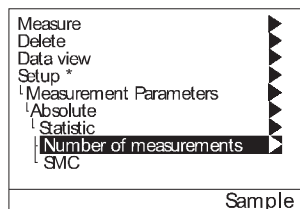
Color

Effect (only with BYK-mac i)

Fluorescence Limit

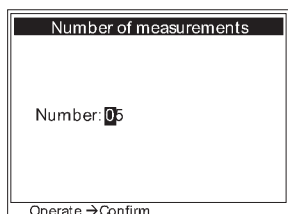
Sample Temp. Alarm

11.1.1 Statistic



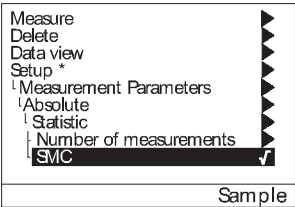
The function "Statistic" lets you set the number for average readings and switch "SMC" (Statistical Measurement Control) on or off.

11.1.1.1 Number of measurements



This function allows selection of the number of readings to be taken per sample. To change the character, turn the scroll wheel. When you press the wheel, the highlighted position moves to the next character. Pressing operate completes the process and the instrument returns to the selection menu. If you entered a wrong input, you can move backward with the esc button.

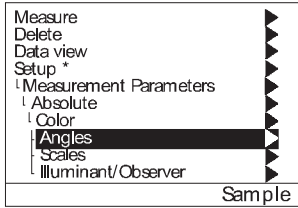
11.1.1.2 SMC - Statistical Measurement Control



Highlight the function with the scroll wheel. Pressing the wheel activates or deactivates the function. If SMC is activated a checkmark appears.

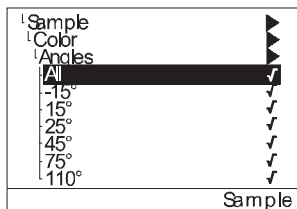
For SMC mode you must preset a minimum number of measurements ($n \geq 3$). To keep the required number of measurements as low as possible, a default standard error is stored in the instrument. In case of uniform surfaces, the standard error is often reached after the minimum number of measurements. In case of non-uniform surfaces, e.g. problem areas, additional measurements will be required by the instrument.

11.1.2 Color



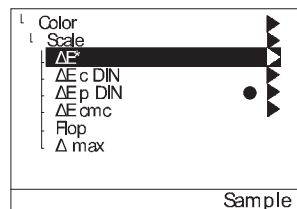
This function lets you choose the measurement angles, scales and illuminant/observer.

11.1.2.1 Angles

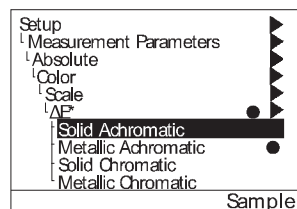


You can choose individual angles or "All".

11.1.2.2 Scales



Here you can decide according to which color scale results are calculated and how they are displayed.



In the sub menu you may find the following:

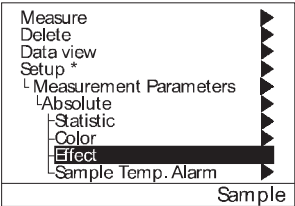
- Solid:
displays only 45° angle
- Metallic:
displays all 6 color angles

11.1.2.3 Illuminant/Observer

- A / 2 °
- A / 10 °
- C / 2 °
- C / 10 °
- D50/2°
- D50/10°
- D65/2°
- D65/10°
- F2 / 2 °
- F2 / 10 °
- F7 / 2 °
- F7 / 10 °
- F11/2°
- F11/10°
- F12/2°
- F12/10°

You can choose among the illuminants/observers shown on the left side.

11.1.3 Effect (only available with BYK-mac i)

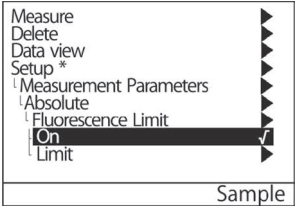


This function lets you choose the effect parameters to be displayed.

- All
- BYK Sparkle15
- BYK Sparkle 45
- BYK Sparkle 75
- BYK Graininess

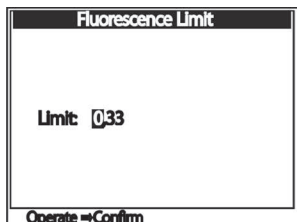
You can choose individual effect parameters or "All".

