User Manual

Ammonia Probe: Model ISENH318101 or ISENH318103

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. ***Note:*** *For return for recycling, please contact the equipment producer or supplier for instructions on how to return end-of-life equipment, producer-supplied electrical accessories, and all auxiliary items for proper disposal.*

Specifications

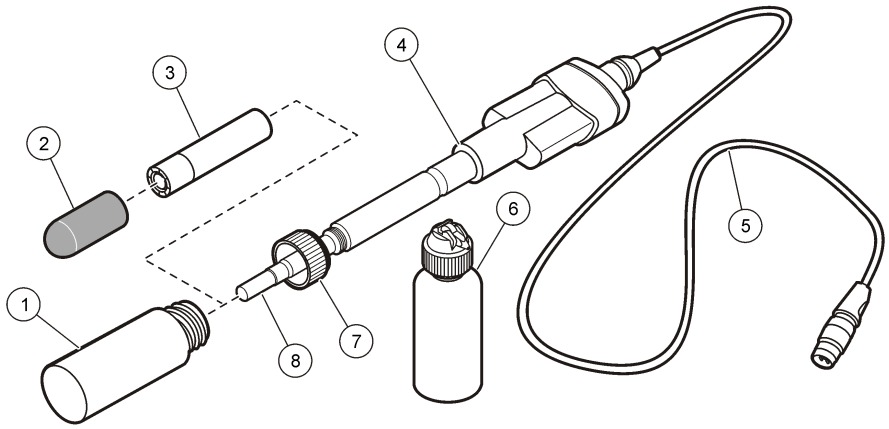
Note: *Specifications are subject to change without notice.*

Specifications	Details
Probe type	Digital combination gas-sensing probe with a refillable outer body, double-junction reference and a built-in temperature sensor
Range	0.01 mg/L ($5x10^{-7}$ M) to 14,000 mg/L (1 M) as NH_3-N
Sample pH range	> pH 11 per Ammonia ISA
Linear region	0.5 mg/L to 14,000 mg/L as NH_3-N
Slope	57 mV/decade (90 to 110% in linear range at 25 °C (77 °F) per Nernstian theoretical value)
Operating temperature range	5 to 50 °C (41 to 122 °F)
Storage temperature range	5 to 35 °C (41 to 95 °F)
Junction	Double junction (annular)
Reference type	Ag/AgCl
Fill solution	3 M KCl gel (non-refillable), 0.1 M NH_4Cl (outer body, refillable)
Membrane	Replaceable Hach ISENH3181 Ammonia membrane module
Response time in linear region	< 60 seconds (application dependent)
Minimum sample volume	15 mL
Minimum immersion depth	25.4 mm (1 in.)
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 ISENH318101 or ISENH318103 probe is a digital combination gas-sensing electrode with a refillable outer body, double-junction reference and built-in temperature sensor (Figure 1). The 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 ammonia concentration in water samples.

Figure 1 Probe overview



1 Soaker bottle	**5** 1 or 3 m (3.28 or 9.84 ft) cable
2 Membrane module protector cap (3x)	**6** Fill solution bottle
3 Membrane module (3x)	**7** Soaker bottle lid
4 Probe body	**8** Glass bulb with integrated temperature sensor

Preparation for use

Prepare the probe for use before calibration or sample measurement.

1. Twist and remove the soaker bottle from the lid to release the pressure.
2. Remove the soaker bottle lid from the probe.
3. Rinse the probe with deionized water. Blot dry with a lint-free cloth. Do not touch the tip of the probe.
4. Get a single membrane module from the shipping package. Do not touch the membrane surface.
5. Add 12 drops (0.5 mL) of the Ammonia probe filling solution in the membrane module.
6. Install the membrane module on the probe and tighten. Do not spill the filling solution.

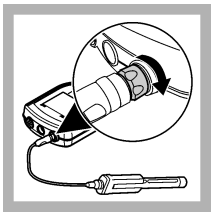
Calibration

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.
Default calibration standard set for ISENH3181 probe requires 1, 10 and 100 mg/L Ammonia standard solutions. A new method can be made if custom calibration or measurement settings are needed. Refer to Advanced operation on page 7 for a list of additional calibration sets.
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.
Make sure the Ammonia membrane module is assembled with the correct amount of Ammonia fill solution.
Prepare the probe for use (refer to Preparation for use on page 2).

