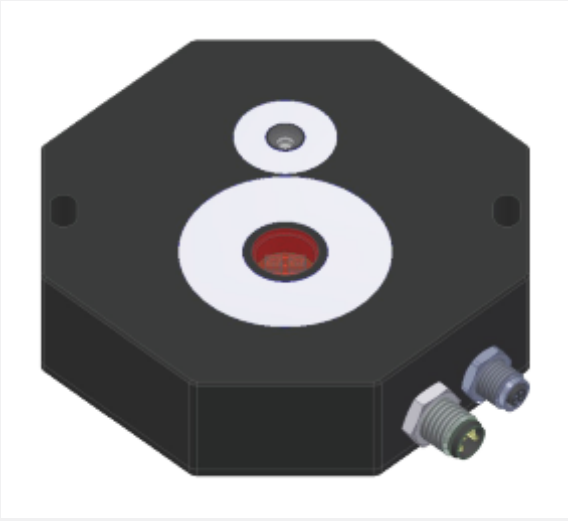
SPECTRO-T-4 Series

SPECTRO-T-4-10-DIF-VISNIR
SPECTRO-T-4-10-DIF-VISNIR-RS485

- **Color/NIR sensor (hybrid sensor) for identifying various plastic granules and flakes as well as textiles made from natural and synthetic fibers in the visible range (VIS) and near-infrared range (NIR)**
- 4 light sources:
  In the VIS range, a white light source and an integrated triple receiver for the red, green, and blue components (true-color detector)
  In the NIR range, three NIR light sources with different wavelengths (1300 nm, 1550 nm, 1650 nm) and a broadband NIR detector
- **Two sensor versions are available:**
  I/O version with digital input IN0 and digital output OUT0
  RS485 version with RS485 interface
- Sequential pulse mode
- Working distance (object distance): typ. 10 mm ± 1 mm
- Half-value width for INTnir: typ. 12 mm (of the detection range)
- Half-value width for INTvis: typ. 8 mm (of the detection range)
- Insensitive to outside light due to pulse mode
- Scan frequency max. 5 kHz
- Averaging can be activated (from 1 to over 32,000 values)
- RS232 interface (USB, Ethernet, or PROFINET adapters optionally available)
- Windows® PC software SPECTRO-T-4-DOCAL-Scope
- Temperature compensation for ambient temperatures from 10°C to 45°C
- Factory calibration and on-site calibration possible
- As SPECTRO-T-4-LAB-VISNIR laboratory measuring system designed for laboratory use
- As SPECTRO-T-4-INLINE-VISNIR inline measuring system in conjunction with sight glass suitable for inline use
- As SPECTRO-T-4-MOBILE-VISNIR mobile measuring system in conjunction with offline unit and handle for use as a handheld
- Various accessories available, e.g. TABUN-13" (battery-powered tablet PC for power supply of the sensor)

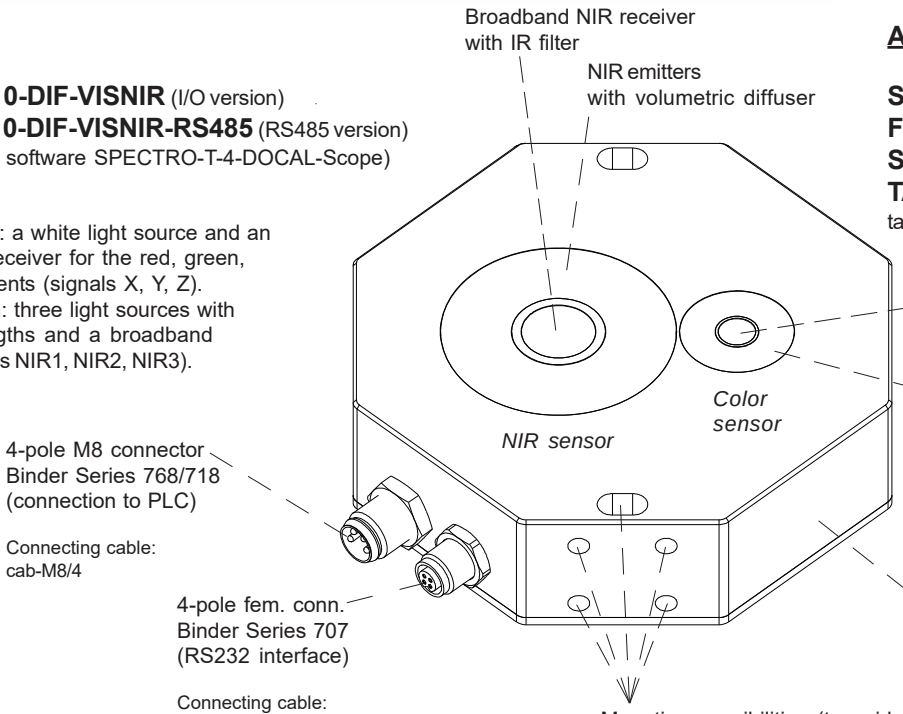


Design

Product name:

SPECTRO-T-4-10-DIF-VISNIR (I/O version)
SPECTRO-T-4-10-DIF-VISNIR-RS485 (RS485 version)
(incl. Windows® PC software SPECTRO-T-4-DOCAL-Scope)

VISNIR:
In the VIS section: a white light source and an integrated triple receiver for the red, green, and blue components (signals X, Y, Z).
In the NIR section: three light sources with different wavelengths and a broadband photodiode (signals NIR1, NIR2, NIR3).



Accessories: (p. 11-14)

SG-B270-75 (Sight glass)
FW-B270-75-OFL (Offline unit)
SPECTRO-T-4-10-HANDLE (Handle)
TABUN-13“ (V1.1) (Battery-powered tablet PC)

