


## Fluoride Probe: Model ISEF12101 or ISEF12103

### 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.

	<p>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.</p> <p><b>Note:</b> 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.</p>
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### Specifications

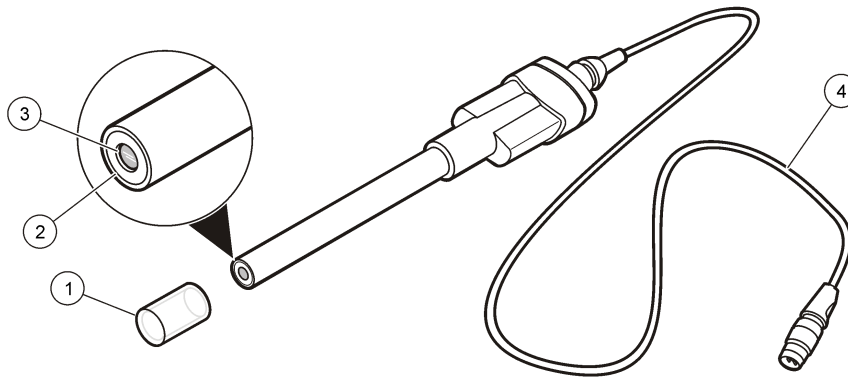
**Note:** Specifications are subject to change without notice.

Specifications	Details
Probe type	Digital combination probe with a non-refillable reference junction and a built-in temperature sensor
Range	0.01 mg/L ( $5 \times 10^{-7}$ M) to 19,000 mg/L (1 M) Fluoride
Sample pH range	pH 4 to 8, must be adjusted to 5.0 to 5.5 by Fluoride ISA
Linear region	0.1 mg/L to 19,000 mg/L
Slope	59 mV/pF (90 to 110% at 25 °C (77 °F) in linear range 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	Single junction (annular porous Teflon <sup>®</sup> )
Reference type	Ag/AgCl
Response time in linear region	< 60 seconds (application dependent)
Minimum sample volume	25 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 ISEF12101 or ISEF12103 probe is a combination fluoride probe with a 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 fluoride concentration in water samples.

**Figure 1 Probe overview**



1 Sensor protection cap	3 Sensing element
2 Reference junction	4 1 or 3 m (3.28 or 9.84 ft) cable

## Preparation for use

Prepare the probe for use before calibration or sample measurement.

1. Remove the sensor protection cap from the probe.
2. Rinse the probe with deionized water. Blot dry with a lint-free cloth.

**Note:** Prior to use, the probe must be conditioned for at least 30 minutes in 100 mL of the lowest concentration standard solution in the calibration set.  
If probe stabilization is slow after storage, condition the probe for up to one hour in 100 mL of the lowest concentration standard solution in the calibration set.

## 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.

Use the factory-set method for drinking water or pure water when applicable to the sample type. The factory-set methods are optimized for concentration levels that are typical of the specified sample type. Refer to [Advanced operation](#) on page 7.

To view the current calibration, push **VIEW**, 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).

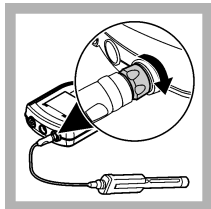
Use plastic containers during calibration and measurements. Glass containers can cause inaccurate measurements.

### Calibration notes:

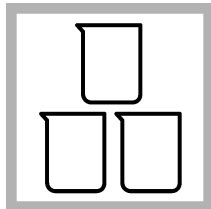
- Stir the standards and samples at a slow and steady rate to prevent the formation of a vortex.
- Additional standard sets along with the minimum number of calibration points can be selected on the Calibration Options menu.
- Push **Skip** to omit a standard from the calibration routine. The display 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  $\pm 2$  °C 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.

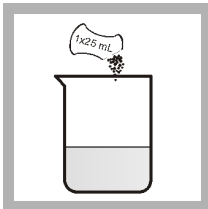
### Calibration procedure:



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



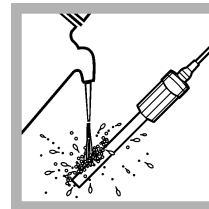
2. In three separate beakers or appropriate containers, prepare Fluoride standard solutions (minimum 25 mL volume).



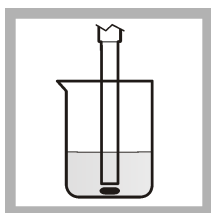
3. Add the contents of one Fluoride ionic strength adjustment (ISA) powder pillow per 25 mL to each standard.



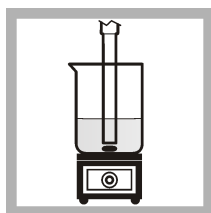
4. Push **Calibrate**. The display shows the current standard value that is to be read from the standard solution set.



