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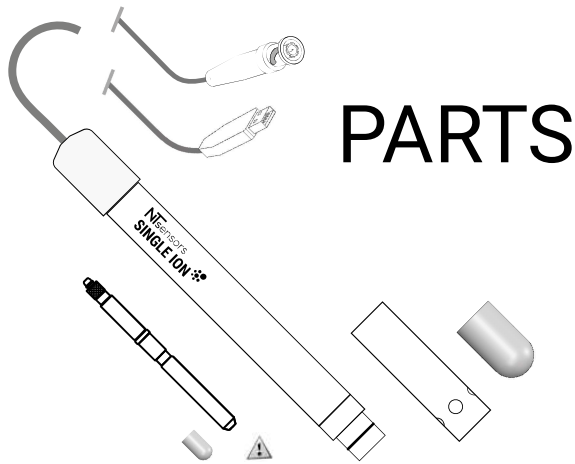
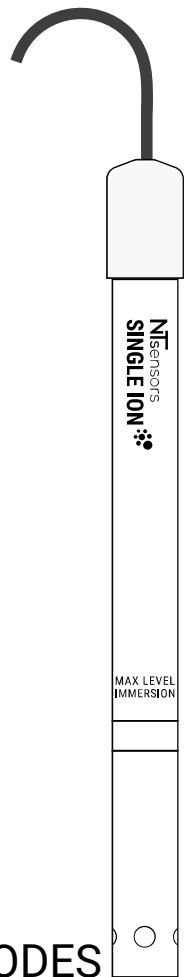
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USER GUIDE SINGLE ION

HALF-CELL ELECTRODES

ION SELECTIVE ELECTRODES BASED ON CARBON NANOTUBES



PARTS

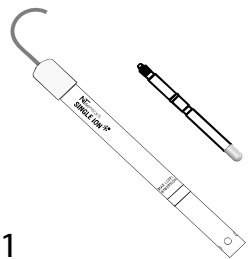
TECHNICAL SPECIFICATIONS

ELECTRODE	Slope mV decade	Linear Range	pH range	Main interferences Selectivity coefficient
AMMONIUM	54±5 mV	5x10 ⁻⁶ ...0,5 M 0.09...9.000 mg/l	4..8.5	K(NH ₄ ⁺ , K ⁺)=10 ^{-1.0} , K(NH ₄ ⁺ +Ca ²⁺)=10 ^{-4.0} K(NH ₄ ⁺ +Na ⁺)=10 ^{-2.9} , K(NH ₄ ⁺ , Mg ²⁺)=10 ^{-3.2}
BROMIDE	-54±5 mV	0.4...8.000 mg/l	1..12	Trace of Ag, S o Hg. To avoid I- and CN At less degree OH- (10 ^{-4.5}) and Cl- (10 ^{-2.7})
CALCIUM	24±5 mV	1x10 ⁻⁵ ...0,1 M 0.4...4.000 mg/l	3.5..8	KCa ²⁺ H ⁺ =10 ^{-2.9} / KCa ²⁺ Na ⁺ =10 ^{-3.7} KCa ²⁺ K ⁺ =10 ^{-3.6} / KCa ²⁺ NH ₄ ⁺ =10 ^{-3.0}
CHLORIDE	-54±5 mV	1,3...35.000 mg/l	2..12	Iodide ions irreversibly damage the membrane. Will not give reliable readings if more than a trace of Ag or S ions are present in the solution.
COPPER	-54±5 mV	0.06...3.000 mg/l	2...7	Unreliable results in presence of Ag, S or H. Br and Cl ions will interfere if their concentration is comparable to copper ions
FLUORIDE	-54±5 mV	1x10 ⁻⁶ - 1 M 0.02 - 19.000 mg/l	4..8	Only hydroxide ion (OH-) affects to the fluoride measurement. To eliminate this interference, pH must be kept below 8. Due to the high complexation of F ions in real samples, a special TISAB must be used.
IODIDE	-54±5 mV	0.1...10.000 mg/l	2..12	Trace of Ag, S o Hg. To avoid CN In less significance Br 10 ^{-3.4} y Cl ⁻ 10 ⁻⁵
LITHIUM	54±5 mV	1.4x10 ⁻⁵ ...0,7 M 0.1...5.000 mg/l	2...12	K (Li ⁺ , Na ⁺)=10 ^{-2.3} / K (Li ⁺ , K ⁺)=10 ^{-2.4} K (Li ⁺ , H ⁺)=10 ⁻³
MAGNESIUM	24±5 mV	1x10 ⁻⁴ ...0,1 M 2.4...2.400 mg/l	3..8.5	K (Mg ²⁺ , K ⁺)=10 ^{-3.6} ; K (Mg ²⁺ , Ca ²⁺)=10 ^{-1.0}
NITRATE	-54±5 mV	1x10 ⁻⁵ ...0,5 M 0.6...31.000 mg/l	2..11	K(NO ₃ ⁻ , Br ⁻)=10 ^{-1.5} ; K(NO ₃ ⁻ , NO ₂ ⁻)=10 ^{-1.7} K(NO ₃ ⁻ , OH ⁻)=10 ^{-1.8} ; K(NO ₃ ⁻ , CH ₃ COO ⁻)=10 ^{-2.2}
NITRITE	-53.6 ±5 mV	0.5...1.000 mg/l	4..8	K(NO ₂ ⁻ , SCN ⁻)=10 ^{-0.2} ; K(NO ₂ ⁻ , ClO ₄ ⁻)=10 ^{-2.4} K(NO ₂ ⁻ , I ⁻)=10 ^{-2.2} ; K(NO ₂ ⁻ , Br ⁻)=10 ^{-3.3}
PERCHLORATE	-54±5 mV	0.1...10.000 mg/l	1..11	K(ClO ₄ ⁻ , SCN ⁻)=10 ^{-1.7} ; K(ClO ₄ ⁻ , I ⁻)=10 ^{-1.7} K(ClO ₄ ⁻ , NO ₃ ⁻)=10 ^{-1.7}
POTASSIUM	54±5 mV	1x10 ⁻⁵ ...0,1 M 0.3...39000 mg/l	1...9	K (K ⁺ , NH ₄ ⁺)=10 ^{-2.1} ; K (K ⁺ , Li ⁺)=10 ^{-4.3} K (K ⁺ , Na ⁺)=10 ^{-4.6} K (K ⁺ , Ca ²⁺)=10 ^{-3.9}
SODIUM	54±5 mV	1x10 ⁻⁴ ...1 M 2.3...23.000 mg/l	1...9	K (Na ⁺ , Li ⁺)=10 ^{-3.2} ; K(Na ⁺ , K ⁺)=10 ^{-2.5} K(Na ⁺ , Ca ²⁺)=10 ^{-4.0}

