Edition 09.2

SensoData 5500

Operator's Manual

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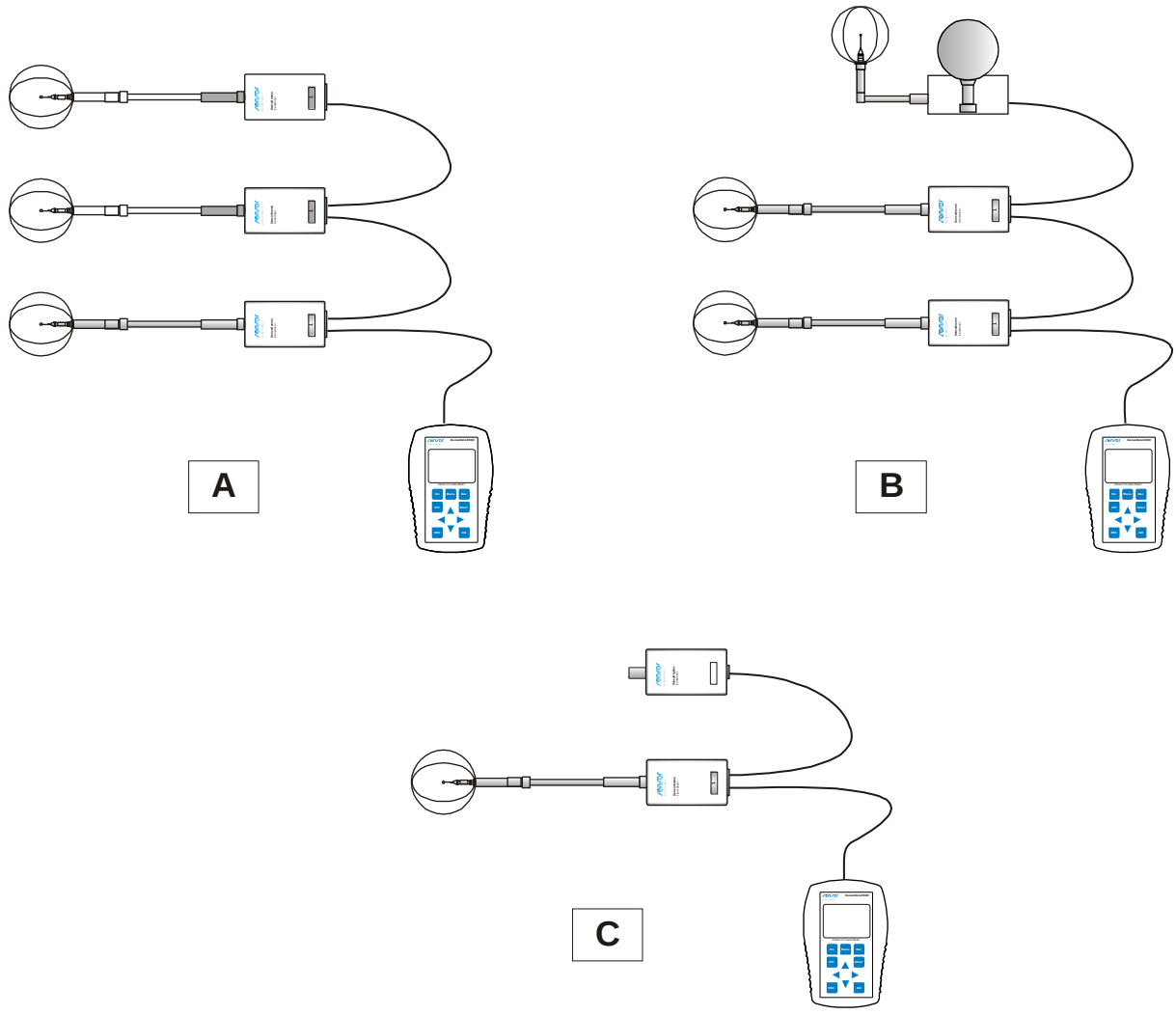
1. GENERAL DESCRIPTION

SensoData 5500 is a universal datalogger, which can be attached to the following transducers or modules:

- anemometer transducer type SensoAnemo 5100
- temperature transducer type SensoThermo 5200
- transducer of pressure and humidity type SensoHygBar 5300
- module of thermal comfort type SensoTCMod *)

The software of datalogger allows automatic detection of connected transducers and adapting to the change of their configuration. Therefore the user depending on metrological needs can configure different device such, as: Thermal Comfort Meter , Anemometer, Thermometer, Hygrometer or Barometer. It is possible to connect 9 transducers to the SensoData 5500 device, but at the most 3 transducers of the same type *). Sample configurations are presented below.



A – configuration with three SensoAnemo 5100SF anemometer transducers
B – configuration with SensoTCMod 5507 module of thermal comfort*) and two SensoAnemo 5100SF anemometer transducers
C – configuration with SensoHygBar 5303 pressure and humidity transducer and SensoAnemo 5100SF anemometer transducer

*) module of thermal comfort contains two or three transducers that should be considered at configuring, for example: the SensoTCMod 5507 module (which contains transducers of anemo, temperature and hygrobaro) can be attach only to two SensoAnemo, two SensoThermo and two SensoHygBar transducers.

Besides the basic version are also specialized versions with built-in transducers, which are the stand-alone integrated devices such as: anemometer or thermometer.
The following versions of the device are accessible:

SensoData 5500	basic version enabling attaching external transducers or modules,
SensoData 5500 Bee	basic version with the built-in wire-less receiver,
SensoData 5500 Anemo	version with built-in anemometer transducer and with the socket for connecting the measuring probe,
SensoData 5500 Anemo B	version with built-in anemometer transducer and with the sensor of barometric pressure,
SensoData 5500 Thermo	version with built-in temperature transducer enabling connecting two temperature probes,
SensoData 5500 Thermo HB	version with built-in temperature and humidity transducer and barometric pressure sensor, enabling connecting two probes of temperature or one temperature probe and one humidity probe,
SensoData 5500 Thermo +	version with built-in temperature transducer enabling connecting four temperature probes.

All specialized versions are equipped with the additional RJ45 socket enabling to attach external transducers or modules. In the photo is presented general view with sockets and indicators:

A – USB socket to connect to a computer
B – socket (depending on the version) to connect the probes or modules
C – RJ45 socket to connect additional transducers or module (only for version Anemo and Thermo).
D – diode of the activity of the wire-less communication *)
E – external power connector

Technical Data:

- averaging time: 10s…100min
- logging interval: 10s…100min
- logging time: 1min…100h
- sampling rate: 8 Hz
- display: LCD graphic 128x64
- interface: RS485, USB
- baud rate: 11500 bps
- wire-less protocol: Zig-Bee [1)]
- range of wire-less comm. : 60m [1)]
- operation temperature: -20…50^{O}C

1) Only for version SensoData 5500 Bee
2) It is not recommended to place the dataloggert below -5^{O}C due to reduction of dynamic range and contrast of the LCD and battery performance. In this case is recommended removal of the datalogger outside the measuring environment and the connection of the measuring module long cable.

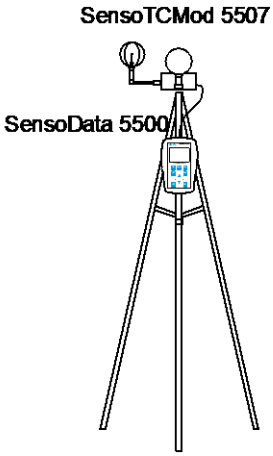
Power supply depending on the option:
- 4 rechargeable batteries Ni-Mh type AA (with low self-discharge, ready to use) or
- 4 alkaline batteries type AA 1.5V or
- external 6V DC/1A adapter

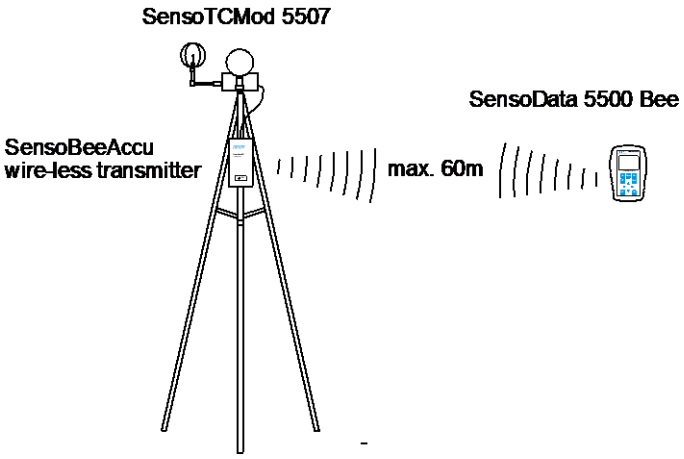
Note !
Battery charging should be in a separate charger delivered together with the device. To do this, remove the batteries from a container on the back of the device.

