HI504

Panel-mounted, Microprocessor-based pH/ORP Process Controller

Instruction Manual

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WARRANTY

HI504 is guaranteed for two years (sensors, electrodes and probes for six months) against defects in workmanship and materials when used for their intended purpose and maintained according to instructions. This warranty is limited to repair or replacement free of charge.

Damages due to accident, misuse, tampering or lack of prescribed maintenance are not covered.

If service is required, contact your local Hanna Instruments Office.

If under warranty, report the model number, date of purchase, serial number and the nature of the problem.

If the repair is not covered by the warranty, you will be notified of the charges incurred. If the 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.

Hanna Instruments reserves the right to modify the design, construction or appearance of its products without advance notice.

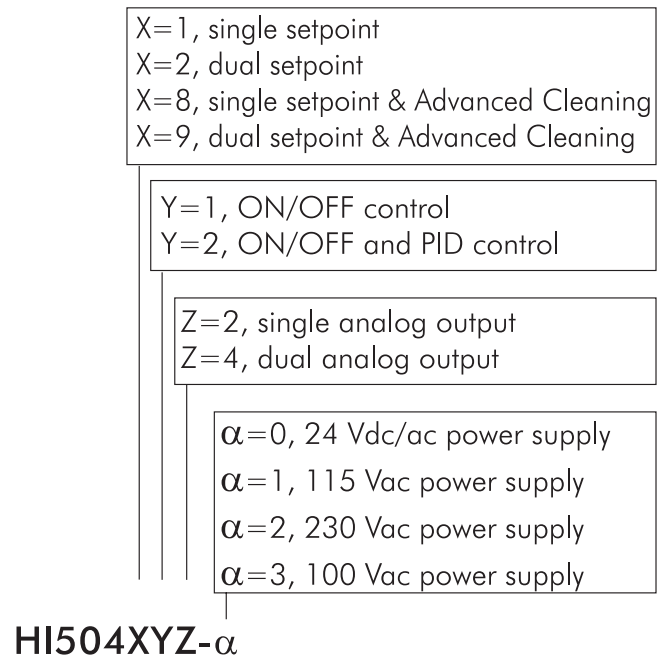
Dear Customer,

Thank you for choosing a Hanna Instruments Product. Please read this instruction manual carefully before using this instrument. This manual will provide you with the necessary information for the correct use of this instrument, as well as a precise idea of its versatility.
If you need additional technical information, do not hesitate to e-mail us at tech@hannainst.com or view our worldwide contact list at www.hannainst.com.

MODEL IDENTIFICATION

The models **HI504XYZ-α** are pH/ORP controllers.

The meaning of the last letters is according to the following scheme:



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 noticeable damage, please contact your local Hanna Instruments Office.

Note Save all packing materials until you are sure that the instrument functions correctly. Any damaged or defective items must be returned in their original packing materials together with the supplied accessories.

GENERAL DESCRIPTION

The product is a real time microprocessor-based pH/ORP controller. It provides accurate measurements, flexible control capabilities and dual alarm signals.
The system is composed of a case inside which the signal conversion circuitry, the microprocessor circuitry and the output power drivers are contained.

MAIN FEATURES

- Configurations: for measure and control of pH or ORP, with two separate sets of control settings. Thus no loss of settings occurs when changing from pH to ORP and vice versa.
- Display: large LCD with 4 ½ 17 mm digits and 3 ½ 10 mm digits.
- LEDs: a green LED (alarm relay) and a red LED for signaling the device status.
- Alarm relay: one output relay for alarm condition (fail safe mode: COM and NC are connected).
- Daily programmable control timing.
- Diagnostic features.
- pH/ORP probe check.
- Temperature sensor (Pt100 or Pt1000 type) with automatic recognition and damage test.
- Hold management, including hold digital input to enter hold mode with an external trigger.
- Logging of the last 100 error, configuration, calibration and cleaning events.

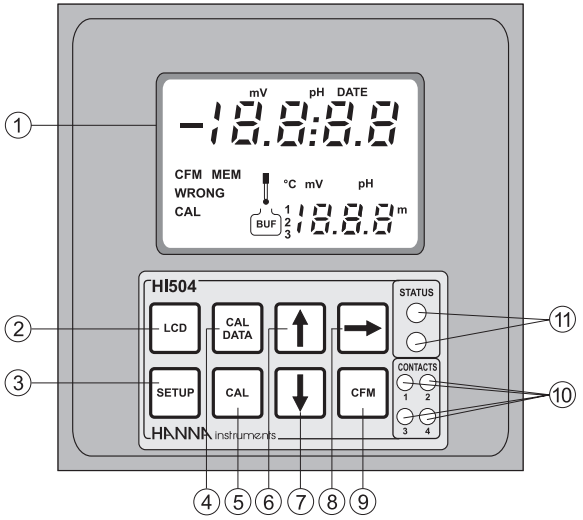
- Calibration and Setup procedures are password protected.
- Calibration: pH calibration at 2 points with two possible sets of buffers (either 7.01 - 4.01 - 10.01 or 6.86 - 4.01 - 9.18), or at 1 point with user-selectable value.
- Temperature compensation of the Hanna Instruments Office standard buffers.
- GLP features: old probe check, dead probe check, calibration time-out, last calibration data internally recorded (nonvolatile EEPROM memory): calibration date and time, pH offset, pH slope, number of calibration points and correspondent pH values.
- Solution compensation of the pH reading.
- Manual temperature setting when the temperature probe is not inserted or temperature is out of range.
- Input: pH/ORP electrode with BNC connector.
- Input: pH/ORP/Temperature Digital Transmitter (**HI504910**) which can be connected up to 1.2 km (0.75 miles) far away.
- Output (0-20 or 4-20 mA): one analog output for recording of pH/ORP or controlling (only for models with PID).
- RS485 communication with Short Messaging Service (SMS) for GSM phones.
- RS485 communication with analog modem for remote connection with PC.
- Data logging: 6000 samples pH/°C or ORP downloadable through RS485 and HI92500 application software.
- Real time clock.

OPTIONAL FEATURES (depending on model)

- LEDs: four yellow LEDs are provided for signaling the energizing of relay 1, relay 2 (optional), relay 3 (optional) and relay 4 (optional).
- Relays: 1, 2 or 4 output relays. The relays LEDs are switched ON whenever the correspondent relay is energized (NO and COM connected).
- Advanced Cleaning is provided through two cleaning commands and variety of trigger events (relays 3 and 4 only).
- Output (0-20 or 4-20 mA): second independent analog output for recording of temperature or controlling (only for models with PID).
- PID control.

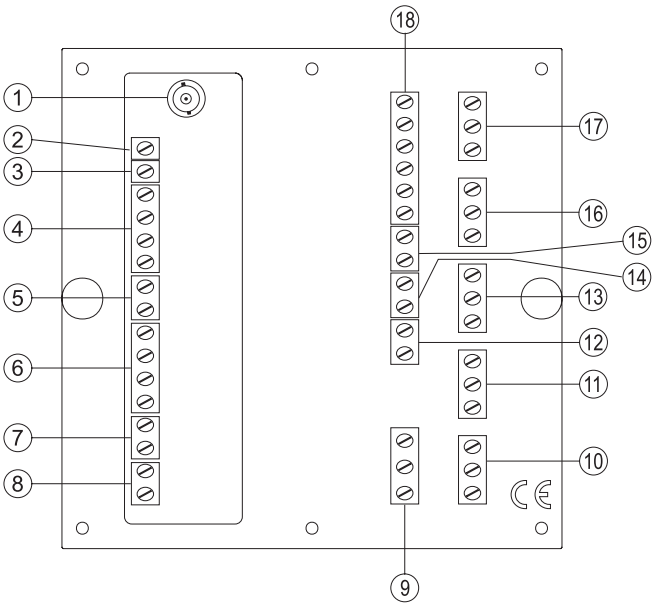
FUNCTIONAL DESCRIPTION

FRONT PANEL



1. Liquid Crystal Display
2. LCD key — enters and exits the event scrolling mode. During pH calibration, alternately displays pH buffer value or current temperature
3. SETUP key — enters and exits setup mode
4. CAL DATA key — last calibration data viewing (enters and exits)
5. CAL key — initiates and exits calibration mode
6. ⇧ key — increases the blinking digit/letter by one when selecting a parameter. Advances forward while in last calibration data viewing mode or event scrolling mode. Increases the temperature setting when temperature probe is not inserted
7. ⇩ key — decreases the blinking digit/letter by one when selecting a parameter. Reverts backward while in last calibration data viewing mode or event scrolling mode. Decreases the temperature setting when temperature probe is not inserted
8. ⇨ key — moves to the next digit/letter (circular buffer) when selecting a parameter. Same as ⇧ key during last calibration data viewing mode. Move to the next piece of information for the current event while in event scrolling mode
9. CFM key — confirms current choice (and skips to the next item) ENTER
10. LEDs — Relay's 1, 2, 3, 4 activation
11. LEDs — Controller Status, alarm activation

REAR PANEL



1. BNC Socket for pH or ORP electrode
2. Connection for Potential Matching Pin
3. Connection for electrode reference
4. Connections for Pt 100/Pt 1000 temperature sensor
5. Not Connected, for future use
6. Digital Transmitter input
7. HOLD input
8. Advanced Cleaning input (optional)
9. Power supply input
10. Alarm terminal
11. Relay 2 - second dosing terminal (optional)
12. Second analog output (optional)
13. Relay 1 - first dosing terminal
14. First analog output
15. HOLD output
16. Relay 4 - for Advanced Cleaning feature (optional)
17. Relay 3 - for Advanced Cleaning feature (optional)
18. RS485 output terminal

⚠ Unplug the meter before starting any electrical connections.

⚠ Disconnect the Potential Matching Pin when setup item I.04="OFF"

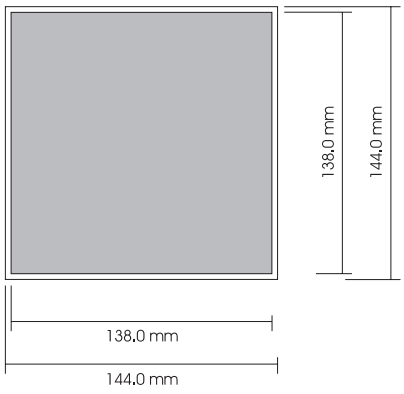
SPECIFICATIONS

Range	-2.00 to 16.00 pH -2000 to 2000 mV -30 to 130.0 °C
Resolution	0.01 pH 1 mV 0.1 °C above -10 °C; 1 °C below
Accuracy (@25 °C/77 °F)	±0.02 pH ±2 mV ±0.5 °C (-9.9 to 130.0 °C); ±1 °C (-30 to -10 °C)
Typical EMC Deviation	±0.2 pH ±10 mV ±0.5 °C
Digital Input for the pH/ ORP/°C Transmitter	RS485
Other Digital Insulated Inputs	• 2 digital insulated inputs: 1 for hold and 1 for the advanced cleaning • ON state: 5 to 24 VDC
Digital Insulated Output	A digital insulated contact closed upon hold mode
Temperature compensation	Automatic or manual from -30 to 130 °C
Temperature probe	With 3-wire or 2-wire Pt100/Pt1000 sensor (with automatic recognition and damage test)
Installation Category	II
Power Supply (depending on model)	24 Vdc/ac 230 Vac, 115 Vac or 100 Vac ±10%; 50/60 Hz
Power Consumption	10VA
Over Current Protection	400 mA 250V Quick Blow Fuse
Max. Oscillation Frequency	8 MHz
Relays 1, 2, 3, 4	Electromechanical relay SPDT contact outputs, 5A-250 VAC, 5A - 30 VDC (resistive load) Fuse protected: 5A, 250V Quick Blow Fuse
Alarm Relay	Electromechanical Relay SPDT contact output, 5A - 250 VAC, 5A - 30 VDC (resistive load) Fuse protected: 5A, 250V Quick Blow Fuse

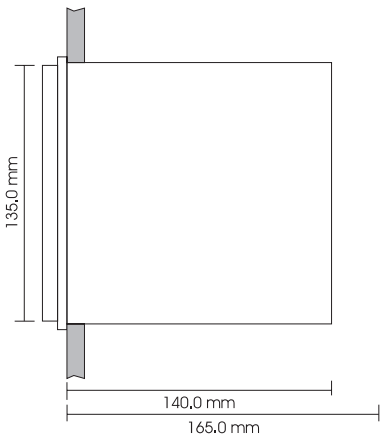
Analog Output	• 2 independent outputs • 0 - 22 mA (configuring as 0-20 mA or 4-20 mA)
Analog Output Resolution	0.1‰ f.s.
Analog Output Accuracy	± 2‰ f.s.
Data logging	6000 pH/°C or ORP samples
Environment	0 to 50 °C; max 85% RH non-condensing
Casing	IP20 (housing); IP54 (front panel)
Enclosure	single case ½ DIN
Weight	approximately 1.6 kg (3.5 lb.)

MECHANICAL DIMENSIONS

FRONT VIEW

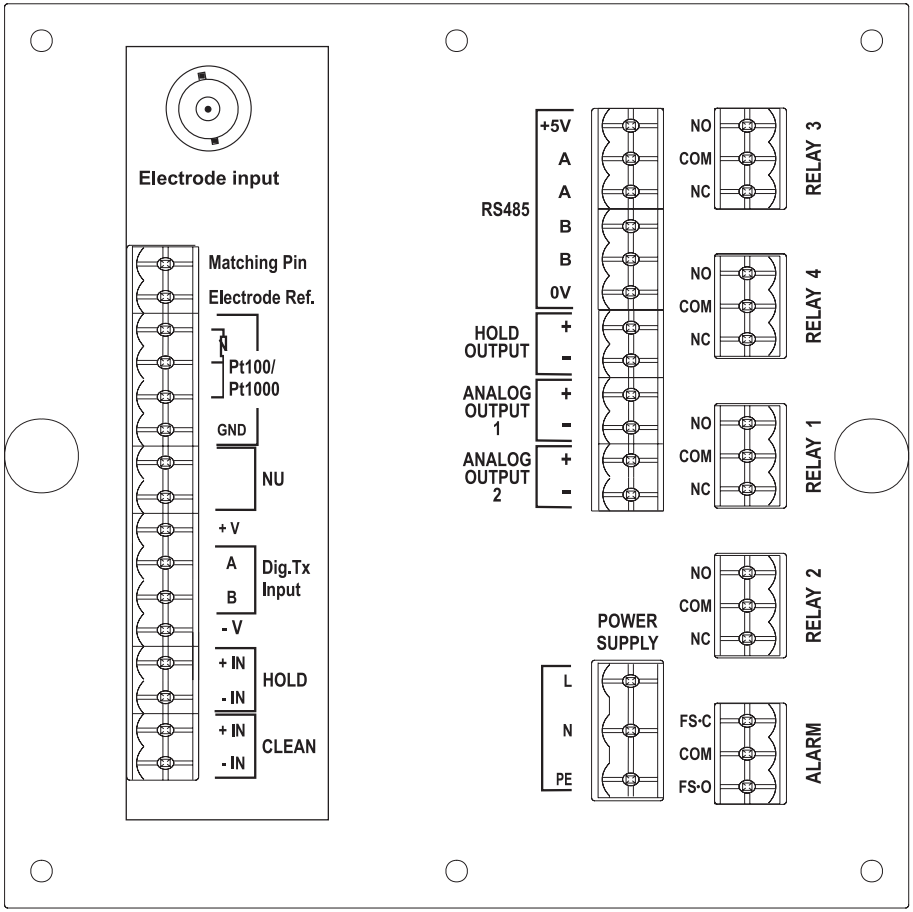


SIDE VIEW

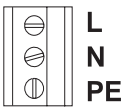


INSTALLATION

Refer to diagram on page #9



- Input power: Connect a 3-wire power cable to the terminal strip line (L), earth (PE) and neutral (N) terminal connections.

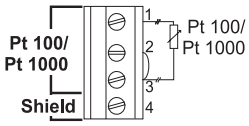


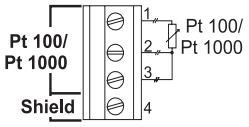
Power: 100VAC-120mA / 115VAC-100mA / 230VAC-50mA.
Line Contact: 400mA fuse inside.
PE must be connected to ground; leakage current 1mA.

- Electrode: Connect the pH or ORP electrode to the BNC socket (#1 at page 9).
  To benefit from the differential (symmetrical) input, connect the proper electrode wire (if available) or a cable with a potential matching pin (grounding bar) to the relevant terminal (#2 at page 9) and enable the differential input through the setup code I.04.

Note When it is not possible to immerse the Potential Matching Pin together with the pH electrode in the solution (asymmetrical input), disable the differential input through the setup code I.04. In this case, detach the Potential Matching Pin from its connector. Failure to do so may cause damage of the reference electrode.

- Pt 100/Pt1000 Terminals: these contacts (#4 at page 9) connect the Pt 100/Pt 1000 temperature sensor for automatic temperature compensation of pH measurement. In the case of shielded wire, connect the shield to pin 4.
  In the case of a 2-wire sensor connect the Pt 100/Pt 1000 to pins 1 and 3, and short pins 2 and 3 with a jumper wire.
  If the Pt 100/Pt 1000 has more than 2 wires, connect the two wires of one end to pins 2 and 3 (pin 2 is an auxiliary input to compensate for the cable resistance) and one wire from the other end to pin 1. Leave the fourth wire unconnected, if present.





Note The instrument automatically recognizes the sensor type (Pt100 or Pt1000).

- Analog Outputs: when using shielded cable, if the shield is not connected at the other end of the cable, then connect it to the "+" terminal, otherwise leave it floating.

All cables connected to rear panel should end with cable lugs.

A circuit breaker (rated 10A max.) must be connected in close proximity to the equipment, and in a position easy to reach by the operator, for disconnection of the instrument and of all the devices connected to the relays.

CALIBRATION MODE

The calibration mode allows to calibrate the pH/ORP input, temperature input and 4-20 mA analog outputs.

The controller is factory calibrated for all these parameters. Periodical calibration of the instrument is recommended, in particular when greatest accuracy is required and at least bi-yearly.

It is possible to calibrate the electrode over only one point, but it is always good practice to perform a 2-point calibration.

To enter the calibration mode press the CAL key.

Enter the correct password and press the CFM key. If a wrong password is entered, the instrument returns to the previous mode.

Note If the meter is set as an ORP controller (setup item G.00), the pH calibration, pH reading offset adjustment, and pH offset and slope are not available. If the meter is selected as a pH controller, no ORP calibration can be selected.

Note Any calibration procedure can be aborted at any time by pressing the CAL key, and the instrument returns to the previous mode.

The pH/ORP controller can be calibrated through a one-point or two-point calibration.

The pH calibration can not be performed if the pH electrode is broken or leaking or the reference electrode is broken or dirty and an error is active. The ORP calibration can not be performed if the "Reference electrode broken or dirty" error is active. For pH calibration the temperature probe should be connected to the process meter.

All calibrations refer to the process controller. No calibration for the Digital Transmitter can be performed by the process controller, but the Digital Transmitter Calibrator must be used for that.

The pH and ORP calibrations can not be initiated while the process controller is configurated to take measurements from the Digital Transmitter.

pH CALIBRATION

It is recommended to perform pH calibration when the probe is replaced and after any cleaning action.

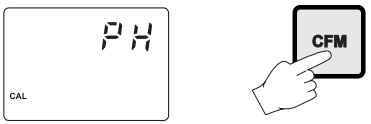
To perform any pH calibration procedure, the instrument has to be set as pH controller.

Initial Preparation

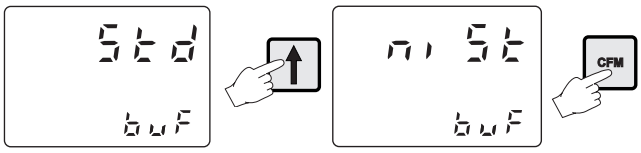
Pour small quantities of pH7.01 (**HI7007**) and pH4.01 (**HI7004**) or pH10.01 (**HI7010**) solutions into individual beakers. If possible, use plastic beakers to minimize any EMC interference.

For accurate calibration use different beakers for each buffer solution, the first one for rinsing the electrode and the second one for calibration. By doing this, contamination between buffers is minimized.

- Enter the calibration mode, select the pH calibration (by moving through the menu with the ⇧ and ⇩ keys), then press the CFM key.

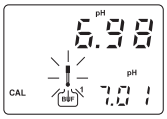


- Choose the pH buffer set between the two available ones: the standard set (4.01, 7.01, 10.01) and the NIST set (4.01, 6.86, 9.18). For the standard set confirm the "Std"; for the NIST set confirm the "niSt" (use the ⇧ and ⇩ keys for select between the two options).



The default buffer set is the one used for last calibration, even if the procedure was not completed.

- Once confirmed the set of buffer values, the primary LCD shows the measured pH value, while the secondary LCD displays the first required buffer value.



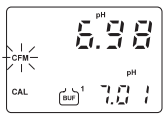
Two-point calibration

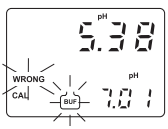
- Remove the protective cap from the pH electrode and immerse it into the buffer solution (e.g. pH7.01) together with the Potential Matching Pin and the temperature probe, then stir gently.

Note The electrode should be submerged approximately 4 cm ($1^1/_2$'') in the solution. The temperature probe has to be located as close as possible to the pH electrode.

Note When it is not possible to immerse the Potential Matching Pin together with the pH electrode in the solution, disable the differential input by setting setup item I.04 to "OFF".

- When the reading becomes stable, the probe indicator will stop flashing (after about 30 seconds), and if the pH value is close to the selected buffer, the "CFM" indicator will start blinking, otherwise the "WRONG" indicator, the pot and the BUF tags will start blinking.





- In the first case press the CFM key to confirm calibration. The meter will show the scrolling message "Press CFM again to confirm the current buffer or right to escape" (to prevent from confirming the calibration point inadvertently).

Pressing again CFM, the secondary LCD will display the second expected buffer value.

- In the second case (pH value not close to the buffer) the meter will remain in the same state until the reading becomes unstable or the calibration mode is quitted.
- For the second buffer value it is possible to choose between pH4.01 and pH10.01 (or pH4.01 and pH9.18 if the NIST set has been selected). Use the ⇧ or ⇩ key to switch between the two possibilities.
- Once selected the buffer, the procedure is the same as for the first calibration point.