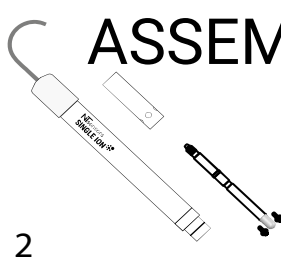
Temp. range 5° to 40°

Time response <1 min.

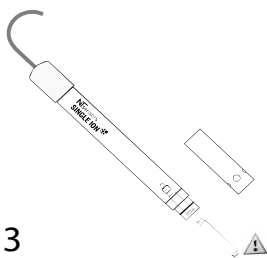
ASSEMBLY



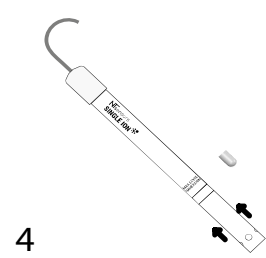
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1 INTRODUCTION

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 at the tip of the sensor 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.

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

The label on the cap indicates the maximum immersion level. Do not place the electrode in liquid solutions above this mark.

2 REQUIRED EQUIPMENT

Is compatible with ION/ISE/pH meters.

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.

3 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 for both standard and 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.

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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.

6 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.

7 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:

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):

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

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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.

4 ELECTRODE CONDITIONING

Conditioning is a key stage in order to have the electrode properly ready to be used. For the first use, and after long time storage, it must be conditioned at least 8 hours. (overnight).

The conditioning time for electrodes with a frequent use is 30 min corresponding to 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 variate.

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.

If the measurement is below 10 ppm a second conditioning in the low concentration will reduce the response time.

5 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 touch the sensing area.
- The number of standards and the frequency on the calibration processes, must be determined according to 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.

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8 STORAGE AND MAINTENANCE

After each measure rinse the downside of the probe with DI water, let 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, place always the cap. Avoid store electrode exposed to the air.

Store the electrode unplugged from the meter. The electrode must 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.

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.
	Air bubbles	Shake the electrode in order to eliminate the presence of air bubbles (Sensing area is not immersed in the sample)
Unstable readings	Electrode damaged	Replace the electrode
	External noise	Turn off or disconnect the equipment that produces electromagnetic interferences (e.g. magnetic stirrer)
	Lack of condition	Condition the electrode at least for 8 h.
Slope not correct	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)

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