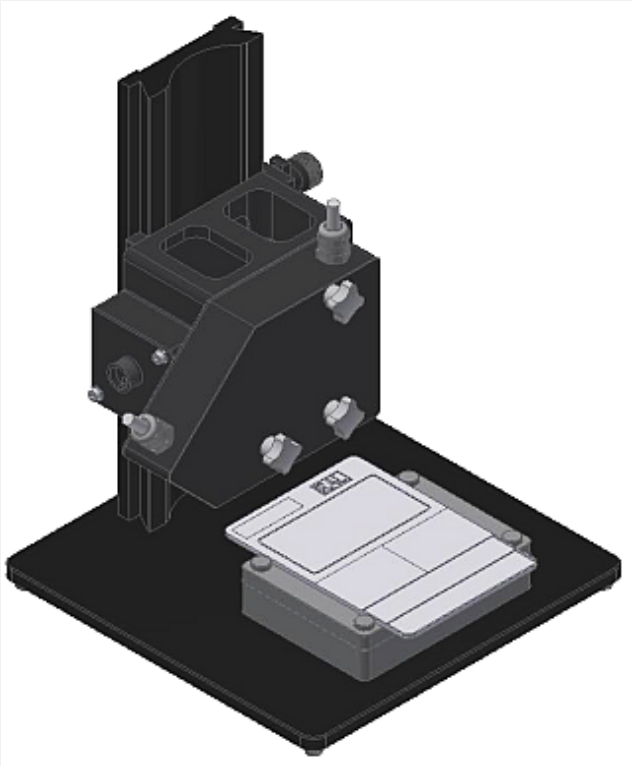
SPECTRO-LAB Series



SPECTRO-3-0°/45°-MST

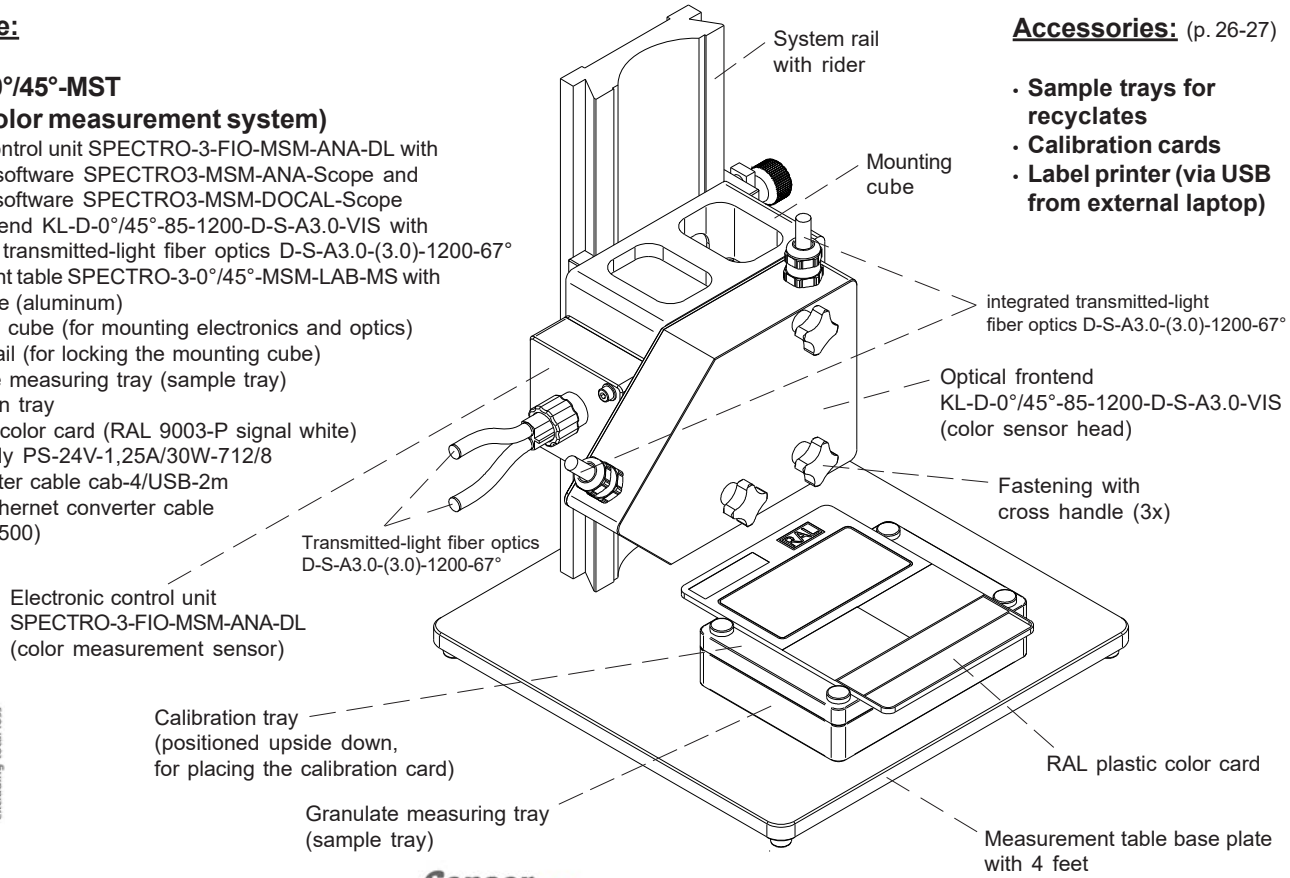
- **Laboratory measurement system for color measurement** (Tristimulus Colorimeter) of plastic granulate, plastic recyclate and plastic flakes
- L*a*b* measurement according to the 0°/45° method
- Calibration on site using RAL plastic color cards or on customer-specific color cards
- High optical averaging due to large white light spot (typ. Ø 20 mm)
- Up to 3 colors can be stored
- Connection to a laptop or a panel PC type SI-PPC-500-15“
- Display of the current color value (L*a*b*) of a sample as well as its color deviation (dL*da*db* and dE) from the reference in the TEACH table
- Averaging adjustable (from 1 to over 32000 values)
- Start and end of measurement sensor-controlled, averaging over the entire measurement process, reproducibility as a result dE < 0.2 (typ.)
- Recording of the measurement results in a file to be created
- The created file can be read out using Excel and Word
- Graphical monitoring of the last 100 measurements dL*da*db* (trend)
- Creation and printing of a label via label printer
- +24V power supply (power supply unit included)
- RS232 interface (USB converter included, optional Ethernet converter)
- Parameterization via Windows® software SPECTRO3-MSM-DOCAL-Scope
- Interactive operation of the software (both during calibration and measurement)
- Measuring table with aluminum plate for placing the granulate measuring trays or the calibration tray

Design

Product name:

SPECTRO-3-0°/45°-MST
(laboratory color measurement system)

incl. electronic control unit SPECTRO-3-FIO-MSM-ANA-DL with Windows® software SPECTRO3-MSM-ANA-Scope and Windows® software SPECTRO3-MSM-DOCAL-Scope
incl. optical frontend KL-D-0°/45°-85-1200-D-S-A3.0-VIS with integrieated transmitted-light fiber optics D-S-A3.0-(3.0)-1200-67°
incl. measurement table SPECTRO-3-0°/45°-MSM-LAB-MS with
1x base plate (aluminum)
1x mounting cube (for mounting electronics and optics)
1x system rail (for locking the mounting cube)
5x granulate measuring tray (sample tray)
1x calibration tray
incl. RAL plastic color card (RAL 9003-P signal white)
incl. power supply PS-24V-1,25A/30W-712/8
incl. USB converter cable cab-4/USB-2m
(optional: Ethernet converter cable cab-4/ETH-500)



Accessories: (p. 26-27)

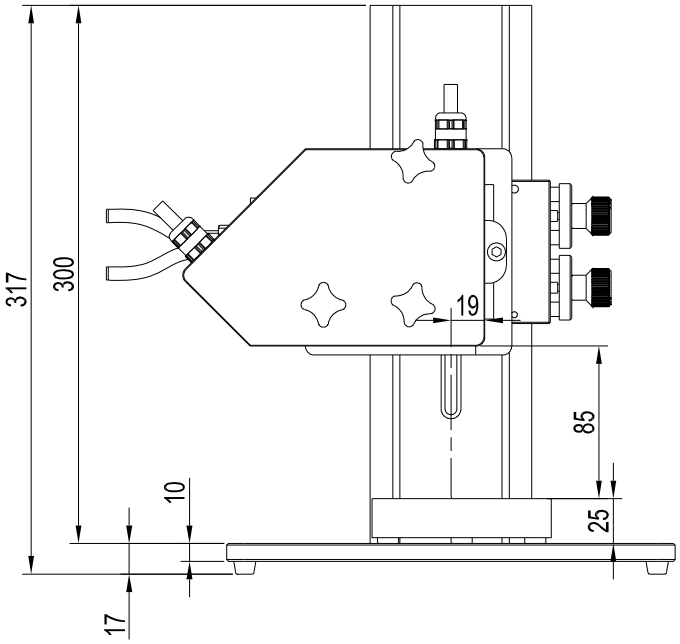
- **Sample trays for recyclates**
- **Calibration cards**
- **Label printer (via USB from external laptop)**

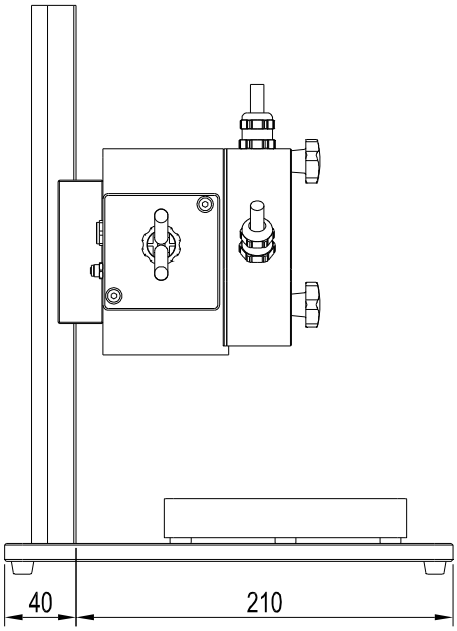
Technical Data

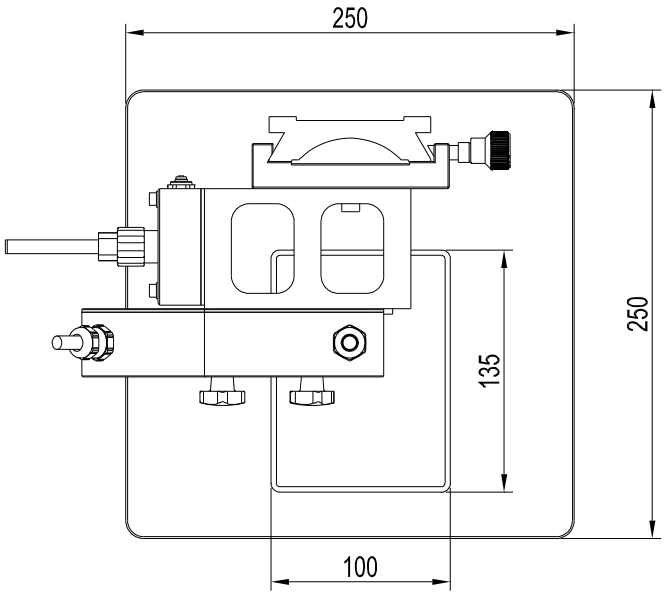
Type	SPECTRO-3-0°/45°-MST
Voltage supply	+24VDC (± 10%), reverse polarity protected, overcurrent protected
Current consumption	< 1A
Max. switching current (int.)	100 mA, short circuit proof
Input digital (1x) (internal)	IN0 (Pin 3), digital (0V/+24V)
Outputs digital (2x) (internal)	OUT0, OUT1 (Pin 4 and 5): digital (0V/+24V), npn-, pnp-able, bright-/dark-switching, can be switched via Windows® software SPECTRO3-MSM-DOCAL-Scope
Outputs analog (3x) (internal)	OUT2, OUT3, OUT4 (Pin 6, 7 and 8): 0...+10V or 4...20mA a*b*L*, XYZ adjustable via Windows® software SPECTRO3-MSM-DOCAL-Scope
Interface	RS232 (USB converter as well as Ethernet converter available)
Pulse lengthening (internal)	0 ... 100 ms
Averaging	max. 32768 Werte, adjustable via Windows® software SPECTRO3-MSM-DOCAL-Scope
Scan frequency (internal) (alternating light mode/ direct light mode)	LED operation AC operation: max. 25 kHz, depends on parameterization, adjustable via Windows® software SPECTRO3-MSM-DOCAL-Scope
Switching frequency (internal)	typ. 60 kHz
Analog band width (internal)	max. 90 kHz (-3dB)
Transmitter (light source)	LED with spectral characteristics similar to D65 (sunlight LED)
Object distance (internal) (measuring range)	typ. 85 mm
Receiver	3-color filter detector (TRUE COLOR detector, “human color perception“), color filter curves acc. to CIE 1931
Ambient light	max. 5000 Lux
Size of light spot	typ. 20 mm in diameter, at 85 mm distance from the sensor frontend
Reproducibility	in the X, Y color range each 1 digit at 12-bit A/D conversion
Temperature drift X,Y	ΔX/ΔT; ΔY/ΔT typ. 0,2 digits/°C (< 0,01% / °C)
Measuring accuracy	typ. ΔE = 0,3
Resolution	ΔE = 0,01
Color space	CIE L*a*b*
Color memory capacity	non-volatile EEPROM with parameter sets for max. 3 colors
Dimensions (complete system)	LxWxH approx. 250 mm x 250 mm x 317 mm
Material (system components)	electronic control unit SPECTRO-3-FIO-MSM-ANA-DL : aluminum, anodized in black sensor frontend (optical frontend) KL-0°/45°-85-1200-D-S-A3.0-VIS: aluminum, anodized in black measurement table SPECTRO-3-0°/45°-MSM-LAB-MS: aluminum, anodized granulate measuring trays (sample trays) and calibration tray: plastic
Enclosure rating	IP54
Connecting cable	USB: cab-4/USB-2m (optionally Ethernet: cab-4/ETH-500) +24V power supply: PS-24V-1,25A/30W-712/8 (length 1.5m)
Operating temperature range	-20°C ... +55°C
Storage temperature range	-20°C ... +85°C
EMC test acc. to	DIN EN 60947-5-2 CE