11.1.4 Fluorescence Limit



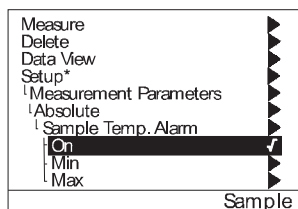
This function allows setting a limit for the instrument to give an audio/video signal when fluorescent light is detected. If the function is activated, a checkmark appears.

You can define the maximum difference between fluorescent compensated and fluorescent non-compensated readings as percentage of the used color tolerance.



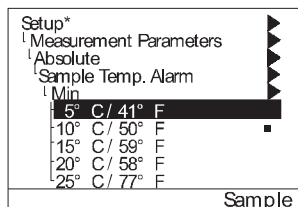
To change the character, turn the scroll wheel. When you press the wheel, the highlighted position moves to the next character. Pressing operate completes the process and the instrument returns to the selection menu. If you entered a wrong input, you can move backward with the esc button.

11.1.5 Sample Temp Alarm



The device has a built in temperature sensor. If the alarm is activated, a checkmark appears.

You can set minimum and maximum values.



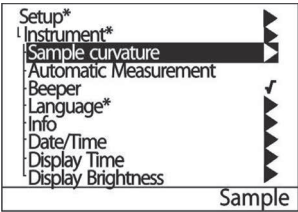
Min:

Choose the appropriate sample temperature and an alarm is set to alert when the temperature is below.

Max:

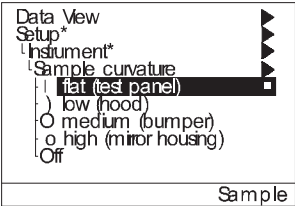
Choose the appropriate sample temperature and an alarm is set to alert when the temperature is exceeded.

11.2 Instrument



In the Setup menu you find functions to adjust general settings of the instrument:

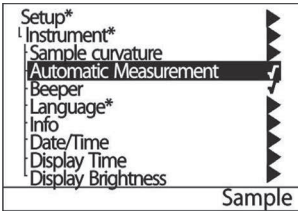
11.2.1 Sample curvature



You can adapt the sensitivity of the pins dependent on the sample curvature.

- Flat: 4 pins < 0.1mm
- Low: 3 pins < 0.1mm, 1 pin < 0.3mm
- Medium: 3 pins < 0.3mm, 1 pin < 0.9mm
- High: 3 pins < 0.6mm, 1 pin off
- Off: pins are deactivated, but it is ensured that no ambient light will enter the aperture.

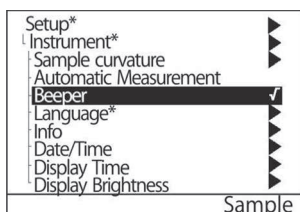
11.2.2 Automatic measurement



The instrument can be set-up to execute a reading by just pressing the four pins.

When the automatic measurement is activated, a checkmark appears.

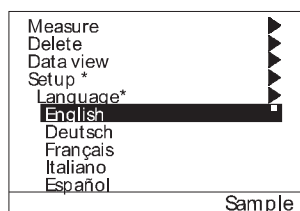
11.2.3 Beeper



This menu option turns the beeper on or off. Use the scroll wheel to move the cursor to Beeper and press the wheel.

When the beeper is activated, a checkmark appears.

11.2.4 Language

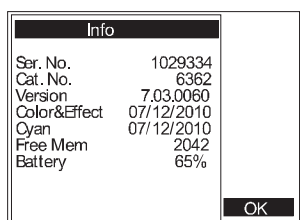


You can use this menu to select the display language.

If a foreign language is activated accidentally, you can find the language settings by following the * symbol in the menus.

Use the scroll wheel to move the cursor to the desired language and press the wheel.

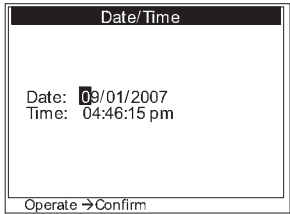
11.2.5 Info



This menu displays the following information about the device:

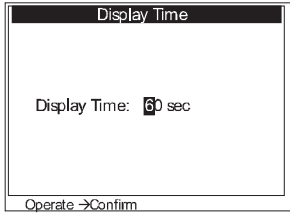
- Serial No.
- Catalog No.
- Version
- Date of last calibration
- Free Memory
- Battery Capacity

11.2.6 Date/Time



The unit contains an integrated clock. This makes date and time of the measurement available for data transfer to a PC. Date and time are not lost even when the battery is changed. If necessary, adjust the data by using the scroll wheel.

