Technical description and operating instructions

Survey meter

OD-01

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1. OD-01 product characteristics / scope of services

The OD-01 is an easy-to-handle survey meter for measuring the directional dose / dose rate equivalent $H'(0{,}07;\Omega);\dot{H}'(0{,}07;\Omega)$ and the ambient dose / - dose rate equivalent $H*(10);\dot{H}*(10)$ of mixed radiation fields (X-rays, gamma and beta radiation).

Product characteristics:

- Compact device consisting of display and control unit, probe, device support and 0.7m of connecting cable
- Radiation detector: air opened ionisation chamber
- Display ranges:
  Dose rate: 0 .. 2000 mSv/h , µSv/h
  Dose: 0 .. 2000 µSv
  Measurement range: 3 decades for dose, 6 decades for dose rate measurement
- Automatic switch of the fine measurement ranges
- Measurement of photon dose of pulsed radiation fields
- Measurement of photon radiation above 6 keV
- Measurement of hard X-rays and gamma radiation as well as bremsstrahlung of up to 15 MeV (> 15 MeV using an additional acrylic plastic shielding)
- Measurement of beta radiation of energies from 60 keV up to 2 MeV
- Probe disposable up to 100 m from display and control unit
- Easy-to-read back-lighted LCD panel
- Battery powered, transportable and stationary applicable device

Scope of services:

- OD-01 display and control unit
- OD-01 probe with detachable wall reinforcement cap
- OD-01 device carrier
- 0.7 m probe cable
- 4 x batteries LR06
- Equipment case
- Technical description and operating instructions

Optional equipment:

- USB cable and software for measurement evaluation via PC
- Power supply (DC 6 V) with power lead
- Variable probe extension cable up to 100 m upon customer request
- Acrylic plastic shielding for energy values E_γ > 15 MeV
- Check Source
- Wall holder for stationary application

2. Safety instructions

- The device may be opened by the manufacturer only. Infringing behaviour will lead to invalidation of any warranty claims!

- **Sensitive parts as the soft radiation chamber must be protected from mechanical effects. In case of damages on the soft radiation chamber a contact voltage of up to 400 V may be reached at power-on state!**

- In general, the survey meter must be kept in a dry place!

- If the survey meter is not used for a period of more than one month, the batteries must be taken out of the device!

- Device transport may be realised with fitted wall reinforcement cap in the equipment case only!

- For cleaning purposes it is not admissible to use solvents or solvent containing cleaners!

- Prior to connecting and disconnecting plug connectors the survey meter must be switched of in general!

- Statutory provisions for regular re-tests of mobile equipment must be met for the optional power supply according to regulations of local authorities!

3. Components

Basic equipment of the OD-01 includes:

- Device carrier (1)
- Probe with detachable probe cable (2)
- Display and control unit (3)
- Wall reinforcement cap (4)

Fig. 1) *OD-01 Standard components (scope of services)*

The following equipment is optionally available:

- USB cable with software CD (5)
- Power supply (6)
- Control beam (7)
- Acrylic plastic shielding (8)
- Wall holders for probe and display unit (9)
- Extension cable up to 100 m (10)

