# FORCE SENSOR
# BT42i

## USER'S GUIDE


**CENTRE FOR MICROCOMPUTER APPLICATIONS**

http://www.cma-science.nl

## Short description

The Force sensor BT42i measures pushing and pulling forces in two measurement ranges, between -5 and 5 N and between -50 and 50 N. The switch allows selecting either of two ranges.

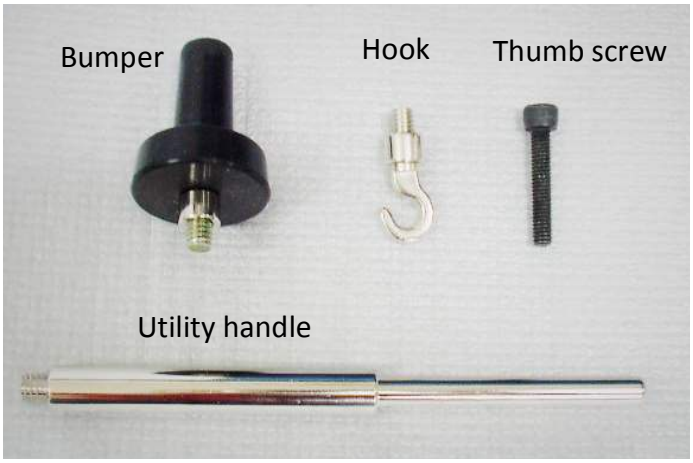
To measure force the Force sensor uses strain gauge technology. Strain gauges attached to both sides of the beam change resistance as the beam bends. The strain gauges are used in a bridge circuit such that a small change in resistance will result in a change in voltage. This voltage change is proportional to the change in force.

A maximal force of 80 N can be applied to the sensor, for forces above 80 N the sensor can be damaged permanently.

The Force sensor 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).

Several accessories are included with the Force sensor:

- A *bumper* to use for collision experiments, or any time you want to measure pushing forces,
- A *hook* to use to measure pulling forces,
- A *thumb screw* to mount the sensor on a ring standard,
- A *utility handle* to mount the sensor to various clamps.




Accessories of the Force sensor.


The Force sensor can be hold by hand or mounted on a ring stand.

## Sensor recognition

The Force sensor BT42i 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 Force sensor is not automatically detected by an interface you have to manually set up your sensor by selecting it from the Coach Sensor Library.
For correct range detection first select the desired range of the sensor and then connect the sensor to your interface.

## Calibration

The CMA Force sensor BT42i supplied calibrated. The output of the sensor is linear with respect to the measured force:

-5 .. 5 N range: $F\ (N) = -2.45 * V_{out}\ (V) + 5.98$.
- 50 .. 50 N range: $F\ (N) = -24.4 * V_{out}\ (V) + 61.0$

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.

## Practical information

- In the range -5 .. 5 N the sensor is so sensitive that the weight of the connection element of the sensor influences the calibration in the vertical direction (even more effect when the hook or bumper is mounted). Calibrate the sensor in this range in the horizontal position to avoid this effect.
- Because the sensor generates an output voltage of 2.5 V for a force of 0 N it can happen that the sensor does not indicate exactly 0. This applies especially for the -5 .. 5 N range, at which the sensor signal is internally amplified.
- Use the 'Shift calibration' option or the 'Set to zero' option in Coach to adjust the zero point of the sensor. These options are also useful to adjust the zero level when something is attached to the sensor, for example in experiments to study oscillations of a spring attached to the sensor (the sensor oscillates around the value of 0 N).

## Suggested experiments

The Force sensor can be used as a replacement for a hand-held spring scale, can be mounted on a ring stand or on a dynamics cart to study collisions.
It can also be used to:

- study simple harmonic motion,
- measure of centripetal or frictional forces, or
- study Hook's law.

## Technical Specifications

| | | |
|---|---|---|
| *Sensor kind* | Analog, generates an output voltage between 0 – 5 V | |
| *Switch position* | -5 .. 5 N | -50 .. 50 N |
| *Force range* | 10 N | 100 N |
| *Calibration function* | F (N) = –2.45 * $V_{out}$ (V) + 5.98 | F (N) = –24.4 * $V_{out}$ (V) + 61.0 |
| | Offset can differ slightly for different samples of this sensor. | |
| *Resolution using 12 bit A/D converter* | 0.003 N (theoretical) | 0.03 N (theoretical) |
| *Accuracy* | ±0.01 N (due to noise) | ±0.05 N (due to noise) |
| *Maximum force* | 80 N (for forces above this value the sensor can be damaged permanently) | |
| *Current consumption* | 45 mA | |
| *Connection* | IEEE1394 connector for BT-IEEE1394 sensor cable.<br>Sensor cable not delivered with the sensor. | |

## Warranty:

The Force sensor BT42i 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.*

Rev. 26/01/2015