5. Rinse the probe with deionized water. Blot dry with a lint-free cloth.



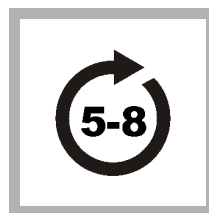
6. Add a stir bar and put the probe in the first standard solution in the set. Do not put the probe on the bottom or sides of the container.



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 Fluoride 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.

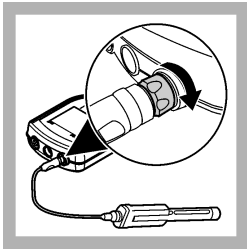
## Measurement—direct method

<b>Before measurement:</b>
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 <a href="#">Calibration</a> on page 2).
Prepare the probe for use (refer to <a href="#">Preparation for use</a> on page 2).
Use plastic containers during calibration and measurements. Glass containers can cause inaccurate measurements.

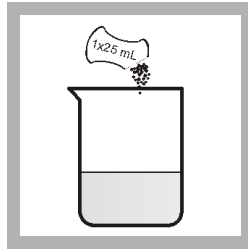
### Measurement notes:

- 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  $\pm 2$  °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.
- 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.

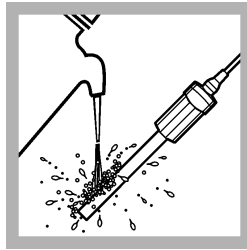
### Measurement procedure:



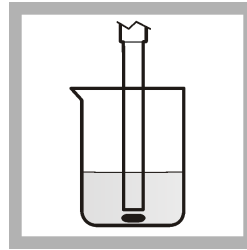
1. Connect the probe to the meter. Make sure that the cable locking nut is securely connected to the meter. Turn the meter on.



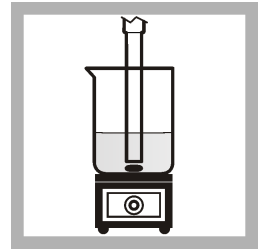
2. Prepare a minimum of 25 mL of the sample(s) in beakers or appropriate containers. Add the contents of one Fluoride ionic strength adjustment (ISA) powder pillow per 25 mL to each sample.



3. Rinse the probe with deionized water. Blot dry with a lint-free cloth.



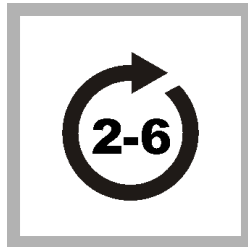
4. Add a stir bar and put the probe in the sample. Do not put the probe on the bottom or sides of the container.



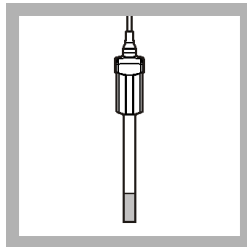
5. Put the beaker on an electromagnetic stirrer and stir at a moderate rate. Check for air bubbles and remove them if necessary.



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 11).

## Low-level measurements

Use the following techniques for measurements at low concentrations ( $<1$  mg/L  $F^-$ ).

- Use plastic containers during calibration and measurements. Glass containers can cause inaccurate measurements.
- Clean the probe regularly as specified in [Maintenance](#) on page 10.
- Soak the probe in the lowest concentration standard solution for up to 1 hour before calibration and measurement.
- Set the stability criteria to a low value (refer to [Change measurement options](#) on page 7).
- Stir the standards and samples at a slow and steady rate to prevent the formation of a vortex.
- Use a dilute ionic strength adjuster (ISA) solution for calibration and measurements:
  1. Dissolve the contents of one ionic strength adjuster powder pillow in 50 mL of deionized water.
  2. Add 5 mL of this solution to every 25 mL of standard or sample that is used.

**Note:** The ionic strength adjuster can be omitted only when all of the following conditions are true:

- The sample does not contain interferences.
- The sample pH is in the range that is given in the specifications.
- Omission of the ISA is accepted by the regulatory reporting agency (if the measurement is for regulatory reporting).

## Interferences

The sensing element responds to fluoride 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:

$$E = E^{\circ} + (RT/(zF))\ln[aN_a + KN_{ax} \times ax]$$

Where

- $ax$ —the activity of the interfering ion
- $KN_{ax}$ —the selectivity coefficient for the interfering ion relative to fluoride

Cations and most anions do not interfere with the ISEF121 probe response to fluoride ions. Anions commonly associated with fluoride (Chloride ( $Cl^-$ ), Bromide ( $Br^-$ ), Sulfate ( $SO_4^{2-}$ ), Bicarbonate ( $HCO_3^-$ ), Phosphate ( $PO_4^{3-}$ ) and acetate) do not interfere with probe operation.

