User Manual

Sodium (Na+) Ion Selective Probe: Model ISENa38101 or ISENa38103

Safety information

Precautionary labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed. A symbol on the instrument is referenced in the manual with a precautionary statement.

	Electrical equipment marked with this symbol may not be disposed of in European public disposal systems after 12 August of 2005. In conformity with European local and national regulations (EU Directive 2002/96/EC), European electrical equipment users must now return old or end-of-life equipment to the Producer for disposal at no charge to the user.

Specifications

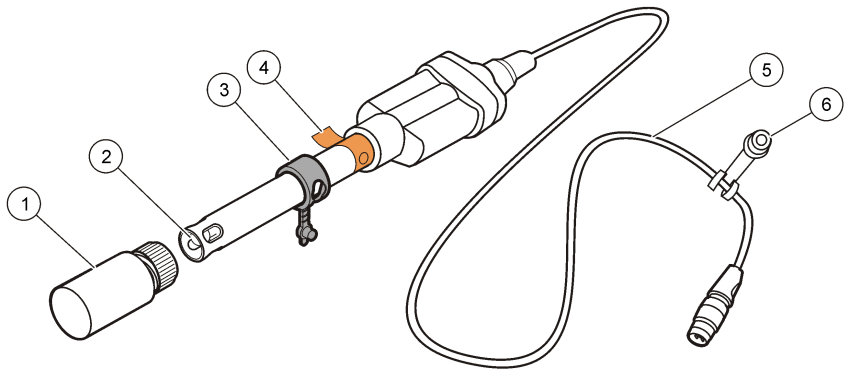
Note: *Specifications are subject to change without notice.*

Specifications	Details
Probe type	Digital, combination ion selective probe with a double junction, refillable junction reference and a built-in temperature sensor
Electrode resistance	< 800 Mohms at 25 °C (77 °F)
Range	0.023 mg/L ($1x10^{-6}$ M) to 23,000 mg/L (1 M) Na^+
Linear region	1.4 mg/L to 23,000 mg/L
Slope	-59 mV/pNa (90 to 110% at 25 °C (77 °F) per Nernstian theoretical value)
Operating temperature range	0 to 50 °C (32 to 122 °F)
Storage temperature range	5 to 40 °C (41 to 104 °F)
Junction	Double ceramic porous pin
Reference type	Ag/AgCl
Fill solution	0.02M NH_4Cl
Response time in linear region	1 to 2 minutes in sample concentration > 1.4 mg/L
Minimum sample volume	25 mL
Dimensions	Diameter: 12 mm (0.47 in.) Length: 175 mm (6.89 in.) Cable length: 1 or 3 m (3.28 or 9.84 ft)
Cable connection	M12 digital output and connector compatible with HQd meters

Product overview

The ISENa381 series probe is a refillable, combination sodium probe with a built-in temperature sensor (Figure 1). The ISENa38101 or ISENa38103 probe is available with a 1 or 3 m (3.28 or 9.84 ft) cable and is intended for laboratory use. The probe measures absolute mV values in wastewater, drinking water and general applications. The probe measures sodium concentration in water samples. A 59 mL bottle of 0.02 M NH4Cl Electrode Filling Solution is included with the probe.

Figure 1 Probe overview



1 Probe soaker bottle	**4** Protective tape and filing-hole
2 Reference junction, glass bulb and temperature sensor	**5** 1 or 3 meter (3.28 or 9.84 ft) cable
3 Filling-hole cap	**6** Probe soaker bottle holder

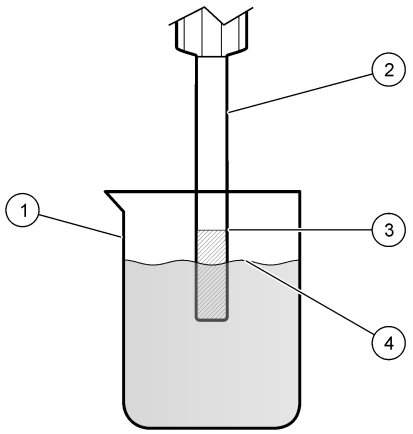
Preparation for use

Prepare the probe for use before calibration or sample measurement.