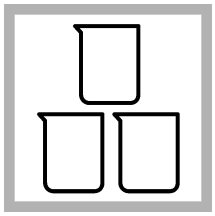
Calibration notes:

- 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.
- 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 11.

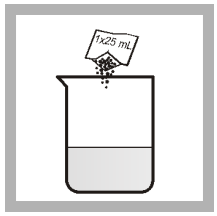
Calibration procedure:



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

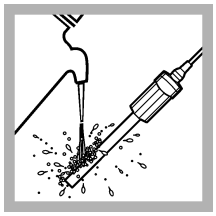


2. In three separate beakers or appropriate containers, prepare Ammonia standard solutions (minimum 25 mL volume).

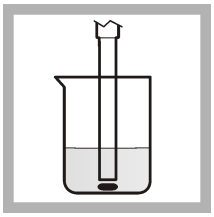


3. Add the contents of one Ammonia ionic strength adjustment (ISA) powder pillow per 25 mL to each standard.

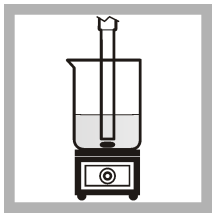
4. Push **Calibrate**. The display shows the current standard value that is to be read from the standard solution set.



5. Rinse the probe with 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.



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 Ammonia 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

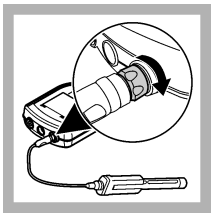
Before measurement:
The probe must have the correct service-life time stamp. Set the date and time in the meter before the probe is attached.
If complete traceability is required, enter a sample ID and operator ID before measurement. Refer to the HQd meter manual for more information.
Make sure the Ammonia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

Measurement notes:

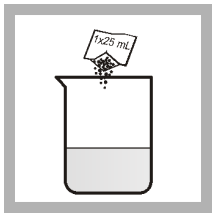
- Stir the standards and samples at a slow and steady rate to prevent the formation of a vortex.
- Stabilization times with smaller concentration changes generally will be longer and can be minimized by proper stirring and conditioning. Experiment to determine the proper stir rate if necessary.

- 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 deionized water. Blot dry with a lint-free cloth. Do not touch the tip of the probe.
- 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 11.

Measurement procedure:

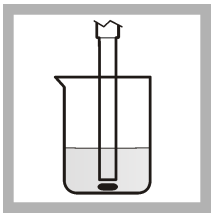


1. Connect the probe to the meter. Make sure that the cable locking nut is securely connected to the meter. Turn the meter on.

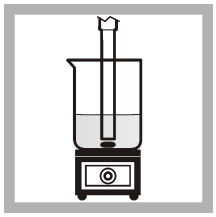


2. Prepare a minimum of 25 mL of the sample(s) in beakers or appropriate containers. Add the contents of one Ammonia ionic strength adjustment (ISA) powder pillow per 25 mL to each sample.

3. Rinse the probe with deionized water. Blot dry with a lint-free cloth. Do not touch the tip of the probe.

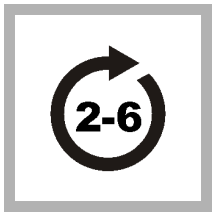


4. Add a stir bar and put the probe in the sample. Do not put the probe on the bottom or sides of the container.

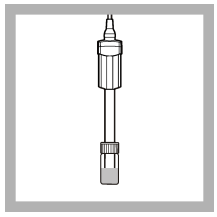


5. Put the beaker on an electromagnetic stirrer and stir at a moderate rate. Check for air bubbles and remove them if necessary.

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 10).

Interferences

The sensing element responds to ammonia 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:

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

Where

- ax—the activity of the interfering ion
- KN_ax—the selectivity coefficient for the interfering ion relative to chloride

Volatile amines interfere with Ammonia ISE measurement. Most gases do not interfere as they are converted to ionic form in basic solutions. Ionic species cannot cross the gas-permeable membrane and are not direct electrode interferences. However, the level of ions in solution can change the solubility of ammonia. Standards and samples should have about the same level of ions and dissolved species.