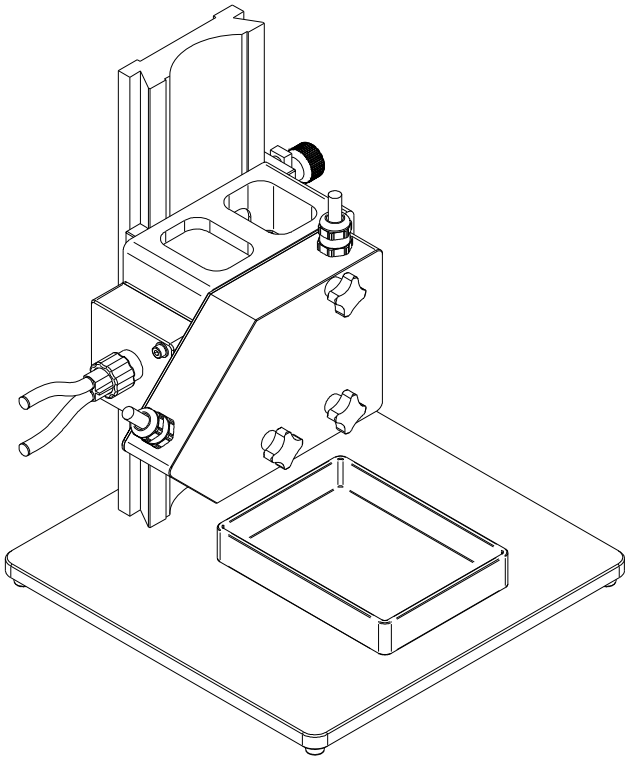
Dimensions

SPECTRO-3-0°/45°-MST with granulat measuring tray (without calibration tray)





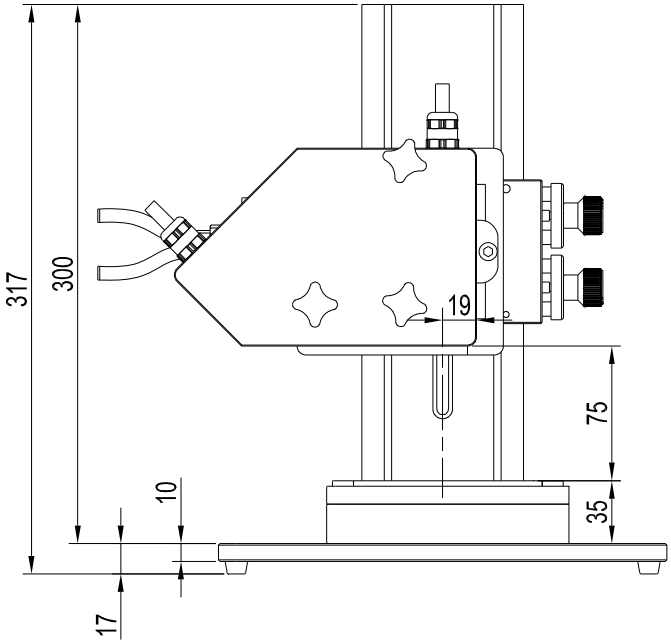


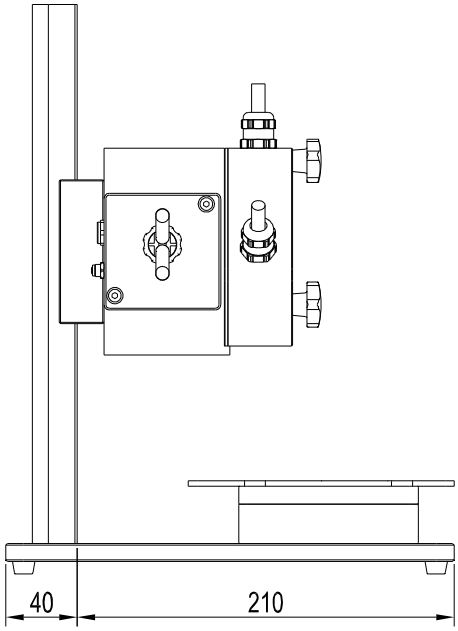


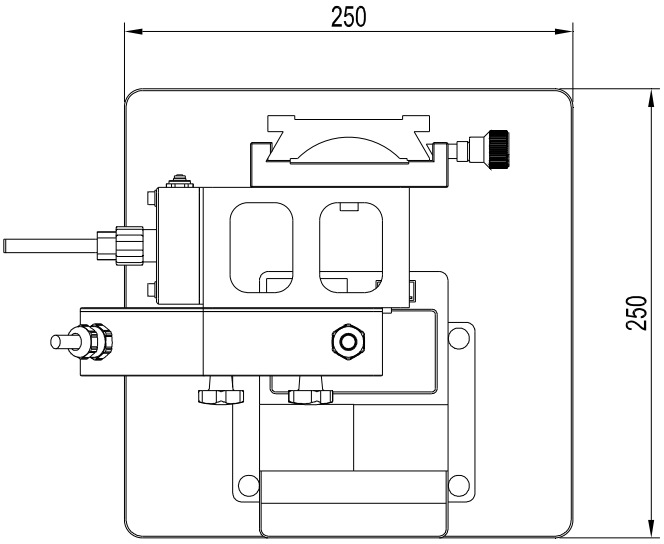
All dimensions in mm

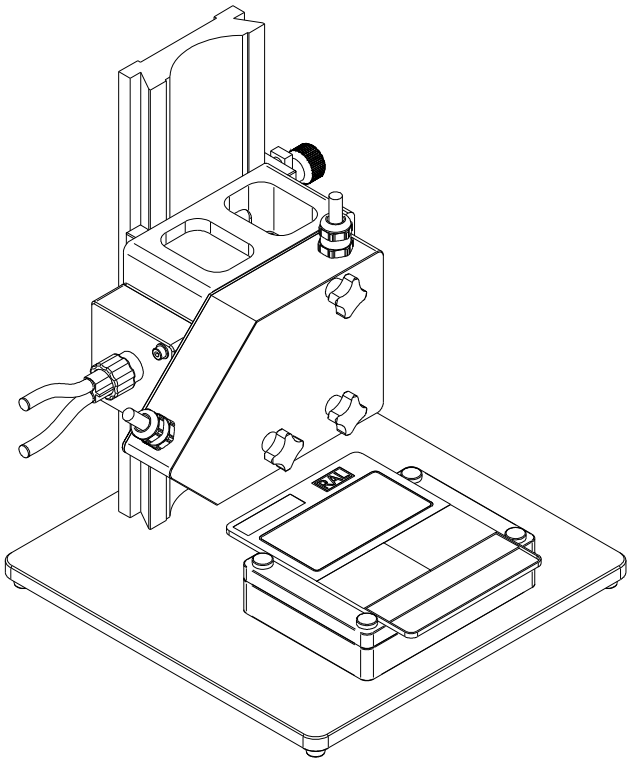
Dimensions

SPECTRO-3-0°/45°-MST with granulat measuring tray and calibration tray as well as RAL plastic color card









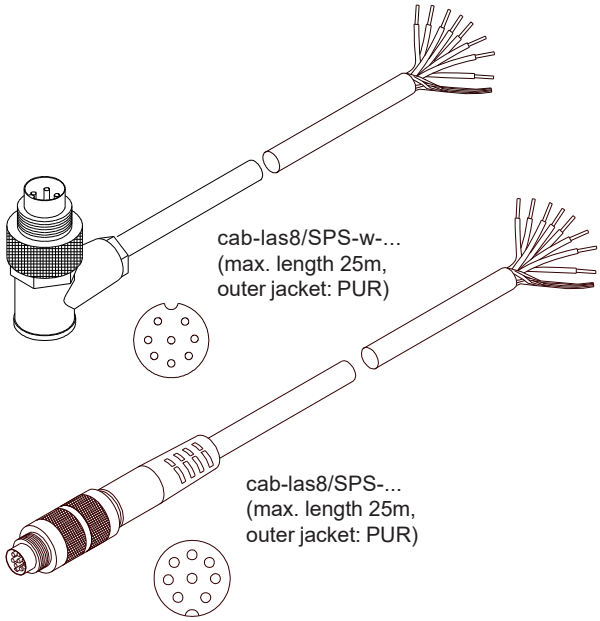
All dimensions in mm

Connector Assignment

Connection of SPECTRO-3-28-0°/45°-MSM-LAB-ANA-LF to PLC:
8-pol. fem. connector Binder series 712

Pin:	Color:	Assignment of connecting cable cab-las8/SPS-...
1	white	GND (0V)
2	brown	+24VDC (±10%)
3	green	IN0 (0V/+24V)
4	yellow	OUT0 (0V/+24V), DIGITAL
5	grey	OUT1 (0V/+24V), DIGITAL
6	pink (or black)	OUT2 a* (0V...+10V oder 4mA...20mA), ANALOG
7	blue	OUT3 b* (0V...+10V oder 4mA...20mA), ANALOG
8	red	OUT4 L* (0V...+10V oder 4mA...20mA), ANALOG

Connecting cable:
cab-las8/SPS-(length) oder
cab-las8/SPS-w-(length) (angle-type, 90°)
(standard length 2m)



cab-las8/SPS-w-...
(max. length 25m,
outer jacket: PUR)

cab-las8/SPS-...
(max. length 25m,
outer jacket: PUR)

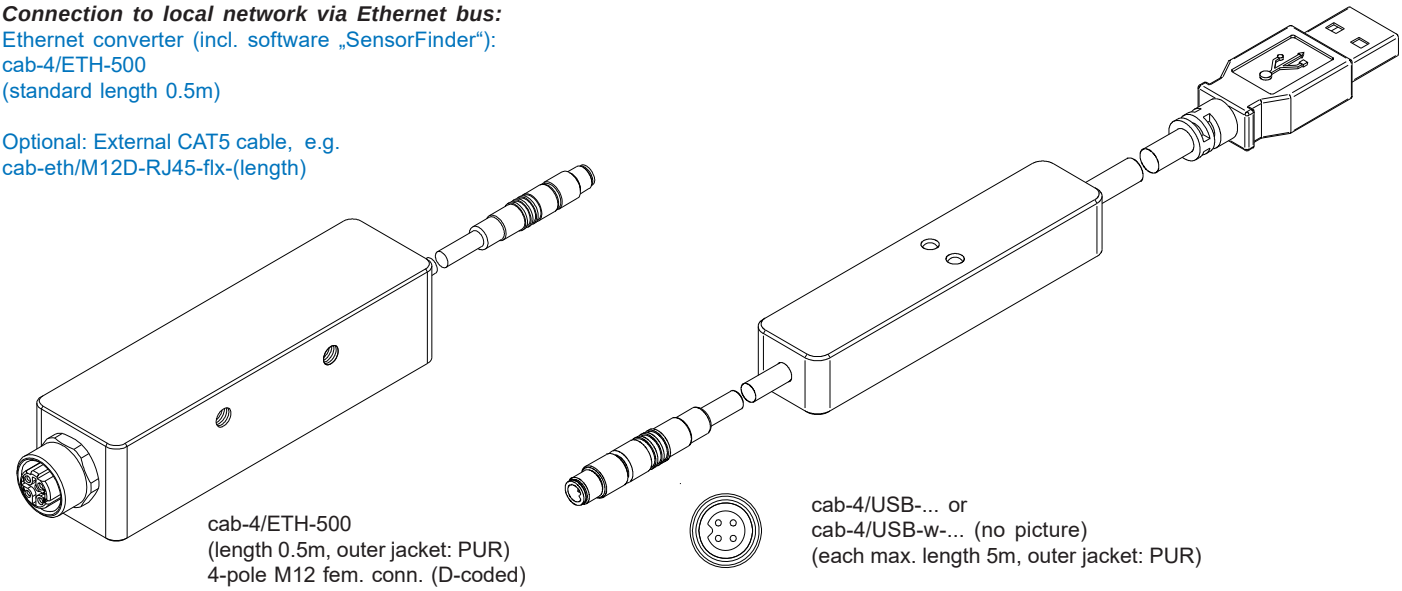
Connection of SPECTRO-3-28-0°/45°-MSM-LAB-ANA-LF to PC:
4-pol. fem. connector Binder series 707

Pin:	Assignment:
1	+24VDC (+Ub, OUT)
2	GND (0V)
3	RxD
4	TxD

Connection via USB interface at the PC:
USB converter (incl. driver software):
cab-4/USB-(length)
cab-4/USB-w-(length) (angle type 90°)
(standard length 2m)

alternative:
Connection to local network via Ethernet bus:
Ethernet converter (incl. software „SensorFinder“):
cab-4/ETH-500
(standard length 0.5m)

Optional: External CAT5 cable, e.g.
cab-eth/M12D-RJ45-flx-(length)



cab-4/ETH-500
(length 0.5m, outer jacket: PUR)
4-pole M12 fem. conn. (D-coded)
for connection of an external
CAT5 cable, e.g.
cab-eth/M12D-RJ45-flx-(length)

cab-4/USB-... or
cab-4/USB-w-... (no picture)
(each max. length 5m, outer jacket: PUR)

Connecting Cables

Power Supply PS-24V-1,25A/30W-712/8
(included in delivery)

This power supply unit enables the system to be connected to the mains.