1. Turn the probe soaker bottle cap counter-clockwise to loosen the cap.
2. Remove the soaker bottle from the probe.
3. Rinse the reference junction and glass bulb with Ionic Strength Adjustor (ISA) rinse solution (refer to Prepare the sodium ISA rinse solution on page 11). Blot dry with a lint-free cloth.
4. Remove the protective tape from the filling hole before initial use (refer to Figure 1 on page 2). Dispose of the protective tape.
5. Add filling solution to the probe as necessary (refer to Fill the probe on page 11). The filling solution must be above the standard solution or sample level during measurement (Figure 2).
6. Make sure that the filling hole is open during measurement for the proper flow of the filling solution.

   Note: *After long-term storage, the probe must be conditioned in 25 mL of 100 mg/L Na^+ standard solution with the contents of one Sodium ISA powder pillow for at least 30 minutes prior to use. If probe stabilization is slow after storage, condition the probe for up to one hour in 25 mL of 100 mg/L Na+ standard solution with the contents of one Sodium ISA pillow.*

Figure 2 Measurement method



1 Container	**3** Filling solution level
2 Probe body	**4** Standard solution or sample level

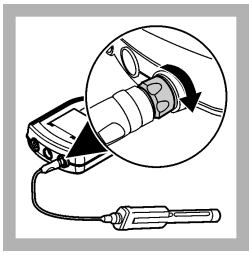
Calibration

Before calibration:
The probe must have the correct service-life time stamp. Set the date and time in the meter before the probe is attached.
It is not necessary to recalibrate when moving a calibrated probe from one HQd meter to another if the additional meter is configured to use the same calibration options.
To view the current calibration, push , select View Probe Data, then select View Current Calibration.
If any two probes are connected, push the **UP** or **DOWN** arrow to change to the single display mode in order to show the Calibrate option.
Prepare the probe for use (refer to Preparation for use on page 2).

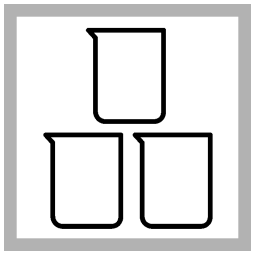
Calibration notes:

- Stir the standards and samples at a slow and steady rate to prevent the formation of a vortex.
- Additional standard sets along with the minimum number of calibration points can be selected on the Calibration Options menu.
- Push **Skip** to omit a standard from the calibration routine. The display will not show Skip until the minimum number of standards is met.
- Begin with the lowest concentration during calibration. This reduces carry-over contamination to give the best results.
- For measurements below 1 ppm (10^{-5} M), use plastic lab-ware.
- Note the temperatures of the standards during calibration. Keep temperatures between calibration standards within ±2 ºC for optimal results.
- The calibration is recorded in the electrode and the data log. The calibration is also sent to a PC, printer or flash memory stick if connected.
- Air bubbles under the sensor tip when submerged can cause slow response or error in measurement. If bubbles are present, gently shake the probe until bubbles are removed.
- If a calibration error occurs, refer to Troubleshooting on page 12.

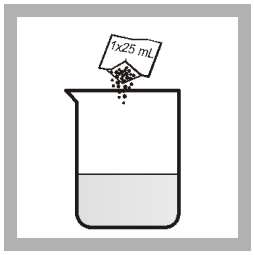
Calibration procedure:



1. Connect the probe to the meter. Make sure that the cable locking nut is securely connected to the meter. Turn the meter on.



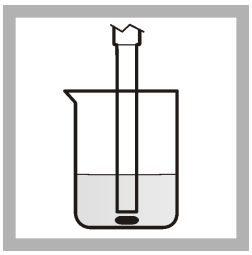
2. In three separate beakers or appropriate containers, prepare 10, 100 and 1000 mg/L Na^+ standard solution or use appropriate standards that are above and below your application range as the standard set.



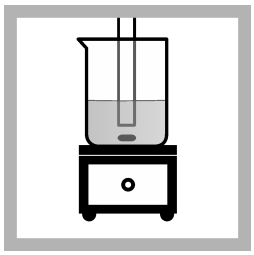
3. Add the contents of one Sodium ionic strength adjustment (ISA) powder pillow per 25 mL to each standard.