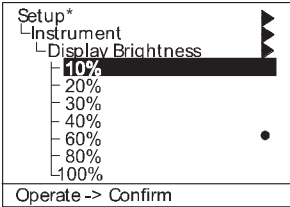
11.2.7 Display Time



To save energy, the unit automatically turns off after a certain amount of time. This time period can be set between 15 and 99 seconds.

If you entered a wrong input, you can move backward with the esc button.

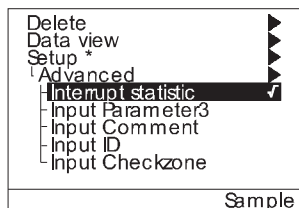
11.2.8 Display Brightness



The brightness of the color display can be adjusted to the surrounding light conditions.

Select the desired setting with the scroll wheel.

11.2.9 Advanced



You can use this menu item to activate:

- Interrupt statistic
- Input Parameter 3
- Input Comment
- Input ID
- Input Checkzone
- Panel match

11.2.9.1 Interrupt statistic

If interrupt statistic is activated you can interrupt a checkzone (sample) before reaching the preset number of measurements.

11.2.9.2,3 Input Parameter 3 and Comment

When active, these parameters allow to assign individual names for identification of a new test series.

11.2.9.4 Input ID

When this function is active, you can enter an identification code e.g. vehicle ID number for each new test series.

11.2.9.5 Input Checkzone

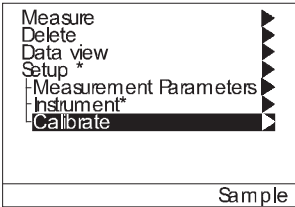
When active, you can enter a name for each sample during a test series. When deactivated, the instrument automatically assigns sample names incrementally, beginning with SAMPLE 01.

11.2.9.6 Panel match

When activated, the BYK-mac i display alters between comparing the body panel to the master standard and comparing the add-on part to the body panel.

Prerequisite is to use an organizer with panel matches being defined and Pass/fail activated. Organizers can be created with the smart-process software.

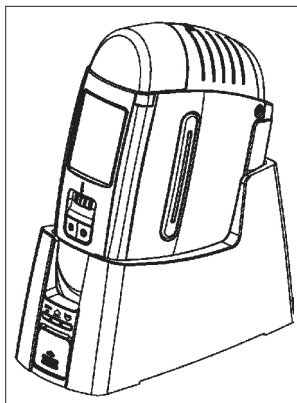
11.3 Calibrate



You can perform a color test and a complete calibration.

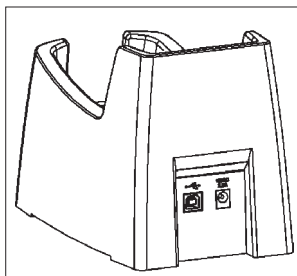
Please refer to the chapter "Calibration".

12. Interface



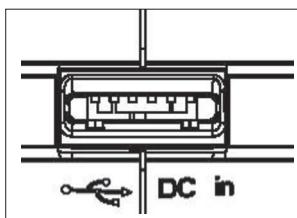
Transfer of data stored in the memory of the instrument takes place through the docking station. It contains the USB interface connecting the instrument with a PC.

To transfer data, the connection cable must be connected to a USB port on the computer. For the position and assignment of the socket, please refer to your computer manual.



The connection point for the USB cable is located at the back of the docking station. Plug in the cable included with delivery.

To transfer data, the instrument must be inserted into the docking station.



To transfer data online from the instrument to the PC, the instrument interface cable can be used. It must be plugged directly into the cable connector on the instrument.

13. Standards

DIN 5033	Colorimetry; basic concepts.
DIN 5036	Radiometric and photometric properties of materials; definitions characteristic.
DIN 6174	Colorimetric evaluation of colour differences of surface colours according to the CIELAB formula.
DIN 6175-2	Tolerances for automotive paints Part 2: Goniochromatic paints
DIN EN ISO 11664	Colorimetry
ISO 7724	Paints and varnishes - Colorimetry
ASTM D 2244	Standard Test Method for Calculation of Color Differences From Instrumentally Measured Color Coordinates.
ASTM E 308	Standard Practice for Computing the Colors of Objects by Using the CIE System.
ASTM E 1164	Standard Practice for Obtaining Spectrophotometric Data for Object-Color Evaluation.
ASTM E 2194	Standard Practice for Multiangle Color Measurement of Metal Flake Pigmented Materials
SAE J 1545	Instrumental Color Difference Measurement for Exterior Finishes, Textiles and Colored Trim