- Secondary 24VDC; current max. 1,25A; power 30W
- Mains voltage: 100...240Veff.; 50...60Hz; 550mA
- Secondary side 8-pole circular connector Binder series 712
- Cable length 1.5m

PS-24V-1,25A/30W-712/8 (power supply):
8-pole circular connector Binder series 712

Pin:	Assignment:
1	GND (0V)
2	+24VDC
3	nicht belegt
4	nicht belegt
5	nicht belegt
6	nicht belegt
7	nicht belegt
8	nicht belegt

USB converter cable cab-4/USB-2m
(included in delivery,
incl. driver software „Self Installing Executable“)

This USB converter cable enables the system to be connected to the PC with a serial interface

- Power supply galvanically isolated:
  +24VDC through sensor
  +5V through USB-HUB
- 4-pole circular connector Binder series 707
- Optionally available in 5m length

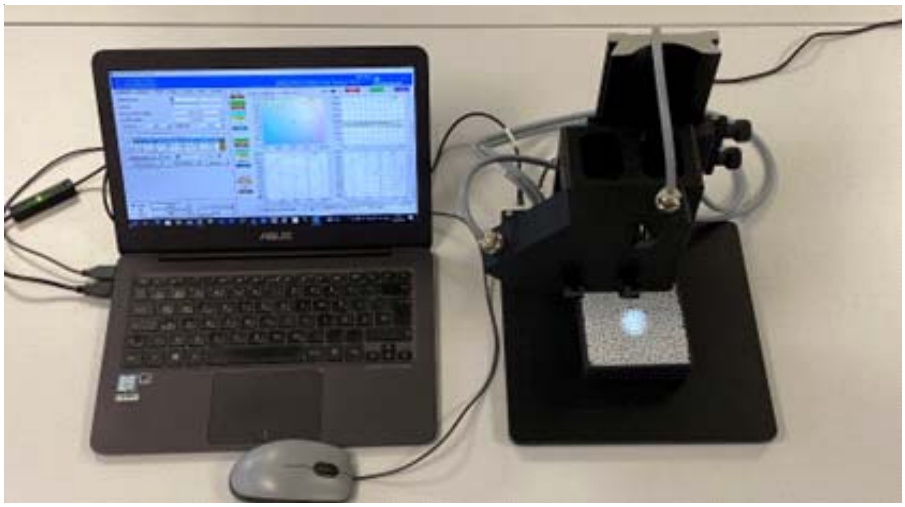
cab-4/USB-2m (USB converter cable):
4-pole circular connector Binder series 707:

Pin:	Assignment:
1	+24VDC (+Ub, OUT)
2	GND (0V)
3	RxD
4	TxD

System Design

The SPECTRO-LAB system SPECTRO-3-0°/45°-MST

At present, the color of plastic recyclates is often still measured with manual measuring instruments in the laboratories of plastics recycling companies. In this process, firstly, the unfavorable relationship between the measurement spot size of the light spot generated by the manual device and the size of the pellets prevents precise color measurement, and secondly, the random positioning of the individual granulate grains in the light spot is a hindrance to a high reproducibility of the measurement result.

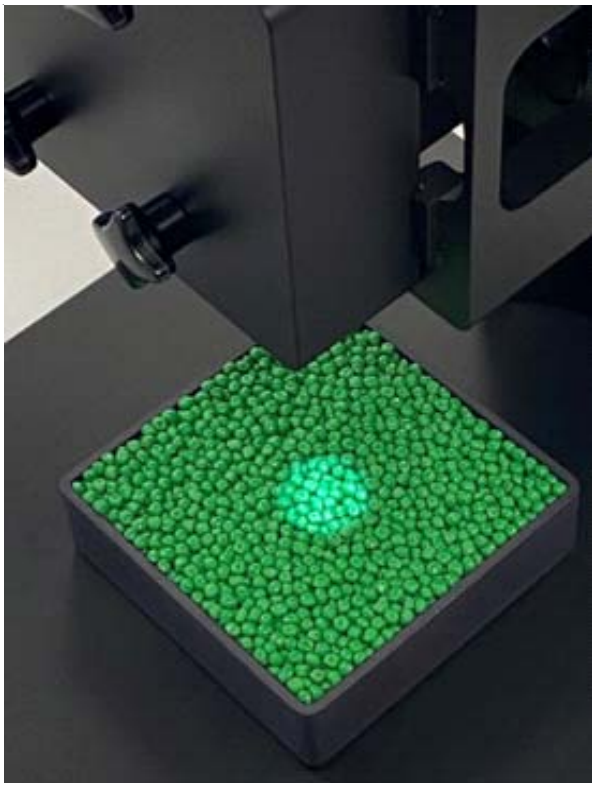


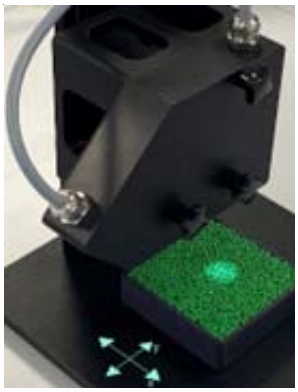
As against that, **Sensor Instruments** uses the same color sensor system for color measurement of granulates in inline as well as laboratory applications. The measurement results are then comparable 1:1 and furthermore, measurement is carried out in both the applications *during* the movement, with the corresponding average value calculation and a sufficiently large light spot diameter of approx. 20mm.

Different calibration processes allow adaptation to the measurement method that is available in the facility. The Windows® software SPECTRO-3-MSM-DOCAL Scope is employed for calibration, measurement and documentation. Operation of the software is easy thanks to the interactive structure. A commercial PC or a laptop can be used for this purpose in conjunction with the SPECTRO-3-MSM-DOCAL Scope software. Optionally, there is also a label printer available for marking the individual samples.

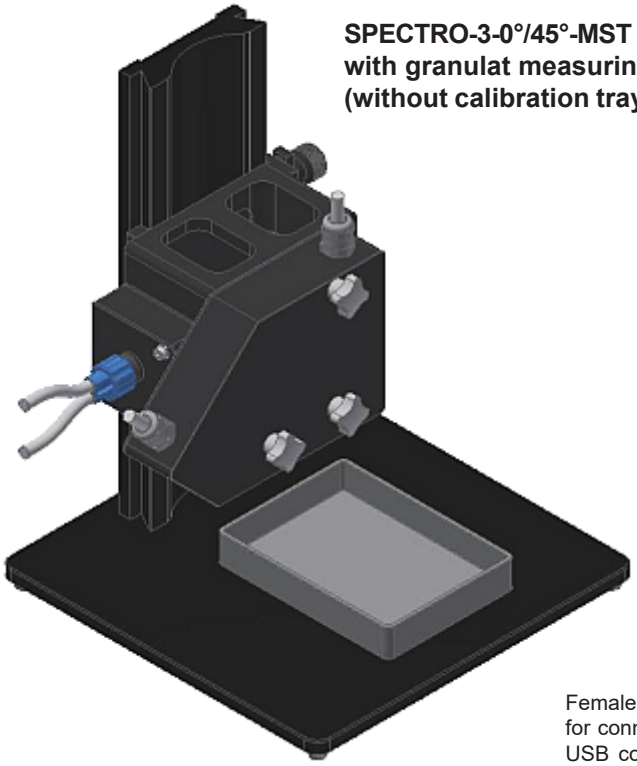
Star handle screws facilitate easy and reproducible assembly of the sensor head (front end of the lens). Moreover, the colorimetric instruments deployed in inline use can also be calibrated in a simple manner.

After manual filling of the individual bowls (there are five granulate measuring bowls as well as one calibration bowl provided in the supplied kit) and after setting the desired measurement time (adjustable up to max. 60s), with manual movement of the measuring bowl in the x- as well as in the y-direction, a L*a*b*-color value with a typical reproducibility of dE < 0.2 can be achieved.



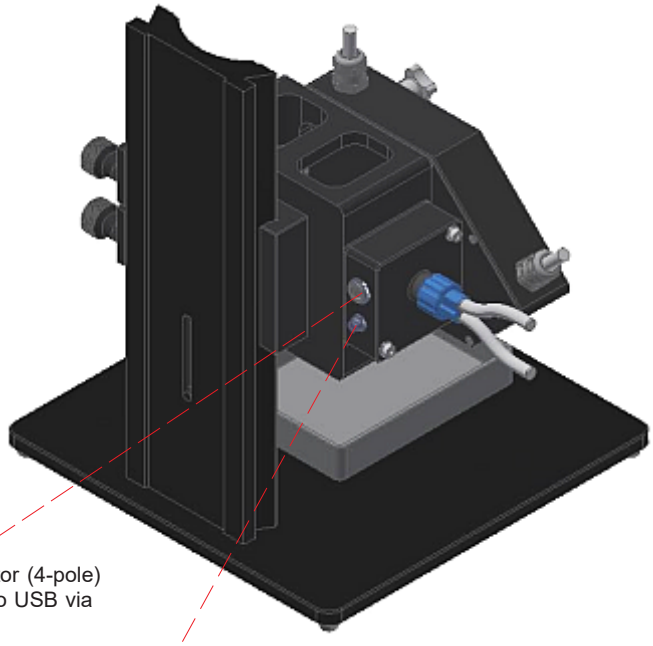


System Design



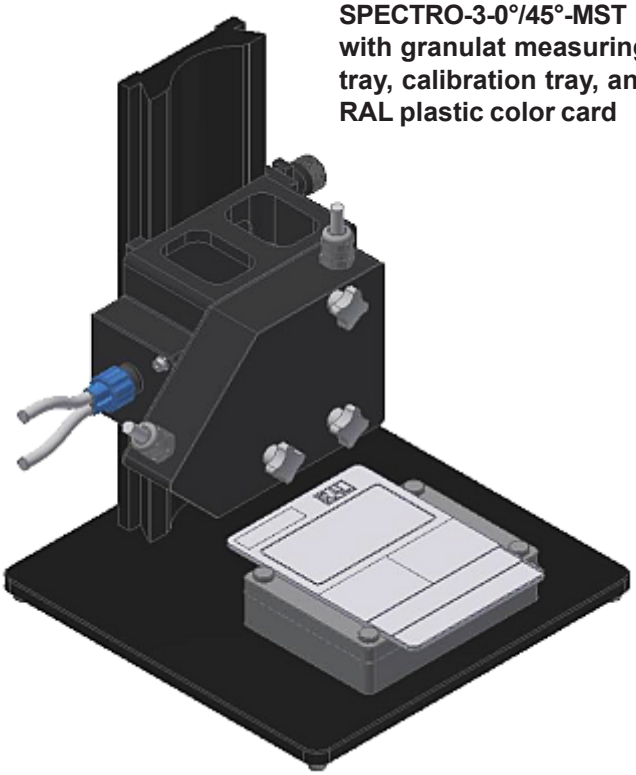
SPECTRO-3-0°/45°-MST with granulat measuring tray (without calibration tray)

SPECTRO-3-0°/45°-MST (rear view) with granulat measuring tray (without calibration tray)