4. Push **Calibrate**. The display shows the current standard value that is to be read from the standard solution set.

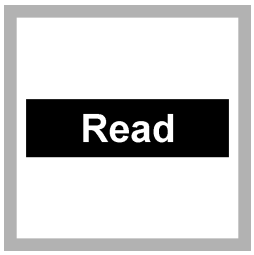
5. Rinse the probe with ISA rinse solution (refer to Prepare the sodium ISA rinse solution on page 11). Never use deionized water. Blot dry with a lint-free cloth. Do not touch the tip of the probe.



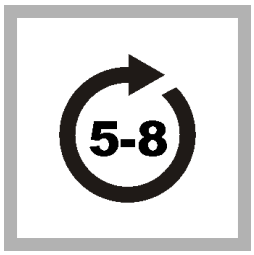
6. Add a stir bar and put the probe in the first standard solution in the set. Do not put the probe on the bottom or sides of the container. Shake the probe from side to side in the sample to refresh the reference junction.



7. Put the beaker on an electromagnetic stirrer and stir at a moderate rate. Check for air bubbles and remove them if necessary.



8. Push **Read**. The display will highlight the standard value and proceed to the next standard value. The display will show "Stabilizing" and a progress bar as the reading stabilizes. The display shows the standard value when the reading is stable.



9. Repeat steps 5-8 for the other Na^+) standard solutions in the set.

10. Push **Done** to view the calibration summary. The display will not show Done until the minimum number of calibration points have been collected.

11. Push **Store** to accept the calibration and return to the measurement mode.

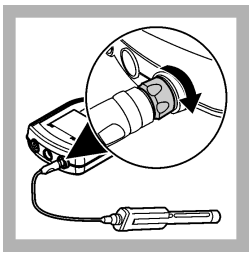
Measurement—direct method

Before measurement:
The probe must have the correct service-life time stamp. Set the date and time in the meter before the probe is attached.
If complete traceability is required, enter a sample ID and operator ID before measurement. Refer to the HQd meter manual for more information.
Regular calibration is required for the best measurement accuracy (refer to Calibration on page 3).
Prepare the probe for use (refer to Preparation for use on page 2).

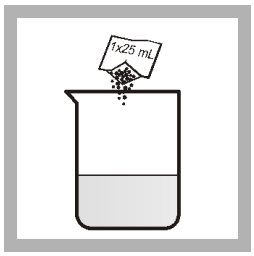
Measurement notes:

- Stir the standards and samples at a slow and steady rate to prevent the formation of a vortex.
- Stabilization times with smaller concentration changes generally will be longer and can be minimized by proper stirring and conditioning. Experiment to determine the proper stir rate if necessary.
- The integrated temperature sensor and HQd meter software do not compensate for differences in temperature between calibration standards and samples. Measurement stabilization is not dependent on temperature stabilization. Temperatures of calibration standards and samples should be kept within ±2 °C of each other for optimal results.
- Data is automatically stored in the data log when **Press to Read** or **Interval** is selected in the Measurement Mode. When **Continuous** is selected, data will only be stored when **Store** is selected.
- Between measurements, rinse the probe with ISA rinse solution. Blot dry with a lint-free cloth. For faster stabilization between measurements, put the probe in 100 mg/L sodium standard (containing Sodium ISA) that is similar in concentration to the samples to be analyzed.
- Air bubbles under the sensor tip when submerged can cause slow response or error in measurement. If bubbles are present, gently shake the probe until bubbles are removed.
- If a measurement error occurs, refer to Troubleshooting on page 12.

Measurement procedure:

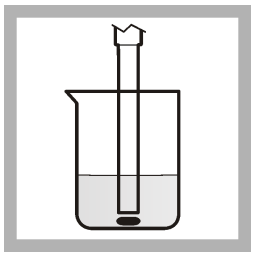


1. Connect the probe to the meter. Make sure that the cable locking nut is securely connected to the meter. Turn the meter on.