Ammonia forms metal complexes with a number of metal ions: mercury, silver, copper, gold, nickel, cobalt, cadmium and zinc. At pH >11, most of these metals form hydroxide complexes or precipitate. The Ammonia ISA adjusts the pH to >11. When hydroxide is present at the 0.1 M level and the ammonia concentration is below 10^{-3} M, only mercury will appreciably complex ammonia. The total ammonia level of the sample will be measured if the mercury in the sample is preferentially bound to some other species. Iodide is recommended for this purpose, since it forms a soluble mercury complex at all pH levels. Use of Ammonia ISA inhibits the formation of some common metal complexes in the sample because it contains a high concentration of hydroxide ion.

Run a check standard

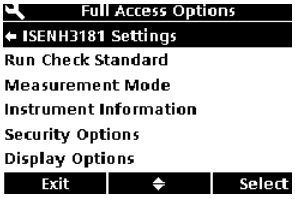
The run check standard feature validates instrument performance between sample measurements. Use the run check standard feature for periodic or user-defined interval measurements of a traceable standard solution. Set the criteria for check standards from the ISENH3181 Settings menu.

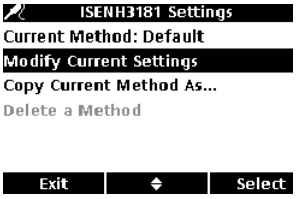
Note: *Access control must be off or a valid password must be entered before any of the check standard method options can be changed.*

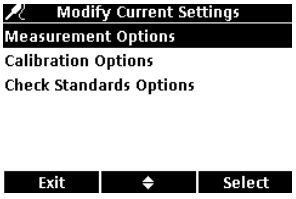
1. Push . The Full Access Options menu is shown.
2. Select Run Check Standard.
   Note: *Select the correct probe if two probes are connected to the meter.*
3. Prepare the standard solution shown on the display. Add one powder pillow per 25 mL of standard solution.
4. Put the probe in the standard solution 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 2).

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 1.

Table 1 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 ISENH3181 Settings.
3. Select Modify Current Settings.
4. Select Measurement Options and update the settings:

Option	Description
Chemical Form	Sets the concentration value—NH_3 or NH_3-N.
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.

Option	Description
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: 0.01 mg/L) or Upper limit (default: 14,000 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 ISENH3181 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— • 1, 10 or 100 mg/L as NH_3–N • 10, 100 or 1000 mg/L as NH_3–N • 1, 10 , 100 or 1000 mg/L as NH_3–N 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 2). ***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 2). Up to five standard values can be made. Each standard value can include a standard set value, Custom or No Standard.

Option	Description
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 30% (acceptable slope criteria, default = 15%). 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 2 Custom standard sets

Standard set values	Option	Description
Std1 Std2 Std3 Std4 Std5	1 mg/L	Pre-set temperature compensated standard values.
	10 mg/L	
	100 mg/L	
	1000 mg/L	
	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 ISENH3181 Settings.
3. Select Modify Current Settings.
4. Select Check Standards Options and update the settings:

Option	Description
Standard	Sets the check standard—1, 10, 100 or 1000 mg/L. 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 sensing element or improper storage conditions.
- Slow response time occurs as a result of contamination on the sensing element.
- The slope is out of range as a result of contamination on the sensing element.

For general contaminants, complete the following steps.

1. Rinse the probe with deionized water. Blot dry with a lint-free cloth. Do not touch the tip of the probe.
2. If harsh contaminants are attached to the probe, polish the probe tip with a soft cloth or cotton swab to remove the contaminants.
3. Soak for 30 seconds in 25 mL of Ammonia probe storage solution.

Storage

Short-term storage

For short-term storage, put the probe with the attached membrane module in 25 mL of Ammonia probe storage solution. Do not let the membrane dry out. A soaker bottle is not required.

Overnight and mid-term (up to one week) storage

1. Put the Ammonia probe with the attached membrane module in 1000 mg/L Ammonia standard solution without Ionic Strength Adjustor (ISA). Do not let the membrane dry out. A soaker bottle is not required.
2. Put a cover over the storage beaker and probe body to prevent solution evaporation.