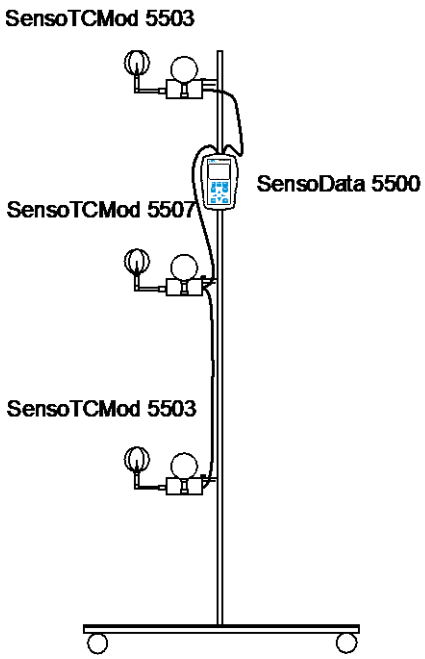
2. DESCRIPTION OF VERSION

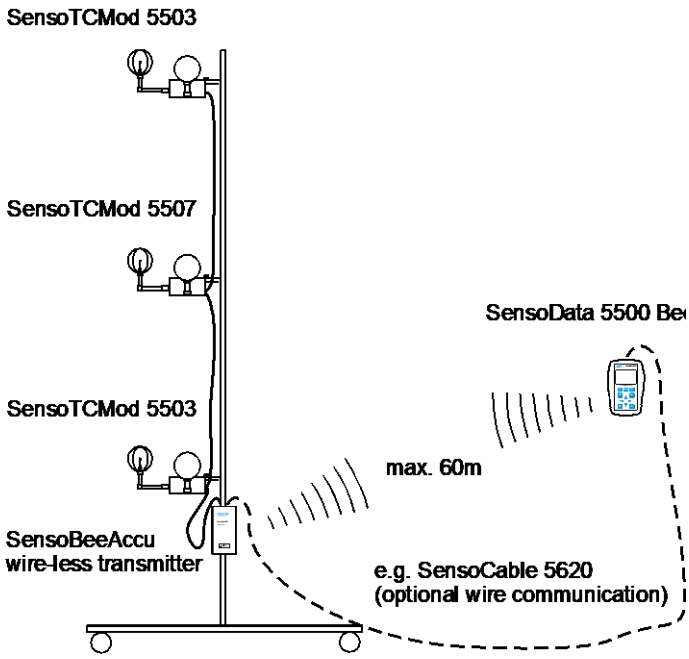
A. SensoData 5500 MK thermal comfort meter

The basic set of thermal comfort meter consists of the SensoData 5500 datalogger and the SensoTCMod 5507 measuring module. Adding to the above set of two SensoTCMod 5503 measuring modules enables the simultaneous measurement at three heights. The SensoData 5500 datalogger has two connectors (see photo n the right) to connecting the measuring modules of the thermal comfort. In the version with built-in wire-less receiver (SensoData 5500 Bee), measuring modules aren't connected to the datalogger, but to the SensoBee Accu wire-less transmitter. The way of connecting measuring modules depending on the option of the device is presented below.









Measuring modules can be connected in any order. As a default SensoCable 5601 cables are delivered with a lenght of 0.7 meters. The user can apply the any 8-conductor internet cable without crossing (1:1) so-called „patch cable" (total length of all connection cables should not be bigger than 10m). The DIN rail clip enables to fasten the SensoData 5500 datalogger on the arm of the mini-tripod, which is delivered in the set of thermal comfort meter (see photo in the right).

- **SensoTCMod 5507 or 5503 measuring modules**

Measuring modules of the thermal comfort are made in the form of cylinders with dimensions of 100x48mm. The SensoTCMod 5507 module includes following transducers: Anemo, Thermo and HygroBaro. The SensoTCMod 5503 module includes Anemo and Thermo transducers, but doesn't include HygroBaro transducer. Air temperature and relative humidity sensors are placed on the top of the cylinder. Natural wet temperature, globe temperature and air speeds sensors are placed on lateral horizontal supports. Additional RTD sensor may be connected to the socket on the lateral wall of the cylinder. It can be used for supplementary temperature measurement, eg. floor-surface temperature or air inlet temperature. Air speed probe can be disconnected from the measuring module and may be transported, stored or calibrated separately. Construction of the anemometer probe enables the measurement in the vertical, horizontal or oblique position. The measuring modules can be mounted on a special folding tripod, which enables mounting three units at the different heights as well as on any photo tripod for mounting one unit. Measuring modules of thermal comfort are in compliant with following standards: ISO 7726, ISO 7730, ISO 13182, ISO 7243, ISO 7933, ISO 8996, ISO 11079 and ASHRAE 55.

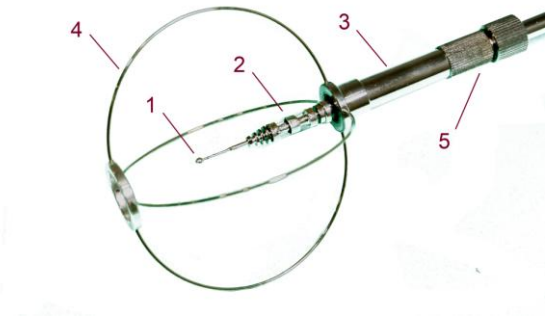
- **Air speed probe** includes the spherical omnidirectional air speed (1) and compensation temperature (2) sensors. Both the sensors are vacuum covered with special aluminium coating that increases their resistance to contamination and decreases the effect of thermal radiation on the accuracy of velocity measurement. The temperature sensor (2) can be additionally protected against radiation by moving shielding tube (3) (it may be necessary only if the airflow

is measured very close to high temperature sources). Both sensors can be also protected against mechanical damage using openwork basket (4) made with wire circles. If such a protection isn't necessary it is possible to removed them from the shielding tube (3). Shielding tube (3) can be moved along the support of the probe and locked by the clamp screw (5).

Technical Data:

- diameter of the speed sensor: 2 mm
- measuring range: 0.05…5 m/s
- resolution: 0.001...0.01 m/s
- accuracy: ±0.02 m/s ±2%
- automatic temperature compensation: < than ±0.1%/K
- temperature compensation: -20^{O}C…50^{O}C
- upper frequency f_{up} [*)]: min. 1Hz, typ. 1.5 Hz

[*)] *The upper frequency is defined as the highest frequency up to which the standard deviation ratio remains in the limits of 0.9 to 1.1 in relation to the standard deviation of the frequency 0 Hz (see the ASHRAE Transaction Vol.1,1998, paper No SF-98-20-2).*



Preparation for measurements:

1. Check if the openwork basket (4) is on the shielding tube (3). If not, put openwork basket (4) on the shielding tube (3). Be particularly careful not to damage the speed sensor (1). To this purpose check if the shielding tube (3) is on the end of the probe completely covering the speed sensor and the clamp screw (5) is properly locked (it does not move). Put on the openwork basket (4) only then when the sensor (1) is covered by the shielding tube (3).
2. Connect the air speed probe to measurement modules. Loosen the clamp screw (5) and move the shielding tube (3) with the openwork basket (4) into the bottom uncovering the sensors (1) and (2).
3. Lock the clamp screw (5).
4. After the measurements move the shielding tube (3) back on the sensors (1) and (2).
5. The probe should be transported in the carrying case only with imposed openwork basket (4).

- **Air, natural wet and globe thermometers** measure temperature using RTD sensors. Automatic correction of thermal drift provides high measurement stability. The use of insulating elements in design of probes (special wood and fiberglass) guarantees the appropriate thermal insulation and high measurement accuracy. In order to improve the accuracy each sensor is individually calibrated.

Technical Data:

- type and diameter of thermometer:	t_a: Pt-100 cylindrical Ø 2.6 mm
	t_g: black globe ε 0.95, Ø 75 mm, tickness 0.8 mm
	t_{nw}: Pt-100 cylindrical, length 30 mm, Ø 5 mm; support Ø 5 mm
- measurement range:	t_a: -20…60 ^{O}C
	t_g: -20…120 ^{O}C
	t_{nw}: 0…50 ^{O}C
- accuracy:	t_a: ±0.3 ^{O}C
	t_g: ±0.3 ^{O}C for range -20..50 ^{O}C i ±0.5 ^{O}C for range 50..120 ^{O}C
	t_{nw}: ±0.3 ^{O}C
- stabilization time of measurement:	15…20 min

- ***Barometric pressure*** probe is located inside the cylinder of the measuring module. The probe utilizes specialized piezoresistive micro-machined sensing element. Each probe is individually calibrated and thermally compensated. The calibration coefficients are programmed into EEPROM memory.

Technical Data:

- measurement range: 500…1500 hPa
- accuracy: ±3 hPa
- response time: 2s

- ***Relative humidity*** probe is located outside on the top of cylinder of the measuring module. The probe includes a capacitive polymer sensing element for relative humidity and a bandgap temperature compensation sensor. Each probe is individually calibrated in a precision humidity chamber with a chilled mirror hygrometer as reference.

