Instruction Manual

HI 4221 & HI 4222

pH/mV/ISE/Temperature Bench Meters

HANNA instruments®
www.hannainst.com

Dear Customer,

Thank you for choosing a Hanna Instruments product. This manual will provide you with the necessary information for correct use of the instrument.

Please read this instruction manual carefully before using the instrument.

If you need additional technical information, do not hesitate to e-mail us at tech@hannainst.com or see the back side of this manual for our worldwide sales and technical service contacts.

These instruments are in compliance with CE directives.

WARRANTY

HI 4221 and **HI 4222** 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 the dealer from whom you purchased the instrument. If under warranty, report the model number, date of purchase, serial number and the nature of the failure. If the repair is not covered by the warranty, you will be notified of the charges incurred. If the instrument is to be returned to Hanna Instruments, first obtain a Returned Goods Authorization number from the Technical Service Department and then send it with shipping costs prepaid. When shipping any instrument, make sure it is properly packed for complete protection.

To validate your warranty, fill out and return the enclosed warranty card within 14 days from the date of purchase.

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PRELIMINARY EXAMINATION

Remove the instrument from the packing material and examine it carefully to make sure that no damage has occurred during shipping. If there is any damage, notify your dealer or the nearest Hanna Service Center.

The meters are supplied complete with:

- **HI 1131B** Glass-body Combination pH Electrode
- **HI 7662-T** Temperature probe
- **pH 4.01 & 7.01** Buffer solutions, 20 mL each
- **HI 700661** Cleaning Solution, 2 x 20 mL
- **HI 7071S** Electrolyte solution
- **HI 76404N** Electrode Holder
- 12Vdc Power Adapter
- Instruction Manual

HI 4221 and **HI 4222** are supplied with 12 Vdc/230 Vac adapter.

HI 4221-01 and **HI 4222-01** are supplied with 12 Vdc/115 Vac adapter.

Note: Save all packing material until you are sure that the instrument works properly. Any defective item must be returned in the original packing with the supplied accessories.

GENERAL DESCRIPTION

HI 4221 and **HI 4222** are professional bench meters with color graphic LCD for pH, ORP (Oxidation Reduction Potential), ISE (**HI 4222** only) and Temperature measurements with Calibration Check.

The display can be configured as a single channel or dual channel display (**HI 4222** only) in various modes: Basic information only, GLP information, Graph mode and Log History mode. Each channel can be configured as pH, mV, Relative mV or ISE (**HI 4222** only).

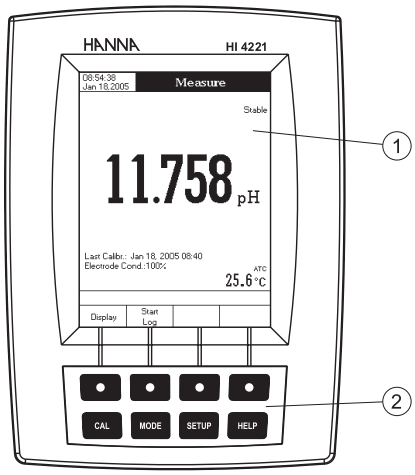
The main features of the instruments are:

- One (**HI 4221**), or two (**HI 4222**) input channels;
- Manual selection, automatic and semiautomatic pH calibration up to five points, with standard (1.68, 3.00, 4.01, 6.86, 7.01, 9.18, 10.01 and 12.45) and custom buffers (up to 5 custom buffers);
- Manual Selection and Custom Standard ISE calibration up to five points, with standard (0.1, 1, 10, 100, 1000 ppm) and custom solutions (up to 5 custom solutions), with or without temperature compensation;
- AutoHold feature to freeze first stable reading on the LCD;
- Two selectable alarm limits;
- Five selectable logging modes: Automatic logging with and without AutoHold feature, Manual logging with or without AutoHold and AutoHold logging mode;
- Up to 100 logging lots;
- Selectable log interval and log sampling features for Automatic logging;
- GLP feature;
- Online and offline graph;
- User-friendly interface on large color graphic LCD (240x320 pixels);
- PC interface via RS232, and USB.

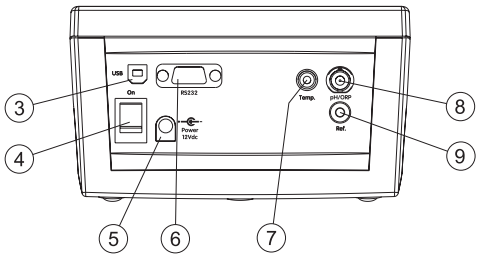
FUNCTIONAL DESCRIPTION

HI 4221 DESCRIPTION

FRONT PANEL



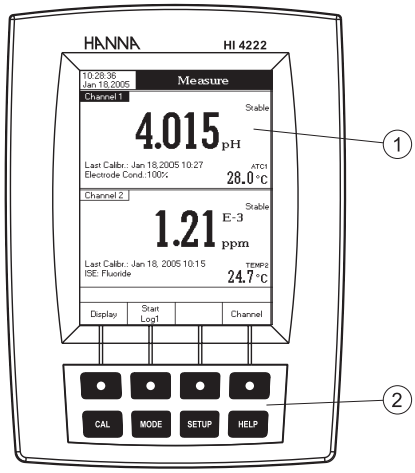
REAR PANEL



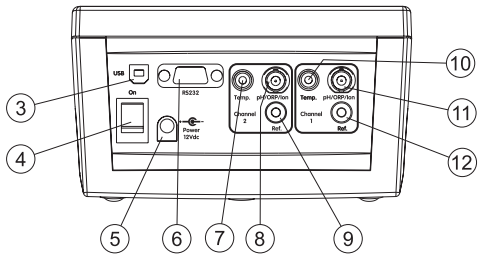
1) Liquid Crystal Display (LCD)
2) Main Keyboard
3) USB connector
4) ON/OFF switch
5) Power adapter socket
6) RS232 serial communication connector
7) Temperature probe socket
8) BNC electrode connector for pH/ORP measurements
9) Reference input socket

HI 4222 DESCRIPTION

FRONT PANEL



REAR PANEL



1) Liquid Crystal Display (LCD)
2) Main Keyboard
3) USB connector
4) ON/OFF switch
5) Power adapter socket
6) RS232 serial communication connector
7) Temperature probe socket (Channel 2)
8) BNC electrode connector for pH/ORP/ISE measurements (Channel 2)
9) Reference input socket (Channel 2)
10) Temperature probe socket (Channel 1)
11) BNC electrode connector for pH/ORP/ISE measurements (Channel 1)
12) Reference input socket (Channel 1)

KEYBOARD DESCRIPTION

FUNCTION KEYS

CAL To enter/exit calibration mode.

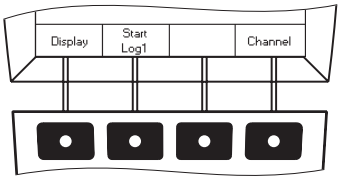
MODE To select the desired measurement mode, pH, mV, Rel mV (or ISE – **HI 4222** only).

SETUP To enter Setup (System, pH, mV or ISE) and to access Log Recall function.

HELP To obtain general informations about the selected option/operation.

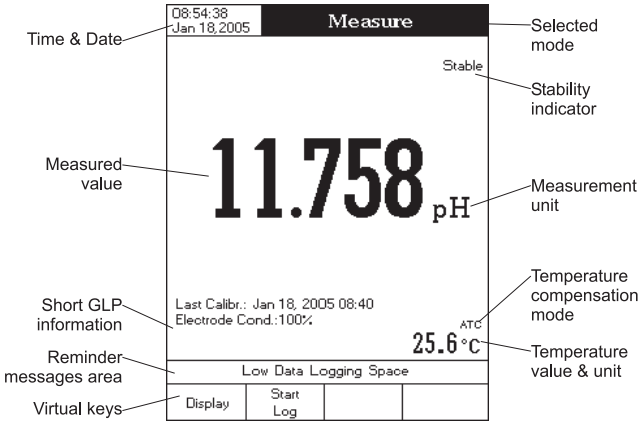
VIRTUAL KEYS

The upper row keys are assigned to the **virtual keys** placed on the bottom of the LCD, which allow you to perform the displayed function, depending on the current menu (e.g. Display, Start Log1 and Channel in *Measure* mode).



Note: All the virtual keys are assigned to the focused channel (**HI 4222** only).

LCD GENERAL DESCRIPTION



SPECIFICATIONS

	HI 4221	HI 4222
RANGE	–2.000 to 20.000 pH	
	±2000.0 mV	
	–	$1*10^{-6}$ to $9.99*10^{10}$ conc.
	–20.0 to 120.0 °C / –4.0 to 248.0 °F / 253.15 to 393.15 K	
RESOLUTION	0.1 pH / 0.01 pH / 0.001 pH	
	0.1 mV	
	–	1 conc. / 0.1 conc. / 0.01 conc. / 0.001 conc.
	0.1 °C / 0.1 °F / 0.1 K	
ACCURACY @20 °C / 68 °F	±0.1 pH ±0.01 pH ±0.002 pH ± 1LSD	
	±0.2 mV ± 1LSD	
	–	±0.5% (monovalent ions) ±1% (divalent ions)
	±0.2 °C / ±0.4 °F / ±0.2 K	
Relative mV offset range	±2000.0 mV	
pH Calibration	Up to five-point calibration, 8 standard buffers available (1.68, 3.00, 4.01, 6.86, 7.01, 9.18, 10.01, 12.45), and 5 custom buffers	
ISE Calibration	–	Up to five-point calibration, 5 fixed standard solutions available for each measurement unit, and 5 custom solutions
Input channels	1	2
Temperature compensation	Manual or Automatic from –20.0 to 120.0 °C / –4.0 to 248.0 °F / 253 to 393 K	
pH Electrode	HI 1131B	
Temperature probe	HI 7662-T	
PC interface	opto-isolated RS232 and USB	
Input impedance	10^{12} ohms	
Power supply	12 Vdc adapter	
Dimensions	160 x 231 x 94 mm (6.3 x 9.1 x 3.7")	
Weight	1.2 Kg (2.6 lb)	
Environment	0 – 50 °C / 32 – 122 °F / 273 – 323 K max. 95% RH non-condensing	
Warranty	2 years	

OPERATIONAL GUIDE

POWER CONNECTION

Plug the 12 Vdc adapter into the power supply socket.

Notes:
- These instruments use non volatile memory to retain the pH, Ion calibrations and all other settings, even when unplugged.
- Make sure a fuse protects the main line.

ELECTRODE AND PROBE CONNECTIONS

For pH or ORP measurements connect a pH/ORP electrode with internal reference to the BNC connector located on the rear panel of the instrument (for the desired channel – **HI 4222** only).

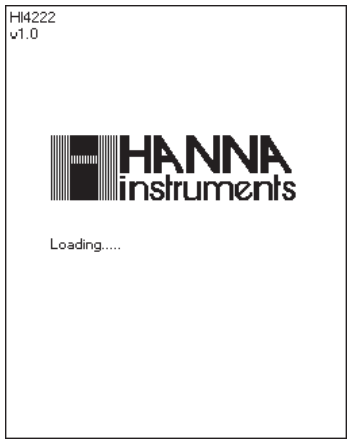
For ISE measurements (**HI 4222** only) connect, to the desired channel, an ISE electrode with internal reference to the BNC connector located on the rear panel of the instrument.

For electrodes with a separate reference connect the electrode's BNC to the BNC connector and the electrode's reference to the reference input socket.

For temperature measurements and automatic temperature compensation connect the temperature probe to the appropriate socket (for the desired channel – **HI 4222** only).

INSTRUMENT START UP

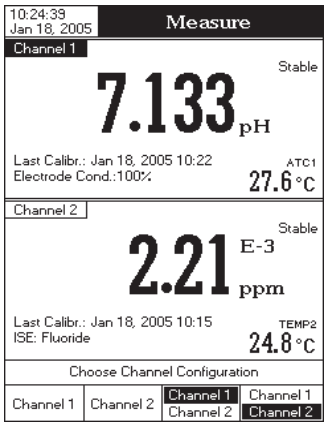
- Turn the instrument on from the power switch located on the rear panel of the instrument.
- Please wait until the instrument finishes the initialization process.



Note: It is normal for the loading process to take a few seconds. If the instrument doesn't display the next screen, restart the meter using the power switch. If the problem persists, contact your dealer.

CHANNEL SELECTION (HI 4222 only)

- Press Channel while in *Measure* mode to access channel selection menu. Four available options will be displayed: Channel 1, Channel 2, or multi-channel with the first or the second channel focused. The "Choose Channel Configuration" message is displayed in the Reminder messages area.
- Select the desired option by pressing the appropriate key: Channel 1, Channel 2, Channel 1 / Channel 2 or Channel 1 / Channel 2. The instrument will enter in the selected option *Measure* mode.



DISPLAYING MODES

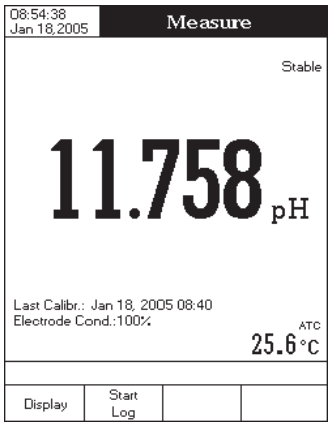
For each measurement mode (pH, mV, Rel mV or Ion) the following display configurations are available: Basic, Good Laboratory Practice (GLP), Graph and Log History.

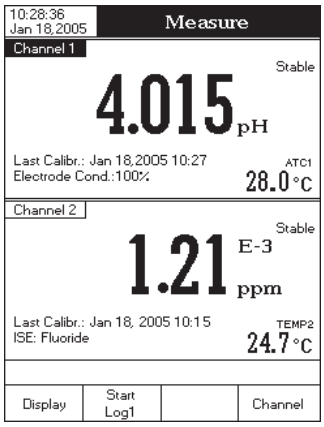
Basic

Accessing this option, the measured value and its units are displayed on the LCD, along with the temperature value, temperature compensation mode, and GLP data.

To choose the Basic displaying mode:

- Press Display while in *Measure* mode. The "Choose Display Configuration" message will be displayed in the Reminder messages area.
- Press Basic. The instrument will display the basic information for the selected measurement mode.





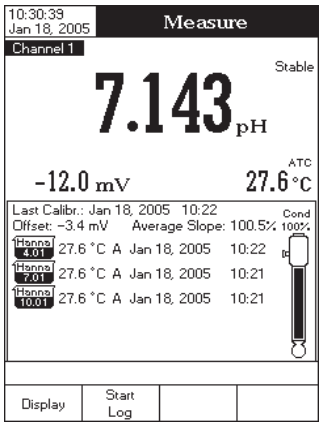
GLP

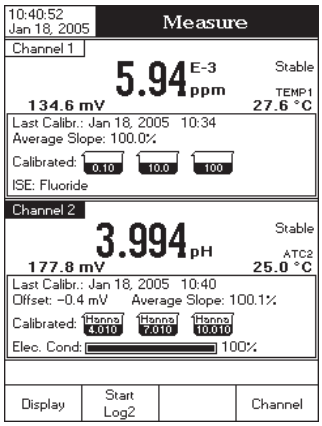
Accessing this option, detailed GLP data will be displayed on the LCD for *pH Measure* and *ISE Measure* modes only: Last Calibration date and time, Offset and Slope values, Calibration Buffers/Standards and general information regarding the buffers/standards: the calibration temperature, temperature compensation mode, date and time. For *pH Measure*, the Electrode Condition is also displayed on the LCD in percent.

Note: If only a one-point pH calibration is performed or the current calibration does not include at least two consecutive standard buffers of pH 4.01, 7.01 (6.86) and 10.01 (9.18) buffers, the Electrode Condition will be unknown.

To access the GLP displaying mode:

- Press Display while in *Measure* mode. The "Choose Display Configuration" message will be displayed in the Reminder messages area.
- Press GLP. The instrument will display the detailed GLP data.





Graph

Accessing this option, the online graph with currently logged values (pH, mV, Rel mV, or ISE vs. Seconds) will be displayed.

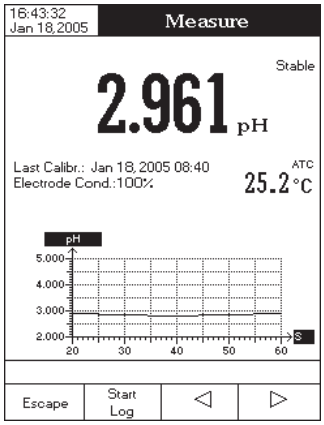
If there is no active log, the previously logged data for the selected parameter will be plotted.

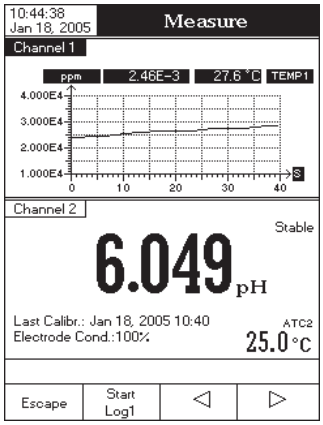
Notes: • If no data were logged, the graph displaying mode will not be accessible.

• If no automatic log is saved, the offline graph will not be available.

To access the offline / online graph:

- Press Display while in *Measure / Logging* mode. The "Choose Display Configuration" message will be displayed in the Reminder messages area.
- Press Graph.





When the **online graph** is displayed:

- Use [◁] and [▷] to move the graph along X (Time) axis.
- Press [SETUP] to access the zoom menu for Y axis. Use [Zoom IN] or [Zoom OUT] for zooming Y (parameter) axis.
- Press [Escape] to return to the main menu.

When the **offline graph** is displayed:

- Use the arrow keys to move the graph along X (Time) and Y (parameter) axes.
- Press [SETUP] to access the zoom menu for X and Y axes. Use [Zoom Time], or [Zoom pH] / [Zoom mV] / [Zoom Rel mV] / [Zoom Ion] to switch between the active zooming axes. Press [Zoom IN] or [Zoom OUT] to zoom the selected axis.

Note: While in zoom graph menu the [MODE] key is not accessible.

- Press [Escape] to return to the main menu.