Note A time-out of 2.5 minutes is present for the pH electrode response time. During calibration, if the pH reading is not stable after 2.5 minutes, the device displays twice the scrolling message "time-out", then shows "WRONG" and it is not possible to complete calibration.

- At the end of calibration, with the meter set as pH controller, the instrument checks if the offset is between -30 and 30 mV and the slope between 53.5 and 62 mV/pH. If the values are not within these ranges, the message "OLd ProbE" scrolls twice across the LCD. The electrode is still working, but it is necessary to perform a cleaning procedure (see "Electrode conditioning and maintenance" and "In-line Cleaning" sections) or replace it.

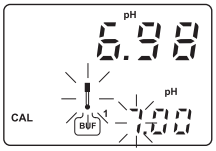
  If the offset is outside the -60 to 60 mV range, the "dEAd ProbE" message will scroll across the LCD and the corresponding error is activated. The electrode has to be replaced as soon as possible because there is no reliability on the measured pH values.

One-point calibration

A one-point calibration at a value different from the standard buffer values is possible by entering the desired calibration value. This is the actual pH value at the current calibration temperature.

- Enter the pH calibration mode (no matter if the standard or NIST buffer set is selected), then press the SETUP key while the secondary LCD is displaying the first buffer value (pH7.01 or pH6.86).

- The pH calibration value will switch to 7.00, the first digit starts blinking and it is possible to change its value simply using the ⇧ or ⇩ key.



- Once selected the first digit value, press the ⇨ key: the first digit will be fixed and the second one will start blinking. Pressing of the ⇨ key repeatedly will result on circularly moving on the secondary LCD.
- When the desired calibration value is reached (must be within 0.00 to 16.00 pH), press the CFM key to confirm and the calibration will proceed as described above.
- If the selected value is outside boundaries, the confirmation is not accepted and the first digit keeps blinking (waiting for confirmation of a valid value).

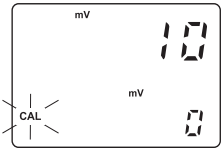
Note If SETUP key is pressed instead of CFM, the calibration value selection is aborted and the meter reverts back to a two-point calibration.

ORP CALIBRATION

To perform ORP calibration it is necessary to connect an **HI931001** or **HI8427** simulator to the BNC socket.

The meter has to be set as ORP controller.

- Set item I.04 to "OFF" to disable the Matching Pin.
- A two-point calibration has to be performed: the first point value is 0 mV and the second one can be chosen between 350 mV and 1900 mV.
- Enter the calibration mode, select the ORP calibration (use the ⇧ and ⇩ keys to move through setup menu) and press the CFM key.
- Set the **HI931001** or **HI8427** simulator to 0 mV.
- The primary LCD will display the current mV measure and the secondary LCD will show the first calibration point (0 mV).



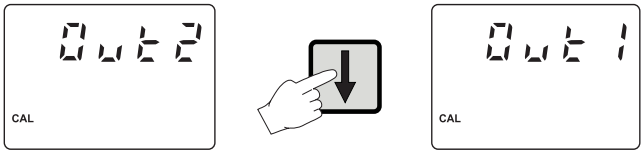
- When the reading becomes stable, if the ORP value is close to the calibration point, the "CFM" indicator starts blinking; otherwise the "WRONG" indicator blinks and the "CAL" is fixed on.
- In the first case press CFM to confirm calibration. The meter will proceed showing the scrolling message "Press CFM again to confirm the current buffer or right to escape" (to prevent from confirming the calibration point inadvertently). Pressing again CFM the secondary LCD will display the second calibration point.
- In the second case (blinking "WRONG") the meter will remain in the WRONG state until the reading becomes unstable or the calibration mode is exited by pressing the CAL key.
- For the second calibration point it is possible to choose between 350 mV or 1900 mV. Pressing the ⇧ or ⇩ key the value on the secondary LCD will switch between the two possibilities.
- Once selected the second calibration point, set the **HI931001** (350 mV) or **HI8427** (350 or 1900 mV) simulator to the same value and the calibration proceeds as for the first point.

Note In ORP calibration there is no time-out.

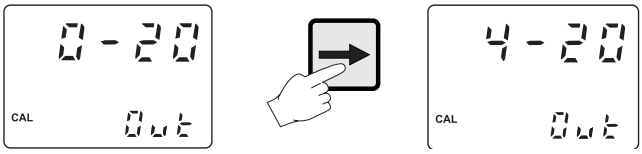
ANALOG OUTPUT CALIBRATION

The instrument can be provided with one or two analog outputs, each of them can be calibrated.

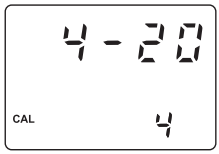
- Connect an Ammeter or the **HI931002** calibrator to the analog output to measure the current erogated by the meter.
- Enter the calibration mode and move through the menu using the ⇧ or ⇩ key until "Out 1" or "Out 2" message appears on the primary LCD.



• Once visualized the selected output, press the ⇨ key to choose the range of the analog output (0-20 mA or 4-20 mA); then press the CFM key to confirm the choice.



• Once selected and confirmed the range for the analog output, the secondary LCD shows the first point of calibration (1 or 4 mA) and the primary LCD displays the range of the actual calibration.



• With the tester check the real current value provided by the instrument at the output port. If this value is different from the expected one, it is possible to change the current erogated by the instrument pressing the ⇧ or ⇩ key.

• Adjust the value until it matches with the first point of calibration, then press CFM to confirm. The instrument will turn to the second calibration point (20 mA).

• The calibration procedure is the same as for the first point.

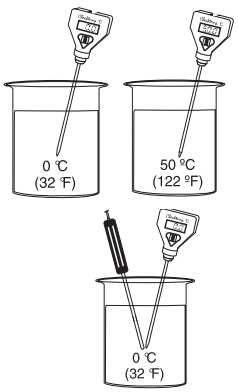
• Once the instrument is calibrated for both points (and confirmed), it will exit from the calibration menu.

TEMPERATURE CALIBRATION

• Prepare a beaker containing crushed ice and water at 0 °C (32 °F) and another one with hot water at 25 °C (77 °F) or 50 °C (122 °F).

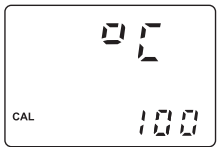
• Use a Checktemp or another calibrated thermometer with a resolution of 0.1° as a reference thermometer.

• Immerse the temperature probe in the beaker with ice and water as near to the Checktemp as possible.



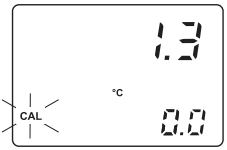
Note The instrument can support Pt100 or Pt1000 temperature sensor and calibration can be performed with anyone of these two probes.

- After entering the calibration mode, move through the menu (using the ⇧ or ⇩ key) to choose the temperature and the correct kind of used probe; the primary LCD shows "°C" and the secondary LCD gives indication about the kind of probe ("100" indicates a Pt100 probe, while "1000" stands for a Pt1000 probe).



  Press the CFM key to confirm selection.

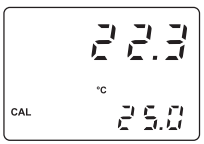
- The calibration has to be performed over two points: the first point has to be 0 °C and the second one can be chosen between 25 °C and 50 °C.



  Once confirmed the type of calibration, the primary LCD will display the current temperature measure and the secondary LCD will show the first calibration point (0 °C).

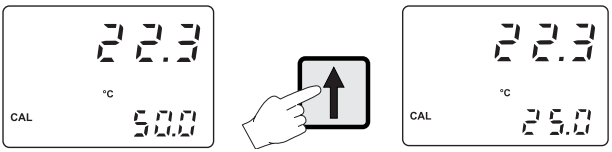
- When the reading becomes stable, if the temperature value is close to the calibration point the CFM tag starts blinking, otherwise the WRONG indicator will flash.
- In the first case press the CFM key to confirm calibration. The meter will proceed showing the scrolling message "Press CFM again to confirm the current buffer or right to escape" (to prevent from confirming the calibration point inadvertently).

- Pressing again the CFM key, the secondary LCD will display the second calibration point.



- In the case the measured temperature is not close to the calibration value, the meter remains in the WRONG status until the reading becomes unstable or the calibration mode is exited (by pressing the CAL key).

- When performing the second calibration point, it is possible to choose between two values, 25 °C and 50 °C. Pressing the ⇧ or ⇩ key the value on the secondary LCD will switch between the two possibilities.



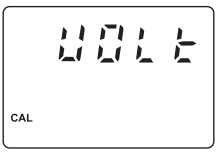
- Once selected the value, immerse the temperature probe in the second beaker as near as possible to the Checktemp and the calibration procedure will be the same as for the first point.

VOLT CALIBRATION

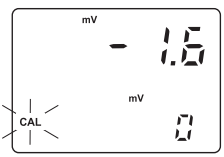
The instrument is factory calibrated; however the user may also perform the Volt calibration, which is a procedure available for the meter configured as pH controller only.

During pH measurements the instrument reads a mV value from the electrode and then converts it into a pH value.

- Set item I.04 to "OFF" to disable the Matching Pin.
- Connect a **HI931001** or **HI8427** simulator to the BNC socket.
- Once entered the calibration mode, move through the menu with ⇧ or ⇩ key, select the Volt calibration (the primary LCD shows "UOLt" message) and confirm it by pressing the CFM key.



- After confirmation the primary LCD will show the actual mV value and the secondary LCD will display the first calibration point.



- The calibration is performed over two points, 0 and 350 mV.
- Set the **HI931001** or **HI8427** simulator to 0 mV.
- When the reading becomes stable, if the measured value is close to the calibration point the CFM tag starts blinking, otherwise the WRONG indicator will flash.

- In the first case press the CFM key to confirm calibration. The meter will proceed showing the scrolling message "Press CFM to confirm the current buffer or right to escape" (to prevent from confirming the calibration point inadvertently).
- Pressing again CFM the secondary LCD will display the second calibration point.
- Set the **HI931001** or **HI8427** simulator to 350 mV and follow the same procedure as for the first point.
- If the measured value is not close to the calibration value, the meter will remain in the WRONG status until the reading becomes unstable or the calibration mode is exited (by pressing the CAL key).

SETUP MODE

The Setup Mode allows the user to set all needed characteristics of the meter.

To enter the mode, press the SETUP key and enter the password when the device is in idle or control mode.

If the correct password is not entered, the user can only view the setup parameters (except for passwords) without modifying them (and the device remains in control mode). An exception is certain setup items, or flags, which can activate special tasks, when set and confirmed.

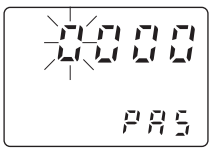
To each setup parameter (or setup item) is assigned a three characters (one letter followed by two digits) setup code which is entered and displayed on the secondary LCD. The first character identifies the group of setup items, while the two digits identify the particular item within that group.

The setup codes can be selected after password is entered and CFM key is pressed. When CFM is pressed, the current setup item is saved on EEPROM and the following item is displayed.

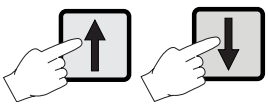
The possible transitions in setup mode are the following:

ENTERING THE PASSWORD

- Press SETUP to enter the setup mode. The primary LCD will display “0000”, while the secondary LCD shows “PAS”. The first digit of the primary LCD will blink.



- Enter the first digit of the password by using the ⇧ or ⇩ key.



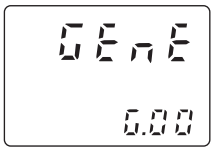
- Then move to the next digit with ⇨ and enter a digit as described above. Continue for the last two digits.

- When the whole password has been inserted, press CFM to confirm it.

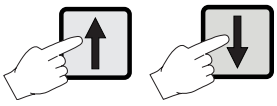
Note The default password is set at "0000".

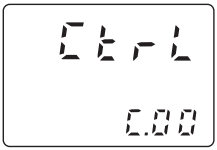
ENTERING SETUP ITEMS

After confirmation of the password the primary LCD will show the name of the first setup group (see table) while the secondary LCD will display the setup code of the first item of the group.

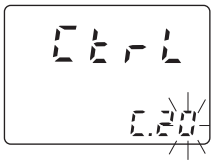


- By pressing the ⇧ or ⇩ key it is possible to cycle through the setup groups; the secondary LCD will always show the code of the first item of the group.



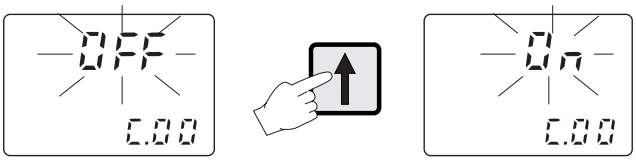


- Once a group is selected, it is possible to choose an item manually. Pressing the ⇨ key, the first digit of the setup code will start blinking. Now it is possible to change its value by pressing the ⇧ or ⇩ key.
- Pressing the ⇨ key again, the first digit will be fixed while the second digit starts blinking and its value can be changed as described above.

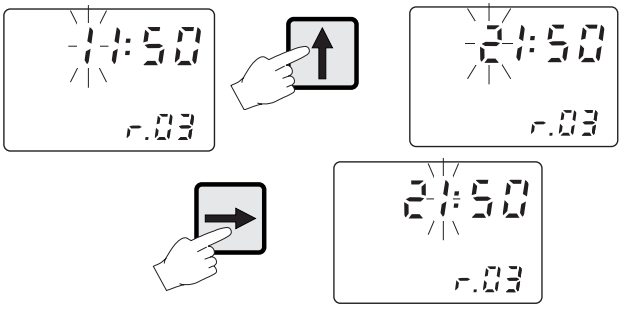


- By pressing the ⇨ key again all the digits will be fixed.
- If CFM key is pressed, the selected item is confirmed; the secondary LCD will show the setup item code while the primary LCD will display the current item value.

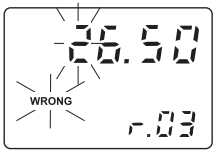
  If a fixed set of values is available for the selected item, use the ⇧ or ⇩ key to switch between them.



Otherwise, if a numeric value has to be entered for the item, use the ⇧ or ⇩ key to change the value of the blinking digit and the ⇨ key to cycle through the number's digits.



- Once a value is set, press the CFM key to confirm. The instrument will turn to the next item and the new item's value will be displayed on the primary LCD.
- If a wrong value is confirmed, the WRONG indicator starts blinking, the new value is not accepted and the instrument will not switch to the next item until a correct value will be confirmed.



- Instead of selecting the item manually, it is possible to cycle through all the items of a selected group by pressing repeatedly CFM key. The procedure to modify the item's value is the same described above.

  If the last item of the group is reached, by pressing the CFM key again the primary display will show the group name and it will be possible to change the group by pressing the ⇧ or ⇩ key.

Note At any time for exiting the setup mode press the SETUP key. If no modification has been confirmed, no setup item is changed.

Note While in the setup mode, if no activity is performed for about 5 minutes after entering the setup mode, the mode is automatically exited and the instrument returns to the previous mode.

The below table lists the setup codes along with the description of the specific setup items, their valid values and whether the item is present for ORP mode.
Titles in *Italic* character (e.g.. "***SETPOINT 1***") represent different subgroups within the same group. The subgroup name (e.g.. "Set1") is showed when entering the first item of the subgroup. To scroll through subgroups, use the ⇨ key.
Depending on the device model, some of the below items or item values may not be available.

Code	Valid Values	Default	Present for ORP
GENERAL ("GEnE")			
G.00 pH/ORP input	"PH", "OrP" (see note 10)	"PH"	yes
G.01 Temperature compensation	"AtC": Automatic "USEr": Manual (see notes 9, 25)	"AtC"	no
G.02 Manual or probe error temperature	-30 to 130.0 °C (see notes 9, 25)	25.0	no
G.10 Factory ID	0000 to 9999 (see note 20)	0000	yes
G.11 Process ID alias RS485 address	00 to 99 (see note 20)	00	yes
G.12 Hardware Identifier (see notes 4, 20)	7 digits identification number, read only		yes
G.98 Calibration/hold password	0000 to 9999 (see notes 2, 20)	0000	yes
G.99 General password	0000 to 9999 (see notes 2, 20)	0000	yes
CONTROL ("CtrL")			
C.00 Control enable	"OFF": Control mode disabled "On": Control mode enabled	"OFF"	yes
SETPOINT 1 ("SEt1")			
C.10 Setpoint 1 mode (M1) (see note 1)	"OFF": Disabled "OOHI": ON-OFF, high set point "OOLO": ON-OFF, low set point "PIdH": P.I.D., high set point / "PIdL": P.I.D., low set point	"OOHI"	yes
C.11 Setpoint 1 (S1) (see note 1)	-2.00 to 16.00 pH or -2000 to 2000 mV	8.00 pH or 500 mV	yes

Code	Valid Values	Default	Present for ORP
C.12 Hysteresis for setpoint 1 (H1) (see note 1)	0.00 to 18.00 pH or 0 to 4000 mV	1 pH or 50 mV	yes
C.13 Deviation for setpoint 1 (D1) (see note 1)	0.50 to 18.00 pH or 25 to 4000 mV	1 pH or 50 mV	yes
C.14 Reset time for setpoint 1	0.1 to 999.9 minutes	999.9 min.	yes
C.15 Rate time for setpoint 1	0.0 to 999.9 minutes	0.0 min.	yes
SETPOINT 2 ("SEt2")			
C.20 Setpoint 2 mode (M2) (see note 1)	"OFF": Disabled "OOHI": ON-OFF, high set point "OOLO": ON-OFF, low set point "PIdH": P.I.D., high set point "PIdL": P.I.D., low set point	"OOLO"	yes
C.21 Setpoint 2 (S2) (see note 1)	-2.00 to 16.00 pH or -2000 to 2000 mV	6.00 pH or -500 mV	yes
C.22 Hysteresis for setpoint 2 (H2) (see note 1)	0.00 to 18.00 pH or 0 to 4000 mV	1 pH or 50 mV	yes
C.23 Deviation for setpoint 2 (D2) (see note 1)	0.50 to 18.00 pH or 25 to 4000 mV	1 pH or 50 mV	yes
C.24 Reset time for setpoint 2	0.1 to 999.9 minutes	999.9 mins	yes
C.25 Rate time for setpoint 2	0.0 to 999.9 minutes	0.0 mins	yes
ALARM ("ALAr")			
C.30 Alarm relay delta value for setpoint 1 (A1) (see notes 1, 22)	0.50 to 18.00 pH or 25 to 4000 mV	1.00 pH or 100 mV	yes
C.31 Alarm relay delta value for setpoint 2 (A2) (see notes 1, 22)	0.50 to 18.00 pH or 25 to 4000 mV	1.00 pH or 100 mV	yes
C.32 Maximum relay ON time (after that an alarm is generated)	1-60 minutes	60	yes
C.33 Alarm mask time	00:00 to 30:00 minutes	00:30	yes
PROGRAMMABLE CONTROL TIMING ("tIME")			
C.41 Hold time start	00:00 to 23:59 (see note 8)	00:00	yes
C.42 Hold time stop	00:00 to 23:59 (see note 8)	00:00	yes
C.51 Monday hold mode enable	"OFF": Disabled "On": Enabled	"OFF"	yes
C.52 Tuesday hold mode	"OFF": Disabled "On": Enabled	"OFF"	yes

Code	Valid Values	Default	Present for ORP
C.53 Wednesday hold mode enable	"OFF": Disabled "On": Enabled	"OFF"	yes
C.54 Thursday hold mode enable	"OFF": Disabled "On": Enabled	"OFF"	yes
C.55 Friday hold mode enable	"OFF": Disabled "On": Enabled	"OFF"	yes
C.56 Saturday hold mode enable	"OFF": Disabled "On": Enabled	"OFF"	yes
C.57 Sunday hold mode enable	"OFF": Disabled "On": Enabled	"OFF"	yes
C.60 Proportional control mode period	01:00 - 30:00 minutes	05:00	yes
C.70 Hold mode end delay	00 to 99 seconds	00	yes
RELAYS ("rELA")			
0.01 Relay 1 mode (see notes 19, 21)	"OFF": Disabled "SEt1": Control, setpoint 1 "SEt2": Control, setpoint 2 "SCLE": Simple cleaning "HOLd": Energized in hold mode	"SEt1"	yes
0.02 Relay 2 mode (see notes 19, 21)	"OFF": Disabled "SEt1": Control, setpoint 1 "SEt2": Control, setpoint 2 "SCLE": Simple cleaning "HOLd": Energized in hold mode	"SEt1"	yes
0.03 Relay 3 mode (see notes 15, 19)	"OFF": Disabled "SCLE": Simple cleaning "ACLE": Advanced cleaning / "HOLd": Energized in hold mode	"OFF"	yes
0.04 Relay 4 mode (see notes 15, 19)	"OFF": Disabled "SCLE": Simple cleaning "ACLE": Advanced cleaning / "HOLd": Energized in hold mode	"OFF"	yes
0.05 Hold digital output	"OFF": Disabled "HOLd": Enabled upon hold mode	"HOLd"	yes
ANALOG OUTPUT #1 ("Out1")			
0.10 Analog output 1 mode (see notes 6, 21)	"rECO": Recorder "SEt": Control, setpoint 1	"rECO"	yes
0.11 Analog output 1 type	"0-20": 0-20 mA "4-20": 4-20 mA	4-20 (6)	yes

