FORCE/ACCELERATION SENSOR W22
USER GUIDE

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Short description

CMA Wireless Force/Acceleration sensor W22 measures forces in the range between -80 and 80 N and accelerations in three directions in the range between -16 and 16 g.

The power button located on the top of the sensor allows you to turn the sensor on and off. The sensor is equipped with an OLED color display which shows some sensor information and the measured by the sensor values. This makes the sensor suitable to use as an independent measuring instrument.

The sensor can be used wirelessly via Bluetooth or wired via USB with the Coach 7 or Coach 7 Lite programs/apps on computers (Windows and Mac), Chromebooks and mobile devices (Android and iOS).

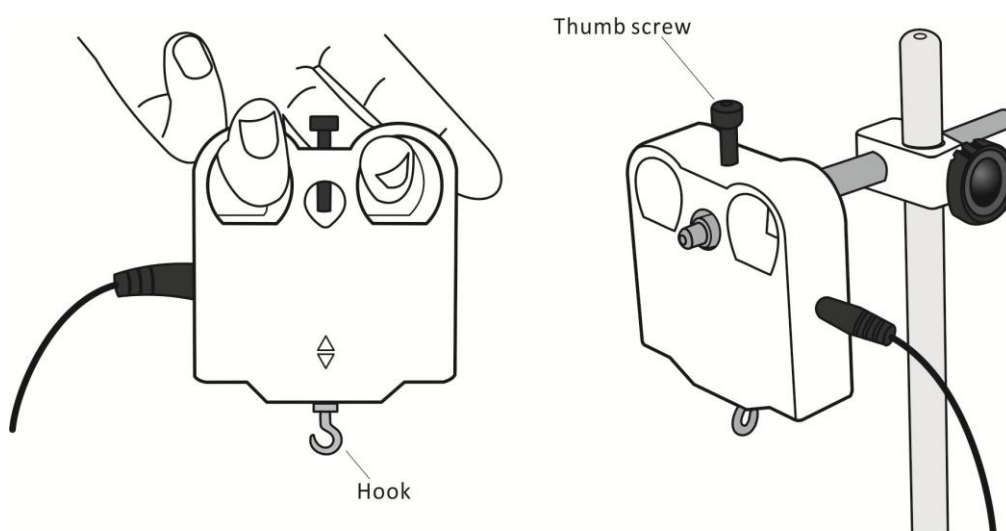Several accessories are included with the Force/Acceleration sensor:
- a *thumb screw* to mount the sensor on a ring standard or on a dynamic cart,
- a *utility handle* to mount the sensor to various clamps,
- a *hook* to use to measure pulling forces,
- a *bumper* to use for collision experiments, or to measure pushing forces.

Force

The Force sensor uses strain gauge technology to measure force, based on the bending of a beam. A maximal force of 100 N can be applied to the sensor, for forces above this value the sensor can be damaged permanently.
The sensor measures both pulls and pushes. Use the hook attachment for pulling and the bumper attachment for pushing.
The Force/Acceleration sensor can be held by hand or mounted with the help of the provided thumb. The sensor can be used as a replacement for a hand-held spring scale or to study motions and collisions.

To zero the measurement of the force sensor double press the power button. Do it again to return to the normal measured value.

3-Axis Acceleration

The 3-Axis Acceleration sensor measures acceleration along 3 axes x, y, and z. The directions of the axes are indicated on the sensor's top label. The sensor gives values on a g scale, whereby one g is the acceleration due to gravity at the Earth's surface, 9.81 m/s^2.
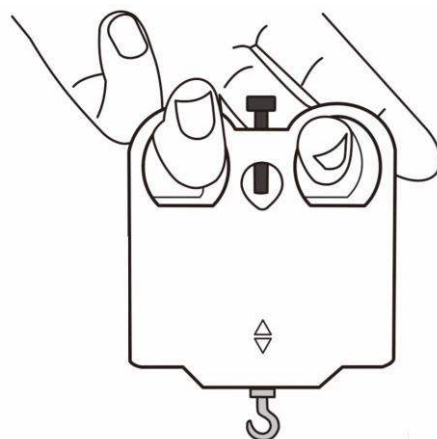
Holding the sensor in the position shown in the picture should give the following values of the measured component accelerations:

x-component = 0 g
y-component = -1 g
z-component = 0 g

The net acceleration is calculated as the square root of the sum of the squares of the component accelerations.