Technical Data:

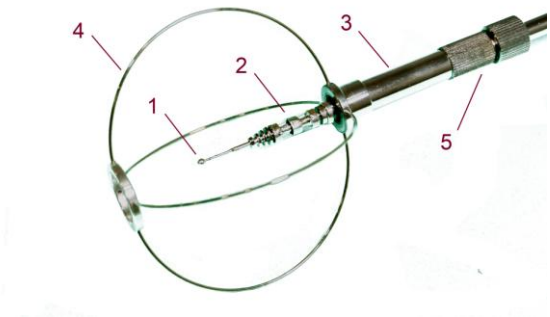
- measurement range:	0…100 % RH
- accuracy:	±2% w zakresie 10…90% RH
- long term stability:	<1% RH/rok
- response time:	<4s

B. SensoData 5500 Anemometer

The SensoData 5500 Anemo is a device for the air speed and temperature measurement. The device enables measurements of jet ventilation and effectiveness of the ventilation in rooms as well as measurements of flow of inside different devices. SensoData 5500 Anemo B with the built-in pressure sensor can read the barometric pressure and enables the automatic correction of anemometer readings at changes of the barometric pressure. The device has the DSubHD15 socket for connecting probes (see photo). The RJ45 socket from the side of the casing enables to connect additional external transducers or modules, so as: SensoAnemo transducer, SensoHygBar transducer, SensoTCMod thermal comfort module. So that it is possible significantly extend the functionality of the device. The device meets the requirements of following standards: ISO 7726, ISO 7730, EN 13182 and ASHRAE 113.

- **Spherical omnidirectional probe SF** enables measurements of jet ventilation and effectiveness of the ventilation in rooms. Includes the spherical omnidirectional air speed (1) and compensation temperature (2) sensors. Both the sensors are vacuum covered with special aluminium coating that increases their resistance to contamination and decreases the effect of thermal radiation on the accuracy of velocity measurement. The temperature sensor (2) can be additionally protected against radiation using moving shielding tube (3) (it may be necessary only if the airflow is measured very close to high temperature sources). Both sensors can be also protected against mechanical damage using openwork basket (4) made with wire circles. If such a protection isn't necessary it is possible to removed them from the shielding tube (3). Shielding tube (3) can be moved along the support of the probe and locked by the clamp screw (5).

Technical Data:



- diameter of the speed sensor: 2 mm
- measuring range: 0.05…5 m/s and -20…50^{O}C
- resolution: 0.001...0.01 m/s and 0.1^{O}C
- accuracy: ±0.02 m/s ±2% and 0.2^{O}C
- directional error above 2m/s: ±2.5%
- automatic temperature compensation:< than ±0.1%/K
- upper frequency f_{up} [2)]: min. 1Hz, typ. 1.5 Hz

[1)] *The additional error caused by the different reaction of the spherical sensor above speed of 2m/s to the change of air flow direction with respect to direction established in the calibration.*

[2)] *The upper frequency is defined as the highest frequency up to which the standard deviation ratio remains in the limits of 0.9 to 1.1 in relation to the standard deviation of the frequency 0 Hz (see the ASHRAE Transaction Vol.1,1998, paper No SF-98-20-2).*

Preparation for measurements:

1. Check if the openwork basket (4) is on the shielding tube (3). If not, put openwork basket (4) on the shielding tube (3). Be particularly careful not to damage the speed sensor (1). To this purpose check if the shielding tube (3) is on the end of the probe completely covering the speed sensor and the clamp screw (5) is properly locked (it does not move). Put on the openwork basket (4) only then when the sensor (1) is covered by the shielding tube (3).
2. Connect the air speed probe to device. Loosen the clamp screw (5) and move the shielding tube (3) with the openwork basket (4) into the bottom uncovering the sensors (1) and (2).
3. Lock the clamp screw (5) so that the speed sensor (1) was in the middle of the openwork basket (4).
4. After the measurements move the shielding tube (3) back on the sensors (1) and (2).

Note!

1. The velocity sensor must be protected during transport by the shielding tube (3). Note that the clamping screw (5) has been properly lock.
2. The openwork basket (4) should be put on and put out only then when the speed sensor (1) is covered and secured by the shielding tube (3).
3. Use the openwork basket (4) if you are not sure of the safety of the sensors during measurements.

- **Cylindrical probe CL** enables measurements of jet ventilation and flow of inside different devices.

Technical Data:

- measuring range: 0.2...20m/s and -20…50^{O}C
- resolution: 0.01...0.1 m/s and 0.1^{O}C
- accuracy: ±0.05 m/s ±5% and 0.4 ºC
- automatic temperature compensation: < niż ±0.3%/K

- **Barometric pressure sensor** (only for SensoData 5500 Anemo B) enables the measurement of the barometric pressure and the automatic correction of anemometer readings at changes of the barometric pressure.

Technical Data:

- measuring range: 500…1500 hPa
- resolution: 0.1 Pa
- accuracy : ±3 hPa
- response time: 2s

C. SensoData 5500 Thermometer.

The SensoData 5500 Thermo is a device for the temperature measurements with the help of the resistive Pt-100 probes working in 4-wire layout. The standard version allows to connect two probes into the D-Sub9 sockets (see photo in the right). The plugs of temperature probes can contain EE-PROM memory with correction factors. It allows to increase accuracy by the individual probe calibration.

The version of SensoData 5500 Thermo+ enables to connect four temperature probe with the help of screw connector (without the correction factors). Extended version SensoData 5500 Thermo HB enables additionally barometric pressure measurement using the built-in sensor and relative humidity measurement using probe connected to the one of the D-Sub9 socket (see photo in the left). All versions are equipped with the additional RJ45 socket enabling to attach external transducers or modules. This can greatly expand the functionality of the device. The device meets the requirements of the ISO 60751 standard.

Technical Data:

- temperature input
  - type of sensors: Pt-100
  - measuring range: -50…600 ^{O}C
  - resolution: 0.01 ^{O}C for <100 ^{O}C; 0.1 ^{O}C for ≥ 100 ^{O}C
  - accuracy: 0.05 ºC + probe error
- barometric pressure sensor (option)
  - measuring range: 500…1500 Pa
  - accuracy : ±3 hPa
  - response time: 2s
- humidity probe (option)
  - measuring range: 0…100 %
  - accuracy: ±2% in the range 10…90% RH
  - long term stability: <1% RH/year
  - response time: <4s

3. TURNING ON THE DEVICE.

Device turns on by pressing the 'On' and turn off by pressing 'Off' keys. After turning on the device reads (scans) the information of all connected transducer and module (both built-in and external). In the absence of the proper probe in the transducer/module or connecting wrong an appropriate announcement is being shown. After scanning, a screen appears with a selection environment (only for thermal comfort module) and next a screen with a configuration (with a list of connected transducers). After pressing the 'ESC' key or automatically after the 5s the default screen with results appears. The screen with the configuration it is possible also to show at any time by pressing the 'Menu' key and next choosing the 'Configuration' item (pressing the 'OK' key). While displaying the screen with the configuration, it is possible to select one of items by pressing the vertical cursor and to go to the screen with the detailed information about the selected transducer after pressing the 'OK' key.

4. CONFIGURATION SELECT.

In the case of connecting a few transducers or modules of the same type (e.g. of a few SensoTCMod modules), the screen 'CONFIG SELECTION' appears after scanning. On this screen are displayed connected transducers of the same type. The appropriate item should be select by pressing the vertical cursors and to accept it by pressing 'OK' key. The 'CONFIG SELECTION' screen appears separately for every group of identical transducer. You can change the configuration (select to display results transducer) at any time by pressing the 'Menu' key and next the '↑' key.

Note!

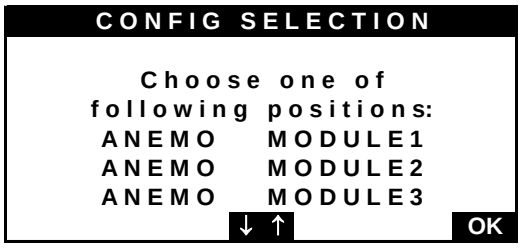
1. The device can simultaneously read and record the results only from one transducer of the same type or one module. In order to read and record the results from another one should change the configuration.

2. In the case of connecting more than three transducers of the same type, are displayed the ones with the lowest ID address.

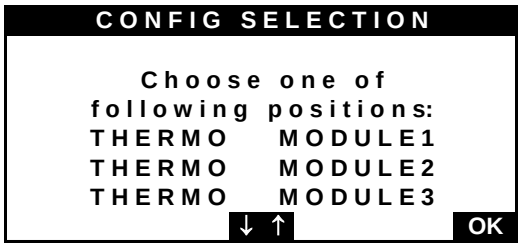
A. Selection the measuring module for SensoData 5500 MK thermal comfort meter.

The SensoData 5500 datalogger can be connected at the same time 3 modules. Each module contains 2 or 3 measuring transducers, which are identified separately by the datalogger. Measuring set for simultaneous measurement of thermal comfort at three levels, requires the use of one SensoTCMod 5507 module with three transducers (Anemo, Thermo, HygroBaro) and two SensoTCMod 5503 modules with two transducers (Anemo, Thermo). To select the suitable module (e.g module 1) to read and record the results, should:

- on the first 'CONFIG SELECTION' screen (see below) that appears, select anemo transducer e.g 'ANEMO MODULE 1' by pressing the vertical cursor and press the 'OK' key



- on the second 'CONFIG SELECTION' screen (see below) that appears, select temperature transducer in the same module e.g 'THERMO MODULE 1' and press 'OK' key.