Code	Valid Values	Default	Present for ORP
0.12 Measurement value for analog output 1 minimum (0_VARMIN1)	-2.00 to 16.00 pH or -2000 to 2000 mV (0_VARMIN1 ≤ 0_VARMAX1-1 pH or 50 mV, 0_VARMIN1 ≤ 0_HOLD1≤ 0_VARMAX1)	0.00 pH or -2000 mV (6)	yes
0.13 Measurement value for analog output 1 maximum (0_VARMAX1)	-2.00 to 16.00 pH or -2000 to 2000 mV (0_VARMIN1 ≤ 0_VARMAX1-1 pH or 50 mV, 0_VARMIN1 ≤ 0_HOLD1≤ 0_VARMAX1)	14.00 pH or 2000 mV (6)	yes
0.14 Analog output 1 value upon hold mode (see note 16)	"USEr": User selected value "HOLd": Previous value is frozen	"HOLd"	yes
0.15 Analog output 1 value upon hold mode if 0.14="USEr" (0_HOLD1)	-2.00 to 16.00 pH or -2000 to 2000 mV (it must be within the 0_VARMIN1 to 0_VARMAX1-1 interval)	7.00 pH or 0 mV (6)	yes
ANALOG OUTPUT #2 ("Out2")			
0.20 Analog output 2 mode (see notes 21, 26)	"rECO": Recorder (temperature) "SEt": Control, setpoint 2 (pH) or "OFF": Disabled "SEt": Control, setpoint 2 (ORP)	"rECO" (pH) or "OFF" (ORP)	yes
0.21 Analog output 2 type	"0-20": 0-20 mA "4-20": 4-20 mA	"4-20"	yes
0.22 Measurement value for analog output 2 minimum (0_VARMIN2)	-30 to 130.0 °C (0_VARMIN2 ≤ 0_VARMAX2-10 °C, 0_VARMIN2 ≤ 0_HOLD2≤ 0_VARMAX2)	0 °C	no
0.23 Measurement value for analog output 2 maximum (0_VARMAX2)	-30 to 130.0 °C (0_VARMIN2 ≤ 0_VARMAX2-10 °C, 0_VARMIN2 ≤ 0_HOLD2≤ 0_VARMAX2)	+100.0 °C	no
0.24 Analog output 2 value upon hold mode (see note 16)	"USEr": User selected value "HOLd": Previous value is frozen	"HOLd"	no
0.25 Analog output 2 value upon hold mode if 0.24="USEr" (0_HOLD2)	-30 to 130.0 °C (it must be within the 0_VARMIN2 to 0_VARMAX2-1 interval)	25 °C	no
BAUD RATE ("bAud")			
0.30 Baud rate (see note 20)	1200, 2400, 4800, 9600, 19200	19200	yes

Code	Valid Values	Default	Present for ORP
0.31 Modem calls answer enable (see note 20)	"OFF": Disabled "On": Enabled	"OFF"	yes
0.32 Modem country code (see note 33)	Dialing code of a country where modem of **HI504902** is certified	"000"	yes
INPUT ("InPU")			
I.00 Measurement input selection (see note 12)	"Prob": BNC "trAn": Digital Transmitter	"Prob"	yes
I.03 Digital Transmitter address (used only if I.00="trAn")	00 to 99	00	yes
I.04 Potential matching pin (see notes 24, 25)	"OFF": unused (asymmetrical input) "On": in use (symmetrical input)	"On"	yes
I.10 Calibration time-out	00 to 99 days (00 means disabled)	90	no
I.11 Life check time (see notes 11, 25)	"OFF": life check disabled 1: 1 hour 2: 2 hours 4: 4 hours	"OFF"	yes
I.12 Minimum pH probe slope (see note 25)	45 to 75 mV/pH	45 mV/pH	no
I.13 pH electrode impedance test enable (see note 25)	"OFF": disabled "On": enabled	"On"	no
I.14 Reference electrode impedance test enable (see note 25)	"OFF": disabled "On": enabled	"On"	yes
I.15 Max ref. electrode impedance (see note 25)	0.5 to 100.0 kΩ	50.0 kΩ	yes
REAL TIME CLOCK ("rtC")			
r.00 Current day	01 to 31 (see note 20)	from RTC (5)	yes
r.01 Current month	01 to 12 (see note 20)	from RTC (5)	yes
r.02 Current year	2000 to 2099 (see note 20)	from RTC (5)	yes
r.03 Current time	00:00 to 23:59 (see note 20)	from RTC (5)	yes
CELLULAR/MODEM/PC CONNECTION ("PHOn")			
P.00 RS485 Connection type (see note 20)	"PC": PC or modem connection "CELL": Cellular module connection	"PC"	yes
P.01 PIN Number (see note 20)	0000 to 9999	0000	yes
P.02 Telephone number #1 (see notes 20, 27)	0000000000000000000 to 99999999999999999999 ("- - - - - - - - - - - - - - - - - - - -" indicates no number)	- - - - - - - - - - - - - - - - - - - -	yes

Code	Valid Values	Default	Present for ORP
P.03 Telephone number #2 (see notes 20, 27)	0000000000000000000 to 9999999999999999999 ("- - - - - - - - - - - - - - - - - - - -" indicates no number)	- - - - - - - - - - - - - - - - - - - -	yes
P.04 Number of remaining messages (see notes 20, 28)	000 to 200 and 222	100	yes
P.05 Number of repeated SMSs (see notes 20, 29)	0 to 5	2	yes
P.06 Delay between two subsequent SMSs (see notes 20, 30)	05 to 60 minutes	10	yes
P.07 SIM expiration day (see notes 20, 31)	01 to 31	01	yes
P.08 SIM expiration month (see notes 20, 31)	01 to 12	01	yes
P.09 SIM expiration year (see notes 20, 31)	2000 to 2099	2010	yes
READING OFFSETS ("OFFS")			
F.00 pH or ORP actual value (see notes 17, 25)	measured value -1.00 pH or -200 mV to measured value +1.00 pH or +200 mV	measured value	yes
F.01 pH or ORP reading offset adjustment (see note 25)	-1.00 to +1.00 pH or -200 to +200 mV	0.00 pH or 0 mV	yes
F.10 Temperature actual value (for ATC only, see notes 18, 25)	measured value -10.0 °C to measured value +10.0 °C	meas. value (see note 17)	no
F.11 Temperature reading offset adjustment (for ATC only, see notes 18, 25)	-10.0 to +10.0 °C	0.0 °C	no
SOLUTION COMPENSATION ("SOLC")			
S.00 Solution compensation enable	"On": compensation enabled "OFF": compensation disabled	"OFF"	no
S.10 pH value for point #1	-2.00 to 16.00 pH	7.00 pH	no
S.11 Temperature value for point #1 (SCT1)	-30 to 130.0 °C |SCT1-SCT2| ≥1.0 °C	20 °C	no
S.20 pH value for point #2	-2.00 to 16.00 pH	7.00 pH	no
S.21 Temperature value for point #2 (SCT2)	-30 to 130.0 °C |SCT1-SCT2| ≥1.0 °C	30 °C	no
IN-LINE CLEANING ("CLEA")			
SIMPLE CLEANING ("SCLE")			
L.00 Rinsing time	5 to 99 s	20 s	yes
L.01 Pause time	10 to 9999 minutes	1440 minutes	yes

Code	Valid Values	Default	Present for ORP
ADVANCED CLEANING ("ACLE")			
L.10 Pre-rinsing time	0 to 99 s	20 s	yes
L.11 Detergent washing	0 to 99 s	10 s	yes
L.12 Rinsing time	5 to 99 s	20 s	yes
L.13 Pause time	Min. pause time (L.14) to 9999 minutes	1440 minutes	yes
L.14 Minimum pause time	10 to Pause time (L.13)	10 minutes	yes
L.15 Cleaning trigger	" ti": Timer only " E": Digital input or RS485 (external) only "ti E": Timer and digital input or RS485 (external) "tiEM": Timer masked by digital input (external)	" ti"	yes
L.16 Repeated cleaning number	0 to 10	0	yes
L.17 Number of cleaning without detergent	0 to 10	0	yes
TEMPERATURE LEVEL ALARM ("tEMP")			
U.00 Max. temperature level (see note 32)	-30 to 130 °C	130.0 °C	no
U.01 Min. temperature level (see note 32)	-30 to 130 °C	-30.0 °C	no
ERROR CONFIGURATION ("Erro")			
E.00 Alarm for setpoint 1 error configuration	0 to 5 and 24 to 29 (see note 7)	3	yes
E.01 Alarm for setpoint 2 error configuration	0 to 5 and 24 to 29 (see note 7)	5	yes
E.02 Max relay ON time error configuration	0 to 5 and 24 to 29 (see note 7)	3	yes
E.03 Life check error configuration (see note 11)	0 to 11 and 24 to 35 (see note 7)	9	yes
E.10 pH electrode broken or leakage	0 to 11 and 24 to 35 (see note 7)	9	no
E.11 Reference electrode broken or dirty or not immersed	0 to 47 (see note 7)	21	yes
E.12 Old pH probe error configuration	0 to 11 and 24 to 35 (see note 7)	0	no
E.13 Dead pH probe error configuration	0 to 11 and 24 to 35 (see note 7)	2	no

Code	Valid Values	Default	Present for ORP
E.14 Calibration time-out error configuration	0 to 11 and 24 to 35 (see note 7)	0	no
E.20 Temperature broken probe error configuration	0 to 11 and 24 to 35 (see note 7)	3	no
E.21 Temperature level error configuration	0 to 5 and 24 to 29 (see note 7)	3	no
E.40 Digital Transmitter error configuration	0 to 5 and 24 to 35 (see note 7)	9	yes
E.50 Cellular error configuration	0 to 11 (see note 7)	3	yes
E.90 Power reset error configuration	0 to 11 and 24 to 35 (see note 7)	2	yes
E.91 EEPROM corruption error configuration	6 to 11 and 30 to 35 (see note 7)	9	yes
E.92 Watchdog error configuration	0 to 11 and 24 to 35 (see note 7)	2	yes
E.99 Level or pulse alarm relay signal (see note 13)	"LE": Level "PULS": Pulse	"LE"	yes
TEST ("tESt")			
t.00 Display test	"OFF": To skip without testing "GO": To start the display test	"OFF"	yes
t.01 Keyboard test	"OFF": To skip without testing "GO": To start the keyboard test	"OFF"	yes
t.02 EEPROM test	"OFF": To skip without testing "GO": To start the EEPROM test	"OFF"	yes
t.03 Relays and LEDs test	"OFF": To skip without testing "GO": To start the test	"OFF"	yes
t.04 Analog output 1 test	"OFF": To skip without testing "GO": To start the test	"OFF"	yes
t.05 Analog output 2 test	"OFF": To skip without testing "GO": To start the test	"OFF"	yes
t.06 Hold digital input test	"OFF": To skip without testing "GO": To start the test	"OFF"	yes
t.07 Advanced cleaning digital input test	"OFF": To skip without testing "GO": To start the test	"OFF"	yes
Warning: cleaning actions could be triggered by the input going high during the test (see note 23).			
t.08 Watchdog test	"OFF": To skip without testing "GO": To start the watchdog test	"OFF"	yes

Notes **(1)**: M1 can not be set to "OOHI" or "OOLO" if O.10 is set to "SEt" and vice versa;

if M1 = "OOHI" then 16.00 pH or 2000 mV S S1+A1;

if M1 = "OOLO" then -2.00 pH or -2000 mV R S1-A1;

if M1 = "PIdH" then D1 R A1 and 16.00 pH or 2000 mV S S1+A1;

if M1 = "PIdL" then D1 R A1 and -2.00 pH or -2000 mV R S1-A1;

M2 can not be set to "OOHI" or "OOLO" if O.20 is set to "SEt" and vice versa;

if M2 = "OOHI" then 16.00 pH or 2000 mV S S2+A2;

if M2 = "OOLO" then -2.00 pH or -2000 mV R S2-A2;

if M2 = "PIdH" then D2 R A2 and 16.00 pH or 2000 mV S S2+A2;

if M2 = "PIdL" then D2 R A2 and -2.00 pH or -2000 mV R S2-A2;

if M1 = "OOHI" and M2 = "OOLO" then S1-H1 S S2+H2;

if M1 = "OOLO" and M2 = "OOHI" then S2-H2 S S1+H1;

if M1 = "PIdH" and M2 = "OOLO" then S1 S S2+H2;

if M1 = "OOLO" and M2 = "PIdH" then S1+H1 R S2;

if M1 = "PIdL" and M2 = "OOHI" then S1 R S2-H2;

if M1 = "OOHI" and M2 = "PIdL" then S1-H1 S S2;

if M1 = "PIdH" and M2 = "PIdL" then S1 S S2;

if M1 = "PIdL" and M2 = "PIdH" then S2 S S1;

were the minimum deviation (DN) is 0.5 pH (pH) or 25 mV (mV).

(2): The calibration/hold password allows only calibrations and hold mode through keyboard for service personnel, while the general password allows everything (including calibration). Obviously, the general password and the calibration/hold password cannot be viewed among other items when the "SETUP" key is pressed without entering the right general password. The pH controller is sold with the general password set to "0000".

(3): When a wrong setup value is confirmed, the pH controller does not skip to the next setup item, but remains in the current item displaying a blinking "WRONG" indicator till the parameter value is changed by the user (the same thing happens also for the setup code selection). In some situations user cannot succeed in getting a parameter set to the desired value if related parameters are not changed accordingly first (e.g. to set a pH high set point to 10.00 the high alarm must be set to a value greater than 10.00 first).

(4): The hardware identifier is a read only value.

(5): When the controller is powered, RTC is checked to see if an RTC reset occurred since last software initialization (if one ever took place). If this is the case the RTC is initialized with the default date and time 01-01-2000 - 00:00. An EEPROM reset does not affect the RTC settings.

(6): Output is pH or mV depending on the controlled magnitude setting (pH or ORP).

(7): The value for error configuration is coded like this:

Error Configuration Value	Alarm Relay	22 mA fault current	3.6 mA fault current	Hold mode	Auto-cleaning	SMS sending
0	Off	Off	Off	Off	Off	Off
1	On	Off	Off	Off	Off	Off
2	Off	On	Off	Off	Off	Off
3	On	On	Off	Off	Off	Off
4	Off	Off	On	Off	Off	Off
5	On	Off	On	Off	Off	Off
6	Off	Off	Off	On	Off	Off
7	On	Off	Off	On	Off	Off
8	Off	On	Off	On	Off	Off
9	On	On	Off	On	Off	Off
10	Off	Off	On	On	Off	Off
11	On	Off	On	On	Off	Off
12	Off	Off	Off	Off	On	Off
13	On	Off	Off	Off	On	Off
14	Off	On	Off	Off	On	Off
15	On	On	Off	Off	On	Off
16	Off	Off	On	Off	On	Off
17	On	Off	On	Off	On	Off
18	Off	Off	Off	On	On	Off
19	On	Off	Off	On	On	Off
20	Off	On	Off	On	On	Off
21	On	On	Off	On	On	Off
22	Off	Off	On	On	On	Off
23	On	Off	On	On	On	Off
24	Off	Off	Off	Off	Off	On
25	On	Off	Off	Off	Off	On
26	Off	On	Off	Off	Off	On
27	On	On	Off	Off	Off	On
28	Off	Off	On	Off	Off	On
29	On	Off	On	Off	Off	On
30	Off	Off	Off	On	Off	On
31	On	Off	Off	On	Off	On
32	Off	On	Off	On	Off	On
33	On	On	Off	On	Off	On
34	Off	Off	On	On	Off	On
35	On	Off	On	On	Off	On
36	Off	Off	Off	Off	On	On
37	On	Off	Off	Off	On	On
38	Off	On	Off	Off	On	On
39	On	On	Off	Off	On	On
40	Off	Off	On	Off	On	On
41	On	Off	On	Off	On	On
42	Off	Off	Off	On	On	On
43	On	Off	Off	On	On	On
44	Off	On	Off	On	On	On
45	On	On	Off	On	On	On
46	Off	Off	On	On	On	On
47	On	Off	On	On	On	On

(8): The hold mode is never enabled by the control timing if the "hold time start" is the same as the "hold time end". Items "C.41" and "C.42" apply to all days. The hold mode can be enabled all day by using items "C.51" through "C.57".

(9): See the "Temperature compensation" subsection for more details on how the Automatic temperature compensation and Manual temperature compensation work.

(10): Whenever the pH/ORP selection item is changed from pH into ORP or vice versa all of the calibration and setup data regarding pH (when changing to ORP) or ORP (when changing to pH) are kept. They are automatically restored if the controlled parameter is changed back later. The following setup items cannot vary when changing from pH to ORP or vice versa (because they are items strictly related to the instrument and not to the controlled magnitude): Factory ID, Process ID alias RS485 address, Calibration/hold password, General password, Baud rate, Modem calls answer enable, Cellular/PC connection items, Hardware identifier and RTC date and time. For proper operation while working with the Digital Transmitter, this item must be equal to the correspondent one in the Digital Transmitter. If the two values do not coincide a "Digital Transmitter error" is generated.

(11): A life check error is generated if the pH reading does not vary for more than ±0.10 pH within the time selected through the "life check time" item (pH controller) or mV reading for more than ±10 mV within the same time (ORP controller).

(12): When the Digital transmitter (**HI504910**) is used, the temperature is measured by the transmitter along with pH (pH controller), or ORP (ORP controller). These measurements are sent to the Process Controller. The calibration data set for the Digital Transmitter is kept within the transmitter and thus it is separated from the BNC set. This means that the calibration slope and offset and the other GLP data are automatically switched from the BNC set to the Digital Transmitter set and vice versa when the measurement input is switched from "Prob" to "trAn" respectively. For example, if the user was using a pH electrode connected to the BNC, and at a later time he starts using the transmitter, and after that the measurement input selection is reverted back to "Prob", it is not necessary to calibrate the pH electrode again.

(13): The alarm relay can be energized continuously (by selecting "LE" for "level") or with a pulse (by selecting "PULS" for "pulse"). The pulse length is fixed to about 5 seconds.

(14): When the instrument is configured as ORP controller some of the above items or the item values are not anymore available to the user.

(15): Relay 3 an relay 4 must be both set to "ACLE" in order to have the advanced cleaning enabled. If only one of them is set to "ACLE" then it will behave as it were set to "OFF". When the advanced cleaning is enabled, relay 3 is used for water pouring while relay 4 is used for detergent pouring.

(16): "HOLd" and "USEr" are effective only when "O.10" and "O.20" are set to "rECO". In the other cases the analog output is set automatically to the minimum value upon hold mode (i.e. "O.14", "O.15" and "O.24", "O.25" have no effect if "O.10" = "SEt" and "O.20" = "SEt" respectively).

(17): "measured value" is the reading value with a null reading offset adjustment.

(18): if the device is set for MTC (item G.01 to "USEr") then items F.10 and F.11 cannot be modified nor seen. When item G.01 is changed from "AtC" into "USEr", item F.11 is automatically zeroed.

(19): When the relay set to "SCLE" is set to something else, the simple cleaning action, if in progress, is aborted immediately. When relay 3 or relay 4 or both of them are set to something else than "ACLE", and the advanced cleaning is in progress, cleaning is aborted immediately (but a complete rinsing phase is done before the actual end of the cleaning session). Only one relay can be set to "SCLE" or, alternatively, relay 3 and 4 can be set to "ACLE". Only one relay can be set to "HOLd". If these rules are not respected, the display shows "WRONG".

(20): These items do not vary when the pH/ORP input selection ("G.00") is changed.

(21): If the relay 1 mode or the relay 2 mode is set to "SEt1", the analog output 1 mode can not be set to "SEt" and vice versa. Similarly, if the relay 1 mode or the relay 2 mode is set to "SEt2", the analog output 2 mode can not be set to "SEt" and vice versa.

(22): Alarm relay delta value for setpoint 1 determines the value of the correspondent alarm threshold by being added to or subtracted from the setpoint value for a high (ON/OFF or PID) or low (ON/OFF or PID) setpoint respectively. The same is true for Alarm relay delta value for setpoint 2. A small fixed hysteresis (0.2 pH for pH and 30 mV for ORP) must be passed to have the alarm turned off (for a high alarm the alarm is turned off below high alarm - hysteresis, while for a low alarm the alarm is turned off above low alarm + hysteresis).

(23): The actual start of a cleaning action depends on how relay 3, relay 4 and the Advanced Cleaning parameters have been configured.

(24): If the item is set to "On", the "m" tag near the secondary display will be fixed on.

If the item is set to "OFF" the connector for the Potential Matching Pin must be left floating. Failure to do so may cause damage of the reference electrode.

(25): When the Digital Transmitter is in use, the correspondent setting in the digital transmitter is used and this item is not visible.

(26): This item is not visible for models without PID or without the second setpoint.

(27): An SMS will be sent to this telephone number (if different from "- - - - - - - - - - - - - - - - - - -") when an error (configured for the SMS sending) occurs.

(28): This item sets the maximum number of SMS that the instrument can send. Before this number reaches 0, an advising message will be sent to the phone number P.02 (and P.03). This feature has been introduced to avoid the discharging of the credit of the SIM card. Once all the available messages have been sent, the user is supposed to extract the SIM card from the instrument and check the remaining credit and expiration date of the card.

The item shows always the remaining available number of SMS that can be sent, so its value is decremented every SMS submission.

If the user sets this item to "222", then no check will be made on the maximum number of SMS and the instrument could send an unlimited number of messages. In this case the item value will not be decremented and no check will be made on the SIM expiration date.

(29): Every SMS sent by the instrument requires a reception confirmation from the user (phone call to the instrument). If this confirmation does not arrive (for example because the message was lost or did not reach the Short Message Service Center), it is possible to set the instrument in order to send again the message. The maximum number of repeated messages is set through this item (see P.06 for the delay between two subsequent messages). If this item is set to 0, then no confirmation is waited by the instrument.

(30): This item sets the delay between the sending of two subsequent messages. It has effect only if item P.05 value is 1 or greater.

(31): The SIM's expiration date has to be inserted manually through these items (P.07 - P.09). The user is supposed to update these items every time a recharge of the card occurs. Three advising messages are sent to the telephone number configured in item P.02 (and P.03) when the card is going to expire (two weeks before, one week before and the day before).

If the user sets the item P.04 to "222" then no check will be made on the SIM expiration date.

(32): A "temperature level" error is generated whenever the measured temperature is greater than the "maximum temperature level" or lower than the "minimum temperature level". The difference between maximum and minimum must be at least 2 °C. A small fixed hysteresis (0.3 °C) must be passed to have the alarm turned off.

(33): The modem present in the **HI504902** module is certified by Telecom to work in the following countries: Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, China, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Hong Kong, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Korea, Liechtenstein, Luxembourg, Malaysia, Mexico, Netherlands, New Zeland, Norway, Philippines, Poland, Portugal, Russia, Singapore, Slovak Republic, South Africa, Spain, Sweden, Switzerland, Taiwan, Turkey, United Kingdom, United States.