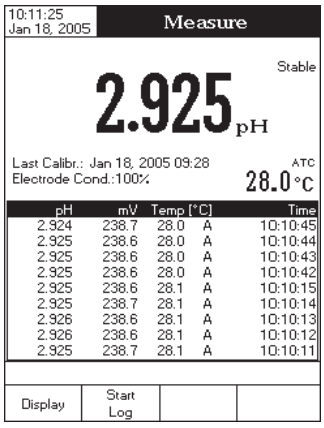
Log History

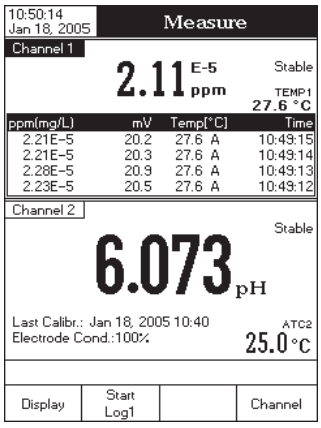
Accessing this option, last logged records will be displayed on the LCD. The log history list also contains the appropriate mV values, the logged temperature, the temperature compensation source, as well as the records time stamp.

Note: If no data were logged, the "Log History Empty" message will be displayed on the LCD.

To access the Log History displaying mode:

- Press [Display] while in *Measure* mode. The "Choose Display Configuration" message will be displayed in the Reminder messages area.
- Press [Log History]. The instrument will display the log history regarding the selected *Measure* mode.





Notes:

- When an alarm condition is active, all logged records will have an exclamation mark (!).
- If another *Measure* mode is selected, the Log History will reset.
- If the temperature unit is changed, all logged temperature values will be automatically displayed in the new temperature unit.

SYSTEM SETUP

The System Setup menu allows the user to customize the user interface, consult the meter information, set the external serial communication interface and to restore the manufacturer settings.

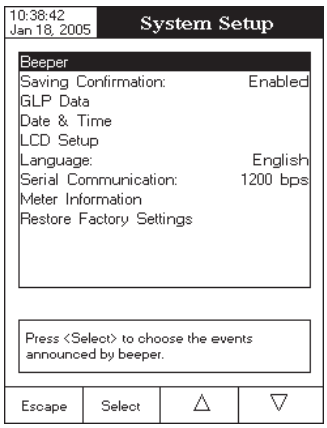
Accessing System Setup

- Press [SETUP] while in *Measure* mode.
- Press [System Setup]. The system setup options will be displayed on the LCD.

To access a System Setup option:

- Use [△] or [▽] to highlight the desired option.
- Press [Select] to access the selected option.

The following is a detailed description of the System Setup option screen.



Beeper

This option allows the user to enable or disable the beeper. When the beeper is enabled, a specific beep will be heard when the reading becomes stable, when an alarm condition is reached, when pressing a key or if a wrong key is pressed.

Stability Indicator

When the reading becomes stable, the instrument delivers a medium beep only if this option is ON, along with the "Stable" indicator on the LCD.

Alarm

If this option is ON, a continuous double beep will be heard each time the set limits in *Measure* mode are exceeded, along with the "Alarm" indicator on the LCD.

Key Pressed

If this option is ON, a short beep will be heard each time a valid key is pressed.

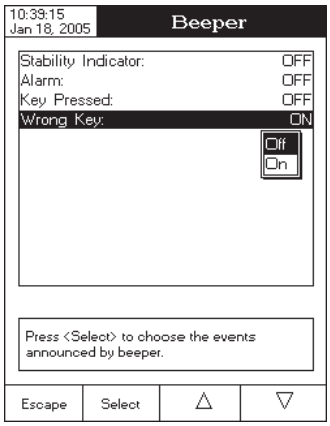
Wrong Key

If this option is ON, a long beep will be heard when an incorrect key is pressed.

To set the Beeper:

- Press [SETUP] while in *Measure* mode.
- Press [System Setup].

- Use △ or ▽ to select the Beeper option.
- Press Select and use △ or ▽ to highlight the desired beeper status option you want to modify.
- Press Select and use △ or ▽ to highlight the desired option.
- Press Select to confirm your selection and return to the Beeper menu or press Escape to return to the Beeper menu without changing.

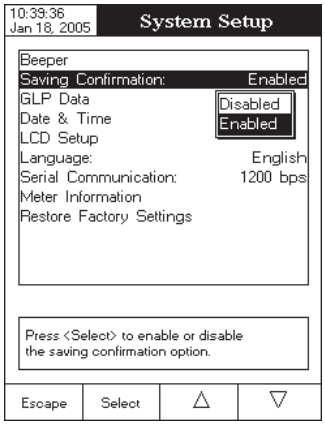


Saving Confirmation

When enabling this option, a prompt will appear on the LCD alerting the user to save the modified values by pressing Yes, exiting without saving by pressing No or canceling the saving operation and return to the editing mode by pressing Cancel. If disabled, the modified values will be saved automatically.

To modify the Saving Confirmation option:

- Press SETUP while in *Measure* mode.
- Press System Setup.
- Use △ or ▽ to select the Saving Confirmation option.
- Press Select and use △ or ▽ to highlight the desired Saving Confirmation option.
- Press Select to confirm your selection or press Escape to cancel operation.



GLP Data

This option allows the user to set general information which will appear in the log reports. The options are available for both channels (**HI 4222** only) and can have a max of 10 characters.

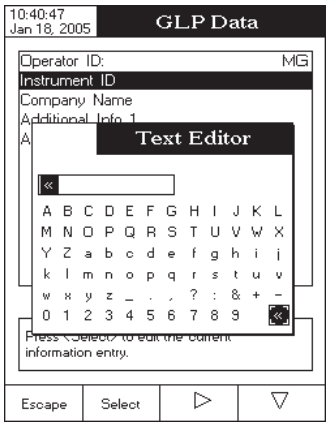
Operator ID – this option allows you to edit the name of the operator.

Instrument ID – this option allows you to edit an identification name/number for the instrument.

Company Name – this option allows you to edit the company name.

Additional Info 1 & Additional Info 2 – for general purpose notations.

To set the GLP Data:



- Press [SETUP] while in *Measure* mode.
- Press [System Setup].
- Use [△] or [▽] to select the GLP Data option.
- Press [Select] and use [△] or [▽] to highlight the desired option.
- Press [Select] to edit the desired information. The Text Editor menu will be displayed on the LCD.
- Enter the desired information by accepting the highlighted character which is added to the text bar, using [Select]. The [▷] and [▽] keys help the user select the desired character. It is also possible to delete the last character by positioning the cursor on the Backspace character («) and pressing [Select].
- Press [Escape] to return to the GLP Data options. If the Saving Confirmation is enabled, press [Yes] to accept the modified option, [No] to escape without saving or [Cancel] to return to the editing mode. Otherwise, the modified options are saved automatically.

Date & Time

This option allows the user to set the current date & time and the format in which they appear. These parameters will be displayed on the *Measure* screens and also when storing measured data.

Set Date and Time

This option allows you to set the current date (year/month/day) and time (hour/minute/second).

Notes:
- Only years starting with 2000 are accepted.
- The time is set using the selected time format. For 12 Hour time format only, the AM/PM can also be selected with [△] or [▽].

Set Time Format

This option allows you to choose between 12 Hour (AM/PM) time format and 24 Hour time format from the displayed pop-up menu.

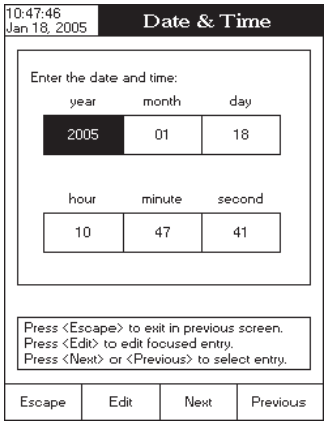
Set Date Format

This option allows you to choose the desired date format from 6 available options: DD/MM/YYYY; MM/DD/YYYY; YYYY/MM/DD; Mon DD, YYYY; DD-MM-YYYY and YYYY-Mon-DD.

To set the Date & Time:

- Press [SETUP] while in *Measure* mode.
- Press [System Setup].

- Use △ or ▽ to select the Date & Time option.
- Press Select and use △ or ▽ to highlight the desired option you want to modify.
- Press Select to confirm your selection. Use Next / Previous to select next/previous entry to be edit. Press Edit and use △ or ▽ to set the desired value, then press Accept to save the modified value (for Set Date and Time option). For the other two options press Select to confirm your selection and select one of the displayed options with △ or ▽.
- Press Select to confirm your selection and return to the Date & Time options.



- Press Escape to return to Date & Time options (for Set Date and Time option only). If the Saving Confirmation is enabled, press Yes to accept the modified option, No to escape without saving or Cancel to return to the editing mode. Otherwise, the modified option is saved automatically.

Note: If the time is changed with more than one hour before last pH/ION calibration, a pop-up warning will appear on the LCD, notifying the user that a date/time conflict has occured and some time-dependent modes could work improperly (e.g. *Measure*, GLP, Log).

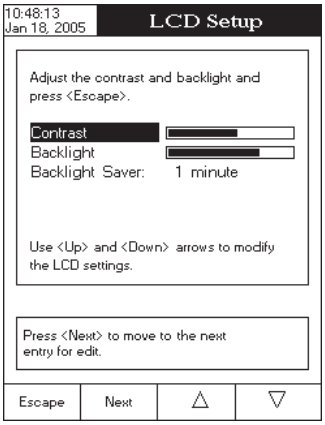
LCD Setup

This option allows the user to set the Contrast, the Backlight of the LCD and the Backlight Saver. The Contrast parameter can be adjusted within 7 steps, while the Backlight parameter within 4 steps. The Backlight Saver can be set from 1 to 60 minutes or it can be OFF (disabled). All the changes are visible on the LCD for each parameter.

Note: If the instrument backlight is turned off after the set period of time, press any key to turn it back on.

To set the LCD Setup:

- Press SETUP while in *Measure* mode.
- Press System Setup.
- Use △ or ▽ to select the LCD Setup option.
- Press Select and use Next key to highlight the desired parameter.
- Use △ or ▽ to adjust the contrast / backlight or to set the desired backlight saver time.
- Press Escape to confirm the modified options and return to the System Setup menu.



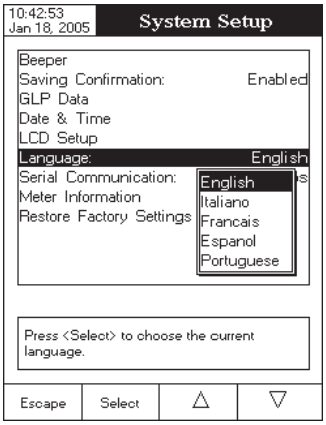
Language

This option allows the user to choose the desired language in which all information will be displayed.

To select the Language:

- Press [SETUP] while in *Measure* mode.
- Press [System Setup].
- Use [△] or [▽] to select the Language option.
- Press [Select] and use [△] or [▽] to highlight the desired language.
- Press [Select] to confirm your selection and return to the System Setup menu or press [Escape] to return to the System Setup menu without changing.

Note: After selecting the desired language, a warning pop-up is displayed on the LCD, informing the user that the selected language becomes the current language only after restarting the instrument.

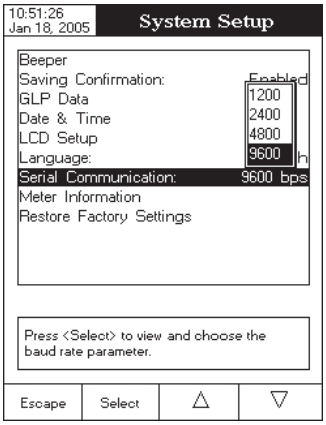


Serial Communication

This option allows the user to set the desired speed for the serial communication (baud rate) between the instrument and PC. The meter and the PC program must have the same baud rate.

To set the Serial Communication:

- Press [SETUP] while in *Measure* mode.
- Press [System Setup].
- Use [△] or [▽] to select the Serial Communication option.
- Press [Select] and use [△] or [▽] to highlight the desired baud rate.
- Press [Select] to confirm your selection and return to the System Setup menu or press [Escape] to return to the System Setup menu without changing.



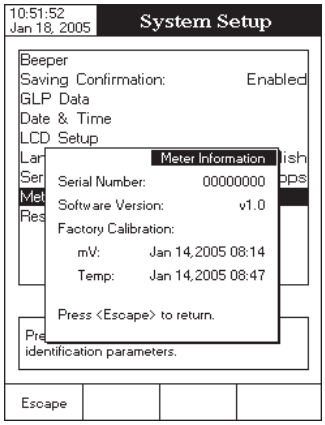
Meter Information

This option provides general information about the instrument serial number (each instrument has an unique identification serial number), the software version and the factory calibration date and time (for mV and temperature).

Note: All the instruments are factory calibrated for mV and temperature. After one year following factory calibration, the "Factory Calibration Due" message will appear on the LCD, in the Reminder messages area, notifying the user that the instrument should be taken to the nearest Hanna Customer Service for factory calibration.

To view the Meter Information:

- Press [SETUP] while in *Measure* mode.
- Press [System Setup].
- Use [△] or [▽] to select the Meter Information option.
- Press [Select] to confirm your selection and to view the Meter Information or press [Escape] to return to the System Setup menu.

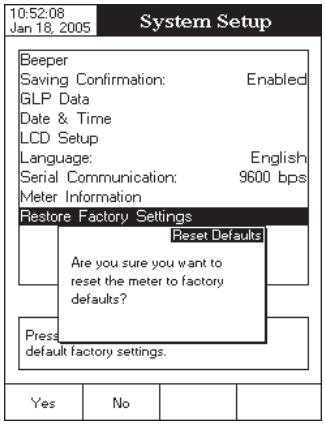


Restore Factory Settings

This option allows the user to reset the instrument to the default factory settings.

To restore the Factory Settings:

- Press [SETUP] while in *Measure* mode.
- Press [System Setup].
- Use [△] or [▽] to select the Restore Factory Settings option.
- Press [Select] to confirm your selection. A pop-up menu will be displayed, asking for confirmation.
- Press [Yes] to confirm your selection and return to the System Setup or press [No] to return to the System Setup menu without restoring defaults.
- Press [Escape] to return to *Measure* mode.



pH SETUP

The pH Setup menu allows the user to set the parameters associated with pH measurement and calibration. These parameters can be set specifically for each channel (**HI 4222** only). The settings will be applied only to the active channel.

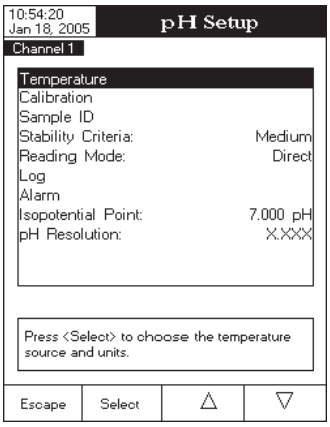
Accessing pH Setup

- Press [MODE] while in *Measure* mode and then [pH] to select pH range for the desired channel.
- Press [SETUP] and then [pH Setup] to access pH Setup menu.

To access a pH Setup option:

- Use [△] or [▽] to highlight the desired option.
- Press [Select] to access the selected option.

The following is a detailed description of the pH Setup option screens.



Temperature

The temperature has a direct influence on pH. This option allows the user to choose the temperature source and units, as well as the desired manual temperature for manual temperature compensation mode.

Temperature Source (**HI 4222 only**)

If using a temperature probe, Automatic Temperature Compensation will be performed relative to the displayed temperature, with the "ATC" indicator displayed on the LCD. For **HI 4222** only, the ATC option can be selected for Channel 1 or Channel 2, in accordance with the active channel utilizing a probe, or for both channels if two temperature probes are used. If no temperature probe is detected, Manual Temperature Compensation will be performed, with the "MTC" indicator on the LCD.

Temperature Unit

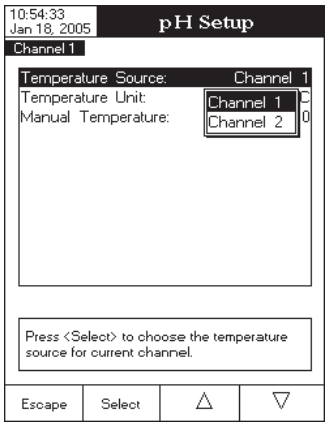
Accessing this option, the desired temperature unit can be chosen (Celsius, Fahrenheit or Kelvin degrees) and the meter will automatically make the conversion for the selected unit.

Manual Temperature

If no temperature probe is connected, the desired temperature can be set manually. The default setting is 25°C. If the measured temperature is different, the value can be manually adjusted in order to obtain an accurate pH reading.

To set one of the Temperature options:

- Press [SETUP] while in *pH Measure* mode.
- Press [pH Setup].
- Use [△] or [▽] to select the Temperature option.
- Press [Select] and use [△] or [▽] to highlight the desired Temperature option you wish to modify.
- Press [Select] and use [△] or [▽] to highlight the desired option (for Temperature Source & Unit options) or use [△] or [▽] to adjust the temperature value between the displayed limits (for Manual Temperature option).
- Press [Select] to confirm your selection (for Temperature Source & Unit options) or press [Accept] to save the current value (for Manual Temperature option). Otherwise, press [Escape] to cancel operation.



Calibration

This option allows the user to set all the data regarding the pH calibration process.

Buffer Entry Type

Three entry modes for the pH buffers used for calibration are available:

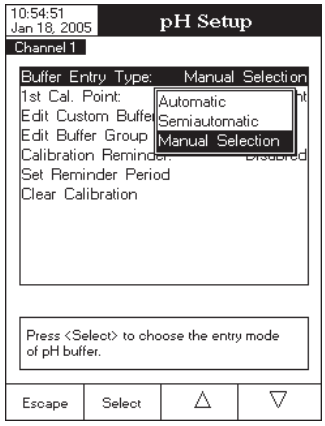
Automatic – the instrument automatically selects the closest buffer to the measured pH value from the edit buffer group.

Semiautomatic – the instrument automatically selects the closest buffers to the measured pH value from all available buffers and you can choose the one used.

Manual Selection – the desired pH buffer is manually selected from all available buffers, regardless of measured value.

To set the Buffer Entry Type:

- Press [SETUP] while in *pH Measure* mode.
- Press [pH Setup].
- Use [△] or [▽] to select the Calibration option.
- Press [Select] and use [△] or [▽] to highlight the Buffer Entry Type option.
- Press [Select] and use [△] or [▽] to highlight the desired option.
- Press [Select] to confirm your selection or press [Escape] to cancel operation.