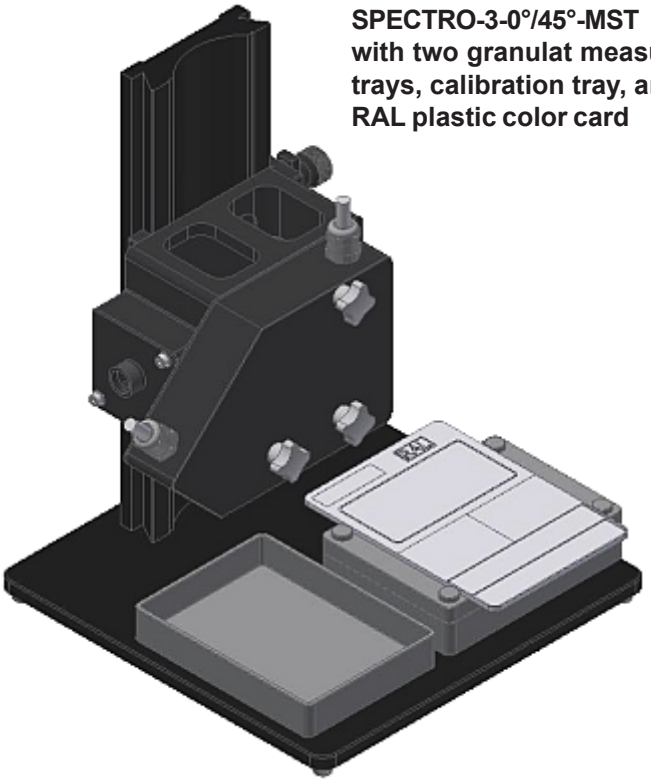


Female connector (4-pole) for connection to USB via USB converter cab-4/USB-2m (optional: connection to Ethernet vis Ethernet converter cab-4/ETH-500)

Female connector (9-pole) for power supply (+24V mains adapter): PS-24V-1,25A/30W-712/8



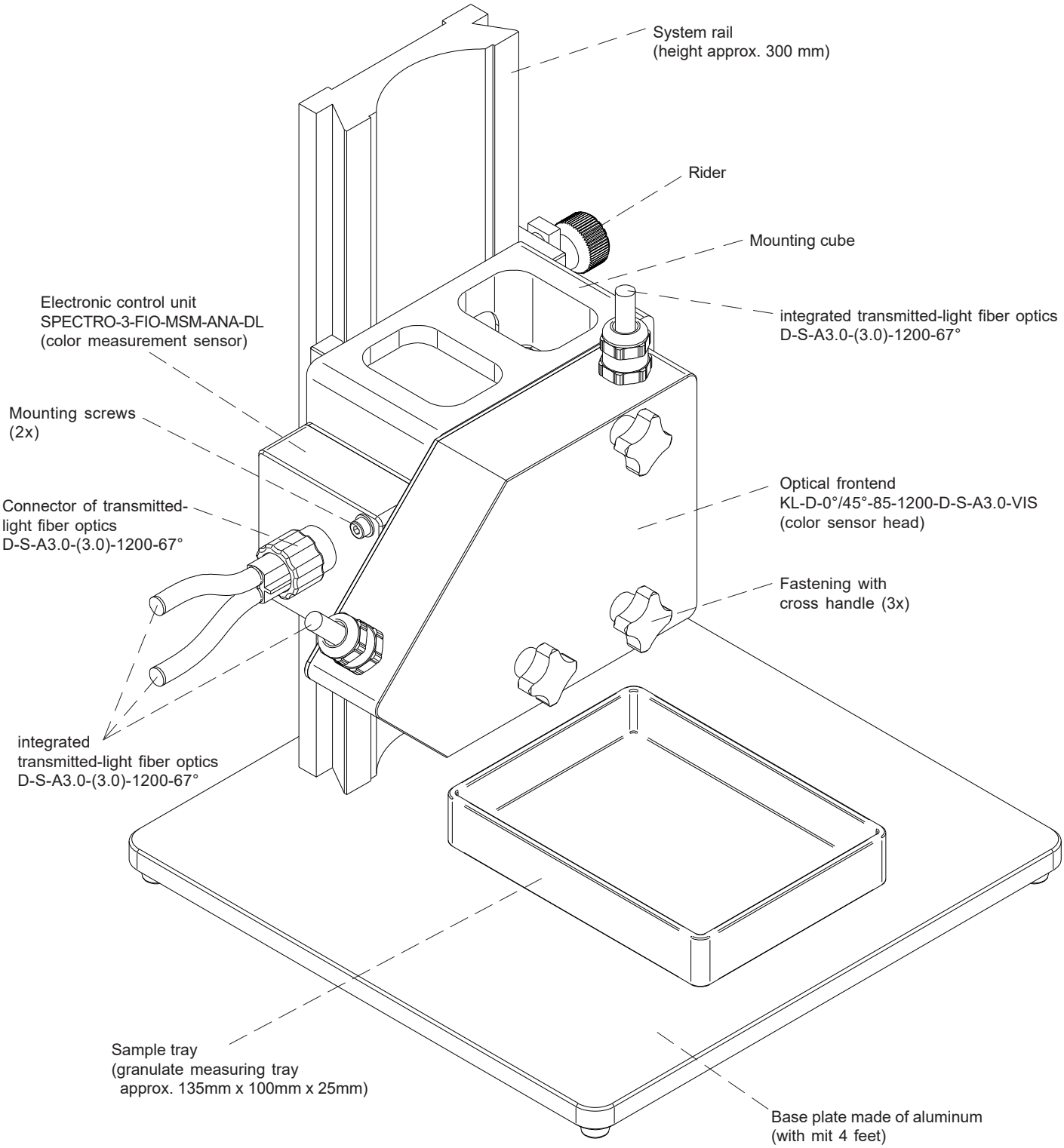
SPECTRO-3-0°/45°-MST with granulat measuring tray, calibration tray, and RAL plastic color card



SPECTRO-3-0°/45°-MST with two granulat measuring trays, calibration tray, and RAL plastic color card

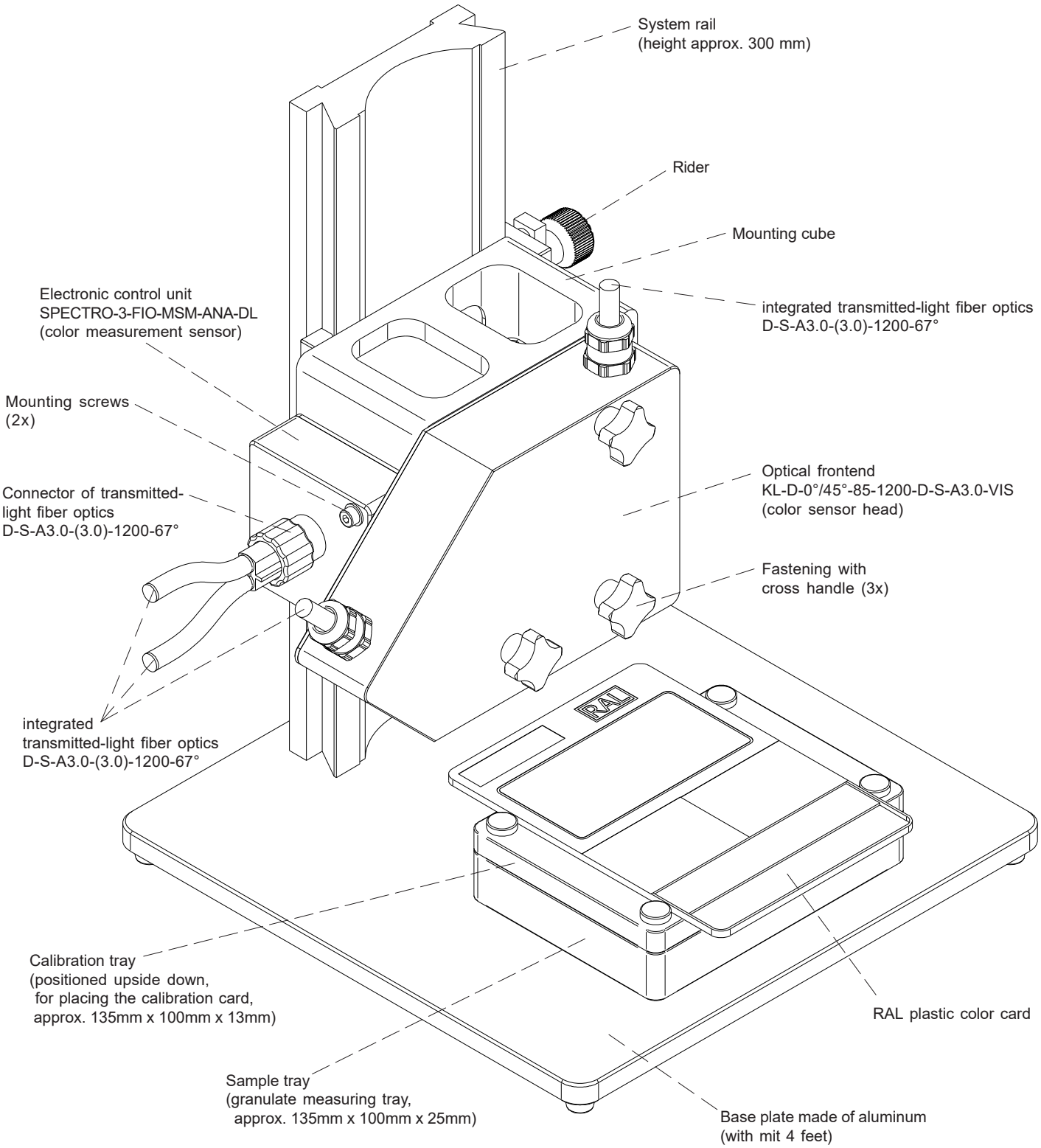
System Design

SPECTRO-3-0°/45°-MST with granulat measuring tray (without calibration tray)



System Design

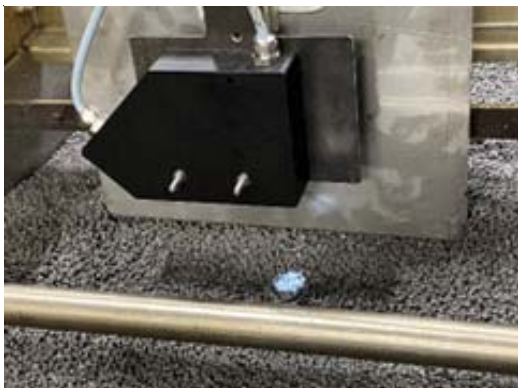
SPECTRO-3-0°/45°-MST with granulat measuring tray and calibration tray as well as RAL plastic color card



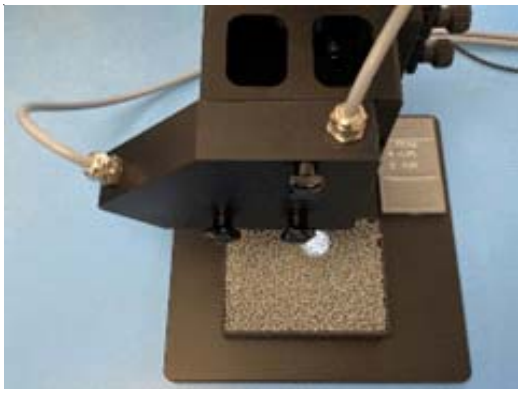
Measuring Principle

Principle of measurement of the SPECTRO-LAB system SPECTRO-3-0°/45°-MST

The object of the development of a colorimetry system for determining the color of plastic granulates was to be able to measure with the same sensor unit both inline as well as mobile and in the laboratory. Firstly, it has to be suitable for rough use in production at product temperatures up to 200°C and secondly, it has to be easy to operate and furthermore, adaptable to the existing manual measuring instruments.



In order that the sensor system should be suitable even for use on jolting conveyors, a principle of measurement that allows measurement even from a relatively large distance had to be selected. The d/8° method was thus eliminated, since it actually only allows measurement with contact. This left a clear choice: the 45°/0° or the 0°/45° method. The 0°/45° measuring process was selected. In addition, however, it should also be possible to take measurements through an inspection glass on the granulate when it is still hot. Calibration at the site would be desirable, so that the standstill times can be reduced to a minimum.

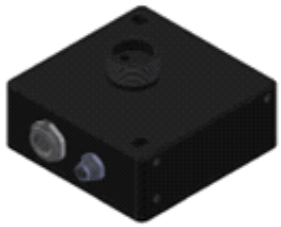


The laboratory color measurement system SPECTRO-3-0°/45°-MST can be employed to quickly and easily calibrate the systems used in inline applications. Moreover, as a result, with the same plastic granulate the same values are shown in the laboratory that were also measured inline, if temperature-caused color displacement is taken into consideration.

A KL-D-0°/45°-85-1200-D-S-A3.0-VIS (color sensor head) in conjunction with a control electronics system of type SPECTRO-3-FIO-MSM-ANA-DL (color measurement sensor) is used as the optical frontend. Here, the distance from the front end of the lens to the measurement object is typically 85 mm and the white light spot size at this distance is of 20 mm diameter. The front end of the lens is temperature-resistant up to typically 200°C and connected to the control electronics via a transmitted light fiber-optic cable with a length of typically 1200 mm.

KL-D-0°/45°-85-1200-D-S-A3.0

The control electronics SPECTRO-3-FIO-MSM-ANA-DL (color measurement sensor) is supplied +24V, has two digital outputs (0V/+24V) and three analog outputs (0V … +10V or 4mA … 20mA) as well as an RS232 port. Communication is also possible via USB or Ethernet by means of an interface adapter. The Windows® software SPECTRO3-MSM-DOCAL Scope is used for evaluating the colorimetric values provided by the sensor system.



