INSTRUCTION MANUAL

HANNA® instruments

HI3220

HI3221

HI3222

HI3220 • HI3221 • HI3222

Calibration Check pH / ORP / ISE / Temperature Bench Meters

Hanna Instruments Inc., 584 Park East Drive, Woonsocket, RI 02895 USA
www.hannainst.com

Dear Customer,

Thank you for choosing a Hanna Instruments® product.

Please read this instruction manual carefully before using this instrument as it provides the necessary information for correct use of this instrument as well as a precise idea of its versatility.

If you need additional technical information, do not hesitate to e-mail us at tech@hannainst.com.
Visit www.hannainst.com for more information about Hanna Instruments and our products.

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1. PRELIMINARY EXAMINATION

Remove the instrument and accessories from the packaging and examine it carefully.
For further assistance, please contact your local Hanna Instruments® office or email us at tech@hannainst.com.
Each unit is supplied with:

- HI1131B pH electrode
- HI7662-TW Temperature probe
- HI76404W Electrode holder
- pH 4.01 buffer solution, 20 mL sachet
- pH 7.01 buffer solution, 20 mL sachet
- Cleaning solution, 20 mL, 2 sachets
- Electrolyte solution
- 12 Vdc power adapter
- Quick Reference guide with instrument quality certificate

Ordering information

HI322x-01 12 Vdc/115 Vac, USA plug
HI322x-02 12 Vdc/230 Vac, European plug

***Note**: Save all packing material until you are sure that the instrument functions correctly. All defective items must be returned in the original packing with the accessories supplied.*

2. GENERAL DESCRIPTION

The HI322x instruments are professional bench pH meters with graphical LCD.
They are provided with a series of new diagnostic features for improved measurement reliability.

Main Features

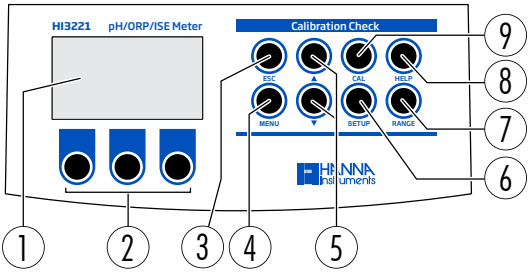
- Single (HI3220 and HI3221) or dual (HI3222) input channels
- 7 standard pH buffers (pH 1.68, 4.01, 6.86, 7.01, 9.18, 10.01 and 12.45) for calibration
- pH calibration up to five calibration points (see instrument specifications)
- Custom calibration with up to five custom buffers
- Messages on the graphic LCD for an easy and accurate calibration
- Diagnostic features to alert the user when the electrode needs cleaning

These instruments also measure with ORP electrodes given their capability to measure mV with a 0.1 mV resolution.
HI3221 and HI3222 measure with ISE electrodes on ppm scale.
The electrode type and unit selection (HI3222), the ion change selection (HI3221), and the ISE calibration in up to five calibration standard solutions make these instruments useful for a large range of measurements.

Other features include:

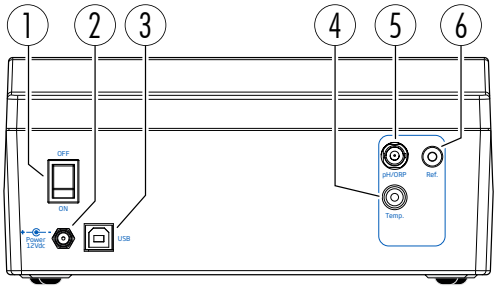
- Relative mV measurements
- Log on demand, up to 400 samples
- Log interval with log on stability feature, up to 600 records
- Auto Hold feature, to freeze first stable reading on the LCD
- GLP feature, to view last calibration data for pH, Rel mV or ISE
- PC interface

3. FUNCTIONAL DESCRIPTION – HI3220 & HI3221



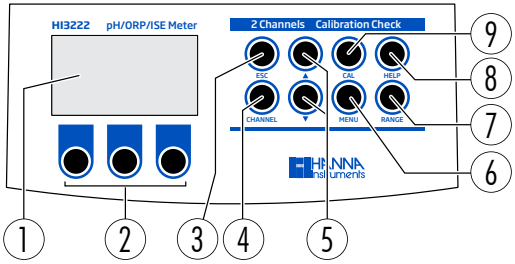
1. Liquid Crystal Display (LCD)
2. Virtual keys (perform action displayed above on the LCD)
3. **ESC** key, exit function
4. **MENU** key, log recall and GLP
5. ▲▼ forward/backward navigation & increase/decrease value
6. **SETUP** key, enter (meter) SETUP mode
7. **RANGE** key, switch between pH and mV range (HI3220); pH, mV, and ISE range (HI3221)
8. **HELP** key, enter/exit contextual help
9. **CAL** key, enter calibration mode

Rear view



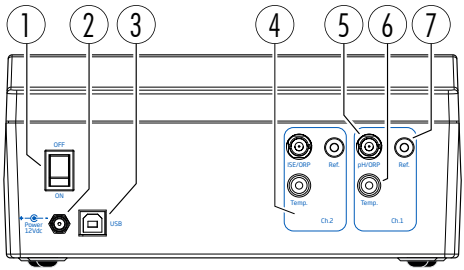
1. Power button
2. Input for power cable
3. Input for PC interface via USB
4. Temperature probe connection port
5. Electrode with BNC
   - pH/ORP (HI3220)
   - pH/ORP/ISE (HI3221)
6. Reference electrode port

4. FUNCTIONAL DESCRIPTION – HI3222 (DUAL INPUT)



1. Liquid Crystal Display (LCD)
2. Virtual keys (perform action displayed above on the LCD)
3. **ESC** key, exit function
4. **CHANNEL** key, toggle pH (Ch1) and ISE (Ch2)
5. ▲▼ forward/backward navigation & increase/decrease valuet
6. **MENU** key, log recall and GLP
7. **RANGE** key, to switch between Ch1 and Ch2
8. **HELP** key, enter/exit contextual help
9. **CAL** key, enter calibration mode

Rear view



1. Power button
2. Input for power cable
3. Input for USB to PC connection
4. Channel 2 (Ch2) inputs:
   - ISE/ORP probe with BNC
   - Reference probe
   - Temperature probe
5. Channel 1 (Ch1) Electrode with BNC
6. Channel 1 (Ch1) Temperature probe port
7. Channel 1 (Ch1) Reference electrode port

5. SPECIFICATIONS HI3220

pH	Range	–2.0 to 20.0 pH –2.00 to 20.00 pH –2.000 to 20.000 pH
	Resolution	0.1 pH 0.01 pH 0.001 pH
	Accuracy	±0.1 pH ±0.01 pH ±0.002 pH
	Calibration	Up to 5 points 7 standard buffers (1.68; 4.01; 6.86; 7.01; 9.18; 10.01; 12.45) 5 custom buffers
ORP	Range	±2000.0 mV
	Resolution	0.1 mV
	Accuracy	±0.2 mV
Temperature	Range	–20.0 to 120.0 °C (–4.0 to 248.0 °F)
	Resolution	0.1 °C (0.1 °F)
	Accuracy	±0.2 °C (±0.4 °F) (excluding probe error)
Rel mV offset range		±2000 mV
Slope calibration		From 80 to 110%
Temperature compensation		Manual Automatic
Electrode		BNC connection pH/ORP electrodes
Temperature probe		RCA connection Recommended option: HI7662-TW
LOG on demand		200 samples
Lot logging		5, 10, 30 seconds 1, 2, 5, 10, 15, 30, 60, 120, 180 minutes, AutoEnd (maximum 600 samples)
Power supply		12 Vdc power adapter
PC interface		opto-isolated USB
Environment		0 to 50 °C (32 to 122 °F) max. RH 55% non-condensing
Dimensions		235×207×110 mm (9.2×8.14×4.33")
Weight (meter only)		1.8 Kg (4.1 lb)

6. SPECIFICATIONS HI3221

pH	Range	–2.0 to 20.0 pH; –2.00 to 20.00 pH; –2.000 to 20.000 pH
	Resolution	0.1 pH; 0.01 pH; 0.001 pH
	Accuracy	±0.1 pH; ±0.01 pH; ±0.002 pH
	Calibration	Up to 5 points 7 standard buffers (1.68; 4.01; 6.86; 7.01; 9.18; 10.01; 12.45) 5 custom buffers
ORP	Range	±2000.0 mV
	Resolution	0.1 mV
	Accuracy	±0.2 mV
ISE	Range	1.00 E^{-3} to 1.00 E^{5} ppm
	Resolution	3 digits
	Accuracy	±0.5% of reading (monovalent ions) ±1% of reading (divalent ions)
	Calibration	Up to 2 points 6 standard solutions (0.1; 1; 10; 100; 1000; 10000 ppm)
Temperature	Range	–20.0 to 120.0 °C (–4.0 to 248.0 °F)
	Resolution	0.1 °C (0.1 °F)
	Accuracy	±0.2 °C (±0.4 °F) (excluding probe error)
Rel mV offset range		±2000 mV
Slope calibration		From 80 to 110%
Temperature compensation		Manual Automatic
Electrode		BNC connection pH, ORP, and ISE electrodes
Temperature probe		RCA connection Recommended option: HI7662-TW
LOG on demand		300 samples
Lot logging		5, 10, 30 seconds 1, 2, 5, 10, 15, 30, 60, 120, 180 minutes, AutoEnd (maximum 600 samples)
Power supply		12 Vdc power adapter
PC interface		opto-isolated USB
Environment		0 to 50 °C (32 to 122 °F) max. RH 55% non-condensing
Dimensions		235×207×110 mm (9.2×8.14×4.33")
Weight (meter only)		1.8 Kg (4.1 lb)

7. HI3222 SPECIFICATIONS

pH	Range	–2.0 to 20.0 pH; –2.00 to 20.00 pH; –2.000 to 20.000 pH
	Resolution	0.1 pH; 0.01 pH; 0.001 pH
	Accuracy	±0.1 pH; ±0.01 pH; ±0.002 pH
	Calibration	Up to 5 points 7 standard buffers (1.68; 4.01; 6.86; 7.01; 9.18; 10.01; 12.45) 5 custom buffers
ORP	Range	±2000.0 mV
	Resolution	0.1 mV
	Accuracy	±0.2 mV
ISE	Range	1.00 E^{-7} to 9.99 E^{10} concentration (choice of units)
	Resolution	3 digits
	Accuracy	±0.5% of reading (monovalent ions) ±1% of reading (divalent ions)
	Calibration	Up to 5 points 6 standard solutions (in units selected)
Temperature	Range	–20.0 to 120.0 °C (–4.0 to 248.0 °F)
	Resolution	0.1 °C (0.1 °F)
	Accuracy	±0.2 °C (±0.4 °F) (excluding probe error)
Rel mV offset range		±2000 mV
Slope calibration		From 80 to 110%
Temperature compensation		Manual Automatic
Electrode		BNC connection pH, ORP, and ISE electrodes
Temperature probe		RCA connection Recommended option: HI7662-TW
LOG on demand		400 samples
Lot logging		5, 10, 30 sec 1, 2, 5, 10, 15, 30, 60, 120, 180 minutes, AutoEnd (maximum 600 samples)
Power supply		12 Vdc power adapter
PC interface		opto-isolated USB
Environment		0 to 50 °C (32 to 122 °F); max. RH 55% non-condensing
Dimensions		235×207×110 mm (9.2×8.14×4.33")
Weight (meter only)		1.8 Kg (4.1 lb)

8. OPERATIONAL GUIDE

8.1. POWER CONNECTION

Plug the 12 Vdc adapter into the power supply socket.