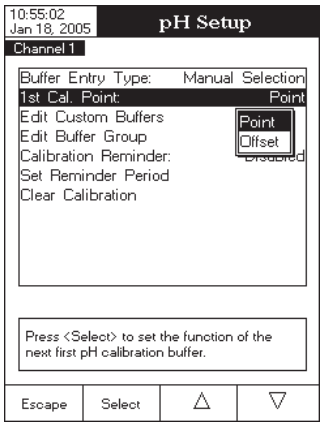
1st Cal. Point

Two options are available for the 1st Cal. Point parameter: Point and Offset.

If Point option is selected, the slope values adjacent to the calibration points will be reevaluated (normal calibration).

If at least a two-point calibration has been performed and an offset correction of the electrode is wanted (maintaining the existing slope values), perform a one-point calibration using the Offset option.

To set the 1st Cal. Point:

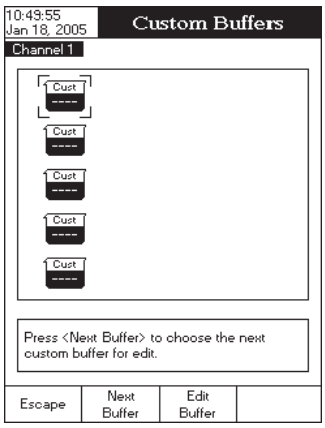


- Press [SETUP] while in *pH Measure* mode.
- Press [pH Setup].
- Use [△] or [▽] to select the Calibration option.
- Press [Select] and use [△] or [▽] to highlight the 1st Cal. Point option.
- Press [Select] and use [△] or [▽] to highlight the desired option.
- Press [Select] to confirm your selection or press [Escape] to cancel operation.

Edit Custom Buffers

If you want to use other buffers than the ones already memorized, the Edit Custom Buffers option is available, allowing you to set the desired pH buffers. Up to five pH custom buffers can be set.

To edit/set the Custom Buffers:



- Press [SETUP] while in *pH Measure* mode.
- Press [pH Setup].
- Use [△] or [▽] to select the Calibration option.
- Press [Select] and use [△] or [▽] to highlight the Edit Custom Buffers option.
- For a previous set value, press [Invalidate Buffer] to set the custom buffer value to "----" if desired and confirm the setting by pressing [Yes], otherwise press [Edit Buffer] to edit the selected custom buffer.
- While in edit custom buffer menu press [Reset Buffer] to set the custom buffer value to 7.000 pH and then use [△] or [▽] to set the desired custom buffer value.

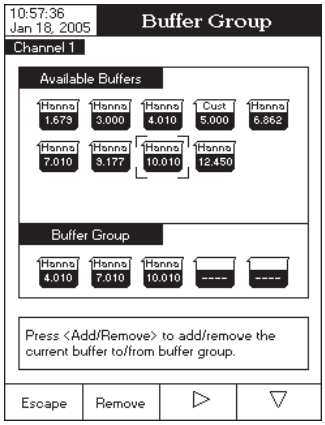
- Press [Escape] to exit custom buffer edit menu. If the Saving Confirmation is enabled, press [Yes] to accept the modified option, [No] to escape without saving or [Cancel] to return to the editing mode. Otherwise, the modified option is saved automatically.
- Use [Next Buffer] key to select the next custom buffer to be set or press [Escape] to return to Calibration options.

Edit Buffer Group

Accessing this option the user can edit the desired group of five pH buffers for automatic buffer recognition (Automatic Buffer Entry Type). If the Buffer Group already contains five pH buffers, at least one pH buffer has to be removed in order to add another buffer.

To edit/set the Buffer Group:

- Press [SETUP] while in *pH Measure* mode.
- Press [pH Setup].
- Use [△] or [▽] to select the Calibration option.
- Press [Select] and use [△] or [▽] to highlight the Edit Buffer Group option.
- Press [Select] and use [▷] and [▽] to choose the pH buffer to be included in the buffer group.
- Press [Add] or [Remove] to add/remove the selected pH buffer to/from the buffer group.
- Press [Escape] to return to Calibration options and to save the changes.

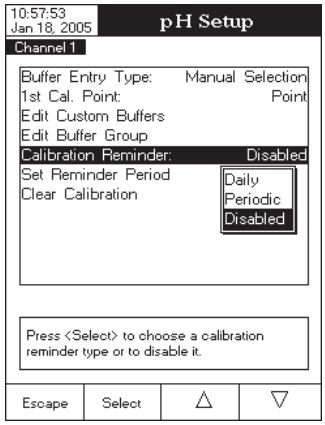


Calibration Reminder

In order to have accurate readings, the instrument must be calibrated frecquently. Three options are available for the calibration reminder: Daily, Periodic or Disabled.

To set the Calibration Reminder:

- Press [SETUP] while in *pH Measure* mode.
- Press [pH Setup].
- Use [△] or [▽] to select the Calibration option.
- Press [Select] and use [△] or [▽] to highlight the Calibration Reminder option.
- Press [Select] and use [△] or [▽] to highlight the desired option.
- Press [Select] to confirm your selection or press [Escape] to cancel operation.

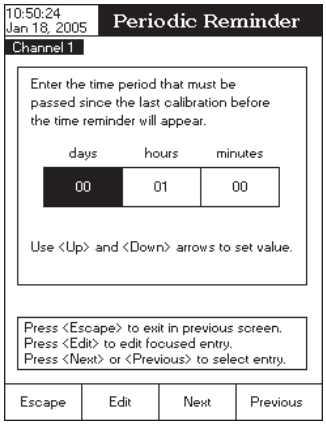


Set Reminder Period

If choosing Daily or Periodic options for the Calibration Reminder, the Set Remind Period must be accessed in order to set the time interval until next calibration. The time interval between two calibrations can be set up to 1 day / 1 year for Daily / Periodic options.

Note: If Set Reminder Period parameter is accessed and the Calibration Reminder is disabled, a warning message appears on the LCD informing the user that the reminder period can be set only if the Calibration Reminder is set as Daily or Periodic.

To set the Reminder Period:

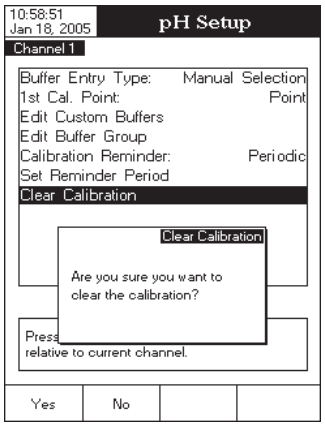


- Press [SETUP] while in *pH Measure* mode.
- Press [pH Setup].
- Use [△] or [▽] to select the Calibration option.
- Press [Select] and use [△] or [▽] to highlight the Set Reminder Period option.
- Press [Select] and use [Next] / [Previous] to select next/previous entry to be edit.
- Press [Edit] and use [△] or [▽] to set the desired value, then press [Accept] to save the modified value.
- Press [Escape] to return to the Calibration options. If the Saving Confirmation is enabled, press [Yes] to accept the modified option, [No] to escape without saving or [Cancel] to return to the editing mode. Otherwise, the modified option is saved automatically.

Clear Calibration

Accessing this option, the existent pH calibration relative to the selected channel can be cleared. If the calibration is cleared, another calibration has to be performed.

To clear Calibration:



- Press [SETUP] while in *pH Measure* mode.
- Press [pH Setup].
- Use [△] or [▽] to select the Calibration option.
- Press [Select] and use [△] or [▽] to highlight the Clear Calibration option.
- Press [Select] to clear calibration. A pop-up menu will be displayed asking for confirmation.
- Press [Yes] to confirm or press [No] to escape without saving and return to the Calibration options.

Sample ID

This option allows the user to give to the measured samples an identification number/name. Two Sample ID options are available: ID Increment Mode and Edit Sample ID.

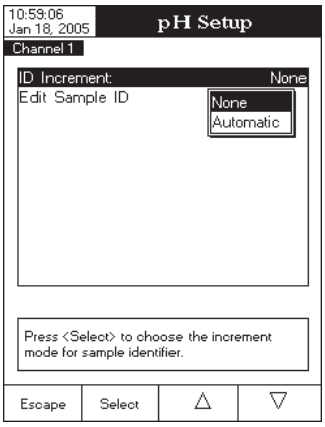
ID Increment Mode

Two increment modes for the sample ID can be selected:

None – the sample ID will be fixed and it can be set alphanumerically.

Automatic – the sample ID will be increased with 1 from the set value, for each new log lot.

To set the ID Increment Mode:



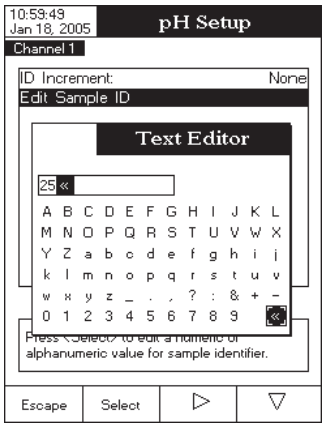
- Press SETUP while in *pH Measure* mode.
- Press pH Setup.
- Use △ or ▽ to select the Sample ID option.
- Press Select and use △ or ▽ to highlight the ID Increment Mode option.
- Press Select and use △ or ▽ to highlight the desired option.
- Press Select to confirm your selection or press Escape to cancel operation.

Edit Sample ID

This option allows the user to edit the sample ID.

Note: If the ID Increment Mode is set to None, the sample ID can be set alphanumerically, otherwise it can be set only numerically.

To edit the Sample ID:

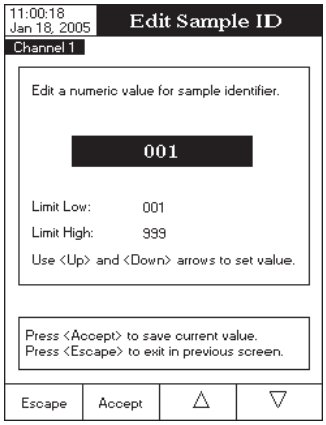


- Press SETUP while in *pH Measure* mode.
- Press pH Setup.
- Use △ or ▽ to select the Sample ID option.
- Press Select and use △ or ▽ to highlight the Edit Sample ID option.
- Press Select to confirm your selection.
- If the selected increment mode is None, the Text Editor menu will be displayed on the LCD, allowing you to enter the desired sample number/name by accepting the highlighted character which is added in the text bar, using Select. The ▷ and ▽ keys help

the user to select the desired character. It is also possible to delete the last character by positioning the cursor on the Backspace character and pressing [Select].

- Press [Escape] to return to Sample ID options. If the Saving Confirmation is enabled, press [Yes] to accept the modified option, [No] to escape without saving or [Cancel] to return to the editing mode. Otherwise, the modified options are saved automatically.

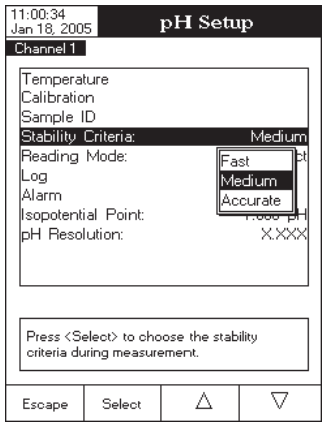
- If the selected increment mode is Automatic, the desired sample ID value can be set using [△] or [▽].
  - Press [Accept] to save the current value or press [Escape] to cancel operation.



Stability Criteria

This option allows the user to select the signal stability criterion for the measured parameter (pH, mV, ISE):
Fast – this criterion will give faster results with less accuracy.
Medium – this criterion will give medium speed results with medium accuracy.
Accurate – this criterion will give slower results with high accuracy.
To set the Stability Criteria:

- Press [SETUP] while in *pH Measure* mode.
- Press [pH Setup].
- Use [△] or [▽] to select the Stability Criteria option.
- Press [Select] and use [△] or [▽] to highlight the desired option.
- Press [Select] to confirm your selection or press [Escape] to cancel operation.

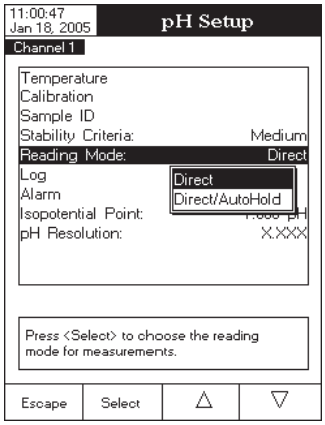


Reading Mode

This option allows the user to select between Direct and Direct/AutoHold pH reading mode. If choosing the second option, the current reading can be frozen on the LCD when [Auto Hold] is pressed and if the stability criterion is reached.

To set the Reading Mode:

- Press [SETUP] while in *pH Measure* mode.
- Press [pH Setup].
- Use [△] or [▽] to select the Reading Mode option.
- Press [Select] and use [△] or [▽] to highlight the desired option.
- Press [Select] to confirm your selection or press [Escape] to cancel operation.



Log

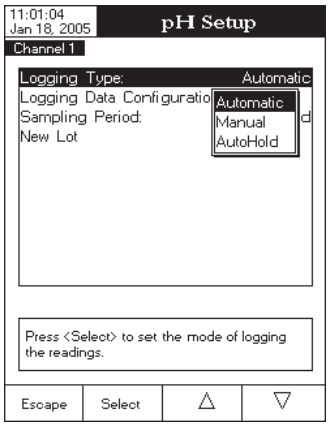
This option allows the user to edit the logging settings: Logging Type, Logging Data Configuration, Sampling Period and New Lot.

Logging Type

Three logging types are available: Automatic, Manual and AutoHold. With the Automatic type the values are logged automatically at constant time intervals while with the Manual type the user has the capability to log a measured value by pressing [Log]. With the AutoHold type the stored values are only the ones frozen on the LCD after the logging session was started.

To set the Logging Type:

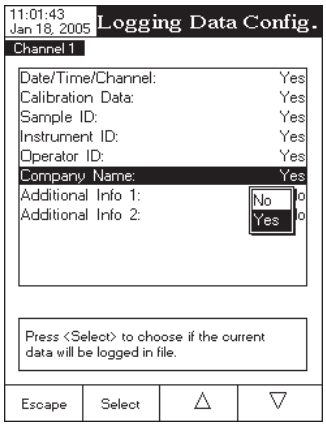
- Press [SETUP] while in *pH Measure* mode.
- Press [pH Setup].
- Use [△] or [▽] to select the Log option.
- Press [Select] and use [△] or [▽] to highlight the Logging Type option.
- Press [Select] and use [△] or [▽] to highlight the desired option.
- Press [Select] to confirm your selection or press [Escape] to cancel operation.



Logging Data Configuration

This option allows the user to select the parameters that accompany a logged value: Date/Time/Channel, Calibration Data, Sample ID, Instrument ID, Operator ID, Company Name, Aditional Info 1 and Aditional Info 2.

To set the Logging Data Configuration:

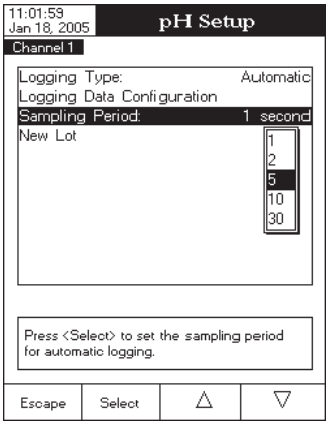


- Press [SETUP] while in *pH Measure* mode.
- Press [pH Setup].
- Use [△] or [▽] to select the Log option.
- Press [Select] and use [△] or [▽] to highlight the Logging Data Configuration option.
- Press [Select] and use [△] or [▽] to highlight the desired parameter to be logged in file.
- Press [Select] to confirm your selection and use [△] or [▽] to enable the parameter by selecting Yes or to disable it by selecting No.
- Press [Select] to confirm your selection or press [Escape] to cancel operation.

Sampling Period

This option allows the user to select the desired sampling period for automatic logging type.

To set the Sampling Period:



- Press [SETUP] while in *pH Measure* mode.
- Press [pH Setup].
- Use [△] or [▽] to select the Log option.
- Press [Select] and use [△] or [▽] to highlight the Sampling Period option.
- Press [Select] and use [△] or [▽] to select the desired option.
- Press [Select] to confirm your selection or press [Escape] to cancel operation.

New Lot

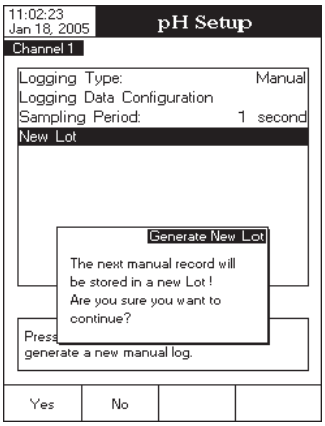
Accessing this option, a new manual lot can be generated next time you want to manually log a measured value.

Note: If New Lot option is accessed and the Logging Type is Automatic, a warning message appears on the LCD informing the user that a new lot can be created only if the Logging Type is set as Manual.

To generate a New Lot:

- Press [SETUP] while in *pH Measure* mode.
- Press [pH Setup].

- Use △ or ▽ to select the Log option.
- Press Select and use △ or ▽ to highlight the New Lot option.
- Press Select to generate a new manual lot. A pop-up menu will be displayed asking for confirmation.
- Press Yes to confirm or press No to escape without saving and return to the Log options.



Alarm

This option allows the user to edit the alarm settings: Alarm State and Alarm Limits. If the Alarm option is enabled, a continuous double beep will be heard, along with the "Alarm" indicator blinking on the LCD, each time the set limits in *Measure* mode are exceeded.

Alarm State

Three modes are available for the Alarm State option:

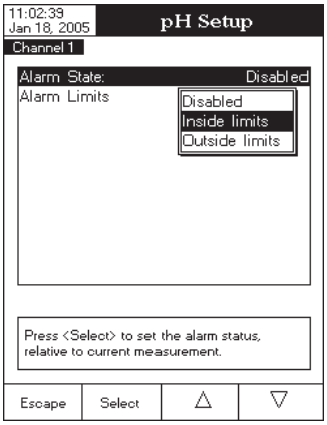
Disabled – the alarm will be disabled.

Inside Limts – the alarm will notify the user when the measured value is inside the set limits.

Outside Limits – the alarm will notify the user when the measured value is outside the set limits.