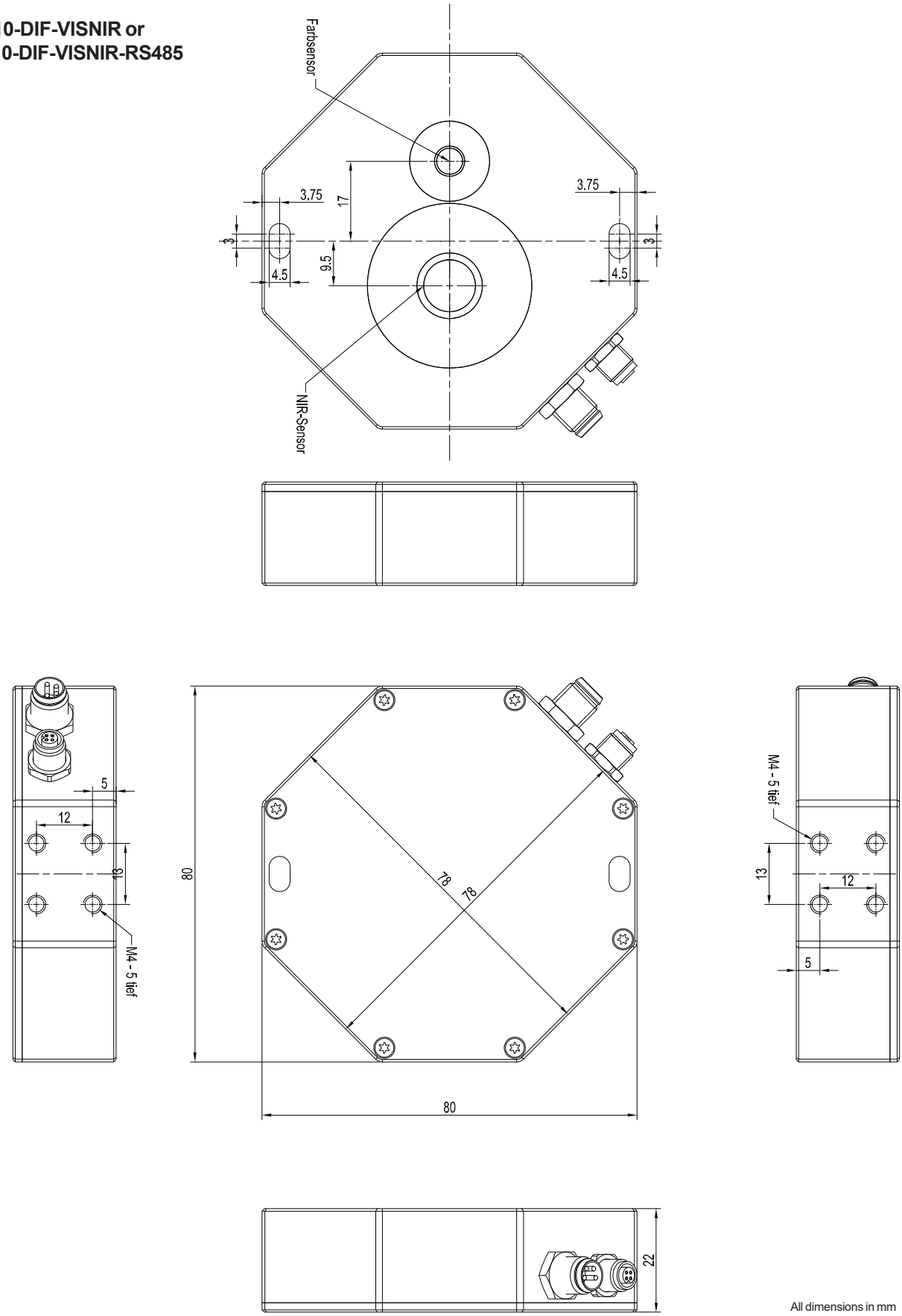
100 % reparierbar/ reparable* * ausgenommen Totalschaden/ excluding total loss

Technical Data

Type	SPECTRO-T-4-10-DIF-VISNIR	SPECTRO-T-4-10-DIF-VISNIR-RS485
Voltage supply	+24VDC (±10%), reverse polarity protected, overcurrent protected	
Current consumption	< 300 mA	
Max. switching current	100 mA, short circuit proof	
Interface	RS232 (USB converter, ETHERNET converter or PROFINET adapter available as an option)	
Digital input	digital input IN0 (Pin 2): input voltage +Ub/0V, with protective circuit	---
Digital output	digital output OUT0 (Pin 4): 100 mA, short-circuit proof	---
Additional interface	---	RS485 interface (A, B), max. baud rate: 460800 Bit/s, RS485 address: (Initial 200)
Pulse lengthening	0 ... 100 ms, adjustable via PC software	
Averaging	max. 32768 values, adjustable via PC software	
Scan frequency	max. 5 kHz	
Measuring spot diameter	see diagrams	
Transmitter (light source)	VIS range: 6 sunlight LEDs, with volumetric diffuser NIR range: 3x 6 NIR emitters with three different wave lengths (1300 nm, 1550 nm, and 1650 nm), with volumetric diffuser	
Receiver	VIS range: true-color detector NIR range: broadband NIR detector (900 nm ... 1700 nm)	
Receiver gain setting	8 steps (AMP1 ... AMP8), adjustable via PC software	
Ambient light	max. 5000 Lux	
Working distance (object distance)	typ. 10 mm ± 1 mm	
Housing dimensions	LxWxH approx. 80 mm x 80 mm x 22 mm (without connectors)	
Housing material	aluminum, anodized in black	
Enclosure rating	IP64	
Connecting cables	to PLC: cab-M8/4-g or cab-M8/4-w to PC/RS232 interface: cab-las4/PC or cab-las4/PC-w USB adapter: cab-4/USB or cab-4/USB-w Ethernet adapter: cab-4/ETH-500 PROFINET adapter: cab-4-PNET-500	
Type of connector	connection to PLC: 4-pole M8 connector (Binder 768/718) connection to PC: 4-pole fem. connector (Binder 707)	
Operating temp. range	-20°C ... +55°C	
Storage temperature range	-20°C ... +85°C	
EMC test acc. to	DIN EN 60947-5-2 CE	

Dimensions

SPECTRO-T-4-10-DIF-VISNIR or
SPECTRO-T-4-10-DIF-VISNIR-RS485



All dimensions in mm

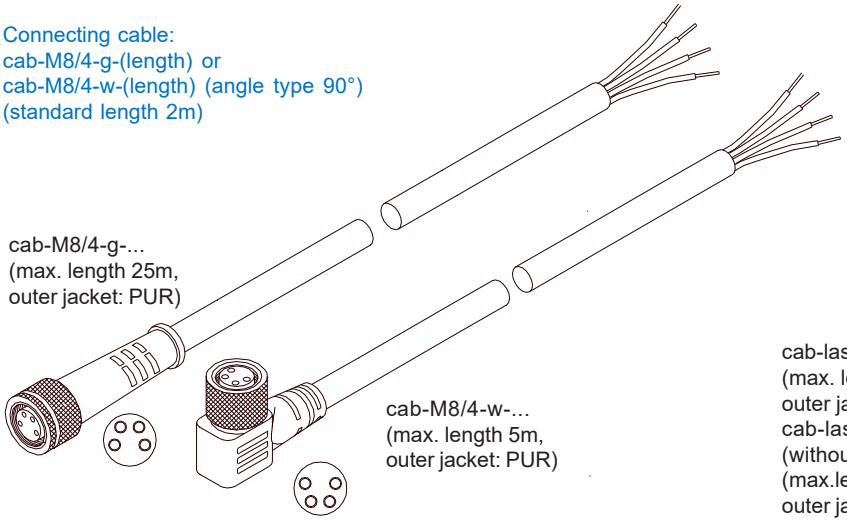
Connector Assignment

Connection of SPECTRO-T-4-10-DIF-VISNIR Version with digital input and output:

Connection to PLC:
4-pole M8 connector Binder Series 768/718

Pin:	Color:	Assignment:
1	brown	+24VDC (±10%)
2	white	IN0 (Digital 0: 0 … 1V, Digital 1: +Ub - 10%)
3	blue	GND (0V)
4	black	OUT0 (Digital 0: 0 … 1V, Digital 1: +Ub - 10%)

Connecting cable:
cab-M8/4-g-(length) or
cab-M8/4-w-(length) (angle type 90°)
(standard length 2m)



cab-M8/4-g-...
(max. length 25m,
outer jacket: PUR)

cab-M8/4-w-...
(max. length 5m,
outer jacket: PUR)