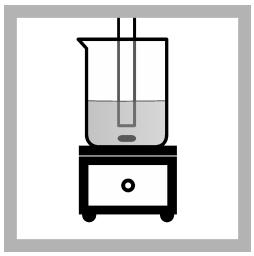


2. Prepare a minimum of 25 mL of the sample(s) in beakers or appropriate containers. Add the contents of one Sodium ionic strength adjustment (ISA) powder pillow per 25 mL to each sample.

3. Rinse the probe with ISA rinse solution (refer to Prepare the sodium ISA rinse solution on page 11). Never use deionized water. Blot dry with a lint-free cloth. Do not touch the tip of the probe.

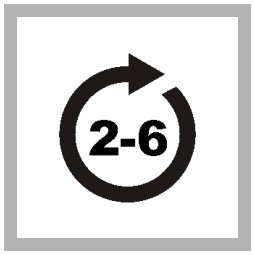


4. Add a stir bar and put the probe in the sample. Do not put the probe on the bottom or sides of the container. Shake the probe from side to side in the sample to refresh the reference junction.

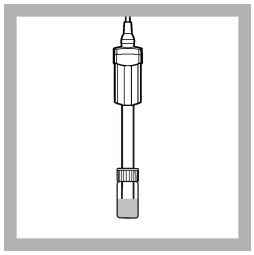


5. Put the beaker on an electromagnetic stirrer and stir at a moderate rate. Check for air bubbles and remove them if necessary.

6. Push **Read**. The display will show "Stabilizing" and a progress bar as the probe stabilizes in the sample. The display will show the lock icon when the reading stabilizes.



7. Repeat steps 2 - 6 for additional measurements.



8. When measurements are done, store the probe (refer to Storage on page 11).

Run a check standard

The run check standard feature validates instrument performance between sample measurements. Use the run check standard feature for periodic or user-defined interval measurements of a traceable standard solution. Set the criteria for check standards from the ISENa381 Settings menu.

Note: *Access control must be off or a valid password must be entered before any of the check standard method options can be changed.*

1. Push . The Full Access Options menu is shown.
2. Select Run Check Standard.
   Note: *Select the correct probe if two probes are connected to the meter.*
3. Prepare the standard solution shown on the display. Add one powder pillow per 25 mL of standard solution.
4. Put the probe in the standard solution and push **Read**. The display will show "Stabilizing" and a progress bar as the reading stabilizes. The display shows the value of the check standard and either Check Standard Passed or Check Standard Failed.
5. If the display shows **Check Standard Passed**, the check standard measurement is within the accepted limits set by the administrative user. Select **Done** to continue with the sample measurement.
6. If the display shows **Check Standard Failed**, the measurement is outside of accepted limits set by the administrative user and a recalibration is recommended. If the acceptance criteria is set to Cal Expires on Failure: Yes, the display shows the calibration icon and a question mark until the probe is recalibrated. To correct the probe calibration and status indicator, calibrate the probe (refer to Calibration on page 3).

Interferences

The glass membrane responds to sodium as well as other ions. Typically, probe response to another ion increases the potential, and causes a positive error. The response to other ions can be semi-quantitatively determined through the Nikolsky equation, an extended Nernst equation:

$E = E° + (RT/(zF)) \ln [aN_a + KN_ax \times ax]$

Where:

- ax = the activity of the interfering ion
- KN_ax = the selectivity coefficient for the interfering ion relative to sodium

If the probe is exposed to high levels of interferences, soak the probe in 1 M sodium chloride to help remove the absorbed ions from the glass membrane. The major interferences are silver and hydrogen ions. Hydrogen ion concentration is decreased by the ISA, which raises the pH.

If the samples are highly acidic, or have a high buffer capacity, check that the sample pH is above 9 after adding ISA. If necessary, add ammonium hydroxide (NH_4OH) to the calibration standards and samples in equal proportions to raise the pH. The ammonium hydroxide (NH_4OH) will not affect the measurement due to the low selectivity coefficient of NH_4^+ ion.