To set the Alarm State:

- Press SETUP while in *pH Measure* mode.
- Press pH Setup.
- Use △ or ▽ to select the Alarm option.
- Press Select and use △ or ▽ to highlight the Alarm State option.
- Press Select and use △ or ▽ to highlight the desired option.
- Press Select to confirm your selection or press Escape to cancel operation.



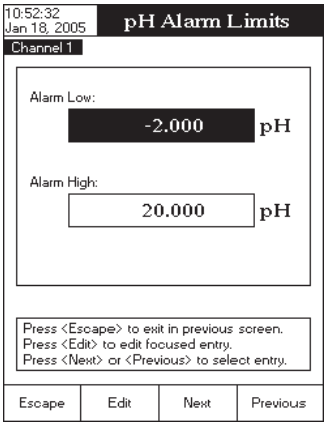
Alarm Limits

This option allows the user to set the alarm limits for the measured value.

Note: The Alarm High value can not be lower than the Alarm Low value.

To set the Alarm Limits:

- Press [SETUP] while in *pH Measure* mode.
- Press [pH Setup].
- Use [△] or [▽] to select the Alarm option.
- Press [Select] and use [△] or [▽] to highlight the Alarm Limits option.
- Press [Select] and use [Next] / [Previous] to select next/previous entry to be edit.
- Press [Edit] and use [△] or [▽] to set the desired value, then press [Accept] to save the modified value.
- Press [Escape] to return to the Alarm options. If the Saving Confirmation is enabled, press [Yes] to accept the modified option, [No] to escape without saving or [Cancel] to return to the editing mode. Otherwise, the modified option is saved automatically.



Isopotential Point

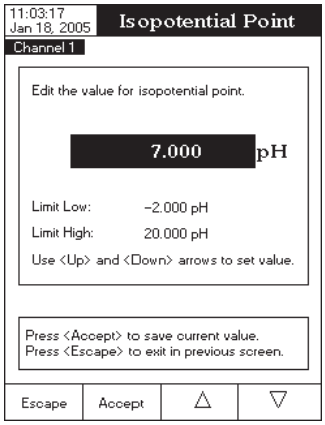
This option allows the user to edit the isopotential point of the electrode used for pH measurements. The isopotential point is the mV reading for an electrode at which temperature has no effect on the measurement. The ideal electrode has an isopotential point of 0.0 mV and 7.00 pH, while an actual electrode tipically deviates slightly from the ideal values.

If the actual isopotential pH for an electrode is known, it can be set by accessing this option. The isopotential pH limits (low and high) will be displayed on the LCD.

Note: If the isopotential point has been modified, recalibration must be performed for the respective channel.

To set the Isopotential Point:

- Press [SETUP] while in *pH Measure* mode.
- Press [pH Setup].
- Use [△] or [▽] to select the Isopotential Point option.
- Press [Select] and set the desired isopotential pH value using [△] or [▽].
- Press [Accept] to save the current value or press [Escape] to cancel operation.

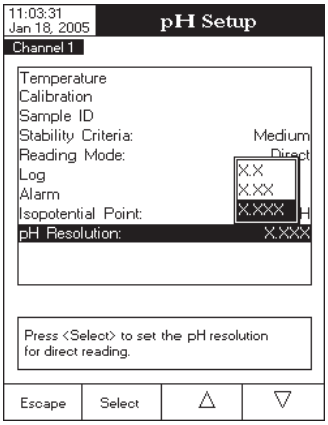


pH Resolution

Accessing this option, the desired pH resolution can be set, with one (x.x), two (x.xx) or three (x.xxx) decimals.

To set the pH Resolution:

- Press [SETUP] while in *pH Measure* mode.
- Press [pH Setup].
- Use [△] or [▽] to select the pH Resolution option.
- Press [Select] and use [△] or [▽] to highlight the desired option.
- Press [Select] to confirm your selection or press [Escape] to cancel operation.



mV SETUP

The mV Setup menu allows the user to set the parameters associated with mV and Relative mV measurements. These parameters can be set specifically for each channel (**HI 4222** only). The settings will be applied only to the active channel.

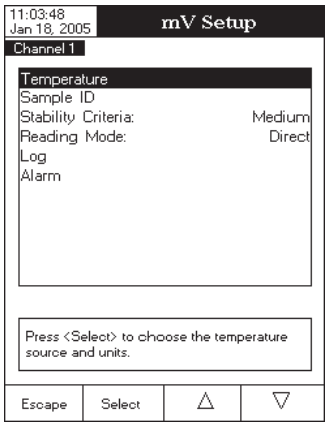
Accessing mV Setup

- Press [MODE] while in *Measure* mode and then [mV] or [Rel mV] to select mV / mV Rel range for the desired channel.
- Press [SETUP] and then [mV Setup] to access mV Setup menu.

To access a mV Setup option:

- Use [△] or [▽] to highlight the desired option.
- Press [Select] to access the selected option.

The following is a detailed description of the mV Setup option screens.



Temperature – See pH Setup section, page 20.

Note: To access mV Setup, press [SETUP] and then [mV Setup].

Sample ID – See pH Setup section, page 20.

Stability Criteria – See pH Setup section, page 20.

Reading Mode – See pH Setup section, page 20.

Log – See pH Setup section, page 20.

Alarm – See pH Setup section, page 20.

Note: The Alarm Limits (Low and High) are set in mV units.

ISE SETUP (HI 4222 only)

The ISE Setup menu allows the user to set the parameters regarding ISE measurement and calibration. These parameters can be set specifically for each channel. The settings will be applied only to the active channel.

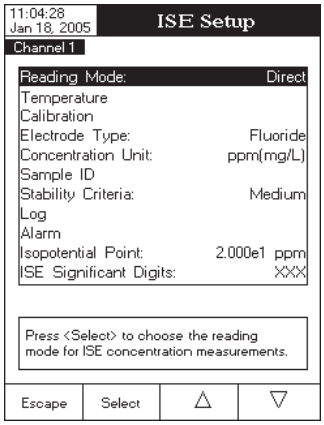
Accessing ISE Setup

- Press [MODE] while in *Measure* mode and then [ISE] to select ISE range for the desired channel.
- Press [SETUP] and then [ISE Setup] to access ISE Setup menu.

To access an ISE Setup option:

- Use [△] or [▽] to highlight the desired option.
- Press [Select] to access the selected option.

The following is a detailed description of the ISE Setup option screens.



Reading Mode

This option allows the user to select the desired reading mode: Direct, Direct/AutoHold, Known Addition, Known Subtraction, Analyte Addition and Analyte Subtraction. Except Direct and Direct/AutoHold, all the other methods are incremental (see ISE Theory section for details, page 54).

Direct

If using Direct reading mode, the ion concentration can be read directly from the instrument. Make sure the instrument was calibrated before taking measurements.

Direct/AutoHold

If using Direct/AutoHold reading mode, the ion concentration can be frozen on the LCD after starting the AutoHold mode.

Known Addition

In the Known Addition method a standard with a known concentration of the measured ion is added to the sample. The difference in mV potential is then used to calculate the concentration of the ion in the sample.

Known Subtraction

In the Known Subtraction method a standard with a known concentration is added to the sample, reacting with the ion to be measured. The stoichiometric ratio between standard and sample must be known. The ion concentration is then calculated using the difference in mV potential.

The method is especially usefull when there is no available ISE for the measured ion.

Analyte Addition

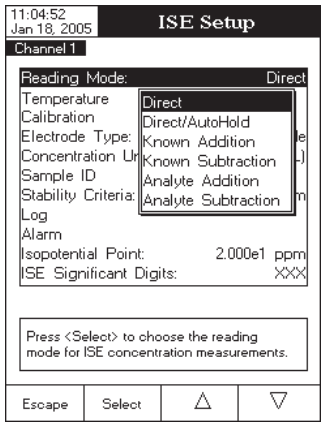
This method is similar to the Known Addition method, with the difference that an aliquot of sample is added to a standard of known concentration. The sample and standard contain the same ion to be measured. The ion concentration is then calculated using the difference in mV potential.

Analyte Subtraction

In the Analyte Subtraction method an aliquot of sample is added to a standard of known concentration, reacting with the ion to be measured. The stoichiometric ratio between standard and sample must be known. The ion concentration is then calculated using the difference in mV potential. The method is especially usefull when there is no available ISE for the measured ion.

To set the Reading Mode:

- Press [SETUP] while in *ISE Measure* mode.
- Press [ISE Setup].
- Use [△] or [▽] to select the Reading Mode option.
- Press [Select] and use [△] or [▽] to highlight the desired option.
- Press [Select] to confirm your selection or press [Escape] to cancel operation.



Temperature – See pH Setup section, page 20.

Notes: • To access ISE Setup, press [SETUP] and then [ISE Setup].

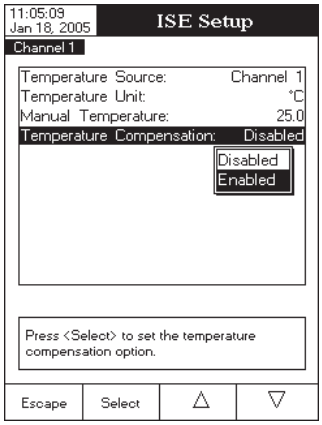
• The Temperature Compensation option is also included in the Temperature parameter.

Temperature Compensation

This option allows the user to enable / disable the temperature compensation for the measurement of Ion concentration.

To set the Temperature Compensation:

- Press [SETUP] while in *ISE Measure* mode.
- Press [ISE Setup].
- Use [△] or [▽] to select the Temperature option.
- Press [Select] and use [△] or [▽] to highlight the Temperature Compensation option.
- Press [Select] and use [△] or [▽] to enable / disable the Temperature Compensation.



- Press [Select] to confirm your selection or press [Escape] to cancel operation.

Note: If an ISE calibration was performed and the Temperature Compensation option is changed, a warning message appears on the LCD informing the user to perform a new calibration or to set the previous option in order to perform accurate measurements.

Calibration

This option allows the user to set all the data regarding the Ion calibration process.

Standard Entry Type

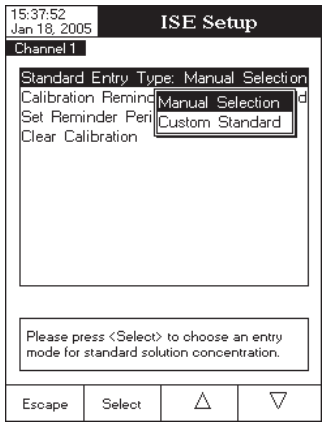
Two entry modes for the standard solutions used for calibration are available:

Manual Selection – when the calibration is started, the desired standard solution can be manually selected from a standard solutions list (0.1 ppm, 1 ppm, 10 ppm, 100 ppm and 1000 ppm).

Custom Standard – when the calibration is started, each standard solution can be manually set (in ppm units) in a displayed pop-up menu.

To set the Standard Entry Type:

- Press [SETUP] while in *ISE Measure* mode.
- Press [ISE Setup].
- Use [△] or [▽] to select the Calibration option.
- Press [Select] and use [△] or [▽] to highlight the Standard Entry Type option.
- Press [Select] and use [△] or [▽] to highlight the desired option.
- Press [Select] to confirm your selection or press [Escape] to cancel operation.



Calibration Reminder – See Calibration option from pH Setup section, page 20.

Set Reminder Period – See Calibration option from pH Setup section, page 20.

Clear Calibration – See Calibration option from pH Setup section, page 20.

Electrode Type

This option allows the user to select the desired Ion Selective Electrode used for measurements from a list: Ammonia, Bromide, Cadmium, Calcium, Carbon Dioxide, Chloride, Chlorine, Cupric, Cyanide, Fluoride, Iodide, Lead, Nitrate, Potassium, Silver, Sodium, Sulfate, Sulfide and five custom ISE. For the standard ISE it is possible to view the Ion constants (Name, Molar Weight and Electric Charge/Slope), while for the custom ISE all these constants can be manually set.

To set the Electrode Type:

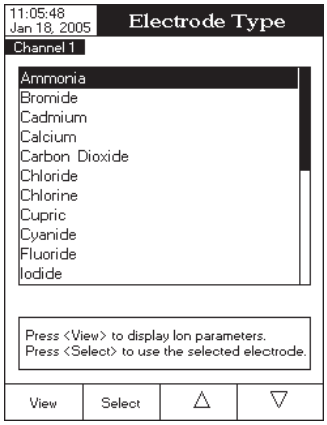
- Press [SETUP] while in *ISE Measure* mode.
- Press [ISE Setup].
- Use [△] or [▽] to select the Electrode Type option.
- Press [Select] and use [△] or [▽] to select the desired standard ISE or a custom one from the list.

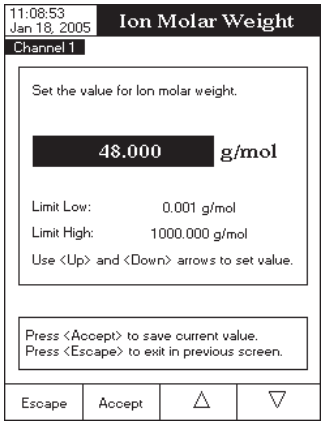
  For standard ISE:

  - Press [View] to visualize the Ion constants and then press [Escape] at any time to exit Ion Constants view mode.
  - Press [Select] to confirm your selection and return to *ISE Setup* options.

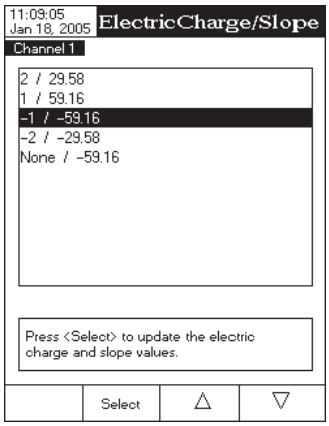
  For custom ISE:

  - Press [View] to edit the Ion constants for the selected custom ISE. Use [△] or [▽] to select the desired Ion constant and press [Select] to enter Ion constant edit mode or [Escape] to cancel operation.
  - For the Ion name the Text Editor menu will be displayed on the LCD. Enter the desired information by accepting the highlighted character which is added in the text bar, using [Select]. The [▷] and [▽] keys help the user to select the desired character. It is also possible to delete the last character by positioning the cursor on the Backspace character and pressing [Select]. Press [Escape] to return to the Ion Constants menu. If the Saving Confirmation is enabled, press [Yes] to accept the modified option, [No] to escape without saving or [Cancel] to return to the editing mode. Otherwise, the modified option is saved automatically.
  - To set the appropriate Ion molar weight (in g/mol units) use [△] or [▽] and then press [Accept] to save the current value or press [Escape] to cancel operation.





- To select the appropriate Electric Charge/Slope use △ or ▽ and then press Select. If the Ion electric charge is None, its slope can be manually set by pressing Edit. A pop-up menu will be displayed on the LCD, in which the slope value can be set using △ or ▽. Press Accept to save the modified value or press Escape to return to the Ion Constants menu.



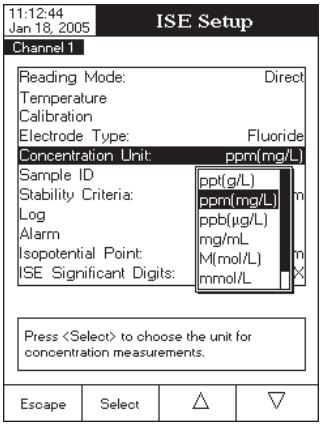
Note: If an ISE calibration was performed and a different Ion Selective Electrode is selected (standard or custom), a warning message appears on the LCD informing the user to perform a new calibration or to select the previous ISE in order to perform accurate measurements.

Concentration Unit

Accessing this option, the user can select the desired concentration unit for the measured ion or chemical compound. The available concentration units are: ppt (g/L), ppm (mg/L), ppb (µg/L), mg/mL, M (mol/L), mmol/L and %w/v.

To set the Concentration Unit:

- Press SETUP while in *ISE Measure* mode.
- Press ISE Setup.
- Use △ or ▽ to select the Concentration Unit option.
- Press Select and use △ or ▽ to highlight the desired option.
- Press Select to confirm your selection or press Escape to cancel operation.



Sample ID – See pH Setup section, page 20.

Stability Criteria – See pH Setup section, page 20.

Log – See pH Setup section, page 20.

Note: The Logging Data Configuration option includes also the Ion Constants parameter. If you want it to appear in the log reports, it must be enabled.

Alarm – See pH Setup section, page 20.

Note: The Alarm Limits (Low and High) are set in the selected concentration unit of the measured ion or chemical compound and are displayed in a scientific format (value and value exponent).

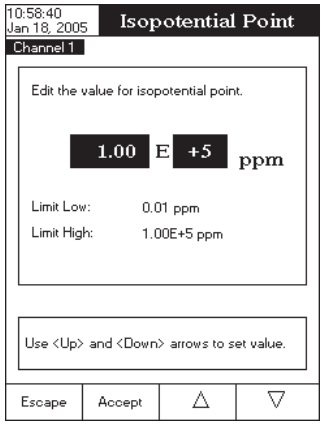
Isopotential Point

This option allows the user to edit the isopotential point of the electrode used for ion measurements. The ion selective electrodes have different isopotential points. If temperature compensation is desired for the ion measurements, the isopotential point value is absolutely necessary.

The isopotential point is always edited in ppm (mg/L) units.

To set the Isopotential Point:

- Press [SETUP] while in *ISE Measure* mode.
- Press [ISE Setup].
- Use [△] or [▽] to select the Isopotential Point option.
- Press [Select] and use [△] or [▽] to increase/decrease the isopotential point value.
- Press [Accept] key to save the modified value.
- Press [Escape] to return to the Ion Setup options. If the Saving Confirmation is enabled, press [Yes] to accept the modified option, [No] to escape without saving or [Cancel] to return to the editing mode. Otherwise, the modified option is saved automatically.



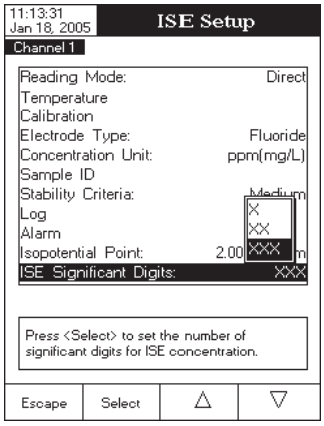
Note: If an ISE calibration was performed and the Isopotential Point option is changed, a warning message appears on the LCD informing the user to perform a new calibration or to set the previous option in order to perform accurate measurements.