SPECTRO-3-FIO-MSM-ANA-DL

Calibration

Calibration of the SPECTRO-LAB System SPECTRO-3-0°/45°-MST

Using the Windows® software SPECTRO3-MSM-DOCAL-Scope that is a part of the supplied kit, the SPECTRO-LAB system SPECTRO-3-0°/45°-MST can be adapted to various color standards, for example, of the measurement geometry 45°/0° as well as d/8°. For this purpose, RAL gGmbH offers a comprehensive range of color cards made of plastic.

Now, in order that these RAL plastic color cards can be used for calibrating the SPECTRO-LAB systems, every single one of these cards is retrospectively calibrated by **Sensor Instruments** according to the 45°/0° method and registered. The calibrated plastic color cards are assigned a 5-digit number and a record is created in a color card file under this number, which includes the corresponding color values L*a*b*. This file is updated continuously. Apart from the file for the 45°/0° method, another file measured by the d/8° method is created. Both the files are available on the homepage of **Sensor Instruments**.

Apart from the calibration using a RAL plastic color card, it is also possible to calibrate to customer-specific plastic color cards. For the L*a*b*-values of the individual plastic cards determined by the customer by using a manual color measuring instrument, a customer-specific color card file can in turn be generated. But furthermore, the specified L*a*b*-values can also be input manually, during the calibration process, in the SPECTRO3-MSM-DOCAL Scope software.

RAL plastic color cards

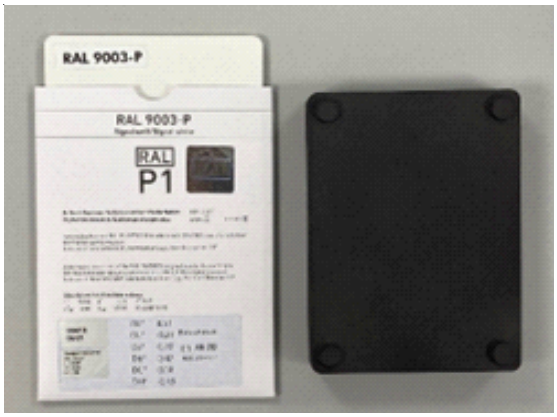
Customer specific plastic color cards

Kalibrieren

But apart from the calibration to RAL or customer-specific plastic color cards, there is also an option to calibrate directly with respect to the respective plastic granulate, if the customer has previously made small plastic plates from the same batch through injection molding and calibrated them using a manual colorimeter.
The L*a*b* color values determined using a manual colorimeter of the respective plastic color cards are used as the reference. As against that, for calibrating the SPECTRO-LAB System, granulate matching the small plastic color plates is used.

The calibration process is simplified to a great extent with the help of the SPECTRO3-MSM-DOCAL-Scope software. For determining the color values XYZ of the respective granulates, which are required for the calibration, a granulate measuring bowl of the SPECTRO-3-0°/45°-MST laboratory measurement system is filled per sample. Here, the color values are determined during the movement of the granulate. To do so, the average of the XYZ values measured over a period that can be set in the software is calculated and then automatically entered in the calibration table of the software through a program and assigned to the corresponding L*a*b* values.

Calibration with RAL plastic color cards



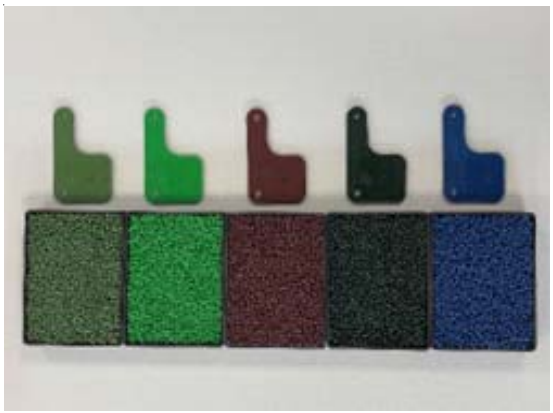
There is a comprehensive selection of plastic color cards available for this purpose. The RAL gGmbH company offers a range of up to 300 different plastic color cards, which have been calibrated according to the d/8° standard. At Sensor Instruments, the individual cards are additionally calibrated according to the 45°/0° method, numbered and saved to two different files (one file each according to the d/8° method and one file according to the 45°/0° method). Both the files are expanded regularly and are available on the homepage of **Sensor Instruments**. Every plastic color card additionally carries a 5-digit number, so that invoking a card from the collection of files, which has now become really large, is simplified.

Using the RAL files that have been generated and are continuously updated clearly simplifies the calibration process. The user of the Windows® software SPECTRO3-MSM-DOCAL Scope is interactively guided through the calibration process. During the calibration process, it is necessary to show the plastic calibration card to be calibrated to the SPECTRO-3-0°/45°-MST laboratory measurement system by means of the calibration bowl. When doing so, it is first necessary to place the RAL plastic color card to be calibrated (the calibration process starts in each case with a white reference card, for example with an RAL 9003-P) on the upended calibration bowl. It is recommended that only such RAL plastic color cards should be used during the calibration process, that more or less reflect the actually manufactured color range.

After the RAL plastic color cards to be calibrated have been submitted to the SPECTRO-LAB system and the user has completed his part of the calibration process, we recommend generating a calibration file so that if any RAL plastic color cards have to be subsequently added, this file can be accessed, so that the calibration process is significantly simplified.

Calibration

Place the RAL plastic color card by means of the calibration tray below the optical frontend KL-D-0°/45°-85-1200-D-S-A3.0-VIS



In the search for matching RAL plastic color cards, the existing measuring trays are filled with the granulate in question

The matching RAL plastic color cards are then placed in succession on the calibration tray and positioned below the optical frontend KL-D-0°/45°-85-1200-D-S-A3.0-VIS

Calibration

Calibration using customer-specific plastic color cards

Apart from the use of RAL plastic color cards, it is now also possible to use customer-specific cards for the calibration process.

To do so, the cards must first be measured by the customer using a manual colorimeter and the L*a*b* color values determined. Of course, it is also possible here to create a customer-specific plastic color card file.

Sensor Instruments is happy to help interested parties in this regard.

After a card insertion holder that is customized to match the customer-specific card has been fabricated, the sequence of the calibration is the same as with the RAL plastic color cards. First, a customer-specific card, which in turn was fitted inside a customized frame, must be placed on the upended calibration tray.

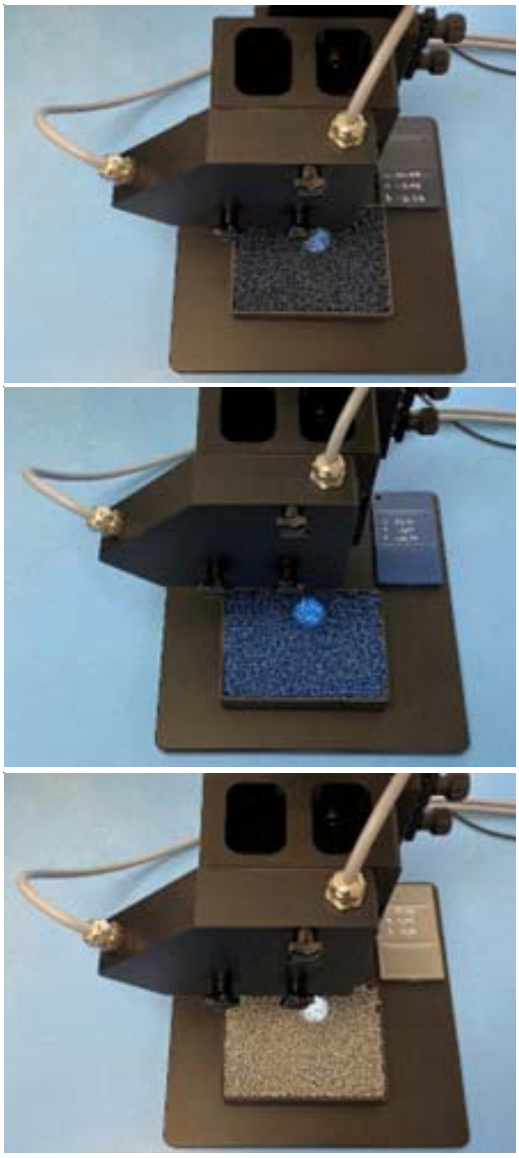
Since the SPECTRO3-MSM-DOCAL Scope software prompts for a white reference at the start of the calibration process, but possibly a white reference is not available on the customer side, falling back on one of the RAL plastic color cards (for example RAL 9003-P or RAL 9010-P) is a possibility.

The L*a*b* values can be obtained from the label on the respective RAL plastic color card and entered in the customer-specific file or in the calibration table.

Upon completion of the calibration process, a calibration file can once again be generated. If the calibration card range is expanded later, the calibration file that has been generated can be invoked.

Calibration

Calibration to granulates related to customer-specific plastic color cards



That the respective granulate shows the same L*a*b* color values as the plastic color cards derived from them is initially somewhat remarkable. The spherical, lenticular or even cylindrical pellets, are illuminated by color sensing systems, they do form any number of shadows between the individual granulate grains.

However, during the calibration process, if the respective granulate related to the plastic color card, instead of the plastic color card itself, is shown to the colorimeter system, the L*a*b*-value of the plastic color card is transferred or adapted to the granulate.

Now, in order that the measurement result is not dependent on the random position of the pellets below the light spot, measurement is performed during the movement of the granulate grains.

By means of the SPECTRO3-MSM-DOCAL Scope software, both the start of measurement as well as the time window during the calibration process can be set manually. Next, if the maximum available calibration time of 60s is used, and the measuring tray filled with granulate is moved during the period of the calibration process, happily, a really high reproducibility of the measurement values is obtained (referred to dE of less than 0.2).

The advantage of this calibration method is the quick availability of the L*a*b* measurement results and the concordance of the color values with the color values of the respective matching plastic color cards.

The calibration process can be performed in the same way for the colorimetry on the jolting conveyor.

CALIB REF | CALIB DATA | SENSOR DATA — Scroll all — CLOSE

SETVALUE TABLE

	L*	a*	b*
1	92.0700	-0.4600	1.3800
2	78.5300	-1.0600	1.1700
3	60.0900	-2.3300	-3.7600
4	39.3100	-1.9600	-1.5900
5	35.6800	0.5300	-4.0800
6	30.8300	-0.1900	-3.7300
7	48.5100	-26.4300	31.7000
8	56.0700	-7.6800	-19.6500
9	84.6400	-1.2000	5.7000

ACTUAL XYZ VALUE TABLE

	X SI	Y SI	Z SI
1	2805	3005	3197
2	1884	2025	2133
3	975	1059	1244
4	368	402	454
5	311	329	406
6	234	249	308
7	454	663	265
8	817	954	1486
9	2182	2349	2322

RAW X 2182 — RAW Y 2349 — RAW Z 2322

Assignment of the XYZ values of the color sensor system to the specified L*a*b* color values of the plastic color cards determined by the customer..

Software

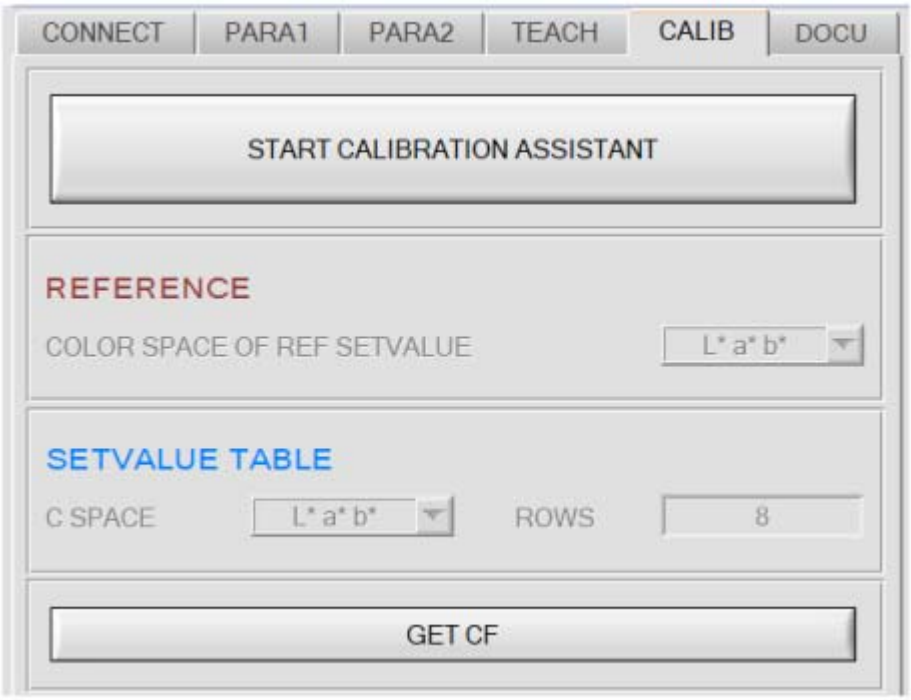
Windows® Software SPECTRO3-MSM-DOCAL Scope

Calibration

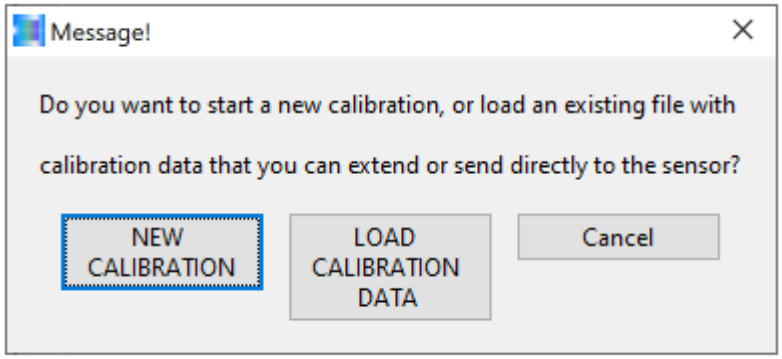
DOCAL stands for DOcumentation and CALibration.
We have striven to make the software as user-friendly as possible. To that end, a software wizard was integrated in the area of the calibration. It interactively guides the user through the calibration process
What a recalibration process could look like has been described below.