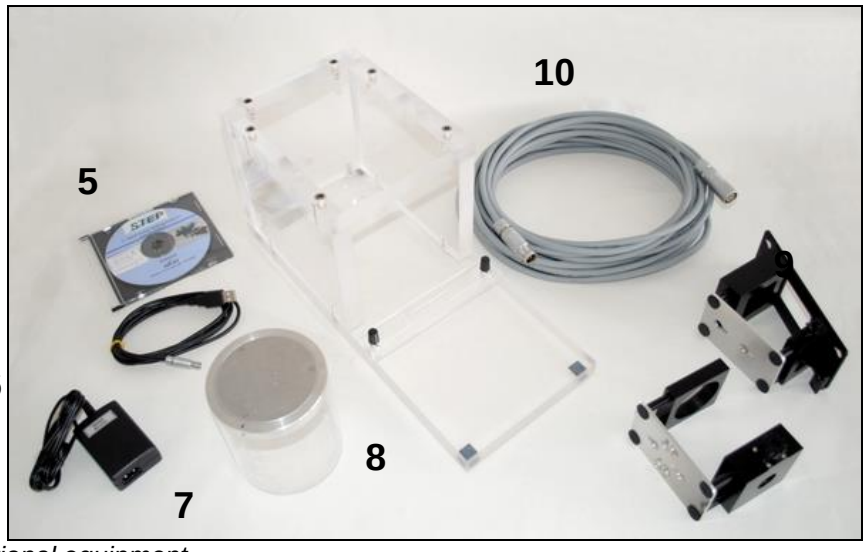
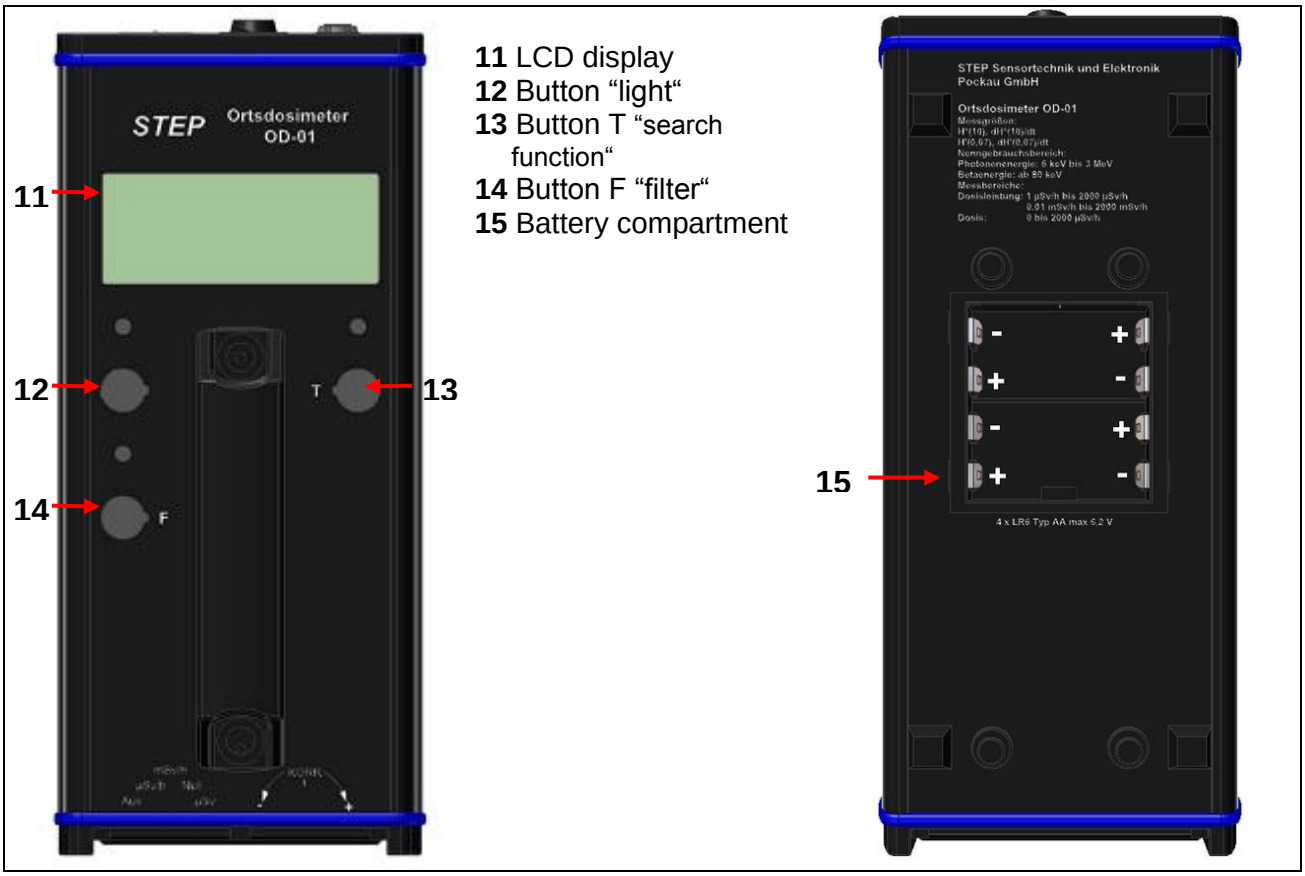