ISE Significant Digits

Accessing this option, the number of ISE significant digits can be set, with one (x), two (xx) or three (xxx) significant digits.

To set the ISE Significant Digits:

- Press [SETUP] while in *ISE Measure* mode.
- Press [ISE Setup].
- Use [△] or [▽] to select the ISE Significant Digits option.
- Press [Select] and use [△] or [▽] to highlight the desired option.
- Press [Select] to confirm your selection or press [Escape] to cancel operation.



pH CALIBRATION & MEASUREMENTS

pH CALIBRATION

Calibrate the instrument often, especially if high accuracy is required.

The instrument should be recalibrated:

- Whenever the pH electrode is replaced.
- At least once a week.
- After testing aggressive chemicals.
- When "No pH Calibration" or "pH Calibration Expired" message appears on the LCD, in the Reminder messages area.

PREPARATION

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 buffer solution. One for rinsing the electrode and one for calibration.

If you are measuring in the acidic range, use pH 7.01 or 6.86 as first buffer and pH 4.01/3.00 or 1.68 as second buffer. If you are measuring in the alkaline range, use pH 7.01 or 6.86 as first buffer and pH 10.01/ 9.18 or 12.45 as second buffer.

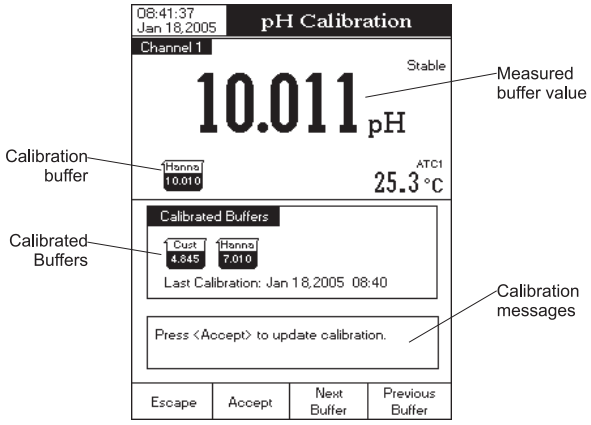
For extended range measurements (acidic and alkaline), perform a five-point calibration by selecting five of the available buffers.

CALIBRATION PROCEDURE

Calibration has a choice of 8 memorized buffers: pH 1.68, 3.00, 4.01, 6.86, 7.01, 9.18, 10.01, 12.45 and up to 5 custom buffers.

For accurate measurements it is recommended to perform a five-point calibration. However, at least a two-point calibration is suggested.

pH Calibration screen description

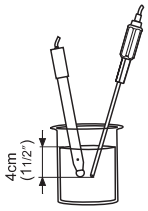


Three buffer entry types are available: Automatic, Semiautomatic and Manual Selection. The default option is Manual Selection.

To calibrate the instrument using Manual Selection buffer entry type:

- Press [CAL]. If the instrument was calibrated before and calibration was not cleared, the old calibration can be cleared by pressing [Clear Cal]. After 10 seconds, [Clear Cal] will no longer be available.

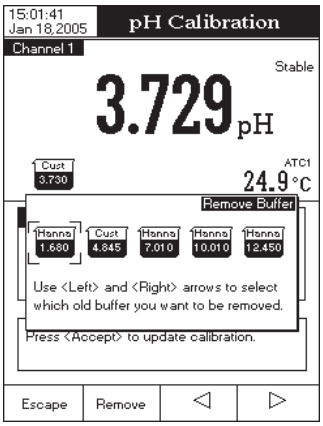
  Note: It is very important to clear calibration history when a new electrode is used because most errors and warning messages that appear during calibration depend on calibration history.



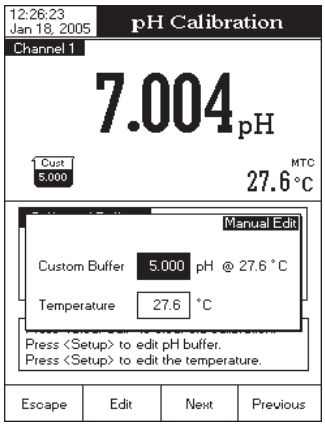
- Immerse the pH electrode and the temperature probe approximately 4 cm (1½") into a buffer solution of your choice (pH 1.68, 3.00, 4.01, 6.86, 7.01, 9.18, 10.01, 12.45 or a custom buffer) and stir gently. The temperature probe should be close to the pH electrode.
- Select the used pH calibration buffer with [Next Buffer] or [Previous Buffer]. The "Please wait..." message will appear on the LCD until the reading is stable or the buffer is validated.
- If the pH buffer is validated, [Accept] will appear on the LCD. Press [Accept] to update calibration. The calibration buffer will be added to the Calibrated Buffers section.
- Immerse the pH electrode and the temperature probe into the next buffer solution and follow the above procedure or press [Escape] to exit calibration.

Notes:

- The new added calibration point will replace an old one if the difference between them is ±0.2 pH.
- If the existing stored calibration is full (five calibration points), a pop-up menu will be displayed on the LCD in which you can select with [◁] or [▷] keys the buffer you want to replace with the current buffer. Press [Remove] to delete the selected buffer and then press [Accept] to update calibration with the new buffer.
- When in MTC mode, if pressing [SETUP] after entering pH calibration and while a HANNA pH calibration buffer with a x.xxx resolution is selected, a pop-up menu will be displayed on the LCD in which the temperature value can be ajusted using [△] or [▽]. Press [Accept] to save the new temperature value.



- When in MTC mode, if pressing [SETUP] after entering calibration and while a custom pH calibration buffer is selected, a pop-up menu will be displayed on the LCD in which the custom buffer and the temperature value can be ajusted by pressing [Edit] and then [△] or [▽] keys. Press [Accept] to save the modified value and then [Next] / [Previous] to select next/ previous value to be adjusted.



- When in ATC mode, if pressing [SETUP] after entering calibration and while a standard pH buffer (with a x.xxx resolution) or a custom pH buffer is selected, a pop-up menu will be displayed on the LCD in which the buffer value can be ajusted using [△] or [▽]. Press [Accept] to save the new buffer value.
- If the Automatic buffer entry type has been selected for the calibration procedure, the instrument will automatically select the closest buffer to the measured pH value from the edit buffer group (see pH Setup for details, page 20).
- If the Semiautomatic buffer entry type has been selected for the calibration procedure, the instrument will automatically select the closest buffers to the measured pH value from all the available buffers and the used buffer value can be selected with [Next Buffer] or [Previous Buffer].

CALIBRATION MESSAGES

- **Wrong buffer. Please check the buffer**: this message appears when the difference between the pH reading and the value of the selected calibration buffer is significant. If this message is displayed, check if you have selected the appropriate calibration buffer.
- **Wrong buffer temperature**: this message appears if the buffer temperature is out of the defined buffer temperature range.
- **Clean the electrode or check the buffer. Press <Accept> to update calibration**: this message alerts the user that some dirt or deposits could be on the electrode. Refer to the electrode Cleaning Procedure (see page 65).
- **Slope too low. Please check the buffer / Slope too high. Please check the buffer**: these messages appear if the current slope is under 80% or over 110% of default slope. Recalibrate the instrument using fresh buffers.
- **Slope too low. Press <Clear Cal> to clear old calibration / Slope too high. Press <Clear Cal> to clear old calibration**: these messages appear as a result of an erroneous slope condition. Follow displayed instructions.

- **Unrecognized buffer. Please check the buffer or the buffer list** (for Semiautomatic and Automatic buffer entry type): this message appears if the current buffer value is not close to any of the buffers from the buffer list/group. Check if the current buffer is present in the buffer list or the appropriate buffer group was selected.
- **The current buffer was already calibrated. Press <Accept> to recalibrate in this point, or change the buffer**: this message appears when calibration is performed in one of the previous calibrated buffers. Follow displayed instructions.

pH MEASUREMENTS

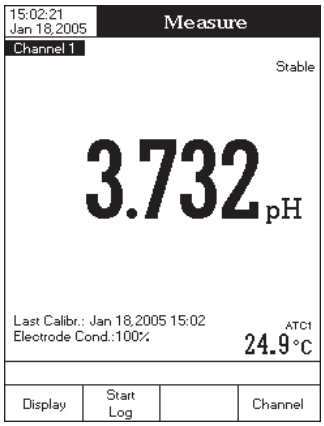
Make sure the instrument has been calibrated before taking pH measurements.

DIRECT MEASUREMENT

To measure the pH of a sample using the Direct reading mode:

- Press MODE and then pH to select *pH Measure* mode (for the selected channel – **HI 4222** only).
- Select the Direct reading mode (see pH Setup for details, page 20).
- Submerge the electrode tip and the temperature probe approximately 4 cm (1½") into the sample to be tested. Allow time for the electrode to stabilize.
- The measured pH value will be displayed on the LCD, together with a short GLP information or "Not Calibrated" message if no pH calibration was performed.

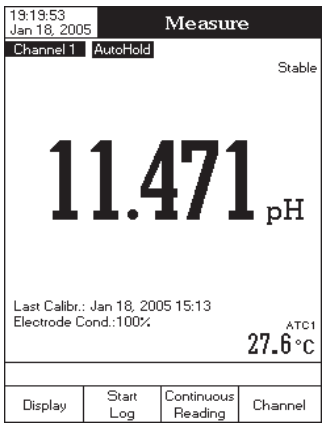
Note: If the reading is out of range, "-----" will be displayed on the LCD.



DIRECT / AUTOHOLD MEASUREMENT

To measure pH of a sample using the Direct/AutoHold reading mode:

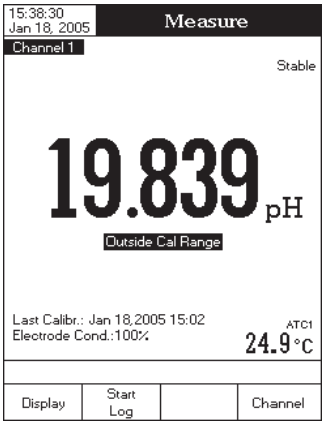
- Press MODE and then pH to select *pH Measure* mode (for the selected channel – **HI 4222** only).
- Select the Direct/AutoHold reading mode (see pH Setup for details, page 20).
- Submerge the electrode tip and the temperature probe approximately 4 cm (1½") into the sample to be tested. Allow time for the electrode to stabilize.
- The measured pH value will be displayed on the LCD. If pressing Auto Hold, the "AutoHold" indicator will start blinking on the LCD until the stability criterion is reached. The pH value will be frozen on the LCD, along with "AutoHold" indicator.



• To return to normal *Measure* mode press Continuous Reading.

Note: If the reading is out of range, "-----" will be displayed on the LCD.

Outside Cal Range feature warns the user if the current reading is out of the calibrated area. The calibrated area is that part of the pH range in which the calibration point assures an accurate reading. If the reading is taken out of the calibration area, the "Outside Cal Range" message will start blinking on the LCD. The calibrated area is calculated in according with the pH resolution used during the reading. To avoid having this message, the calibration points have to be well distributed in the desired measurement range.



If measurements are taken successively in different samples, it is recommended to rinse the electrode thoroughly with deionized water or tap water and then with some of the next sample to prevent cross-contamination and to condition the electrode before immersing it into the sample solution.

The pH reading is affected by temperature. In order to measure the pH accurately, the temperature effect must be compensated. To use the **Automatic Temperature Compensation** (ATC) feature, connect and submerge the **HI 7662-T** temperature probe into the sample as close as possible to the electrode and wait for a few seconds. If the temperature of the sample is known, **Manual Temperature Compensation** (MTC) can be performed by disconnecting the temperature probe.

Notes:
- For single channel pH measurements (**HI 4221**) "MTC" or "ATC" indicators will be displayed on the LCD, while for dual channel pH measurements (**HI 4222**) "MTC" or "ATC1"/"ATC2" indicators will be displayed, depending on the temperature compensation mode and selected channel.
- For mV/Rel mV measurements "NO PROBE" or "TEMP" indicators will be displayed on the LCD (**HI 4221** only), respectively "NoProbe" or "TEMP1"/"TEMP2" indicators (**HI 4222** only) for mV/Rel mV/ISE measurements, depending on the temperature compensation mode and selected channel.
- When in MTC mode, the temperature can be modified by pressing MTC for *pH Measure* mode and Manual Temp for *mV/Rel mV Measure* mode (**HI 4221** only) if the Reading Mode option is Direct (**HI 4222** only). The temperature value can be ajusted with △ or ▽ from –20.0 ºC to 120.0 ºC. Press Accept to save the new temperature value or press Escape to return to *Measure* mode.
- When in ATC mode for pH, respectively TEMP for mV/Rel mV, "-----" will be displayed on the LCD if the measured temperature is under or over temperature range (–20.0 ºC to 120.0 ºC).

mV & Relative mV MEASUREMENTS

mV/ORP MEASUREMENTS

Oxidation-reduction potential (ORP) measurements provide the quantification of the oxidizing or reducing power of the tested sample.

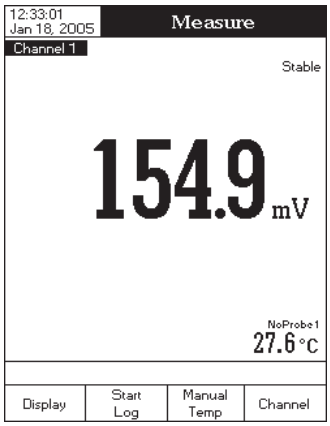
To correctly perform a redox measurement, the surface of the ORP electrode must be clean and smooth.

DIRECT MEASUREMENT

To measure the mV of a sample using the Direct reading mode:

- Press MODE and then mV to enter *mV Measure* mode (for the selected channel – **HI 4222** only).
- Select the Direct reading mode (see mV Setup for details, page 32).
- Submerge the tip of the ORP electrode (4 cm/1½") into the sample to be tested and allow a few seconds for the reading to stabilize.
- The instrument will display the measured mV value on the LCD.

Note: If the reading is out of range, "-----" will be displayed on the LCD.



DIRECT / AUTOHOLD MEASUREMENT

To measure mV of a sample using the Direct/AutoHold reading mode:

- Press MODE and then mV to select *mV Measure* mode (for the selected channel – **HI 4222** only).
- Select the Direct/AutoHold reading mode (see mV Setup for details, page 32).
- Submerge the tip of the ORP electrode approximately 4 cm (1½") into the sample to be tested and allow a few seconds for the reading to stabilize.
- The measured mV value will be displayed on the LCD. If pressing Auto Hold, the "AutoHold" indicator will start blinking on the LCD until the stability criterion is reached. The mV value will be frozen on the LCD, along with "AutoHold" indicator.
- To return to normal *Measure* mode press Continuous Reading.

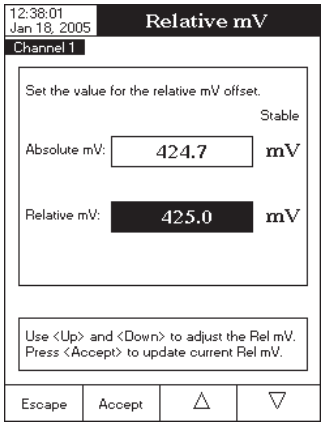
Note: If the reading is out of range, "-----" will be displayed on the LCD.

Relative mV MEASUREMENTS

To measure the Relative mV of a sample:

- Press [MODE] and then [Rel mV] to enter *Relative mV Measure* mode.
- The instrument will display the measured Relative mV value on the LCD, together with a short GLP information about the last calibration or "Not Calibrated" message if no Rel mV calibration was performed (no Rel mV offset set).

Notes:
- If the measured mV potential is out of range, "-----" will be displayed on the LCD.
- If pressing [CAL] while in *Relative mV Measure* mode, the Relative mV offset screen will be displayed on the LCD. Press [Clear Ref mV Offset] to clear the existing Relative mV or use [△] or [▽] to adjust the Relative mV value and then press [Accept] to save the current Relative mV. Press [Escape] at any time to return to *Relative mV Measure* mode.
- Before performing a Rel mV calibration, make sure that the electrode is immersed into the sample to be measured.



ISE CALIBRATION & MEASUREMENTS (HI 4222 only)

ISE CALIBRATION

For greatest accuracy, it is recommended to calibrate the instrument frequently. The instrument should also be recalibrated whenever "No ISE Calibration" or "ISE Calibration Expired" message appears on the LCD, in the Reminder messages area.

Due to electrode conditioning time, the electrode must be kept immersed a few seconds to stabilize. The user will be guided step by step during calibration with easy to follow messages on the display. This will make the calibration a simple and error-free procedure.

PREPARATION

Pour small quantities of the standard 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.

Note: For accurate measurements, add the appropriate **ISAB** (Ionic Strength Adjustment Buffer) to the calibration standards.

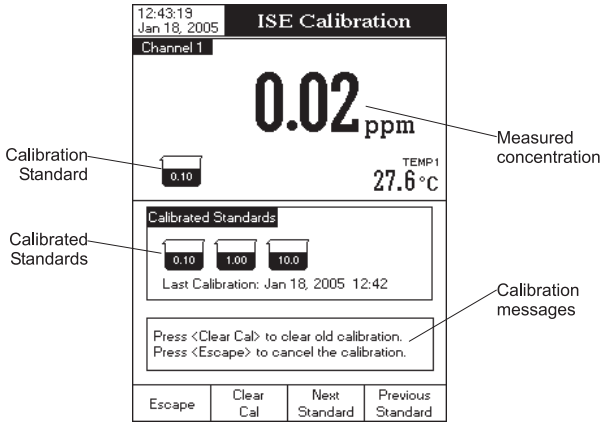
CALIBRATION PROCEDURE

Up to five-point calibration is possible, using five memorized standard solutions: 0.1, 1, 10, 100, 1000 ppm and 5 custom solutions.

The ISE calibration and measurement can be performed with or without temperature compensation. If the temperature compensation option is enabled, the isopotential point of the electrode must be set in ISE Setup in order to perform correct concentration measurements.

Before calibrating, make sure that the appropriate Electrode Type has been selected in ISE Setup according to the measured Ion/compound.

ISE Calibration screen description

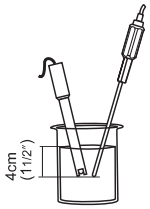


Two standard entry types are available: ManualSelection and Custom Standard. The default option is Manual Selection.