Connection to PC:
4-pole fem. connector Binder Series 707

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

Connection via RS232 interface at the PC:
Connecting cable:
cab-las4/PC-(length)
cab-las4/PC-w-(length) (angle type 90°)
(standard length 2m)

alternative:
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)

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

Connection to PROFINET network via PROFINET adapter:
cab-4-PNET-500
(standard length 0.5m)

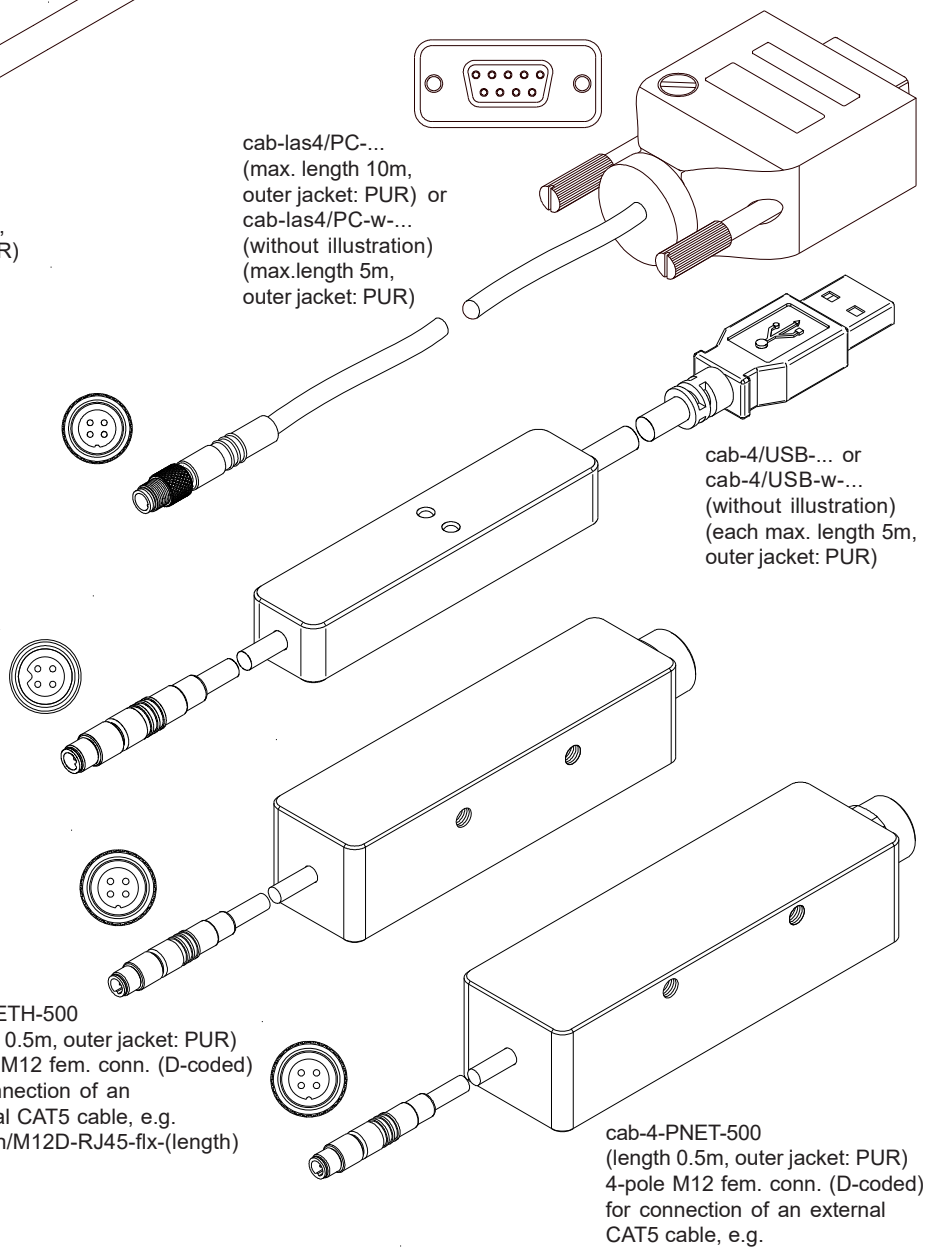
Optional: External CAT5 cable, e.g.
cab-eth/M12D-RJ45-flx-(length)
(available lengths: 2m, 5m, 10m, 20m)

Connection of SPECTRO-T-4-10-DIF-VISNIR-RS485 Version with RS485 interface:

Connection to PLC:
4-pole M8 connector Binder Series 768/718

Pin:	Color:	Assignment:
1	brown	+24VDC (±10%)
2	white	RS485-A
3	blue	GND (0V)
4	black	RS485-B

Connecting cable:
cab-M8/4-g-(length) or
cab-M8/4-w-(length) (angle type 90°)
(standard length 2m)



cab-las4/PC-...
(max. length 10m,
outer jacket: PUR) or
cab-las4/PC-w-...
(without illustration)
(max.length 5m,
outer jacket: PUR)

cab-4/USB-... or
cab-4/USB-w-...
(without illustration)
(each max. length 5m,
outer jacket: PUR)

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-PNET-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)

Sensor Versions

Sensor versions of the SPECTRO-T-4 series: I/O and RS485

With the SPECTRO-T-4 there are two sensor versions avaiable for the different types (VISNIR, UVNIR):
One I/O version with the digital input IN0 and the output OUT0 and one with RS485 interface on the 4-pole M8 connector.

Example for the I/O version: SPECTRO-T-4-10-DIF-VISNIR
Example for the RS485 version: SPECTRO-T-4-10-DIF-VISNIR-RS485

Please note that the RS485 interface cannot be addressed with the I/O version, and that the input and output are not available with the RS485 version. With the RS485 version, it is normally up to the user to collect the data via RS485 and then evaluate it themselves. In this case, the RS232 interface is only used to parameterize and calibrate the sensor once and to assign an RS485 address to the sensor. With the I/O version, data acquisition and documentation are typically performed using the SPECTRO-T-4-DOCAL-Scope PC software.

Measuring Principle

Measuring principle of the sensors of SPECTRO-T-4 Series:

The SPECTRO-T-4 sensors were developed to identify different plastic granulates and flakes as well as textiles made of natural and synthetic fibers. With the VISNIR sensor type, the determination takes place in the visible range (VIS) and in the near infrared range (NIR). With the UVNIR sensor type, the determination takes place in the UV range (UV) and in the near-infrared range (NIR).

For this purpose, the sensor has a white light source in the VIS range and an integrated triple receiver for the red, green and blue proportion. This provides 3 signals (X, Y, Z) in the VIS range.
The same applies to the UVNIR sensor type, with the difference that a UV light source is used here.

In the NIR range, the sensor has 3 light sources with different wavelengths and a broadband photodiode which records the individual wavelengths analogously. Here you also obtain 3 signals (NIR1, NIR2, NIR3).
The 4 light sources are switched on one after the other, so that the signals do not overlap.

