

COLORIMETER & TURBIDITY SENSOR W06

USER GUIDE



cma-science.nl

Short description

CMA Wireless Colorimeter/Turbidity sensor W06 combines two sensors:

- Colorimeter, which measures the amount of light transmitted through a sample solution (transmittance) and it can be used to determine the concentration of a solution. It uses six different light wavelengths: 425, 470, 515, 555, 640, and 745 nm.
- Turbidity sensor, which measures the level of turbidity in the water in the range between 0 and 200 NTU.

The sensor is delivered with 10 disposable smooth cuvettes with caps and one small bottle containing 100 NTU StablCal Formazin Standard, which is used to calibrate the sensor.

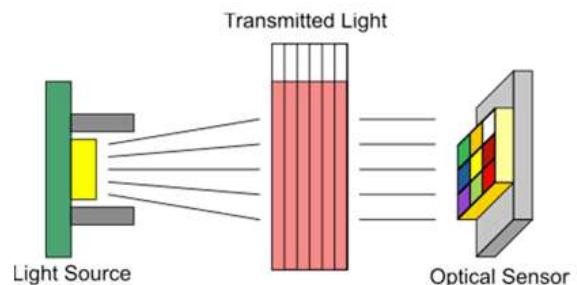
The power button located on the top of the sensor allows you to turn the sensor on and off. The sensor is equipped with an OLED color display which shows sensor information and the measured values. This makes the sensor suitable to use as an independent measuring instrument. The power button allows to select the sensor and its range. For accurate sensor detection in the Coach software, **first** select the desired range before connecting it.

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).

Colorimeter

Light from the white LED passes through a cuvette containing a sample solution. An optical sensor at the other end of the cuvette detects the amount of transmitted light. This sensor can detect six wavelengths of light.

In general, the proportion of the light that passes through the solution is known as **Transmittance T** and is expressed as the ratio of the intensity of the transmitted light I_t to the initial intensity of the light beam I_0 :



$$T = \frac{I_t}{I_0}$$

The reciprocal of transmittance of the sample varies logarithmically with three factors: the molar absorptivity of the solution ε , the cell or cuvette width b , and the molar concentration c :

$$\log\left(\frac{1}{T}\right) = \varepsilon * b * c$$

Many experiments designed to use a Colorimeter require a measurement of

Absorbance A, which is defined as:

$$A = \frac{1}{T} \text{ or } A = \varepsilon * b * c$$

For a given solution contained in a cuvette with a constant cell width, one can assume ε and b to be constant. This leads to the equation:

$$A = k * c, \text{ where } k \text{ is a proportionality constant.}$$

This equation shows absorbance to be related directly to concentration (Beer's law) and so absorbance can be used to measure the concentration of a solution.

Transmittance can be also expressed as **Percent Transmittance** or $\%T$. Since $T = \%T/100$, the formula describing the relationship between absorbance and transmittance can be rewritten as:

$$A = \log\left(\frac{1}{\%T}\right) \text{ or } A = 2 - \log(\%T)$$

The linear relationship between Absorbance and Concentration does not hold across the whole Transmittance range. For best results our testing of the Colorimeter indicates that transmittance or absorbance values should be within these ranges:

- Transmittance: 10% - 90%
- Absorbance: 0.05 – 1.0.

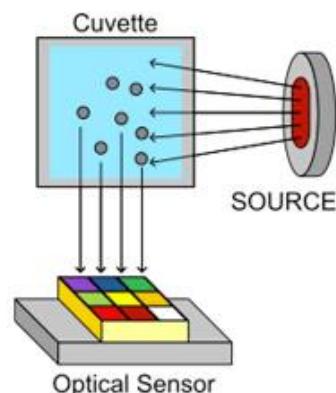
Experiments using the absorbance range should be designed to fit within these values. If you have a solution that transmits very low level of light, consider diluting the solution so that it falls within this range.

Turbidity sensor

Turbidity is a measure of water clarity; how much the material suspended in water causes light passing through the water to be scattered. The higher the intensity of scattered light, the higher the turbidity.

Suspended materials in the water are for example soil particles (clay, silt, and sand), micro-organisms (phytoplankton, zooplankton) and other substances. These materials are typically in the size range of 0.004 mm (clay) to 1.0 mm (sand). Turbidity is measured in Nephelometric Turbidity Units (NTU).

The turbidity sensor measures light scattered at a 90-degree angle from the sample. An infrared light beam is directed at a cuvette containing the sample water. An optical detector, consisting of a photodiode, is positioned to the side of the light beam. More light reaches the detector if there are many small particles scattering the source beam than if there are few particles.



Conducting measurements with the sensor

By default, the sensor is set to Colorimeter mode when turned on. Each time you briefly press the power button, the colorimeter wavelength changes sequentially. Turbidity value appears after the wavelength of 745 nm.

The Colorimeter/Turbidity sensor is designed to use standard smooth cuvettes, and a set of such cuvettes is provided with the sensor.