Since the 3-Axis Accelerometer is equivalent to three accelerometers, you can use just one channel of it to study acceleration along a single axis. Mount the accelerometer so that a particular axis is in the direction of interest and monitor just that channel.

Calibration

The Force/Acceleration sensor W22 converts measured force and acceleration values to digital values. It uses 14-bit analogue-to-digital conversion resulting in a force resolution of 0.012 N and acceleration resolution of 0.0004 g.

The sensor is supplied with a factory calibration of force in Newtons N and acceleration in g values.

When working with the Coach program the pre-defined calibration can be shifted by using the **Set to Value** option. This can be done independently for each sensor.

Software

You can use the Force/Acceleration sensor W22 with Coach 7 or Coach 7 Lite (free) program on computers (Windows and Mac) or Coach 7 and Coach 7 Lite (free) app on mobile devices (Android and iOS). For Chromebooks, we offer a special Android app. The support for wireless sensors is added starting from Coach version 7.10.

https://cma-science.nl/downloads_en

Check the CMA website for the latest installations.

Collecting data without software connection

- Turn the Force/Acceleration sensor on by pressing its power button.
- The sensor briefly displays its Bluetooth identification code. This ID code is also printed on the sticker located on the bottom side of the sensor box.
- Then the display shows:
  - the Bluetooth mode, 'Mobile' or 'PC'.
    Mobile indicates Bluetooth Low Energy mode which should be used when working with mobile devices (Android, iOS), Chromebook and Apple computers.
    PC indicates Bluetooth Classic which should be used for Windows computers.
  - the battery level, and
  - the measured value(s).
- Now you can use the sensor as an independent measuring instrument.
- To turn off the sensor press and hold its power button for 3 sec. To save its battery the sensor automatically turns off after a few minutes of inactivity (no connection to power, no communication).

Collecting data via the Bluetooth connection

Mobile devices, Chromebooks, and Apple computers
For mobile devices (Android, iOS), Chromebooks and Apple computers Bluetooth Low Energy technology is used for wireless communication. For these devices **do not pair** the sensor just use it directly in the Coach software.

- Turn the Force/Acceleration sensor on.
- Ensure your sensor is set to Mobile mode.
  If the display shows in the top-left corner 'PC' first you must set the sensor to the Mobile mode. Turn off the sensor. Then press and hold the power button until the text 'Bluetooth mode Change Mobile' is shown, then release the button. The mode is set to 'Mobile', meaning Bluetooth Low Energy is used.
- Start the Coach 7 or Coach 7 Lite program/app.
- Select the Dashboard Activity 'Measurement with Wireless sensors'.
- On opening of the Activity Coach starts searching for sensors which are turned on and in the Mobile discovery mode. The found Bluetooth sensors appear in the list.
- Select the Force/Acceleration sensor you want to connect to. If needed check the sensor's Bluetooth ID which is located on the sensor's bottom label.
- When the connection is established the Bluetooth symbol appears in the top-left corner of the sensor's display and the icons of the sensors (force, ax, ay and az) appear showing the measured force and acceleration values.
- Now you are ready to use the Force/Acceleration sensor for your measurement.

Windows computers

For Windows computers, Bluetooth Classic technology is used for wireless communication. Before you start to use the sensor for measurement in Coach you **have to pair** it.

- Turn the Force/Acceleration sensor on.
- Ensure your sensor is set to PC mode.
  If the display shows in the top-left corner 'Mobile' first you must set the sensor to the PC mode. Turn off the sensor. Then press and hold the power button until the text 'Bluetooth mode Change PC' is shown, then release the button. The mode is set to 'PC', meaning Bluetooth Classic is used.
- Pair your sensor.
  - Go to the Windows Settings **Bluetooth and other devices** and select **Add Bluetooth or other devices**. Select **Bluetooth device**.
  - Windows looks for Bluetooth devices and after a while lists discovered devices. The wireless sensors are listed with their Bluetooth IDs.
  - Select the sensor you want to connect to. If needed check the sensor's Bluetooth ID which is located on the bottom label of your sensors.
  - When the connection is successfully established Windows indicates that the sensor is paired and ready to go.
  - Click **Done** to accept it. The sensor appears in the list of paired Bluetooth devices.
- Start the Coach 7 or Coach 7 Lite program.
- Select the Dashboard Activity 'Measurement with Wireless sensors'.
- Coach starts searching and displays the list with detected sensors, even if they are not paired.
- Select the Force/Acceleration sensor you want to connect to. If needed check the sensor's Bluetooth ID which is located on the sensor's bottom label. If the sensor was not paired yet Coach will force you to pair the sensor first via Windows Settings.
- When the connection is established the Bluetooth symbol appears in the top-left corner of the sensor's display and icons of the sensors (force, ax, ay and az) appear showing the measured force and acceleration values.
- Now you are ready to use the Force/Acceleration sensor for your measurement.