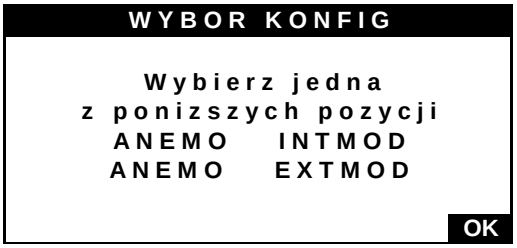
I order to change the configuration (measuring module) you must press 'Menu' key and select the 'Change config' item by pressing the '↑' key. Next should carry out the procedure the selection of the measuring module in the same way as described above.

Note!

1. *SensoTCMod module contains three (Anemo, Thermo, HygroBaro) or two (Anemo, Thermo) measuring transducers, which are identified separately by the datalogger. Therefore, when selecting or changing the module will be shown at least twice the 'CONFIG SELECTION' screen independently for each type of transducers. Pay attention so as to select transducers from the same module. If you select the transducers with different modules (eg. Anemo from module 1 and Thermo from module 2) should properly to interpret the obtained results.*
2. *It must always be connected SensoTCMod 5507 module with HygroBaro transducer. Otherwise there will not be calculated parameters, which depend on the humidity and barometric pressure.*
3. *In the case of two or three modules of type SensoTCMod 5507 (with humidity and pressur), in addition to the listed two 'CONFIG SELECTION' screens will be shown the third screen to choose HygroBaro transducers.*

B. Selection external transducer for SensoData 5500 Anemo

To select external transducer, that is connected to the RJ45 socket (connector C – see Chapter 1), should on the 'CONFIG SELECTION' screen, that appears after turning on the datalogger, choose e.g 'ANEMO EXTMOD' by pressing the vertical cursors and press 'OK' key (transducer called ANEMO INTMOD is built-in).



In order to again choose internal measuring transducer press 'Menu' key and select the 'Change config' item by pressing the '↑' key. Next should carry out the procedure the selection of the measuring transducer in the same way as described above.

5. INDICATORS ON THE DISPLAY

← Z Environment indicator (change after pressing the '←' key)
C – cold; M – moderate; H – hot

REC Recording indicator.
Enabled indicates recording procedure in automatic mode or saving in memory of the last result in single mode.

AUT Mode indicator.
Indicates the selected mode. In automatic mode indicator 'AUT' is displayed and in single mode indicator 'SIN' is displayed.

BAR Indicator of anemometer compensation with regard to barometric pressure.
Enabled automatically in the case an identification of the barometric pressure transducer or manually after setting the 'BARcmp' as enabled in 'SETTINGS' screen selecting from main menu. It is important to set the actual barometric pressure.

ECO Indicator of economy mode (optionally).
Enabled indicates economy mode.

[ ] Flashing indicator appearing during the averaging at the single mode.

00:08 Elapsed time counter.
A time for the end of full averaging (updating the shown result) is displaying.
The counter decreases from the averaging value to zero. In automatic mode decreases sequentially and in single mode stops on the value of averaging time until restarting the measurement by pressing 'Start' key.

◊ Low battery indicator.

6. KEY DECRIPTION

On	Turn on
Menu	Shortcut Menu
Rec	Automatic recording or writing samples to memory in single mode (SIN)
Off	Turn off
Start	Start the measurement in single mode (SIN)
▲	Scroll up screens with the results
▼	Scroll down screens with results
◀	Changing the type of environment
▶	Change of settings
ESC	Enter to the status screen
OK	Enter to the zoom screen (only for some screens with results)

7. MODES

- **Automatic AUT**
  Automatic mode is the default i.e. is enabled always after turn on the device. Measurement and averaging is done cyclically. After each cycle, the results are updated on the display.

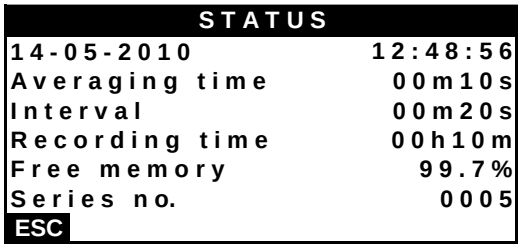
- **Single SIN**
  In this mode, the measurement and averaging is performed in one cycle. Begins at the moment of pressing of the 'Start' key on the keyboard or button on the probe handle and ends with getting the full value of the average measurement or stopping the measurement by the user. Stopping the measurement can be done by new pressing the 'Start' key or the button on the probe handle. During the measurement and the averaging a rectangular indicator in the right bottom corner of the display (beside the time counter) is flashing. Beginning and the end of the measurement is indicated by buzzer. The average value on the display are updated every 2s from the beginning of measurement. After stopping the measurement the definitive averaging value is locked on the screen until the next initiation of measurement. Switching to single mode and back again is done by pressing the 'Menu' key and next 'Start' key.

- **ECO (option)**
  In economy mode, the measurement modules are put to sleep when there is need to perform measurements for long time. Economy mode significantly reduces power consumption, which prolongs battery life.

8. RESULTS SCREEN OVERVIEW.

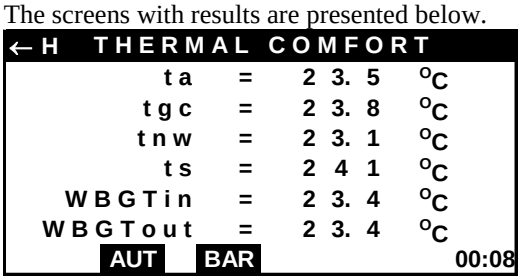
Measurement results are displayed on the scrolling screens depending on the configuration and the type of environment. Screens can be scrolled using the vertical cursor keys. If the screen is displayed more results, then after pressing 'OK' key you can display the 'ZOOM' screen with enlarged single result. Next single results are displayed after pressing vertical cursor keys. To the previous screen with overall results returns by pressing the 'ESC' key.

Pressing the 'ESC' key (while displaying screen with results) enables to display the 'STATUS' screen (see picture below) with the following information: date and time, averaging time, interval and recording time, space of free memory and number of measurement series.



A. SensoData 5500 MK Thermal Comfort meter

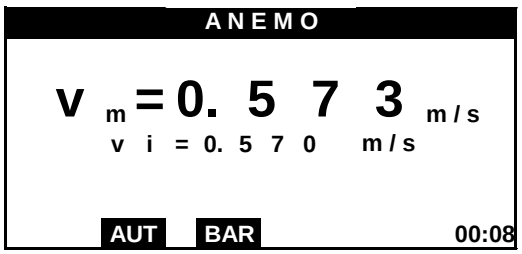
The screens with results are presented below.



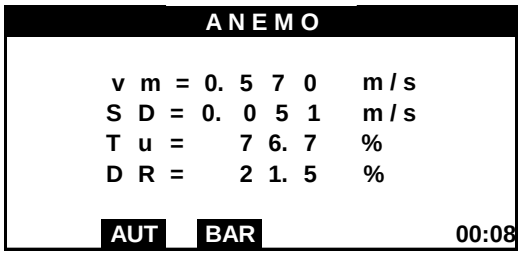
ta - air temperature
tgc - globe temperature
tnw - natural wet temperature
ts - temperatura dodatkowa (np. powierzchni)
WBGTin - wet bulb globe temperature (indoor)
WBGTout – wet bulb globe temperature (outdoor)

Supplementary temperature ts is displayed only when it is activated on the 'SETTINGS' screen selected after pressing the '→' key or from main menu.

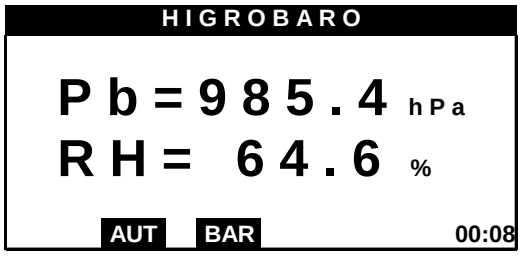
Note!
The globe temperature tgc is the corrected temperature that corresponds to globe with a diameter 15 cm. Correction is possible only when the anemometer probe is connected. The tgc isn't displayed in the case of the lack of the probe (like the other results that depend on this temperature: WBGTin, WBGTout, tr)



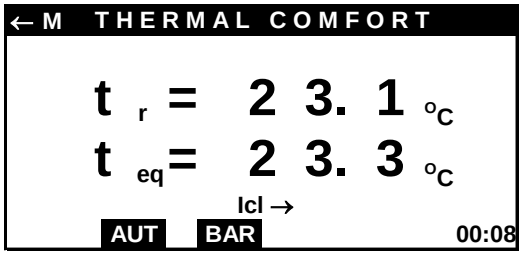
vm - mean speed
vi - instantaneous speed



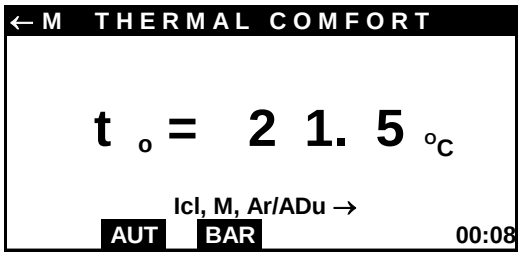
SD – standard deviation of air speed
Tu – turbulence intensity of air speed
DR – draught rating



Pb - barometric pressure
RH - relative humidity

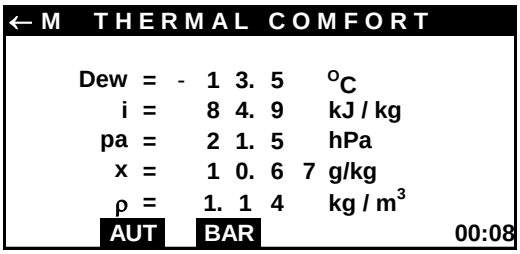


tr - mean radiant temperature
teq - equivalent temperature

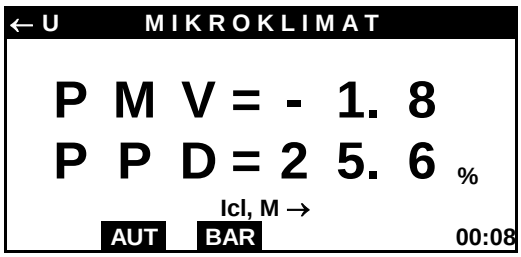


to - operative temperature

Input parameters: Icl – clothing insulation
M – metabolic rate
Ar/ADu – body area fraction exposed
changed after pressing the '→' key or from the main menu when you select 'SETTINGS'.



