CONDUCTIVITY SENSOR ML57M

USER'S GUIDE

CENTRE FOR MICROCOMPUTER APPLICATIONS

http://www.cma-science.nl

Short description

The Conductivity sensor ML57m measures conductivity of a solution in the range between 0 to 20,000 µS/cm.

The Conductivity sensor consists of a conductivity electrode and an amplifier. The Conductivity electrode is a simple ABS-bodied 2-cell graphite type.

The Conductivity sensor is an I2C digital sensor, which gives calibrated values of the measured quantity. This sensor can only be connected to special interfaces that support I2C digital sensors like the CMA MoLab interface. The sensor cable needed to connect the sensor to MoLab is not supplied with the sensor, it is supplied with MoLab.

Sensor specifications

The Conductivity sensor ML57m is a digital sensor that converts the measured conductivity value to a digital value via 16-bit analog-to-digital conversion. The maximal sampling rate of the sensor is 15 Hz.

How the sensor works

The Conductivity sensor measures the ability to conduct electricity in water solutions. When salts and other inorganic chemicals dissolve in water, they break apart into electrically charged ions. Ions increase the water's ability to conduct electricity. Common ions in water that conduct electrical current include sodium, chloride, calcium, and magnesium. Organic compounds, such as sugars, oils, and alcohols, do not form ions.

The principle by which the sensor measures conductivity is simple - two graphite plates (cells) are placed in the sample, a potential is applied across the plates and the current is measured. The Conductivity probe actually measures the conductance of the solution (the inverse of the resistivity R), which is determined from the voltage and current values according to Ohm's law (G = 1/R = I/V)

The specific cell constant (K) of the conductivity electrode is used to determine the conductivity (C). The conductivity is the cell conductance multiplied by the cell constant, C=G*K. The electrode separation distance divided by the electrode area determines the cell constant. The supplied electrode has a nominal cell constant K of 1.0 cm^{-1}.

The SI unit of conductance is Siemens (S). Since S is a very large unit, conductance of aqueous samples is commonly measured in µS, and conductivity in µS/cm.

In order to prevent complete ion migration to the two electrodes, the sensor uses alternating current. With each cycle of alternative current the polarity of the electrodes are reversed which in turn reverses the direction of ion flow. This will prevent electrolysis and polarization.

Calibration

The Conductivity sensor is supplied with a factory calibration in μS/cm. The Coach 6 program allows shifting the pre-defined calibration or creating a new 3-point calibration if needed. The user calibration is stored in non-volatile user sensor memory.

For more accurate measurements sensor can be calibrated. To be sure that the electrodes are clean soak the tip of the conductivity electrode in distilled water for about 10 minutes. If this is not possible, rinse the tip thoroughly with distilled water before use. Wipe the outer part of the electrode body with a clean paper towel. Shake vigorously to remove any droplets from the cell chamber.

- **Zero calibration point**
  Simple perform this calibration point with the electrode out of any solution (e.g. in air). Call this value 0 μS/cm.
- **Standard solution calibration point**
  Place the sensor into a standard solution (solution of known concentration), for example Sodium Chloride Calibration Standard which is equivalent to 1000 μS/cm. Be sure the entire elongated hole with electrode surfaces is submerged in the solution. Wait for the displayed voltage to stabilize. Enter the value of the standard solution e.g. 1000 μS/cm.

For even better results, a three-point calibration can be performed using three standard solutions that bracket the expected range of conductivity values.

Having accurate standard solutions is essential for performing good calibrations. You can prepare your own standard solutions as shown in the table below.

Amount of NaCl to make 1 liter of solution	Equivalent Conductivity values
0.0474 g (47.4 mg/l)	100 μS/cm
0.491 g (491 mg/l)	1000 μS/cm
1.005 g (1005 mg/l)	2000 μS/cm
5.566 g (5566 mg/l)	10000 μS/cm

Collecting data

This Conductivity sensor works only with specific interfaces. The sensor will be automatically detected when connected to such an interface. For detailed information about measurements with sensors consult the User Manuals of the interface and the Coach 6 software.

To take measurements:

- Soak the tip of the Conductivity electrode in distilled water for about 10 minutes. If this is not possible, rinse the tip thoroughly with distilled water.

- Wipe the outer part of the electrode body with a clean paper towel. Shake vigorously to remove any droplets from the cell chamber.
- Place the Conductivity electrode in the sample to be tested. The sample must be at least 3 cm deep to ensure the cell chamber is fully submerged.
- Stir the solution gently to get rid of any air bubbles that could be trapped in the cell chamber. Wait for 10 seconds to allow the readings to stabilize.
- If you are taking readings in a solution that has a temperature below 10^{o}C or above 35^{o}C, allow more time for the readings to stabilize.
- Clean thoroughly when the measurement is complete to avoid any contamination for the electrode's next use.