A. To calibrate the instrument using **Manual Selection** standard entry type:

- Press [CAL]. If the instrument was calibrated before and calibration was not cleared, the old calibration can be cleared by pressing [Clear Cal]. After 10 seconds, [Clear Cal] will no longer be available.

  Note: It is very important to clear calibration history when a new electrode is used because most errors and warning messages that appear during calibration depend on calibration history.



- Add ISAB to all standard solutions.
- Immerse the Ion Selective Electrode and the temperature probe approximately 4 cm (1½") into the less concentrated standard solution and stir gently.
- Select the used standard solution concentration with [Next Standard] or [Previous Standard]. The "Please wait..." message will appear on the LCD until the reading is stable or the concentration is validated.

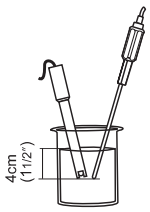
Note: When in ATC mode, if pressing [SETUP] a pop-up menu will be displayed on the LCD in which the concentration value can be ajusted using [△] or [▽]. Press [Accept] to save the new concentration value.

- If the standard solution concentration is validated, [Accept] will appear on the LCD. Press [Accept] to update calibration. The calibration point value will be added to the Calibrated Standards section.
- The "Please wait..." message will appear on the LCD for 10 seconds and until the reading is stable, time in which immerse the ion selective electrode and the temperature probe into the next standard solution and follow the above procedure or press [Escape] to exit calibration.

B. To calibrate the instrument using **Custom Standard** entry type:

- Press [CAL]. If the instrument was calibrated before and calibration was not cleared, the old calibration can be cleared by pressing [Clear Cal]. After 10 seconds, [Clear Cal] will no longer be available.

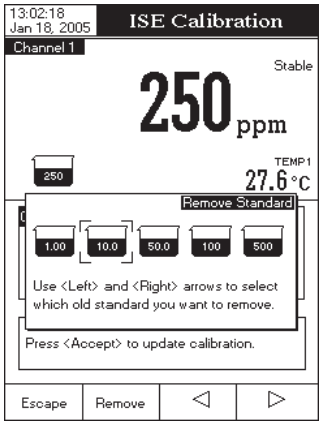
  Note: It is very important to clear calibration history when a new electrode is used because most errors and warning messages that appear during calibration depend on calibration history.

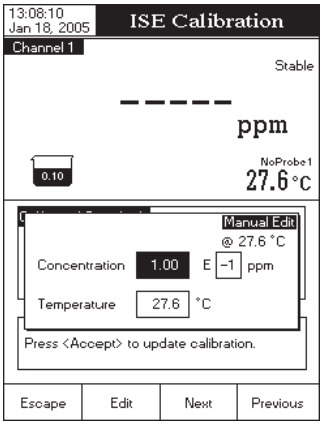


- Add ISAB to all standard solutions.
- Immerse the Ion Selective Electrode and the temperature probe approximately 4 cm (1½") into the less concentrated standard solution and stir gently.
- When the stability condition is reached and 10 seconds elapsed, a pop-up menu will appear on the LCD in which the standard concentration value can be set.
- Press [Next] / [Previous] to select next/previous entry to be edit. Press [Edit] and use [△] or [▽] to set the desired value. Press [Accept] to save the modified value and then press [Escape] to store the set concentration value.

- If the standard solution concentration is validated, Accept will appear on the LCD. Press Accept to update calibration. The calibration point value will be added to the Calibrated Standards section.
- The "Please wait..." message will appear on the LCD until the reading is stable and 10 seconds elapsed, time in which immerse the Ion Selective Electrode and the temperature probe into the next standard solution and follow the above procedure or press Escape to exit calibration.

Notes:
- The new added calibration point will replace an old one if the difference between them is less than 20% of the standard solution.
- If the existing stored calibration is full (five calibration points), a pop-up menu will be displayed on the LCD in which you can select with ◁ or ▷ the standard solution you want to replace with the current one. Press Remove to delete the selected calibrated point and then press Accept to update calibration with the new standard solution.
- If the isopotential point of the electrode is unknown, the ion calibration and measurements can be performed only without temperature compensation (see ISE Setup, Temperature option for details, page 33). When the temperature compensation option is disabled, at least a two-point calibration must be performed in order to perform ISE measurements. Otherwise, "-----" will appear on the LCD.
- When in MTC mode, if pressing SETUP after entering ISE calibration and while a standard solution is selected, a pop-up menu will be displayed on the LCD in which the concentration and the temperature value can be ajusted by pressing Edit and then △ or ▽ keys. Press Accept to save the modified value and then Next / Previous to select next/ previous value to be adjusted.





CALIBRATION MESSAGES

- **Wrong standard solution. Please check the standard solution**: this message appears when the difference between the ppm reading and the value of the selected standard solution concentration (ppm) is significant. If this message is displayed, check if you have selected the appropriate calibration standard.

- **Wrong new slope. Please check the standard solution**: this message appears if the current slope exceeds slope window (50% to 120% of default slope for the corresponding ion charge - see ISE Theory section for details, page 54). Recalibrate the instrument using fresh standards.
- **Wrong old slope. Press <Clear Cal> to clear old calibration**: this message appears as a result of an erroneous slope condition. Press [Clear Cal] to clear old calibration and restart calibration.
- **Difference between standards temperature is too high. Press <Accept> to update the calibration or clear old calibration**: this message appears when the difference between two standards temperature is greater than 5 ºC. Recalibrate the instrument while paying attention to the standards temperature.

ISE MEASUREMENTS

Make sure the instrument has been calibrated before taking ISE measurements.

When using one of the incremental methods for measurement and no or only a one-point ISE calibration was performed, a warning message will be displayed on the LCD, notifying the user that at least a two-point ISE calibration must be performed.

For accurate measurements, add the appropriate **ISAB** (Ionic Strength Adjustment Buffer) to both samples and standards, if necessary. If ISAB is added to the calibration standards, it is important to add ISAB also to the samples to be measured.

DIRECT MEASUREMENT

To measure the concentration of a sample using the Direct reading mode:

- Press [MODE] and then [ISE] to select *ISE Measure* mode for the selected channel.
- Select the Direct reading mode (see ISE Setup for details, page 33).
- Add ISAB to the sample solution.
- Submerge the Ion Selective Electrode tip and the temperature probe approximately 4 cm (1½") into the sample to be tested. Allow time for the electrode to stabilize.
- The measured concentration value will be displayed on the LCD in the selected units.

Note: If the reading is out of range, "-----" will be displayed on the LCD.

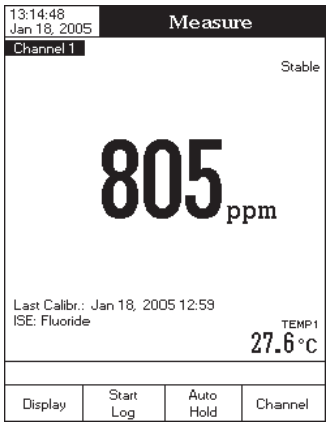
DIRECT/AUTOHOLD MEASUREMENT

To measure the concentration of a sample using the Direct/AutoHold reading mode:

- Press [MODE] and then [ISE] to select *ISE Measure* mode for the selected channel.
- Select the Direct/AutoHold reading mode (see ISE Setup for details, page 33).

- Add ISAB to the sample solution.
- Submerge the Ion Selective Electrode tip and the temperature probe approximately 4 cm (1½") into the sample to be tested. Allow time for the electrode to stabilize.
- The measured concentration value will be displayed on the LCD. If pressing [Auto Hold], the "AutoHold" indicator will start blinking on the LCD until the stability criterion is reached. The concentration value will be frozen on the LCD, along with "AutoHold" indicator.
- To return to normal *Measure* mode press [Continuous Reading].

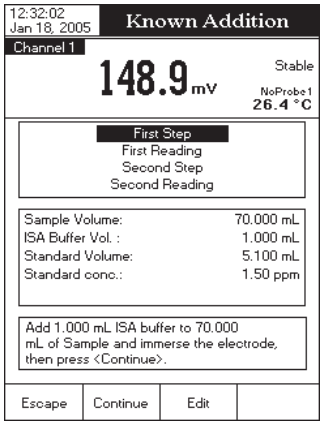
Note: If the reading is out of range, "-----" will be displayed on the LCD.

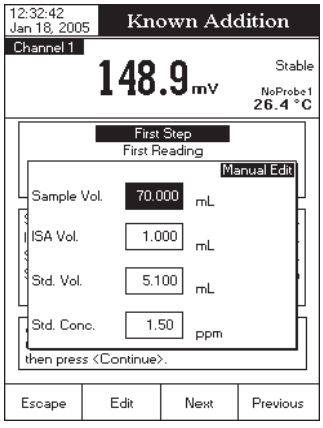


KNOWN ADDITION

To measure the concentration of a sample using the Known Addition incremental method:

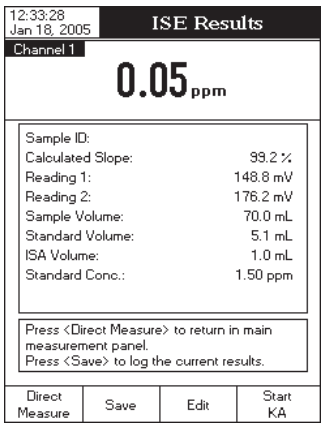
- Press [MODE] and then [ISE] to select *ISE Measure* mode for the selected channel.
- Select the Known Addition method (see ISE Setup for details, page 33).
- Press [Start KA] to start the measurement. The first step of the method will be displayed on the LCD in which the user is notified to add the appropriate ISA Buffer Volume (if different from 0 mL) to the sample and to immerse the electrode into the Sample Volume. The method parameters are also displayed on the LCD.
- Press [Edit] to set the method parameters. Press [Next] / [Previous] to select next/previous parameter to be edit, then press [Edit] and use [△] or [▽] to set the desired parameter value. Press [Accept] to save the modified value and then press [Escape] to exit method parameters edit menu.
- Make sure that the set parameters values are the used ones and submerge the Ion Selective Electrode tip approximately 4 cm (1½") into the sample to be tested.
- Press [Continue] to take the first mV reading.





- When the reading is stable, press [Read] to store the first mV reading. The second step of the method will be displayed on the LCD in which the user is notified to add the Standard Volume of set concentration to the sample. The method parameters are also displayed on the LCD.
- Press [Edit] to change the desired method parameters as indicated in the first step of the method.
- Press [Continue] to take the second mV reading.
- When the reading is stable, press [Read] to store the second mV reading. The ISE measurement results will be displayed on the LCD.
- Press [Save] to log the current results into a ISE Method Report or press [Direct Measure] to return to *ISE Measure* mode.
- If pressing [Edit], the method parameters can be changed and the sample concentration will be recalculated.
- Press [Start KA] to start another measurement.

Note: Press [Escape] at any time to stop the measurement and return to *ISE Measure* mode.



KNOWN SUBTRACTION

To measure the concentration of a sample using the Known Subtraction incremental method:

- Press [MODE] and then [ISE] to select *ISE Measure* mode for the selected channel.
- Select the Known Subtraction method (see ISE Setup for details, page 33).
- Press [Start KS] to start the measurement. The first step of the method will be displayed on the LCD in which the user is notified to add the appropriate ISA Buffer Volume (if different from 0 mL) to the sample and to immerse the electrode into the Sample Volume. The method parameters are also displayed on the LCD.
- Press [Edit] to set the method parameters. Press [Next] / [Previous] to select next/previous parameter to be edit, then press [Edit] and use [△] or [▽] to set the desired parameter value. Press [Accept] to save the modified value and then press [Escape] to exit method parameters edit menu.

Note: For the Known Subtraction method, the stoichiometric ratio (factor) between standard and sample must also be set in order to take accurate measurements.

- Make sure that the set parameters values are the used ones and submerge the Ion Selective Electrode tip approximately 4 cm (1½") into the sample to be tested.
- Press [Continue] to take the first mV reading.
- When the reading is stable, press [Read] to store the first mV reading. The second step of the method will be displayed on the LCD in which the user is notified to add the Standard Volume of set concentration to the sample. The method parameters are also displayed on the LCD.

- Press [Edit] to change the desired method parameters as indicated in the first step of the method.
- Press [Continue] to take the second mV reading.
- When the reading is stable, press [Read] to store the second mV reading. The ISE measurement results will be displayed on the LCD.
- Press [Save] to log the current results into a ISE Method Report or press [Direct Measure] to return to *ISE Measure* mode.
- If pressing [Edit], the method parameters can be changed and the sample concentration will be recalculated.
- Press [Start KS] to start another measurement.

Note: Press [Escape] at any time to stop the measurement and return to *ISE Measure* mode.

ANALYTE ADDITION

To measure the concentration of a sample using the Analyte Addition incremental method:

- Press [MODE] and then [ISE] to select *ISE Measure* mode for the selected channel.
- Select the Analyte Addition method (see ISE Setup for details, page 33).
- Press [Start AA] to start the measurement. The first step of the method will be displayed on the LCD in which the user is notified to add the appropriate ISA Buffer Volume (if different from 0 mL) to the standard and to immerse the electrode into the Standard Volume of set concentration. The method parameters are also displayed on the LCD.
- Press [Edit] to set the method parameters. Press [Next] / [Previous] to select next/previous parameter to be edit, then press [Edit] and use [△] or [▽] to set the desired parameter value. Press [Accept] to save the modified value and then press [Escape] to exit method parameters edit menu.
- Make sure that the set parameters values are the used ones and submerge the Ion Selective Electrode tip approximately 4 cm (1½") into the standard solution.
- Press [Continue] to take the first mV reading.
- When the reading is stable, press [Read] to store the first mV reading. The second step of the method will be displayed on the LCD in which the user is notified to add the Sample Volume to the standard solution. The method parameters are also displayed on the LCD.
- Press [Edit] to change the desired method parameters as indicated in the first step of the method.
- Press [Continue] to take the second mV reading.
- When the reading is stable, press [Read] to store the second mV reading. The ISE measurement results will be displayed on the LCD.
- Press [Save] to log the current results into a ISE Method Report or press [Direct Measure] to return to *ISE Measure* mode.

- If pressing [Edit], the method parameters can be changed and the sample concentration will be recalculated.
- Press [Start AA] to start another measurement.

Note: Press [Escape] at any time to stop the measurement and return to *ISE Measure* mode.

ANALYTE SUBTRACTION

To measure the concentration of a sample using the Analyte Subtraction incremental method:

- Press [MODE] and then [ISE] to select *ISE Measure* mode for the selected channel.
- Select the Analyte Subtraction method (see ISE Setup for details, page 33).
- Press [Start AS] to start the measurement. The first step of the method will be displayed on the LCD in which the user is notified to add the appropriate ISA Buffer Volume (if different from 0 mL) to the standard and to immerse the electrode into the Standard Volume of set concentration. The method parameters are also displayed on the LCD.
- Press [Edit] to set the method parameters. Press [Next] / [Previous] to select next/previous parameter to be edit, then press [Edit] and use [△] or [▽] to set the desired parameter value. Press [Accept] to save the modified value and then press [Escape] to exit method parameters edit menu.

Note: For the Analyte Subtraction method, the stoichiometric ratio (factor) between standard and sample must also be set in order to take accurate measurements.

- Make sure that the set parameters values are the used ones and submerge the Ion Selective Electrode tip approximately 4 cm (1½") into the standard solution.
- Press [Continue] to take the first mV reading.
- When the reading is stable, press [Read] to store the first mV reading. The second step of the method will be displayed on the LCD in which the user is notified to add the Sample Volume to the standard solution. The method parameters are also displayed on the LCD.
- Press [Edit] to change the desired method parameters as indicated in the first step of the method.
- Press [Continue] to take the second mV reading.
- When the reading is stable, press [Read] to store the second mV reading. The ISE measurement results will be displayed on the LCD.
- Press [Save] to log the current results into a ISE Method Report or press [Direct Measure] to return to *ISE Measure* mode.
- If pressing [Edit], the method parameters can be changed and the sample concentration will be recalculated.
- Press [Start AS] to start another measurement.

Note: Press [Escape] at any time to stop the measurement and return to *ISE Measure* mode.

ISE THEORY

An Ion Selective Electrode (ISE) is an electrochemical sensor that changes voltage with the activity or concentration of ions in solutions. The change in voltage is a logarithmic relationship with concentration and is expressed by the Nernst equation:

$$E = E^o + S\log(a)$$

where: E - the measured voltage;

E^o - standard voltage and other standard system voltages;

a - the activity of the ion being measured;

S - the Nernst slope factor and is derived from thermodynamic principles:

$$S = 2.303RT / nF$$

R - the universal gas constant (8.314 $J*K^{-1}*mol^{-1}$);

T - the temperature in degrees Kelvin;

F - the Faraday's constant (96,485 $C*mol^{-1}$);

n - the ion charge.

The slope may be positive or negative depending upon the ion charge (n).

SPECIES	SLOPE (mV/decade)
Monovalent cation	+59.16
Monovalent anion	–59.16
Divalent cation	+29.58
Divalent anion	–29.58

Activity and concentration are related by an "activity coefficient", expressed as:

$$a = \gamma C$$

where: a - the activity of the ion being measured;

γ - the activity coefficient;

C - the concentration of the ion being measured.

In very dilute solutions γ approaches 1 so activity and concentration are the same.

Actual samples that are more concentrated have much smaller activity coefficients ($\gamma < 1$). The addition of an inert background salt to standards and samples stabilizes the activity coefficient so that concentration measurements may be made directly. Hanna's Ionic Strength Adjustment Buffer (ISAB) formulations also may optimize pH, and complex interferences in addition to standardizing the ionic strength.

The Nernst equation can be rewritten:

$$E = E^o + S\log(C)$$

ION SELECTIVE ANALYSIS METHODS

Direct Analysis

This method is a simple procedure for measuring multiple samples. It should only be used in the linear working regions of the sensor. A direct reading instrument such as the **HI 4222** determines concentration of the unknown by a direct reading after calibrating the instrument with the standards. The instrument is calibrated as described in "ISE CALIBRATION & MEASUREMENTS" section, with two or more freshly made standards that are in the measurement range of the unknowns. Ionic strength adjustment is made to samples and standards. Unknowns are measured directly by the instrument.
At lower concentrations, in non-linear regions of the electrode response, multiple calibration points will extend measurements to a practical detection limit. Calibrations must be performed more frequently in these cases.