Since individual plastic cuvettes can vary slightly in light absorption, it is recommended to either use the same cuvette for all trials of a particular experiment or use a *matched* set of cuvettes. Matched cuvettes are those that absorb light at approximately the same level when empty. The included black arrow stickers can be used to mark the side of the cuvette that has been used.

When preparing solutions for analysis:

- Handle the cuvettes with care especially to avoid getting fingerprints on the sides through which the light beam passes.
- Fill the cuvettes 3/4 full with the test solution and cap them.
- If needed, clean the sides of the cuvette using a lint-free wipe before inserting it into the chamber.

When measuring turbidity, the value may initially fluctuate after adding the turbidity solution. The correct turbidity value is obtained when the reading stabilizes and shows minimal change, typically within about 30 seconds to 1 minute.

Calibration

The sensor is supplied calibrated with a factory calibration in %T (In the software this can be adjusted in absorbance) for the colorimeter and in NTU for the turbidity sensor.

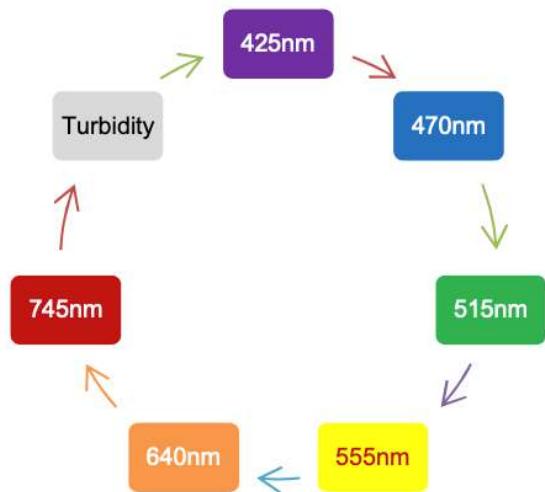
For more accurate measurements, a user 2-point calibration can be performed and stored in the sensor's memory.

Before starting the calibration prepare:

- a blank calibration cuvette filled with distilled water, and
- a calibration cuvette filled with Turbidity Standard (100 NTU) provided with your sensor.

Close both cuvettes with caps. Handle the cuvettes by the cap and avoid touching it with your fingers. If needed, clean the cuvette carefully using a lint-free wipe before inserting it into the test chamber.

CAUTION: Turbidity standard solution (100 NTU) may be irritating to eyes or skin. It



may also cause allergic skin reactions. If it gets into your eyes, rinse them under running water for about 15 minutes and then consult a doctor. If swallowed, consult a doctor immediately. The solution is reusable. Close the solution well after use and store the bottle upright.

Calibrate the sensor before connecting it to Coach!

Set the W06 to either PC or Mobile mode, depending on the device you will be using. The manual explains how to do this (pages 6-7).

Please note that this device consists of two sensors, and both need to be calibrated separately. Steps 1 to 3 describe the calibration of the colorimeter, while steps 4 and 5 cover the calibration of the turbidity sensor.

1. Turn on the sensor. Press the power button twice to enter the user calibration mode. A countdown timer will start.
2. When the display shows Colorimeter and 0 T, close the empty chamber with the cover and press the power button. A countdown timer will start.
3. When the display shows Colorimeter and 100 T, open the chamber, insert the blank calibration cuvette containing the distilled water into the chamber and close the lid. Press the button. A countdown timer will start.
4. When the display shows Turbidity and 0 NTU, keep the chamber closed, you are going to use the same cuvette containing distilled water. Press the button. A countdown timer will start.
5. When the display shows Turbidity and 100 NTU, open the chamber and replace the blank calibration cuvette with the calibration cuvette with the 100 NTU standard solution. Close the chamber and press the button.

Mobile 007 
Colorimeter
0 T : 1

Mobile 007 
Colorimeter
100 T : 25555

Mobile 007 
Turbidity
0 NTU : 55555

Mobile 007 
Turbidity
100 NTU : 55555

Mobile 007 
100.0 
Color %T
425nm

Your calibration is now completed and the symbol 'U0' is displayed above the unit on the sensor display.

To restore the Factory calibration double-press the power button, the symbol 'U0' disappears.

Which wavelength should you use for your colorimeter measurement?

There are several ways one can decide which of the six light wavelengths to use.

Method 1

An easy method is to place a cuvette containing the solution in question in the Colorimeter and check to see which of the wavelengths yields the highest absorbance.

Method 2

Directions for most colorimetry experiments express a recommended wavelength. Use the wavelength closest in value to the recommended wavelength. Even if the LED wavelength is somewhat different, a Beer's law curve can usually be obtained at almost any wavelength in the vicinity of the recommended wavelength.

Software

You can use the Colorimeter/Turbidity sensor W06 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 this wireless sensor is added starting from Coach version 7.11.



https://cma-science.nl/downloads_en

Check the CMA website for the latest installations.

Collecting data without software connection

- Turn the Colorimeter/Turbidity 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 current measured value.
- Now you can use the sensor as an independent measuring instrument.