Note: *have a fuse protected main line*

8.2. ELECTRODE AND PROBE CONNECTIONS

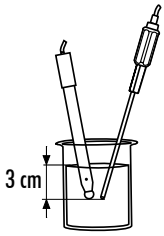
For pH or ORP measurements connect a combination pH/ORP electrode to the BNC connector located on the rear panel of the instrument.
For ISE measurements (HI3221 & HI3222) connect a combination ISE electrode to the BNC connector located on the rear panel of the instrument.
For half cell electrodes with a separate reference connect the electrode's BNC to the BNC connector and the electrode's reference to the corresponding reference input socket.
For temperature measurements and automatic temperature compensation connect the temperature probe to the appropriate socket.
HI3222, two channels instrument, use the designated temperature socket of each channel. As the channels are fully isolated, use 2 temperature probes to view independent temperature readings for each channel.

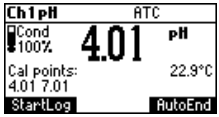
8.3. INSTRUMENT START UP

- Turn the instrument on from the power switch located on the rear panel of the instrument.
- Wait until the instrument finishes the initialization process. During this process the Hanna Instrument logo is displayed.

8.4. pH MEASUREMENTS

To take a pH measurement remove the electrode protective cap and submerse the electrode and the temperature probe 3 cm (1¼") into the sample to be tested.
If necessary, press **RANGE** until the display changes to the pH mode.
Enter **SETUP** menu to select the pH resolution.
For HI3222, use **Channel** to select pH measure mode.
Allow for the electrode to adjust and reading to stabilize (hourglass symbol turns off).





pH screen displays:

- pH reading with selected resolution.
- Temperature reading in the selected unit (°C or °F).
- Temperature compensation mode (**MTC** - manual, **ATC** - automatic).
  While in **MTC** mode the ▲▼ indicate that the temperature can be manually changed using **ARROW** keys.

- Electrode condition during the calibration day.
- The buffers used in last pH calibration (if feature is enabled in **SETUP**).

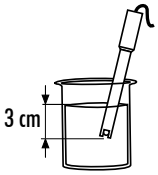
Ensure the instrument is calibrated (see pH CALIBRATION section for details).
Keep the electrode moist and rinse thoroughly with the sample before use.
The pH reading is directly affected by temperature. If the sample temperature is different from the temperature at which the pH electrode was kept, allow a few minutes to reach thermal equilibrium.
To use the instrument's Automatic Temperature Compensation feature, submerse the temperature probe into the sample as close to the electrode as possible and wait for a few seconds.

For manual temperature compensation (MTC)measurements, disconnect the temperature probe.

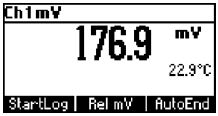
The display will show the default temperature of 25 °C, the last measured temperature reading, or the last set temperature, with the "**MTC**" indication.
The "**MTC**" indication and the ▲▼ symbol light up on the LCD to indicate that the instrument is in **MTC** mode and the **ARROW** keys can be used to enter the desired temperature value.

Note: *When in MTC mode the user can press and hold an ARROW key, and the instrument will start incrementing /decrementing the temperature value. The instrument keeps measuring and the display is updated periodically.*

8.5. ORP MEASUREMENTS



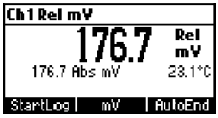
- Connect an ORP electrode (see ACCESSORIES section) to the instrument, and turn it ON.
- Press **RANGE** to enter mV mode.
- Submerse the ORP electrode 3 cm (1¼") into the sample to be tested and wait a few seconds for the reading to stabilize.
  Measurements are displayed with 0.1 mV resolution.



The "ATC" (or "MTC") message is not displayed because mV readings are not temperature compensated.
Keep electrode surface clean and smooth to ensure accuracy. Pretreatment solutions are available to condition the electrode and improve its response time (see ACCESSORIES section).

8.6. RELATIVE MV MEASUREMENTS

Use **Rel mV** function key from mV measurement mode. The relative mV reading is displayed along with the Absolute mV value and the current temperature reading.

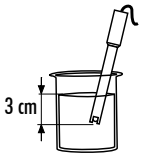


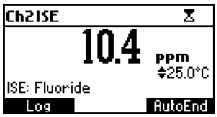
The relative mV reading is equal to the difference between the absolute mV input value and relative mV offset established in the relative mV calibration.

Note: *If using the pH or ISE electrode while in mV mode, the instrument will measure the mV generated by the electrode.*

8.7. ISE MEASUREMENTS (HI3221, HI3222 ONLY)

Connect an ISE electrode (and the corresponding reference if necessary) to the corresponding instrument input.
Turn instrument ON.
On HI3222 the instrument input must be Channel 2. Press **Channel**, to enter ISE measure mode.
On HI3221, press **RANGE** to enter the ISE mode.
Submerse the ISE electrode tip 3 cm (1¼") into the sample to be tested and wait for the reading to stabilize.
The ISE reading is displayed along with the current temperature reading.





The "ATC" (or "MTC") message is not displayed because ppm readings are not temperature compensated.
To take accurate ISE measurements, ensure that the appropriate ISE electrode type and ISE unit are configured in SETUP menu (HI3222), or the proper ion charge and slope is set (HI3221), and the instrument is calibrated (see ISE CALIBRATION section for details).

Notes:

- *When the reading is out of range, the display will flash the closest full-scale value.*
- *The instrument displays "----" on the first LCD line if not calibrated. Perform at least a single-point calibration in order to take ISE measurements.*
- *ISE electrode SETUP menu reconfiguration requires calibration.*

8.8. TEMPERATURE MEASUREMENTS

Connect the HI7662-TW temperature probe to the appropriate socket.
Immerse the temperature probe into the sample and allow the reading to stabilize (see second LCD line).

Note: *The temperature can be displayed in Celsius degrees (°C) or in Fahrenheit degrees (°F).*

8.9. BACKLIGHT FEATURE

The instrument is provided with a Backlight feature. The Backlight levels can be selected in the SETUP menu.

9. pH CALIBRATION

It is recommended to calibrate the instrument frequently, especially if high accuracy is required.
The pH range should be recalibrated:

- Whenever the pH electrode is replaced.
- At least once a week.

- After testing aggressive chemicals.
- When calibration alarm time out is expired - "CAL DUE" is displayed blinking (feature enabled in SETUP).
- "Outside Cal Range" messages displayed blinking during pH measurement indicates that the measurement range is not covered by current calibration (feature enabled in SETUP).

9.1. PROCEDURE

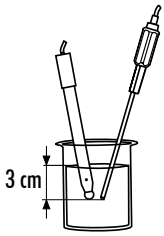
The HI322X family supports use of 7 standard buffers (1.68, 4.01, 6.86, 7.01, 9.18, 10.01 and 12.45 pH) and up to 5 custom buffers.
Standard pH buffers are temperature compensated during calibration whereas custom buffers are not.
When a custom buffer is selected during calibration, the **Custom** key is displayed.

- Press **Custom** to correct the value to the actual pH value at the temperature of measurement.
- Use **ARROW** keys to change the value within a ±1.00 pH window and then press **Accept**.
- Press **ESC** to leave custom buffers value unchanged. Press **Confirm**.

For accurate pH measurements a two-point calibration is required.
The instrument automatically skips the buffers within ±0.2 pH window, around one of the calibrated buffers.

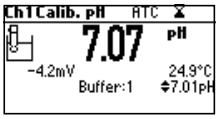
- Pour small quantities of selected buffer solutions into clean beakers. Use two beakers for each buffer solution. One for rinsing the electrode and the second for calibration.
- Remove the protective cap, open the fill hole and rinse the electrode with some of the buffer solution to be used for the first calibration point.

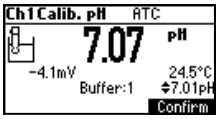
9.2. FIVE-POINT CALIBRATION



- Immerse the pH electrode and the temperature probe approximately 3 cm (1¼") into a buffer solution and stir gently.

  ***Note**: The temperature probe should be close to the pH electrode.*
- Press **CAL**. The instrument displays the measured pH, the first expected buffer and the temperature reading.
- Use the **ARROW** keys to configure a different buffer value.
- The "⧖" tag is displayed blinking until the reading is stable.
- When the reading is stable and close to the selected buffer, **Confirm** is displayed.

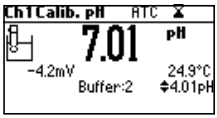


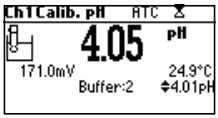


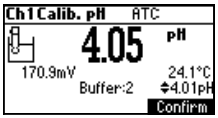
- Press **Confirm** to confirm first point.
- The calibrated value and the second expected buffer value are displayed.
- Immerse the pH electrode and the temperature probe approximately 3 cm (1¾") into the second buffer solution and stir gently.

  ***Note**: The temperature probe should be close to the pH electrode.*

- Use the **ARROW** keys to configure buffer value.
- The "⧖" tag is displayed blinking until the reading is stable.
- When the reading is stable and close to the selected buffer, **Confirm** is displayed.

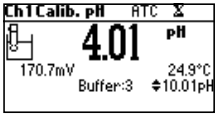


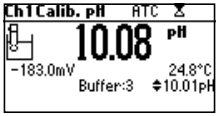


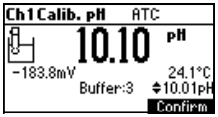


- Press **Confirm** to confirm calibration.
- The calibrated value and the third expected buffer value are displayed.
- Immerse the pH electrode and the temperature probe approximately 3 cm (1¾") into a third buffer solution and stir gently.

  ***Note**: The temperature probe should be close to the pH electrode.*
- Use the **ARROW** keys to configure buffer value.
- The "⧖" tag is displayed blinking until the reading is stable.
- When the reading is stable and close to the selected buffer, the **Confirm** is displayed.







- Press **Confirm** to confirm calibration.

Repeat this procedure with two additional pH buffers to cover the entire sample pH range.

9.3. FOUR, THREE OR TWO-POINT CALIBRATION

- Proceed as described in "FIVE-POINT CALIBRATION" section.
- Press **CAL** or **ESC** after the appropriate accepted calibration point. The instrument returns to measurement mode and memorizes the calibration data.