If your country is not present in the list, please contact your local Hanna Instruments Office.

If the country code is shorter than 3 characters, fill the code with zeros in front.

CONTROL MODE

The control mode is the normal operational mode for this meter. During control mode **HI504** fulfills the following main tasks:

- convert information from pH/ORP and temperature inputs to digital values and show them on the display;
- control relays and generate the analog outputs as determined by the setup configuration;
- display alarm condition;
- perform cleaning actions according to the relays configuration;
- start and stop hold mode according to the programmed control timing;
- RS485 management.

In addition, the meter can log working data through RS485 connection. These data include:

- pH, mV and °C measured values;
- last calibration data;
- setup configuration (also from a remote workstation);
- event data.

In a normal situation, during control mode, the green LED is ON and the error LED (red) is OFF. The red LED is never fixed ON and blinks only upon an error.

The green LED is associated to the alarm relay and is OFF if the alarm is active.

To deactivate the control mode set CONTROL ENABLE to "OFF" in setup menu (CONTROL ("CtrL") group).

When measurements are in overflow, the upper or lower range limit is shown on the LCD with blinking digits.

RELAY MODES

There are four relay options that can be configured through the setup menu to perform different tasks.

Once enabled, relays 1 and 2 can be used in four modes:

1. setpoint 1 (Analog output #1 must be set to recorder, "rECO");
2. setpoint 2 (Analog output #2 must be set to recorder, "rECO");
3. simple cleaning;
4. hold mode.

In the first two cases the configuration of Setpoint (1 or 2) determines the operating mode of the relay. Once enabled, the control relay can be configured to control as a ON/OFF or PID control of the acid/base dosage.

A High-hight Alarm is imposed for acid/base dosage time when the relays are energized continuously. This parameter can be set through setup procedure (CONTROL group, set-up item C.32). When the upper time boundary is reached, an alarm is generated and device stays in alarm condition until relay is de-energized.

If the "hold mode" is selected for the relay, then it is energized only when the meter is in hold mode. In this case there is no time boundary for the ON state of the relay.

The option for relays 3 and 4 can be configured to operations in three modes:

1. simple cleaning;
2. advanced cleaning;
3. hold mode.

ON/OFF CONTROL MODE

Once a relay is enabled (set 1, set 2), the setpoint can be configured to be activated as a high limit ("OOHI") or as a low limit ("OOLO"). In both cases the following values have to be defined through setup:

- setpoint value (pH/mV; setup item C.11 or C.21);
- hysteresis for setpoint (pH/mV value; setup item C.12 or C.22).

A control device can be wired to the contact output.

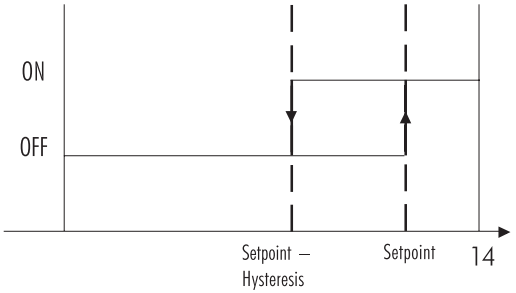
Connect the device to the COM and NO (Normally Open) or NC (Normally Closed) terminals of the relay.

The ON relay state occurs when relay is energized (NO and COM connected, NC and COM disconnected).

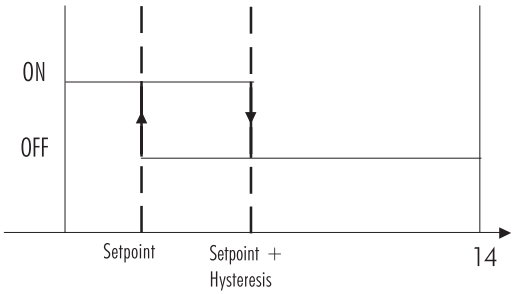
The OFF relay state occurs when relay is de-energized (NO and COM disconnected, NC and COM connected).

The following graph shows relay state along with pH measured value (similar graph can be derived for mV control).

As shown below, when the measured pH exceeds the set-point threshold, the relay(s) is (are) energized, until the pH measure falls below setpoint value minus hysteresis.
Such a behavior is suitable to control an acid dosing pump.



A relay enabled as a low setpoint, is energized when the pH value is below the setpoint and is de-energized when the pH value is above the sum of setpoint and the hysteresis. This operational mode may be used to control an alkaline dosing pump.

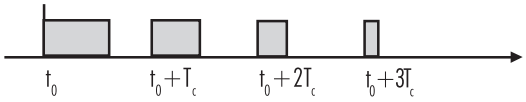


P.I.D. CONTROL MODE

PID control is designed to eliminate the cycling associated with ON/OFF control in a rapid and steady way by means of the combination of the Proportional, Integral and Derivative control methods.

With the proportional function, the duration of the activated control is proportional to the error value (Duty Cycle Control Mode); as the measurement approaches setpoint, the ON (relay energized) period diminishes.

The following graph describes the pH process controller behavior. Similar graph may apply to the mV controller.



During proportional control the process controller calculates the relay activation time at certain moments t_0, t_0+T_c, t_0+2T_c etc. The ON interval (the shaded areas) is then dependent to the error amplitude.

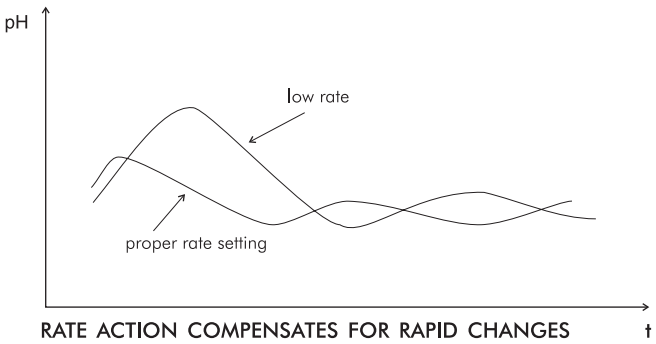
With the integral function (reset), the controller will reach a more stable output around the setpoint providing a more accurate control than with the ON/OFF or proportional action only.

The derivative function (rate action) compensates for rapid changes in the system reducing undershoot and overshoot of the pH value.

During PID control, the ON interval is dependent not only to the error amplitude but even to the previous measurements.

Definitely PID control provides more accurate and stable control than ON/OFF controllers and it is best suitable in system with a fast response, quickly reacting to changes due to addition of acid or base solution.

An example of how the response overshoot can be improved with a proper rate action setting is depicted in the following graphic.



RATE ACTION COMPENSATES FOR RAPID CHANGES

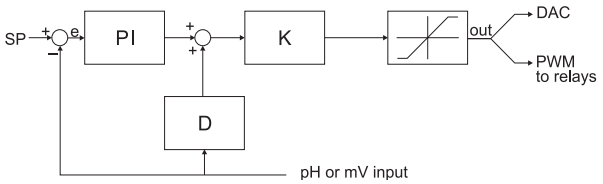
PID TRANSFER FUNCTION

The transfer function of a PID control is as follows:

$$Kp + Ki/s + s\,Kd = Kp(1 + 1/(s\,Ti) + s\,Td)$$

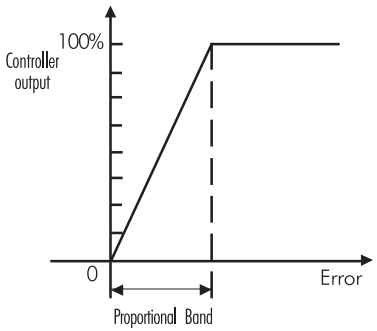
with Ti = Kp/Ki, Td = Kd/Kp,

where the first term represents the proportional action, the second is the integrative action and the third is the derivative action.



Proportional action can be set by means of the Proportional Band (PB). Proportional Band is expressed in percentage of the input range and is related to Kp according to the following:

Kp = 100/PB.



The proportional action is set directly as "Deviation" in pH and mV units respectively. Relation between Deviation (D) and PB is:

D = Range * PB/100

Each setpoint has a selectable proportional band: PB1 for setpoint1 and PB2 for setpoint2. Two further parameters must be provided for both setpoint:

Ti = Kp/Ki, **reset time**, measured in minutes
Td = Kd/Kp, **rate time**, measured in minutes.

Ti1 and Td1 will be the reset time and rate time for setpoint1, while Ti2 and Td2 will be the reset time and the rate time for setpoint2.

TUNING A PID CONTROLLER

The proportional, integrative, derivative terms must be tuned, i.e. adjusted to a particular process. Since usually the process variables are not completely known, a "trial and error" tuning procedure must be applied to get the best possible control for the particular process. The target is to achieve a fast response time and a small overshoot.

Many tuning procedures are available and can be applied to **HI504**. A simple and profitable procedure is reported in this manual and can be used in almost all applications.

The user can vary five different parameters, i.e. the setpoint (S1 or S2), the deviation (D1 or D2), the reset time, the rate time and the proportional control mode period T_c .

Note User can disable the derivative and/or integrative action (for P or PI controllers) by setting Td = 0 and/or Ti = MAX (Ti) respectively through the setup procedure.

SIMPLE TUNING PROCEDURE

The following procedure uses a graphical technique of analyzing a process response curve to a step input.

Note This procedure allows only a rough setting of the PID parameters and could not fit all the processes.
It is suggested that I and D parameters be set by technical personnel, because their inadequate values may cause undesired behaviors of the system.

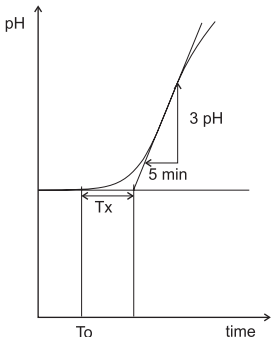
Connecting an external device (chart recorder or PC) to the controller, the procedure is easier and doesn't need the use of hand plotting the process variable (pH or mV).

1. Starting from a solution with a pH or mV value different from the dosed liquid (at least a 3 pH or 150mV difference) turn on the dosing device at its maximum capacity without the controller in the loop (open loop process). Note the starting time.
2. After some delay the pH or mV starts to vary. After more delay, the pH or mV will reach a maximum rate of change (slope). Note the time that this maximum slope occurs and the pH or mV value at which it occurs. Note the maximum slope in pH or mV per minute. Turn the system power off.
3. On the chart draw a tangent to the maximum slope point until intersection with the horizontal line corresponding to the initial pH or mV value. Read the system time delay Tx on the time axis.

4. The deviation, Ti and Td can be calculated from the following:
   - Deviation = Tx * max. slope (pH or mV)
   - Ti = Tx / 0.4 (minutes)
   - Td = Tx * 0.4 (minutes).
5. Set the above parameters and restart the system with the controller in the loop. If the response has too much overshoot or is oscillating, then the system can be fine-tuned slightly increasing or decreasing the PID parameters one at a time.

Example:

the chart recording in the figure aside was obtained continuously dosing an alkaline solution to a weak acid solution in a tank. The initial settings will be:



Max. slope = 3 pH/5 mins = 0.6 pH/min

Time delay = Tx = approx. 7 mins

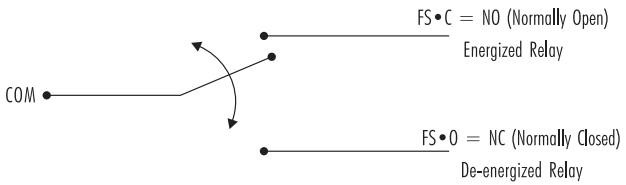
Deviation = Tx * 0.6 = 4.2 pH

Ti = Tx / 0.4 = 17.5 mins

Td = Tx * 0.4 = 2.8 mins

ALARM RELAY

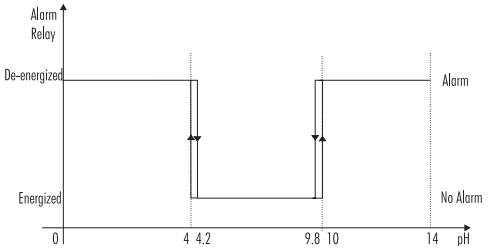
The alarm relay functions in the following manner:



During normal operation (no alarm condition) the alarm relay is energized; during an alarm condition or power failure the relay will be de-energized. As long as a separate battery power system is used an alarm will sound.

Example: High alarm set at 10 pH
Low alarm set at 4 pH

An hysteresis will eliminate the possibility of continuous sequences 'energizing/de-energizing' of the alarm relay when the measured value is close to the alarm setpoint.



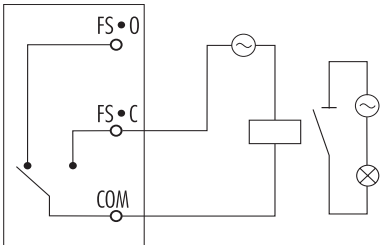
The hysteresis amplitude is 0.2 pH for pH and 30 mV for ORP.
Moreover the alarm signal is generated only after an user selectable time period (alarm mask) has elapsed since the controlled value has overtaken one alarm threshold. This additional feature will avoid fake or temporary alarm conditions.

Note If the power supply is interrupted, the relay is de-energized as if in alarm condition to alert the operator.

In addition to the user-selectable alarm relays, the meter is equipped with the **Fail Safe** alarm feature.

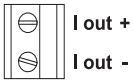
The **Fail Safe** feature protects the process against critical errors arising from power interruptions, surges and human errors. This sophisticated yet easy-to-use system resolves these predicaments on two fronts: hardware and software. To eliminate problems of blackout and line failure, the alarm function operates in a "Normally Closed" state and hence alarm is triggered if the wires are tripped, or when the power is down. This is an important feature since with most meters the alarm terminals close only when an abnormal situation arises, however, due to line interruption, no alarm is sounded, causing extensive damage. On the other hand, software is employed to set off the alarm in abnormal circumstances, for example, if the dosing terminals are closed for too long a period. In both cases, the red LED will also provide a visual warning signal. The Fail Safe mode is accomplished by connecting the external alarm circuit between the FS•C (Normally Open) and the COM terminals.

This way, an alarm will warn the user when pH goes over the alarm thresholds, the power breaks down and in case of a broken wire between the process meter and the external alarm circuit.



Note In order to have the Fail Safe feature activated, an external power supply has to be connected to the alarm device.

CONTROL THROUGH ANALOG OUTPUT



Instead of configuring relays, it is possible to have an output signal (selectable among 0-20 mA and 4-20 mA) proportional to the PID action at the analog output terminals.

With this output, the actual output level amplitude is varied continuously (with an update delay of 5 seconds) between the maximum and the minimum values rather than varying the proportion of ON and OFF times (duty cycle control).

The output signal range can be selected through setup items O.11 (output #1) and O.21 (output #2).

A device with analog input (e.g. a pump with a 0-20 mA input) can be connected to these terminals.

The analog output #1 is associated to setpoint 1 and the analog output #2 to setpoint 2.

To have a control through analog output, a setpoint has to be configured to "PidL" or "PidH" and the corresponding output has to be set to Control instead of Recorder: "SEt" value in setup item O.10 (analog output #1) or O.20 (analog output #2).

In this case no relay can be associated with the same set-point to be used for the control, otherwise it is not possible to set O.10 (or O.20) to "SEt". On the other hand if a control through analog output is already associated with a setpoint, it is not possible to configure a relay to the same setpoint.

IN-LINE CLEANING

The cleaning feature allows an automatic cleaning action of the electrodes. To perform cleaning, the controller activates an external device (pump).

Cleaning can be of two types:

- **Simple cleaning**: with water only, it can be triggered only by a timer (periodical cleaning) or by an error for which a cleaning action can be configured (i.e.a "Reference electrode broken or dirty" error).
- **Advanced cleaning** (optional): with water and detergent, it can be triggered by the following events:
  - timer (setup item L.15 set to "ti");
  - digital input or RS485 command (external trigger; setup item L.15 set to "E");
  - timer and digital input or RS485 command (external trigger; setup item L.15 set to "ti E");
  - timer masked by external digital input (an external digital input disables the cleaning; setup item L.15 set to "tiEM");
  - error for which a cleaning action is configured (i.e. a "Reference electrode broken or dirty" error).

The type of cleaning action is selected through the relays configuration and the time between two consequent cleaning (if timer configured) has to be set through setup item L.01 for simple cleaning and L.13 for advanced cleaning.

Cleaning actions do never take place if no relay is configured for cleaning. The advanced cleaning requires both relays 3 and 4 configured for that kind of cleaning: relay 3 is associated with water and relay 4 corresponds to detergent.

A minimum pause time has to be set for advanced cleaning (setup item L.14) to avoid continuous cleaning due to the external trigger. A cleaning action with detergent can be followed by one or more actions without detergent, when desired.

Simple cleaning actions are performed in the following order:

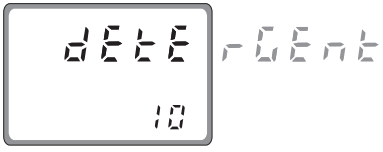
- **Rinsing time**: the device enters hold mode; all relays configured for simple cleaning are energized. If the device is in normal measurement mode, the "rinSinG" message scrolls on the LCD; otherwise (i.e. the device is in setup mode) the cleaning is performed, but no message appears.
- **Hold mode end delay** (set by item C.70): if the device was controlling when the cleaning action started, then the hold mode end delay must expire before restarting control.

Advanced cleaning actions are performed in the following order:

- **Pre-rinsing time**: the device enters hold mode and relay 3 is energized. If the device is in normal measurement mode, the "PrE-rinSinG" message scrolls on the LCD.
- **Detergent washing time**: relay 4 is energized (and relay 3 continues to be energized). If the device is in normal measurement mode, the "dEtErGEnt" message scrolls on the LCD. It is possible to configure some cleaning without detergent (setup item L.17). In this case the message displayed is "no dEtErGEnt".
- **Rinsing time**: relay 4 is de-energized (and relay 3 continues to be energized). If the device is in normal measurement mode, the "rinSinG" message scrolls on the LCD.
- **Hold mode end delay**: if the device was controlling when the cleaning action started, then the hold mode end delay must expire before restarting control.

The time each of these actions last for can be configured through setup menu, items L.00 or L.10, L.11, L.12.

When performing a cleaning action (either "simple " or "advanced") with the device in normal measurement mode, the secondary LCD displays a countdown for the seconds remaining to the cleaning action end.



If the “Repeated cleaning number” value (setup item L.16) is different from 0, then the advanced cleaning is repeated a number of times equal to this value after the first cycle (e.g. one more cycle if L.16=1).

Note If a cleaning session is being performed, it is possible to stop it by pressing and holding the ⇨ and ⇩ keys together (⇨ key first) or through RS485 by sending the appropriate command. When the advanced cleaning is aborted, in any case a complete rinsing phase is performed before the actual termination of the cleaning action. If the abortion is issued during the rinsing phase, the phase continues normally till its natural end.

Note Calibration of whatever input or output can not be initiated while the Simple or Advanced Cleaning is in progress. Conversely, cleaning can not be triggered while whatever calibration is being performed.

IDLE MODE

During idle mode the device performs only measurements but it does not activate relays in order to control the process or let out a control signal to the analog output.

In a normal situation the alarm relay is energized (no alarm condition) and the green LED is ON, the red LED is also fixed ON to warn users the device is not controlling the process, the yellow LEDs are OFF.

Moreover, the alarm relay could be de-energized upon an error (whether that happens or not, depends on the customized alarm configuration; see "Alarm" section for more details). Nevertheless, the error due to alarm threshold overtaking does never generate an alarm during idle mode since all the control functions have been disabled by the user.

The red LED flashes in any case upon an error.

Idle mode is useful to disable control actions when the external devices are not properly settled or whenever any fault circumstance is detected.

To set the meter to idle mode it is sufficient to disable the control mode (setup item C.00 to "OFF").

When measurements are in overflow, the upper or lower range limit is shown on the LCD with blinking digits.

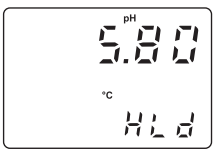
HOLD MODE

This function is started by:

- calibration;
- setup;
- cleaning in place;
- the hold digital insulated input[1] when it is on; normally, the signal level is polled at least every 4 seconds;
- the proper key combination (⇨ and ⇧ keys together) for service; the same key combination is used both to start and to stop the hold mode (the key combination acts as the hold digital input). To activate the hold mode in this way, password is required;
- the daily programmable control timing (see setup items C.41 through C.57);
- an error event (see also the "Alarm - Error Configuration" section);
- the hold start/stop RS485 command;
- the service hold (Calibration and Setup) in the Digital Transmitter.

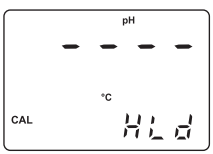
During hold mode, control and control relays are disabled.

If the meter is in idle or control mode and displaying measurements, the last measured value (both for temperature and pH/ORP) is frozen on the display; the secondary LCD shows "HLd";



the temperature value can be displayed on the secondary LCD by pressing and holding the ⇨ key; when the ⇨ key is released the "HLd" message comes back on the secondary LCD.

If the pH or mV or temperature values are not available because the meter did note take any measurement before going to hold mode, then the primary or the secondary LCD shows dashes.



[1] There are two digital insulated inputs: one for hold mode and one for advanced cleaning.

All the alarm signals (red LED, alarm relay, fault currents) are suspended while in hold mode (the correspondent error events are not closed), unless the hold mode is being triggered by one or more errors and no other trigger source (different from an error) is active.

The analog output follows these rules:

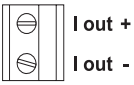
- if it is configured for control (i.e. setup item O.10 or O.20 set to "SEt"), its value is set to the minimum (e.g. 4 mA for 4-20 mA output);
- if it is configured for a recorder, its value is either set to a user-selected value through the setup item O.15 or O.25 (when item O.14 or O.24 is set to "USEr") or frozen to the last value, i.e. the output value just before entering the hold mode (when item O.14 or O.24 is set to "HOLd").

After the cause which made the instrument enter the hold mode expires, the device exits hold mode but control and alarms remain disabled for a delay which can be user-selected (0 to 99s) through setup item C.70. In that situation measurements are normally acquired, displayed and recorded through the analog output or the RS485.