With the recorded signal values X, Y, Z or NIR1, NIR2, NIR3, the 3 color space coordinates L*a*b* are calculated for the visible range for the VISNIR sensor type respectively for the UV range for the UVNIR sensor type, and the three NIR space coordinates N*i*r* for the near-infrared range are calculated.
These coordinates each represent a point (vector) in space and uniquely characterize the surface.

Signal detection with the SPECTRO-T-4 is very flexible. The stepless adjustment possibility of the integrated light sources as well as a selectable amplification of the receiver signal and an INTEGRAL function enable the sensor to be adjusted to almost any surface.

The SPECTRO-T-4 sensor can be taught a status (surface) with adjustable tolerance.
This data is used on the PC interface for documentation purposes.
In addition, this data is used with the I/O version to indicate via the OUT0 output whether the current surface data is within the taught-in tolerance or not.
The IN0 input is used on the I/O sensor for documentation purposes.

Sensors in the SPECTRO-T-4 series have no analog or digital inputs or outputs.
Data is exchanged via the sensor's internal RS232 interface.
Parameters and measurement values can be exchanged between a PC and the SPECTRO-T-4 sensor through the serial RS232 interface. All the parameters can be saved to the non-volatile EEPROM of the SPECTRO-T-4 sensor through the serial RS232 interface. When parameterisation is finished, the sensor continues to operate with the current parameters in STAND-ALONE mode without a PC. With the RS485 version, the measurement data can also be read out via RS485.

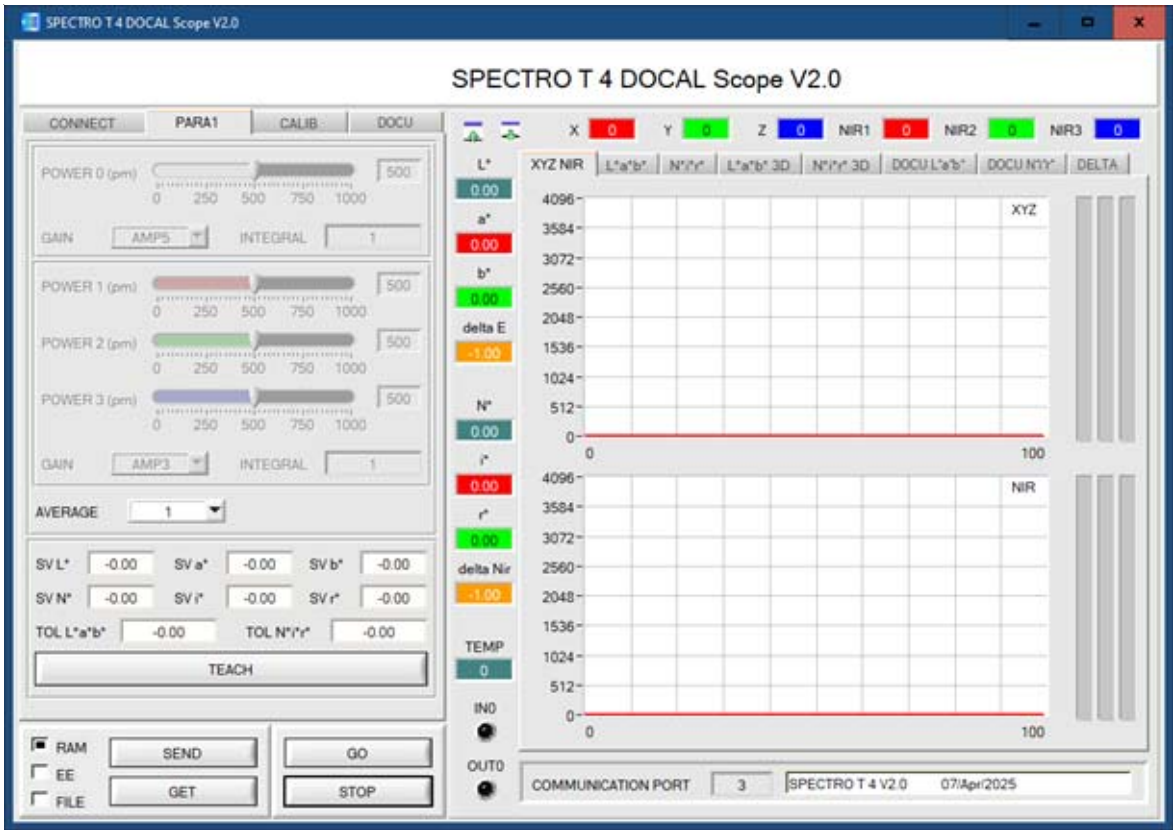
Possible firmware updates can be easily performed through the RS232 interface, even with the sensor system in installed condition.

Software

Windows® user interface:

(The current software version is available for download on our website.)

The SPECTRO-T-4-DOCAL-Scope software enables data to be recorded and also allows the measurement data to be viewed during recording. Furthermore, trends in deviations from the respective reference value are displayed, and any exceedance of the respective tolerance values is indicated by a colored frame around the affected measurement values.



The PARA1 tab is used to set sensor parameters such as:

- POWER: Setting the transmitter power of the 4 transmitter light sources (VIS or UV, NIR1, NIR2, NIR3)
- GAIN: Receiver gain (8 levels available: AMP1 ... AMP8)
- INTEGRAL: Number of samples (measured values) over which the raw signal measured at the receiver is summed. This integral function allows even extremely weak signals to be reliably detected.
- AVERAGE: Number of samples (measured values) over which the raw signal measured at the receiver is averaged.
- SV and TOL: Specification of a set value (SV) and a tolerance (TOL) for L*a*b* and N*i*r*

The sensor can be calibrated for different surfaces using the CALIB tab:

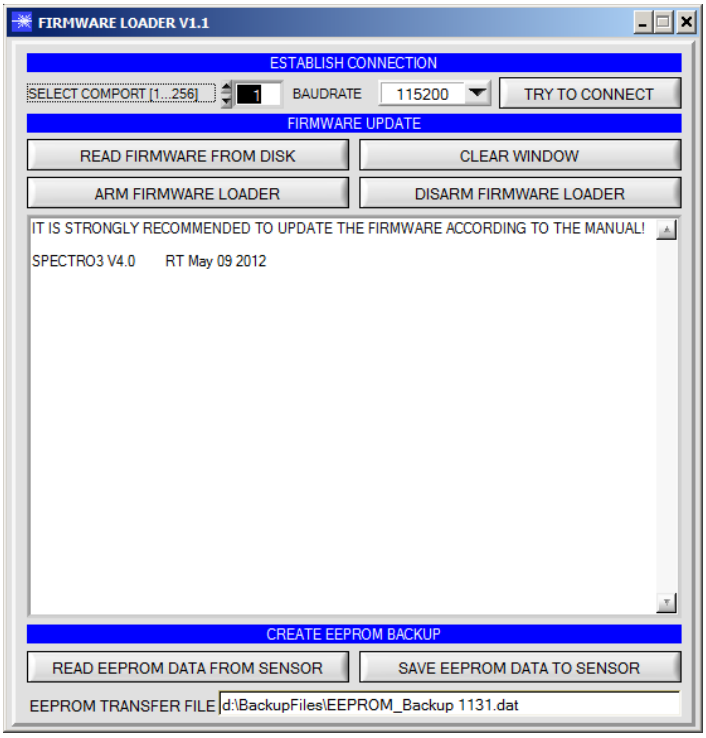
The sensors are calibrated at the factory. The CALIBRATION parameter is set to ON and cannot be changed. The sensor operates in calibrated mode. The user can calibrate the sensor to different surfaces. When this is done, the factory calibration is overwritten and the sensor operates with the calibration performed by the user.
START CALIBRATION ASSISTANT starts the wizard, which guides you step by step through the calibration process.