Long-term (more than one week) storage

1. Remove the Ammonia membrane module from the probe body.
2. Rinse the probe and membrane module with deionized water. Blot dry with a lint-free cloth. Do not touch the tip of the probe. Do not rub the membrane surface.
3. Install the protector cap over the membrane module and put the Ammonia membrane module in a protected area. The disassembled membrane module can be allowed to dry.
4. Fill the probe soaker bottle halfway with Ammonia probe storage solution.
5. Install the probe soaker bottle. Make sure the storage solution in the cap completely surrounds the glass bulb.

Note: *After long-term storage, the ISENH3181 probe (with membrane module assembled) might need to be conditioned in Ammonia probe storage solution for up to 30 minutes to improve the stabilization speed.*

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 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.
Slow response time	Dirty sensing element	Clean the probe (body, membrane module and glass bulb). Refer to Clean the probe on page 10.
	Membrane failure	Replace the membrane module.
	Dirty filling solution	Replace the filling solution.
	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, traditionally the longer the response time.
	Bubbles trapped under sensor tip	Gently shake the probe until bubbles are removed from under sensor tip.
Slope out of range (refer to Check probe response on page 13)	pH is incorrect	Make sure the pH is > 11 after each ISA addition.
	Ionic strength adjustor (ISA) not used	Add ISA to each sample and standard (one powder pillow per 25 mL of solution).
	Insufficient conditioning	Condition for at least in ammonia probe storage solution.
	Damaged probe	Contact a Technical Support Representative.
	Incorrect standards	Calibrate using freshly prepared standards.
	Dirty sensing element	Clean the probe (body, membrane module and glass bulb) and recalibrate.
	Bubbles trapped under sensor tip	Gently shake the probe until bubbles are removed from under sensor tip.

Message or symptom	Possible cause	Action
Drifting/inaccurate readings	Dirty sensing element	Clean the probe (body, membrane module and glass bulb).
	Clogged reference	Rinse reference junction with deionized water thoroughly and shake the probe downward to remove any air bubbles.
	Samples lose ammonia content	Measure samples and standards within 15 minutes after ISA is added (ammonia gas can escape from the solution). Add Parafilm over the top of the samples and standards to reduce Ammonia loss. Cut a hole for the electrode.
	Improper storage conditions	Clean or condition the probe (refer to Clean the probe on page 10) and attempt another calibration. To re-condition the probe and reference junctions, allow the probe to soak in ammonia probe storage solution for at least 30 minutes prior to use.
	Membrane failure	Replace the membrane module.
	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.
	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.
	Insufficient amount of filling solution	Add filling solution.
	Colloidal and/or particles in the filling solution.	Replace the filling solution, calibrate and retest.
	Bubbles trapped under sensor tip	Gently shake the probe until bubbles are removed from under sensor tip.
	Temperatures of calibration standards and samples are not within ±2 °C of each other.	Make sure that the temperatures are within ±2 °C of each other.
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.

Message or symptom	Possible cause	Action
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.
Below detection limit	Measurement is not quantifiable with current saved calibration (based on IUPAC-defined practical detection limit).	Perform a new calibration. Check that sample concentration is bracketed between two standard solution values (if within linear range).
		Re-run calibration and measurement, optimizing meter settings for slope acceptance and stabilization criteria for expected sample concentration.
		Re-run calibration and sample measurement with the tips for low-level measurement.
	Measurement value is outside of range.	Make sure sample is within the range of the probe.

Check probe response

To make sure there is a probe response, measure the probe potential (in mV) of two Ammonia Standard Solutions one decade apart that are above and below the expected sample concentration. For example, use 10 and 100 mg/L Ammonia Standard Solutions. The two solutions should have potentials (difference in mV readings) that are 57 mV apart at 25 ºC (within the slope limits of the method is acceptable). Both solutions should be above 0.5 mg/L Ammonia.

Check accuracy of sample reading

To make sure the sample measurement is accurate, add a spike of Ammonia Standard Solution with the volumetric pipet. Refer to Table 3 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 3 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 formula to calculate the percent recovery when the sample volume is 25 mL:

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

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

- S = mg/L of Ammonia 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 Ammonia)

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