Note Alarms (red LED, alarm relay, fault currents) are not disabled if the hold mode is being triggered by an error and no other trigger source is active.

ANALOG OUTPUT

The meter is provided with two insulated current outputs.



It is possible to configure the operating mode of each output through setup menu (items O.10 and O.20).

If the meter is configured as an ORP controller, the output #2 can be enabled to operate in control mode only (setup item O.20 set to "SEt"; see the "Control through analog output" section for more details).

If the meter is set as a pH controller, each available output can be used as recorder or in control mode.

To configure an output to control mode the corresponding item (O.10 for output #1 and O.20 for output #2) has to be set to "SEt" (see the "Control through analog output" section for more details).

When set to recorder (setup item O.10 or O.20 set to "rECO"), the output #1 gives a current signal proportional to the actual pH value, while the output #2 gives a signal proportional to the temperature value.

By default, the minimum and maximum values of analog output correspond to the minimum and maximum of meter's range. For example, for a selected analog output of 4-20 mA associated to output #1, the default values are -2.00 and 16.00 pH corresponding to 4 and 20 mA respectively.

These values can be changed by the user to have the analog output matching a different pH range; for example, 4mA = 3.00pH and 20mA = 5.00pH.

To change the default values, enter the setup mode and change the items O.12 and O.13 for output #1, and O.22 and O.23 for output #2.

The analog output signal range (0-20 mA or 4-20 mA) of each output is also selectable through the setup items O.11 and O.21.

PC COMMUNICATION

RS485 standard is a digital transmission method that allows long lines connections. Its current-loop system makes this standard suitable for data transmission in noisy environments.

Data transmission from the instrument to the PC is possible with the **HI92500** Windows® compatible application software offered by Hanna Instruments and an RS232 to RS485 adapter with Send Data Control connected to the serial port of your PC.

The user-friendly **HI92500** offers a variety of features such as logging selected variables or plotting the recorded data. It also has an on-line help feature to support you throughout the operation.

The readings logged into the **HI504** internal memory can be downloaded through **HI92500**.

HI92500 makes it possible for you to use the powerful means of the most diffused spreadsheet programs. Simply run your favorite spreadsheet program and open the file downloaded by **HI92500**. It is then possible to elaborate the data with your software (e.g. graphics, statistical analysis).

To install **HI92500** you need a few minutes: just insert the installation CD into the PC and the software menu window should start automatically (if it does not, go to the main CD folder and double-click "setup.exe"). Click "Install software" and follow the instructions.

Contact your local Hanna Instruments Office to request a copy.

SPECIFICATIONS

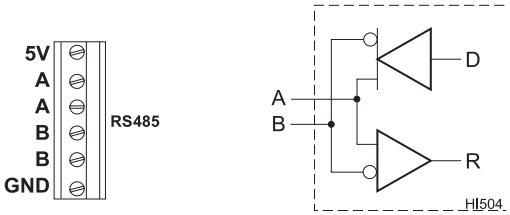
The RS485 standard is implemented in **HI504** with the following characteristics:

Data rate:	up to 19200 bps (manually selected)
Communication:	Bidirectional Half-Duplex
Line length:	up to 1.2 Km typ. with 24AWG cable
Loads:	up to 32 typ.
Internal termination:	none

Windows® registered Trademark of "Microsoft Co."

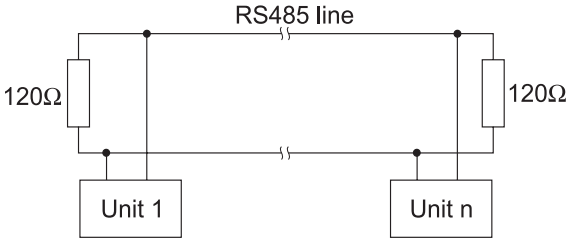
CONNECTIONS

The connections for the 6-pin RS485 terminal provided are as follows:



There is an internal short between the two A pins and between the two B pins.

The instrument has no internal line termination. To terminate the line, an external resistor equal to the characteristic line impedance (typically 120Ω) must be added at both ends of the line.



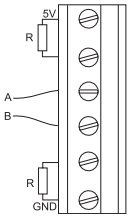
The RS485 can connect up to 31 **HI504** on the same physical network. All the units are slave devices and are monitored and controlled by a single master station (typically an industrial PLC or PC).

Each **HI504** unit is identified by its Process ID number, included in the 00 to 99 interval, which corresponds to the Process ID configured through the setup item G.11.

(If the instrument does not recognize the address within the command string, then it discards all the following bytes).

As additional feature, the controller is also provided with two pins (5V and GND) in order to apply the Fail Safe Open Line protection method. To avoid erroneous readings in Open-Line conditions, pull-up and pull-down resistors should be connected as shown.

The Fail-Safe resistors are connected only to one unit in the line, and their value depends on the application and characteristic impedance of the connection cable.



The GND pin of the interface connector and all the interface signals are optoisolated from the ground of the instrument, the electrode and the temperature sensor.

Before connecting the meter to the computer, consult the computer manual.

The process controller can only work as a slave component. In other words it can work as a remote terminal equipment answering to the commands only.

RS485 PROTOCOL FOR HI504

Commands are composed of four parts: addresses, command identifier, parameter, end of command.

Some commands are used when the master is requesting information from the controller, other when the master wants to set a parameter in the process memory (RAM or EEPROM).

The end of commands corresponds to the CR char (0x0d).

The master software must send the command string with a maximum delay of 20ms between each character.

The program on the master must not allow setting commands other than keyboard or cleaning start/stop commands if the general password has not been entered. After the general password recognition through the "PWD" command, a 1-minute time-out is let before the process meter locks again, i.e. if the PC program waits for more than 1 minute between two subsequent setting commands, the second one is not fulfilled and the "PWD" command must be issued again.

Following is the complete list of commands available:

Command	Parameter	Remarks
NNMDR	not available	Requests firmware code (always available)
NNHOP	not available	Requests hardware options
NNSNR	not available	Requests hardware identifier (always available
NNSTS	not available	Requests instrument status (relays, LEDs, configuration change flag, etc.)
NNPHR	not available	Requests last pH reading (instrument configured for pH)
NNMVR	not available	Requests last mV reading (always available)
NNTMR	not available	Requests temperature reading (instrument configured for pH)
NNCAR	not available	Requests all last calibration data (always available)
NNGET	CNN	Requests setup item C.NN. Use the NNSNR command if hardware identifier is needed. (NNGET command is answered with "<ProcessID><CAN>" for the hardware identifier)
NNPWD	$C_1C_2C_3C_4$	Sends the general password (always available)
NNSET	$CNNP_1P_2C_1C_2C_3C_4$	Sets setup item C.NN with parameter $P_1P_2C_1C_2C_3C_4$(*) (not available in setup mode)
NNEVF	not available	Requests event log file (available in idle, event scrolling or last calibration data scrolling mode w/control OFF)
NNEVN	not available	Requests new events (always available)
NNAER	not available	Requests active errors (always available)
NNCLS	not available	To start advanced cleaning (always available)
NNCLP	not available	To abort cleaning (always available)

Command	Parameter	Remarks
NNHLD	not available	To enter/exit the hold mode (always available; pwd required)
NNKDS	null	Same as LCD key
NNKCD	null	Same as CAL DATA key
NNKUP	null	Same as ⇧ key
NNKRG	null	Same as ⇨ key
NNKST	null	Same as SETUP key
NNKCL	null	Same as CAL key
NNKDW	null	Same as ⇩ key
NNKCF	null	Same as CFM key
NNK02	null	Same as LCD+CAL+SETUP keys

(*) $C_1C_2C_3C_4$ are ASCII chars corresponding to the setup item content; P_1P_2 are two additional bytes used for sign and half digit as follows:

P_1	=	+	if>0
P_1	=	-	if<0
P_2	=	0	if most significant digit is not used
P_2	=	1	if most significant digit is used

When an item is shorter than 4 digits the C_i characters are filled with blanks.

Following are examples for setup item format:

• item C.32, maximum relay ON time: parameter value = 15, format = "**+015**◊◊", where ◊ indicates a blank;

• item C.21, setpoint 2 value while in ORP mode: parameter value = -1200 mV, format = "**-01200**";

• item G.01, temperature compensation: parameter value = "AtC", format = "**+0*AtC**".

For all items with a fixed set of choices, blank spaces on the left of the value displayed are replaced with "*" (as many "*" characters are needed to reach the maximum string length, which is for example 3 for item C.57).

Blanks must be put on the tail for all items in order to have always a total length of 6 characters (see the setup table).

The same parameter format used for setup item setting is used also for setup item getting (i.e. when a "*NN*GET*CNN*<CR>" command is received from the PC, the reply "*NN*<STX>$P_1P_2C_1C_2C_3C_4$<ETX>" is sent back).

To perform a "*NN*SET*CNN*..." command the general password has to be sent in advance through the "*NN*PWD..." command. See above for the password effectiveness timeout.

Some special setup items can not be set through RS485 commands. In particular it is not possible to access any setup item that performs a test on the instrument and it is not possible to configure the hardware identifier (setup item G.12).

The "*NN*SET..." and "*NN*GET..." commands when used for password items, baud rate, hardware identifier, F.00 and F.10 items, P.00 through P.09 items, are answered with "*NN*<CAN>".

As soon as the process controller realizes that a command has been received, it sends one of the following answers:

1) "*NN*", ACK (char 0x06) if the process controller recognizes the set command and performs the requested task;
2) "*NN*", STX (char 0x02), *DATA*, ETX (char 0x03) if the received command is a request of data;
3) "*NN*", NAK (char 0x15) if the process controller does not recognize the command or if the command syntax is wrong;
4) "*NN*", CAN (char 0x18) if the process controller can not answer to the request (e.g. the current process model does not support the request, the given general password is wrong, etc.)

The "NN" in the front of the answer is the Process ID ("00" to "99").

The time-out for the above answers is:

1) answer to "STS", "PHR", "MVR", "TMR", "AER" commands: 30 ms @ 19200 or 9600 bit/s, 40 ms @ 4800 bit/s, 60 ms @ 1200 bit/s (for the complete answer, from STX to ETX).
2) answer to other commands: 2s (for the first character of the answer).

The minimum delay between the last received and the first sent character is 15 ms to allow the master to set itself into receiving mode.

Here are descriptions of the answers format (for setup item request see above):

The ***NN*SNR** request produces the following answer:

"*NN*<STX><7-character long ASCII string representing hardware identifier><ETX>" (e.g. "29<STX>1234567<ETX>" if the Process ID alias RS485 address is 29 and the hardware identifier is 1234567).

The ***NN*GET** command is answered with "*NN*<CAN>" when used for the hardware identifier.

The ***NN*MDR** request produces the following answer:

"*NN*<STX>FP504XYZ*VV*--ABCD<ETX>"

where *VV* is the firmware version, e.g. "10" for 1.0;

XYZ are the three model digits, e.g. XYZ=214 for dual setpoint, ON/OFF and PID control, dual analog output;

AB is the first **HI92500** software version compatible with the firmware, even if it may not be able to exploit all the features of the firmware, e.g. "34" for 3.4;

CD is the first **HI92500** software version fully compatible with this firmware, e.g. "45" for 4.5.

The ***NN*PHR**, ***NN*MVR**, ***NN*TMR** requests produce the following answer:

"*NN*<STX><ASCII string for a float>*S*<ETX>"

where *S* means "status" and can be equal to "A" (control and alarm ON), "C" (control ON and alarm OFF), "N" (control OFF).

The ***NN*HOP** request produces the following answer:

"*NN*<STX>$C_1C_2C_3C_4$<ETX>"

where C_1C_2 are the ASCII representation of byte B_1 described below (e.g. B_1 = 0xF3 ⇨ C_1 = "F", C_2 = "3"), C_3C_4 are the ASCII representation of byte B_2 described below (e.g. B_2 = 0x1D ⇨ C_3 = "1", C_4 = "D"). The meaning of B_1 and B_2 is:

B_2	bit 0	optional relay 2 (1: available; 0: not available)
B_2	bit 1	Digital Transmitter input (1: available; 0: not available)
B_2	bit 2	PID control (1: available; 0: not available)
B_2	bit 3	free for future use (and set to 0)
B_2	bit 4	free for future use (and set to 0)
B_2	bit 5	free for future use (and set to 0)
B_2	bit 6	free for future use (and set to 0)
B_2	bit 7	free for future use (and set to 0)
B_1	bit 0	serial port (1: available, 0: not available)
B_1	bit 1	serial port type (0: RS485)
B_1	bit 2	analog outputs (1: available, 0: not available)
B_1	bit 3	second analog output (1: available, 0: not available; no meaning if bit 2 = 0)
B_1	bit 4	optional relay 3 and relay 4 (1: available, 0: not available)
B_1	bit 5	hold digital output (1: available)
B_1	bit 6	free for future use (and set to 0)
B_1	bit 7	relay 1,2,3,4 type (0: electromechanical)

The answer to the ***NN*STS** command is:

"*NN*<STX>$C_1C_2C_3C_4$<ETX>"

where C_1C_2 are the ASCII representation of byte B_1 described below (e.g. B_1 = 0xF3 ⇨ C_1 = "F", C_2 = "3"), C_3C_4 are the ASCII representation of byte B_2 described below (e.g. B_2 = 0x1D ⇨ C_3 = "1", C_4 = "D").

The meaning of B_1 and B_2 is:

B_2 bit 0 alarm relay
(1: energized, 0: de-energized)

B_2 bit 1,2 red LED
(bit 2 = 0 and bit 1 = 0: LED is OFF;
bit 2 = 1 and bit 1 = 0: LED is fixed ON;
bit 2 = 1 and bit 1 = 1: LED blinks)

B_2 bit 3 relay #1 (1: energized, 0: de-energized)

B_2 bit 4 relay #2 (1: energized, 0: de-energized)

B_2 bit 5 relay #3 (1: energized, 0: de-energized)

B_2 bit 6 relay #4 (1: energized, 0: de-energized)

B_2 bit 7 hold digital output (1: ON, 0: OFF)

B_1 bit 0 control (1: ON, 0: OFF)

B_1 bit 1,2 setup mode
(bit 2=0 and bit 1=0: not in setup mode;
bit 2=1 and bit 1=0: setup mode, view only;
bit 2=1 and bit 1=1: setup mode, unlocked)

B_1 bit 3 calibration mode with device unlocked
(1: yes, 0: no)

B_1 bit 4 setup updated
(set to 1 after a device power-up or a device reset or a change in setup made through the instrument keyboard; reset to 0 after receiving a GET command)

B_1 bit 5 calibration mode
(set to 1 after a device power-up or whatever complete calibration; reset to 0 after receiving a CAR command)

B_1 bit 6 hold mode (1: ON, 0: OFF)

B_1 bit 7 free for future use (and set to 0)

The ***NN*CAR** request produces the following answer:

1) ***Process controller configured for pH:***

If pH is not calibrated: "*NN*<STX>0<ETX>"

If calibration has been performed: "*NN*<STX>1 *date time offset slope1 slope2 buf1 buf2 N*<ETX>"

The items in italic are separated by blank spaces and have the following formats:

date	ddmmyy	("020498" for April 2, 1998)
time	hhmm	("1623" for 4:23 pm)
offset	ASCII string for a float	(example: "-0.2")
slope1	ASCII string for a float	(example: "62.5")
slope2	ASCII string for a float	(example: "60.4")
buf1	ASCII string for a float	(example: "7.01")
buf2	ASCII string for a float	(example: "4.01")

When some of the above items is missing (for example *buf2* when a 1-point calibration is performed) it is indicated with a "N" letter.

2) ***Process controller configured for ORP:***

If mV is not calibrated: "*NN*<STX>0<ETX>"

If calibration has been performed: "*NN*<STX>1 *date time N N N buf1 buf2 N*<ETX>"

The items in italic are separated by a blank spaces and have the following formats:

date	ddmmyy	("020498" for April 2, 1998)
time	hhmm	("1623" for 4:23 pm)
buf1	ASCII string for a float	(example: "0")
buf2	ASCII string for a float	(example: "1900")

None of the items above can be missing when the Process Controller is configured to measure and control ORP (as it always has to be calibrated on two points).

Note When the "measurement input selection" item is set to "Digital Transmitter" the last calibration data retrieved through this command refer to Digital Transmitter and is stored in that device.

The event log file is requested through the ***NN*EVF**<CR> command. The maximum length of the event log file is 100 records. Here is the format for the answer:

If there is no generated error or event, the answer has the format "*NN*<STX>0<ETX>", otherwise:

"*NN*<STX>*events_no event_code*$_1$ *start_date*$_1$ *start_time*$_1$ *end_date*$_1$ *end_time*$_1$ *desA*$_1$*desB*$_1$ ...

event_code$_2$ *start_date*$_2$ *start_time*$_2$ *end_date*$_2$ *end_time*$_2$ *desA*$_2$*desB*$_2$...

event_code$_m$ *start_date*$_m$ *start_time*$_m$ *end_date*$_m$ *end_time*$_m$ *desA*$_m$*desB*$_m$<ETX>"

where *m* is the number of events. Each token is followed by a blank space, except the last one ("*desB*$_m$"), directly followed by the <ETX> character.

"*events_no*" is the number of events and its format is the ASCII format for a number ("1", "2".... "99", "100").

The meaning of "*start_date*$_i$" and "*start_time*$_i$" is:

- for errors: date and time at which the error was generated;
- for setup events: date and time of a setup item change;
- for calibration events: date and time of a calibration;
- for cleaning events: start date and time of cleaning action.

The meaning of "*end_date*$_i$" and "*end_time*$_i$" is:

- for errors: end date and time if the error is not active anymore;
- for setup events: no meaning;
- for calibration events: no meaning;
- for cleaning events: no meaning.

The tokens format is described here below:

event_code$_i$ (errors)	ER*NN*	(e.g. "ER01" for Setp.1 alarm)
event_code$_i$ (setup)	S*CNN*	(e.g. "Sr01" for current month)
event_code$_i$ (calibration)	CALE	(always the string "CALE")
event_code$_i$ (cleaning)	CLEA	(always the string "CLEA")
start_date$_i$	ddmmyy	("010798" for July 1, 1998)
start_time$_i$	hhmm	(e.g. "1735" for 5:35 pm)
end_date$_i$ (active errors)	N	(just the letter "N")

end_date_i (not active err.)	ddmmyy	("020798" for July 2, 1998)
end_time_i (active errors)	N	(just the letter "N")
end_time_i (not active err.)	hhmm	(e.g. "0920" for 9:20 am)
$desA_i$ (errors)	N	(just the letter "N")
$desA_1$ (setup)	$P_1P_2C_1C_2C_3C_4$ (setup item format, prev. value)	
$desA_i$ (calibration)	"XXPHX", "XOrPX", "XX^CX", "UOLtX", "0-201", "4-201", "0-202", "4-202"	
$desA_i$ (cleaning)	"AdCL" for advanced cleaning, "SICL" for simple cleaning	
$desB_i$ (errors)	N	(just the letter "N")
$desB_1$ (setup)	$P_1P_2C_1C_2C_3C_4$ (setup item format, new value)	
$desB_i$ (calibration)	N	(just the letter "N")
$desB_i$ (cleaning)	N	(just the letter "N")

See above in this section for the description of setup item format "$P_1P_2C_1C_2C_3C_4$".

Events are logged in the event log file in chronological order, i.e. record number 1 refers to the oldest event. When the event log file is full, the oldest event is replaced with the oncoming one.

In order to speed up the updating of a remote monitor for the events, the ***NN*EVF**<CR> command is supported by ***NN*EVN**<CR>, the new event request command, which is answered with the list of events occurred since the last reception of a ***NN*EVF**<CR> or ***NN*EVN**<CR> command.

Here is the format for answer to ***NN*EVN**<CR>:

"*NN*<STX>0<ETX>" if there is no new event, otherwise:

"*NN*<STX>*new_events_no event_code*$_1$ *start_date*$_1$ *start_time*$_1$ *end_date*$_1$ *end_time*$_1$ *desA*$_1$*desB*$_1$ ...

event_code$_2$ *start_date*$_2$ *start_time*$_2$ *end_date*$_2$ *end_time*$_2$ *desA*$_2$*desB*$_2$ ...

event_code$_m$ *start_date*$_m$ *start_time*$_m$ *end_date*$_m$ *end_time*$_m$ *desA*$_m$*desB*$_m$<ETX>"

where *m* is the number of events. Each token is followed by a blank space, except the last one ("*desB*$_m$"), directly followed by the <ETX> character.

"*new_events_no*" is the number of new events and its format is the ASCII format for a number ("1", "2".... "99", "100").

When a ***NN*EVF**<CR> or ***NN*EVN**<CR> command is received by the instrument, the new events list is reset and a following ***NN*EVN**<CR> command will be answered with "*NN*<STX>0<ETX>" if no event took place in the meantime. Thus, if the answer to ***NN*EVN**<CR> command is not received correctly, to update a remote monitor for events, the ***NN*EVF**<CR> command for the whole event log file must be used.

Note After a reset of the instrument, the answer to ***NN*EVN**<CR> is the same as ***NN*EVF**<CR> (all events are new).

Note A modified record due to the closing of an error is not transmitted by ***NN*EVN**<CR>, so again the ***NN*EVF**<CR> command is needed.

A small subset of the event log file, with information about the active errors, can be downloaded through the ***NN*AER**<CR> command, always available, even during controlling. The answer is:

"*NN*<STX>$C_1C_2C_3C_4C_5C_6$<ETX>"

where C_1C_2 are the ASCII representation of byte B_1 described below (e.g. B_1 = 0xF3 ⇨ C_1 = "F", C_2 = "3"), C_3C_4 are the ASCII representation of byte B_2 described below (e.g. B_2 = 0x1D ⇨ C_3 = "1", C_4 = "D"), C_5C_6 are the ASCII representation of byte B_3 described below (e.g. B_3 = 0xBE ⇨ C_5 = "B", C_6 = "E").