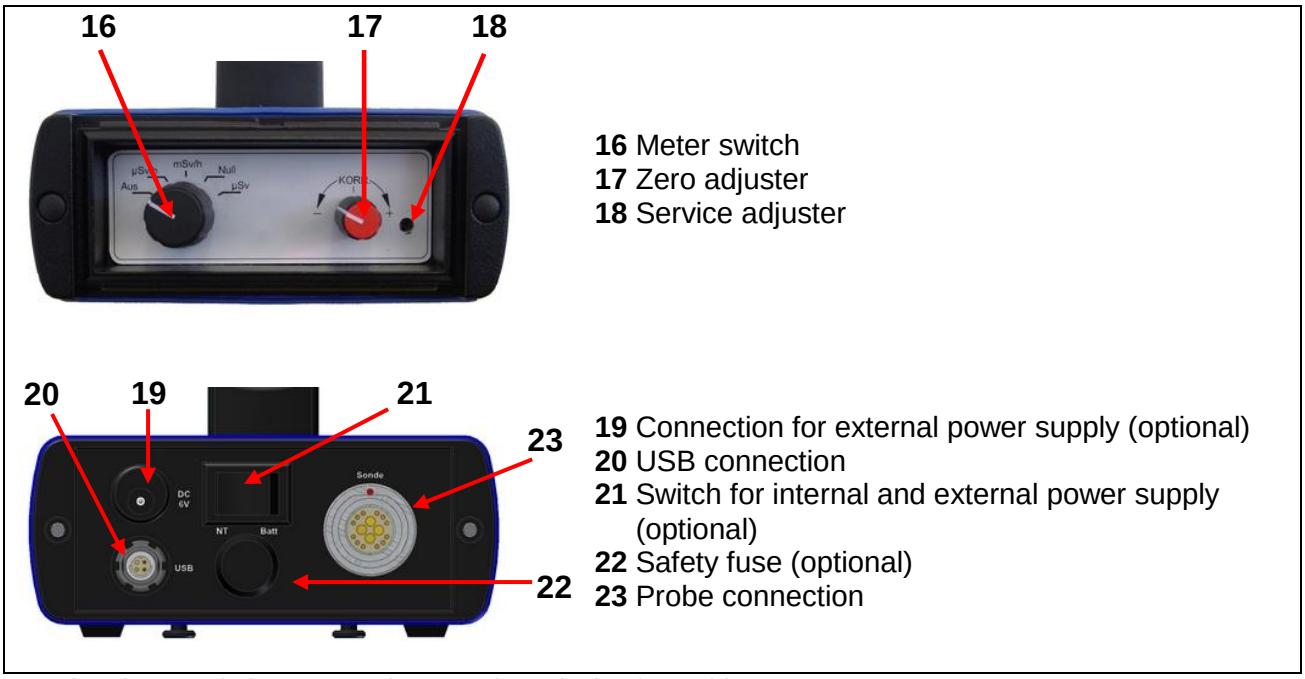
Fig. 2) *OD-01 Optional equipment*

3.1. Control elements



11 LCD display
12 Button “light“
13 Button T “search function“
14 Button F “filter“
15 Battery compartment

Fig. 3) *Control elements front and rear side*



16 Meter switch
17 Zero adjuster
18 Service adjuster

19 Connection for external power supply (optional)
20 USB connection
21 Switch for internal and external power supply (optional)
22 Safety fuse (optional)
23 Probe connection

Fig. 4) *Control elements and connections device front side*

3.1.1. Meter switch (16)

The meter switch serves for switching the device on and off, selection of one of the coarse measurement range decades (µSv/h, mSv/h und µSv) as well as for function call of adjustment of the electrical zero. The functions are described in detail in chapters 4 and 5.

3.1.2. Zero balancer (17)

The zero balancer permits electrical zero balancing of the OD-01 (see chapter 4.1).

3.1.3. Button “light“ (12)

The display backlight is switched on by pressing the button “light“ and switched off by pressing this button once again.
Attention: The lighting places load on the batteries and thus should not be switched on unnecessarily.
A yellow light emitting diode (LED) above the button indicates the state of the lighting (LED active at switched on backlight).

3.1.4. Button T “search function activation “ (13)

This button permits the activation of a “rapid search function“ by means of an increase of the conversion rate of the analogue-to digital converter and thus an increase of the number of measuring values to be indicated per time unit.

3.1.5. Button F “filter“ (14)

An additional low pass filter may be activated by pressing this button.
The filter particularly permits a smoothing of the measuring values to be indicated for measurements at the lowest dose rates in the area of the device background effect. The filter effectiveness is limited to the range ($0 \leq 5$ µSv/h).

3.1.6. External power supply (option)

The OD-01 can be operated with an internal (batteries) as well as with an external DC voltage supply (4 .. 6,2 V). Therefore the switch for internal and external power supply (21) must be set at the respective operating mode (“NT“ for power supply mode and “Batt.“ for battery mode). In battery mode, the device is operated with 4 batteries or rechargeable batteries type LR06 (AA), supplying a maximum operating voltage of 6.2V. In power supply mode, the device, which is protected by a safety fuse, may be operated with a DC voltage (19) from 4 to 6.2 V only.

3.1.7. USB interface

The survey meter is equipped with an USB interface for reading out the measuring values. A special software and a connecting cable are optionally available for use.

4. Measuring principle

The directional dose equivalent $H'(0{,}07)$ and the directional dose rate equivalent $\dot{H}'(0{,}07)$ represent the determinant measuring values for survey dosimetry of beta radiation within an energy range equal to or less than 2 MeV and of low energy photon radiation (≤ 15 keV).
For X-ray and gamma radiation exceeding this energy level, the ambient dose equivalent $H^*(10)$ and the ambient dose rate equivalent $\dot{H}^*(10)$ represent the relevant measuring values. The separate capture of the dose equivalents H*(10) and H'(0.07;Ω) by means of the survey meter is performed by measurement with or without wall reinforcement cap:

Measuring probe without wall reinforcement cap	Measuring value = $\dot{H}^*(10) + \dot{H}'(0{,}07)$ $H^*(10) + H'(0{,}07)$
Measuring probe with wall reinforcement cap	Measuring value = $\dot{H}^*(10)$ $H^*(10)$

Beta radiation with energies up to 2 MeV (Sr-90) is shielded by the fitted wall reinforcement cap in a sufficient way, so that in such case the measuring variables are $H^*(10)$ and $\dot{H}^*(10)$.

The response of the applied ionisation chamber amounts to approx. 4.2 fA/µSv·h^{-1}.
The current generated by the ionisations chamber is transformed by the probe electronics into processable voltage. Thereby a transimpedance amplifier converts the current via a switchable feedback network into a proportional voltage signal. In order to transmit the amplified signal without signal losses to the display unit via an appropriate cable of variable length, an output driver was integrated. At the same time, the driver amplifies the signal in such a way that it is optimally adjusted to the display system. The survey meter is equipped with an automatic switch for fine measurement range decades.

4.1. Electrical zero balancing

Prior to each measurement (at least if the device has not been switched on for a longer period) it is recommendable to verify the electrical zero of the measuring device. This is necessary since the sensitive electronic system depends on the ambient temperature, the inherent noise and other influencing factors.
Therefore the meter switch is set at position “ZERO“ and the indicated value must be set as far as possible at 0.00 (see figure 5) via the adjustment of the electrical zero (17).