14. Technical Data

General technical data:

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
Rel. humidity	Up to 85% non-condensing/35°C (95 °F)
Operation altitude	Up to 2000 m / 6561 ft

Measurement unit:

Measuring Geometry	Illumination 45°, -15°, 15°, 25°, 45°, 75°, 110° aspecular viewing
Measuring Area	Ø23mm (0.91 in.) or 12mm (0.47 in.)
Spectral Range	400 - 700 nm, 10 nm resolution
Measurement Range	0 to 600 % reflectance
Measuring time	
BYK-mac i	< 6 seconds
BYK-mac i COLOR	< 4 seconds
Repeatability	0.01 dE* 10 consecutive readings on white tile
Reproducibility	Grey BCRA tiles: avg. dE* < 0.10 Chromatic BCRA tiles: avg. dE* < 0.25
Color scales	dE*, dE CMC, dE 94, dE 2000, dE 99, dE DIN 6175 and customer specific scales
Index	Flop, Int-Em
Illuminants	A; C; D50; D65; F2; F7; F11; F12
Observer	2°; 10°

Effect (only with BYK-mac i)

Measurement Geometry	15°, 45°, 75° and diffused illumination perpendicular viewing
Effect parameters	dS, dS_a, dS_i, dG
Repeatability	S_a / S_i: 5% or > 0.50 / G = ± 0.05, 1σ
Reproducibility	S_a / S_i: 10% or > 1.00 / G = ± 0.15, 1σ
Memory	1000 Standards/Samples

Technical Data

Display	2.7 in. TFT color LCD display
Power supply	Rechargeable battery pack or 4 mignon AA batteries (Alkaline or rechargeable)
Dimensions (LxWxH)	218 x 81 x 147mm (8.6 x 3.2 x 5.8 in.)
Weight	approx. 1300g/2.86 lbs.
Interface	USB-B

External power supply:

External power supply	Docking station
Input	100 - 240 VAC, 50 - 60 Hz max. 1 A
Output	12 VDC, 3 A

15. Errors and Warning Messages

Info

Warning

The surface temperature is under ..°C

The sample temperature is lower than the sample temperature alarm.

Warning

The surface temperature is over ..°C

The sample temperature is higher than the sample temperature alarm.

Single measurements can no longer be deleted.

You can delete measurements only within the active checkzone.

Calibration interval expired:
Effect, Color, Color reference

Appears when the instrument is switched on and the calibration interval has expired.
Perform calibration.

Error

Memory full

The maximum number of measurements has been stored. Delete data which is no longer needed.

Pins not pressed!

Appears when sensor pins are not pressed during a reading. Confirm and repeat the reading.

Wrong Standard
Use Black Trap

The wrong standard was used for black calibration.

Wrong Standard
Use White Standard

The wrong standard was used for white calibration.

Error

Instrument temperature out of range	Temperature is outside the operating temperature range.
Ambient light	Appears when there is too much ambient light during measurement or when measuring bright colors (white and light silver) in direct sunlight. Please refer to chapter 5 “Getting started/Ambient light”
Please clean Color reference	Appears when the color test failed. Please make sure that temperature and humidity are within specification. Then clean all standard tiles and perform calibration and color test again.
Please calibrate	Appears when the instrument is not calibrated and the user wants to take a reading.
Humidity too high	Humidity is outside the operating humidity range.
Battery Low	Replace the batteries or recharge the rechargeable battery pack.
Input required	Data must be input.

16. Cleaning and Maintenance



- Do not insert any objects into the measurement aperture for cleaning. The instrument could get damaged.



- **Do not use any acetone for cleaning the unit!** The instrument housing is resistant to a number of solvents, but cannot be guaranteed to withstand all chemicals. You should therefore use a soft, moist cloth for cleaning. For cleaning excessive dirt, use ethanol or cleaning alcohol.



- Do not attempt to make any repairs yourself! If a malfunction occurs on your measuring device, our Customer Service department will be happy to help you as quickly as possible.

Cleaning standards

Do not use any acetone!



The accuracy of the measurement can be significantly impacted by using dirty or damaged standards.

Since the surfaces of the standards are 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.