9.4. SINGLE-POINT CALIBRATION

Options: **Replace** and **Offset**

Option is configured in SETUP, parameter First Point Mode

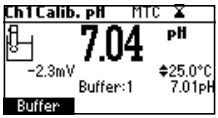
If "Replace" is selected a new calibration point is added to the existing data, and the slope is calculated. The slopes between current buffer and nearest lower and higher buffers are reevaluated.

If "Offset" is selected, an electrode offset correction is performed to all buffer data keeping the existing slopes unchanged.

- Proceed as described in "FIVE-POINT CALIBRATION" section.
- Press **CAL** or **ESC** after the first calibration point is confirmed. The instruments memorizes the single-point calibration data and returns to measurement mode.

Notes:

- *Press MTC key to toggle pH buffer selection and temperature reading during calibration (temperature probe is not connected, MTC mode).*

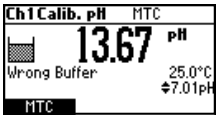


- *The displayed arrow is moving to the temperature value. Use ARROW keys to configure temperature value.*

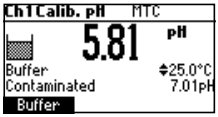
9.5. ERROR SCREENS

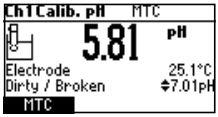
Wrong Buffer: calibration cannot be confirmed

The pH reading is not close to the selected buffer. Select another buffer or change the buffer.



Electrode Dirty/Broken alternatively with **Buffer Contaminated**: calibration cannot be confirmed

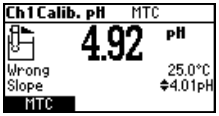




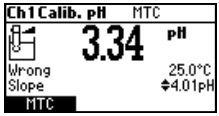
Electrode offset is not in the accepted range. Check the electrode. Clean the electrode following the Cleaning Procedure (see ELECTRODE CONDITIONING AND MAINTENANCE section). Check the quality of the buffer. If necessary, change the buffer.

Wrong Slope: Calibration cannot be confirmed

Slope is less than the lowest accepted value (80% of default slope).

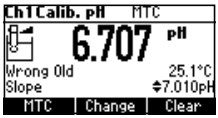


Slope is more than the highest accepted value (110 % of default slope).



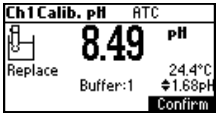
Wrong Old Slope

An inconsistency between new and previous (old) calibration is detected. Clear old calibration parameters and initiate calibration from the current point. The instrument will keep all confirmed values during current calibration.



Note: *For single-point calibration the electrode condition is not displayed in the measurement screen.*

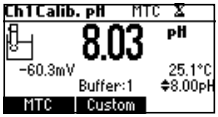
Each time a buffer is confirmed, the new calibration parameters replace the older calibration parameters of the corresponding buffer.
If an additional single buffer calibration is added at a latter time, the new buffer point will be added to the stored calibration.
If the existing stored calibration is full (five calibration points), after confirming the calibration point, the instrument will ask which buffer will be replaced by current buffer. On the Buffer line will be displayed the proposed buffer.

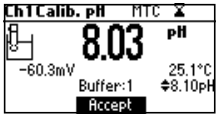


Use **ARROW** keys to select another buffer.
Press **Confirm** to confirm.
Press **CAL** or **ESC** to exit. In this case, the buffer will not be entered.
***Note**: The replaced buffer is not removed from calibration list and it can be selected for the next calibration points.*

9.6. WORKING WITH CUSTOM BUFFERS

Custom buffers configured in SETUP menu can be selected for calibration (use **ARROW** keys).
Custom key is displayed. Press **Custom** to adjust the buffer value at the current temperature.
Use the **ARROW** keys to change the buffer value.
Press **Accept** to accept new value or **ESC** to exit.



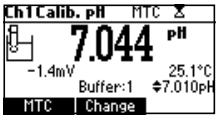


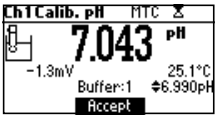
***Note**: Custom buffer value can be adjusted within a ±1.00 pH window, around the set value.*

9.7. WORKING WITH MILI pH BUFFERS

Hanna® millesimal pH buffers are ± .002 pH buffers formulated to correspond to nominal pH values. (1.000, 2.000, 3.000, 4.010, 5.000, 6.000, 7.010, 8.000, 9.000, 10.010, 11.000, 12.000, 13.000 and 9 that fall between). These buffers require the user to use the closest standard buffer and adjust it, or to use custom buffers. With these buffers it is possible to closely bracket the measurement range of interest and insure an accurate measurement.
The resolution of the meter must be set to 0.001 pH (see SETUP section). Eight buffers are stored in instrument for calibration.
If calibration is invoked using millesimal buffers, the calibration buffer can be modified within a ±0.020 pH range in accordance with the label on the calibration buffer.

Press **Change** to enter buffer edit mode.

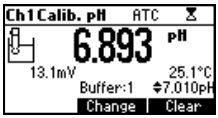


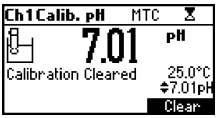


Use **ARROW** keys to change the buffer value.
Press **Accept** to accept new value or **ESC** to exit.

9.8. CLEAR CALIBRATION

Press **Clear** key to clear previous calibrations.
The instrument will display "Calibration Cleared".



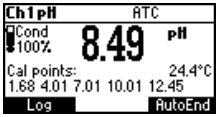


All previous calibrations are cleared and the instrument enters calibration mode.

***Note**: If Clear calibration is invoked during the first calibration point, the instrument returns to measurement mode with CAL DUE message flashing.*

Electrode Condition

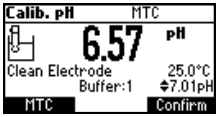
Electrode condition icon and a numeric value (unless the feature is disabled) indicates electrode status after calibration. The "cond" remains active until the end of the day.



***Note**: The electrode condition is evaluated only if current calibration includes at least two standard buffers.*

Clean Electrode Warning

Each time pH calibration is performed the instrument compares the new calibration with the one previously stored. When there is significant difference, the "Clean electrode" warning message notifies the user that the pH electrode needs to be cleaned (see ELECTRODE CONDITIONING AND MAINTENANCE section for details).



Calibrate after cleaning.

***Note**: If the calibration data are cleared, the comparison is done with the default values.*

10. pH BUFFER TEMPERATURE DEPENDENCE

Temperature has an effect on pH buffers. During calibration the instrument will automatically calibrate to the pH value corresponding to the measured or set temperature.

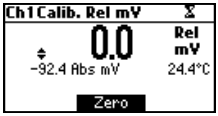
Temp		pH Buffers						
°C	°F	1.68	4.01	6.86	7.01	9.18	10.01	12.45
0	32	1.67	4.01	6.98	7.13	9.46	10.32	13.38
5	41	1.67	4.00	6.95	7.10	9.39	10.24	13.18
10	50	1.67	4.00	6.92	7.07	9.33	10.18	12.99
15	59	1.67	4.00	6.90	7.05	9.27	10.12	12.80
20	68	1.68	4.00	6.88	7.03	9.22	10.06	12.62
25	77	1.68	4.01	6.86	7.01	9.18	10.01	12.45
30	86	1.68	4.02	6.85	7.00	9.14	9.96	12.29
35	95	1.69	4.03	6.84	6.99	9.11	9.92	12.13
40	104	1.69	4.04	6.84	6.98	9.07	9.88	11.98
45	113	1.70	4.05	6.83	6.98	9.04	9.85	11.83
50	122	1.71	4.06	6.83	6.98	9.01	9.82	11.70
55	131	1.72	4.08	6.84	6.98	8.99	9.79	11.57
60	140	1.72	4.09	6.84	6.98	8.97	9.77	11.44
65	149	1.73	4.11	6.84	6.99	8.95	9.76	11.32
70	158	1.74	4.12	6.85	6.99	8.93	9.75	11.21
75	167	1.76	4.14	6.86	7.00	8.91	9.74	11.10
80	176	1.77	4.16	6.87	7.01	8.89	9.74	11.00
85	185	1.78	4.17	6.87	7.02	8.87	9.74	10.91
90	194	1.79	4.19	6.88	7.03	8.85	9.75	10.82
95	203	1.81	4.20	6.89	7.04	8.83	9.76	10.73

During calibration the instrument will display the pH buffer value at 25 °C.

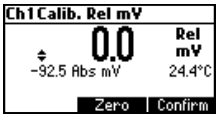
11. RELATIVE mV CALIBRATION

The relative mV value calibration is used to perform a single point calibration with an ORP standard or remove the contribution of the reference electrode to display mV equivalent to a SHE.

- Press **CAL** when the instrument is in relative mV mode. The relative mV value and the temperature values are displayed.
- Use the **ARROW** keys to configure relative mV value.



- Use **ZERO** key for Rel mV reading to be zero (Relative mV offset equals the mV reading).
- When the reading is stable in mV range and the relative mV offset is inside the offset window (±2000 mV), the **Confirm** is displayed.



- Press **Confirm** to confirm relative mV calibration. The instrument returns to measurement mode.
- If the absolute mV reading is out of range or the Relative mV offset is out of the offset window, "Wrong relative offset" message is displayed.

Change the input value or the Relative mV value to complete the calibration process.

***Note**: If a Rel mV offset calibration exists, CLR function key is displayed. Press CLR if you want Rel mV offset to be 0.0 mV.*

12. ISE CALIBRATION (HI3221 & HI3222)

It is recommended to calibrate the instrument frequently, especially if high accuracy is required.
Additionally, the ISE range should be recalibrated:

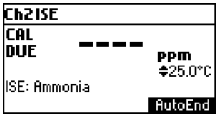
- Whenever the ISE probe or ion charge is changed.
- At least once a day.
- After testing aggressive chemicals.
- When calibration time out alarm has expired - "CAL DUE" displayed blinking.

Follow instructions for the individual electrode.
The electrode must be kept immersed a few seconds to stabilize.
On-screen messages guide the user during calibration.

12.1. PROCEDURE

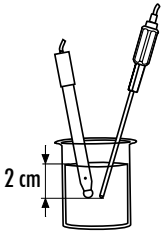
Select the ISE probe in SETUP menu (HI3222) or select the Ion Charge slope (see SETUP section for details).

***Note**: If the ISE probe has not been calibrated (one point), "----" is displayed.*



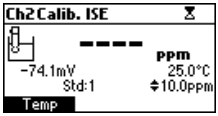
Pour small quantities of the buffer solutions into clean beakers. If possible, use plastic beakers to minimize any EMC interferences.
For accurate calibration and to minimize cross-contamination, use two beakers for each standard solution. One for rinsing the electrode and one for calibration.
HI3221 supports up to 2 points calibration with six standard solutions: 0.1, 1, 10, 100, 1000, 10000 ppm.
HI3222 offers additional ranges for other concentration units. These cover 5 decades of concentration. The HI3222 supports a 5 point calibration. It is advised to bracket expected ion concentration with your standards.
For fluoride electrode the 2 ppm standard is available (HI3222).
Remove the protective cap from the ISE electrode.