Hydroxyl ions ( $OH^-$ ) do interfere with probe response above pH 8. Some ions, such as Carbonate ( $CO_3^{2-}$ ) or Phosphate ( $PO_4^{3-}$ ), make the sample more basic, which increases Hydroxyl ( $OH^-$ ) interference, but do not directly interfere with the probe operation. Hydroxide ( $OH^-$ ) ions interfere with the probe response to fluoride when the level of hydroxide is greater than 10% of the level of fluoride present. At pH 8 or less, there are no hydroxide ions to interfere. The error increases when the pH is increased and the fluoride levels are decreased.

If Fluoride ISA is added to standards and samples, the pH is buffered between 5.0 and 5.5, which prevents hydroxide ion interferences.

The selectivity coefficient is the approximate apparent increase in the measured concentration caused by one unit of the interfering ion (e.g., 1 unit of  $OH^-$  raises the fluoride concentration by 0.1). The approximate selectivity coefficients for some ions with the IntelliCAL<sup>®</sup> Fluoride ISE are shown in [Table 1](#).


**Table 1 Interferences**

Interference	Selectivity coefficient
Hydroxyl ( $OH^-$ )	0.1 (below pH 8)

## 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 ISEF121 Settings menu.

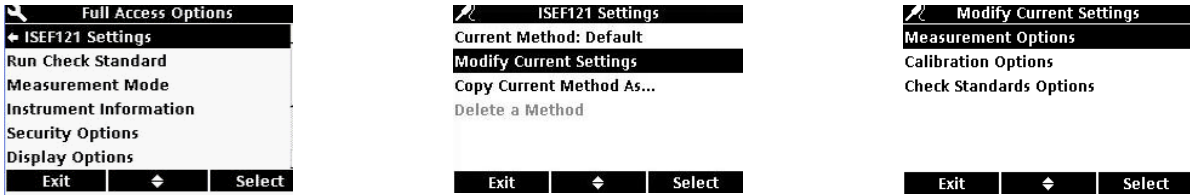
**Note:** Access control must be off or a valid password must be entered before any of the check standard method options can be changed.

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 2](#).


**Table 2 Parameter-specific settings**

Setting	Options
Measurement Options	<ul style="list-style-type: none"> <li>• Units</li> <li>• Significant digits</li> <li>• Auto stabilization</li> <li>• Stability criteria</li> <li>• Upper and lower range limits</li> </ul>
Calibration Options	<ul style="list-style-type: none"> <li>• Standard set</li> <li>• Calibration units</li> <li>• Minimum calibration points</li> <li>• Slope limit</li> <li>• Calibration reminder</li> </ul>
Check Standard Options	<ul style="list-style-type: none"> <li>• Standard</li> <li>• Check standard reminder</li> <li>• Acceptance criteria</li> </ul>

## 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.


Setting	Option	Recommended range
Current method	Pure water	0.1 to 1.0 mg/L F <sup>-</sup>
	Drinking water	0.5 to 2.0 mg/L F <sup>-</sup>
	Default	>2.0 mg/L F <sup>-</sup>

1. Make sure a probe is connected to the meter.
2. Push  and select ISEF121 Settings.
3. Select Modify Current Settings.
4. Select Measurement Options and update the settings:

Option	Description
<b>Units</b>	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. <i>Note: The mV units are shown when the detailed display is selected.</i>
<b>Significant Digits</b>	Sets the significant digits shown—2, 3 (default) or 4.
<b>Auto Stabilization</b>	Sets auto stabilization—on (default) or off. The default stability drift rate is 1.0 mV/min.
<b>Stability Criteria</b>	When Auto Stabilization is off, sets the stability criteria—0.1 to 9.9 mV/min. <ul style="list-style-type: none"> <li>• Lower stability criteria will require longer stabilization times, but the measurement will be more precise.</li> <li>• Higher stability criteria will require shorter stabilization times, but the measurements may be less precise.</li> <li>• Stability criteria for factory-set methods: Pure water (0.2 mV/min), Drinking water (0.4 mV/min); Default (1.0 mV/min).</li> </ul>
<b>Measurement Limits</b>	Sets the measurement limits—Lower limit (default: 0.01 mg/L) or Upper limit (default: 19,000 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 ISEF121 Settings.
3. Select Modify Current Settings.