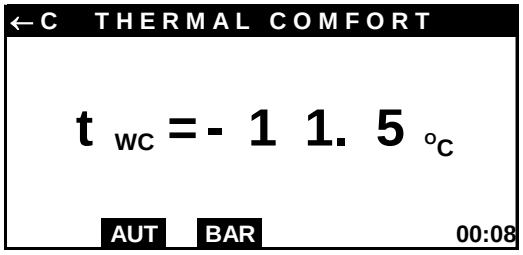
Dew - dewpoint temperature
i - enthalpy of humid air
pa - partial water vapour pressure in the air
x - humidity ratio
ρ - air density



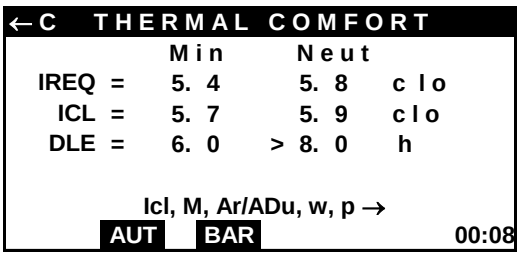
PMV - predicted mean vote
PPD - predicted percentage of dissatisfied

Input parameters: Icl – clothing insulation
M – metabolic rate
changed after pressing the key '→' or from the main menu when you select 'SETTINGS'.

For cold environment appears the following screens additionally:



twc - wind chill temperature



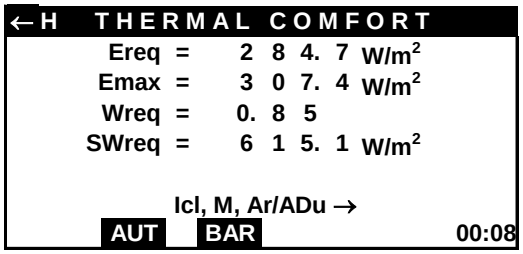
IREQ – required clothing insulation (minimal and neutral)

ICL – required basic thermal insulation (minimal and neutral) according to ISO 9920

DLE – duration limited exposure (minimal and neutral)

Input parameters: Icl – clothing insulation
M – metabolic rate
Ar/ADu – body area fraction exposed
w – walking speed
p – air permeability
changed after pressing the '→' key or from the main menu when you select 'SETTING'.

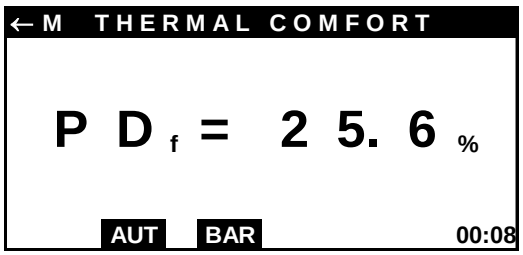
For hot environment appears the following screen.



Ereq - required evaporation rate
Emax - maximum evaporation rate
Wreq - required skin wettedness
SWreq - required sweat rate

Input parameters: Icl – clothing insulation
M – metabolic rate
Ar/ADu – body area fraction expose
changed after pressing the '→' key or from the main menu when you select 'SETTINGS'.

If the supplementary probe ts is activated, it appears the following screen. Activation of the ts probe is made on 'SETTINGS' screen selected after pressing the '→' key or from the main menu.

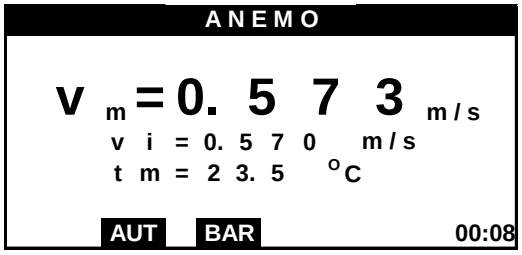


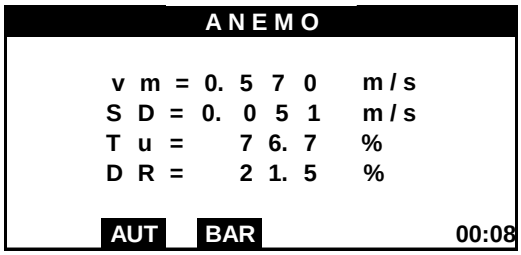
PDf - percentage dissatisfied due to floor temperature
PDv - percentage dissatisfied due to vertical temperature difference (head-ankles)

Depending on the choice of the option on the 'SETTINGS' screen displayed is a PDf or PDv index.

B. SensoData 5500 Anemo-meter.

The device automatically identifies the type of probe and the presence of pressure transducer.
Below are presented the screens with the results for spherical probe SF. For a cylindrical probe CL is not displayed the screen on the right side.

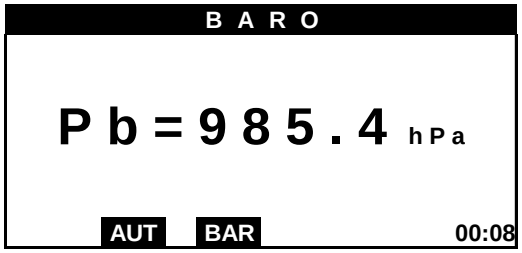




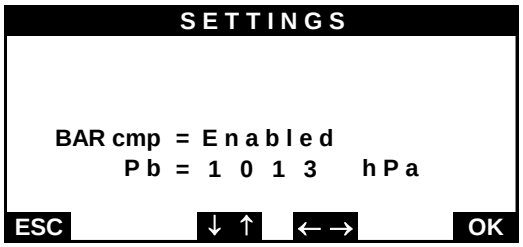
vm - mean air speed
vi - instantaneous speed
tm – mean air temperature

SD – standard deviation of velocity
Tu – turbulence intensity
DR – draught rate

In addition, in the case of the presence of a pressure sensor (option 5500 SensoData Anemo B), the following screen is displayed. Then device automatically compensates pressure influence on the air speed.



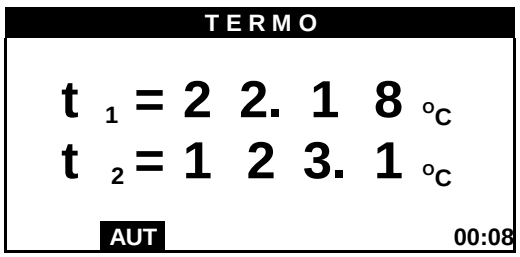
In order to compensate pressure influence on the air speed (in the absence of built-in pressure transducer) you should enable compensation (BARcmp = Enabled) and enter barometric pressure Pb on the 'SETTINGS' screen selected after pressing the '→' key or from main menu (see below).

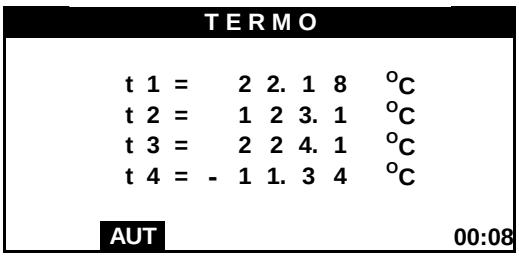


Note !
In the case the absence of barometric pressure transducer in order to minimize the errors is preferred that every time when you turn on the device to enable pressure compensation and enter the current value of the pressure.

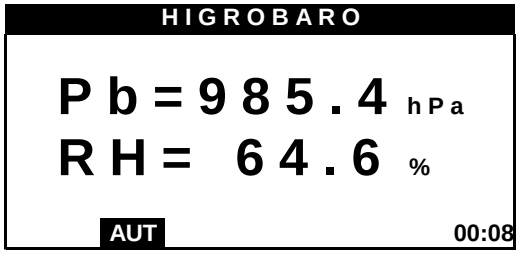
C. SensoData 5500 Thermo-meter.

Below are presented the screens with results for SensoData 5500 Thermo (left) and SensoData 5500 Thermo+ (on the right).





In addition for SensoData 5500 Thermo HB is displayed screen with results (see below).

