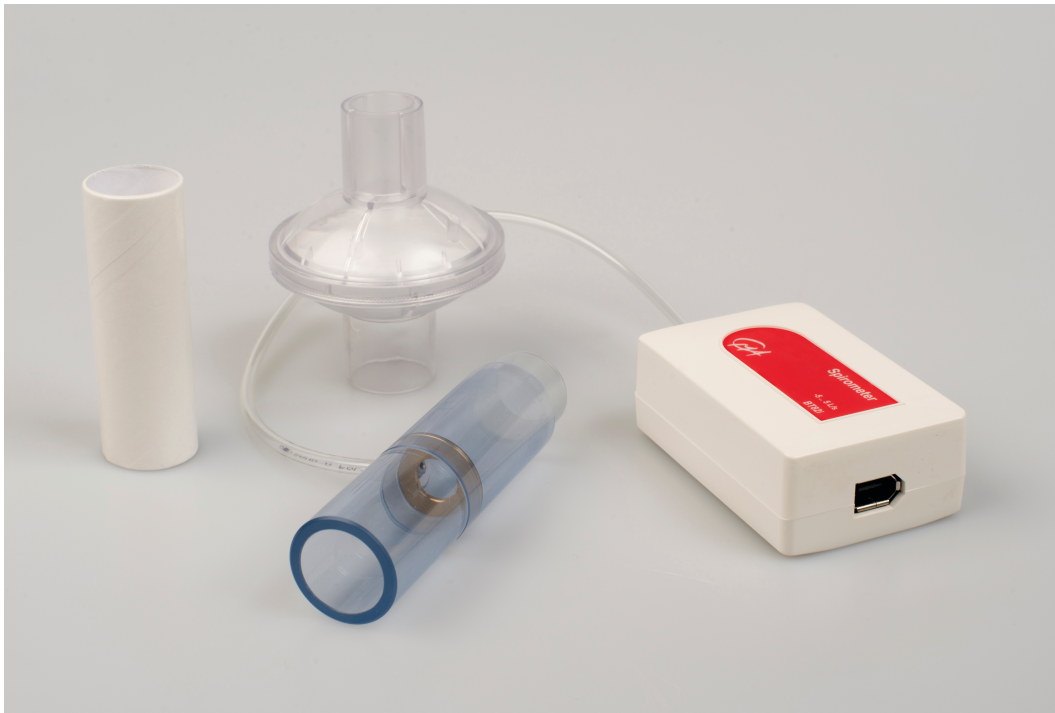

SPIROMETER BT82i

USER'S GUIDE



CENTRE FOR MICROCOMPUTER APPLICATIONS

<http://www.cma-science.nl>

Short description

The CMA Spirometer BT82i measures air flow rate during respiration in the range from -5.0 to 5.0 L/s. The sensor consists of a flow tube through which the air is inhaled and exhaled and a differential pressure sensor.

To lessen the possibility of cross contamination between subjects the Spirometer is delivered with a disposable bacterial filter and 10 disposable mouthpieces. Replacement of a bacterial filter (CMA art. nr BT82fil) and a pack of mouthpieces (CMA art. nr BT82mp) can be ordered separately from CMA.

The Spirometer can be directly connected to the analog BT inputs of the CMA interfaces. The sensor cable BT - IEEE1394 needed to connect the sensor to an interface is not supplied with the sensor and has to be purchased separately (CMA Article BTsc_1).

Sensor recognition

The Spirometer BT82i has a memory chip (EEPROM) with information about the sensor: its name, measured quantity, unit and calibration. Through a simple protocol this information is read by the CMA interfaces and the sensor is automatically recognized when it is connected to these interfaces. If your Spirometer is not automatically detected by an interface you have to manually set up your sensor by selecting it from the Coach Sensor Library.

How the Spirometer works

The Spirometer consists of a flow tube through which the air is inhaled and exhaled. The flow tube is connected with a plastic tube to the pressure sensor. Inside the flow tube a small resistive disc, narrowing the middle of the tube is placed. When air travels through the tube, a pressure difference is created on one side of the disc. A very sensitive differential pressure sensor measures this pressure difference. This pressure difference is proportional to the velocity of the air travelling through the tube and is converted to air flow rate. Note that when air flows through the tube in the opposite direction, the sensor measures a negative value.