4. Select Calibration Options and update the settings:

Option	Description
<b>Std Set</b>	<p>Sets the temperature compensated standard sets that are used for calibration—</p> <ul style="list-style-type: none"><li>• 0.5, 1 or 2 mg/L</li><li>• 1 or 10 mg/L</li><li>• 0.1, 1 or 10 mg/L</li><li>• 1, 10 or 100 mg/L</li></ul> <p>Standard set values are shown on the Calibration Options screen.</p> <p>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 .</p> <p><b>Note:</b> Only the minimum calibration points must be measured for Done to be shown on the calibration screen.</p>
<b>Chemical Form</b>	Sets the chemical form.
<b>Calibration Units</b>	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.
<b>Std Set Values</b>	<p>When Std Set is set to Custom, sets the standard set values.</p> <p>Up to five standard values can be made. Each standard value can include a standard set value, Custom or No Standard.</p>
<b>Minimum Cal Points</b>	Sets the minimum number of calibration points necessary before a calibration can be completed—2 or 3.
<b>Slope Limit</b>	<p>Sets the slope limit—1 to 30% (acceptable slope criteria, default = 15%). For factory-set methods, there are different slope limits: Pure water (slope limit = 25%); Drinking water (slope limit = 15%); Default (slope limit = 15%).</p> <p>The slope must fall within set limits for successful calibration.</p>


5. Select Calibration Reminder and update the settings:

Option	Description
<b>Reminder Repeat</b>	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.
<b>Expires</b>	<p>Calibration expires after the selected time—Immediately, Reminder + 30 min (default), Reminder + 1 h, Reminder + 2 h or Continue Reading.</p> <p><b>Note:</b> The meter cannot be used to read samples after calibration has expired unless Continue Reading is selected.</p>

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.

## Change check standard options

1. Make sure a probe is connected to the meter.
2. Push  and select ISEF121 Settings.
3. Select Modify Current Settings.
4. Select Check Standards Options and update the settings:

Option	Description
<b>Standard</b>	Sets the check standard—0.5, 1.0 (default), 2.0, 10.0 mg/L or Custom. The standard value is shown on the Check Standards Options screen.

Option	Description
<b>Standard Units</b>	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.
<b>Standard Value</b>	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
<b>Reminder</b>	Sets the check standard reminder—On or Off (default). The meter automatically shows the check standard screen if Reminder is On.
<b>Allow Defer</b>	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
<b>Acceptance Limits</b>	Sets the tolerance limits for check standard—1% to 20%.
<b>Cal Expires on Failure</b>	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.
2. If harsh contaminants are attached to the probe, use a small amount of plain fluoride toothpaste (no teeth whiteners or abrasives) and gently rub it into the crystal with a circular motion. Continue to rub until the toothpaste film is removed. When finished, rinse with deionized water to clean the probe.
3. Soak for 30 minutes in 1 mg/L Fluoride standard solution.

## Storage

The probe can be stored dry. To protect the sensing element, rinse with DI water and blot dry with a lint-free cloth. Install the sensor protection cap.

**Note:** The probe must be conditioned after long-term storage. Refer to [Preparation for use](#) on page 2.

## 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 <sup>®</sup> 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	Electrical issue	Contact a Technical Support Representative.
Slow response time	Dirty sensing element	Clean the probe (refer to <a href="#">Clean the probe</a> on page 10).
	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 <a href="#">Check probe response</a> on page 13)	pH is incorrect	Make sure the pH is between 5.0 and 5.5 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 30 minutes in a 0.1 mg/L standard solution with ISA.
	Damaged probe	Contact a Technical Support Representative.
	Incorrect standards	Calibrate using freshly prepared standards.
	Dirty sensing element	Clean the probe 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 (refer to <a href="#">Clean the probe</a> on page 10).
	Clogged reference	Rinse reference junction with deionized water thoroughly and shake the probe downward to remove any air bubbles. The air bubbles will not be visible.
	Improper storage conditions	Clean or condition the probe and attempt another calibration. To re-condition the probe and reference junctions, allow the probe to soak in a conditioning solution (that contains ISA) for at least 30 minutes prior to 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.
	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.
	Bubbles trapped under sensor tip	Gently shake the probe until bubbles are removed from under sensor tip.
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.

Message or symptom	Possible cause	Action
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 with the Drinking Water or Pure Water default methods to optimize meter settings for slope acceptance and stabilization criteria at lower levels.
	Measurement value is outside of range.	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 Fluoride Standard Solutions that are above and below the expected sample concentration. For example, use 1 and 10 mg/L Fluoride Standard Solutions. The two solutions should have potentials (difference in mV readings) that are 59 mV apart at 25 °C (within the slope limits of the method is acceptable). Both solutions should be above 1 mg/L Fluoride.

### Check accuracy of sample reading

To make sure the sample measurement is accurate, add a spike of Fluoride 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 Fluoride in sample (before spike)
- C = concentration of standard used for spiking (mg/L)
- V<sub>1</sub> = spike volume (mL)
- V<sub>2</sub> = 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 Fluoride)

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