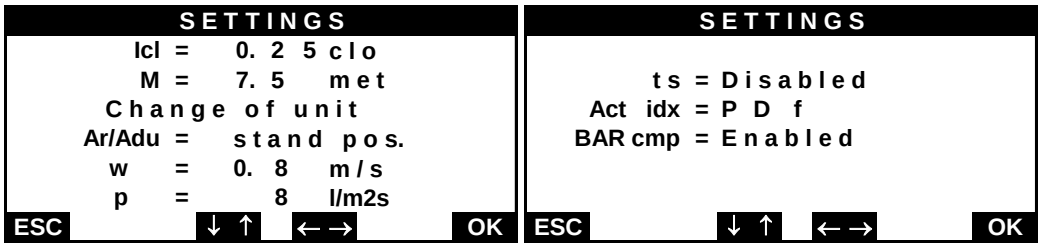


9. CHANGING INPUT PARAMETERS, MEASURING UNITS AND OTHER SETTINGS.

In order to enter or change the input parameters, such as:

Icl – clothing insulation
M – metabolic rate
Ar/ADu – body area fraction exposed
w – walking speed
p – air permeability

press the '→' key or double-press the 'Menu' key.
If you select this procedure are displayed the following screens (see below).



In order to change parameters, select the items by pressing the vertical cursors and then to change the value of the parameter by pressing the horizontal cursors. All settings are stored in the memory of the device.
Changing the units of measurement for parameters: M and Icl (independently) can be made by pressing the horizontal cursor in the item 'Change of unit'.
On the second screen, you can activate the display of supplementary temperature 'ts' (see the description of the measuring module in Chapter 2A). For the 'ts=Enabled' item it is possible to choose the type of the 'Act idx' between:

PDf - percentage dissatisfied due to floor temperature
PDv - percentage dissatisfied due to vertical temperature difference (head-ankles)

10. RECORDING OF MEASURING RESULTS.

- **Recording results in the automatic mode.**
  Pressing the 'Rec' key in automatic mode starts recording results. The results are saved in the internal memory of the device with the chosen interval and time recording. While recording 'REC' indicator blinks at the bottom on the screen. Selection of recording parameters is available only before you start recording (by pressing the 'Menu' key and next 'Rec' key. Recording parameters are also saved. Recording ends with lapse of time recording (signalized by buzzer) or can be stopped at any time by pressing once more the 'Rec' key. The current recording status information, such as: date and start time, interval, averaging time, number of samples and series, remaining time to the end of the recording, you can see when you press the 'ESC' key.

- **Writing result to memory in single mode.**
  The locked result on the screen can be saved in the memory by pressing the 'Rec' key. Write to memory is confirmed by the message with the current series and number of the sample. After you save the result appears 'REC' indicator at the bottom of the screen. Re-writing the same result is locked. After pressing the 'Start' key and starting the next measurement, the 'REC' disappears. Current information about the recording parameters such as: date and time, averaging time, number of sample and series, free space of memory available, you can see by pressing the 'ESC' key.

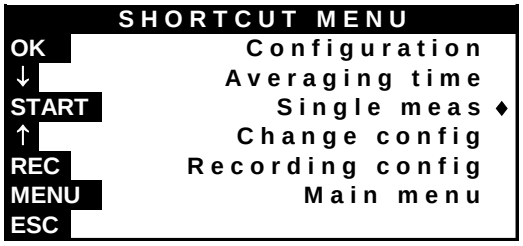
- **Organization of data in memory**
  The measuring results are sorted into a series and a samples. Every time you start recording in automatic mode, the series number is increased by 1. In single mode, all results (samples) are stored in one series. Serial number

increases at each entrance to the single mode. The serial number can be increased also by pressing the keys sequence: 'Menu' and 'Rec'. At each of the measuring series is placed a header with the date and the input parameters. Each sample contains the time stamp and all results.

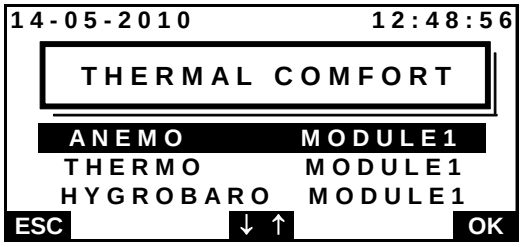
- **Memory delete.**
  After double-pressing the 'Menu' key, appears 'MAIN MENU' screen. When you select 'Memory delete' and press 'OK' key, you can choose 'All series' or 'Last serie' to remove.

11. SHORTCUT MENU

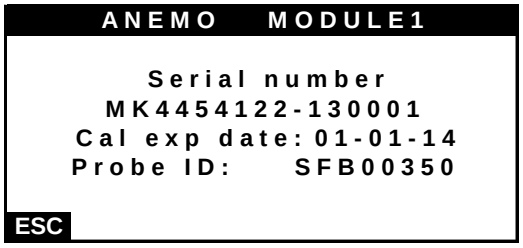
A user has access to multi-level menu when showing the results. After pressing the 'Menu' key, appears the 'SHORTCUT MENU' with most commonly used features. Access to these features is possible after pressing the corresponding key, whose symbol is located beside the features name (see below).



- **Configuration**
  After pressing the 'OK' key, appears screen below on which are shown connected transducers.



While displaying the screen with the configuration, it is possible to select one of items by pressing vertical cursors and after pressing the 'OK' key to go to the screen with the detailed information about the selected transducer (see below the example for anemo transducer).

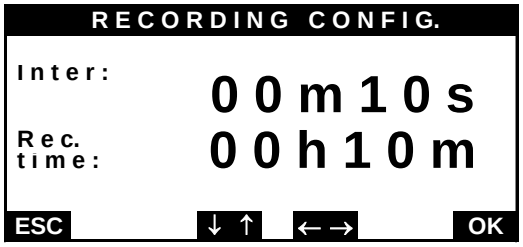


- **Averaging time**
  After pressing the '↓' key, appears 'AVERAGING TIME' screen. In order to change the averaging time should push the vertical cursors, so that to increase or decrease the value in the seconds or minutes. By pressing the horizontal cursors moves between the items of the seconds and minutes. You must accept the changes press the 'OK' key. Averaging time is not stored and after each reboot the device it is set by default to the 10s.

- **Single measurement**
  Pressing the 'Start' key switches modes between automatic 'AUT' and single 'SIN'. 'SIN' mode indicates by a tag placed on the right side of the item name and the 'SIN' indicator in the bottom bar of the screen with results. The mode is set as 'AUT' after each the reboot the device.

- **Change configuration**
  After pressing the '↑' key, appears the 'CONFIG SELECTION' screen to select another transducer (see Chapter 4).

- **Recording configuration**
  After pressing the 'Rec' key, appears the following screen with the recording parameters:
  Interval – specifies the time between samples
  Recording time – specifies the time since the start, after which you want to stop recording.

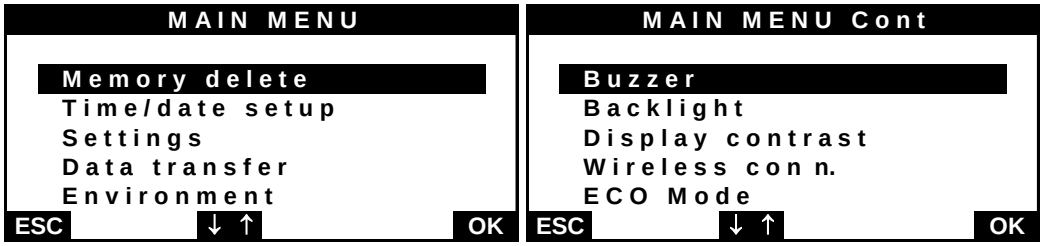


  In order to change the recording parameters, select corresponding items: seconds, minutes or hours, by pressing the horizontal cursors and next change the value by pressing the vertical cursors. The changes should be accept by pressing the 'OK ' key. This feature is not available during recording or single mode.

- **Main Menu**
  After pressing the 'Menu' key appears the 'MAIN MENU' screens.

12. MAIN MENU

To enter the main menu press twice the 'Menu' key. The main menu consist of two screens that appear successively as scrolled page. In order to enter into the feature, select the appropriate item by pressing horizontal cursors and press 'OK' key. During the recording, some features may not be available.



- **Memory delete**
  - select the appropriate item by pressing the vertical cursors (all series or last series)
  - press the 'OK' key
  - confirm again, if you are unsure.

- **Time / date setup**
  - select appropriate item: hour, minutes, seconds, year, month or day by pressing the horizontal cursors
  - change the value of item by pressing horizontal cursors
  - press 'OK' key to store or 'ESC' key

- **Settings** (change of an input parameters)
  By choosing appears 'SETTINGS' screens (see Chapter 9).

- **Data transfer**
  See Chapter 13.

- **Environment**
  When you select this feature, appears the 'ENVIRONMENT TYPE' screen to choose the environment. Depending on the environment are displayed the appropriate screens with the results. Access to this feature is also possible directly from any screen with the results after pressing the ' ← ' key. The type of the selected environment is identified in the upper-left corner of each screen with the results (C – cold, M – moderate, H – hot).

- **Buzzer** (the threshold speed)
  Beginning and end of the recording in auto mode, beginning and end of the measurement in single-mode and exceeding the speed threshold can be indicated by a buzzer. In order to enabled this feature:
  - select enabled or disabled by pressing the horizontal cursors
  - if you select 'enabled', press the '↓' key and select the 'Limit' item before the decimal point

- set the appropriate value of the threshold speed by pressing horizontal cursors
- press the '↓' key again to select 'Limit' item after the decimal point and set the value by pressing horizontal cursors
- press the 'OK' key to store or 'ESC' key.