Note: The numerical value on the display will be positive, if the left segment of the bar display is active. In case of negative values this segment will not be activated. The zero balancing is performed in a sufficiently exact way, if a value within the range of 0 ≤ 0.05 is indicated.

Fig. 5) *Display at the zero balancing*

Important: Upon electrical zero balancing the zero balancer (17) should not be used any more.

4.2. Calculated air pressure correction

The changes of air pressure and temperature cause air pressure changes in the ionisation chamber, resulting into faulty measuring values.
For compliance with the indicated error tolerances, all measuring values M must be related to reference conditions (20 °C, 101.3 kPa).

This possibility for correction considers the influence of air pressure changes on the measuring result. Thereby it is important to know the air pressure and the temperature at the measuring location in order to determine the correction factor. The correction factor f is indicated in the nomogram in the appendix or can be determined with the formula:

$$f = \frac{101{,}3}{p/kPa} \cdot \frac{273 + \vartheta/°C}{293} = \frac{760}{p/Torr} \cdot \frac{273 + \vartheta/°C}{293}$$

p	-	Air pressure in kPa and Torr
ϑ	-	Temperature in °C.

The corrected measuring value M_0 results from:

$$M_0 = M \cdot f$$

M	-	Displayed measuring value
f	-	Correction factor

5. Measurement preparation and performance

Prior to the first measurement the device must be commissioned as follows:

1. Insertion of the batteries in the battery compartment (15) at the rear side of the display unit. For opening the battery compartment, a recess is provided at the upper part of the cover. Care must be taken to ensure that the batteries are inserted with the correct polarity as indicated on the bottom of the battery compartment.
2. The measuring probe is connected with the display unit via the plug connector. Therefore, the meter switch (16) must be in the position OFF.

	The measuring device must be switched on if the measuring probe is connected only.

5.1. Preselection of the measuring values

The measuring variables ambient dose $H^*(10)$ and ambient dose rate equivalent $\dot{H}^*(10)$ are measured with fitted wall reinforcement cap (delivery status) and indicated by the symbol "γ" on the display.
Upon removal of the acrylic plastic shielding, attention must be paid to the fact that the marks on the shielding do not coincide with the marks on the soft radiation chamber at fitting (Fig. 6).

Fig. 6) *Interlock of the acrylic plastic shielding*

If the acrylic plastic shielding (4) is removed, the indicated measuring value at dose equivalent measurement corresponds to the sum of $H^*(10)$ and $H'(0.07)$ and to the sum of $\dot{H}^*(10)$ and $\dot{H}'(0{,}07)$ respectively at dose rate equivalent measurement. The symbols "γ" and "β" are both indicated on the display.

	**Attention!** The entry windows are sensitive to mechanical stresses! After measurement completion, the wall reinforcement cap must be refitted on the probe and the device must be switched off.
	**Note:** Measurements in electromagnetic fields, e.g. next to mobile phones, etc. must be avoided because these may influence the measuring results.

5.2. Dose rate equivalent measurement

Prior to performance of dose rate equivalent measurements, the meter switch (16) must be moved to the switch position “ZERO“ upon connection of the measuring device and the electrical zero must be verified after a short warm-up time of the OD-01 (recommended value: 0 ≤ 0.05). In case of deviations, please perform an electrical zero balancing (see 4.1.).

For dose rate equivalent measurements the meter switch (16) must be set at position “µSv/h“ or “mSv/h“ respectively. Changing between “µSv/h“ and “mSv/h“ means changing the chamber voltage. The step change on the display which can be observed in general is related to charge reversal of the chamber capacity. The reset of the display to a value near zero takes 2 minutes at maximum.

For lowest dose rate equivalent measurements above the natural ambient radiation (0.1 to 5 µSv/h), it is recommended to switch on the filter (see chapter 3.1.5)

5.3. Dose equivalent measurement

Prior to performance of dose equivalent measurements, the meter switch (16) must be moved to the switch position “ZERO“ upon connection of the measuring device and the electrical zero must be verified after a short warm-up time of the OD-01 (recommended value: 0 ≤ 0.05). In case of deviations, please perform an electrical zero balancing (see 4.1.).

For dose equivalent measurement the meter switch (16) directly must be set at the measuring range “µSv“ upon verification and/or electrical zero balancing.

Attention: If a switch of chamber voltage has been performed prior to dose equivalent measurement (via switching between the coarse dose rate equivalent measurement range decades, particularly from “µSv/h“ to “mSv/h“), it is recommended to stay in switch position for approx. 2 min. before activation of this dose equivalent measurement range decade.

5.4. Display of the excess of measurement range

At excess of the limits (2000) of the coarse measurement range decades “µSv/h“, “µSv“ and “mSv/h“, such excess of measurement range will be indicated on the display by fade-in of the number “1“.