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 sensor on by pressing its power button.
- 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' which means that 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 Colorimeter/Turbidity 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 icon of the sensor appears showing the measured values.
- Now you are ready to use the Colorimeter/Turbidity 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 Colorimeter/Turbidity 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' which means that 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 Colorimeter/Turbidity 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 the icon of the sensor appears showing the

measured values.

- Now you are ready to use the Colorimeter/Turbidity sensor for your measurement.

Collecting data via the USB connection

For computers (Windows and Mac) the Colorimeter/Turbidity sensor can also be used as USB sensor.

- Turn the Colorimeter/Turbidity 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 a Measurement Activity. If it is made for another interface choose **Use with Wireless sensors** during opening of the activity or right click the interface panel and choose **Change interface** in the activity.
- The connected USB sensor should be detected automatically, and its icon appears 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 the icon shows measured data.
- Now you are ready to use the Colorimeter/Turbidity sensor for your measurement.

Practical information

- Do not let liquids enter the sensor chamber.
- Do not use organic compounds from the aromatic, halogenated, aliphatic, ketone, aldehyde or ester groups in the polystyrene cuvettes.
- Avoid collecting data around bright lights. Make sure that the lid is closed securely.
- Avoid or dilute dark-colored samples.
- Always fill the cuvette to the lid.
- Before making a turbidity reading, use a sieve or pipette to remove “floaters” or large, visible particles of sediment from the sample.

Storage and maintenance

- Handle and store cuvettes in a manner to prevent dirt, scratches, or other damage. Keep them clean, inside and out. After each use, wash with non-phosphate laboratory detergent, rinse repeatedly with deionized water until all detergent residue is removed, and allow cells to air dry in a dust-free environment.
- The square chamber in which the cuvette is located protects the very precise optical sensor, so be careful not to contaminate the measurement sample. If it becomes contaminated, lift it vertically to prevent contaminants from entering the sensor. Separate it, wash it with distilled water, and rinse it thoroughly. Dry it completely before reinstalling.
- Store the 100 NTU Turbidity standard solution cuvette in a shaded place between 5 and 25°C degrees. If possible, use the product upright with the lid closed, and be careful not to touch the skin, eyes, or body when opening.
- If the 100NTU standard has been stored for more than a month, do the following

before using it for calibration:

- Prior to use, gently invert the vial containing the 100 NTU standard solution several times to evenly redistribute the particles settled at the bottom. Avoid creating air bubbles.
- Fill the cuvette 3/4 full with the calibration solution.
- Thoroughly clean the outside of the cuvette.
- If handled cleanly, the solution can be reused. Ensure the storage bottle is tightly sealed.

CAUTION: Turbidity standard solution (100 NTU) may be irritating to eyes or skin. It may also cause allergic skin reactions. If it gets into your eyes, rinse them under running water for about 15 minutes and then consult a doctor. If swallowed, consult a doctor immediately.

100 NTU StablCal Formazin Turbidity Standard (or other Stabilized Formazin Turbidity Standards) have a lifetime of 2 years and can be ordered from a local distributor of Hach company (<https://www.hach.com>).

- Product Name: **StableCal®** Standard, 100NTU
- Catalog Nr: 2660249

NOTE: The 100 NTU standard sample should provide accurate results ($\pm 7\%$) up to the expiration date.

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 Colorimeter can be used in experiments such as:

- Application of Beer's law e.g. Crystal violet or Copper Sulphate.
- Measuring of unknown concentrations.
- Reaction kinetics – measuring reaction rate, reaction order or reaction equilibrium.
- Quantitative determination of biological molecules e.g. sugars, protein, vitamins.
- Quantitative determination of inorganic ions e.g. nitrate, phosphate.
- Population growth of microorganisms.

The Turbidity sensor can be used in experiments such as:

- The measurement of turbidity is a key test of water quality. Compare the turbidity of water samples from various locations.
- Determine the rate of settling of a sample.
- Measure the formation of a precipitate.

Technical Specifications

<i>Sensor kind</i>	Digital (on-sensor digital conversion)
<i>Colorimeter wavelengths</i>	425, 470, 515, 555, 640, 745 nm
<i>Measurement range</i> <i>Colorimeter</i>	Percent Transmittance: 90% .. 10% Absorbance: 0.05 .. 1.0
<i>Turbidity sensor</i>	0 .. 200 NTU
<i>Resolution</i>	
<i>Colorimeter</i>	0.1 %T
<i>Turbidity sensor</i>	0.2 0.1 NTU
<i>Operating Environment</i>	0 to 60°C, Max. 85%RH
<i>Maximal sampling rate</i>	2 Hz
<i>Battery life after full charge</i>	Approximately 4 hours Battery life varies by use, configuration, temperature, and many other factors; actual results will vary.
<i>Connection</i>	Bluetooth 5, Low Energy (Mac, Android, iOS) Bluetooth 2.1, Classic (Windows) USB 2.0 (type C)
<i>Bluetooth ID</i>	W06COLO-xxx

Warranty

The Colorimeter/Turbidity sensor W06 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.