12.2. FIVE-POINT CALIBRATION (HI3222)



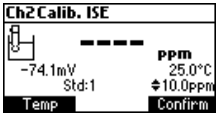
Use part of this procedure for 2, 3 or 4 point calibration. Press **ESC**.

- Immerse the ISE electrode approximately 2 cm (¾") into the less concentrated standard solution and stir gently.
- Press **CAL**. The first LCD line displays the ion concentration in the selected unit or "---" if not calibrated and first standard value.

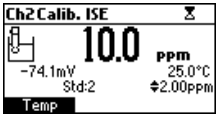


- Use the **ARROW** keys to select a different standard value.

- The "⧖" tag is displayed blinking until the reading is stable.
- When the reading is stable and close to the selected standard, **Confirm** is displayed.



- Press **Confirm** to confirm calibration.
- The calibrated value and the second expected standard value are displayed.



- After the first calibration point is confirmed, immerse the ISE electrode app. 2 cm (¾") into the second calibration solution.
- Use **ARROW** keys to select a different standard value.
- The "⧖" tag is displayed blinking until the reading is stable.
- When the reading is stable and close to the selected standard, **Confirm** is displayed.
- Press **Confirm** to confirm calibration.
- The calibrated value and the third expected standard value will be displayed.
- After the second calibration point is confirmed, immerse the ISE electrode app. 2 cm (¾") into the third calibration solution.
- Use **ARROW** keys to select a different standard value.
- The "⧖" tag is displayed blinking until the reading is stable.
- When the reading is stable and close to the selected standard, **Confirm** is displayed.
- Press **Confirm** to confirm calibration.
- The calibrated value and the fourth expected standard value are displayed.
- After the third calibration point is confirmed, immerse the ISE electrode app. 2 cm (¾") into the fourth calibration solution.
- Use **ARROW** keys to select a different standard value.
- The "⧖" tag is displayed blinking until the reading is stable.
- When the reading is stable and close to the selected standard, **Confirm** is displayed.
- Press **Confirm** to confirm calibration.
- The calibrated value and the fifth expected standard value are displayed.
- After the fourth calibration point is confirmed, immerse the ISE electrode app. 2 cm (¾") into the fifth calibration solution.
- Use **ARROW** keys to select a different standard value.
- The "⧖" tag is displayed blinking until the reading is stable.
- When the reading is stable and close to the selected standard, **Confirm** displayed.

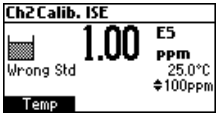
- Press **Confirm** to confirm calibration. The instrument stores the calibration value and returns to normal measurement mode.

***Note**: The instrument automatically skips standards used during calibration.*

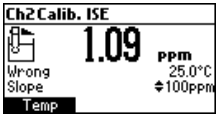
12.3. ERROR SCREENS

Wrong Standard: calibration cannot be confirmed

Verify that the correct standard is selected.
Message displayed if mV input is out of ±2000 mV range.



Wrong Slope: calibration cannot be confirmed
Message displayed if slope is out of the accepted range.
Slope under accepted value (30 % default slope). Verify that the correct standard is selected.



Slope over accepted value (130 % default slope).

Wrong Old Slope

An inconsistency between present and old calibration is detected.
Clear old calibration and proceed calibration from the current point. The instrument keeps all confirmed values during current calibration.
The instrument displays "----" on first LCD line if is not calibrated or if all calibrations are cleared.
Selecting "**Clear**" during first claibration point returns the instrument to measurement mode.

Notes:

- *Press **Temp** key to select temperature value to be changed if the temperature probe is not connected*
- *ISE range is not temperature compensated*
- *Standards and samples should be at the same temperature*

13. GOOD LABORATORY PRACTICE (GLP)

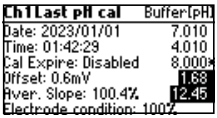
GLP is a set of functions that allows storage and retrieval of data regarding the maintenance and status of the electrode. All data regarding pH, Rel mV or ISE calibration is stored for the user to review when necessary.

Expired Calibration

The "expired calibration" status is triggered when the instrument detects a calibration time out. The "CAL" "DUE" warning is displayed blinking to warn the user that the instrument should be recalibrated.
The calibration time out can be set from 1 to 7 days or disabled (see SETUP section for details).
For example, if a 4 days time out is configured, the instrument issues the alarm 4 days after the last calibration. However, if the expiration value changes (e.g. 5 days), the alarm is recalculated and issued 5 days after the last calibration.

Notes: • *When the instrument is not calibrated or calibration is cleared (default values loaded) there is no "expired calibration", and the display shows the "CAL" "DUE" warning blinking.*
• *When an abnormal condition in the RTC (Real Time Clock) is detected, the instrument issues "expired calibration" status.*

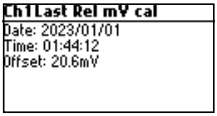
Last pH Calibration Data



The last pH calibration data is stored automatically after a successful calibration. To view the pH calibration data, use **GLP** key when the instrument is in the pH measurement mode. If GLP function key is not displayed press **MENU** key.
The instrument displays calibration buffer, offset, slope, electrode condition.

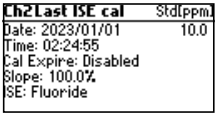
Note*: Buffers displayed highlighted are from previous calibrations.*
The custom buffers are marked with an "" .*
"No user calibration" is displayed if calibrations are cleared or the instrument was not calibrated in the pH range.

Last Relative mV Calibration Data



Last Relative mV calibration data is stored automatically after a successful calibration. To view the Relative mV calibration data, use **GLP** key while in Relative mV measurement mode.
The instrument displays: calibration date, time, and offset.

Last ISE Calibration Data



Last ISE calibration data is stored automatically after a successful calibration. To view the ISE calibration data, use **GLP** key while in ISE measurement mode. If GLP key is not displayed press **MENU** key.
The instrument displays: calibration date, time, slope, calibration status and electrode type.

Notes: • *Press ESC for the instrument to return to measurement mode.*
• *If no calibration, the instrument displays "No user calibration" message.*
• *The calibration standards (previous calibrations) are displayed in video inverse mode.*

14. SETUP

Setup mode allows viewing and modifying the measurement parameters. These are general SETUP parameters for all the ranges and range specific parameters.

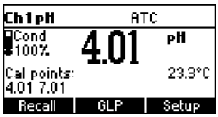
The following table lists the general SETUP parameters, their valid range and the factory default settings.

New	Description	Valid Value	Default
Backlight	Backlight level	0 to 8	4
Contrast	Contrast level	0 to 20	10
Date/Time		01.01.2006 to 12.31.2099 00:00 to 23:59	current date/time
Time Format		AM/PM or 24 hours	24 hours
Date Format		DD/MM/YYYY MM/DD/YYYY YYYY/MM/DD YYYY-MM-DD Mon DD, YYYY DD-Mon-YYYY YYYY-Mon-DD	YYYY/MM/DD
Language	Message display language	Up to four languages	English
Temperature unit		°C or °F	°C
AutoEnd Stability	Select AutoEnd Stability Criteria	Fast, Medium, Accurate	Medium
Log interval	Select log interval	Manual AutoEnd 5, 10, 30 s 1, 2, 5, 10, 15, 30, 60, 120, 180 min.	Manual (Log on demand)
Beep ON	Beeper Status	Enabled or Disabled	Disabled
Instrument ID	Instrument identification	0000 to 9999	0000
Baud Rate	Serial Communication	600, 1200, 1800, 9600	9600
Meter information	Displays general information		

The following table lists the specific range parameters.

Item	Description	Valid Value	Default
Calibr. Timeout (pH & ISE)	Number of days after Calibration warning is displayed	Disabled 1 to 7 days	Disable
First point mode (pH)	Management of 1 point calibration	Replace or offset	Replace
Custom buffer (pH)	Custom buffer setting	Max. 5 buffers	No
pH Resolution	Set pH resolution display	0.1 0.01 0.001	0.01
View calibr. points (pH)	Display calibration points	Enable or disabled	Enable
Display out of calibr. range warning		Enable or disabled	Enable
ISE probe (HI3222 only)	Type of ISE probe	Custom or Standard (18)	Fluoride
ISE unit (HI3222 only)		User, ppt, g/L, ppm, mg/L ppb, M, mol/L, mmol.L, % W/V	ppm
Ion Charge (HI3221 only)	±1, ±2, none		±1

To enter SETUP menu, press **Setup** function key while in measuring mode.

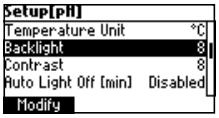


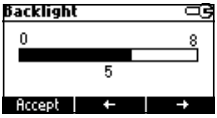
If **Setup** is not displayed press **MENU** key.

14.1. GENERAL PARAMETER SCREENS

Backlight

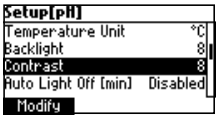
Select *Backlight*.
Press **Modify**.
Use ←/→ keys to change the intensity then press **Accept** to confirm.
Press **ESC** to leave without changing.

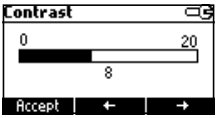




Contrast

Select *Contrast*.
Press **Modify**.
Use ←/→ keys to change contrast then press **Accept** to confirm.
Press **ESC** to leave without changing.



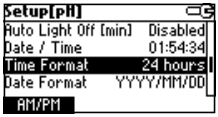


Date/Time

Select *Date/Time*.
Press **Modify**.
Use ←/→ keys to select item. Use **ARROW** keys to change focused values.
Press **Accept** to confirm new setting, or **ESC** to leave without changing.

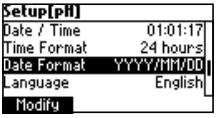
Time Format

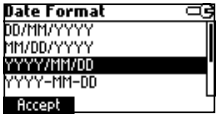
Select *Time Format*.
Press function key to change the option.



Date Format

Select *Date Format*.
Press **Modify**.
Use **ARROW** keys to select date format then press **Accept**.
Press **ESC** to leave without changing.





Language

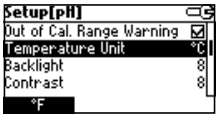
Select *Language*.
Use the desired function key to change the option. Wait until new language is loaded. If language load fails the instrument will try to reload current language.

If any language can't be loaded, the instrument will work in safe mode. In this mode all messages are displayed in English and **Help** is not available.

Temperature Unit

Select *Temperature unit*.

Press the displayed function key in order to change the temperature unit.

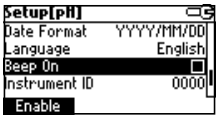


Beep On

Select *Beep On*.

Press the displayed function key to enable/disable option.