Fig. 7) *Display excess of measurement range*

5.5. Special remarks for measurement performance

- The calibration of the survey meter OD-01 is performed in beta radiation fields according to ISO 6980 and photon radiation fields according to ISO 4037-1 (homogeneous radiation field). The point of reference (chamber centre of gravity) is also marked on the detector by a line.
- The indicated measuring value *H 0.07* may be corrected as follows in order to obtain the effective value M(E,α): $M(E,\alpha) = \frac{A}{\varepsilon(ß) \cdot \varepsilon(\alpha)}$

  The values for the energy or angle dependent response ε(E) and ε(α) are indicated on the calibration certificate and in table 1 of the appendix.
- Beta radiation with a maximal energy of 2 MeV (Sr-90/Y-90) is shielded by the fitted wall reinforcement cap in a sufficient way so that in such case only the measuring variable $H^*(10)$ is captured. In case of beta radiation with a higher energy, a measurement uncertainty of at least 20 % must be assumed at the determination of $\dot{H}^*(10)$.
- The correction of the air density influence on the response of the air opened ionisation chamber may be performed by means of calculation based on the nomogram in the appendix.
- Upon irradiation with high dose rate equivalents, a resetting time of up to 2 minutes must be considered.
- Shocks and mechanical stresses on the measuring probe (e.g. at fitting the wall reinforcement cap) may influence the measuring values to be displayed.

5.6. Remarks on battery lifetime

- It should be noted that the total current consumption of the measuring device is 3 times higher at switched on background lighting. The battery lifetime which is indicated in the specifications refers to the display lighting switched to off.
- The battery symbol on the LCD display indicates that the batteries are discharged and must be replaced. In such case, measuring values captured under such conditions must be refused.
- At replacing the batteries, it must be ensured that the batteries are inserted with the correct polarity. Having replaced the batteries, it is recommended to ensure the correct insertion via the complete display by means of activating the device.
- It must be ensured that the device is not stored for a longer period with inserted batteries because the contact material may be affected by electrolyte leakage.

	The manufacturer will not assume any responsibility for damages due to incorrect insertion of batteries or utilisation of an incorrect battery type!

5.7. Utilisation of the device carrier

For mobile application, it is possible to connect the measuring probe (3) with the display unit via the device carrier (1) (delivery status). Thus the survey meter can be compact operated (delivery status see fig. 8).

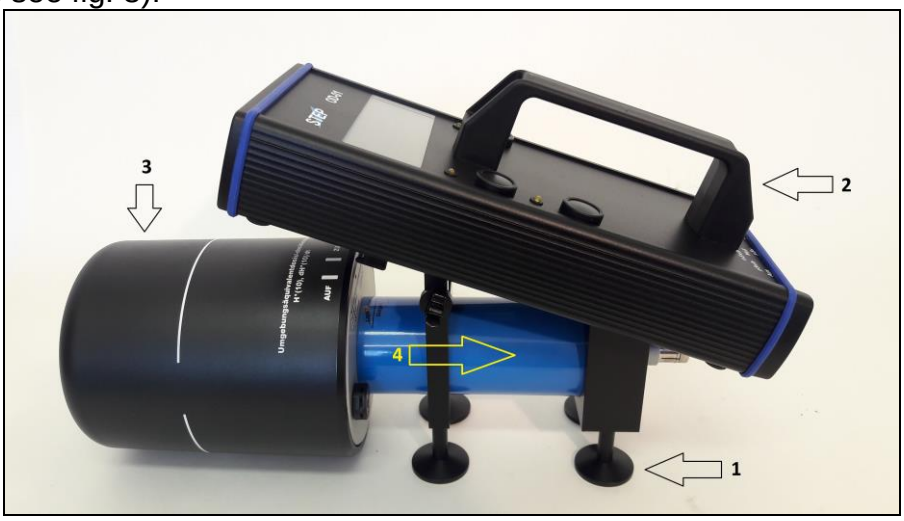


Fig. 8) *Display unit and probe engaged on the device carrier.*

Therefore the four fastening bolts (see fig. 9) on the lower side of the display unit (2) must be engaged in arrow direction in the recesses on the device carrier (1). Prior to locking the display unit on the device carrier, the device carrier (2) and the measuring probe (3) must be separated from each other. It must be ensured that the device is switched off.

Fig. 9) *Engagement principle display unit / device carrier.*

The probe must be inserted into the instrument device carrier with slight pressure as shown in Fig. 8 (4). The probe and the display unit can then be connected to the probe cable.

In order to separate the display unit and measuring probe from the device again, the reverse order must be observed. At the removal of the display unit, the interlock (see fig. 10) must be moved downwards.

Fig. 10) *Unlocking of the display unit at the device carrier.*

Disconnection of the plug connection between probe cable and display unit is performed by holding the ribbed connector part with the thumb and the index finger and pulling for separation from the bushing (see fig. 11a).
Disconnection of the plug connection between probe cable and measuring probe, the connector at the probe must be moved backwards (at the ribbed part) during disconnection (fig. 11b).
The connectors must not be turned out of position at connecting and separating.

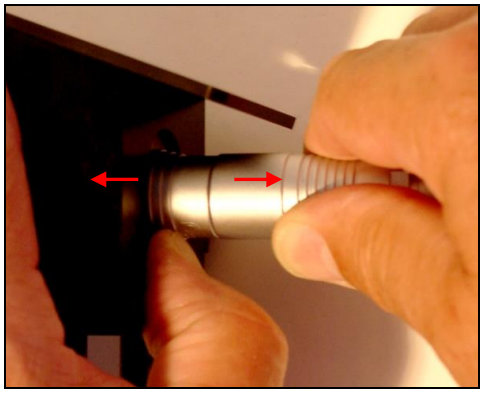
a)  *b)* 

Fig. 11) *Disconnection of the plug connectors measuring probe cable.*

	Measuring probe and display unit must be separated at disconnected state only! Do not turn the connector out of position at separating.

