

User guide

SINGLE ION HALF-CELL ELECTRODES

Ion selective electrodes based on carbon nanotubes

NT SENSORS SL

Ion	Sensibility	Lineal range	pH	Tresp	T ^a (°C)	Interferences
Ammonium NH ₄ ⁺	54±5	0,09 a 9000 mg/L 5e-6 a 0.5 mol/L	4 a 8.5	< 1 min	5 a 50	K (-0,8); Na (-2,7) Mg (-3,2); Ca (-4)
Bromide Br ⁻	-54±5	0,4 a 8000 mg/L 5e-6 a 0,1 mol/L	1 a 12	< 1 min	5 a 50	Error presence Ag, S, I o CN Cl (-2,7); OH (-4,5)
Calcium Ca ²⁺	24±5	0,4 a 4000 mg/L 1e-5 a 0,1 mol/L	3.5 a 8	< 1 min	5 a 50	NH ₄ (-3); K (-3,6) Na (-3,7)
Chloride Cl ⁻	-54±5	1,5 a 35000 mg/L 4e-5 a 1 mol/L	2 a 12	< 1 min	5 a 50	Error presence of Ag or S- damaged I irrev.membrana
Copper Cu ²⁺	24±5	0,6 a 3200 mg/L 1e-5 a 0,05 mol/L	2 a 7	< 1 min	5 a 50	Na (-3,1); Ca (-3,6)
Fluoride F ⁻	-54±5	0,1 a 1900 mg/L 5e-6 a 0,1 mol/L	4 a 8	< 1 min	5 a 50	OH (-1) Maintain pH < 8
Iodide I ⁻	-54±5	0,1 a 12000 mg/L 1e-6 a 0,1 mol/L	2 a 12	< 1 min	5 a 50	Error presence Ag o S Br (-3,4); Cl (-6)
Lithium Li ⁺	54±5	0,1 a 5000 mg/L 1e-5 a 0,7 mol/L	2 a 12	< 1 min	5 a 50	Na (-2,3); K (-2,4) H (-3)
Magnesium Mg ²⁺	24±5	2,4 a 2400 mg/L 1e-4 a 0,1 mol/L	3 a 8.5	< 1 min	5 a 50	Ca (-1); K (-3,6) Na (-3,9)
Nitrate NO ₃ ⁻	-54±5	0,6 a 31000 mg/L 1e-5 a 0,5 mol/L	2 a 11	< 1 min	5 a 50	Br (-1,2); NO ₂ (-1,7) OH (-1,8); AcO (-2,2)
Nitrite NO ₂ ⁻	-54±5	2,5 a 1000 mg/L 5,4e-5 a 0,02 mol/L	4 a 8	< 1 min	5 a 50	SCN (-0,2); I (-2,2) ClO ₄ (-2,4); Br (-3,3)
Perchlorate ClO ₄ ⁻	-54±5	1 a 10000 mg/L 1e-5 a 0,1 mol/L	1 a 11	< 1 min	5 a 50	SCN (-1,7); NO ₃ (-1,7) I (-1,7)
Silver Ag ⁺	56±5	0,1 a 10000 mg/L 1e-6 a 0,1 mol/L	1 a 9	< 1 min	5 a 50	Error presence S o Hg
Potassium K ⁺	54±5	0,4 a 39000 mg/L 1e-5 a 0,1 mol/L	1 a 9	< 1 min	5 a 50	NH ₄ (-2,1); Ca (-3,9) Li (-4,3); Na (-4,6)
Sodium Na ⁺	54±5	2.3 a 23000 mg/L 3e-6 a 0,1 mol/L	1 a 9	< 1 min	5 a 50	K (-2,5); Ca (-3) Li (-3,2)

1 INTRODUCTION

The Single ION probe is a half-cell electrode. Single ION belongs to the family of all-solid-state ion-selective electrodes based on carbon nanotubes (CNT-ISE) for the detection and quantification of ionic species in a wide sample range and fields of application: natural water, clinical analysis, industrial process, waste-water, aquaculture, hydroponics.



Single ION requires a reference electrode to work with.