Recalibration by means of the calibration software wizard of the SPECTRO3-MSM-DOCAL Scope:

1.

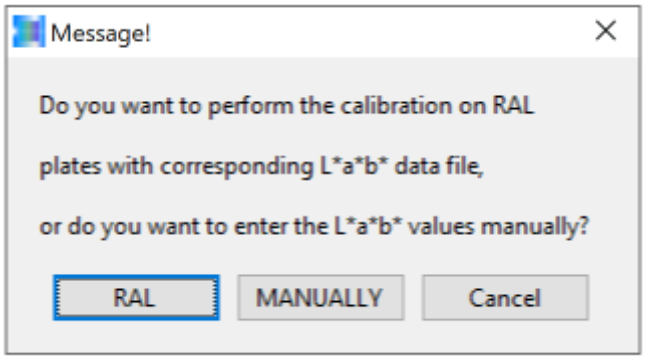


2.



Software

3.



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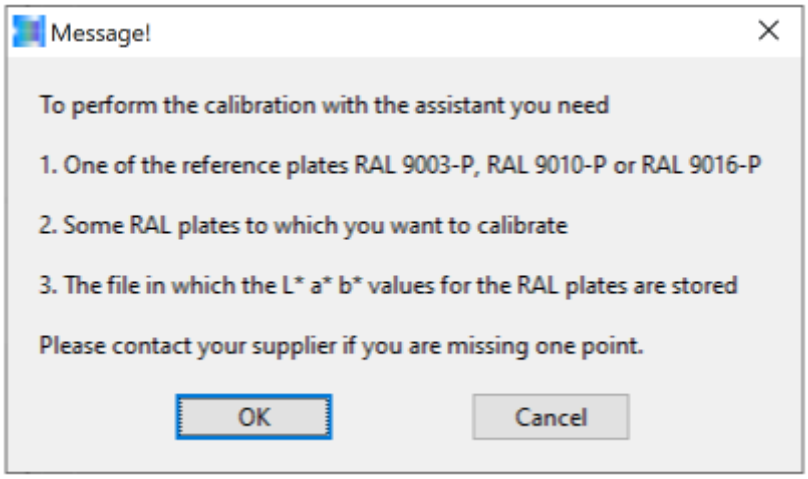

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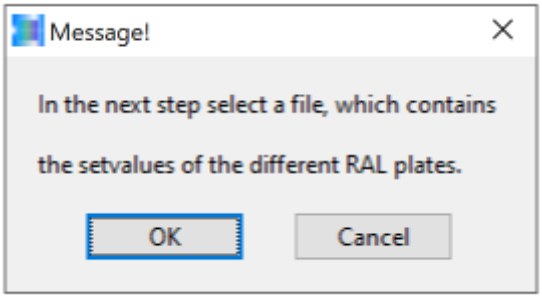
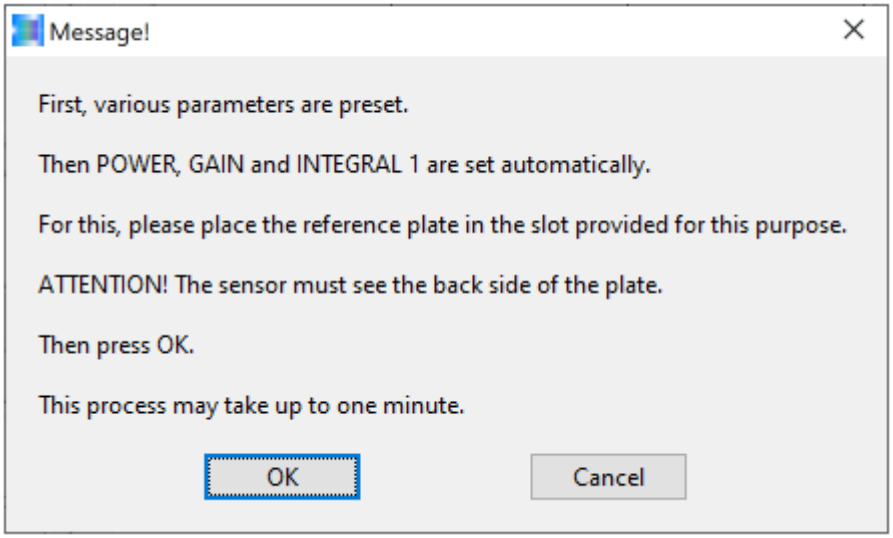
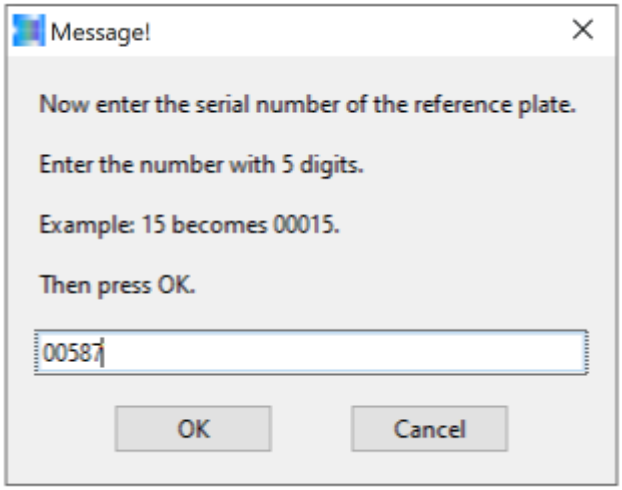


Software

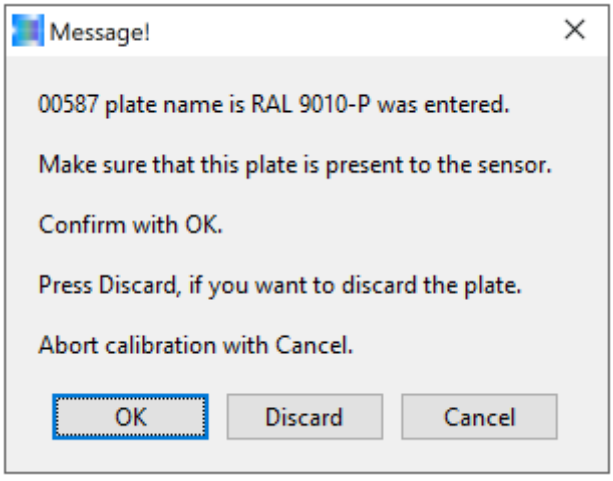
6.



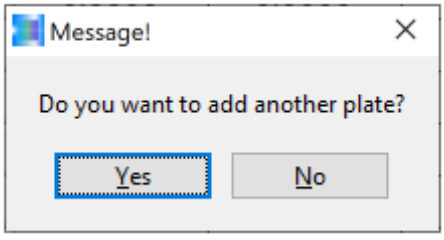
7.



8.

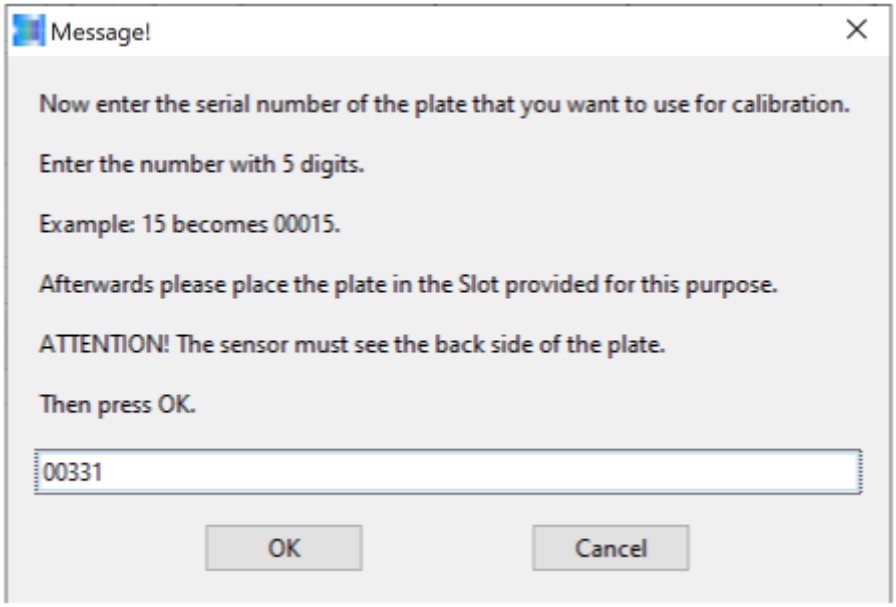


9.

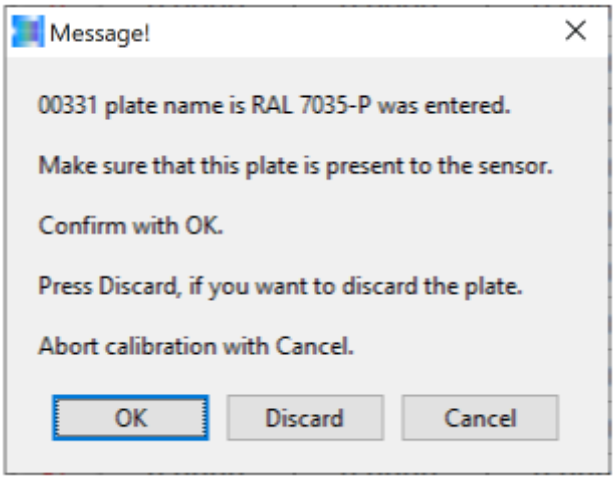


Software

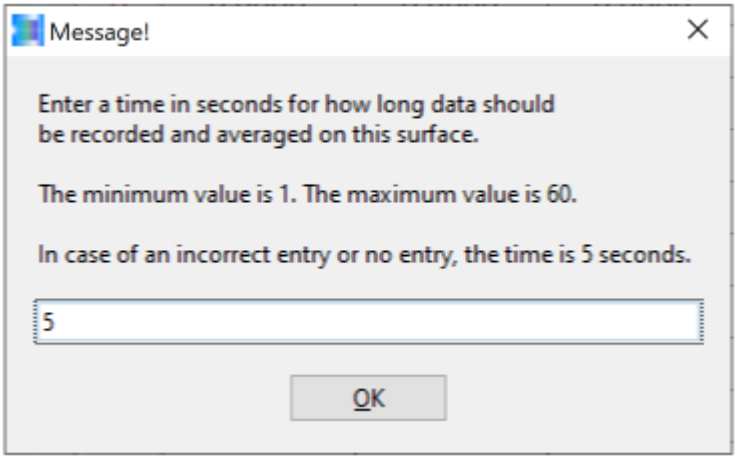
10.



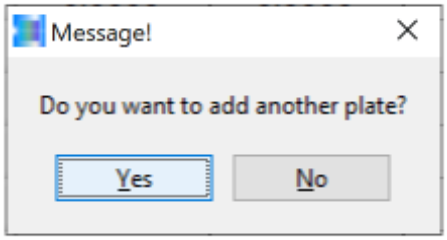
11.



12.



13.



Software

After calibrating to additional RAL plastic color cards, the calibration table could look like this:

CALIB REF | CALIB DATA | SENSOR DATA — Scroll all

SETVALUE TABLE

	L*	a*	b*
1	92.0700	-0.4600	1.3800
2	78.5300	-1.0600	1.1700
3	60.0900	-2.3300	-3.7600
4	39.3100	-1.9600	-1.5900
5	35.6800	0.5300	-4.0800
6	30.8300	-0.1900	-3.7300
7	48.5100	-26.4300	31.7000
8	56.0700	-7.6800	-19.6500

ACTUAL XYZ VALUE TABLE

	X SI	Y SI	Z SI
1	2805	3005	3197
2	1884	2025	2133
3	975	1059	1244
4	368	402	454
5	311	329	406
6	234	249	308
7	454	663	265
8	817	954	1486

Here, the L*a*b*-color values of the RAL plastic color cards used are listed under SETVALUE TABLE and the XYZ color values correspondingly determined from the color sensor under ACTUAL XYZ VALUE TABLE. Just before completion of the calibration process, the respective conversion factors are determined per table entry and saved in the control electronics.

Upon completion of the calibration process, the color sensor system shows, in conjunction with the SPECTRO3-MSM-DOCAL Scope software upon comparison with the individual RAL plastic color cards, the same L*a*b* values as those that can be seen in the table.