Data recording can be started via the DOCU tab:

Pressing CAPTURE DATA FRAME starts recording the color space coordinates. The data can also be output to a label printer.

Firmware Update

Firmware update by means of the software „Firmware Loader“:



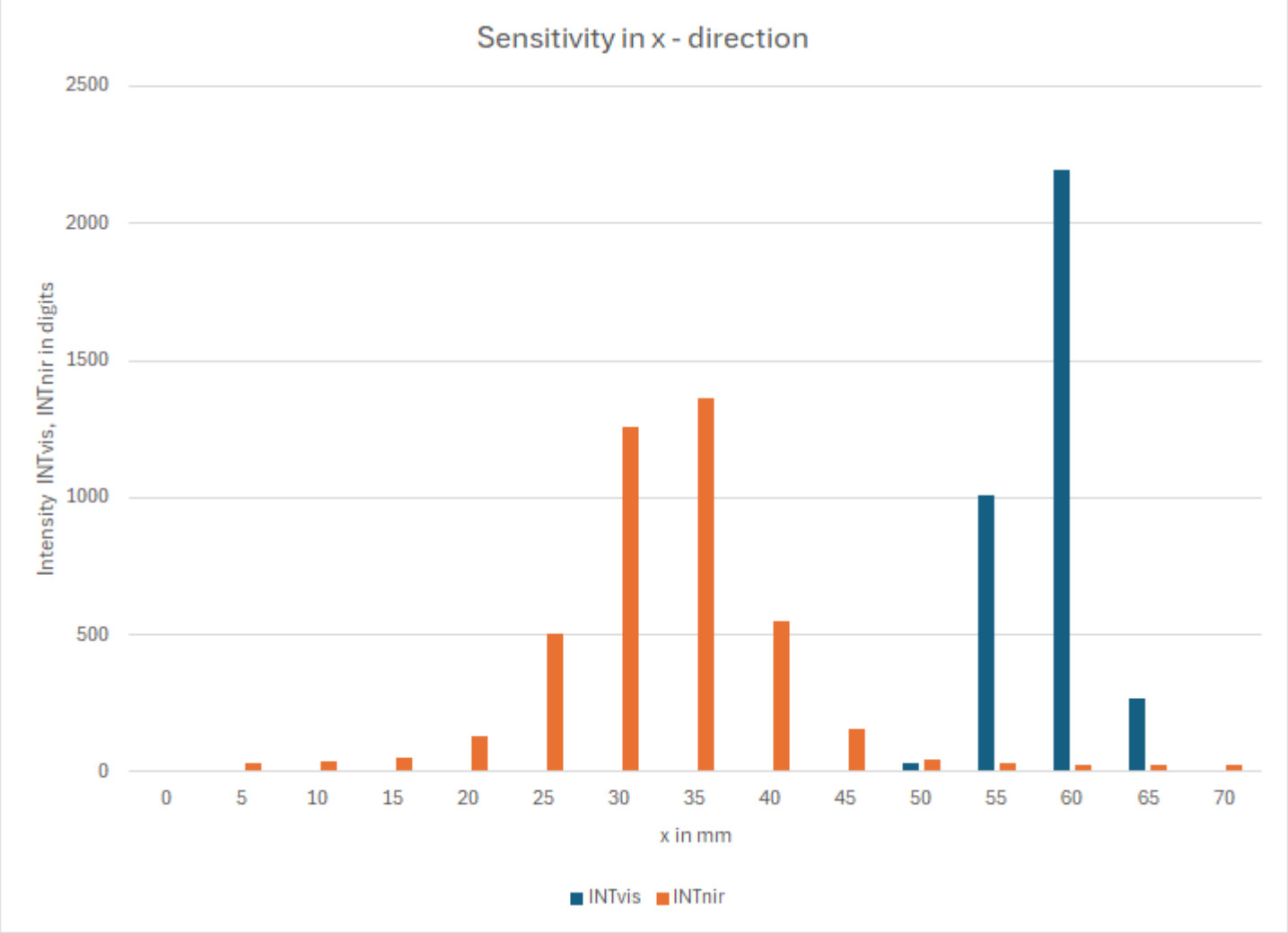
The software „Firmware Loader“ allows the user to perform an automatic firmware update. The update will be carried out through the RS232 interface.

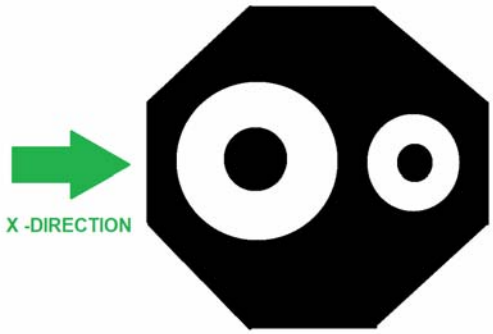
An initialisation file (xxx.ini) and a firmware file (xxx.elf.S) are required for performing a firmware update. These files can be obtained from your supplier. In some cases an additional firmware file for the program memory (xxx.elf.p.S) is also needed, and this file will be automatically provided together with the other two files.

Diagrams

Diagrams: **Sensitivity in x-direction**
SPECTRO-T-4-10-DIF-VISNIR or SPECTRO-T-4-10-DIF-VISNIR-RS485 color/NIR sensor

AMP4 INT2 (color)
AMP2 INT2 (NIR)