Incremental Methods

Incremental methods are useful for the measurement of samples whose constituents are variable or concentrated. Incremental techniques can reduce errors from such variables as temperature, viscosity, or pH extremes and will provide indirect analysis of ions for which there is no ISE sensor for a direct measurement. There are four different incremental methods for sample measurement. They are Known Addition, Known Subtraction, Analyte Addition and Analyte Subtraction. **HI 4222** allows the analyst to use these techniques as a simple routine procedure thus eliminating calculations or tables. The method once set up can be used for repetitive measurements on multiple samples.

Known Addition and Known Subtraction

With Known addition, *standard is added* to a sample being measured. The standard and sample contain the same ion. mV are taken before and after the standard addition. From the mV the sample concentration is determined.

$$C_{SAMPLE} = C_{STD}\frac{V_{STD}}{V_T 10^{\Delta E/S} - V_{SAMPLE}}$$

With Known subtraction, *a known standard is added to an ionic sample* being measured. The standard reacts with the measured ion in the sample in a known manner thus removing measured ions from the solution. From the change in mV the concentration of the sample is determined.

$$C_{SAMPLE} = C_{STD}\frac{V_{STD}}{V_{SAMPLE} - V_T 10^{\Delta E/S}} f$$

where: C_{SAMPLE} - the sample concentration;
C_{STD} - the standard concentration;
V_{SAMPLE} - the sample volume;
V_{STD} - the standard volume;
and $V_T = V_{SAMPLE} + V_{STD}$

ΔE - the difference of potential from the electrode;
S - the electrode slope, determined in a previous calibration;
f - the stoichiometric ratio between sample and standard;

Example 1

You have sulfide samples and you are adding Ag^+. The reaction is:

$$S^{2-} + 2Ag^+ \rightarrow Ag_2S$$

One mole sulfide sample reacts with 2 moles silver standard ($f = ½$).

Example 2

You have sulfide samples and you are adding Pb^{2+}. The reaction is:

$$S^{2-} + Pb^{2+} \rightarrow PbS$$

One mole sulfide sample reacts with 1 mole lead standard ($f = 1$).

Analyte Addition and Analyte Subtraction

Analyte Addition and Subtraction are variations of the previous two methods.
With Analyte Addition, *sample (analyte) is added* to an ion standard being measured. The standard and sample contain the same ion. mV are taken before and after the sample addition. From the mV the analyte concentration is determined.

$$C_{SAMPLE} = C_{STD} \frac{V_T 10^{\Delta E / S} - V_{STD}}{V_{SAMPLE}}$$

With Analyte Subtraction, *sample (analyte) is added to an ion standard* being measured. The analyte reacts with the measured ion in a known manner thus removing measured ions from the solution. From the change in mV the concentration of the analyte is determined.

$$C_{SAMPLE} = C_{STD} \frac{V_{STD} - V_T 10^{\Delta E / S}}{V_{SAMPLE}} f$$

where: C_{SAMPLE} - the sample concentration;
C_{STD} - the standard concentration;
V_{SAMPLE} - the sample volume;
V_{STD} - the standard volume;
and $V_T = V_{SAMPLE} + V_{STD}$

ΔE - the difference of potential from the electrode;
S - the electrode slope, determined in a previous calibration;
f - the stoichiometric ratio between sample and standard;

LOGGING

This feature allows the user to log pH, mV (or ISE - **HI 4222** only) measurements, together with temperature automatically. The logging behaviour is dependent on the Logging Type and Reading Mode options from the appropriate unit setup.

The Logging Data Configuration options from the appropriate unit setup must be set first in order to be saved into the log report.

The maximum number of logged records is 5000/lot, the maximum logging time is 24h and up to 100 lots can be saved.

Regarding data logging, the available logging modes are shown in the table below:

Logging Mode	Logging Type	Reading Mode
1	Automatic	Direct
2	Automatic	Direct/AutoHold
3	Manual	Direct
4	Manual	Direct/AutoHold
5	AutoHold	Direct/AutoHold

LOGGING MODE 1

This logging mode can be used to monitor a chemical reaction (e.g. biochemical processes). By choosing this logging mode, Start Log will be available in *Measure* mode.

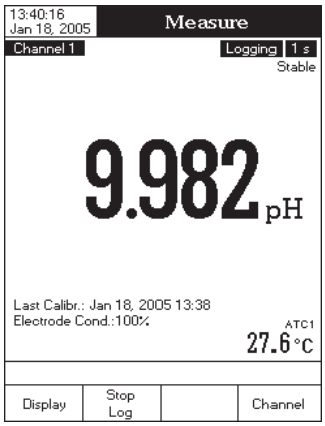
Note: For **HI 4222**, the Start Log1 or Start Log2 will be available in multichannel *Measure* mode, depending on the focused channel.

To log data using this mode:

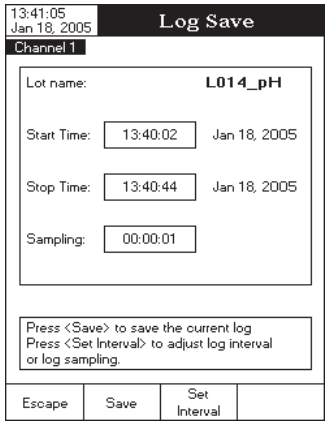
- Press Start Log while in *Measure* mode to start the logging session. The "Logging" and the Sampling Period indicators will be displayed on the LCD and data will be stored at the set sampling period.

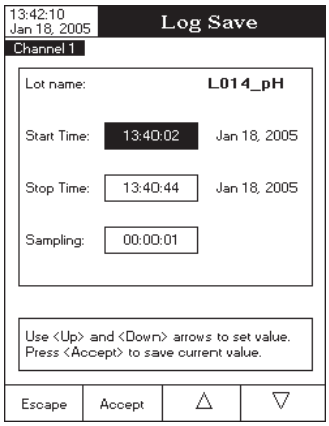
Note: While automatic logging is running, the measured unit setup is not available. A warning message will be displayed on the LCD if the setup is accessed.

- If accessing Graph option while logging, the online graph can be visualized on the LCD (see Display Mode section for details, page 11).



- If accessing Log History option while logging, last logged data can be visualized on the LCD (see Display Mode section for details, page 11).
- To stop the logging session, press Stop Log or Stop Log1 / Stop Log2. The Log Save screen will be displayed in which the logged lot parameters can be set:
  - Press Set Interval to adjust the log interval and/or the log sampling or press Save to save the current log in the displayed format.
  - Press Edit to enter log interval edit menu and use △ or ▽ to adjust the logging start/stop time or the log sampling. Press Accept to save the current value and use Next or Previous to adjust next/previous parameter.





Note: The minimum log sampling which can be set is calculated related to the logging time thus the 5000 records/lot not to be exceeded (e.g. for a 50.000 seconds logging time, the minimum log sampling will be 10 seconds).

- Press Escape to exit log interval edit menu and then press Save to save the current log with the new configuration. While the instrument is saving the data, a "Please wait..." pop-up message will be displayed on the LCD.

Note: For larger logged lots, the saving time can be up to several minutes.

LOGGING MODE 2

This logging mode can be used for multiple samples measurement. By choosing this logging mode, Start Log and Auto Hold will be available in *Measure* mode.

Note: For **HI 4222**, the Start Log1 or Start Log2 and Auto Hold1 or Auto Hold2 will be available in multichannel *Measure* mode, depending on the focused channel.

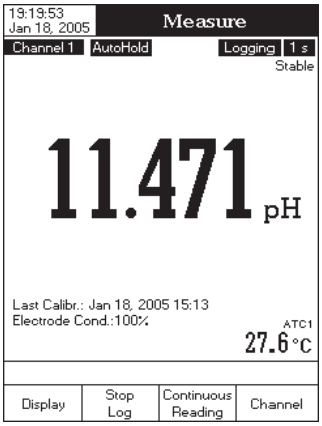
To log data using this mode:

- Press Start Log while in *Measure* mode to start the logging session. When the measured value is frozen on the LCD by pressing Auto Hold and the stability criterion is reached, the logged value is the one that has been frozen on the LCD until returning to normal logging mode by pressing Continuous Reading.

The "Logging", sampling period and "AutoHold" indicators will be displayed on the LCD.

Note: While automatic logging is running, the measured unit setup is not available. A warning message will be displayed on the LCD if the setup is accessed.

- To store another frozen value, press [Auto Hold] again.
- To stop the logging session, press [Stop Log] or [Stop Log1] / [Stop Log2].



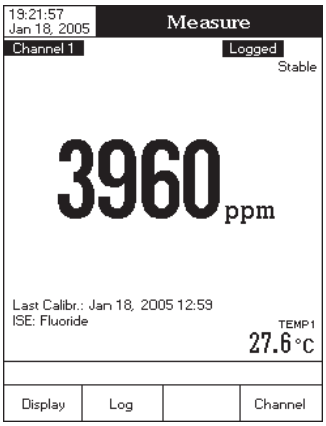
LOGGING MODE 3

This logging mode can be used for any sample measurements. By choosing this logging mode, [Log] will be available in *Measure* mode.

Note: For **HI 4222**, [Log1] or [Log2] will be available in multichannel *Measure* mode, depending on the focused channel.

To log data using this mode:

- Press [Log] while in *Measure* mode to manually log a record. The "Logged" indicator will be displayed on the LCD.
- The records will be stored in one lot. In order to change the logging lot, see the measured unit *Setup* for details, Log option, New Lot generation.



LOGGING MODE 4

This logging mode can be used for multiple samples measurement. By choosing this logging mode, [Log] and [Auto Hold] will be available in *Measure* mode.

Note: For **HI 4222**, [Log1] or [Log2] and [Auto Hold1] or [Auto Hold2] will be available in multichannel *Measure* mode, depending on the focused channel.

To log data using this mode:

- Press [Log] while in *Measure* mode to manually log a record. Each value is logged at the time when the key was pressed. When the measured value is frozen on the LCD by pressing [Auto Hold] and the stability criterion is reached, the logged value is the one that has been frozen on the LCD.

- To store another frozen value, press [Continuous Reading] to return to normal logging mode and then [Auto Hold] again.
- The records will be stored in one lot. In order to change the logging lot, see the measured unit *Setup* for details, Log option, New Lot generation.

LOGGING MODE 5

This logging mode can be used for multiple samples measurement. By choosing this logging mode, [Start Log] and [Auto Hold] will be available in *Measure* mode.

Notes: • For **HI 4222**, the [Start Log1] or [Start Log2] and [Auto Hold1] or [Auto Hold2] will be available in multichannel *Measure* mode, depending on the focused channel.

• If the Reading Mode option is set as Direct and the Logging Mode 5 session is started, a warning pop-up will be displayed on the LCD, informing the user that the Reading Mode option must be set as Direct/AutoHold in order to use this logging mode.

To log data using this mode:

- Press [Start Log] while in *Measure* mode to start the logging session. The logged values are only the ones frozen on the LCD, after [Auto Hold] was pressed and the stability criterion reached.
- To store another frozen value, press [Continuous Reading] to return to normal logging mode and then [Auto Hold] again.
- To stop the logging session, press [Stop Log] or [Stop Log1] / [Stop Log2].

Notes: • For the automatic logging, if the maximum logging time (24h) has been reached, a warning pop-up will be displayed on the LCD in order to stop the current log and start another one in a new lot.

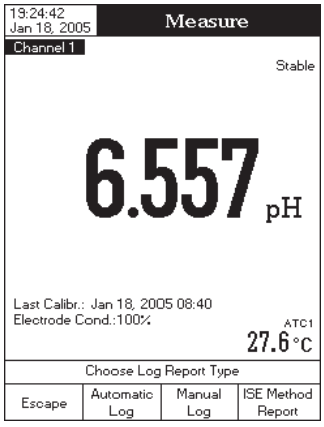
• If 100 lots have been saved or maximum 5000 records have been manually stored, a warning pop-up will be displayed on the LCD in order to delete one lot or to select a new lot for the manual logging to log other records.

LOG RECALL

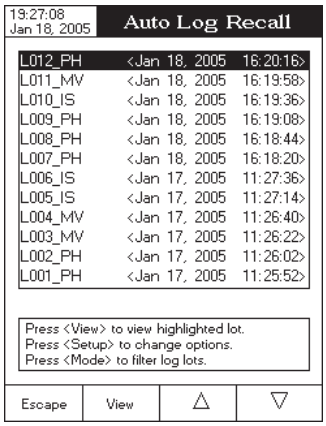
This feature allows the user to view all stored data. If no data were logged, the "No records were found" message will be displayed on the LCD in the Log Recall screen. Otherwise, the instrument will display all the memorized lots in accordance with the selected option: Automatic Log, Manual Log or ISE Method Report (**HI 4222** only).

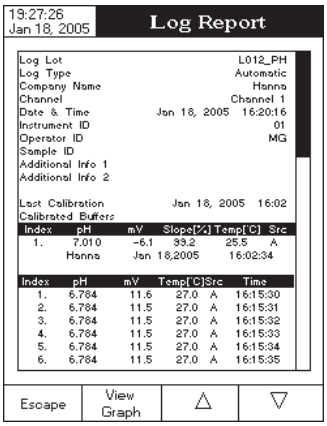
To view the memorized data:

- Press [SETUP] while in *Measure* mode.
- Press [Log Recall]. The "Choose Log Report Type" message will be displayed in the Reminder messages area.



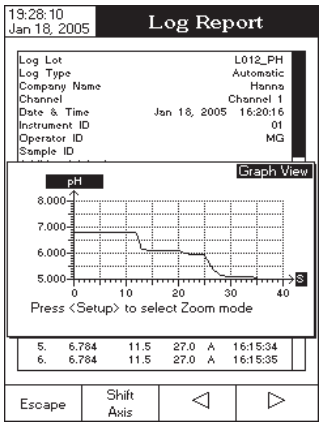
- Press Automatic Log, Manual Log or ISE Method Report to select the desired Log Report type. All logged lots for the selected Log Report type will be displayed on the LCD.
- To filter the displayed lots, press MODE and then the desired unit (pH, mV or ISE – **HI 4222** only). Only the selected measurement unit lots will be displayed on the LCD.
- Select the desired lot with △ or ▽ and press View to display the logged data from the highlighted lot. The "Please wait..." message will be displayed on the LCD for one second. The selected Logging Data Configuration options will be displayed on the LCD, together with GLP information (last calibration date and calibrated buffers/ standards) if a calibration has been performed on the selected mode, and the logged values (measured value, mV value, temperature value, temperature compensation mode and the logging time).





Note: For automatic logging only, it is possible to view the plotted graph.

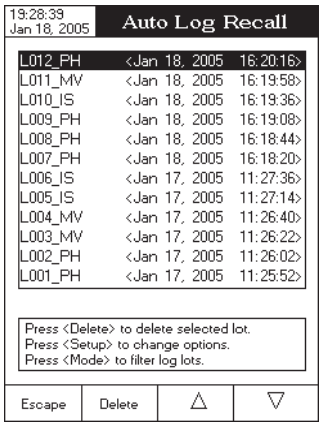
- Press View Graph to display the graph.
- By pressing Shift Axes it is possible to move the graph along the X or Y axis with the arrow keys.
- If pressing SETUP while the graph is displayed, the zoom menu for the X and Y axes will be accessed. Press Zoom Time, or Zoom pH / Zoom mV / Zoom Rel mV / Zoom Ion to switch between the active zooming axes and then zoom in or out on the selected axis by pressing the appropriate virtual key.



- Press Escape to return to the previous menu at any time.

To delete lots:

- Press SETUP while in *Log Recall* mode.
- Press Delete or Delete All to access delete or delete all mode. Otherwise, press View to return to *Log Recall* view mode.
- After selecting one of the deleting modes, use △ or ▽ to select one lot and then press Delete or Delete All to delete the selected lot or all lots. The "Please wait..." message will be displayed on the LCD until the selected lot or all lots are deleted.
- Press SETUP and then press View to exit deleting mode and return to *Log Recall* view mode.
- Press Escape to exit *Log Recall* mode and return to *Measure* mode.



Note: Logged lots should also be deleted whenever "Please Delete Old Log Files" or "Low Data Logging Space" message appears on the LCD, in the Reminder messages area.

PC INTERFACE

Data transmission from the instrument to the PC can be done with the **HI 92000** Windows® compatible software (optional). **HI 92000** also offers graphing and on-line help feature.

Data can be exported to the most popular spreadsheet programs for further analysis.

HI 4221 and **HI 4222** instruments have two available serial interfaces: RS232 and USB. The desired serial interface can be selected from the settings window of the **HI 92000** software.

If choosing the **RS232** serial interface, use the optional Hanna **HI 920010** cable connector to connect your instrument to a PC. Make sure that your instrument is switched off and then plug one connector to the instrument RS232 socket and the other one to the serial port of your PC.

Note: Other cables than **HI 920010** may use a different configuration. In this case, communication between instrument and PC may not be possible.

If choosing the **USB** serial interface, use a standard USB cable to connect your instrument to the PC.

For both serial interfaces, make sure that the instrument and the **HI 92000** software have the same baud rate and the appropriate communication port.

pH BUFFER TEMPERATURE DEPENDENCE

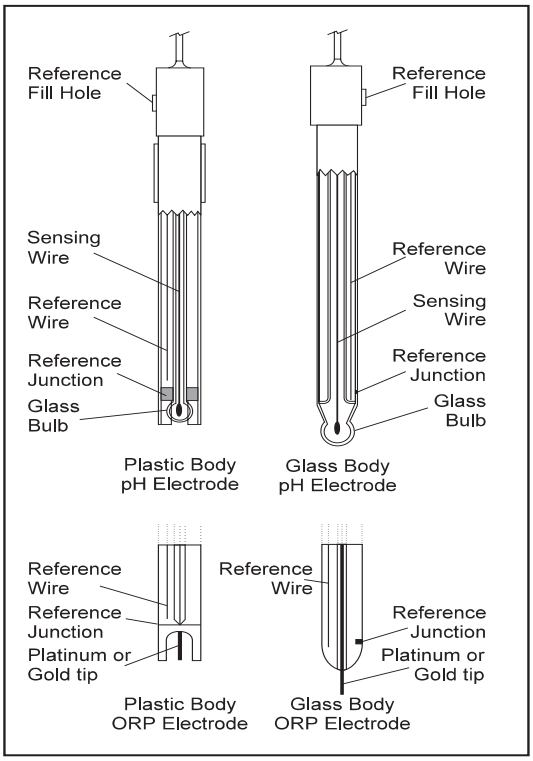
Temperature has an effect on pH. The calibration buffer solutions are affected by temperature changes to a lower degree than normal solutions.