6. Storage, handling and transport instructions

- Prior to long-time storage and transport the batteries must be taken off and stored at the place provided in the case.
- Condensation actuation on the device must be avoided.
- Storage in chemically aggressive and polystyrene dissolving vapours is not admissible.
- Transport and shipping must be effected in the manufacturer provided transport case only.
- Transport always has to be effected with fitted wall reinforcement cap.

7. Cleaning of the device

If in the exceptional case cleaning should be necessary, this must be effected with a damp cloth.

Cleaning of the ionisation chamber made of foam polystyrene is impossible. Therefore for measurements in danger of measuring probe contamination the ionisations chamber must be equipped with a protective coating (e. g. PE bag).

	Polystyrene solving agents, such as fuel, benzol or acetone containing substances, must not be used.

8. Service

Inspections and recalibrations shall be performed by the manufacturer only.

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E-mail: info@step-sensor.de

The manufacturer recommends performing inspections and recalibrations at an interval 2 years.

Important note:

	In case of destruction or removal of the ionisation chamber, a contact voltage of up to 400 V may be reached at power-on state.

9. Technical data

Measuring values:	Ambient dose equivalent $H*(10)$ Ambient dose rate equivalent $\dot{H}*(10)$ Directional dose equivalent $H'(0.07, \Omega)$ Directional dose rate equivalent $\dot{H}'(0{,}07; \Omega)$	
Display ranges:		
Dose:	1 coarse measuring range 3 fine measuring ranges*:	µSv 20 / 200 / 2000 (final values)
Dose rate:	2 coarse measuring ranges: 3 fine measuring ranges*:	µSv/h, mSv/h 20 / 200 / 2000 (final values)
	* automatic switch of the fine measuring ranges	
Energy ranges:		
Photons		
- *Without wall reinforcement cap for H'(0.07) and H*(10)*	6 keV ... 100 keV	
- *With set up wall reinforcement cap for H*(10)*	100 keV .. 15 MeV (> 15 MeV with an acrylic plastic shielding)	
Beta radiation	60 keV ... 2 MeV	
Radiation direction (referred to probe longitudinal axis)	- 90° ... + 90° for H*(10) - 45° ... + 45° for H'(0.07)	
Measurement uncertainty:	≤ 15 % (fine measurement range 20) < 10 % (fine measurement ranges 200 and 2000)	
Linearity	± 5 %	
Saturation deficit	- 5 % @ 2000 mSv/h	
Radiation detector		
Type	air-opened ionisation chamber	
Volume	600 cm^3	
PMMA-Shielding	disposable, 550 mg/cm^{-2}	
Entry window	3.3 $mg \cdot cm^{-2}$ (PET foil metallised on one side)	
Preferred direction; point of reference	axial; marked on detector	
Wall potential	+ 400 V (mSv/h, µSv) + 40 V (µSv/h)	
Warm-up time	2 minutes	

Power supply

Batteries	4 batteries or rechargeable batteries type LR06 (AA)
Current consumption	approx. 30 mA @ 6 V
Battery lifetime	approx. 100 h
Control battery voltage	battery symbol on display
External DC voltage supply (option)	4 .. 6.2 V DC voltage (delay safety fuse: 315 mA)

Dimensions

Measurement probe	diameter 112 mm, length 260 mm
Display unit	250 mm x 108 mm x 42 mm (L x W x H)
Cable length	0.7 m (standard)

Weight

Measurement probe	600 g
Display unit	900 g (incl. batteries)

Display screen

3 ½ digit LC display, back lighted,
Digit height: 12 mm
Additional bar display
Automatic switch for fine measurement range decades
Setting regulator for manual background effect adjustment