Calibration

The CMA Spirometer BT82i is supplied calibrated. The output of the Colorimeter is linear with respect to the air flow rate. The calibration function is:

$$\text{Flow rate(L/s)} = 2.2 * V_{\text{out}}(\text{V}) - 5.28$$

N.B. Spirometers BT82i, sold before June 2016, are supplied with an incorrect EEPROM. Make sure your spirometer is calibrated with the calibration function as written above. Adjust this when necessary with the (new) calibration and store this calibration in the Coach Sensor Library.

Air expired from the lungs is measured as positive flow, inspired air as negative.

The Coach software allows selecting the calibration supplied by the sensor memory (EEPROM) or the calibration stored in the Coach Sensor Library. For better accuracy the

pre-defined calibration can be shifted. Use the *Set to zero* option to zero the values when there is no air flow in the tube.

Collecting data

To take measurements:

- Connect the plastic tube into the opening of the pressure sensor on the sensor box.
- Put a disposable mouthpiece, followed by the bacterial filter to the flow tube.
- Connect the sensor to your CMA interface. In most cases the sensor will be automatically detected. If this not happen manually select the Spirometer BT82i from the Coach Sensor Library.
- Set the sensor to zero (**Set to... Zero**).
- Let the test subject sit upright and comfortably.
- Place the mouthpiece between the test subjects' teeth with the lips creating a seal to ensure that all inspired and expired air flows through the mouthpiece.
- Use a nose clip or have the test subject hold his or her nose to ensure that all breathing is done through the mouth.
- Hold the flow tube horizontally and still and let the test subject breathe.

Converting air flow data to volume

Spirometer measures air flow rate, which is the rate of movement of air that flows in and out from the lungs. Volume shows the amount of air that has moved through the Spirometer, it therefore indicates the amount of air that has entered or left the lungs. It can be calculated by integrating the air flow rate as a function of time. This can be done in the Coach program by using the option *Analyze/Process > Integral* available via the Graph Tool menu. An easier method is *Analyze/Process > Area*, drag the red vertical lines to select the area, Liter/s*s unit is automatically given.

Volumes in and out may not be equal; speech for example requires retention of air and controlled release. Also the inhaled air normally is colder than the exhaled air, due to warming-up in the lungs. So you may find an upward or downward trend in the volume data. This is quite normal, especially for an open flow spirometer. As long as the drift is no more than 0.3 liters in 30 seconds it can be ignored.

Suggested experiments

The spirometer is especially designed for measurements of flows and volumes of air in the lungs. It can be used to perform a variety of experiments:

- Recording breathing patterns before, during and after exercise
- Measuring important lung capacities like:
 - Forced Expiratory Volume (FEV) - the volume of air exhaled after a short period of constant effort. When this test is done over a one-second interval, it is known as FEV1.
 - Forced Vital Capacity (FVC) - the volume of air exhaled by a forced maximal exhalation after a full inhalation.

- Tidal Volume (TV) - the volume of air, inhaled and exhaled at rest.

Cleaning

The flow tube can be separated into parts (two plastic tube parts and the metal ring) and cleaned using standard hospital grade disinfectant.

Practical information

- It is only allowed to use the flow tube by more, but healthy, persons. The instructor should make efforts to check the subject is healthy and has no history of cardiovascular or respiratory problems e.g. asthma.
- You can use only a disposable cardboard mouthpiece with the Spirometer for experiments in which the students will only exhale through the Spirometer.
- Use a disposable cardboard mouthpiece and a disposable bacterial filter with the Spirometer for experiments in which the students inhale and exhale through the Spirometer. In an ideal situation, every student would have his or her own bacterial filter and disposable mouthpiece.
- The nature of the Spirometer means that some persons will feel discomfort when using the device. Efforts should be made to put the test person at ease. Stop the investigation if the persons' discomfort becomes too great.
- During the use the inside of the spirometer's housing tube may become coated with condensation. The amount formed will depend upon the temperature of the room and the level of breathing.

Technical Specifications

<i>Sensor kind</i>	Analog, generates an output voltage between 0..5 V
<i>Measurement range</i>	-5 .. 5 L/s
<i>Resolution using 12 bit AD converter</i>	0.01 L/s
<i>Calibration functions</i>	Flow rate (L/s) = $2.2 * V_{out}(V) - 5.28$
<i>Connection</i>	IEEE1394 connector for BT-IEEE1394 sensor cable. Sensor cable not delivered with the sensor.

Warranty:

The Spirometer BT82i is warranted to be free from defects in materials and workmanship for a period of 12 months from the date of purchase provided that it has been used under normal laboratory conditions. This warranty does not apply if the sensor has been damaged by accident or misuse.

Note: *This product is to be used for educational purposes only. It is not appropriate for industrial, medical, research, or commercial applications.*

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