When enabled, an acoustic signal is heard every time a key is pressed or when a calibration can be confirmed. A long acoustic signal alerts that the pressed key is not active or a wrong condition is detected while in calibration.

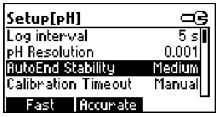


AutoEnd Stability

Select *AutoEnd*.

Press one of the displayed function keys to select the AutoEnd stability criteria. Three options are available: Fast, Medium, Accurate.

For the pH range the stability criteria are different for different pH resolution selected (Medium in 0.01 pH range is different than Medium in 0.001 range).



Log Interval

Select *Log interval*.

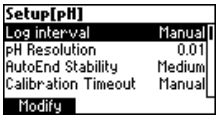
Press **Modify** to change the option.

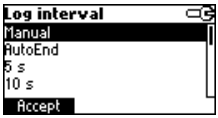
Use the arrow keys to select an option.

If the selected option is *Manual* the Log on demand is selected.

If *AutoEnd* is selected the reading will be memorized only when is stable.

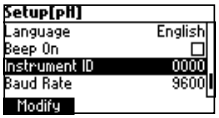
If a specific interval is selected, the reading is memorized at the start of the specific interval.

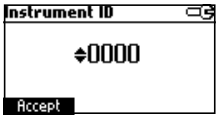




Instrument ID

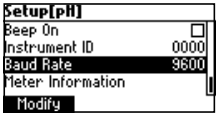
Select *Instrument ID*.
Press **Modify**.
Use **ARROW** keys to change the instrument ID.
Press **Accept** to confirm or **ESC** to exit without saving.

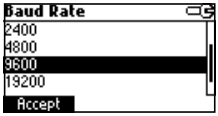




Baud Rate

Select *Baud Rate*.
Press **Modify**.
Use **ARROW** keys to select the desired communication baud.
Press **Accept** to confirm or **ESC** to exit.

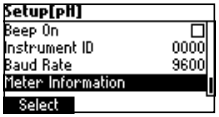


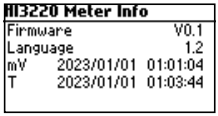


Meter Information

Select *Meter Information*.
Press **Select**.
The following meter information is displayed:

- firmware version
- language version
- mV and temperature factory calibration time/date

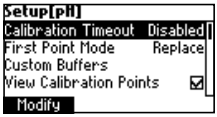


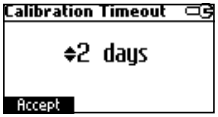


14.2. RANGE SPECIFIC PARAMETERS SCREENS

Calibration Timeout

Select *Calibration Timeout*.
Press **Modify**.
Use **ARROW** keys to set desired value.
Press **Accept** to confirm or **ESC** to return without saving.

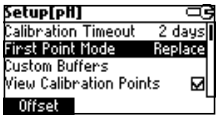




***Note**: If enabled "CAL DUE" warning will be displayed, the set number of days after calibration is over passed.*

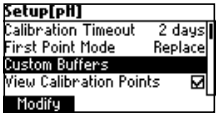
First Point Mode

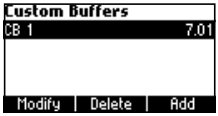
Select *First Point*.
Press the displayed function key in order to change the option.
First point mode refers to the behaviour of the instrument regarding "One point calibration".
If **Offset** is set, after one point calibration the instrument evaluate the offset and keep unchanged the slopes.



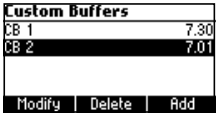
Custom Buffers

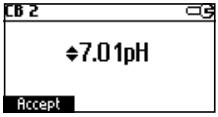
Select *Custom Buffers*.
Press **Modify**.





Press **Delete** to delete selected buffer.
Press **Add** to add a new buffer to the list (maximum 5).
Press **Modify** to set custom buffer value.



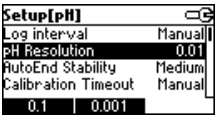


Use **ARROW** keys to change the value.
Press **Accept** to confirm custom buffer value or **ESC** to exit without saving.

pH Resolution

Select *pH resolution.*

Press the displayed function key to change option

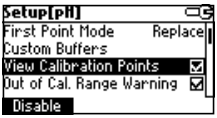


View Calibration Points

Select *Calibration Point.*

Press the displayed function key to change option.

If option is enabled the calibration buffers corresponding to the last calibration are displayed in the pH measurement screen.

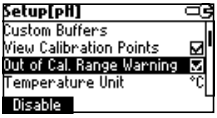


Out of Cal-Range Warning

Select *Out of Cal-Range Warning.*

Press the displayed function key in order to change option.

If enabled, the "Out Cal Range" message will be displayed if the pH reading is not within the calibration range.



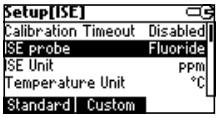
ISE probe (HI3222)

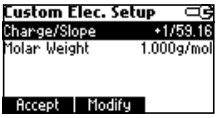
Select *ISE probe.*

Press **Custom** to set the parameters for a custom probe.

Press **Standard** to select probe from the standard probes list.

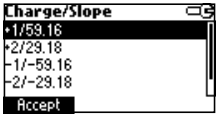
If **Custom** is pressed:



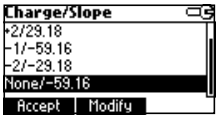


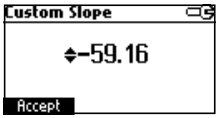
Use **ARROW** keys to select parameter to be changed i.e."Change Slope" or "Molar Weight".

Select *Change Slope*.

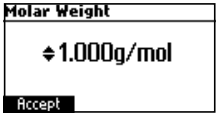


Use **ARROW** keys to select the desired combination.
If *None/-59.16* is selected the slope of the probe can be changed by pressing **Modify** key.
Press **Modify**.
Use **ARROW** keys to change the slope. Press **Accept** to confirm or **ESC** to exit.

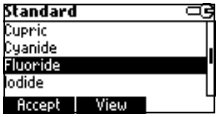


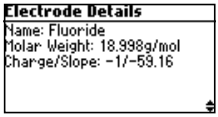


Select *Molar Weight*.
Press **Modify** to change molar weight.



Use **ARROW** keys to change the value. Press **Accept** to confirm or **ESC** to exit.
If **Standard** was pressed.

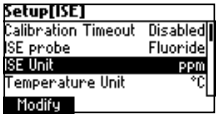


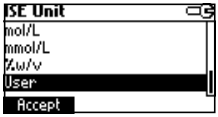


Use **ARROW** keys to focus on the desired electrode.
Press **Accept** to confirm setting or **ESC** to exit.
Press **View** to see probe parameters.

ISE unit (HI3222)

Select *ISE unit*.
Press **Modify**.
Use **ARROW** key to select unit. Press **Accept** to confirm selection or **ESC** to exit.





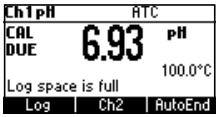
Note: • *If the unit is changed or "User" is selected a warning message alerts that the ISE range must be calibrated.*
• *If a new probe was selected or custom probe parameter are changed, the ISE range must be calibrated.*

15. LOGGING

All logged data can be transferred to a PC through the USB port.
The logging space includes 200, 300 or 400 records of Log on demand, acoording to the model, and 600 records of Log interval (lot logging). The log interval is organized in lots. A maximum of 100 lots are accepted. One lot can occupy all the memory space available.

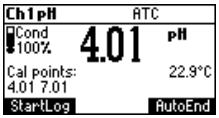
15.1. LOGGING THE CURRENT DATA

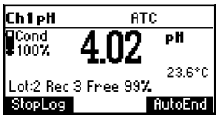
To store the current reading, press **LOG** while in measurement mode.
The instrument displays the record number and the amount of the free log space.
If the LOG space is full, the "Log space is full" message is displayed when **Log** key is pressed. Enter View Logged Data Mode and delete records to free up log space.



15.2. LOT LOGGING

Select the desired interval in SETUP as a timed interval or AutoEnd (instrument waits for a stable value before logging.
Press the **StartLog** key to start Log interval and **StopLog** to stop.



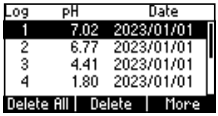


Notes:

- *At Power Off the current lot is automatically closed.*
- *If the 600 records space (or 100 lots) is reached, the "Log space is full" message is displayed.*
- *Enter View Log Data mode and delete lots in order to free space.*

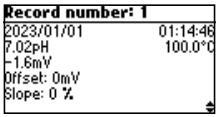
15.3. VIEW LOGGED DATA

Press the **Recall** key to retrieve stored information. If the **Recall** key is not displayed press **MENU** key.
The Recall selection screen is displayed.
Press the corresponding function key to view the records.
If **Man.Log** is pressed, the list of records is displayed.



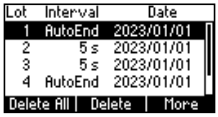
If no data were logged, the instrument will display "No Records" message.

Use **ARROW** keys to scroll between the records from the list.
Press **Delete All** to enter *Delete All* screen.
Press **Delete** to enter *Delete records* screen.
Press **More** to view more information of the focused record.
If **More** is pressed.

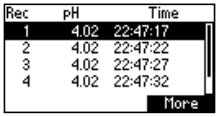


Use **ARROW** keys to scroll between complete log information.
If **Delete** is pressed.

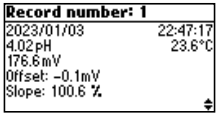
Use **ARROW** key to focus the record to be deleted and then press **Confirm**.
Press **ESC** to exit.
If **Delete All** is pressed the instrumet asks for confirmation.
Press **Confirm** to confirm or **ESC** to exit without deleting.
If **AutoLog** is pressed.
The lot information of the specific range are displayed.



Use the **ARROW** keys to scroll the lots.
Press the **Delete All** function key to enter the Delete All lots screen.
Press the **Delete** function key to enter the Delete lot screen.
Press the **More** function key to view the records information of the focused lot.



If **More** is pressed.

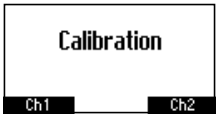


16. mV AND TEMPERATURE CALIBRATION (FOR TECHNICAL PERSONNEL ONLY)

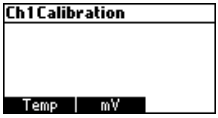
All the instruments are factory calibrated for mV and temperature.
Hanna's temperature probes are interchangeable and no temperature calibration is needed when they are replaced.
If the temperature or ORP measurements are inaccurate, calibration should be performed.
For an accurate recalibration, contact tech@hannainst.com, or follow the instructions below.

16.1. ENTER CALIBRATION MODE

With the instrument off, press and hold down the ▲/▼ then power on the instrument.
Press either "Ch1" or "Ch2" function key to enter the corresponding calibration screen.

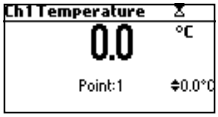


The calibration screen is displayed. Press "Temp" function key to enter the temperature calibration mode.