Operating conditions

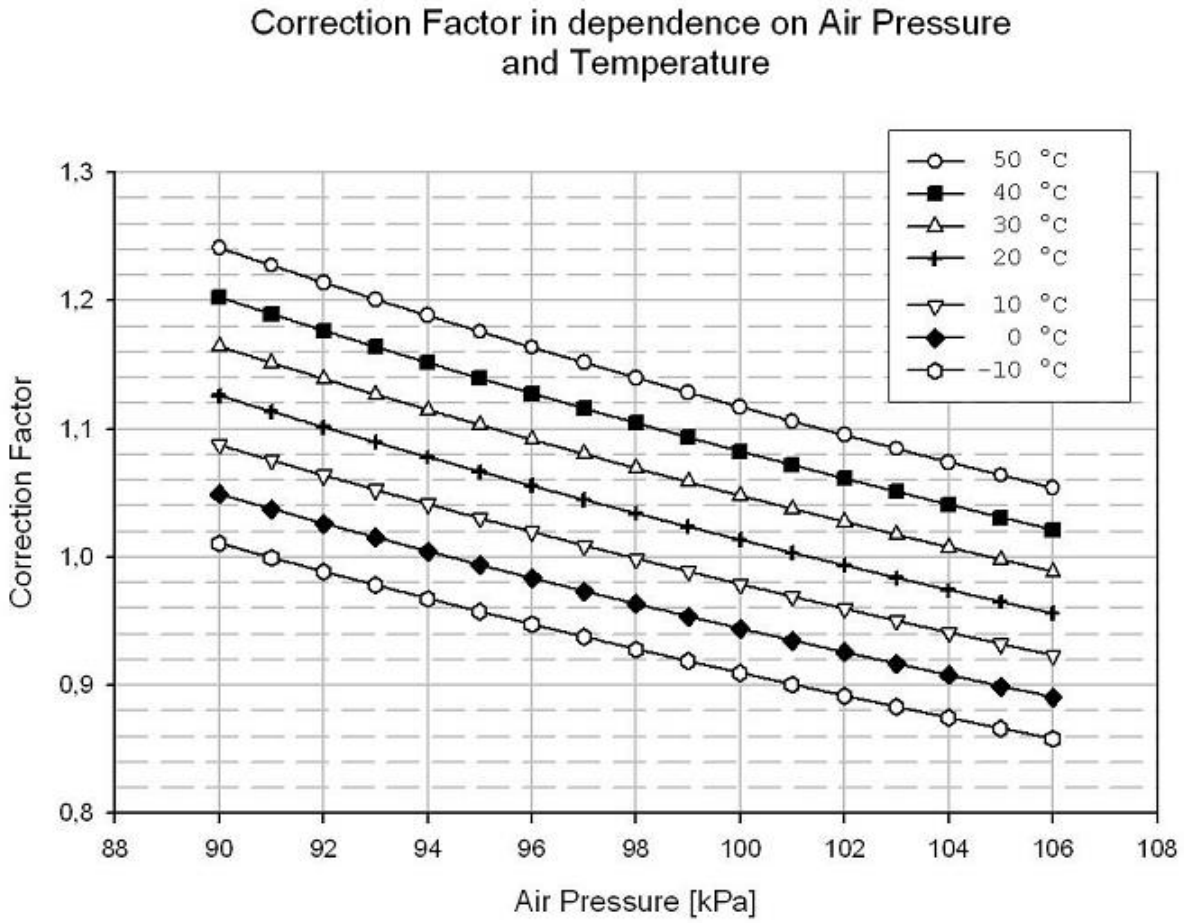
Operating temperature range	-10 ... +45 °C
Storage and transport temperature range	-20 ... +55 °
Air pressure	80 ... 110 kPa
Relative air humidity	max. 80 %

EMC test Acc. to EN 61000

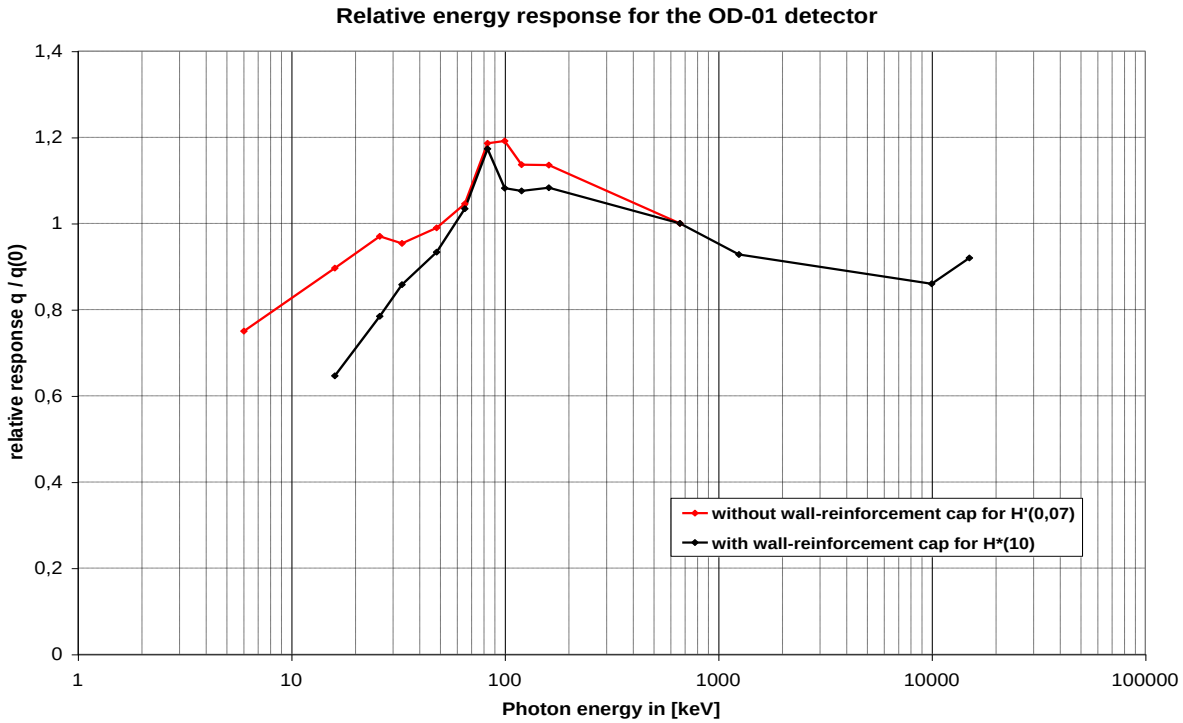
The manufacturer reserves the right to any modification of the specifications as may be required technically.