The meaning of B_1, B_2, B_3 is:

B_3 bit 0	Alarm for setpoint 1
B_3 bit 1	Alarm for setpoint 2
B_3 bit 2	Maximum relay ON time exceeded
B_3 bit 3	Life check error
B_3 bit 4	pH electrode broken or leakage
B_3 bit 5	Reference electrode broken or leakage
B_3 bit 6	Old pH probe
B_3 bit 7	Dead pH probe
B_2 bit 0	Calibration time-out
B_2 bit 1	Temperature probe broken
B_2 bit 2	free for future use (and set to 0)

B_2 bit 3	Digital transmitter error
B_2 bit 4	Power reset
B_2 bit 5	EEPROM corruption
B_2 bit 6	Watchdog reset
B_2 bit 7	Temperature level error
B_1 bit 0	free for future use (and set to 0)
B_1 bit 1	free for future use (and set to 0)
B_1 bit 2	free for future use (and set to 0)
B_1 bit 3	free for future use (and set to 0)
B_1 bit 4	free for future use (and set to 0)
B_1 bit 5	free for future use (and set to 0)
B_1 bit 6	free for future use (and set to 0)
B_1 bit 7	free for future use (and set to 0)

Each bit is equal to 1 if the correspondent error is ON and equal to 0 if the correspondent error is OFF.

Note After issued the ***NN*HLD**<CR> command to enter the hold mode, the command has to be issued again for exit from the mode. If the device is already in hold mode when the ***NN*HLD**<CR> is issued the first time, the command has no effect.

When a "NAK" or "CAN" char is sent, the whole process reception buffer is cleared.

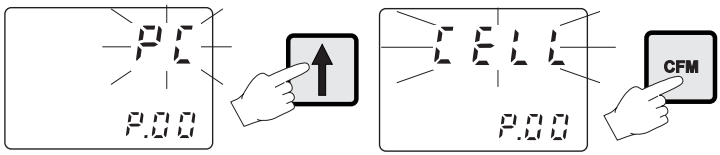
When the meter is receiving and answering to commands other than "PHR", "MVR", "TMR", "AER", "STS", the primary LCD displays "r485".

SHORT MESSAGING SERVICE (SMS)

It is possible to connect the Hanna Instruments Office **HI504900** GSM module to the RS485 port of the instrument. This connection enables the instrument to send SMSs to one (or two) cellular phone(s) and through this feature the device can be monitored at every moment. Moreover if an error occurs on the **HI504**, it is possible to have an SMS sent to the cellular phone(s) advising immediately the user about the problem.

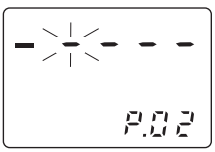
To use the SMS feature, a SIM card able to make voice calls must be used.

The SMS feature can be enabled through the setup item P.00 by selecting "CELL" for cellular module connection instead of "PC" connection.



Before enabling this feature it is necessary to enter the PIN of the SIM card of the GSM module (setup item P.01) and one or two phone numbers associated with the service (setup items P.02 and P.03) to which the messages will be sent.

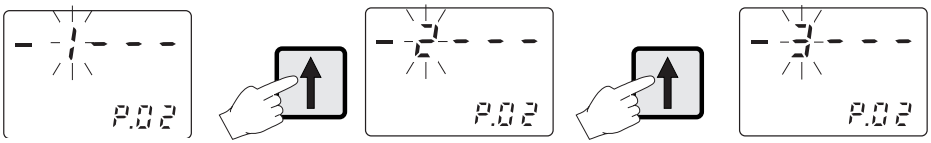
The phone numbers have to be inserted using the international format excluding the starting "+" character and without any space inside the number. For example if the cellular number is "+39123456789" (+39 is the country code), the number to be stored in the **HI504** is "39123456789".



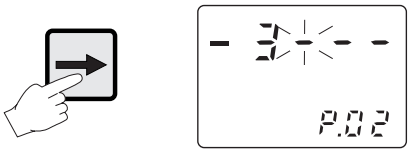
When the item P.02 (or P.03) is selected, the primary display will show the first four digits of the correspondent phone number. A minus sign is added in the front of the number to indicate that the first four digits are shown and the first digit will blink to indicate the possibility to modify the value.

The user can select the desired digit using the ⇧ or ⇩ key.

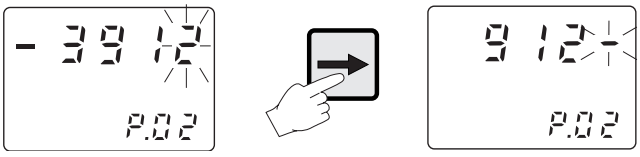
Note "-" character indicates that the digit is not used (leave dashes on the right of the number).



By pressing the ⇨ key, the first digit will be fixed on and it will be possible to select the next digit.



When the fourth digit is reached, by pressing the ⇨ key again, the number on the primary display will scroll of one position to the left and the fifth digit of the phone number will be shown on the fourth position. The minus sign in the front of the number disappears because the shown digits are not the first four ones anymore.



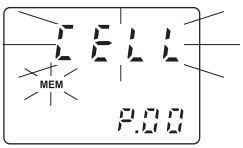
By pressing the ⇧ or ⇩ key it is possible to modify the value of the blinking digit and pressing the ⇨ key it is possible to skip to the next digit. When the end of the phone number is reached, the user has to fill the remaining positions with "-" character.

The space reserved for a phone number is of 20 digits. When the last position is reached, by pressing the ⇨ key, the primary display will return to the first four digits (recognizable by the minus sign in the front of the number). In this way it is possible to run cyclically through the number by pressing repeatedly the ⇨ key.

When the desired phone number is entered, press CFM to confirm.
The WRONG tag will blink if the user tries to confirm an incorrect number (the first digit of the number has to be on the first position and the "-" character have not to be present in the middle of the number). The WRONG tag will disappear only when a digit of the phone number is modified.

Two cases have to be distinguished when the cellular module connection is selected.

1) If one or two phone numbers have been set in items P.02 and P.03, then when the connection is activated (when "CELL" is confirmed on item P.00), the two numbers will be saved on the SIM card of the instrument with the codes "HI504PH1" and "HI504PH2" and the GSM module initialized.
   During the saving of the phone numbers, "CELL" and the MEM tag will blink alternatively on the LCD.

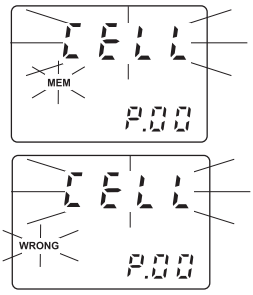


Note The numbers are saved on the first two locations of the phonebook area in the SIM card. If there are other phone numbers previously stored on these locations, they will be overwritten. If only one phone number is entered in item P.02 (or P.03) then the location correspondent to the other number on the SIM card phonebook area will be automatically erased.

2) On the other case, if no phone number has been set in items P.02 and P.03 (both the items filled with "- - - - - - - - - - - - - - - - - - - -"), then when the connection is activated (when "CELL" is confirmed on item P.00) the instrument tries to read the SIM card looking for some number associated with the code "HI504PH1" or "HI504PH2" (previously saved by the instrument on the SIM card). If it finds any, then the phone number(s) will be loaded by the instrument (items P.02 and P.03 automatically updated),the cellular module initialized and the SMS service activated.

During the reading of the SIM card, "CELL" and the MEM tag will blink alternatively on the LCD.

Otherwise, if the instrument does not find any correct number, then it will not be possible to activate the SMS service and the WRONG tag will blink on the LCD.



If the PIN set in P.01 is wrong, then it will be not possible to confirm the cellular module connection.

Note If the first attempt to initialize the GSM engine fails because of a wrong PIN, then no other attempt will be allowed until the setup item P.01 is modified (prevention of sending three wrong PINs. Infact if it happens, the user has to extract the SIM card and manually enter the PUK using his own cellular phone to unlock the SIM card).

The communication baud rate is set through the item O.30 and it is the same both for a "PC" connection and for the **HI504900** GSM module connection. Normally there is no need to modify the default baud rate (19200).

Note It is important to set the desired baud rate before enabling the SMS service. The GSM cellular mode will automatically recognize the baud rate during the initialization. Once activated the SMS service, it is important NOT to change the baud rate during the normal functioning of the instrument. If a baud rate changing is required, first switch setup item P.00 to "PC", then change the baud rate (setup item O.30), and finally reactivate the SMS service switching item P.00 to "CELL".

To have an error associated with the SMS service, the user has to select a proper configuration in the Error group (see "Setup mode" section).

When an error configurated for the SMS service is switched on, the following message will be sent to the programmed phone numbers: "Rem_msg: xxx; The following error occurred on HI504: XXXXX".

"xxx" stands for a three digits number indicating the remaining messages; "XXXXX" stands for a text string correspondent to the activated error.

Here is reported a list of all the possible error strings:

- "Alarm for setpoint 1"
- "Alarm for setpoint 2"
- "Max relay ON time error"
- "Life check error"
- "pH electrode broken or leakage"
- "Reference electrode broken or leakage"
- "Old pH probe error"
- "Dead pH probe error"
- "Calibration time-out error"
- "Temperature probe broken error"
- "Digital transmitter error"
- "Power reset error"
- "Cellular error"
- "EEPROM corruption error"
- "Watchdog error"
- "Temperature level error"

After the submission of the message, a phone call is made by the instrument to the programmed number(s). This is done because the SMS can be received with a considerable delay due to network overload, while the phone call takes place immediately and has a long ring which is more likely to be heard. The phone call advises the user that something happened on the **HI504** and a SMS is going to be received. It is not necessary for the user to answer the phone call and it is suggested to close it without any answer.

When an error occurs, a confirmation of the message reception is waited by the instrument. The confirmation can be done by the receiver simply calling the **HI504** phone number (number of the GSM module). The instrument will answer and send an SMS with its current status (this confirmation is managed as an information request; see further on for details).

It is possible to configure the instrument to have repeated messages sent if confirmation is not received immediately (see items P.05 and P.06). This user-selectable feature has been introduced to prevent losing of the warning message due for example to overload of the telephone lines.

The P.05 item sets the number of repeated messages to send (0 is associated with no repetition: only one warning message will be sent and no confirmation waited), while the P.06 item sets the delay (in minutes) between two subsequent messages.

When the instrument receives a phone call (coming from one of the programmed cellular numbers), it interprets the calling as an information request and answers hanging up and sending an SMS with its current status report (number of remaining messages, pH or ORP and temperature values, current active errors). The message will be as for example: "Rem_msg: 150; pH: 8.32; Temp: 25.8; Alr set1; Rel on".

The maximum number of characters for an SMS is 160, so that, if many errors are active, it is possible that the message be truncated. To avoid this problem, a coded notation is used to identify the active errors.

Here is the list of the error strings coded notation:

- Alarm for setpoint 1: "Alr set1"
- Alarm for setpoint 2: "Alr set2"
- Max relay ON time error: "Rel on"
- Life check error: "Life chk"
- pH electrode broken or leakage: "pH brk"
- Reference electrode broken or leakage: "Ref brk"
- Old pH probe error: "Old prb"
- Dead pH probe error: Dead prb"
- Calibration time-out error: "Cal tout"
- Temperature probe broken error: "Temp brk"
- Digital transmitter error: "Tx err"
- Cellular error: "Cell err"
- Power reset error: "Pwr rst"
- EEPROM corruption error: "EEPr cor"
- Watchdog error: "Wtc dog"
- Temperature level error: "Temp lvl"

If no error is active, then the correspondent string will be: "No error".

If at the information request the instrument is in Hold mode, the "Hold" string is added before the pH (or ORP) indication. If the instrument is performing a cleaning action, The "Cleaning" string is added before the readings information.

The information about SIM charge and expiration date are not saved in the SIM card but are managed by the network operator; the instrument can not get directly the information.

To prevent the discharge of the SIM card, the user has to configure manually (accordingly with the credit stored on the SIM card) the maximum number of SMSs that can be sent (item P.04).

Note Every time an SMS is submitted, the item P.04 is updated and it will always indicate the remaining number of messages that can be sent by the instrument.

When the number of remaining messages is going to reach zero (the lower limit depends on the value of item P.05), the message "Rem_msg: xxx; Maximum number of Sms reached. Please check the **HI504** SIM card charge level" will be sent by the instrument to the programmed phone number(s). This particular situation is managed as an error occurrence and a confirmation of the SMS reception is waited.

In this case the user is supposed to extract the SIM card from the cellular module as soon as possible and to check the remaining credit (using its own cellular phone and calling the network operator).

When a confirmation is given to the message, the "Cellular error" is switched on and no more messages will be sent by the instrument in case of error occurrences. To disactivate the "Cellular error", it is necessary to modify the item P.04.

Every time a recharge of the cellular module SIM card is performed, the corresponding expiration date has to be manually updated in the Setup menu (items P.07 - P.09). A check is performed daily between the current (see "Real time clock" subgroup in Setup menu) and the expiration date. Two weeks before the expiration date, the message "Rem_msg: xxx; The HI504 SIM card will expire on: DD-MM-YYYY. Please recharge or substitute it" is sent to the programmed phone number(s). The same message will be sent again also one week before, and the day before the expiration date.

Note This particular warning message does not need confirmation.

In this case the user has to recharge or substitute the SIM card. The sending of the repeated warning messages will be reset when the expiration date is changed. If the expiration date is reached without any updating of the items P.07 - P.09, then the "Cellular error" will be switched on and no more messages will be sent by the instrument until the error is disactivated.

To disactivate this error it is necessary to update the SIM expiration date.

If the user has unlimited credit on the SIM card, the item P.04 has to be set to "222", which is interpreted by the instrument as unlimited number of SMSs that can be sent. In this case the value of remaining messages will not be decremented and no check will be performed on the SIM card expiration date. Moreover, at the beginning of each SMS it will not be present the remaining-messages information ("Rem_msg: xxx").

Note It is possible to ask information (about the current pH, ORP and temperature readings and active errors) to the **HI504** also from a cellular phone different from the one(s) selected through the item P.02 (and P.03). This is accomplished by sending to the instrument the SMS "+Pxx", where "xx" indicates the ID of the **HI504** (setup item G.11).

The instrument will recognize the command and reply sending the requested information.

Note If a communication problem occurs during the normal functioning of the instrument, the "Cellular error" will be switched on and no SMS can be submitted until this error will be disactivated (when this error occurs, the instrument will try repeatedly to initialize the cellular engine and the error will be disactivated only after a successful initialization, or if the SMS service is disabled by setting item P.00 to "PC").

All the settings of the SMS group in the Setup menu are the same for both pH and ORP configuration.

MODEM CONNECTION

A modem connection can be established between **HI504** and a remote computer over telephone line. It is possible to make two different type of remote connection:

- Over the **GSM network**, connecting the **HI504900** cellular module to **HI504** RS485 port.

To enable the modem connection with **HI504900**, first configure the cellular phone (refer to "Short messaging service" section for more details) and in particular set item P.00 to "CELL" and finally set item O.31 ("Modem calls answer enable") to "On".

Note A SIM card able to receive data calls must be used.

- Over a standard **analog telephone line**, connecting the **HI504902** modem module to **HI504** RS485 port.

To enable the modem connection with **HI504902**, first set item P.00 to "PC", then set item O.31 to "On" and finally set item O.32 with the dialing code of the country where the instrument is installed (for example "049" for Germany or "001" for United States).

The **HI504902** modem module must be connected to **HI504** RS485 port (not necessary to telephone line) and switched on while the previous configuration is carried out.

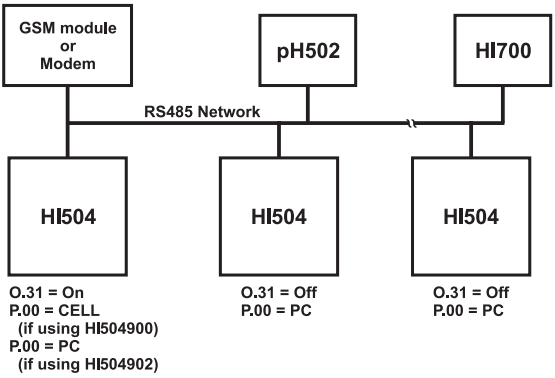
If the country code is shorter than 3 characters, fill the code with zeros in front (for example the country code "49" must be entered as "049" or the country code "1" must be entered as "001").

Note The modem present in the **HI504902** module is Telecom certified for working in all the following countries: Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, China, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Hong Kong, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Korea, Liechtenstein, Luxembourg, Malaysia, Mexico, Netherlands, New Zealand, Norway, Philippines, Poland, Portugal, Russia, Singapore, Slovak Republic, South Africa, Spain, Sweden, Switzerland, Taiwan, Turkey, United Kingdom, United States.

If your country is not present in the list, please contact your local Hanna Instruments Office.

The modem connection (both with **HI504900** and **HI504902**) allows the user to ask the controller from a remote position about its status, measurements and to change some parameters, while for receiving alarm indications it is necessary to install the **HI504900** cellular module.

Many devices can be monitored through a remote modem connection, simply connecting all the devices and the modem or cellular module to the same RS485 network.



Only one device has to be configured through O.31 to answer to modem calls. That device will be the one controlling the modem or the cellular module. To avoid conflicts, the following must never be done:

- put more than one modem or cellular module in the same RS485 network;
- set O.31 to "On" in more than one device in the same RS485 network;
- set P.00 to "CELL" in more than one device in the same RS485 network (SMSs can not be sent from more than one **HI504**);
- set O.31 to "On" in one device and P.00 to "CELL" in another one within the same RS485 network;
- put a PC monitor within the RS485 network.

Provided the above, any Hanna instrument with RS485 port can be attached to the network and monitored remotely.

When making a call, after the data connection is established, the "*NN*PWD..." command (where "*NN*" is the address of the device controlling the modem, i.e. the one with O.31 set to "On") must be issued by the remote computer within 15 seconds. When the data connection is up, the RS485 protocol for a remote connection is all the same as for a local network (see the previous section). An automatic disconnection takes place if no character is received in the RS485 network in 3-4 minutes.

When a modem connection is up, the cellular module does not send any SMS. If an error for which the SMS sending is enabled is active after closing the modem connection, an alarm SMS will be sent by the HI504 after disconnection.

pH/ORP PROBE CHECK

The pH electrode and the reference electrode for both pH and ORP can be automatically monitored through HI504. Setup items involved are I.13 (pH electrode impedance test enable), I.14 (reference electrode impedance test enable), I.15 (maximum reference electrode impedance) and I.04 (potential matching pin enable).

A "pH electrode broken or leakage error" (error code: 10) is generated whenever the pH electrode impedance is less than approximately 1 MΩ. This error can be due to breakage of the electrode glass or short circuits caused by moisture or dirt.

A "reference electrode broken or dirty or not immersed" error (error code: 11) is generated whenever the reference electrode impedance is greater than the value set in item I.15 (maximum reference electrode impedance range is 0.5 to 100.0 KΩ, default is 50.0 KΩ). This error can be due to soiling of the reference electrode. It can occur also when either the reference electrode or the matching pin are not immersed in the solution. An automatic cleaning procedure can be triggered by this error (see the "Alarm - Error configuration" section for more details).

The pH electrode test is performed when the following conditions are satisfied:

- the test has been enabled through the setup item I.13;
- the device is in one of the following modes: idle, last calibration data scrolling, event log file scrolling;
- the device is not in hold mode;
- the device is configured to measure pH.

Note **If an amplified electrode is used, the pH electrode test must be disabled through the setup item I.13.**

The reference electrode test is performed when the following conditions are satisfied:

- the matching pin has been enabled through the setup item I.04;
- the test has been enabled through the setup item I.14;
- the device is in one of the following modes: idle, last calibration data scrolling, event log file scrolling;
- the device is not in hold mode.

Note **When testing or calibrating the instrument through a pH/ORP simulator like HI931001 or HI8427, temporarily set the items I.13 and I.04 to "OFF".**

SOLUTION COMPENSATION

The instrument is provided with a solution compensation function which can be enabled through setup menu (setup item S.00). This function is a compensation curve (actually a line) defined through 2 couples of pH and temperature values:

- point #1: pH_1 , T_1
- point #2: pH_2 , T_2

The only restriction on the values of pH and temperatures is $|T_1-T_2| \cup 1.0°C$.

When the solution compensation is enabled, the pH reading will be equal to:

$$pH \text{ (with solution compensation)} = pH \text{ (without solution compensation)} + [(pH_1-pH_2)/(T_1-T_2) \times (25-T_2) + pH_2] - [(pH_1-pH_2)/(T_1-T_2) \times (T-T_2) + pH_2]$$

where T is the current temperature reading (Celsius degree units).

With this kind of compensation formula, the pH value with solution compensation will be the same (i.e. $(pH_1-pH_2)/(T_1-T_2) \times (25-T_2) + pH_2$) at point #1 and point #2.

This solution compensation feature is useful, for example, in the following case:

HI504 is measuring $pH=pH_1$ at temperature T_1; a sample is taken out and carried in the laboratory room to be checked with a reference pH-meter; in the meantime the temperature decreases to T_2 and also the pH value measured with the reference pH-meter changes to pH_2 (due to the chemical properties of the solution); if the same solution compensation formula is applied in both **HI504** and the reference pH-meter, they will read the same value.

To enable the solution compensation, set the S.00 item in the setup menu to "ON".

The solution compensation is disabled in any case when calibrating pH.

TEMPERATURE COMPENSATION

If the setup item G.01 is set to "AtC" an automatic temperature compensation will be performed using the temperature value acquired with the Pt100/Pt1000 input.

If the probe appears to be unconnected, or anyway it does not give a valid temperature (temperature outside the -30 to 130 °C range), the instrument will generate a broken temperature probe error, which will be handled as stated in the error configuration. In this case the temperature will be automatically set to the setup item G.02 ("Manual or probe error temperature") and the setup item G.01 will be automatically set to "USEr" (see below).

After that, the Pt100/Pt1000 input continues to be monitored to track the Pt100/Pt1000 error closing.

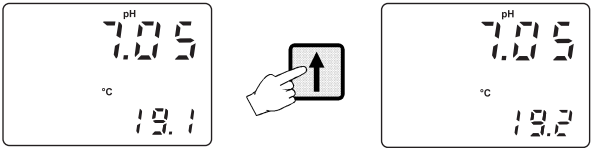
The setup item G.01 is automatically changed back to "AtC" when the Pt100/Pt1000 error is closed.

During error condition, if the user decides to start working in manual mode (and so manually close the error), he has to go in setup menu (item G.01), change the value to "AtC" (automatic compensation) without giving confirmation, then change again to "USEr" and finally give confirmation by pressing the CFM key.