The sensing area is located in the downside /tip from the modular electrode. The electrode does not contain any internal electrolyte. The sensing area is supplied with a plastic rubber cap, which must be removed when using the electrode.

Single ION probe from NT Sensors, SL can be used with equipment commercially available in the market. See the required equipment section.

The electrode must be used always as seen in the image below.



 Always use with the protective head, in order to avoid the tip of the sensor to be in contact with the bottom of the flask of the sample/solutions.

 The grey circumference is the maximum immersion level. Do not place the electrode in liquid solutions above the grey mark/circumference.

2 TECHNICAL SPECIFICATIONS

- Working temperature range: 4 °C – 40 °C

In order to achieve high accuracy calibration standard solutions and samples must be at the same temperature.

- Working pH range: 2-12

The CNT_ISE from NT Sensors S.L. allow to working in a wide pH range without showing any structural defects. Moreover, each analyte or ionic specie has its own pH range in order to be reliably determined, related to its nature (see *table*).

3 REQUIRED EQUIPMENT

Measuring equipment or ionmeter, which allows recording the electrical signal generated by the electrodes system. The measuring equipment or ionmeter must be able to read the electromotive force generated in millivolts (mV)

Reference electrode or pH combination electrode in order to close the electrical circuit.

NT Sensors, have several equipment in order to perform your measures, please ask which equipment is the most suitable according to your requirements. .

It is strongly recommended to properly read the instruction or userguide from your meter.

4 PRACTICAL HINTS

Calibration standards and samples must be at the same temperature.

The stirring of the solution is optional. It is important to carry out the experimentation with the same conditions both in standard and in samples. All measures must be done with the same condition, still or non-stirring or maintain the same speed while stirring.

Take care that stirring could increase the temperature of the liquid solution, and therefore could change temperature of the standards/samples.

The mechanical damage and the deposit over the sensing area could interfere over the electrode response.

Please advise the pH range for your specific electrode.

The ion selective electrode determines the ionic specie free in the liquid solution. If the ion is not in its free ionic form, it could not be quantified.

Besides is usually not required the ISAB (ionic strength adjustment buffer) with our electrodes, there are several cases where it will be necessary to use it;

- Sample pH out from the working pH
- Complex matrix
- Highly accuracy requirements.
- Matrix where the ion is chelated, e.g. in the fluoride determination.

5 ELECTRODE ASSEMBLY

Please follow the insertion procedure.



6 ELECTRODE CONDITIONING

Conditioning is a key stage in order to have the electrode properly ready to be used.

For the first time use, and after long time storage, it must be conditioned at least 2 hours and maximum 8 hours.

The conditioning time for electrodes with a frequent use is 15 min corresponding a daily or weekly use.

 **Conditioning process must be carried with the probe unplugged from the meter.**

The conditioning process is done at 0.1 M of the target ion (or alternatively at 1000 mg/L f). Remove the rubber cap, without damaging the sensing area and immerse de electrode in the conditioning solution for the time period recommended.

After the conditioning process, rinse with DI water, and the electrode will be ready to use.

NOTE: When changing from high concentration to a low concentration, the response time could be modified. In some cases, the electrodes must be keep some minutes in the low-concentration solution before obtaining a stable reading in order to start the calibration process.

7 DIRECT CALIBRATION

- Read carefully the userguide of your meter.
- Calibrate in ascending concentration sequence.
- When moving the electrode from one solution to another, it must be rinsed with DI water and dried with a clean tissue paper. Do not hit the sensing area.
- The number of standards and the frequency on the calibration processes, must be determined according the working conditions and the accuracy required. The minimum calibration must be done with at least to standard solutions, and it is recommended that they differ at least in one magnitude order. To achieve the best accuracy, or in solutions close to the limit of detection is recommended to calibrate using three standards. The sample concentration must be located in the center of the calibration range.
- Check the concentration range of your electrode.
- Check the slope obtained in the calibration process. The meters usually admit a slope value ranging from the 30 and 140% from the theoretical value.