Calibration to customer-specific plastic color cards or to the respective granulate

But, instead of calibration to RAL plastic color cards, calibration can also be performed to customer-specific color cards or even to the respective granulate. To do so, granulate is taken from the ongoing production. A part of the granulate sample is now used to fill a measuring tray, and also, a small injection-molded plate is made from the same granulate sample and using the colorimetry instrument available in the laboratory, the L*a*b*-value of the small injection-molded plate is measured. This color value now serves as a reference to the color value determined from the granulate sample in the measuring tray by means of the SPECTRO-3-0°/45°-MST. Upon completion of the calibration procedure, the SPECTRO-3-0°/45°-MST laboratory measurement system returns the same L*a*b* color value from the granulate sample as was previously determined, using the colorimetry system available in the laboratory, from the injection-molded plate made from the granulate.

Teaching

Up to three different products can be learned with the SPECTRO3-MSM-DOCAL Scope software in conjunction with the SPECTRO-3-FIO-MSM-ANA-DL control electronics. Here, if the currently measured L*a*b* color values are within the tolerances of an entry given in the table, the respective digital output or the corresponding binary coding is output at the two digital outputs.

The entry in row 0 has a special role to play, because it serves as a set (desired) value for the trend display upon activation of the measurement process. Starting from this value, the deviation in dL*, da* and in db* is displayed both in numerical and graphical format and saved in a file that can be selected. The set value L*a*b* can be input directly in row 0 at the places provided for the purpose, or selected from a so-called *Teach Reference File*. To do so, the TEACH REFERENCE FROM FILE TO ROW 0 has to be clicked.

The program prompts for a 5-digit number under which the respective reference was saved in the file. Upon inputting the 5-digit number and acknowledging with OK, the respective L*a*b* color values are entered in the TEACH table in row 0 and in addition, the PLATE NAME entered in the *Teach Reference File* is also transferred to the GUI.

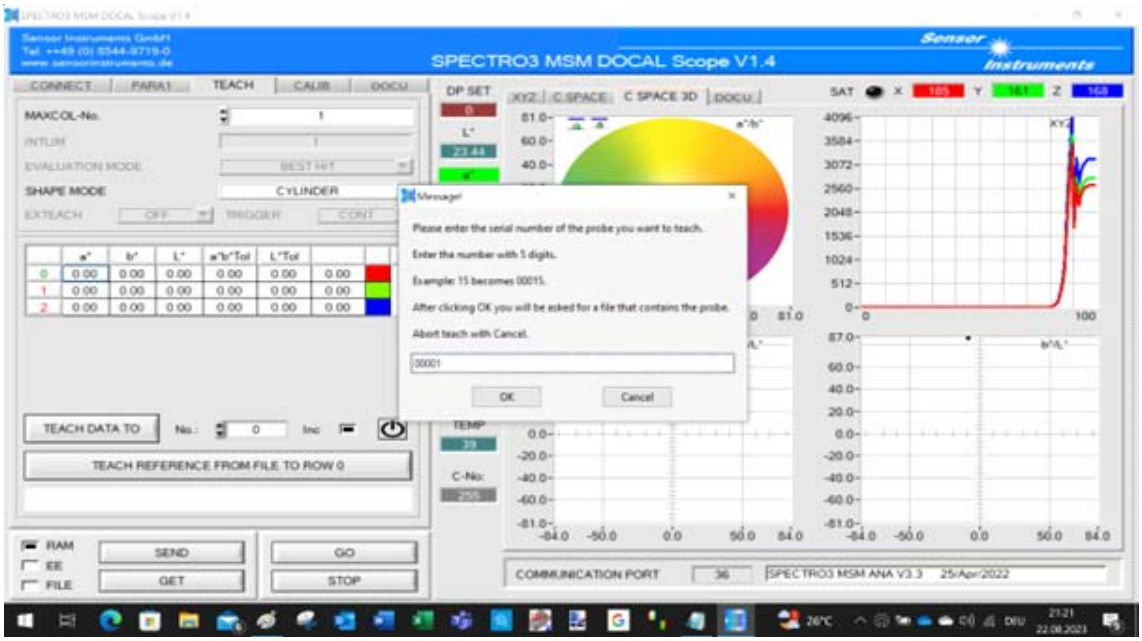
In the example here, after selecting the number 00001, the color value L* = 38.60, a*= -10.90 and b*=11.80 is entered in the TEACH table under 0 and in the white field below TEACH REFERENCE FROM FILE TO ROW 0, the text *00001 Green FC040* is entered.

Teach Reference File - Editor

Datei Bearbeiten Format Ansicht Hilfe

```
[00001]
PLATE NAME = "Grün FC040"
L* = 38.60
a* = -10.90
b* = 11.80

[00002]
PLATE NAME = "Grün FC049"
L* = 46.00
a* = -37.60
b* = 28.10

[00003]
PLATE NAME = "Rot FC071"
L* = 23.30
a* = 16.90
b* = 4.80

[00004]
PLATE NAME = "Grün FC144"
L* = 18.90
a* = -7.70
b* = 2.40

[00005]
PLATE NAME = "Blau FC387"
L* = 28.70
a* = -5.70
b* = -20.10
```

Software



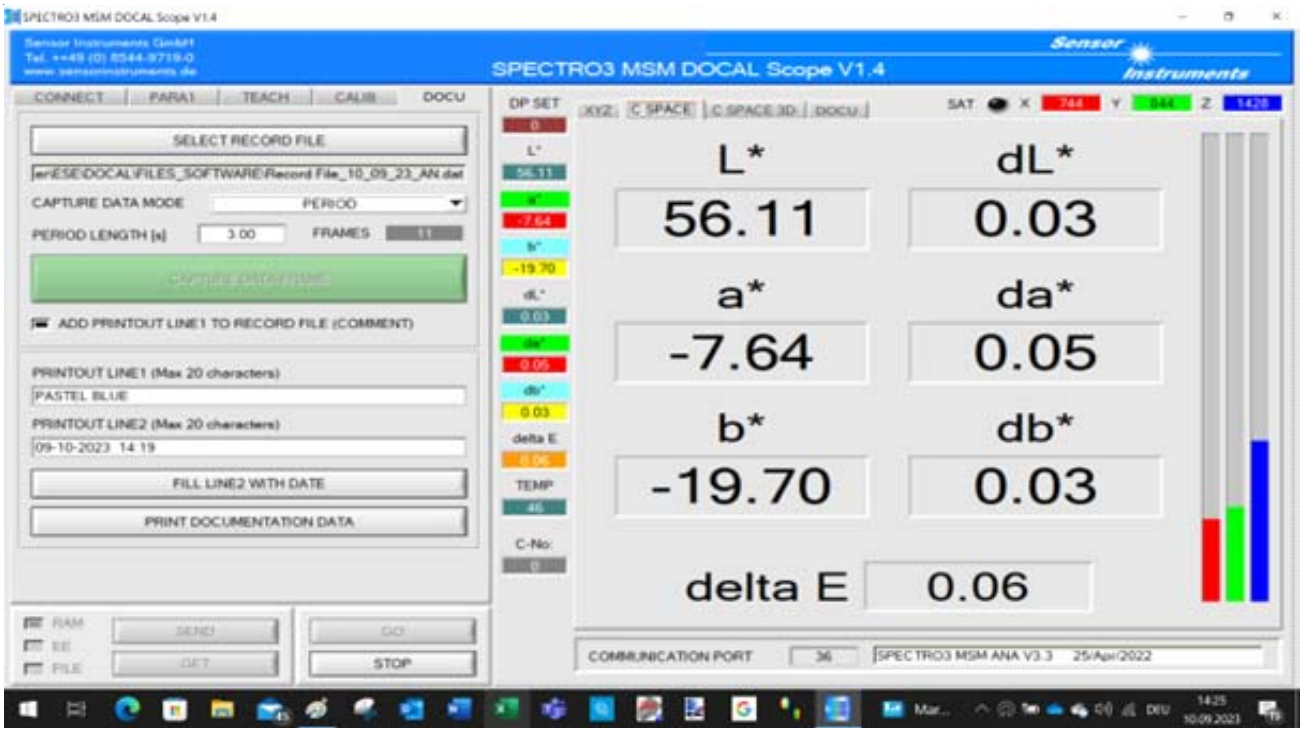
GUI menu option TEACH

Now, in the TEACH table, a selection can be made from among SPHERE (tolerance in dE), CYLINDER (tolerance in da*=db* and dL*) and BLOCK (da*, db* and dL*). If the tolerance is exceeded in one of the specified ranges, an error message is output at the digital outputs and moreover, the fact of the tolerance range being violated is notified in the DOCU Windows® interface.

Software

Measurement

In the DOCU option, the SPECTRO3-MSM-DOCAL Scope software accesses the L*a*b* reference values stored in row 0 of the TEACH table and in addition, after activation of the measurement, checks whether the current color value $L^*_{current}$ $a^*_{current}$ $b^*_{current}$ is within the given tolerances. Here, the measurement values can be depicted numerically (C SPACE), graphically (C SPACE 3D) or as a trend display (DOCU)..



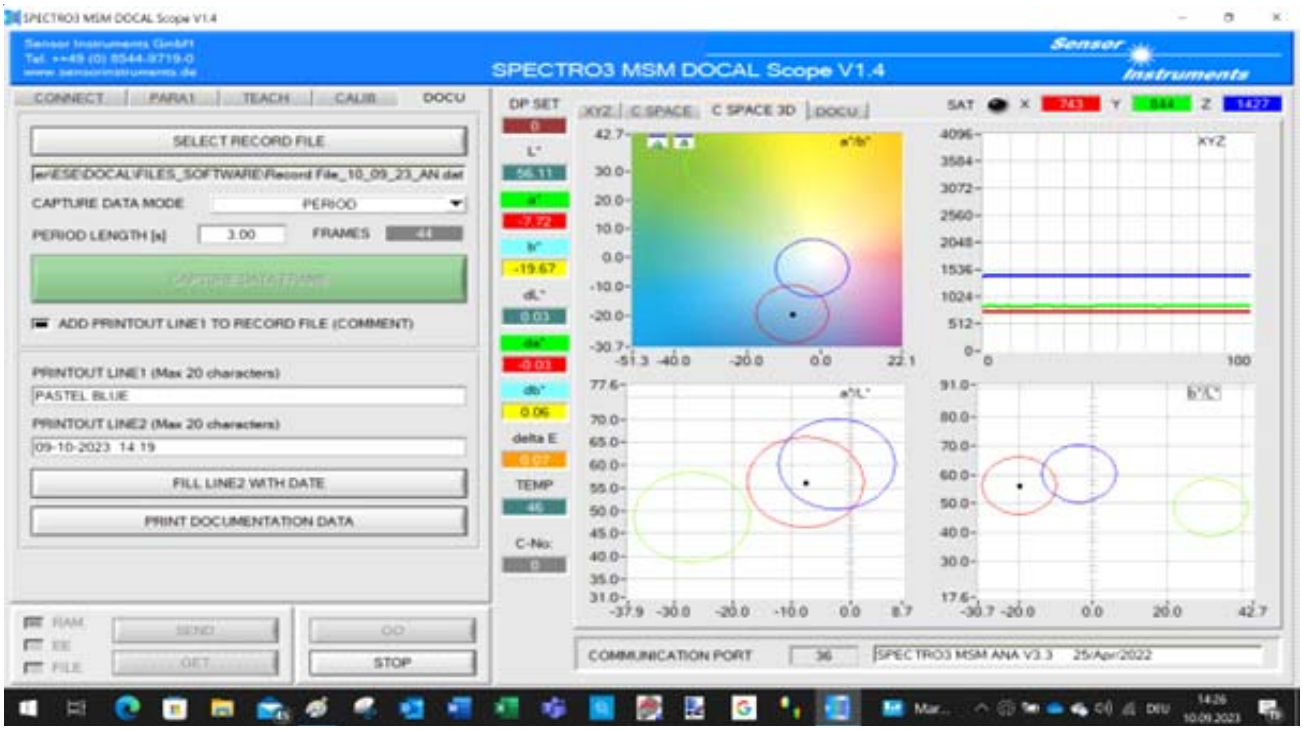
Numerical display

In the *numerical display*, after activating the measurement, upon clicking the CAPTURE DATA FRAME button in the right-hand half of the GUI, the current L*a*b* color values as well as their deviation from the respective reference color value are shown.