If the setup item G.01 is set to "USEr" a manual temperature compensation will be performed, no matter whether the temperature probe is connected to the Pt100/Pt1000 input or not.

The start value for temperature, when entered the manual mode, is the one stored at G.02 ("Manual or probe error temperature").

If the user wants to change the temperature value while in manual mode, he has to press the ⇧ or ⇩ key. Pressing once the ⇧ key it will add 0.1 °C to the actual temperature value, while pressing the ⇩ key it will subtract 0.1 °C.



For quickly changing the temperature value press and hold down the ⇧ (or ⇩) key: the temperature will be incremented (decremented) of 0.1 °C until the total amount is 0.4 °C, and then the increment (decrement) will turn to 1 °C.

During these operations both the temperature value displayed and setup item G.02 are updated (the last one is updated with a maximum delay of 10s).

Note When the Digital Transmitter is used, the temperature compensation is performed in the transmitter.

LAST CALIBRATION DATA

If the meter is set as pH controller, the following data about the last calibration are stored in the EEPROM:

- Date
- time
- offset, in mV
- slope, in mV/pH
- up to two buffers.

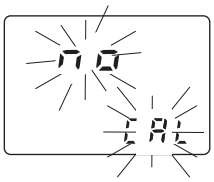
If the meter is set as ORP controller, the data stored in the EEPROM are the following:

- Date
- time
- first calibration point
- second calibration point.

While displaying these data the pH/ORP controller remains in control mode.

To enter the last calibration data mode, press the CAL DATA key.

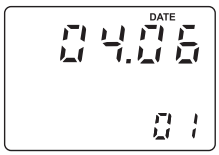
If the meter has never been calibrated or an EEPROM reset has occurred, no calibration data is shown when CAL DATA is pressed. The “no CAL” message will blink for a few seconds, then the meter skips back to the previous mode.



If the meter is set as pH controller, once entered the last calibration data, the following messages could scroll twice on the primary LCD before showing the calibration date:

- “Old probe”
- “Dead probe”
- “Probe needs calibration”.

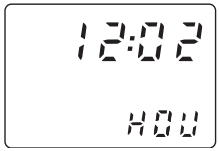
Otherwise the last calibration date will appear on the primary LCD displayed as DD.MM format, while the secondary display will show the last two digit of the year.



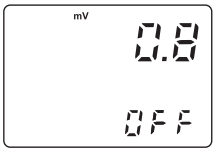
Pressing the ⇩ key, the meter will cycle through the following steps in reverse order, i.e. beginning from last buffer.

Note At any time pressing LCD or CAL DATA key the meter will return to the regular operating display.

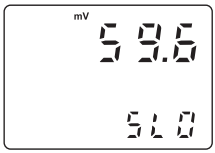
- Press the ⇧ or ⇨ key to view the time of last calibration. The secondary display will show "HOU" to indicate "hour and minute" while the primary LCD will show the time as HH:mm format.



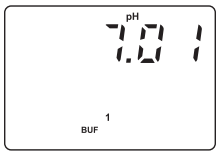
- Press the ⇧ or ⇨ key again to view the offset in mV at the time of last calibration. The secondary display will show "OFF" to indicate "offset".



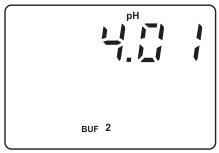
- Press the ⇧ or ⇨ key again to view the slope in mV/pH at the time of last calibration. The secondary display will show "SLO" to indicate "slope".



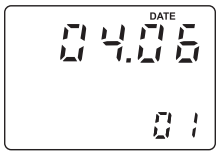
- Press the ⇧ or ⇨ key again to view the first memorized buffer at the time of last calibration. The secondary display will show "BUF1" to indicate "first buffer".



- Press the ⇧ or ⇨ key again to view the second memorized buffer (if present) at the time of last calibration. The secondary display will show "BUF2" to indicate "second buffer".



- Press the ⇧ or ⇨ key again to return to the first CAL DATA display (date) at the time of last calibration.

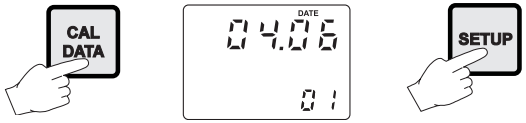


Note When the "Measurement input selection" item is set to "Digital Transmitter" the displayed last calibration data refer to the Digital Transmitter and is stored in that device. This does not mean that the calibration data of the process controller are lost, but they come back when changing back the "Measurement input selection" later.

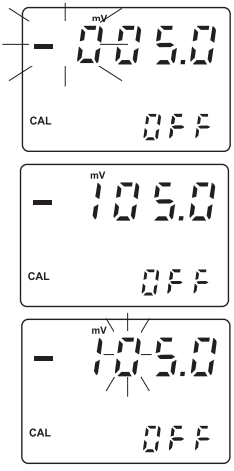
OFFSET AND SLOPE DIRECT SELECTION

It is possible to edit directly the values of the offset and the slope to calibrate the instrument.

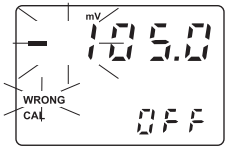
- Press the CAL DATA key entering the last calibration data scrolling and then press the SETUP key.



- A password entry is required. If a wrong password is confirmed, the instrument reverts back to the normal mode.
- Otherwise, if correct password is confirmed, the LCD will appears as follows: the secondary LCD shows "OFF" to indicate "offset" while the primary one shows offset default value. The first digit on the primary LCD is blinking, and it is possible to change it by pressing ⇧ or ⇩ key.
- Pressing the ⇨ key will move to the second digit while the first one will be fixed.

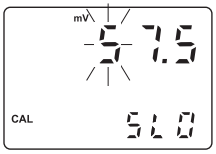


- Pressing repeatedly the ⇨ key will move cyclically through the digits of the primary LCD.
- Once selected the desired value, press CFM to confirm the calibration offset.
- If the offset is invalid, the "WRONG" indicator will blink on the display.



Note If LCD or CAL DATA key is pressed before CFM, calibration is aborted without changing the previous calibration data.

- If an offset calibration has been made, the instrument will turn to "slope" calibration (as indicated by the "SLO" message on the secondary display. The slope value is shown on the primary LCD and the first digit is blinking to permit modifications).



- Press the ⇧ or ⇩ key to modify the value or ⇨ key to move to the next digit.
- Once selected the desired value, press CFM to confirm.
- After confirmation the instrument will turn back to normal mode.
- If the slope is invalid, the "WRONG" indicator will blink on the LCD.

Note Press LCD or CAL DATA key to exit calibration. The slope will be set to the default value (57.5 mV/pH).

After direct selection of offset and slope, calibration data can be viewed by pressing the CAL DATA key while in normal mode, but no pH-buffer values will be displayed during the data scrolling on the LCD.

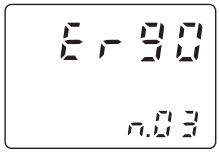
EVENT LOG FILE SCROLLING

The event log file is composed by a maximum of 100 recorded events, which include errors, calibration events (type of calibration, date, time), configuration changes and cleaning events (type of cleaning, start date and time).

To enter the event log file scrolling, press the LCD key while in control, hold or idle mode (the log feature is not available in setup or calibration mode). Event scrolling does not affect control actions, which continue normally.

If there is no event in the event log file, nothing happens when the LCD key is pressed.

Otherwise the primary display will show the code of the last logged event while the secondary LCD will show the number (index) of the event.



For each event the following is reported in any case:

- error code (displayed "Er" followed by the error number) or setup item code (displayed "S" followed by the setup item code) or "CALE" indication or "CLEA" indication;
- event index (the oldest event has index 0, the latest event has the higher index) shown on the secondary LCD.

In addition, the following information can be visualized:

- for errors:
  - start date
  - start time

and if error is not on anymore:

  - end date
  - end time.

- for configuration changes:
  - date of change
  - time of change
  - previous value
  - new value

- for calibrations:
  - date of calibration
  - time of calibration
  - calibrated unit ("pH", "OrP", "°C", "4-20", "UoLt", "0-20 $_1$", "4-20 $_1$", "0-20 $_2$", "4-20 $_2$")

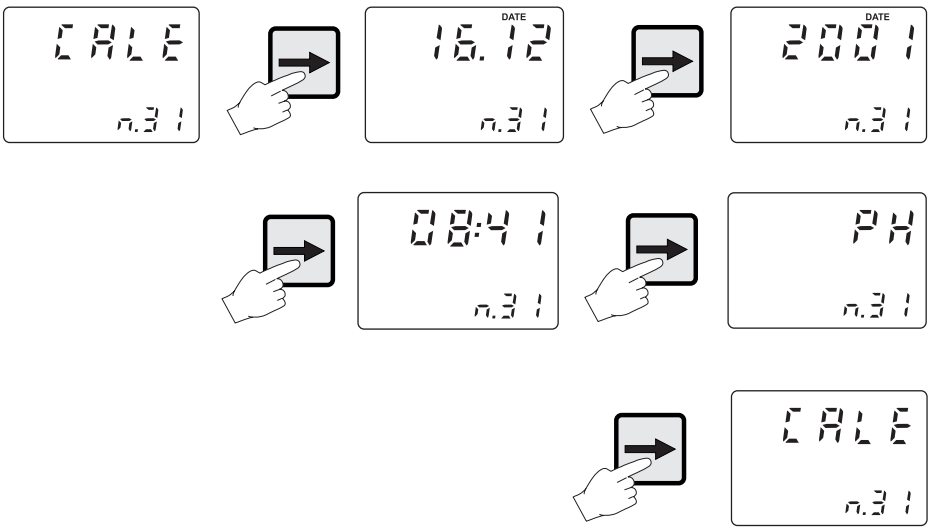
- for cleaning events:
  - start date
  - start time
  - type of cleaning

  ("AdCL" for advanced cleaning;
  "SICL" for simple cleaning).

Once entered the log event scrolling, press the ⇧ or ⇩ key to move through the events.

If the event is an error still active, the error code on the primary LCD will blink, otherwise it will be fixed.

To have a look at the additional information of a selected event press the ⇨ key (it will cycle through the additional information).



Note To exit the log event scrolling, press the LCD key.

The logged event information can be downloaded to a PC through the **HI92500** application software.

FAULT CONDITIONS

The below fault conditions may be detected by the software:

- EEPROM data error
- serial communication internal bus failure
- software dead loop.

EEPROM data error can be detected through EEPROM test procedure at start-up or when explicitly requested using setup menu, or during normal operational mode if a checksum control fails.

When an EEPROM error is detected during normal mode, a fault alarm is generated according to the user configuration for the EEPROM corruption error (see "Alarm" section).

To close an error an EEPROM test (see "Selftest procedures" section) or reset is required.

As soon as an EEPROM error is detected, the scrolling message "EEPROM reset needed - Press up button to reset stored data or right button to ignore" will appear on the primary LCD.

If the ⇨ key is pressed, the process controller restarts operation, but alarm actions are performed as configured by the user (see "Alarm - Error configuration" section). Note that the device will be in Hold mode in any case.

If the ⇧ key is pressed, all the data stored in the EEPROM are erased and the default values loaded. After that, the device must be completely recalibrated.

An internal bus error is detected when internal transmission is not acknowledged or a bus fault occurs for more than a certain number of unsuccessful transmission attempts (due for example to a damage occurred to one of the ICs connected to the internal bus). After that the controller displays a sliding message "Serial bus error".

If the error is due to impossible communication with the EEPROM or the RTC, all the pH/ORP controller tasks are stopped, the alarm relay is de-energized, the red LED blinks and the “Serial bus error” slides forever (repair can not be postponed).

A software watchdog is provided in order to detect dead loop conditions or other causes that make the software stuck. If it happens, a software reset is generated after a time-out of 1 second.

SELFTEST PROCEDURES

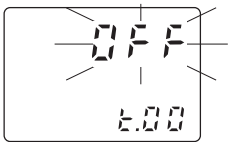
The selftest procedure can be made only entering the setup menu and selecting one of the items of the "tESt" group (t.00 - t.08).

Note All the tests are made while in setup mode, where a time-out is present. If no action is performed for about 5 minutes, the mode is automatically exited and the instruments returns to previous mode.

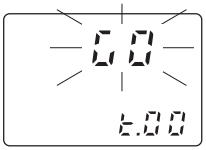
DISPLAY TEST

The display selftest procedure consists of lighting up all the display segments together.

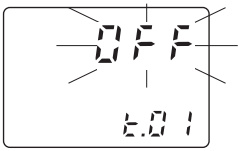
- To start the procedure select setup item t.00 and an "OFF" blinking message will appear on the primary LCD.



- Press the ⇧ (or ⇩) key once and the message will switch to a blinking "GO".

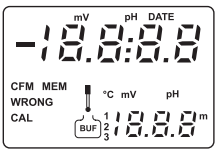


- Press CFM key to confirm or the ⇧ (or ⇩) key again to return to the previous status.
- If confirmation is given when the "OFF" message is blinking, no action is performed and it will move to the next setup item (t.01).



- The display test is announced by a scrolling "Display test" message.

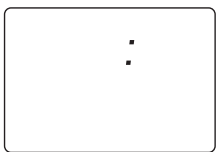
- All the segments light up for a few seconds and then switch off before exiting the display test procedure and moving to the next setup item (t.01).



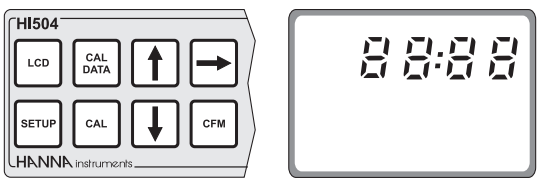
KEYBOARD TEST

- To enter the keyboard test procedure select setup item t.01. A blinking "OFF" message will appear on the primary LCD.
- Press the ⇧ (or ⇩) key once and the message will switch to a blinking "GO".
- Press CFM to confirm or the ⇧ (or ⇩) key again to return to the previous state.
- If confirmation is given when the "OFF" message is blinking, no action is performed and it will move to the next setup item (t.02).
- Once confirmed, the keyboard selftest procedure begins with the scrolling message "Button test - Press LCD and CAL and SETUP together to escape".

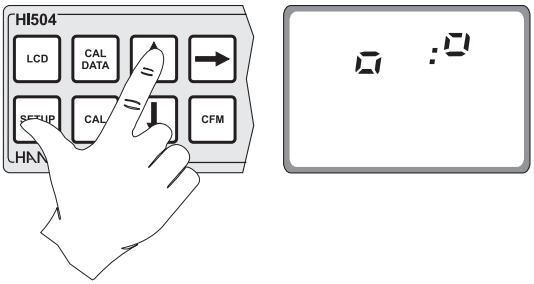
- The LCD will then show only a colon.



- As soon as one more key is pressed, the appropriate segment out of 88:88 corresponding to the pressed key will light up on the screen.



For example, if SETUP and ⇧ keys are pressed together the LCD will look like this:



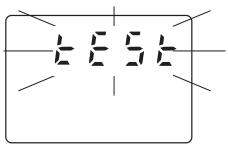
Note A maximum of two keys may be pressed simultaneously to be properly recognized.

- To exit the keyboard test procedure press LCD, CAL and SETUP simultaneously; the instrument will remain in the setup menu and move to the next item (t.02).

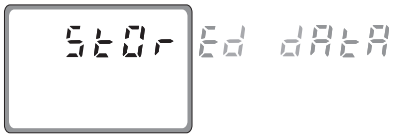
EEPROM SELFTEST

The EEPROM selftest procedure involves verifying the stored EEPROM checksum.

- To enter the EEPROM test procedure select the setup item t.02 and an "OFF" blinking message will appear on the LCD.
- Press the ⇧ (or ⇩) key once and the message will switch to a blinking "GO".
- Press CFM key to confirm or the ⇧ (or ⇩) key again to return to the previous status.
- If confirmation is given when the "OFF" message is blinking, no action is performed and it will move to the next setup item (t.03).
- After confirmation, the selftest procedure begins with the "tESt" message blinking for a few seconds.



- During this time the instrument performs the EEPROM check, and if the checksum is correct, the "Stored data good" message will scroll on the primary display.



- After that, the meter will remain in setup menu and move to the next setup item.
- If the checksum fails, a fault alarm is generated and the following message appears on the LCD: "Stored data error - Press "UP" button to reset stored data or "RIGHT" button to ignore".
- If the ⇨ key is pressed the process controller restarts operation, but alarm actions are performed as configured by the user (see "Alarm - Error configuration" section).

  Note that the device will be in Hold mode in any case.
- If the ⇧ key is pressed, all the data stored in the EEPROM are erased and the default values loaded.
- Once performed the selected action, the instrument will remain in the setup menu and move to the next setup item (t.03).

RELAYS AND LEDS TEST

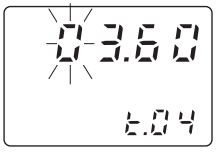
- To enter the relays and LEDs test procedure select the setup item t.03 and an "OFF" blinking message will appear on the LCD.
- Press the ⇧ (or ⇩) key once and the message will switch to a blinking "GO".
- Press CFM key to confirm or the ⇧ (or ⇩) key again to return to the previous status.
- If confirmation is given when the "OFF" message is blinking, no action is performed and it will move to the next setup item (t.04).
- Once confirmed the test, all the relays and LEDs (if anyone was active) are switched off and the message "Relays and LEDs test - Press CFM to escape" will scroll on the primary LCD during all the test.

- Some keys are used to toggle relays and LEDs ON and OFF:
  - the LCD key toggles the alarm relay and the alarm LED;
  - the CAL DATA key toggles the red LED;
  - the ⇧ key toggles relay 1 and the corresponding LED;
  - the ⇨ key toggles relay 2 and the corresponding LED;
  - the SETUP key toggles relay 3 and the corresponding LED;
  - the CAL key toggles relay 4 and the corresponding LED;
  - the ⇩ key toggles the digital insulated hold output.
- When a relay/LED is activated, all the others are disactivated.
- LEDs are verified simply by looking at them, while relays can be verified through a multimeter set for continuity test.
- To exit the test press the CFM key and the previous configuration of the relays is reestablished. The instrument will remain in the setup menu and move to the next setup item (t.04).

ANALOG OUTPUT TEST

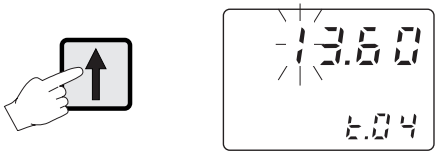
The analog output test is done through the setup items t.04 (analog output 1) and t.05 (analog output 2).

- To enter the analog output test procedure select the corresponding setup item and an "OFF" blinking message will appear on the LCD.
- Press the ⇧ (or ⇩) key once and the message will switch to a blinking "GO".
- Press CFM key to confirm or the ⇧ (or ⇩) key again to return to the previous status.
- If confirmation is given when the "OFF" message is blinking, no action is performed and it will move to the next setup item.
- Once confirmed the test, a start output value (mA) is proposed and displayed on the primary LCD.



This value is let out to the analog output and coincides with the minimum value of the analog output type chosen with setup item O.11 (analog output 1) and O.21 (analog output 2).

- A new output value can be edited manually. It is possible to change the value of the first blinking digit by pressing the ⇧ or ⇩ key.



- To move to the next digit press the ⇨ key once; the first digit will be fixed and the second one will start blinking.

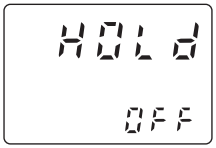
- Pressing repeatedly the ⇨ key will result in cycling through the digits on the primary LCD.
- Once a value is selected, the corresponding current is immediately erogated by the selected output and no confirmation is required.
- The minimum and maximum values let out are 3.6, 22 mA for the 4-20 mA output and 0, 22 mA for the 0-20 mA output. This depends on the possibility of the fault currents to be let out (see "Alarm - error configuration" section for more details).
- To verify the erogated current use a multimeter connected to the corresponding output.
- To exit the test press the CFM key; the instrument will remain in the setup menu and move to the next setup item.

HOLD DIGITAL INPUT TEST

This test is made to verify if the instrument recognizes the digital input signal at the hold input.

- To enter the test procedure select the setup item t.06 and an "OFF" blinking message will appear on the LCD.
- Press the ⇧ (or ⇩) key once and the message will switch to a blinking "GO".

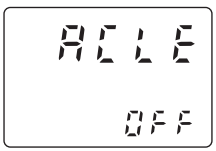
- Press CFM key to confirm or the ⇧ (or ⇩) key again to return to the previous status.
- If confirmation is given when the "OFF" message is blinking, no action is performed and it will move to the next setup item (t.07).
- Once the test is confirmed, the primary LCD will display the "HOLd" message, while the secondary LCD shows the status ("OFF" or "On") of the digital input corresponding to the hold command.



- Toggle the digital input between high and low levels and verify the corresponding status on the secondary LCD.
- To exit the test press the CFM key; the instrument will remain in the setup menu and move to the next setup item (t.07).

ADVANCED CLEANING DIGITAL INPUT TEST

- To enter the test procedure select the setup item t.07 and an "OFF" blinking message will appear on the LCD.
- Press the ⇧ (or ⇩) key once and the message will switch to a blinking "GO".
- Press CFM key to confirm or the ⇧ (or ⇩) key again to return to the previous status.
- If confirmation is given when the "OFF" message is blinking, no action is performed and it will move to the next setup item (t.08).
- Once the test is confirmed, the "ACLE" message will appear on the primary LCD, while the secondary LCD shows the status ("OFF" or "On") of the digital input corresponding to the advanced cleaning.



- To perform this test, relays #3 and #4 have to be configured for the advanced cleaning, otherwise the cleaning will never start and on the secondary display is indicated the digital input status only.
- To avoid continuous cleaning it is necessary to configure the minimum pause time between two consequent cleaning (setup item L.14).

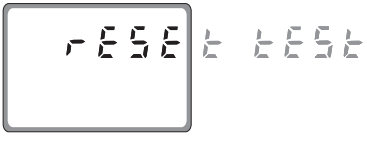
- To exit the test press the CFM key; the instrument will remain in the setup menu and move to the next setup item (t.08).