Appendix

Nomogram

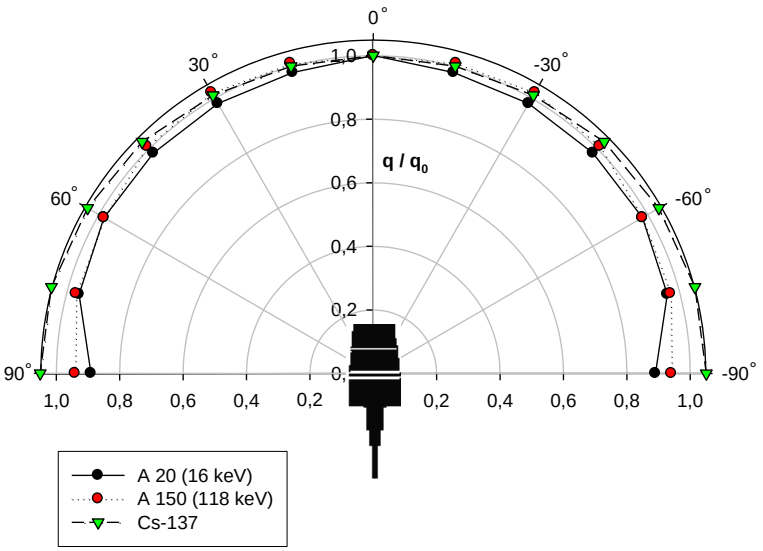


Energy dependent response

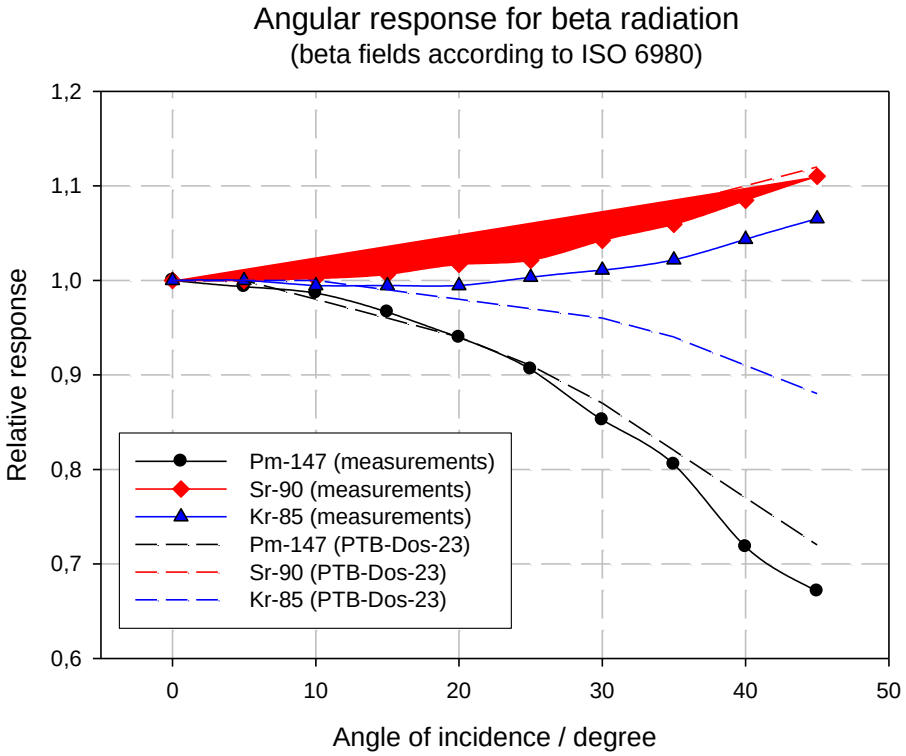


In the figure for energy dependence the characteristic values are shown only. The values which are valid for the respective concrete measuring device are available on the respective calibration certificate.

Angular dependent response for photon radiation



Angular dependent response for beta radiation



Relative response for various beta energies (characteristic values)

Radiation	Isotope	Energy in keV	Relative response	Direction of incidence
Beta	Sr-90/Y-90	800	0.70	axial
Beta	Kr-85	240	0.30	axial
Beta	Pm-147	60	0.20	axial

In the figures and tables concerning the response the characteristic values are shown only. The values which are valid for the respective concrete measuring device are available on the respective calibration certificate.

Operation sheet

OD-01

Serial number:

External power supply: present □ not present □

Internal software version:

Final inspection date:

Delivery date:

Notes:

EC declaration of conformity

Hereby we confirm that the following product:

OD-01

corresponds to the fundamental protection requirements as determined in the directive of the Council for approximation of the laws of the Member States relating to electromagnetic compatibility (89/336/EWG).

This declaration is valid for all specimens which are produced.

For product evaluation in regard to electromagnetic compatibility, paragraphs of the following standard were used as a basis:

EN 61000

This declaration is transmitted on behalf of the manufacturer

STEP Sensortechnik und Elektronik Pockau GmbH
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by

Dr. Werner Schüler,
Managing Director

Pockau-Lengefeld, 28-11-2016

Legally valid signature