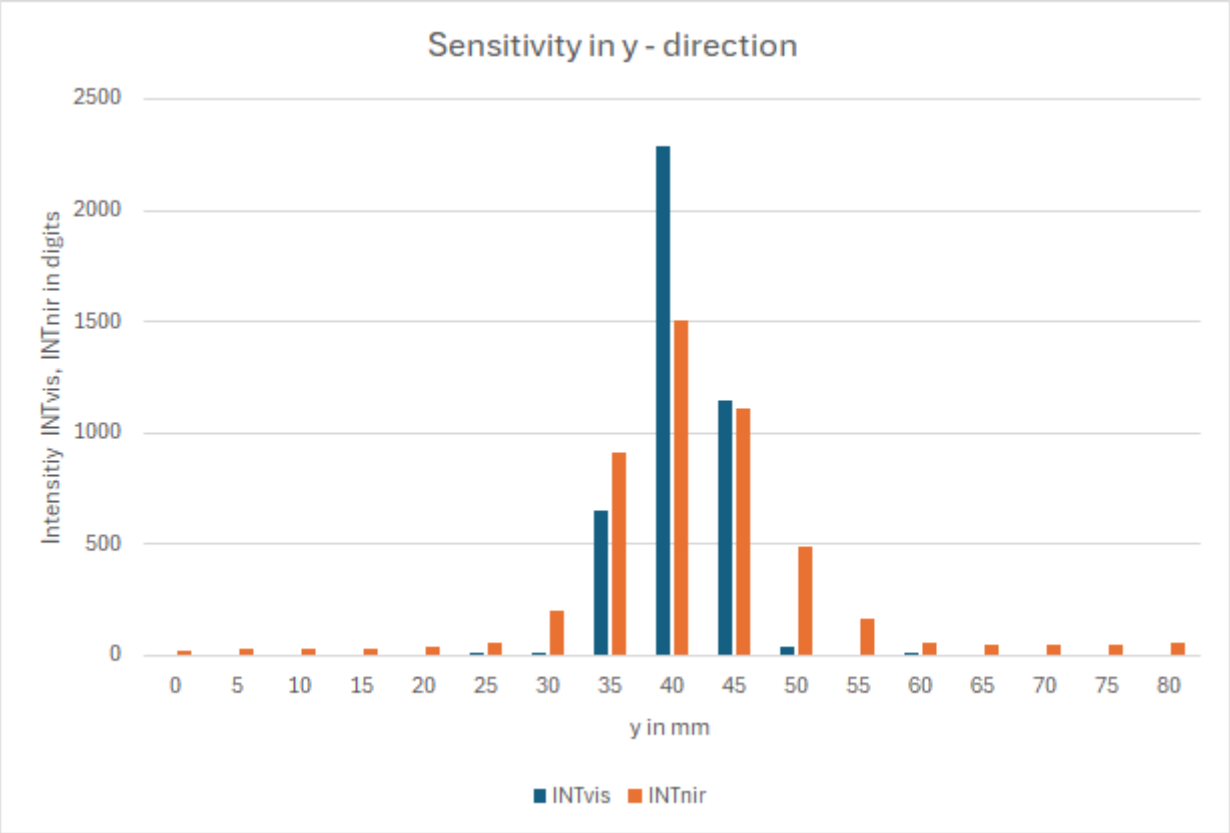


Half value width for INTnir: typ. 12 mm (of the detection range)
Half value width for INTvis: typ. 8 mm (of the detection range)

Diagrams

Diagrams: **Sensitivity in y-direction**
SPECTRO-T-4-10-DIF-VISNIR or SPECTRO-T-4-10-DIF-VISNIR-RS485 color/NIR sensor

AMP4 INT2 (color)
AMP2 INT2 (NIR)



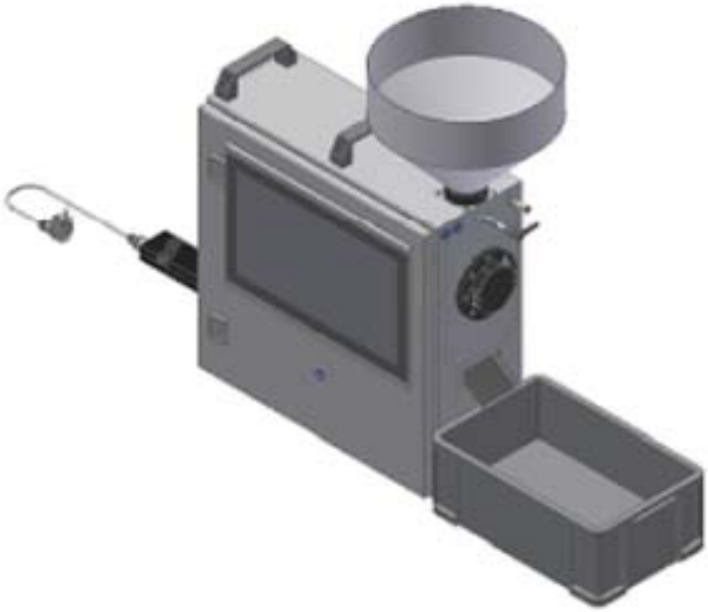
Half value width for INTnir: typ. 12 mm (of the detection range)
Half value width for INTvis: typ. 8 mm (of the detection range)

Sensor Systems

Based on the SPECTRO-T-4-10-DIF-VISNIR (or SPECTRO-T-4-10-DIF-VISNIR-RS485) hybrid sensor, various measurement systems are available depending on the application:

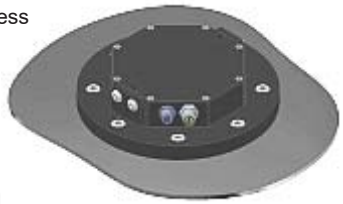
SPECTRO-T-4-LAB-VISNIR
(Laboratory measurement system)

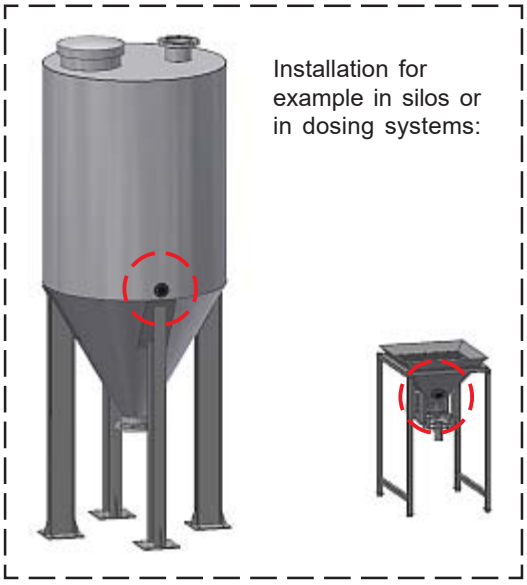
incl. Color/NIR sensor (hybrid sensor) SPECTRO-T-4-10-DIF-VISNIR
incl. Windows® software SPECTRO-T-4-DOCAL-Scope
incl. Sight glass SG-B270-75
incl. Offline unit FW-B270-75-OFL
incl. Protective cover for sensor and sight glass
incl. Stainless steel funnel system (capacity 11 l)
incl. 2 pellet sample collection containers (9 l each)
incl. RAL plastic color card „RAL 9010-P pure white“
incl. Aluminum card in RAL format (148x105mm) colorless
incl. Connecting cable cab-M12/4-w-712/4male-0.2m (D-LAS2-T)
incl. Connecting cable cab-las8-M8/4fem-2m (sensor)
incl. USB converter cab-4/USB-2m
(optional: Ethernet converter cab-4/ETH-500)
incl. External power supply PS-24V-3,3A/80W-712/3
incl. Logitech wireless keyboard with wireless mouse



SPECTRO-T-4-INLINE-VISNIR or
SPECTRO-T-4-INLINE-VISNIR-RS485
(Inline measurement system)

incl. Color/NIR sensor (hybrid sensor) SPECTRO-T-4-10-DIF-VISNIR or
SPECTRO-T-4-10-DIF-VISNIR-RS485
incl. Windows® software SPECTRO-T-4-DOCAL-Scope
incl. Sight glass SG-B270-75
incl. Offline unit FW-B270-75-OFL
incl. RAL plastic color card „RAL 9010-P pure white“
incl. Aluminum card in RAL format (148x105mm) colorless
incl. External power supply PS-24V-1,25A/30W-M8/4
incl. USB converter cab-4/USB-2m
(optional: Ethernet converter
cab-4/ETH-500)