Note During the test the relays are activated, the primary LCD will always show the "ACLE" message and on the secondary display will be shown the actual status of the digital input ("On" or "OFF").

WATCHDOG TEST

This test executes a dummy dead loop that causes a watchdog reset signal to be generated.

- To enter the test procedure select the setup item t.08 and an "OFF" blinking message will appear on the LCD.
- Press the ⇧ (or ⇩) key once and the message will switch to a blinking "GO".
- Press CFM key to confirm or the ⇧ (or ⇩) key again to return to the previous status.
- If confirmation is given when the "OFF" message is blinking, no action is performed and it will move to the beginning of the test setup menu.
- Once confirmed the test, the "Reset test" message will scroll once on the primary LCD, and then the start-up procedure is initiated.



ALARM - ERROR CONFIGURATION

This section is dedicated to all the possible error causes for alarm generation, and to the actions performed according to the alarm configuration (setup menu "Error configuration").

Each alarm cause can be referred to an error to which an error code is assigned and which is logged in a dedicated memory space (see "Event logging" section for more details).

Five configuring actions are foreseen upon generation of an alarm:

1. Alarm relay de-energized;
2. Auto-cleaning (control actions are stopped during auto-cleaning mode; can be enabled only for the "Reference electrode broken or dirty" error);
3. 3.6 or 22 mA fault current for the 4-20 mA output; 22 mA fault current for the 0-20 mA output;
4. Hold mode (entered in any case for the following errors: EEPROM corruption, serial bus error).
5. SMS sending to the selected telephone numbers in order to advise of error occurrence.

Note The red LED flashes in any case upon generation of an alarm, i.e. it can not be disabled by changing the error configuration.

Here is a table with errors, error codes and default error handling configuration:

ERROR	Error Code	Alarm Relay de-energizing	22 mA fault current	3.6 mA fault current	Hold mode	Auto-cleaning	SMS sending
Alarm for setpoint 1	00	On	On	Off	Off	–	Off
Alarm for setpoint 2	01	On	Off	On	Off	–	Off
Max. relay ON time exceeded	02	On	On	Off	Off	–	Off
Life check error (*)	03	On	On	Off	On	–	Off
pH electrode broken or leakage (*)	10	On	On	Off	On	–	Off
Reference electrode broken or dirty (*)	11	On	On	Off	On	On	Off
Old pH probe (*)	12	Off	Off	Off	Off	–	Off
Dead pH probe (*)	13	Off	On	Off	Off	–	Off
Calibration timeout	14	Off	Off	Off	Off	–	Off
Temperature probe broken (*)	20	On	On	Off	Off	–	Off
Temperature level	21	On	On	Off	Off	–	Off
Digital transmitter error	40	On	On	Off	On	–	Off
Cellular error	50	On	On	Off	Off	–	–
Power reset	90	Off	On	Off	Off	–	Off
EEPROM corruption	91	On	On	Off	–	–	Off
Watchdog reset	92	Off	On	Off	Off	–	Off

(*): When the Digital Transmitter is used, these errors are generated in the Digital Transmitter, but they are handled as if they were generated in the Process Controller.

- If the condition to generate a "Reference electrode broken or dirty" error is met, the error is not generated immediately, but first auto-cleaning is performed up to 2 times (the cleaning type depends upon relays configuration).

  If the Reference electrode is not OK after two auto-cleaning, the "Reference electrode broken or dirty" error is generated.

Note The second auto-cleaning cycle is done only when the first one is not enough.

Note Both the cleaning modes (simple or advanced cleaning), when enabled through the relay mode items, are triggered upon the "Reference electrode broken or dirty" error.

- The "pH electrode broken or leakage" and the "Reference electrode broken or dirty" errors are never generated if the correspondent tests are not enabled through setup items I.13 and I.14. The Reference electrode test can not be made if the Potential matching pin is not in use (see setup item I.04).
- The 3.6 mA fault current is always off unless the 4-20 mA output has been configured; the 22 mA fault current is always off unless the 0-20 mA or 4-20 mA output has been configured.

  The 3.6 mA and the 22 mA fault current cannot be both set to ON. If two errors are active when output is configured as 4-20 mA (#1 or #2), and one of them is configured for the 22 mA fault current, while the other one is configured for the 3.6 mA fault current, the 22 mA current is let out to the analog output.

  The fault current is automatically disabled when the analog output is used for controlling (item O.10 equal to "SEt"), no matter whether the fault current itself has been configured "On" or "OFF".
- In case of a "Temperature probe broken" error, the fault current, if configured, is let out to both analog outputs (unless O.20 is equal to "SEt"). In all the other cases only the first analog output (for pH and ORP) can let out the fault current.

- The “Cellular error” is never activated if the serial lines are not configured for cellular module connection. The error will be active if the instrument is not able to communicate with the cellular engine (for example because the serial cable is broken or because the cellular engine is not powered), if the number of available SMS is finished (menu item P.04) or if the SIM expiration date is overrun.
- The “Power reset” and the “Watchdog reset” errors are active only for the short time of the start-up session (selftests, process name and version displaying). That start-up session ends when the first measurement is acquired and displayed.
- When the Hold mode is enabled for the “Life check error”, this error can be closed automatically if the measurement vary enough.

The alarm relay (when configured to be activated) is de-energized (fail-safe ON) continuously or with a pulse of about 5 seconds. This parameter can be configured through setup item E.99 (“LE” stands for level and “PULS” for pulse). If pulse is configured, a new pulse will be let out upon every new error, no matter whether the red LED is already blinking (i.e. some error is active) or not. When the pulse finish, the relay is energized but the error remains still active (red LED blinking) until the error is closed.

Note The “Digital Transmitter error” is generated by one of the following causes:

1. Digital Transmitter is off;
2. connection problems between the Process Controller and the Digital Transmitter;
3. EEPROM data corruption in the Digital Transmitter;
4. Digital Transmitter not calibrated;
5. the Process Controller is configured to pH while the Digital Transmitter is configured to ORP, or vice versa;
6. other failures in the Digital Transmitter excluding: life check error, pH electrode broken or leakage, Reference electrode broken or dirty, old pH probe, dead pH probe, temperature probe broken error. These errors are handled separately and exactly in the same way as if they were generated in the Process Controller.

To understand which cause generated the “Digital Transmitter error”, the Digital Transmitter must be examined through its calibrator.

pH VALUES AT VARIOUS TEMPERATURES

Temperature has a significant effect on pH. The calibration buffer solutions are effected by temperature changes to a lesser degree than normal solutions.

For manual temperature calibration please refer to the following chart:

TEMP		pH VALUES				
°C	°F	4.01	6.86	7.01	9.18	10.01
0	32	4.01	6.98	7.13	9.46	10.32
5	41	4.00	6.95	7.10	9.39	10.24
10	50	4.00	6.92	7.07	9.33	10.18
15	59	4.00	6.90	7.04	9.27	10.12
20	68	4.00	6.88	7.03	9.22	10.06
25	77	4.01	6.86	7.01	9.18	10.01
30	86	4.02	6.85	7.00	9.14	9.96
35	95	4.03	6.84	6.99	9.10	9.92
40	104	4.04	6.84	6.98	9.07	9.88
45	113	4.05	6.83	6.98	9.04	9.85
50	122	4.06	6.83	6.98	9.01	9.82
55	131	4.07	6.84	6.98	8.99	9.79
60	140	4.09	6.84	6.98	8.97	9.77
65	149	4.11	6.85	6.99	8.95	9.76
70	158	4.12	6.85	6.99	8.93	9.75

For instance, if the buffer temperature is 25 °C, the display should show pH4.01, 7.01 or 10.01 at pH4, 7 or 10 buffers, respectively.

At 20 °C, the display should show pH4.00, 7.03 or 10.06. The meter reading at 50 °C will then be 4.06, 6.98 or 9.82.

ELECTRODE CONDITIONING AND MAINTENANCE

PREPARATION

Remove the electrode protective cap.

DO NOT BE ALARMED IF ANY SALT DEPOSITS ARE PRESENT.

This is normal with electrodes and they will disappear when rinsed with water.

During transport tiny bubbles of air may have formed inside the glass bulb. The electrode cannot function properly under these conditions. These bubbles can be removed by "shaking down" the electrode as you would do with a glass thermometer.

If the bulb and/or junction are dry, soak the electrode in **HI70300 Storage Solution** for at least one hour.

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

TEST MEASUREMENT

Rinse the electrode tip with distilled water.

Immerse the tip (bottom 4 cm / 1½") in the sample and stir gently for approx. 30 seconds.

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

STORAGE

To minimize clogging and assure a quick response time, the glass bulb and the junction should be kept moist and not allowed to dry out. This can be achieved by installing the electrode in such a way that it is constantly in a well filled with the sample (stream or tank).

When not in use, replace the solution in the protective cap with a few drops of **HI70300** Storage Solution or, in its absence, **HI7082** KCl 3.5M Solution.

Follow the Preparation Procedure above 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 the connection to the controller 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.

CLEANING PROCEDURE

General Soak in Hanna Instruments Office **HI7061** General Cleaning Solution for approximately ½ hour.

Removal of films, dirt or deposits on the membrane/junction:

Protein Soak in Hanna Instruments Office **HI7073** Protein Cleaning Solution for 15 minutes.

Inorganic Soak in Hanna Instruments Office **HI7074** Inorganic Cleaning Solution for 15 minutes.

Oil/grease Rinse with Hanna Instruments Office **HI7077** Oil and Fat Cleaning Solution.

IMPORTANT After performing any of the cleaning procedures rinse the electrode thoroughly with distilled water and soak the electrode in **HI70300** Storage Solution for at least 1 hour before reinstalling it.

TROUBLESHOOTING

Evaluate your electrode performance based on the following.

- Noise (Readings fluctuate up and down) could be due to clogged or dirty junction: refer to the Cleaning Procedure above.
- Dry Membrane/Junction: soak in Storage Solution **HI70300** for at least 1 hour. Check to make sure the installation is such as to create a well for the electrode bulb to constantly remain moist.
- Drifting: soak the electrode tip in warm Hanna Instruments Office Solution **HI7082** for one hour and rinse tip with distilled water.
- Low Slope: refer to the cleaning procedure above.

- No Slope:
  - Check the electrode for cracks in glass stem or bulb (replace the electrode if cracks are found).
  - Make sure cable and connections are not damaged nor lying in a pool of water or solution.
- Slow Response/Excessive Drift: soak the tip in Hanna Instruments Office Solution **HI7061** for 30 minutes, rinse thoroughly in distilled water and then follow the Cleaning Procedure above.
- For ORP Electrodes: polish the metal tip with a lightly abrasive paper (paying attention not to scratch the surface) and wash thoroughly with water.

Note With industrial applications, it is always recommended to keep at least one spare electrode handy. When anomalies are not resolved with a simple maintenance, change the electrode (and recalibrate the controller) to see if the problem is alleviated.

DEFINITIONS

DEVIATION	Same as proportional band, but expressed in units of the controlled magnitude (e.g. 1pH, 50 mV).
EEPROM	Electrically Erasable Programmable Read-only Memory (permanent memory).
FAIL SAFE ALARM	Signaling of the alarm by de-energizing the alarm relay instead of energizing it. That protects against power failures and interruptions of the alarm relay external wires.
GLP	Good Laboratory Practice.
HYSTERESIS	Interval that must be passed over by the controlled magnitude in the opposite direction after having activated a relay, before deactivating it, in order to avoid uninterrupted activation/deactivation of the relay.
IN-LINE CLEANING	Automatic procedure to stop control, clean the electrode and then activate control again.
NIST	National Institute of Standards and Technology.
PID	Proportional Integrative Derivative control.
POTENTIAL MATCHING PIN	Pin for connection of the potential matching (or grounding) steel bar, which must be immersed into the measured fluid, and is used together with a differential input to avoid damage of the reference electrode due to ground loop current.
PROPORTIONAL BAND	Interval, measured in percentage of the input range, where the proportional action spans from 0 to 100 %.
PWM	Pulse Width Modulation.
RAM	Random Access Memory (non-permanent memory).
RTC	Real Time Clock.
SETPOINT	Value at which the measurement needs to be controlled.
SOLUTION COMPENSATION	Technique for compensating the differences on the pH of the solution under measurement when its temperature varies.
THRESHOLD	Value above/below which a control or alarm relay is activated or deactivated.
TRIGGER	An event or command that acts like a mechanical trigger in initiating a process.
WATCHDOG	Mechanism for issuing a reset of the device in case it gets stuck.

ACCESSORIES

pH CALIBRATION SOLUTIONS

HI7004M or HI7004L	pH4.01 Buffer Solution, 230 or 500 ml bottle
HI7006M or HI7006L	pH6.86 Buffer Solution, 230 or 500 ml bottle
HI7007M or HI7007L	pH7.01 Buffer Solution, 230 or 500 ml bottle
HI7009M or HI7009L	pH9.18 Buffer Solution, 230 or 500 ml bottle
HI7010M or HI7010L	pH10.01 Buffer Solution, 230 or 500 ml bottle

ORP SOLUTIONS

HI7021M or HI7021L	Test Solution, 240 mV, 230 or 500 ml bottle
HI7091M or HI7091L	Pretreatment Reducing Solution, 230 or 500 ml bottle
HI7092M or HI7092L	Pretreatment Oxidizing Solution, 230 or 500 ml bottle

ELECTRODE STORAGE SOLUTIONS

HI70300M or HI70300L	Storage Solution, 230 or 500 ml bottle
HI7082	3.5M KCl Electrolyte, 4x50 mL

ELECTRODE CLEANING SOLUTIONS

HI7061M or HI7061L	General Cleaning Solution, 230 or 500 ml bottle
HI7073M or HI7073L	Protein Cleaning Solution, 230 or 500 ml bottle
HI7074M or HI7074L	Inorganic Cleaning Solution, 230 or 500 ml bottle
HI7077M or HI7077L	Oil & Fat Cleaning Solution, 230 or 500 ml bottle

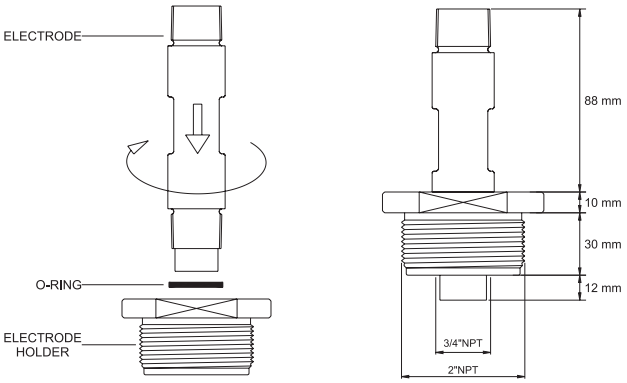
OTHER ACCESSORIES

HI504900	Hanna Instruments Office GSM Module
HI504901	Hanna Instruments Office GSM Supervisor
HI504902	Hanna Instruments Office RS485 Modem
HI504910	Digital Transmitter
BL PUMPS	Dosing Pumps with Flow Rate from 1.5 to 20 LPH
ChecktempC	Stick Thermometer (range -50 to 150 °C)
ChecktempF	Stick Thermometer (range -58 to 302 °F)
HI7610	Stainless steel Pt100 probe with standard 1/2'' external threads on both ends for in-line and immersion installation; 5 m (16.5') cable
HI7620	Glass Pt100 probe with external PG13.5 thread and 5 m (16.5') cable

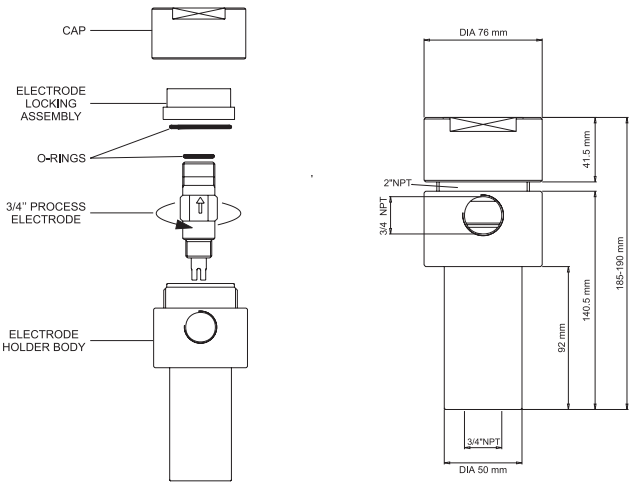
HI7611	Stainless steel Pt1000 probe with standard 1/2'' external threads on both ends for in-line and immersion installation; 5 m (16.5') cable
HI7621	Glass Pt1000 probe with external PG13.5 thread and 5 m (16.5') cable
HI60542-0	1 set of O-rings for HI60542 electrode holder
HI60545-0	1 set of O-rings for HI60545 electrode holder
HI60501-0	1 set of O-rings for HI60501 electrode holder
HI605011	PVC mounting flange for HI60501 electrode holder
HI8427	pH / ORP Electrode Simulator
HI931001	pH / ORP Electrode Simulator with LCD Display
HI931002	4-20 mA Simulator
HI8614	pH Transmitter
HI8614L	pH Transmitter with LCD
HI8615	ORP Transmitter
HI8615L	ORP Transmitter with LCD
HI92500	Windows® Compatible Application Software

pH AND ORP ELECTRODE HOLDERS

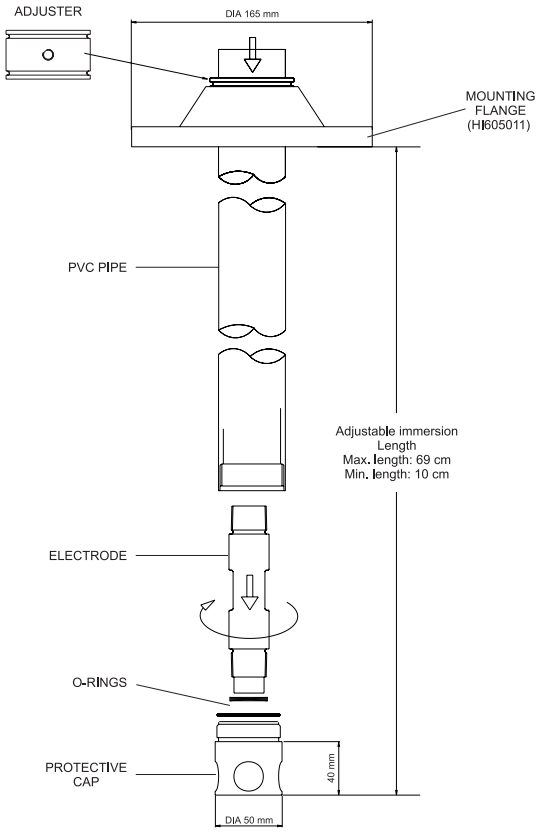
HI60542 In-line electrode holder for direct pipe installation



HI60545 Bypass loop electrode holder



HI60501 Immersion electrode holder for tanks, vessels, baths and open channels

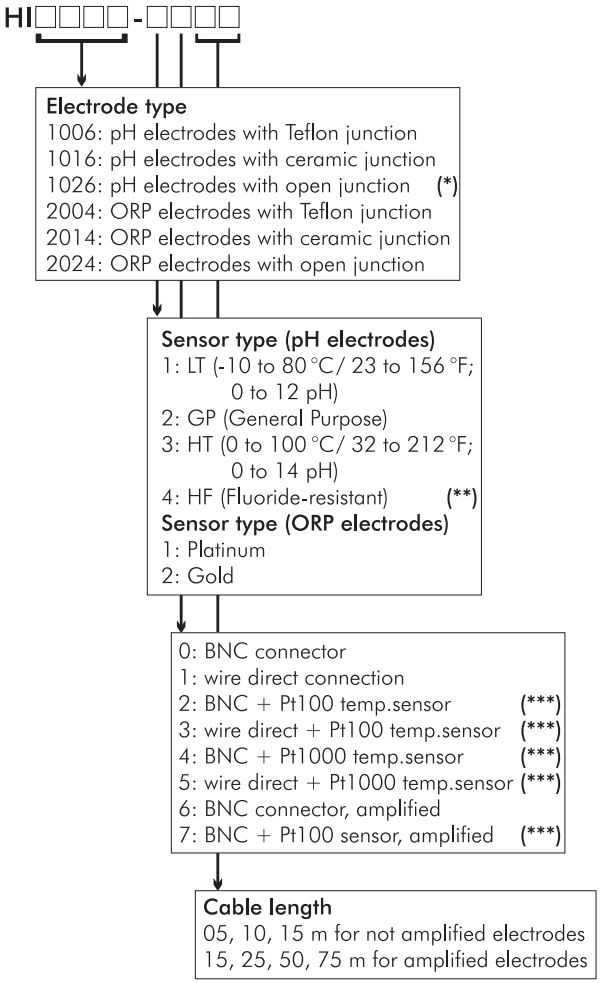


Specifications	HI60542	HI60545	HI60501
Electrode Holder Material	PVC	PVC	PVC
O-Ring Material	NBR	NBR	NBR
Min. & Max. Temperature	-10 °C (14 °F) & 60 °C (144 °F)		
Min. Immersion Length Max. Immersion Length	---	---	10 cm (3.9'') 69 cm (27.1'')
Max. Pressure	8 BAR (116 PSI) @25 °C or 3 BAR (43.5 PSI) @50 °C		---

pH AND ORP ELECTRODES

Hanna Instruments produces a wide range of pH and ORP electrodes specifically designed for needs of industrial uses. For a complete list of available electrodes visit our web site at **www.hannainst.com** or contact your local Hanna Instruments Office.

The below table lists all the Combination, Flat tip, PVDF-body, polymer filled electrodes with Matching Pin, operating pressure: up to 6 bar (87 psi)



(*) Available with GP sensor type only
(**) Fluoride-resistant glass sensor (F^-<2g/L, temperature<60 °C, pH>2)
(***) Not for ORP electrodes

Recommendations for Users

Before using these products, make sure that 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.

To maintain the EMC performance of equipment, the recommended cables noted in the user's manual must be used.

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 voltage at the measurement surface exceed 24VAC or 60VDC.

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

Unplug the instruments from power supply before the replacement of the fuse.

External cables to be connected to the rear panel should be terminated with cable lugs.

For e-mail contacts and complete list of Sales and Technical offices, please see ***www.hannainst.com***

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