8 MEASURES

In order to obtain accurate and reliable reading, please take care on the following items:

- Use the same temperature, stirring/still, and pH conditions used in the calibration process.
- The solid particles, the color, or turbidity does NOT affect the performance of the electrodes.
- If the sample contains solid particles, rinse properly the probe.
- Determine the contribution of the ionic interferences from the sample that affect to the reading obtained. This interferences must be taken into account only when using the direct calibration methodology. For determining the presence of other ionic species, complementary electrodes could be used in order to quantify the amount of interfering ions. Alternatively the standard addition technique could be used.

9 STANDARD ADDITION

The concentration of the ion specie in a sample can be quantified using the standard addition technique. This technique is recommended when sample matrix are complex and in solutions where it is unknown the effect of possible interference.

A brief summary of the procedure is:

1. Read the potential (mV) E_p in the sample
2. Add a known amount of the target ion (standard solution) . This addition must promote a mV change at least between 10 - 30 mV.
3. Read the potential (mV) in the sample solution + standard solution added E_{ps} .

The concentration of the target ion in the sample can be calculated as follows:

$$C_p = \frac{C_s \left(\frac{V_s}{V_p + V_s} \right)}{10^{\frac{E_{ps} - E_p}{S}} - \left(\frac{V_p}{V_p + V_s} \right)}$$

Where:

- C_p = sample target ion concentration (mol/l)
- C_s = standard solution concentration (mol/l)
- V_p = sample volume (ml)
- V_s = volume of standard solution added (ml)
- E_p = sample potential reading (mV)
- E_{ps} = sample+standard solution added potential reading (mV):

10 STORAGE AND MAINTENANCE

After each measure rinse the downside of the probe with DI water, dry the remaining drops with tissue paper, avoiding direct contact with the sensing area.



Store always with the protective rubber cap on. The electrode must be stored dry.

If the electrode is not in use, replace always the cap. Avoid store electrode exposed to the air.



Store the electrode unplugged from the meter. The electrode has NOT to be connected to the meter when it is not in use.

When the electrode have been exposed to samples with high interferences or solid particle, after rinsing, and before storing, it must be immersed in the conditioning solution in order to regenerate the sensing area around 20-30 minutes.

Store below 25°C. Store in dry and dark place, avoiding direct sunlight.

11 WARRANTY

The warranty is valid through a 6 month from the invoice of the electrode. The warranty cover any type of manufacturing defect.

It must be note than the lifespan of the electrode could be less than this warranty period due to the use, the sample type/matrix, or the storage conditions.

NT Sensors will replace without additional cost the Sensors which, after being revised by its technical post-service have been considered as “defect from origin”.

The Guaranty of the sensors does not cover the defects caused by:

- inadequate use,
- the usual aging of the sensor,
- the logic premature aging caused by certain samples,
- the damaged caused by accident.

The guaranty is valid through a period of 6 months.

11.1 TROUBLESHOOTING

Please contact to the Technical Service Assistance for customers from NT Sensors.

If the electrode must be returned to our facilities for its review/fix you will be provided of a Number Case Intervention.

Send the electrode to the provided address, properly packed, and with prepaid shipping, indicating the Number of Intervention.

12 TROUBLESHOOTING, POSSIBLE CAUSES AND ACTIONS

Problem	Possible reason	Solution/Action
Invariable mV reading	No signal received	Check the BNC connection from the electrode to the meter. Ensure the selected on the meter channel is correct Remove air bubble in the sensing area.
No signal	-	Turn on the meter. Check the BNC connection from the electrode to the meter.
Unstable readings	Air bubbles	Shake the electrode in order to eliminate the presence of air bubbles(Sensing area is not immersed in the sample)
	Electrode damaged	Replace the elect
	External noise	Turn off or disconnect the equipment that produces electromagnetic interferences (e.g. magnetic stirrer)
Slope not correct	Lack of condition	Condition the electrode at least for 8 h
	Standard solutions	Check the standard solution preparation.
	Reference electrode/ Sensing area	Replace your reference electrode/working electrode
Out of scale values	Connection	Unplug and plug again the electrode
	Air bubbles	Shake the electrode in order to eliminate the presence of air bubbles(Sensing area is not immersed in the sample)