- **Backlight**
  - select the appropriate mode by pressing the horizontal cursors
  - if you select 'Auto off' mode, press the '↓' key to go to the item to set the time after which you want to automatically turn off the screen backlight
  - select the required time by pressing the horizontal cursors
  - press the 'OK' key to store or 'ESC' key.

- **Display contrast**
  - change the screen contrast by pressing the horizontal cursors
  - press the 'OK' key to store or 'ESC' key.

- **Wireless connection** (active only for version SensoData 5500 Bee)
  - select enabled or disabled by pressing the horizontal cursors
  - press the 'OK' key to store or 'ESC' key.

- **ECO Mode (disabled)**

13. DATA TRANSFER

Recorded measuring results can be transferred to your computer and saved as a text file with chosen name. You can save all memory or last measurement series. To transfer the results of measurement:

- Select from the main menu (press 'Menu' key twice) the 'Data transfer' item
- When appears the 'Communication' screen, connect the device to the USB port of computer. The USB socket in the device is located on the left side of the casing. Before the first using, you must install the software (for data transfer)
- Run the program SensoData Transfer.

14. INSTALATION OF THE SOFTWARE

- Install the program to transfer data 'Transfer_SensoData'. The program can be found on the supplied CD or you can download it from the website: www.sensor-electronic.pl. In order to install the program, run the Setup.exe file in the folder SensoData Transfer_Inst and follow the instructions. The setup program automatically installs the driver for the USB port.
- Locate the USB port and connect the device to the computer. Windows automatically identifies the new device and select the appropriate driver. In the case of trouble, find a DriverInstaller shortcut in the Transfer SensoData application and run it.
- To verify whether the hardware is properly installed and to determine the COM port assignment for the device follow the steps:
  - open the "Control Panel", and then double click on the "System" icon.
  - once the System Properties window is displayed select the "Device Manager" button.
  - double-click on Ports (COM &LPT).
  - if the hardware is correctly installed, you should now see the USB device listing and the assigned COM port.
- If you need to assign the COM port name to another Port Number:
  - double-click on the USB device to view the properties
  - once the properties window opens click on the Port Settings tab and select the advanced button
  - when the Advanced Settings dialog box appears on the screen, click on the COM Port Number drop down the box to check what other port number are available
  - try to reassign COM port to a unused port number
  - click OK when finished.

15. WIRELESS COMMUNICATION

The device in the SensoData 5500 Bee version is equipped with a radio receiver that allows wireless communication with measuring modules (transducers). Modules (transducers) must be connected to the SensoBee 485 wire-less transmitter (see Chapter 2A page 4). In order to switch the SensoData 5500 Bee in a wire-less mode:

- turn on the SensoBee 485 wire-less transmitter (switch on the side to the 'Bee' position), the blue led on top of the casing will blink
- double press 'Menu' key on the keyboard
- select 'Wireless conn' item and press 'OK' key
- select enable mode by pressing the horizontal cursor
- press 'OK.' key, blue led on the right side of the display starts blink, the device establishes radio communication with the SensoBee 485 transmitter and starts the scanning process.
- when you turn on again, the device starts in wireless communication mode

Notes!

1. *Before turning on the device in wireless communication mode must first be turned on the SensoBee 485 transmitter and connected to him modules (transducers).*
2. *Low battery charge status of the wireless transmitter can cause a loss of communication between the device and the measuring modules (transducers). Replace the batteries if the blue led is not blink.*
3. *Radio signal does not generate additional measurement errors. Lack of signal transmission can only lead to a break in displaying and recording of the measuring result.*

16. PHYSICAL MODEL

- **Standard deviation of velocity** [m/s]

$$SD = \sqrt{\overline{v^2} - (\overline{v})^2}\ ,\ \text{where}\ \overline{v} = \frac{\sum_{i=1}^{n} \overline{v}_i}{n},\ \overline{v^2} = \frac{\sum_{i=1}^{n} \overline{v^2}_i}{n}\ ,$$

- **Turbulence Intensity** [%]

$$Tu = \frac{SD}{v_m} 100\%$$

- **Draught Rate** (The percentage of people dissatisfied due to draught) [%]

$$DR = (34 - t_m)(v_m - 0{,}05)^{0{,}62}(37SD + 3{,}14),\ \text{dla}\ t_m > 34^{O}C\ \text{lub}\ v_m < 0.05 m/s \Rightarrow DR = 0$$

- **Partial Water Vapour Pressure** in the air [hPa]

$$p_a = 0.061078 RH \bullet 10^{\frac{At_a}{B+t_a}},\ \text{gdzie dla}\ t_a > 0 \Rightarrow A = 7.5;\ B = 237.3\ \text{i dla}\ t_a \le 0 \Rightarrow A = 9.5;\ B = 265.5$$

- **Humidity ratio** [g/kg]

$$x = 612.98 \frac{p_a}{P_b - p_a}$$

- **Dewpoint Temperature** [^{O}C]

$$Dew = \sqrt[8]{\frac{RH}{100}}[112 + 0.9t_a] + 0.1t_a - 112$$

- **Enthalpy for humid air** [kJ/kg]

$$i = 1.005t_a + x(1.84t_a + 2501)$$

- **Air Density** [kg/m^3]

$$\rho = \frac{(1+x)P_b}{4.62(0.622 + x)(t_a + 273)}$$

- **Mean Radiant Temperature** [^{O}C]

$$t_r = \left[\left(t_g + 273\right)^4 + h_{cg} \frac{\left(t_g - t_a\right)}{5.38 \bullet 10^{-8}} \right]^{\frac{1}{4}} - 273, \text{ where}$$

$$h_{cg} = \max\_ of \begin{cases} 17.755 v_m{}^{0,6} \\ 2.675 \left| t_g - t_a \right|^{0,25} \end{cases},$$

where t_g is globe temperature for globe diameter of 7.5cm

- **WBGT-index** [^{O}C]

$$WBGT_{in} = 0.7 t_{nw} + 0.3 t_{gc}$$

$$WBGT_{out} = 0.7 t_{nw} + 0.2 t_{gc} + 0.1 t_a$$

where t_{gc} is corrected globe temperature corresponds to globe with a diameter 15 cm

- **Operative Temperature** [^{O}C]

$$t_o = \frac{h_c t_a + h_r t_r}{h_c + h_r}, \text{ where}$$

$$h_c = \max\_ of \begin{cases} 3.5 + 5.2 v_{ar} \quad for\ v_{ar} < 1\ or\ 8.7 v_{ar}{}^{0.6} \quad for\ v_{ar} \geq 1 \\ 2{,}38 \left| t_{sk} - t_a \right|^{0,25} \end{cases}$$

$$h_r = 21.9996 \bullet 10^{-8} AR \left(\frac{t_r + t_{sk}}{2} + 273 \right)^3$$

$$v_{ar} = v_a + \min\_ of \begin{cases} 0.0052(58.15M - 58) \\ 0.7 \end{cases}$$

$$t_{sk} = (30 + 0.093 t_a + 0.045 t_r - 0.571 v_a + 0.254 p_a + 0.074432 M - 0.553 I_{cl}$$

- **Required Evaporation Rate** [W/m^2]

$$E_{req} = 58.15(M - W) - C_{res} - E_{res} - CON - R, \text{ where}$$

$$C_{res} = 0.08141 M (35 - t_a)$$

$$E_{res} = 1.005995 M (5.619 - p_a)$$

$$CON = h_c F_{cl} (t_{sk} - t_a)$$

$$R = h_r F_{cl} (t_{sk} - t_r)$$

$$F_{cl} = \frac{1}{1 + (h_c + h_r) \left(0.155 I_{cl} - \frac{1 - \frac{1}{1 + 0.30535 I_{cl}}}{h_c + h_r} \right)}$$

- **Maximal Evaporation Rate** [W/m^2]

$$E_{\max} = h_e(p_{sk} - p_a), \text{ where}$$

$$h_e = 16.7 h_c F_{pcl}$$

$$F_{pcl} = \frac{1}{1 + 2.22 h_c \left(0.155 I_{cl} - \frac{1 - \frac{1}{1 + 0.30535 I_{cl}}}{h_c + h_r} \right)}$$

$$p_{sk} = 0.6105 \exp\left(\frac{17.27 t_{sk}}{t_{sk} + 237.3} \right)$$

- **Required Skin Wettedness** [-],
  Required Sweat Rate [W/m^2]

$$W_{req} = \frac{E_{req}}{E_{\max}}$$

$$SW_{req} = \frac{E_{req}}{1 - 0.5 W_{req}^{\ 2}}$$

if $E_{\max} \le 0$ then $W_{req} = 2, SW_{req} = 2E_{req}$
if $E_{req} \le 0$ then $W_{req} = 0, SW_{req} = 0$
if $W_{req} > 1$ then $SW_{req} = 2E_{req}$

- **Adjusted Dry-Bulb Temperature** [^{O}C]

$t_{adb} = A t_a + (1 - A) t_r$, where A=0.5 for v_m<0.2m/s
A=0.6 for 0.2≤v_m≤0.6m/s
A=0.7 for v_m>0.6m/s