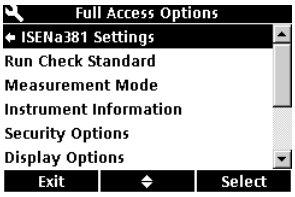
The ions that interfere in sodium determinations are given for molar concentrations of all ions. The smaller the value of the selectivity coefficient, the lower the interference. Approximate values of selectivity constants (K) are ordered from highest to lowest in Table 1.

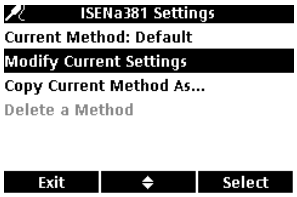
Table 1 Interferences

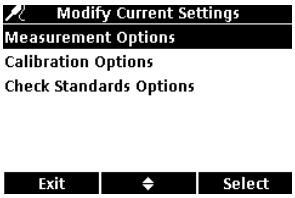
Interference	Selectivity coefficient
Ag+ (>1000)	H+ (20) - reduced by ISA addition
Li+ (0.01)	K+ (0.001)
Ti+ (0.0002)	—

Advanced operation

Parameter-specific settings can be changed through the Full Access Options menu. Details about menu navigation, available options and how to change them are given in the screens, tables and procedures throughout this section.







The settings that can be changed are shown in Table 2.

Table 2 Parameter-specific settings

Setting	Options
Measurement Options	• Units • Significant digits • Auto stabilization • Stability criteria • Upper and lower range limits
Calibration Options	• Standard set • Calibration units • Minimum calibration points • Slope limit • Calibration reminder
Check Standard Options	• Standard • Check standard reminder • Acceptance criteria

Change measurement options

Methods are groups of factory-set or user-defined settings relevant to specific applications. If the meter is set to a factory-set method and the Modify Current Settings option is chosen, a prompt for a new name is shown after the changes are entered. The settings are saved with this name to distinguish them from the factory-set methods, which cannot be changed. A saved method can be used instead of multiple adjustments to the individual settings. Changes made to a user-defined method are automatically saved with the existing name. Multiple methods can be saved for the same probe on each meter.

1. Make sure a probe is connected to the meter.
2. Push and select ISENa381 Settings.
3. Select Modify Current Settings.
4. Select Measurement Options and update the settings:

Option	Description
Units	Sets the preferred unit for ISE measurements—mg/L (default), µg/L, g/L, g/kg, mol/L, mmol/L, mol/kg, %, ppm or ppb. ***Note:*** *The mV units are shown when the detailed display is selected.*
Significant Digits	Sets the significant digits shown—2, 3 (default) or 4.
Auto Stabilization	Sets auto stabilization—on (default) or off. The default stability drift rate is 1.0 mV/min.
Stability Criteria	When Auto Stabilization is off, sets the stability criteria—0.1 to 9.9 mV/min. • Lower stability criteria will require longer stabilization times, but the measurement will be more precise. • Higher stability criteria will require shorter stabilization times, but the measurements may be less precise.
Measurement Limits	Sets the measurement limits—Lower limit (default: 0.023 mg/L) or Upper limit (default: 14.00 mg/L). The measurement limits can be set to match the acceptable values for the sample. When the measurement is above the upper limit setting or below the lower limit setting, the meter shows an "Out of limits" message. This message is an alert to a potential problem with the process conditions.

5. If prompted, enter a name for the new method settings. Additional changes made to the settings of an existing method are automatically saved with the same method name.
6. Push **EXIT** until the meter returns to the measurement mode.