Warning: Do not place the electrode in viscous, organic liquids, such as heavy oils, glycerin (glycerol) or ethylene glycol. Do not place the probe in acetone or non-polar solvents, such as pentane or hexane.

Automatic temperature compensation

Temperature has a large effect on conductivity. The Conductivity electrode has a built-in temperature sensor that is used to compensate for changes in the conductivity of solutions with a temperature between 5 and 35°C. Readings are automatically referenced to a conductivity value at 25°C – therefore the sensor will give the same conductivity in a solution that is at 15°C as it would if the same solution were warmed to 25°C. This means that one calibration can be used for measurements in water samples of different temperatures. Without temperature compensation the conductivity readings change with temperature, even though the actual ion concentration did not.

Practical information

- The Conductivity electrode needs to be kept clean and free of deposits and other types of build-up. When finishing using the sensor, simply rinse it off with distilled water and blot it dry using a paper towel.
- Avoid scratching the inside electrode surfaces of the probe. The probe can be stored dry.
- If the probe cell surface is contaminated (also if used in solutions with a high ion concentration), soak the electrode cell portion in water with a mild detergent for 15 minutes. Then soak it in a diluted acid solution such as 0.1 M hydrochloric acid or 0.5 M acetic acid for another 15 minutes. Then rinse thoroughly with distilled water.
- The most common reason for inaccurate measurements is cross contamination of samples. Take care not to transfer droplets of one sample to another. Clean the

electrode with distilled water between different samples and shake vigorously to remove droplets. Ideally air-dry and then place the cell in a sample of the solution to be measured.

- Be sure that samples are capped to prevent evaporation. It is best to fill sample bottles to the brim to prevent a gas such as carbon dioxide dissolving in the water sample.
- Do not use the sensor in a situation that could result in damage to the graphite plates in the cell chamber. Do not attempt to blot or wipe the inside of the cell.
- The automatic temperature compensation for this electrode operates over the range 10^{o}C to 35^{o}C, but it can be placed in solutions within a temperature range of 0 to 80^{o}C.
- The conductivity electrode not only measures conductivity between the graphite plates but also, to a lesser extent, in a field to the sides the electrode. In a narrow vessel, the walls may interfere with this field. If the electrode is held too close to the top of the liquid level or other objects (e.g. the bottom of a beaker) an incorrect reading may result.
- There is no exact relationship between Conductivity in µS/cm and total solids TDS in ppm (parts per million). It has been discovered experimentally that for particular types of water there is an approximate relationship. In water with a higher proportion of sodium chloride, to get to ppm just multiply the µS/cm reading by 0.5. For most other water solutions use a factor of 0.67 instead.

Using the Conductivity Sensor with other sensors

It is very important to know that the Conductivity Sensor will interact with some other sensors, if they are placed in the same solution and they are connected to the same interface (e.g., the same MoLab). This situation arises because the conductivity sensor outputs a signal in the solution, and this signal can affect the reading of another sensor. The following sensors cannot be connected to the same interface and placed in the same solutions:

- dissolved oxygen sensor,
- pH sensor,
- salinity sensor, and

More sensors can be connected at the same time to the interface but only one at a time can be placed inside the solution to take readings.

Suggested experiments

Conductivity is one of the easiest environmental tests for aquatic samples. Even though it does not tell you specific ions that are present, it does quickly determine the total concentration of ions in a sample. It can be used to perform a wide variety of experiments to determine the changes in or levels of total dissolved ions or salinity:

- Confirmation of the direct relation between conductivity and ion concentration in aqueous solutions. Concentration of unknown samples can be determined.
- Measurement of changes in conductivity resulting from photosynthesis in aquatic plants, with the resulting decrease in bicarbonate-ion concentration from the carbon dioxide consumption.
- Monitoring the rate of reaction in a chemical reaction in which dissolved ions and solution conductivity varies with time due to ionic species being consumed or produced.
- Performing a conductivity titration to determine when stoichiometric quantities of two substances have been combined.
- Finding the rate at which ionic species diffuse through a membrane such as dialysis tubing.
- Monitoring changes in conductivity or total dissolved solids in an aquarium containing aquatic plants and animals. These changes could be due to photosynthesis or respiration.

Technical Specifications

Sensor kind	Digital: 16-bits resolution (on-sensor digital conversion) communication via I2C
Measuring range	0 .. 20,000 μS/cm
Resolution	0.3 μS/cm
Accuracy	±2% after cal. at 25°C
Response time	98% of full-scale reading in 5 s, 100% in 15 s.
Temperature *- compensation* *- range*	 automatic between 10°C and 35°C. between 2°C and 80°C
Cell constant	1.0 cm-1
Sensor dimensions	Housing: 60 x 18 x 16 mm
Connection	5-pins mini jack plug

Warranty:

The Conductivity sensor ML57m 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. 10/06/2012