Now, if one of the measurement values is outside the given tolerance, that is highlighted in color accordingly:

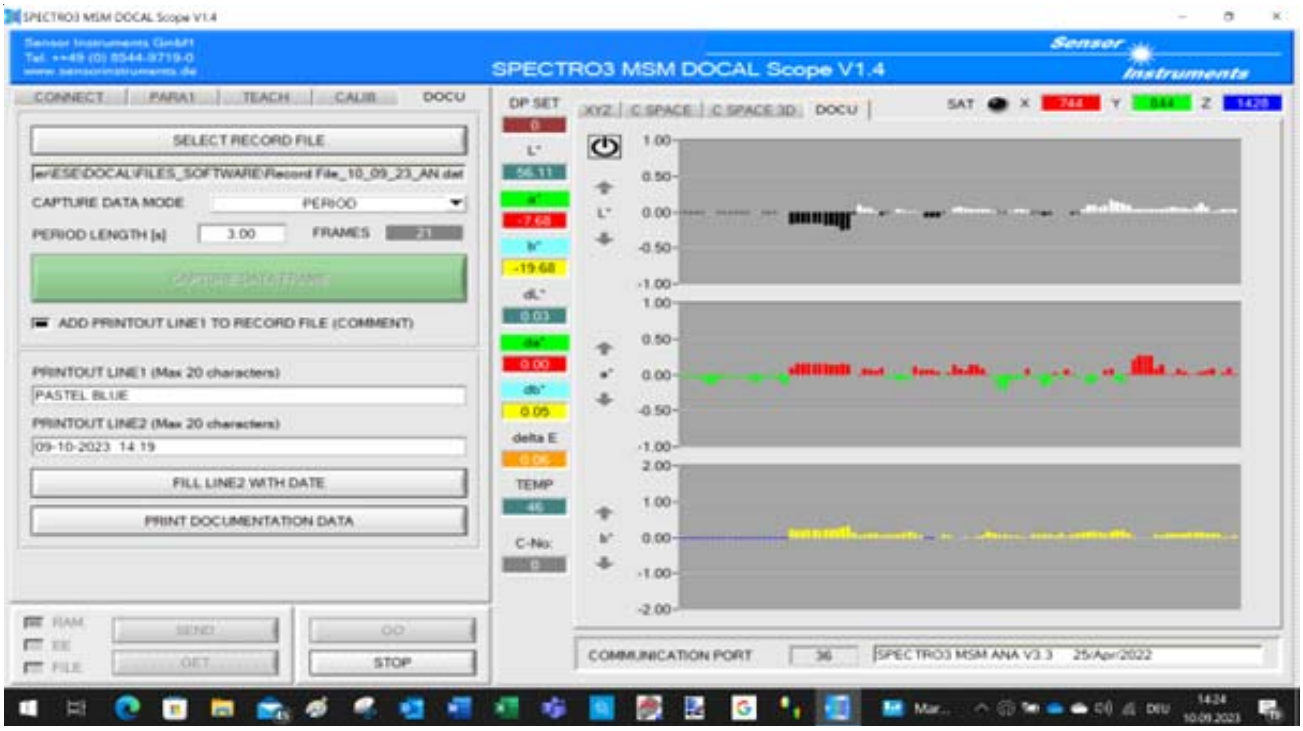
Tolerance window is exceeded:	in L*: white	in a*: red	in b*: yellow
Tolerance window is underrun:	in L*: black	in a*: green	in b*: blue

Software



Graphical display

In the *graphical display*, after activating the measurement, the current color value is depicted upon clicking the CAPTURE DATA FRAME button in the 3D color space, or rather, in the three different views of the color space (from the top a*b*, from the front a*L* and from the side b*L*).



Trend display

In the *trend display*, the 100 last recorded measurement value deviations from the specified reference (in the TEACH table, row 0) are depicted. If the current L* is greater than the L*-value of the reference, the depiction is in white. On the other hand, if the L*-value is smaller than the L*-reference value, an entry is made in black. If the a*-value is greater than the reference value, the depiction is red and if it is smaller than the reference value, the depiction is in green. If the b*-value is greater than the reference value: Yellow, if it is smaller: Blue.

Software

Now, during the progression of a measurement, by making a selection under CAPTURE DATA MODE, it is possible to choose between manual input, i.e. a measurement is performed upon clicking the CAPTURE DATA FRAME button, or by using EXTERN TRIGGER IN0, a measurement is performed for every increasing flank of the 0V/+24V - IN0 signal. Furthermore, the periodic measurement (PERIOD) can also be activated. Here, the measurement process is initiated by clicking the CAPTURE DATA FRAME button. Then, depending on the specified PERIOD LENGTH (in seconds), an average value across this period is displayed each time.

Documentation

In addition to the displays, the measurement values are saved to a file that can be selected by the user. The file can be opened with Windows® editor or even with Word® or Excel®. Moreover, the current L*a*b*-value, the deviations dL*, da* and db* from the reference value as well as the date, time and designation can be printed in the form of a label.

Record results of: SPECTRO3 MSM DOCAL Scope V1.4

DATE	TIME	X	Y	Z	L*	a*	b*	delta E	delta L*	delta a*	delta b*	COLOR	TEMPs	COMMENT
09.10.2023	13:44:22	744	844	1427	56.128	-7.683	-19.638	0.102	0.046	0.003	0.091		0	45
09.10.2023	13:44:27	744	844	1427	56.119	-7.683	-19.646	0.091	0.037	0.003	0.083		0	45
09.10.2023	13:44:32	744	844	1427	56.132	-7.682	-19.634	0.107	0.050	0.004	0.095		0	45
09.10.2023	13:44:38	744	844	1427	56.126	-7.676	-19.632	0.107	0.044	0.010	0.097		0	45
09.10.2023	13:44:43	744	844	1427	56.139	-7.682	-19.628	0.116	0.058	0.004	0.101		0	45
09.10.2023	13:44:48	744	844	1427	56.111	-7.684	-19.652	0.082	0.030	0.002	0.076		0	45
09.10.2023	13:44:53	744	845	1428	56.142	-7.750	-19.649	0.119	0.061	-0.063	0.080		0	45
09.10.2023	13:44:58	744	845	1428	56.146	-7.708	-19.631	0.119	0.065	-0.021	0.097		0	45
09.10.2023	13:45:03	743	843	1426	56.101	-7.671	-19.637	0.095	0.019	0.015	0.092		0	45
09.10.2023	13:45:09	742	841	1422	56.054	-7.636	-19.612	0.130	-0.028	0.050	0.117		0	45
09.10.2023	13:45:14	742	841	1422	56.052	-7.590	-19.608	0.157	-0.029	0.096	0.121		0	45
09.10.2023	13:45:19	742	842	1423	56.061	-7.606	-19.618	0.138	-0.021	0.080	0.110		0	45
09.10.2023	13:45:24	741	841	1424	56.046	-7.788	-19.676	0.120	-0.036	-0.102	0.052		0	45
09.10.2023	13:45:29	741	841	1424	56.051	-7.819	-19.656	0.154	-0.031	-0.133	0.072		0	45
09.10.2023	13:45:35	741	841	1424	56.057	-7.831	-19.651	0.166	-0.024	-0.144	0.078		0	45
09.10.2023	13:45:40	737	835	1411	55.879	-7.588	-19.515	0.310	-0.203	0.098	0.213		0	45
09.10.2023	13:45:45	737	836	1411	55.888	-7.579	-19.518	0.306	-0.194	0.107	0.211		0	45
09.10.2023	13:45:50	738	836	1412	55.888	-7.537	-19.526	0.318	-0.194	0.149	0.203		0	45
09.10.2023	13:45:55	737	836	1411	55.888	-7.589	-19.516	0.304	-0.194	0.097	0.213		0	45
09.10.2023	13:46:00	736	835	1410	55.873	-7.633	-19.501	0.313	-0.209	0.053	0.228		0	45
09.10.2023	13:46:06	736	834	1408	55.845	-7.511	-19.490	0.380	-0.237	0.176	0.239		0	45
09.10.2023	13:46:11	736	834	1408	55.839	-7.541	-19.494	0.367	-0.242	0.145	0.235		0	45
09.10.2023	13:46:16	737	835	1409	55.858	-7.539	-19.477	0.367	-0.224	0.147	0.251		0	45
09.10.2023	13:46:21	741	840	1418	56.006	-7.580	-19.547	0.224	-0.076	0.107	0.182		0	45
09.10.2023	13:46:27	744	844	1425	56.131	-7.683	-19.567	0.169	0.049	0.004	0.162		0	45
09.10.2023	13:46:32	744	844	1424	56.130	-7.683	-19.541	0.194	0.048	0.004	0.188		0	45
09.10.2023	13:46:37	744	843	1424	56.098	-7.626	-19.569	0.171	0.016	0.061	0.159		0	45
09.10.2023	13:46:42	743	842	1423	56.059	-7.590	-19.605	0.158	-0.022	0.096	0.124		0	45
09.10.2023	13:46:47	742	841	1422	56.043	-7.591	-19.613	0.155	-0.039	0.095	0.116		0	45
09.10.2023	13:46:52	742	841	1422	56.055	-7.594	-19.607	0.155	-0.027	0.092	0.121		0	45
09.10.2023	13:46:58	744	844	1426	56.132	-7.759	-19.585	0.169	0.051	-0.073	0.143		0	45
09.10.2023	13:47:03	745	846	1428	56.171	-7.810	-19.574	0.217	0.089	-0.124	0.154		0	45
09.10.2023	13:47:08	744	844	1426	56.129	-7.626	-19.609	0.142	0.047	0.060	0.120		0	45
09.10.2023	13:47:13	741	841	1422	56.040	-7.715	-19.629	0.112	-0.042	-0.029	0.100		0	45
09.10.2023	13:47:18	744	842	1425	56.076	-7.519	-19.644	0.187	-0.006	0.167	0.084		0	45
09.10.2023	13:47:24	746	845	1429	56.163	-7.621	-19.647	0.132	0.081	0.065	0.082		0	45
09.10.2023	13:47:29	745	845	1428	56.142	-7.637	-19.626	0.129	0.060	0.049	0.102		0	45
09.10.2023	13:47:34	744	843	1425	56.099	-7.562	-19.613	0.170	0.018	0.124	0.115		0	45
09.10.2023	13:47:39	743	842	1423	56.059	-7.590	-19.605	0.158	-0.022	0.096	0.124		0	45
09.10.2023	13:47:44	743	842	1423	56.081	-7.565	-19.596	0.180	-0.000	0.121	0.133		0	45
09.10.2023	13:47:49	745	845	1426	56.145	-7.623	-19.561	0.190	0.063	0.063	0.168		0	45
09.10.2023	13:47:55	745	845	1427	56.161	-7.767	-19.571	0.195	0.079	-0.081	0.158		0	45
09.10.2023	13:48:00	743	843	1424	56.095	-7.643	-19.579	0.156	0.013	0.043	0.149		0	45

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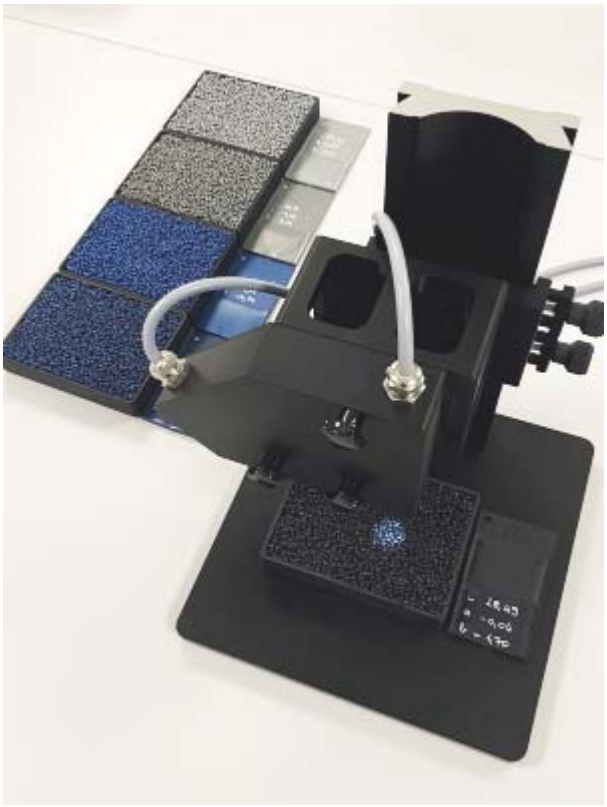
Accessories

Sample trays for recyclates

For the recyclates to be examined, there are five sample trays (granulate measuring trays) available (contained in the supplied kit of the SPECTRO-3-0°/45°-MST laboratory measurement system), which, in terms of their dimensions, are selected in such a way that they can be placed optimally on the measurement table base plate below the optical frontend and in addition, can be used to place the upended calibration tray on it during the calibration.



For calibrating the colorimetry system, it is recommended that RAL plastic color cards should be used, which are visually similar to the respective recyclate samples.

Calibration cards

RAL plastic color cards are used as calibration cards. Since these were calibrated according to the d/8° method (diffuse lighting and viewed below 8° to the normal) at the factory (RAL gGmbH, Bonn, a non-profit company), but the color sensor system used in the colorimetry system is based on the 0°/45° measurement method, the available RAL plastic color cards were re-calibrated by Sensor Instruments by the 45°/0 measurement method with a calibrated manual instrument; the corresponding L*a*b* values were then indicated with a label on the respective cards as well as card covers.

In addition, a file was generated, during which an assignment of the RAL numbers with regard to the matching L*a*b* values was carried out.

An RAL plastic color card (RAL 9003-P signal white) is contained in the supplied kit of the SPECTRO-3-0°/45°-MST color measurement system.

Accessories

Label printer

A printer of type **cab eos2 mobile/300** is used as label printer ((not included in scope of delivery, please order separately).

The label printer is preset at the factory so that the interface driver, the label format and the label roll are suitable for this application.

The connection to the laboratory device is established via a USB interface cable.