Change calibration options

1. Make sure a probe is connected to the meter.
2. Push and select ISENa381 Settings.
3. Select Modify Current Settings.

4. Select Calibration Options and update the settings:

Option	Description
Std Set	Sets the temperature compensated standard sets that are used for calibration— • 10, 100 or 1000 mg/L • 100 or 1000 mg/L Standard set values are shown on the Calibration Options screen. Custom standard sets are characterized at 25 °C (77 °F). Custom standard values are not temperature compensated. Select the Custom buffer to make a custom standard. Up to five standard values can be made (refer to Table 3). ***Note:*** *Only the minimum calibration points must be measured for Done to be shown on the calibration screen.*
Chemical Form	Sets the chemical form.
Calibration Units	Sets the preferred unit for ISE Calibration—mg/L (default), µg/L (available only for custom calibration set), g/L, g/kg, mol/L, mmol/L, mol/kg, %, ppm or ppb.
Std Set Values	When Std Set is set to Custom, sets the standard set values (refer to Table 3). Up to five standard values can be made. Each standard value can include a standard set value, Custom or No Standard.
Minimum Cal Points	Sets the minimum number of calibration points necessary before a calibration can be completed—2 or 3.
Slope Limit	Sets the slope limit—1 to 15% (acceptable slope criteria, default = 10%). The slope must fall within set limits for successful calibration.

5. Select Calibration Reminder and update the settings:

Option	Description
Reminder Repeat	Meter will make an audible sound when a calibration is due and repeat the sound at the selected interval—Off (default), 2 h, 4 h, 8 h, 2 d, 5 d or 7 d.
Expires	Calibration expires after the selected time—Immediately, Reminder + 30 min (default), Reminder + 1 h, Reminder + 2 h or Continue Reading. ***Note:*** *The meter cannot be used to read samples after calibration has expired unless Continue Reading is selected.*

6. If prompted, enter a name for the new method settings. Additional changes made to the settings of an existing method are automatically saved with the same method name.
7. Push **EXIT** until the meter returns to the measurement mode.

Table 3 Custom buffer sets

Buffer set values	Option	Description
Std1 Std2 Std3 Std4 Std5	10.0 mg/L	Pre-set temperature compensated standard values.
	100.0 mg/L	
	1000.0 mg/L	
	2299.0 mg/L (0.1 M NaCl)	
	Custom	Custom standard value. Custom standard values are not temperature compensated.
	No standard	Standard is undefined when this option is selected.

Change check standard options

1. Make sure a probe is connected to the meter.
2. Push and select ISENa381 Settings.
3. Select Modify Current Settings.
4. Select Check Standards Options and update the settings:

Option	Description
Standard	Sets the check standard—10, 100, 1000 mg/L, 0.1 M NaCl or Custom. The standard value is shown on the Check Standards Options screen.
Standard Units	When Standard is set to Custom, sets the preferred unit for ISE check standard—mg/L (default), µg/L, g/L, g/kg, mol/L, mmol/L, mol/kg, %, ppm or ppb.
Standard Value	When Standard is set to Custom, enter the standard value using the up/down arrow keys.

5. Select Check Standard Reminder and update the settings:

Option	Description
Reminder	Sets the check standard reminder—On or Off (default). The meter automatically shows the check standard screen if Reminder is On.
Allow Defer	Allows the postponement of check standard reminders—Yes or No. Measurement of the check standard can be delayed if Allow Defer is set to Yes.

6. Select Acceptance Criteria and update the settings:

Option	Description
Acceptance Limits	Sets the tolerance limits for check standard—1% to 20%.
Cal Expires on Failure	Recalibration required if check standard fails—Yes or No. The calibration expires if the check standard fails and Cal Expires is set to Yes.

7. If prompted, enter a name for the new method settings. Additional changes made to the settings of an existing method are automatically saved with the same method name.
8. Push **EXIT** until the meter returns to the measurement mode.

Maintenance

Clean the probe

Clean the probe when:

- Drifting/inaccurate readings occur as a result of contamination on the glass sensor or the probe being left dry for extended periods of time.
- Slow stabilization time occurs as a result of contamination on the glass sensor.
- The slope is out of range as a result of contamination on the glass sensor.

For general contaminants:

1. Rinse the probe with ISA rinse solution and blot dry with a lint-free cloth.
2. Soak the glass bulb for 12 to 16 hours in Hach Electrode Cleaning Solution.
3. Rinse or soak the probe for 1 minute in 25 mL of 100 mg/L sodium standard (that contains Sodium ISA).
4. Clean the probe with tap water, then rinse with ISA rinse solution.
5. Calibrate and test the probe again using the measurement procedures.

Fill the probe

Add filling solution to the probe when the filling solution level is low (refer to Preparation for use on page 2). Refer to Specifications on page 1 for the applicable filling solution.