Collecting data via the USB connection

For computers (Windows and Mac) the Force/Acceleration sensor can also be used as USB sensor. When using this connection, the sensor can measure with a higher sampling frequency of up to 1000 Hz.

- Turn the Force/Acceleration sensor on
- Use the provided USB cable to connect the sensor to a USB port.
- Start the Coach 7 or Coach 7 Lite program.
- Select the Dashboard Activity 'Measurement with Wireless sensors'.

- The connected USB sensor should be detected automatically, and its icons (force, ax, ay and az) appear on the first empty sensor position in the Wireless sensors panel.
- When the connection is established the USB symbol appears in the top-left corner of the sensor's display and icons show measured data.
- Now you are ready to use the Force/Acceleration for your measurement.

Charging a battery

An internal rechargeable battery (Li-Poly 3.7 V, 700 mAh) powers the sensor. The battery symbol located in the top-right corner of the sensor's display shows the battery level. When the battery level becomes critical, the battery gauge shows an empty battery. Use the provided cable to connect the sensor to a USB port for charging. A fully discharged battery requires up to 2 hours of charge time to become fully charged again. To prolong battery life, automatic power down turns the sensor off after 5 minutes of inactivity.

To replace the battery, use **only** the approved rechargeable batteries provided by CMA.
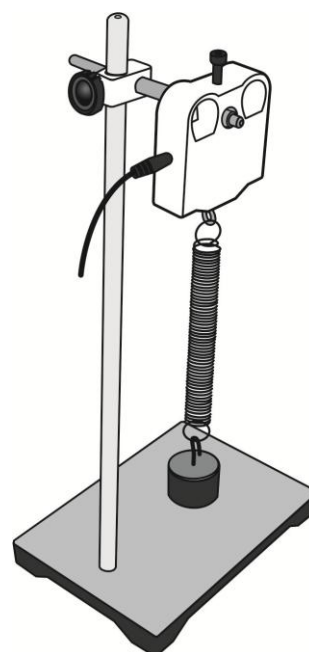
Suggested experiments

The Force sensor can be used for:
- measuring of forces and impulses during collisions,
- studying simple harmonic motion,
- measuring of centripetal or frictional forces,
- studying Hook's law,
- studying Newton's second law.

The 3-Axis Acceleration sensor can be used to study, e.g.:
- dynamic cart motions and collisions,
- pendulum motion,
- tilting of an object,
- acceleration of elevators, remote-controlled cars, bicycles, or automobiles.

Technical Specifications

Sensor kind	Digital, on-sensor digital conversion, 14-bit resolution
Measuring ranges	Force: - 80 .. 80 N Acceleration: -16 .. 16 g in three directions x, y and z.
Resolution	Force: 0.012 N / Acceleration: 0.0004 g
Accuracy	Typical ± 0.5% of full scale at 25°C
Maximum force	100 N (For forces above this value the sensor can be damaged permanently.)
Maximal sampling rate	Bluetooth: 100 Hz USB: 1000 Hz
Display	OLED 0.96" (128*64 px)
Battery	Li-Poly Rechargeable Battery (3,7 V 700 mAh)
Battery life after full charge	Approximately 12 hours Battery life varies by use, configuration, temperature, and many other factors; actual results will vary.
Connection	Bluetooth 5, Low Energy (Mac, Android, iOS) Bluetooth 2.1, Classic (Windows) USB 2.0 (type C)
Bluetooth ID	W22FORC-xxx
Sensor dimensions	Housing: 89 x 21 x 74 mm Thumb screw: 39 mm; Hook: 28 mm

Warranty

The Conductivity sensor W04 is warranted to be free from defects in materials and workmanship for a period of 3 years 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.

The sensor battery is consumable and is warranted to be free from defects in materials and workmanship for a period of 12 months from the date of purchase.

Discard batteries according to local regulations.

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

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