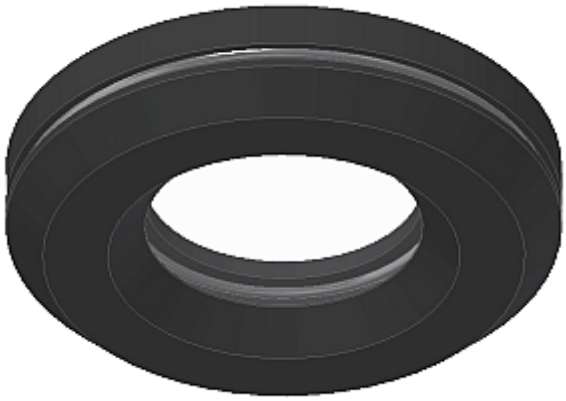
SPECTRO-T-4-MOBILE-VISNIR
(Mobile measurement system)

incl. Color/NIR sensor (hybrid sensor) SPECTRO-T-4-10-DIF-VISNIR
incl. Windows® software SPECTRO-T-4-DOCAL-Scope
incl. Offline unit FW-B270-75-OFL
incl. Handle SPECTRO-T-4-10-HANDLE
incl. RAL plastic color card „RAL 9010-P pure white“
incl. Aluminum card in RAL format (148x105mm) colorless
incl. External power supply PS-24V-1,25A/30W-M8/4
incl. USB converter cab-4/USB-2m
(optional: Ethernet converter cab-4/ETH-500)

Accessories

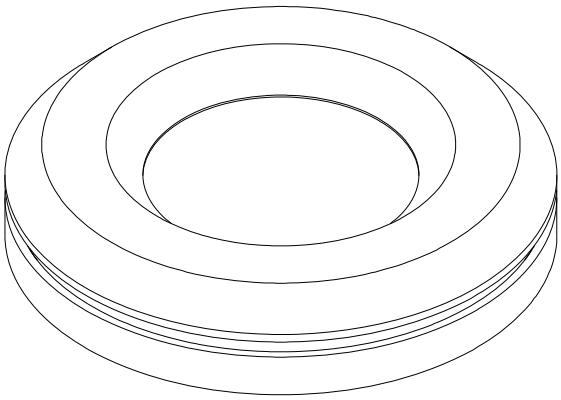
SG-B270-75 (sight glass)
(please order separately)

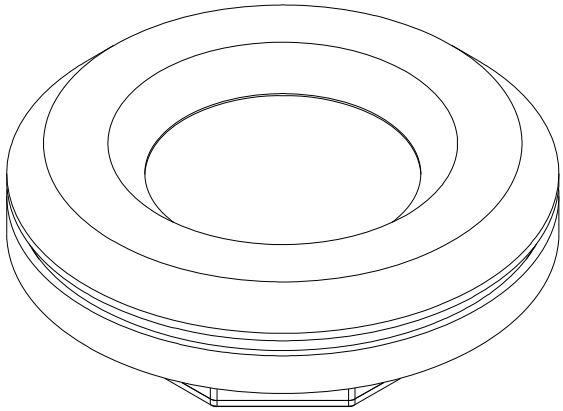
The SG-B270-75 sight glass is included in the scope of delivery of the SPECTRO-T-4-LAB-VISNIR laboratory measurement system and the SPECTRO-T-4-INLINE-VISNIR (SPECTRO-T-4-INLINE-VISNIR-RS485) inline measurement system.

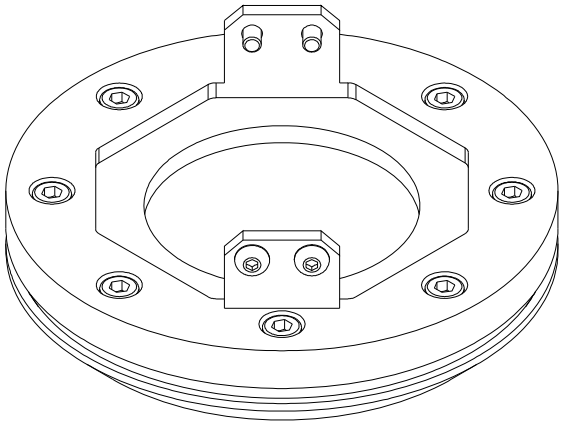


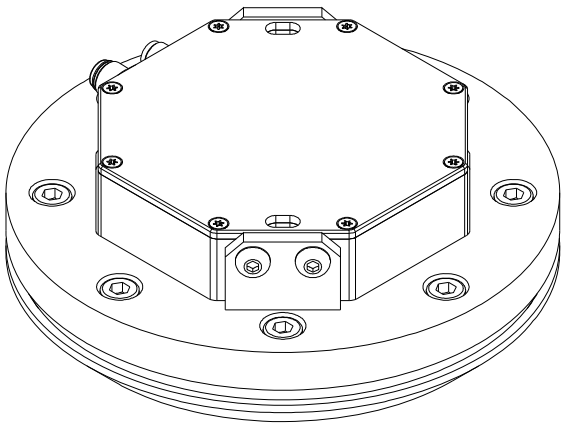
SG-B270-75 (sight glass)

SG-B270-75 (sight glass)
with SPECTRO-T-4-10-DIF-VISNIR or
SPECTRO-T-4-10-DIF-VISNIR-RS485









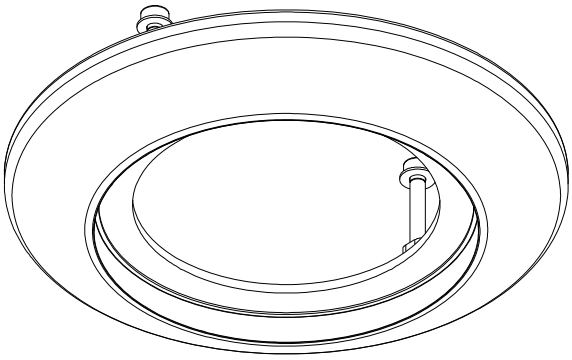
Accessories

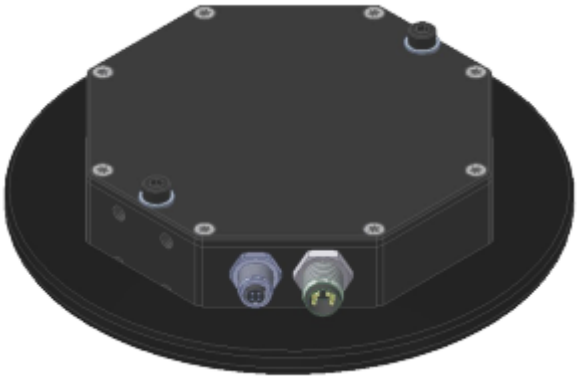
FW-B270-75-OFL (offline unit)
(please order separately)

The FW-B270-75-OFL offline unit is included in the scope of delivery of the SPECTRO-T-4-LAB-VISNIR laboratory measurement system, the SPECTRO-T-4-INLINE-VISNIR (SPECTRO-T-4-INLINE-VISNIR-RS485) inline measurement system, and the SPECTRO-T-4-MOBILE-VISNIR mobile measurement system.