1. If the filling hole is closed, remove the filling-hole cap from the filling hole (refer to Product overview on page 1).
2. Remove the cap from the tip of the filling solution bottle.
3. Hold the bottle so that the tip is down. Put the tip of the bottle in the filling hole.
4. Slowly squeeze the bottle and fully fill the probe.
   Note: *Fully fill the probe for the best performance.*
5. Put the probe into storage if not used immediately (refer to Storage on page 11).
6. Keep the filling solution bottle and cap for later use.
   Note: *If the dispensing tip becomes clogged, remove the dispensing tip and soak the tip in warm ISA rinse solution. Fully dry and assemble the tip.*

Prepare the sodium ISA rinse solution

Add one sodium ISA powder pillow (0.4 g) to every 25 mL of deionized water. Put the sodium ISA rinse solution in a rinse bottle.

Prepare the storage solution

To prepare the storage solution, add one Sodium Ionic Strength Adjustor (ISA) powder pillow (0.4 g) to 25 mL of 100 mg/L Na+ standard solution.

Storage

For the best probe performance, do not let the reference junction dry out.

Short-term storage

1. Put the filling-hole cap in the filling hole (Figure 1 on page 2).
2. Store the probe in a 25 mL of 100 mg/L Na+ standard solution with one Sodium Ionic Strength Adjustor (ISA) powder pillow (0.4 g).

Long-term storage

1. Put the filling-hole cap in the filling hole (refer to Figure 1 on page 2).
2. Rinse the probe with ISA rinse solution (refer to Prepare the sodium ISA rinse solution on page 11). Never rinse with deionized water. Dry the probe with a lint-free cloth.
3. Fill the probe soaker bottle half full with 0.02 M NH_4Cl Electrode Filling Solution..
4. Loosen the soaker bottle cap and put the soaker bottle on the probe.
5. Turn the soaker bottle cap clockwise to tighten the soaker bottle cap.
6. Make sure that the solution in the soaker bottle completely covers the glass bulb and reference junction holes.
7. Before use after long-term storage, condition the probe in 25 mL of 100 mg/L Na+ standard solution with one Sodium ISA pillow (0.4 g) for at least 8 hours.

Troubleshooting

Message or symptom	Possible cause	Action
Probe not supported	Software not updated	To download the most current version of the software, refer to the applicable product page on the manufacturer's website. Refer to the HQd Series meter manual for specific instructions for the meter model.
	HQd meter does not support IntelliCAL® probe	Contact a Technical Support Representative.
Connect a probe or probe requires service	Probe not connected properly	Disconnect, then connect the probe. Tighten the locking nut.
	Software not updated	To download the most current version of the software, refer to the applicable product page on the manufacturer's website. Refer to the HQd Series meter manual.
	Large number of methods stored on probe	Continue to let probe connect. Do not disconnect probe.
	Damaged probe	Make sure that there is connectivity with another probe or meter to confirm isolated issue with probe. Contact a Technical Support Representative.
mV reading is the same for all solutions	Soaker bottle not removed	Remove the soaker bottle.
	Electrical issue	Contact a Technical Support Representative.
Standard not recognized error	Soaker bottle not removed	Remove the soaker bottle.
	Incorrect or contaminated standard solution	Use fresh standard solution as specified in the method.
	Contaminated filling solution	Replace the filling solution.
Slow stabilization time	Tape not removed from the filling hole	Remove the tape.
	Contaminated glass sensor	Clean the probe (refer to Clean the probe on page 10).
	Contaminated filling solution	Drain and replace the filling solution with fresh solution.
	Filling-hole cap is closed	Open the filling-hole cap while in use.
	Low sample temperature or temperature difference between samples	Check the sample temperature. The lower the temperature or the greater the difference of temperatures between samples, the longer the response time.
	Air bubbles around inner reference electrode	Gently tap the probe with hand or shake the probe downward to remove any air bubbles.
Slope out of range (refer to Check probe response on page 13)	pH is too low	Make sure the pH is greater than 9 after each ISA addition.
	Ionic strength adjustor (ISA) not used	Add ISA to each sample and standard.
	Insufficient conditioning	Condition for at least 8 hours in storage solution.
	Damaged probe	Contact a Technical Support Representative.
	Incorrect standards	Calibrate using freshly prepared standards.
	Contaminated glass sensor	Clean the probe and recalibrate.
	Air bubbles around inner reference electrode	Gently tap the probe with hand or shake the probe downward to remove any air bubbles.