- **Equivalent Temperature** [^{O}C]

$t_{eq} = t_o$ for v_m<0.1m/s

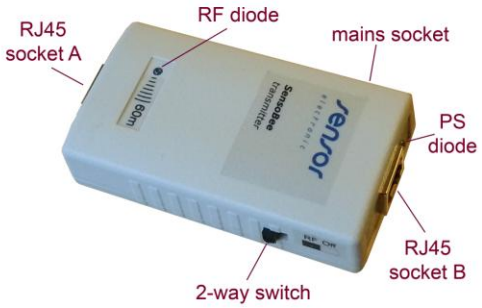
$t_{eq} = 0.55 t_a + 0.45 t_r + \left[\left(0.24 - 0.75 \sqrt{v_m} \right) / (1 + I_{cl}) \right] (36.5 - t_a)$ for v_m≥0.1m/s

- **Wind Chill Temperature** [^{O}C]

$t_{wc} = 13.12 + 0.6215 t_a - 11.37 v_{10}^{\ 0.16} + 0.3965 t_a v_{10}^{\ 0.16}$, gdzie $v_{10}[km/h] = 5.4 v_m[m/s]$

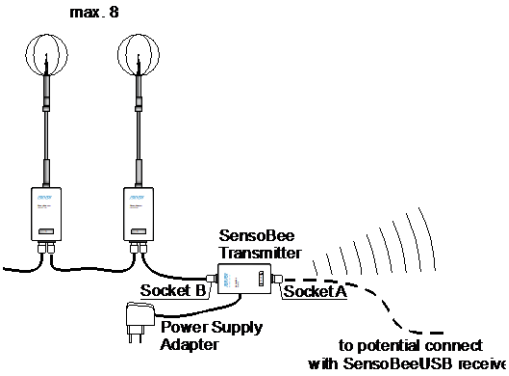
17. OPTIONAL EQUIPMENT

A. SensoBee wire-less transmitter



The SensoBee transmitter contains an RF module for wire-less data transmission. The RF module operates under ZigBee (802.15.4) protocol accepted by ETSI/EC (Europe), FCC (U.S.A) and IC (Canada). The transducers are connected to the SensoBee wire-less transmitter by RJ45 socket B. In the case of the lack or mistakes in the wire-less transmission, you can connect the transmitter with the receiver by cable. To do this, move 2-way switch from the RF to the Off position and connect socket A with SensoBeeUSB receiver by the cable. If the power supply is plugged into the mains socket, the PS diode lights up. The RF diode is blinking when the RF module is turned on, ie. 2-way switch is in RF position.

Connecting to the measuring system:



Technical Data:

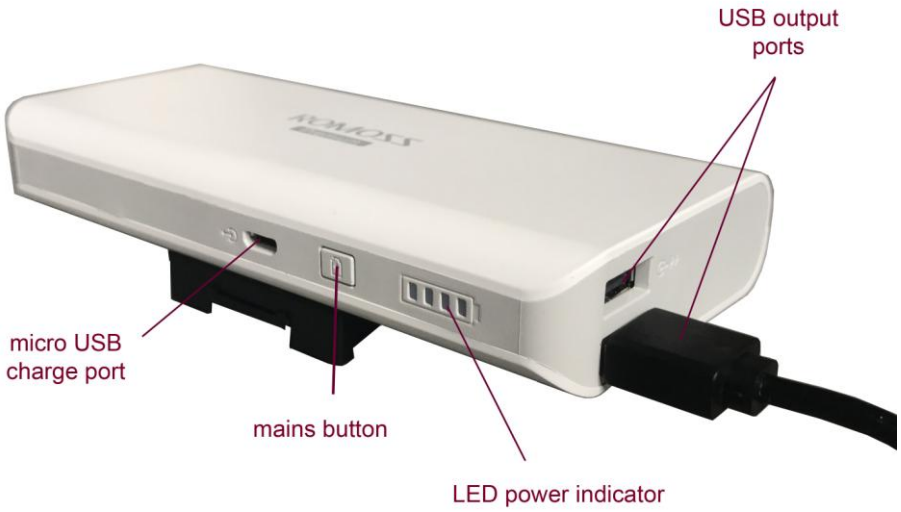
- indoor (urban) range: up to 60m
- outdoor line-of-sight range: up to 100m
- transmit power output: 100mW (20dB) EIRP
- operating frequency: 2.4GHz
- RF data rate: 250 kbps
- power supply: 5…9 VDC/1A

Notes!

1. ***In the absence of wire-less communications, verify that the 2-way switch is in the position of RF.***
2. ***Don't use the data transmission via cable at the same time when the RF module is turned on (only position Off of 2-way switch is allowed in this case). Otherwise the measuring system (software) will be suspended.***

B. PowerBank

PowerBank is a high-performance external battery pack with latch for DIN rail. The latch allows for easy installation of the device on a tripod along with other parts of the measuring system. Includes a charging cable (USB to micro USB) and spiral power cable (USB-plug DC) with a length of 30-100 cm.



Technical data:

- Power port: 2 x USB DC 5V/1A
- Real capacity*): 8500mA
- Minimum supply current: 135mA
- Charging port: micro USB 5V/2.1A max
- Charging time: 15 h
- Long time efficiency: 300 cycles of full charge and discharge will leave 85% of nominal capacity

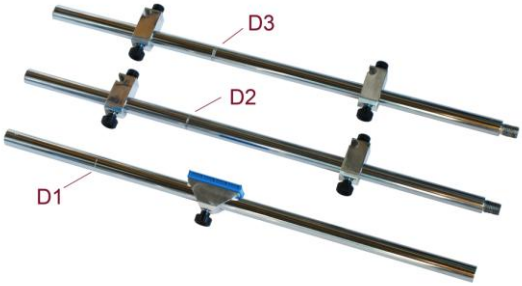
*) capacity due to reduced efficiency when converting from battery voltage 3.6 V to the output voltage 5V (theoretical capacity of batteries is 13000mAh).

Notes!

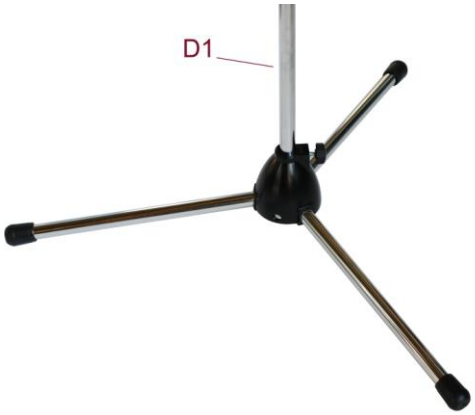
1. ***Turn off the device by disconnecting the power cable when you are finished working. Otherwise, this may lead to rapid discharge of the battery.***
2. ***Charge and discharge the device once every 3 months, if it is not used for a longer period of time.***
3. ***Due to the minimum supply current, the device may automatically turn off after a few seconds in the case of smaller receivers power supply current consumption (ie. a single SensoAnemo transducer). Proper operation is achieved when are powered at least two SensoAnemo transducers and SensoBee wire-less transmitter.***
4. ***See picture next to how to connect PowerBank with SensoBee wireless transmitter.***

C. Fold-out tripod

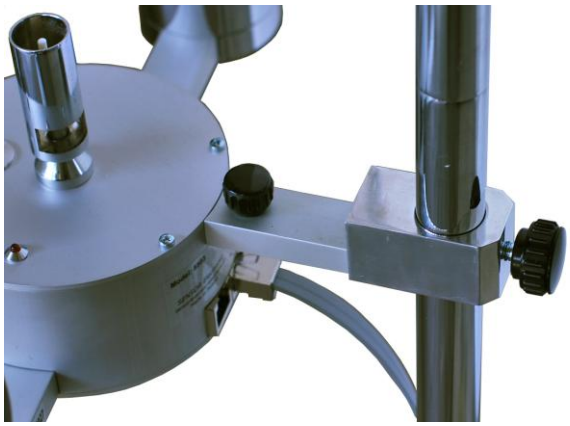
Measurement system can be equipped with a fold-out tripod adapted to mount several measuring transducers with accessories. The tripod consists of the following parts presented in the photos below.



The way of assembling of the tripod is shown in the photos below. Attention should be paid to the pipes D1 ... D3 turn in the order corresponding to the incisions, ie. D1 pipe (single) to the D2 (dual), and D2 to D3 pipe (triple). D1 pipe should be inserted to the base of the tripod and locked by the knob. Then place the grips for fastening the measuring modules and DIN grips for the accessories and lock them using the knobs.



D. Grip for the measurement modules



The grip enables to mount on the tripod the measuring module at the any height from the floor.

E. DIN rail-mounted grip

The DIN rail-mounted grip enables to mount the devices equipped with latch for DIN rail, so as: SensoBee wire-less transmitter or SensoData 5500 datalogger.

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18. GUARANTEE AND REPAIRS

Manufacturer guarantees the correct operation of the devices. The guarantee period is 24 months, beginning from the date of sale. All defects due to faulty material or manufacturing will be repaired. What is under guarantee is repair and replacement of detective parts. Damages of the devices owing to wrong transport or use will not be recovered.

ARRANGEMENT OF THE EQUIPMENT IN TRANSPORT CASE