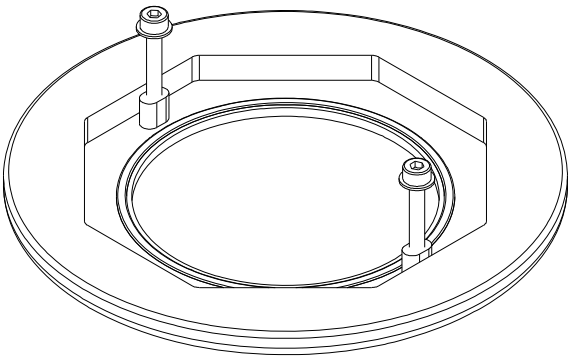
FW-B270-75-OFL (offline unit)

FW-B270-75-OFL (offline unit)
with SPECTRO-T-4-10-DIF-VISNIR or
SPECTRO-T-4-10-DIF-VISNIR-RS485





FW-B270-75-OFL (offline unit)
with SPECTRO-T-4-10-DIF-VISNIR or
SPECTRO-T-4-10-DIF-VISNIR-RS485



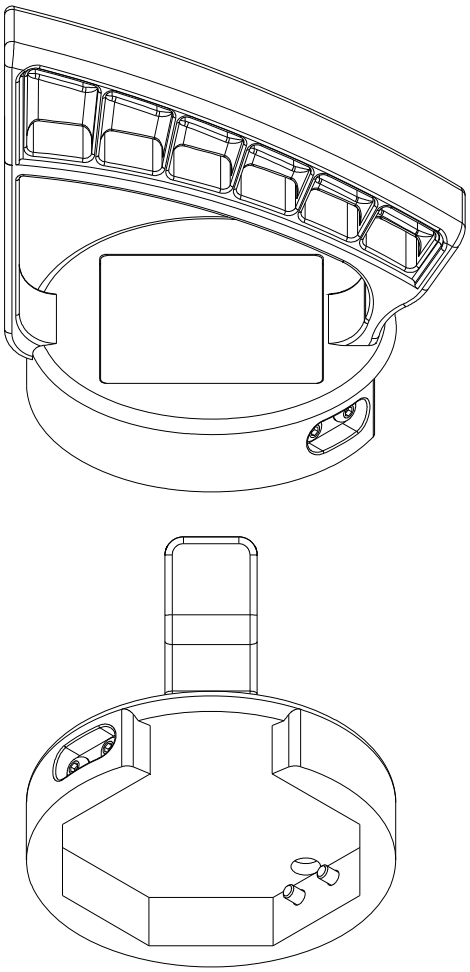
Accessories

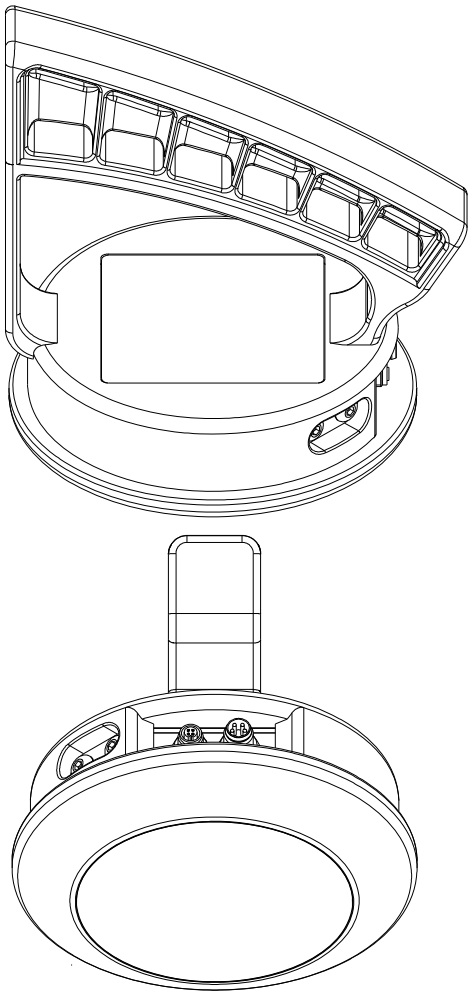
SPECTRO-T-4-10-HANDLE (handle)
(please order separately)

The SPECTRO-T-4-10-HANDLE is included in the scope of delivery of the SPECTRO-T-4-MOBILE-VISNIR mobile measuring system.

SPECTRO-T-4-10-HANDLE

SPECTRO-T-4-10-HANDLE
with SPECTRO-T-4-10-DIF-VISNIR

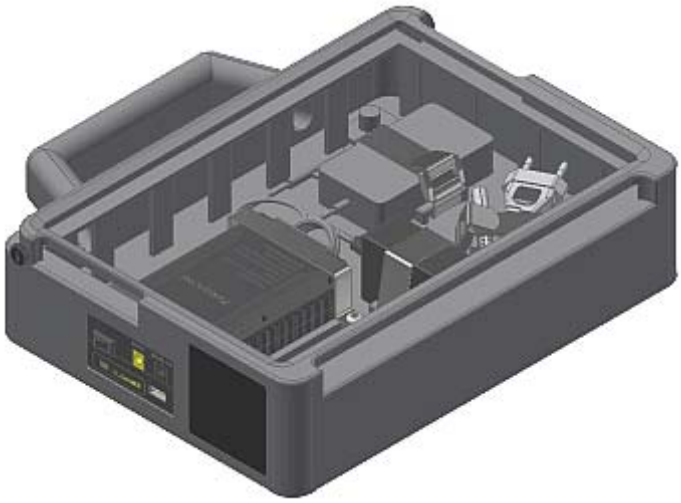




Accessories

TABUN-13“ (V1.1) (battery-powered tablet PC for power supply of SI sensors)
(please order separately)

TABUN-13“ (V1.1)
incl. Microsoft Surface Pro 11 (Windows® tablet PC)
incl. Microsoft Surface keyboard with Slim Pen 2
incl. Power supply (2-piece) for tablet PC Surface Pro 11
incl. Rechargeable lithium-ion battery TalentCell PB240A1
incl. Power supply for battery TalentCell PB240A1



The battery-powered **TABUN-13" (V1.1)** tablet PC can be connected to almost all Sensor Instruments sensors featuring an RS232 interface. Various cables, available separately as accessories, enable connection to the +24V battery integrated in the TABUN-13" (V1.1) housing.

The Microsoft Surface Pro 11 tablet PC can be connected to the RS232 socket of the respective sensor using the USB-C interface adapter cable cab-4/USBC-... (available separately). The sensor and TABUN-13“ (V1.1) thus form a self-sufficient, mobile unit.

The Windows® software versions from Sensor Instruments required for using the SI sensors can be preinstalled on the TABUN-13” (V1.1).

View:
Microsoft Surface Pro 11
(tablet PC)

View:
Microsoft Surface keyboard
with Slim Pen 2