Message or symptom	Possible cause	Action
Drifting/inaccurate readings	Contaminated glass bulb	Clean the probe (refer to Clean the probe on page 10).
	Clogged reference	Rinse the reference junction with ISA rinse solution thoroughly and shake the probe downward to remove any air bubbles.
	Improper storage conditions/dehydrated glass bulb	Clean or condition the probe and attempt another calibration. The probe may not function correctly if the probe has been left dry for extended periods of time. To re-condition the glass sensor and reference junctions, allow the probe to soak in storage solution (that contains Sodium ISA) for at least 8 hours before use.
	Stabilization criteria not optimized for the application	Adjust the stabilization criteria in the Measurement Options menu.
	Magnetic stirrers may generate sufficient heat to change solution temperature.	Put a piece of insulating material between the stirrer and beaker.
	Filling-hole cap is closed	Open the filling-hole cap while in use.
	Damaged probe	Contact a Technical Support Representative.
	Electromagnetic Forces (EMF) such as voltaic cells, thermoelectric devices, electrical generators, resistors and transformers	Do not use in areas where EMF is present.
	Colloidal and/or particulates in the filling solution	Replace the filling solution, calibrate and retest.
	Air bubbles around inner reference electrode	Gently tap the probe with hand or shake the probe downward to remove any air bubbles.
Out of range	Measurement value is outside of range	Make sure that the sample is within the range of the probe.
Out of limits	Check standard value is outside of limits set in the current method	Make sure that the standard is within the limits of the current method.
		Make another method that expands the acceptable limits.
	Measurement value is outside of measurement limits set in the current method.	Make sure that the sample is within the limits of the current method.
		Make a new method with an expanded range.
Temperature out of range	Calibration temperature value is outside of range	Make sure that the sample temperature is within the range of the probe.
		Make sure that the temperature sensor is working correctly.
	Measured temperature is outside the range of the probe	Make sure that the standard temperature is within the range of the probe.
		Make sure that the temperature sensor is working correctly.
	Check standard temperature value is outside of range	Make sure that the check standard temperature is within the range of the probe.

Check probe response

To check the probe response, measure the probe potential (in mV) of two Sodium Standard Solutions one decade apart in concentration that are above and below the

expected sample concentration. For example, use 10 and 100 mg/L Sodium Standard Solutions. The two solutions should have potentials (difference in mV readings) that are 59 mV (±3 mV) apart at 25 °C. Both solutions should be above 1.4 mg/L Na^+.

Check accuracy of sample reading

To check the accuracy of the sample reading, add a spike of Standard Sodium Solution with the volumetric pipet. Refer to Table 4 and formulas to calculate the percent of recovery.

Typically a percent of recovery of 100% ±5% is a good indication that the instrument, technique and the sample do not contribute to measurement errors.

Table 4 Spike reference

Measured sample concentration	Volume of standard at add	Concentration of standard
1 to 2 mg/L	0.5 mL	100 mg/L
3 to 6 mg/L	1.0 mL	100 mg/L
7 to 15 mg/L	0.3 mL	1000 mg/L
15 to 30 mg/L	0.5 mL	1000 mg/L
30 to 60 mg/L	1.0 mL	1000 mg/L

Percent recovery

Use the following formulas to calculate the percent recovery when the sample volume is 25 mL.

$E = (C \times V_1) / V_2$

$R = (A / (E + S)) \times 100$

Where:

- S = mg/L of Na^+ in sample (before spike)
- C = concentration of standard used for spiking (mg/L)
- V_1 = spike volume (mL)
- V_2 = spike volume (mL) + 25 mL sample volume
- E = expected concentration of spike (mg/L)
- R = percent recovery
- A = actual reading on meter after spike (mg/L Na^+)

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