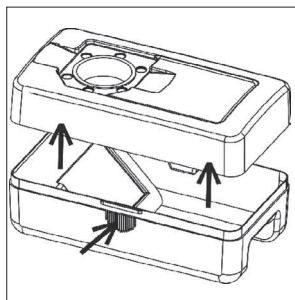
Apply only slight pressure as you clean and make certain there are no large particles stuck in the cloth that could damage the surface.

The best cleaning results are achieved when moving the optical cloth from left to right, not wiping in circles.

For dirt that is difficult to remove, use an optical cloth dipped in liquid. Then wipe the surface with a dry optical cloth.

It is highly recommended to handle the standards with great care. They should always be stored enclosed.

Cleaning the Black Trap

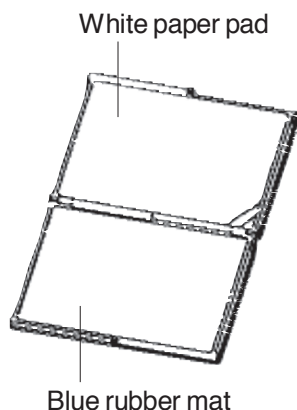


From time to time the black trap should be cleaned with clean, dry air to remove any dust or contamination.

The black trap is taken apart by compressing the lower part on both sides of the case with your fingers, and then separating the two sections.

Exact calibration is not possible unless the standard is in perfect condition. If the condition of the standard seems doubtful because of its appearance or measurement errors, we will be happy to check it for you.

Cleaning the Bottom Plate



Please use only the cleaning set included with the instrument.

Place the instrument on the white paper pad. Repeat placing the instrument several times to make the pins grease-free.

Then place the instrument on the blue rubber mat. Repeat placing the instrument several times to make the pins lint-free.

Do not drag the instrument over the surface!

Please make sure that all rubber pins are still attached after cleaning.

Clean the blue rubber mat with Isopropanol and a microfiber cloth.

17. Service and Certification

Service

Besides the repair of your instrument we offer the following additional services:

First diagnosis on the telephone or by e-mail

Call us or send us an e-mail and we will try to solve your problem. If this is not successful, please send us the instrument for repair.

Preventive maintenance, calibration, and recertification

For precautionary reasons we recommend regular preventive maintenance. We carry out this preventive maintenance automatically when you send us your instrument for maintenance and recertification. We clean the optics, check all functions, test and, if required, adjust the measured values by using reference standards. You will receive a certificate, which includes the retraceability to international standards.

Loaners

During the period of repair we furnish you with a loaner on request and availability.

Maintenance agreement

In case you want to make sure that the necessary maintenance is being done on a regular basis and on time, we recommend a maintenance agreement.

Extended warranty contracts

Furthermore, you can request an extended warranty contract for additional 12 months.

Ordering information:

107207030	Calibration service BYK-mac i
107207032	Calibration service BYK-mac i COLOR
107307030	Extended warranty BYK-mac i
107307032	Extended warranty BYK-mac i COLOR

Service Centers for BYK-Gardner products

Germany

BYK-Gardner GmbH
Lausitzer Strasse 8
82538 Geretsried
Germany
Phone: +49-8171-3493-0
Fax: +49-8171-3493-166

USA

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9104 Guilford Road, Suite H
Columbia, MD 21046
USA
Phone: +1-301-483-6500
Fax: +1-301-483-6555

China

BYK-Gardner China
Instruments Service
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Shanghai 200231
P.R. China
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Fax: +86(021)6496-7932

Brazil

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Bairro Paraíso - Santo André-SP
CEP 09190-640
Brazil
Tel.: +55-11-2147-1199
Fax: +55-11-2147-1168

18. Copyright

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.

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BYK-Gardner GmbH offers no guarantee that the software will function without error or that the functions incorporated therein can be executed in all applications and combinations selected by you.

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 GmbH reserves the right to update the software and written documentation without prior notice.

Declaration of Conformity

Hereby,

BYK Gardner GmbH
Lausitzer Strasse 8
D-82538 Geretsried

declares, that the products of type

- **BYK-mac i**
- **BYK-mac i COLOR**

comply with the requirements of the following directives of the European Union (EU):

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

The following harmonized standards were applied:

- EN 61010-1:2010/A1:2019 - Safety Requirements
- EN IEC 61326-1:2021 - EMC Requirements

Geretsried, December 4, 2024



Dr. Jörg Krames
President • BYK-Gardner GmbH

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