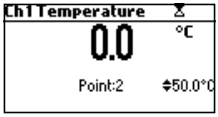


16.2. TEMPERATURE CALIBRATION

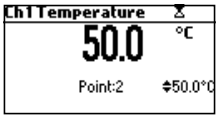
- Prepare a vessel containing ice and water and another one containing hot water (at approximately 50 °C or 122 °F). Place insulation material around the vessels to minimize temperature changes.
- Use a calibrated thermometer with a resolution of 0.1 °C as a reference thermometer. Connect the temperature probe to the appropriate socket.



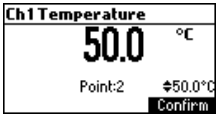
- Immerse the temperature probe or the pH probe including temperature sensor into the vessel with ice and water as close as possible to the reference thermometer. Allow a few seconds for the probe to stabilize.
- Use the **ARROW** keys to set the calibration point value to that of ice and water mixture, measured by the reference thermometer. When the reading is stable and close to the selected calibration point, the **Confirm** function key is displayed.
- Press **Confirm** to confirm.
- The second expected calibrated point is displayed.



- Immerse the temperature probe into the second vessel as close as possible to the reference thermometer. Allow a few seconds for the probe to stabilize.



- Use the **ARROW** keys to set the calibration point value to that of the hot water.
- When the reading is stable and close to the selected calibration point, **Confirm** function key is displayed.



- Press **Confirm** to confirm. The instrument returns to measurement mode.

***Note**: Use ARROW keys to change calibration point if necessary (±10.0 °C) around the point.*

If the reading is not close to the selected calibration point, "Wrong" message will blink. Change the temperature probe and restart calibration.

16.3. mV CALIBRATION

A two point calibration can be performed at 0 mV and 1800 mV.

- Attach to the BNC connector a mV simulator with an accuracy of ±0.1 mV.
- Enter the calibration screen. Press **mV** function key.
- Set **0.0 mV** on the simulator.
- When the reading is stable and close to the selected calibration point, the **Confirm** function key is displayed.
- Press Confirm to confirm. The second calibration point of 1800 mV will be displayed.
- Set **1800.0 mV** on the simulator.
- When the reading is stable and close to the selected calibration point, the **Confirm** function key is displayed.
- Press **Confirm** to confirm. The instrument returns to calibration screen.
- Press **ESC** to return to measurement mode.

***Notes**:*

- *If the reading is not close to the selected calibration point, "WRONG" tag will blink. Verify calibration condition or contact your vendor if you cannot calibrate.*
- *Press CAL or* **ESC** *in any moment of the calibration process. The instrument will return in the measurement mode.*

17. PC INTERFACE

Data transmission from the instrument to the PC can be done with the HI92000 Windows® compatible software (optional). HI92000 also offers graphing and on-line help feature.
Data can be exported to the most popular spreadsheet programs for further analysis. To connect your instrument to a PC, use an USB cable connector. Make sure that your instrument is switched off and plug one connector to the instrument USB socket and the other to the serial or USB port of your PC.

***Note**: If you are not using Hanna Instruments HI92000 software, please see the following instructions.*

Sending Commands from PC

It is also possible to remotely control the instrument with any terminal program. Use an USB cable to connect the instrument to a PC, start the terminal program and set the communication options as follows: 8, N, 1, no flow control.

Command Types

To send a command to the instrument follow the next scheme:

<command prefix> <command> <CR>

where: <command prefix> is the 16 ASCII character
<command> is the command code.

***Note**: Either small or capital letters can be used.*

Simple Commands

KF1 Is equivalent to pressing **function key 1**
KF2 Is equivalent to pressing **function key 2**
KF3 Is equivalent to pressing **function key 3**
RNG Is equivalent to pressing **RANGE** key
CAL Is equivalent to pressing **CAL** key
UPC Is equivalent to pressing the **UP** arrow key
DWC Is equivalent to pressing the **DOWN** arrow key
SET Is equivalent to pressing **SETUP** key (HI3220, HI3221)
MNU Is equivalent to pressing **MENU** key
ESC Is equivalent to pressing **ESC** key
CLR Is equivalent to pressing **CLR** key
CHRxx Change the instrument range according with the parameter value (xx):

- xx=10 pH range/0.001 resolution on channel 1
- xx=11 pH range/0.01 resolution on channel 1
- xx=12 pH range/0.1 resolution on channel 1
- xx=13 mV range on channel 1
- xx=14 Relative mV range on channel 1
- xx=15 ISE range on channel 1 (HI3221)
- xx=20 ISE range on channel 2 (HI3222)

- xx=21 mV range on channel 2 (HI3222)
- xx=22 Relative mV range on channel 2 (HI3222)

The instrument will answer for these commands with:

<STX> <answer> <ETX>

where: <STX> is 02 ASCII code character (start of text)
<ETX> is 03 ASCII code character (end of text)
<answer>:
<ACK> is 06 ASCII code character (recognized command)
<NAK> is 21 ASCII code character (unrecognized command)
<CAN> is 24 ASCII code character (corrupted command)

Commands Requiring an Answer

The instrument will answer for these commands with:

<STX> <answer> <checksum> <ETX>

where the checksum is the bytes sum of the answer string sent as 2 ASCII characters.
All the answer messages are with ASCII characters.

RAS Causes the instrument to send a complete set of readings in according with the current range:

- pH, temperature and mV reading on pH range.
- Rel mV, absolute mV and temperature reading on Rel mV range.
- concentration, mV and temperature reading on ppm range (HI3221, HI3222).

The answer string contains:

- Meter mode (2 chars):
  - 10 pH range/0.001 resolution on channel 1
  - 11 pH range/0.01 resolution on channel 1
  - 12 pH range/0.1 resolution on channel 1
  - 13 mV range on channel 1
  - 14 Relative mV range on channel 1
  - 15 ISE range on channel 1 (HI3221)
  - 20 ISE range on channel 2 (HI3222)
  - 21 mV range on channel 2 (HI3222)
  - 22 Relative mV range on channel 2 (HI3222)
- Meter status (2 chars of status byte): represents a 8 bit hexadecimal encoding.
  - 0x10 - temperature probe is connected
  - 0x01 - new GLP data available
  - 0x02 - new SETUP parameter
  - 0x04 - out of calibration range
  - 0x08 - the meter is in autoend point mode
- Reading status (2 chars): R - in range, O - over range, U - under range. First character corresponds to the primary reading. Second character corresponds to mV reading.

- Primary reading (corresponding to the selected range) - 11 ASCII chars, including sign and decimal point and exponent.
- Secondary reading (only when primary reading is not mV) - 7 ASCII chars, including sign and decimal point.
- Temperature reading - 8 ASCII chars, with sign and two decimal points, always in °C.

MDR Requests the instrument model name and firmware code (16 ASCII chars).

GLPx Requests the calibration data record.

- x=1 calibration data from channel 1
- x=2 calibration data from channel 2 (HI3222)

The answer string contains:

- GLP status (1 char): represents a 4 bit hexadecimal encoding.
  - 0x01 - pH calibration available
  - 0x02 - Rel mV calibration available
  - 0x04 - ISE calibration available
- pH calibration data if x=1 (if available), which contains:
  - the number of calibrated buffers (1 char)
  - the ion charge, with sign (2 chars) (HI3221)
  - the offset, with sign and decimal point (7 chars)
  - the average of slopes, with sign and decimal point (7 chars)
  - the calibration time, **yymmddhhmmss** (12 chars)
  - buffers information (for each buffer)
    - type (1 char): 0 - standard, 1 - custom
    - status (1 char): N (new) - calibrated in last calibration;
      O (old) - from an old calibration.
    - warnings during calibration (2 chars): 00 - no warning, 04 - Clean Electrode warning.
    - buffer value, with sign and decimal point and exponent (11 chars).
    - calibration time, **yymmddhhmmss** (12 chars).
    - electrode condition, with sign (3 chars). The "-01" code means not calculated.
- Rel mV calibration data (if available), which contains:
  - the calibration offset, with sign (7 chars)
  - the calibration time, **yymmddhhmmss** (12 chars).
- ISE calibration data (if available) when x=1 (HI3221) or when x=2 (HI3222), which contains:
  - the number of calibrated standards (1 char)
  - the ion charge, with sign (2 chars) (HI3221)
  - the calibration slope, with sign and decimal point (7 chars)
  - the calibration time, **yymmddhhmmss** (12 chars)

- standards information (for each standard)
  - type (1 char): 0 - always standard solution.
  - status (1 char): N (new) - calibrated in last calibration;
    O (old) - from an old calibration.
  - warnings during calibration (2 chars): 00 - no warning.
  - standard value, with sign and decimal point and exponent (11 chars).
  - calibration time, **yymmddhhmmss** (12 chars).

PARx Requests the setup parameters setting.

- x=1 setup parameters for channel 1
- x=2 setup parameters for channel 2 (HI3222)

The answer string contains:

- Backlight Value (1 ASCII char)
- Contrast Value (2 ASCII char)
- Instrument ID (4 chars)
- Calibration Alarm time out for pH (2 chars) when x=1
- Calibration Alarm timeout for ISE (2 chars) - if ISE available when x=1 (HI3221) or when x=2 (HI3222)
- SETUP information (2 chars): 8 bit hexadecimal encoding.
  - 0x01 - beep ON (else OFF)
  - 0x04 - degrees Celsius (else degrees Fahrenheit)
  - 0x08 - Offset calibration (else Point calibration)
- The number of custom buffers (1 char) when x=1
- The custom buffer values, with sign and decimal point, for each defined custom buffer (7 chars) when x=1
- The ID of the ISE electrode (2 chars) - if ISE available when x=1 (HI3221) or when x=2 (HI3222)
- The molar weight of the selected ION, with sign and decimal point (9 ASCII characters) when x=1 (HI3221) or when x=2 (HI3222)
- The electrode slope (6 ASCII chars)
- The ion charge (2 chars)
- The ISE unit (2 chars)
- The short name of the selected language (3 chars)

NSLxy Requests the number of logged samples (4 chars).

The command parameter (2 chars):

- x=1 request for channel 1
- x=2 request for channel 2
- y=P request for pH range when x=1
- y=M request for mV and Rel mV ranges
- y=I request for ISE range when x=1 (HI3221) or when x=2 (HI3222)

LLSxy Requests the number of lots (information about lots) on the specified channel and range (x - channelnumber; y - range number)
- xy = 11 - channel 1; range pH;
- xy = 13 - channel 1; range mV;
- xy = 22 - channel 2; range ISE;
- xy = 23 - channel 2; range mV;

The answer string contains:
- number of lots (3 chars)
- ID lot (3 chars)
- date (6 chars)
- time (6 chars)
- log type (2 chars)

GLDxxx Requests all records for the lot with ID=xxx
The answer string contains:
- Lot header data:
  - logging interval (5 char)
  - log type (1 char)
  - temperature mode (1 char)
  - offset (3 char)
  - slope (4 char)
  - unit (1 char)
- Lot record data:
  - temperature (3 char)
  - value (6 char)
  - second value (6 char)

LODxPyyy Requests the yyyth pH record logged data when x=1.