During calibration the instrument will automatically calibrate to the pH value corresponding to the measured or set temperature.

TEMP			pH BUFFERS							
°C	°K	°F	1.679	3.000	4.010	6.862	7.010	9.177	10.010	12.454
0	273	32	1.670	3.072	4.007	6.982	7.130	9.459	10.316	13.379
5	278	41	1.670	3.051	4.002	6.949	7.098	9.391	10.245	13.178
10	283	50	1.671	3.033	4.000	6.921	7.070	9.328	10.180	12.985
15	288	59	1.673	3.019	4.001	6.897	7.046	9.273	10.118	12.799
20	293	68	1.675	3.008	4.004	6.878	7.027	9.222	10.062	12.621
25	298	77	1.679	3.000	4.010	6.862	7.010	9.177	10.010	12.450
30	303	86	1.683	2.995	4.017	6.851	6.998	9.137	9.962	12.286
35	308	95	1.688	2.991	4.026	6.842	6.989	9.108	9.919	12.128
40	313	104	1.693	2.990	4.037	6.837	6.983	9.069	9.881	11.978
45	318	113	1.700	2.990	4.049	6.834	6.979	9.040	9.847	11.834
50	323	122	1.707	2.991	4.062	6.834	6.978	9.014	9.817	11.697
55	328	131	1.715	2.993	4.076	6.836	6.979	8.990	9.793	11.566
60	333	140	1.724	2.995	4.091	6.839	6.982	8.969	9.773	11.442
65	338	149	1.734	2.998	4.107	6.844	6.987	8.948	9.757	11.323
70	343	158	1.744	3.000	4.123	6.850	6.993	8.929	9.746	11.211
75	348	167	1.755	3.002	4.139	6.857	7.001	8.910	9.740	11.104
80	353	176	1.767	3.003	4.156	6.865	7.010	8.891	9.738	11.003
85	358	185	1.780	3.002	4.172	6.873	7.019	8.871	9.740	10.908
90	363	194	1.793	3.000	4.187	6.880	7.029	8.851	9.748	10.819
95	368	203	1.807	2.996	4.202	6.888	7.040	8.829	9.759	10.734

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

ELECTRODE CONDITIONING & MAINTENANCE



PREPARATION PROCEDURE

Remove the protective cap of the pH electrode.

DO NOT BE ALARMED IF SALT DEPOSITS ARE PRESENT. This is normal with electrodes. They will disappear when rinsed with water.

During transport, tiny bubbles of air may form inside the glass bulb affecting proper functioning of the electrode. These bubbles can be removed by "shaking down" the electrode as you would do with a glass thermometer.

If the bulb and/or junction is dry, soak the electrode in **HI 70300** or **HI 80300** Storage Solution for at least one hour.

For refillable electrodes:

If the filling solution (electrolyte) is more than 2½ cm (1") below the fill hole, add **HI 7082** or **HI 8082** 3.5M KCl Electrolyte Solution for double junction or **HI 7071** or **HI 8071** 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 run down and the electrode should be replaced.

MEASURE

Rinse the pH electrode tip with distilled water. Immerse the tip (bottom 4 cm /1½") 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.

STORAGE PROCEDURE

To minimize clogging and assure 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 **HI 70300** or **HI 80300** Storage Solution or, in its absence, Filling Solution (**HI 7071** or **HI 8071** for single junction and **HI 7082** or **HI 8082** for double junction electrodes). Follow the Preparation Procedure on page 64 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.

pH Probe Maintenance

For refillable electrodes:

Refill the reference chamber with fresh electrolyte (**HI 7071** or **HI 8071** for single junction or **HI 7082** or **HI 8082** for double junction electrodes). Allow the electrode to stand upright for 1 hour. Follow the Storage Procedure above.

pH CLEANING PROCEDURE

- *General* Soak in Hanna **HI 7061** or **HI 8061** General Cleaning Solution for approximately ½ hour.
- *Protein* Soak in Hanna **HI 7073** or **HI 8073** Protein Cleaning Solution for 15 minutes.
- *Inorganic* Soak in Hanna **HI 7074** Inorganic Cleaning Solution for 15 minutes.
- *Oil/grease* Rinse with Hanna **HI 7077** or **HI 8077** Oil and Fat Cleaning Solution.

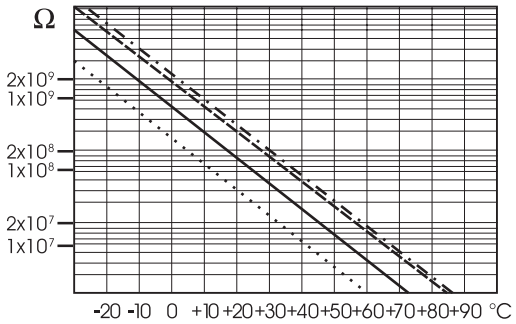
IMPORTANT: After performing any of the cleaning procedures, rinse the electrode thoroughly with distilled water, refill the reference chamber with fresh electrolyte (not necessary for gel-filled electrodes) and soak the electrode in **HI 70300** or **HI 80300** Storage Solution for at least 1 hour before taking measurements.

TROUBLESHOOTING GUIDE

SYMPTOMS	PROBLEM	SOLUTION
Slow response/excessive drift.	Dirty pH electrode.	Soak the electrode tip in HI 7061 solution for 30 minutes and then clean the electrode.
Readings fluctuate up and down (noise).	Clogged/dirty junction. Low electrolyte level (refillable electrodes only).	Clean the electrode. Refill with fresh solution (for refillable electrodes only).
The LCD displays "-----" during measurements (pH, mV, mV Rel or ISE).	Out of range in the appropriate scale.	Make sure the sample is in the specified range. Recalibrate. Check the electrolyte level and the general state of the pH/ORP or ISE electrode.
Out of range in the mV scale.	Dry membrane/junction.	Soak in HI 70300 Storage solution for at least one hour.
The instrument does not work with the temperature probe.	Out of order temperature probe.	Replace the probe.
The meter fails to calibrate or gives faulty readings.	Broken or out of order electrode.	Replace the electrode.
Explicit warnings are displayed during calibration.	Dirty/broken electrode, contaminated buffers.	Follow displayed instructions.
The electrode condition is not displayed after calibration.	Only one-point calibration has been performed.	Perform at least a two-point calibration.
The instrument does not override the loading process.	Internal or software error.	Restart the instrument using the power switch. If the error persists, contact your vendor.

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

ACCESSORIES

pH BUFFER SOLUTIONS

HI 6001	pH 1.679 Buffer Solution, 500 mL bottle
HI 6003	pH 3.000 Buffer Solution, 500 mL bottle
HI 8004L	pH 4.01 Buffer Solution in FDA approved bottle, 500 mL
HI 6004	pH 4.010 Buffer Solution, 500 mL bottle
HI 8006L	pH 6.86 Buffer Solution in FDA approved bottle, 500 mL
HI 6068	pH 6.862 Buffer Solution, 500 mL bottle
HI 8007L	pH 7.01 Buffer Solution in FDA approved bottle, 500 mL
HI 6007	pH 7.010 Buffer Solution, 500 mL bottle
HI 6091	pH 9.177 Buffer Solution, 500 mL bottle
HI 8009L	pH 9.18 Buffer Solution in FDA approved bottle, 500 mL
HI 8010L	pH 10.01 Buffer Solution in FDA approved bottle, 500 mL
HI 6010	pH 10.010 Buffer Solution, 500 mL bottle
HI 6124	pH 12.450 Buffer Solution, 500 mL bottle

ELECTRODE STORAGE SOLUTIONS

HI 70300L	Storage Solution, 500 mL bottle
HI 80300L	Storage Solution in FDA approved bottle, 500 mL

ELECTRODE CLEANING SOLUTIONS

HI 70000P	Electrode Rinse Sachets, 20 mL, 25 pcs
HI 7061L	General Purpose Solution, 500 mL bottle
HI 7073L	Protein Cleaning Solution, 500 mL bottle
HI 7074L	Inorganic Cleaning Solution, 500 mL bottle
HI 7077L	Oil & Fat Cleaning Solution, 500 mL bottle
HI 8061L	General Purpose Solution in FDA approved bottle, 500 mL
HI 8073L	Protein Cleaning Solution in FDA approved bottle, 500 mL
HI 8077L	Oil & Fat Cleaning Solution in FDA approved bottle, 500 mL

ELECTRODE REFILL ELECTROLYTE SOLUTIONS

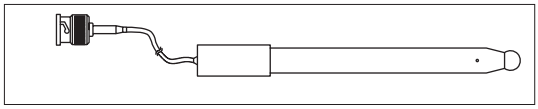
HI 7071	3.5M KCl + AgCl Electrolyte, 4x30 mL, for single junction electrodes
HI 7072	1M KNO_3 Electrolyte, 4x30 mL
HI 7082	3.5M KCl Electrolyte, 4x30 mL, for double junction electrodes
HI 8071	3.5M KCl + AgCl Electrolyte in FDA approved bottle, 4x30 mL, for single junction electrodes
HI 8072	1M KNO_3 Electrolyte in FDA approved bottle, 4x30 mL
HI 8082	3.5M KCl Electrolyte in FDA approved bottle, 4x30 mL, for double junction electrodes
HI 8093	1M KCl + AgCl Electrolyte in FDA approved bottle, 4x30 mL

ORP PRETREATMENT SOLUTIONS

HI 7020L Test Solution 200-275 mV, 500 mL bottle
HI 7021L Test Solution 240 mV, 500 mL bottle
HI 7022L Test Solution 470 mV, 500 mL bottle
HI 7091L Reducing Pretreatment Solution, 500 mL
HI 7092L Oxidizing Pretreatment Solution, 500 mL

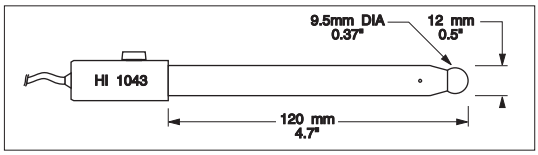
pH ELECTRODES

All electrodes part numbers ending in B are supplied with a BNC connector and 1 m (3.3') cable, as shown below:



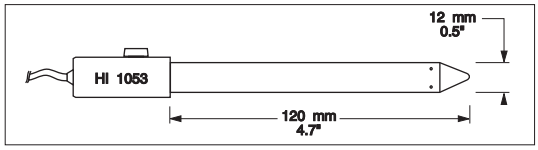
HI 1043B

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



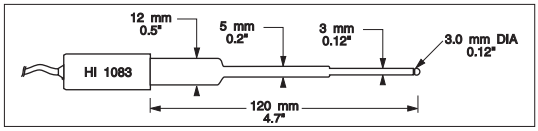
HI 1053B

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



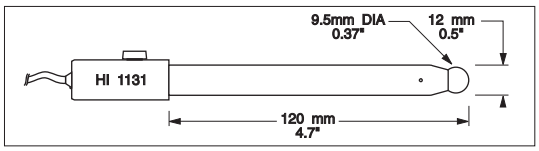
HI 1083B

Glass-body, micro, Viscolene, non-refillable, combination **pH** electrode.
Use: biotechnology, micro titration.



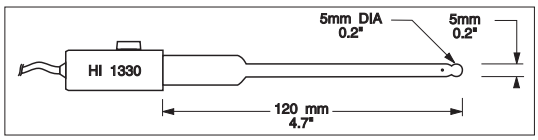
HI 1131B

Glass-body, single junction, refillable, combination **pH** electrode.
Use: general purpose.



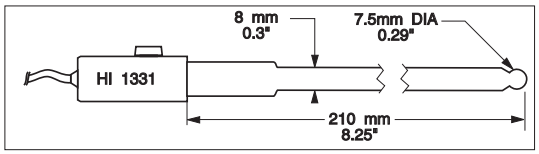
HI 1330B

Glass-body, semimicro, single junction, refillable, combination **pH** electrode.
Use: laboratory, vials.



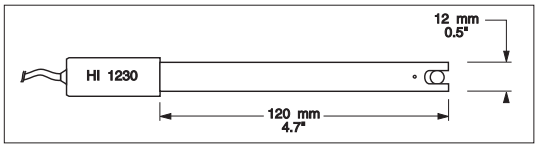
HI 1331B

Glass-body, semimicro, single junction, refillable, combination **pH** electrode.
Use: flasks.



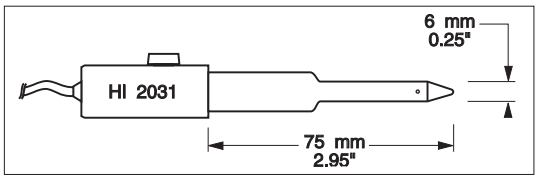
HI 1230B

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



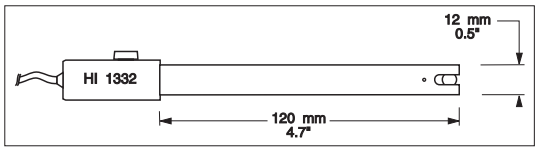
HI 2031B

Glass-body, semimicro, conic, refillable, combination **pH** electrode.
Use: semisolid products.



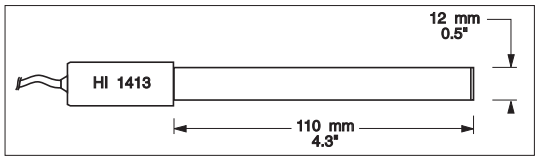
HI 1332B

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



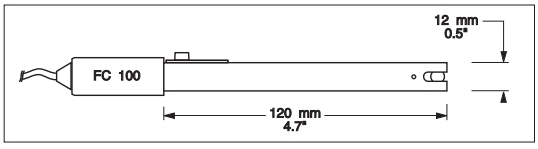
HI 1413B

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



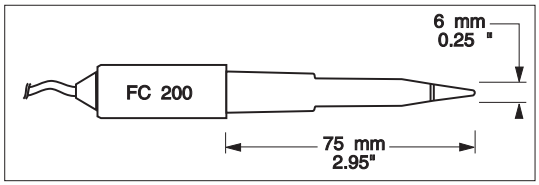
FC 100B

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



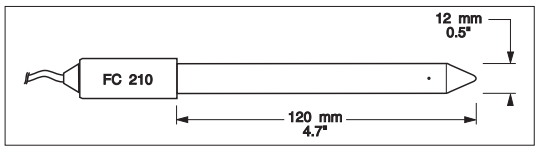
FC 200B

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



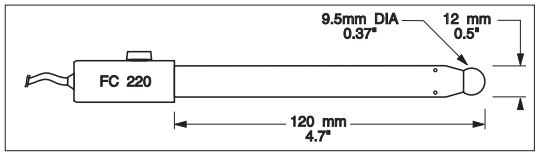
FC 210B

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



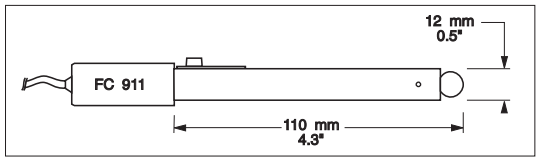
FC 220B

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



FC 911B

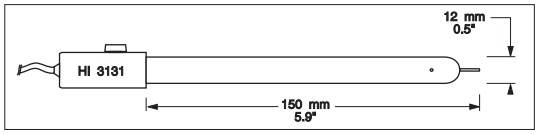
Plastic-body (PVDF®), double junction, refillable with built-in amplifier, combination **pH** electrode.
Use: very high humidity.



ORP ELECTRODES

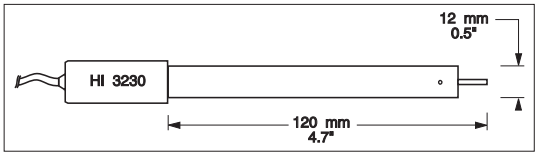
HI 3131B

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



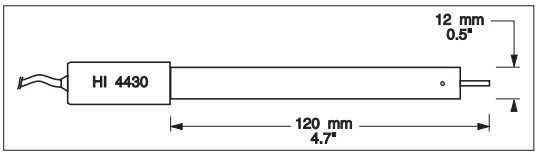
HI 3230B

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



HI 4430B

Plastic-body (PEI®), gel-filled, combination gold **ORP** electrode.
Use: general purpose.

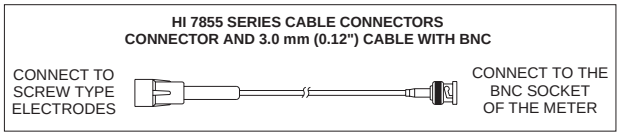


Consult the Hanna General Catalog for more electrodes with screw-type or BNC connectors.

PEI® is registered Trademark of "General Electric Co."
PVDF® is registered Trademark of "Pennwalt Corp."

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

HI 7855/1 Extension cable 1 m (3.3') long
HI 7855/3 Extension cable 3 m (9.9') long



OTHER ACCESSORIES

HI 710005/8 Voltage adapter from 115 Vac / 12 Vdc 800 mA (USA plug)
HI 710006/8 Voltage adapter from 230 Vac / 12 Vdc 800 mA (European plug)
HI 76404N Electrode holder
HI 8427 pH and ORP electrode simulator with 1 m (3.3') coaxial cable ending in female BNC connectors
HI 931001 pH and ORP electrode simulator with LCD and 1 m (3.3') coaxial cable ending in female BNC connectors
HI 7662-T Temperature probe with 1 m (3.3') cable
HI 92000 Windows® compatible software
HI 920010 9 to 9-pin RS232 cable

RECOMMENDATIONS FOR USERS

Before using these products, make sure they are entirely suitable for the environment in which they are used.

Operation of these instruments in residential areas could cause unacceptable interferences to radio and TV equipment, requiring the operator to follow all necessary steps to correct interferences.

The glass bulb at the end of the pH electrode is sensitive to electrostatic discharges. Avoid touching this glass bulb at all times.

During operation, ESD wrist straps should be worn to avoid possible damage to the electrode by electrostatic discharges.

Any variation introduced by the user to the supplied equipment may degrade the instruments' EMC performance.

To avoid electrical shock, do not use these instruments when voltages at the measurement surface exceed 24 Vac or 60 Vdc.

To avoid damage or burns, do not perform any measurement in microwave ovens.

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