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# CHARGE SENSOR BT19i

## USER'S GUIDE



**CENTRE FOR MICROCOMPUTER APPLICATIONS**

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

## Short description

The Charge sensor BT19i measures electrostatic charges. It can replace a traditional electroscope by showing not only the polarity of the charge but also performing quantitative measurements.

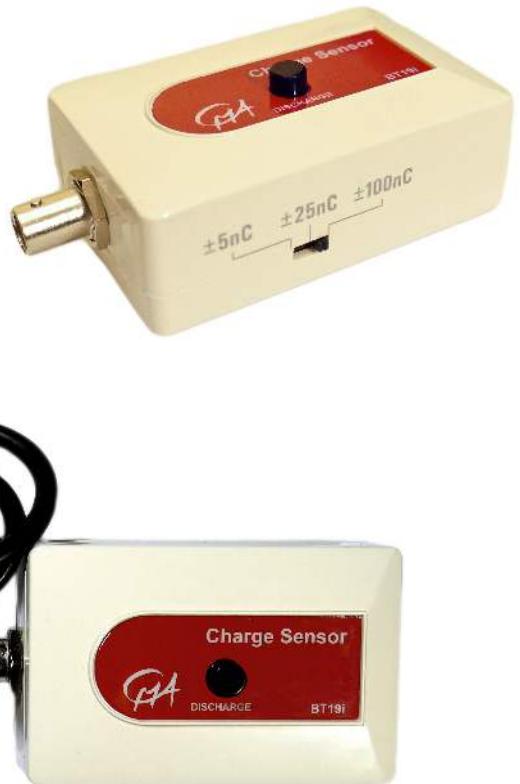
The sensor has three operating ranges, which can be selected using a switch located on the side of the sensor box:

- -5 .. 5 nC
- -25 .. 25 nC
- -100 .. 100 nC.

It also has a Discharge button to reset the input capacitor.

The sensor is supplied with a shielded BNC/crocodile lead.

The lead ends with a red and black 4-mm crocodile clip.



The CMA Charge 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).

## Sensor recognition

The Charge sensor BT19i 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 Charge 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.

## How the Charge Sensor Works

The Charge sensor is an extremely high impedance voltage sensor with a 0.01  $\mu$ F input capacitor. The capacitor will accumulate charge until the source's voltage is reached, i.e. equilibrium is achieved. Small amounts of charge can be measured even though their initial potential is higher than the input range of the sensor. The input circuit also includes a 1 M $\Omega$  resistor in series with the capacitor to protect the unit from large current surges. When used with CMA interfaces, the negative polarity (black) input lead is grounded to the computer.

## Calibration

The CMA Charge sensor BT19i is supplied calibrated. The output of the charge sensor is linear with respect to the charge. Each of its measurement ranges has its own calibration. The supplied calibration functions are:

Measurement range 0 .. 5 nC:	$C \text{ (nC)} = 2.2 * V_{\text{out}}(\text{V}) - 5.5$
Measurement range 0 .. 25 nC:	$C \text{ (nC)} = 10,0 * V_{\text{out}}(\text{V}) - 25,0$
Measurement range 0 .. 100 nC:	$C \text{ (nC)} = 39.0 * V_{\text{out}}(\text{V}) - 97,5$

The Coach program 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 tips

- The sensor should be stored with the input leads shorted together to protect it from high static potential that could damage the sensor.
- Since the sensor is capable of measuring very small amounts of charge (sensitive to stray electrostatics fields) it is important to begin experiments by resetting the sensor (zeroing a charge). Simply press the Discharge button for a few seconds.
- Whenever changing range setting discharge the sensor with the leads shorted together just to make sure all charge is depleted from the internal capacitor.
- Pressing and releasing the Discharge button with the leads connected to a voltage source such as a power supply or battery will cause an error in the reading. It is, however, acceptable to use the Discharge button when connected to a collector screen or floating capacitor plate. As long as the sensor reads zero after resetting, you should get the correct readings.
- Be careful when handling the leads or you may alter the readings with stray charge. The insulator on the clip lead quickly becomes oily from handling, and fingers often carry small amounts of charge at high potential that can easily leak through the insulator and affect your reading. The best way to minimize this is by grounding your fingers to remove any charge before releasing the positive lead from its ground connection. Start recording data before removing the lead from ground so you will be aware if any stray charge accumulates before making your connection. When connecting to static sources (not a fixed voltage like a battery), the Discharge button can be used while connected to a passive charge receptor. Make sure the output reads zero after reset.
- The sensor is not differential; therefore the negative (black) side has to be always at ground potential.
- In some circumstances wrapping the sensor in aluminum foil may help stabilize reading.
- Complete your experiment quickly. Due to leakage currents in the cable and apparatus, the reading will rarely be reliable after 15 s.
- Weather conditions can have effects on readings. In dry weather keep body movement to a minimum to reduce the effect of stray static charge. In humid weather the charge may leak too rapidly to get reasonable results from some investigations.

### Suggested experiments

The charge sensor can be used in a variety of experiments, such as:

- Investigating magnitude and sign of the charge on different objects
- Investigating electrostatic phenomena
- Faraday's ice pail investigations
- Electrostatic shielding
- Charging by induction
- Charging by contact
- Measurement how quickly an object lose charge

## Technical Specifications

<i>Sensor kind</i>	Analog, generates an output voltage between 0 - 5 V
<i>Measurement range</i>	$\pm 5 \text{ nC}$ $\pm 25 \text{ nC}$ $\pm 100 \text{ nC}$
<i>Resolution using 12 bit AD converter</i>	0.0025 nC 0.013 nC 0.050 nC
<i>Calibration functions</i> <i>measurement range <math>\pm 5 \text{ nC}</math></i> <i>measurement range <math>\pm 25 \text{ nC}</math></i> <i>measurement range <math>\pm 100 \text{ nC}</math></i>	$C \text{ (nC)} = 2.20 * V_{\text{out}} \text{ (V)} - 5.5$ $C \text{ (nC)} = 10.0 * V_{\text{out}} \text{ (V)} - 25.0$ $C_3 \text{ (nC)} = 39.0 * V_{\text{out}} \text{ (V)} - 97.5$
<i>Maximum input</i>	$\pm 50 \text{ V}$
<i>Typical bias input current</i>	0.01 pA
<i>Input capacitor</i>	0.01 $\mu\text{F}$
<i>Input resistance</i>	1 $\text{M}\Omega$
<i>Instrument time constant</i>	0.1 s
<i>Connection</i>	IEEE1394 connector for BT-IEEE1394 sensor cable. Sensor cable is not delivered with the sensor.

### Warranty:

The Charge sensor BT19i is warranted to be free from defects in materials and workmanship for a period of 24 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.

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**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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