LODxMyyy Requests the yyyth mV/Rel mV record logged data.

LODxIyyy Requests the yyyth ISE record logged data when x=1 (HI3221) or when x=2 (HI3222).

LODxPALL Requests all pH Log on demand when x=1.

LODxMALL Requests all mV/Rel mV Log on demand.

LODxIALL Requests all ISE Log on demand when x=1 (HI3221) or when x=2 (HI3222).
The answer string for each record contains:
- The logged mode (2 chars):
  - xx=10 pH range/0.001 resolution on channel 1
  - xx=11 pH range/0.01 resolution on channel 1
  - xx=12 pH range/0.1 resolution on channel 1
  - xx=13 mV range on channel 1
  - xx=14 Relative mV range on channel 1
  - xx=15 ISE range on channel 1 (HI3221)

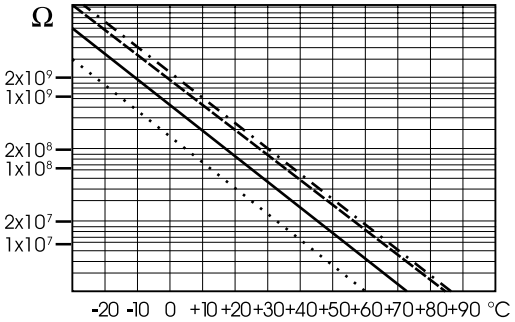
    - xx=20 ISE range on channel 2 (HI3222)
    - xx=21 mV range on channel 2 (HI3222)
    - xx=22 Relative mV range on channel 2 (HI3222)
  - Reading status (1 char): R, O, U
  - Calculated reading, with sign and decimal point and exponent (13 chars) - for pH, Rel mV and ISE range
  - Temperature reading, with sign and two decimal points (8 chars)
  - mV reading status (1 char): R, O, U
  - The mV reading, with sign and decimal point (7 chars)
  - The logged time, yymmddhhmmss (12 chars)
  - The calibration slope, with sign and decimal point (7 chars) - not available for Rel mV range
  - The calibration offset, with sign and decimal point (7 chars) - not available for ISE
  - Temperature probe presence (1 char)

Notes:

- *"Err3" is sent if the Log on demand is empty.*
- *"Err4" is sent if the requested parameter is not available.*
- *"Err6" is sent if the requested range is not available.*
- *"Err8" is sent if the instrument is not in measurement mode.*
- *Invalid commands will be ignored.*

18. TEMPERATURE CORRELATION FOR pH SENSITIVE GLASS

The resistance of glass electrodes partially depends on the temperature. The lower the temperature, the higher the resistance. It takes more time for the reading to stabilize if the resistance is higher. In addition, the response time will suffer to a greater degree at temperatures below 25 °C (77 °F).



Since the resistance of the pH electrode is in the range of 50 – 200 Mohm, the current across the membrane is in the pico Ampere range. Large currents can disturb the calibration of the electrode for many hours.
For these reasons high humidity environments, short circuits and static discharges are detrimental to a stable pH reading.
The pH electrode's life also depends on the temperature. If constantly used at high temperatures, the electrode life is drastically reduced.

Typical Electrode Life

Ambient Temperature	1 – 3 years
90 °C (194 °F)	Less than 4 months
120 °C (248 °F)	Less than 1 month

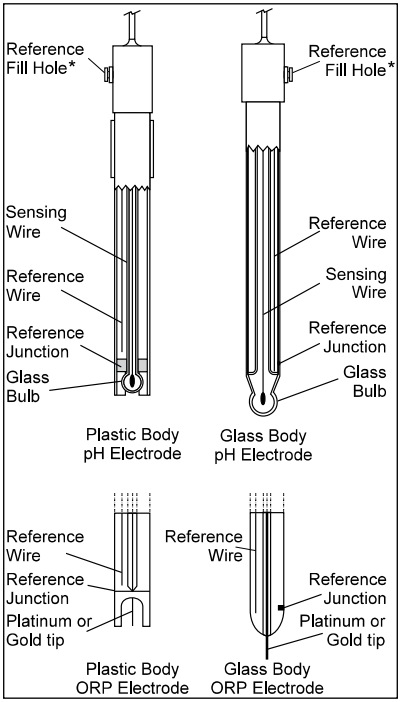
Alkaline Error

High concentrations of sodium ions interfere with readings in alkaline solutions. The pH at which the interference starts to be significant depends upon the composition of the glass. This interference is called alkaline error and causes the pH to be underestimated. Hanna's glass formulations have the indicated characteristics.

Sodium Ion Correction for the Glass at 20-25 °C (68-77 °F)

Concentration	pH	Error
0.1 Mol L^{-1} Na^{+}	13.00	0.10
	13.50	0.14
	14.00	0.20
1.0 Mol L^{-1} Na^{+}	12.50	0.10
	13.00	0.18
	13.50	0.29
	14.00	0.40

19. ELECTRODE CONDITIONING AND MAINTENANCE



* Not present in gel electrodes.

Preparation Procedure

- Remove the sensor protective cap. Do not be alarmed if any salt deposits are present. This is normal with pH / ORP probes and they will disappear when rinsed with water.
- Shake down the probe to eliminate any air bubbles inside the glass bulb.
- If the bulb and/or junction are dry, soak the electrode in HI70300 Storage solution for at least 30 minutes. To ensure a quick response, the glass bulb and the junction should be kept moist and not allowed to dry.

***Note**: Never use distilled or deionized water to store electrode.*

For refillable electrodes:

If the filling solution (electrolyte) is more than 2½ cm (1") below the fill hole, add HI7082 or HI8082 3.5M KCl Electrolyte Solution for double junction or HI7071 or HI8071 3.5M KCl+AgCl Electrolyte Solution for single junction electrodes.

For faster response, unscrew the fill hole screw during measurements.

For AmpHel® electrodes:

If the electrode does not respond to pH changes, the battery has run down and the electrode should be replaced.

Measurement

Rinse the pH electrode tip with distilled or deionized water. Immerse the tip 3 cm (1¾") in the sample and stir gently for a few seconds.

For a faster response and to avoid cross-contamination of the samples, rinse the electrode tip with a few drops of the solution to be tested, before taking measurements.

Ensure that the sleeve holes of the ORP probe are completely submersed.

Storage Procedure

To minimize clogging and ensure a quick response time, the glass bulb and the junction of pH electrode should be kept moist and not allowed to dry out. Replace the solution in the protective cap with a few drops of HI70300 or HI80300 Storage Solution or Filling Solution (HI7071 or HI8071 for single junction; and HI7082 or HI8082 for double junction electrodes). Follow the Preparation Procedure before taking measurements.

***Note**: Never store the electrode in distilled or deionized water.*

Periodic Maintenance

Inspect the electrode and the cable. The cable used for connection to the instrument must be intact and there must be no points of broken insulation on the cable or cracks on the electrode stem or bulb. Connectors must be perfectly clean and dry. If any scratches or cracks are present, replace the electrode. Rinse off any salt deposits with water.

Refillable electrodes

Refill the reference chamber with fresh electrolyte. Use HI7071 or HI8071 for single junction or HI7082 or HI8082 for double junction electrodes. Allow the electrode to stand upright for 1 hour.

pH Cleaning Procedure

- General Soak in HI7061 or HI8061 General Cleaning Solution for approximately ½ hour.
- Protein Soak in HI7073 or HI8073 Protein Cleaning Solution for 15 minutes.
- Inorganic Soak in HI7074 Inorganic Cleaning Solution for 15 minutes.
- Oil/grease Rinse with HI7077 or HI8077 Oil and Fat Cleaning Solution.

***Important**: After cleaning, rinse the electrode thoroughly with distilled water, refill the reference chamber with fresh electrolyte (not necessary for gel-filled electrodes) and soak the electrode in HI70300 or HI80300 Storage Solution for at least 1 hour before calibrating.*

20. TROUBLESHOOTING GUIDE

Symptoms	Problem	Solution
Slow response/excessive drift.	Dirty pH electrode.	Soak the electrode tip in HI7061 cleaning solution for 30 minutes then rinse and condition (see ELECTRODE CONDITIONING AND MAINTENANCE section). Refill with fill solution.
Reading fluctuates up and down (noise).	Clogged/dirty junction. Low electrolyte level (refillable electrodes only).	Clean the electrode (see above). Refill with fresh electrolyte (refillable electrodes only).
Display shows blinking full scale value.	Reading out of range.	Check that sample is within measurable range; Check electrolyte level and general electrode status.
mV scale out of range.	Dry membrane or dry junction.	Soak electrode in HI70300 storage solution for at least 30 minutes.
Display shows ▲▼ symbol in front of temperature reading.	Out of order or missing temperature probe.	Replace temperature probe or check the connection.
Display shows "Clean electrode" blinking.	Difference between new and previous calibration has been detected.	Clean electrode, condition and recalibrate. If the problem remains, check the buffer solutions.
Meter does not work with temperature probe.	Broken temperature probe.	Replace temperature probe.
Meter fails to calibrate or gives faulty readings.	Broken pH electrode.	Replace electrode.
Error messages are displayed during pH calibration procedure.	Wrong or contaminated buffer, electrode dirty or broken.	Check that buffer solution is correct and fresh, and the meter is set for the correct buffer.
"Errxx" message at start up.	Internal error.	Contact tech@hannainst.com.

21. ACCESSORIES

21.1. pH CALIBRATION SOLUTIONS

HI50004-01	pH 4.01 Buffer Solution, 20 mL sachet, 10 pcs.
HI50004-02	pH 4.01 Buffer Solution, 20 mL sachet, 25 pcs.
HI50007-01	pH 7.01 Buffer Solution, 20 mL sachet, 10 pcs.
HI50007-02	pH 7.01 Buffer Solution, 20 mL sachet, 25 pcs.
HI50010-01	pH 10.01 Buffer Solution, 20 mL sachet, 10 pcs.
HI50010-02	pH 10.01 Buffer Solution, 20 mL sachet, 25 pcs.
HI5016	pH 1.68 Buffer Solution, 500 mL bottle
HI5004	pH 4.01 Buffer Solution, 500 mL bottle
HI5068	pH 6.86 Buffer Solution, 500 mL bottle
HI5007	pH 7.01 Buffer Solution, 500 mL bottle
HI5091	pH 9.18 Buffer Solution, 500 mL bottle
HI5010	pH 10.01 Buffer Solution, 500 mL bottle
HI5124	pH 12.45 Buffer Solution, 500 mL bottle
HI8004L	pH 4.01 Buffer Solution in FDA approved bottle, 500 mL
HI8006L	pH 6.86 Buffer Solution in FDA approved bottle, 500 mL
HI8007L	pH 7.01 Buffer Solution in FDA approved bottle, 500 mL
HI8009L	pH 9.18 Buffer Solution in FDA approved bottle, 500 mL
HI8010L	pH 10.01 Buffer Solution in FDA approved bottle, 500 mL

21.2. ELECTRODE STORAGE SOLUTION

HI70300L	Storage Solution, 500 mL bottle
HI80300L	Storage Solution in FDA approved bottle, 500 mL

21.3. ELECTRODE CLEANING SOLUTIONS

HI70000P	Electrode Rinse Solution, 20 mL sachet, 25 pcs.
HI7061L	General Purpose Solution, 500 mL bottle
HI7073L	Protein Cleaning Solution, 500 mL bottle
HI7074L	Inorganic Cleaning Solution, 500 mL bottle
HI7077L	Oil & Fat Cleaning Solution, 500 mL bottle
HI8061L	General Purpose Cleaning Solution in FDA approved bottle, 500 mL
HI8073L	Protein Cleaning Solution in FDA approved bottle, 500 mL
HI8077L	Oil & Fat Cleaning Solution in FDA approved bottle, 500 mL

21.4. ELECTRODE REFILL ELECTROLYTE SOLUTIONS

HI7071	3.5M KCl + AgCl Electrolyte for single junction electrodes, 4×30 mL
HI7072	1M KNO3 Electrolyte, 4×30 mL
HI7082	3.5M KCl Electrolyte for double junction electrodes, 4×30 mL
HI8071	3.5M KCl + AgCl Electrolyte in FDA approved bottle, 4×30 mL, for single junction electrodes
HI8082	3.5M KCl Electrolyte in FDA approved bottle, 4×30 mL, for double junction electrodes
HI8093	1M KCl + AgCl Electrolyte in FDA approved bottle, 4×30 mL

21.5. ORP PRETREATMENT SOLUTIONS

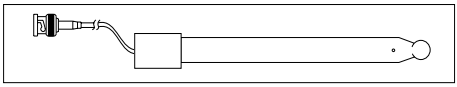
HI7091L	Reducing Pretreatment Solution, 500 mL bottle + 14 g (set)
HI7092L	Oxidizing Pretreatment Solution, 500 mL bottle

21.6. ORP SOLUTIONS

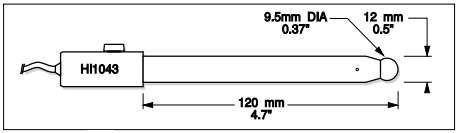
HI7021L	Test Solution 240 mV, 500 mL bottle
HI7022L	Test Solution 470 mV, 500 mL bottle

21.7. pH ELECTRODES

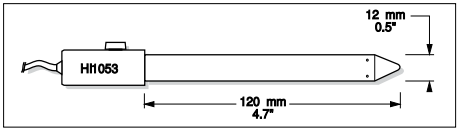
All electrodes part numbers ending in B are supplied with a BNC connector and 1 m (3.3') cable.



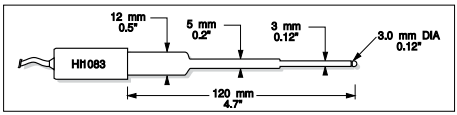
HI1043B Glass-body, double junction, refillable, combination pH electrode.
Use: strong acid/alkali.



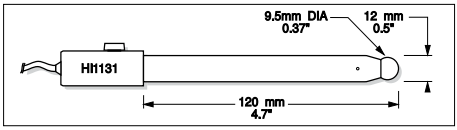
HI1053B Glass-body, triple ceramic, conic shape, refillable, combination pH electrode.
Use: emulsions.



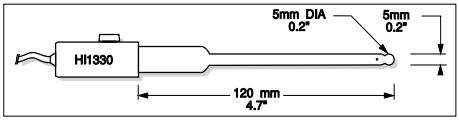
HI1083B Glass-body, micro, viscolene, non-refillable, combination pH electrode.
Use: biotechnology, micro titration.



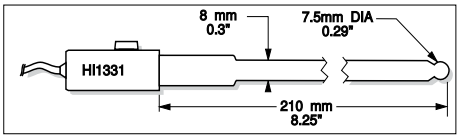
HI1131B Glass-body, double junction, refillable, combination pH electrode. Use: general purpose.



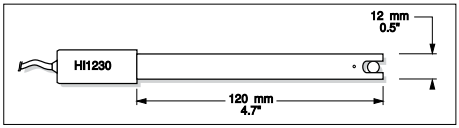
HI1330B Glass-body, semi-micro, single junction, refillable, combination pH electrode.
Use: laboratory, vials.



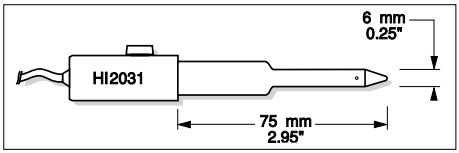
HI1331B Glass-body, semi-micro, single junction, refillable, combination pH electrode. Use: flasks.



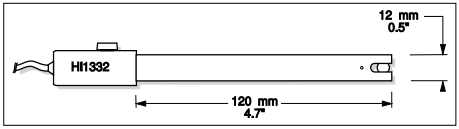
HI1230B Plastic-body (PEI), double junction, gel-filled, combination pH electrode. Use: general, field.



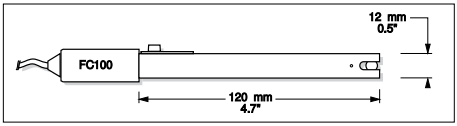
HI2031B Glass-body, semi-micro, conic, refillable, combination pH electrode. Use: semisolid products.



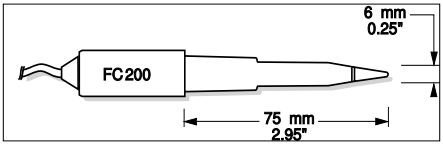
HI1332B Plastic-body (PEI), double junction, refillable, combination pH electrode.
Use: general purpose.



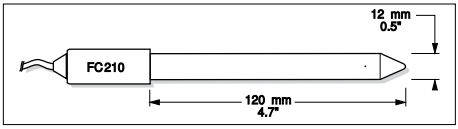
FC100B Plastic-body (PVDF), double junction, refillable, combination pH electrode.
Use: general purpose for food industry.



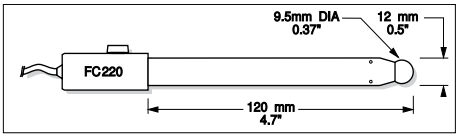
FC200B Plastic-body (PVDF), open junction, conic, viscolene, non-refillable, combination pH electrode.
Use: meat & cheese.



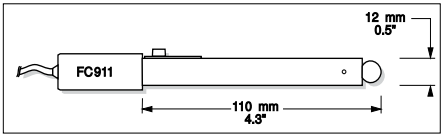
FC210B Glass-body, double junction, conic, viscolene, non-refillable, combination pH electrode.
Use: milk, yogurt.



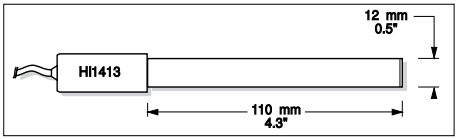
FC220B Glass-body, triple-ceramic, single junction, refillable, combination pH electrode.
Use: food processing.



FC911B Plastic-body (PVDF), double junction, refillable with built-in amplifier, combination pH electrode.
Use: very high humidity.

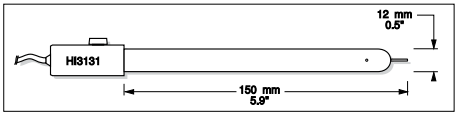


HI1413B Glass-body, single junction, flat tip, viscolene, non-refillable, combination pH electrode.
Use: surface measurement.

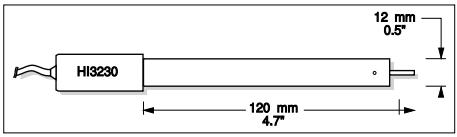


21.8. ORP ELECTRODES

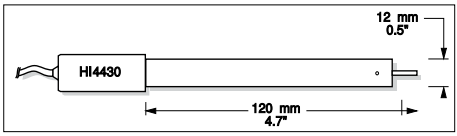
HI3131B Glass-body, refillable, combination platinum ORP electrode. Use: titration.



HI3230B Plastic-body (PEI), gel-filled, combination platinum ORP electrode. Use: general purpose.



HI4430B Plastic-body, gel-filled, combination gold ORP electrode. Use: general purpose.

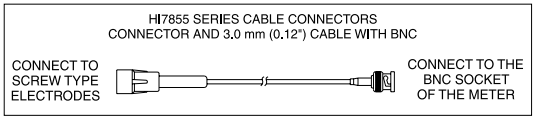


Consult the Hanna General Catalog for a complete and wide selection of electrodes.

21.9. EXTENSION CABLE FOR SCREW-TYPE ELECTRODES (SCREW TO BNC ADAPTER)

HI7855/1 Extension cable 1 m (3.3') long

HI7855/3 Extension cable 3 m (9.9') long



21.10. OTHER ACCESSORIES

HI740155P	Capillary pipette for electrode refilling, 20 pcs.
HI76404W	Electrode holder
HI7662-TW	Stainless steel Temperature probe with 1 m (3.3') screened cable
HI8427	pH and ORP electrode simulator with 1 m (3.3') coaxial cable ending in female BNC connectors
HI931001	pH and ORP electrode simulator with LCD and 1 m (3.3') coaxial cable ending in female BNC connectors

CERTIFICATION

All Hanna® instruments conform to the **CE European Directives.**

CE RoHS compliant

Disposal of Electrical & Electronic Equipment. The product should not be treated as household waste. Instead, hand it over to the appropriate collection point for the recycling of electrical and electronic equipment, which will conserve natural resources.
Ensuring proper product and battery disposal prevents potential negative consequences for the environment and human health. For more information, contact your city, your local household waste disposal service, or the place of purchase.

RECOMMENDATIONS FOR USERS

Before using this product, make sure it is entirely suitable for your specific application and for the environment in which it is used. Any variation introduced by the user to the supplied equipment may degrade the meter's performance. For your and the meter's safety do not use or store the meter in hazardous environments.

WARRANTY

The HI322x series are warranted for two years against defects in workmanship and materials when used for their intended purpose and maintained according to instructions.
Electrodes and probes are guaranteed for six months.
This warranty is limited to repair or replacement free of charge. Damage due to accidents, misuse, tampering, or lack of prescribed maintenance is not covered.
If service is required, contact your local Hanna Instruments® office. If under warranty, report the model number, date of purchase, serial number (engraved on the bottom of the meter), and the nature of the problem.
If the repair is not covered by the warranty, you will be notified of the charges incurred.
If the meter is to be returned to Hanna Instruments, first obtain a Returned Goods Authorization (RGA) number from the Technical Service department and then send it with shipping costs prepaid. When shipping any meter, make sure it is properly packed for complete protection.