HI510

Process Controller

INSTRUCTION MANUAL

HANNA® instruments

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 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 contact list at www.hannainst.com.

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About this Manual

- This manual contains instructions for installation and operation of the Hanna Instruments HI510 Universal Process Controller.
- This release of the product manual contains information that applies to HI510 Process Controller operating with HI10X6-Y8ZZ pH & Temperature or HI20X4-Y8ZZ ORP & Temperature series of smart probes.
- The HI510 Process Controller can be paired up with a family of smart probes that can be ordered separately. When pairing up the controller with a different probe, probe-specific setup information as well as calibration and accessories sections need to be updated. This manual covers HI510-0320 & HI510-0540 models as well as HI1006-1805 & HI2004-1805 smart probes.
- Procedures and instructions in the Safety Measures section may require special precautions to ensure the safety of the personnel performing the operations.

1. PRELIMINARY EXAMINATION

Remove the instrument and accessories from the packaging and examine it carefully.
For further assistance, please contact your local Hanna Instruments Office or email us at tech@hannainst.com.

Each HI510 Process Controller is delivered in a cardboard box and is supplied with power cable (3 meters long), a set of cable gland seals, instrument certificate, and instruction manual.
All mounting kits must be ordered separately.

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

2. SAFETY MEASURES

General Safety Precautions & Preliminary Installation Recommendations

- Electrical connection, installation, start-up, operation and maintenance must be carried out by specialized personnel only.
- The specialized personnel must have read and understood the instructions in this manual and should adhere to them.
- User serviceable connections are all accessible inside the enclosure.
- Do not operate or energize the instrument with the case open.
- Before powering the controller, verify wiring has been done properly.

- Always disconnect the instrument from power when making electrical connections.
- Do not run other cables through the same cable gland with the power cable.
- A clearly marked disconnect switch must be installed in the vicinity of the instrument to ensure that the electrical circuit is completely de-energized for service or maintenance.
- Do not operate damaged instruments which could pose a danger.
- Damaged instruments should be clearly marked as faulty and replaced.
- If faults cannot be repaired, the instrument must be taken out of service and secured against unintentional start-up.

Built-in Safety Features

- All electrical connections are enclosed inside IP65 - rated enclosure.
- Galvanic isolation is provided for all inputs and outputs.
- EMC compliant hardware and software design.

Note: *If system faults or a power failure occurs, a fault-signaling contact triggers the alarm. HI510 has been tested for electromagnetic compatibility in industrial use according to radiated emissions.*

3. SPECIFICATIONS

3.1. CONTROLLER SPECIFICATIONS

Digital probes	Smart HI10X6 series – pH & Temperature with RS485 interface Smart HI20X4 series – ORP & Temperature with RS485 interface
Display	Graphic LCD, 128 x 64 pixel B/W with backlight
Digital inputs	2 independent, galvanically isolated inputs (configurable for Hold & Cleaning functions) On state: 5 to 24 Vdc, low or high level active
Analog outputs Analog output accuracy	2 or 4 independent, galvanically isolated outputs 0 – 22 mA configurable as: 0 – 20 mA; 4 – 20 mA 22 mA as alarm signal, configurable option ±0.2% f.s.
Digital communication	RS485 serial port - Remote monitoring and control USB-C port - Retrieve log files and firmware upgrading
Relays	Up to 5 relays (independently configurable for process variables, Hold & Cleaning functions) Electromechanical relay SPDT and SPST contact outputs 5A – 250 Vac; 5A – 30 Vdc (resistive load) Fuse protected: 5A, 250V slow blow fuse
Alarm relay for all measurement alarms	Electromechanical relay SPDT contact output 5A – 250 Vac; 5A – 30 Vdc (resistive load) Fuse protected: 5A, 250V slow blow fuse
Data logging	Interval log, up to 100 files, maximum 8600 records on each stored file. When the maximum limit of 100 stored files is reached, the most recent file will automatically erase the oldest one. Event log, maximum 100 records. When the maximum limit is reached, the last record overwrites the oldest one.
Power supply	100 – 240 Vac ±10%; 50/60 Hz; 15VA; fuse protected (2A, 250V slow blow fuse)
Power consumption	15VA
Installation category	II
Enclosure*	Single case ½ DIN, type 4X, IP65 ingress protection

*For a water tight seal, tighten the front four screws on the front casing to 13.3 lbf·in (1.5 N·m, maximum 2.0 N·m), of torque.

Weight	Approximately 1.6 kg (3.5 lb.)	
Dimensions	Width	144.0 mm (5.7″)
	Height	144.0 mm (5.7″)
	Depth	151.3 mm (6.0″)
Environment	-20 to 50 °C (-4 to 122 °F); maximum 100% RH non-condensing	

3.2. PROBE SPECIFICATIONS

HI1006-1805 pH Digital Probe

Range	0.00 to 12.00 pH
Temperature	-5.0 to 80.0 °C / 23 to 176 °F
Accuracy	±0.02 pH
Temperature compensation	Automatic or manual from -5.0 to 80.0 °C
Body	PVDF
Junction	PTFE
Sensor	Low Temperature (LT) glass sensor
Sensor tip	Self-cleaning, flat
Maximum pressure	6 bar
Probe cable length	5 meters
Built-in titanium matching pin, to avoid fluctuating measurements & poor process regulation	
3/4″ NPT external thread for insertion mounting	

Note: *See 5.2 SMART PROBES section for all pH probes configurations*

HI2004-1805 ORP Digital Probe

Range	-2000 to +2000 mV
Temperature	-5.0 to 80.0 °C / 23 to 176 °F
Accuracy	±2 mV
Body	PVDF
Junction	PTFE
Sensor	Platinum ring
Sensor tip	Flat
Maximum pressure	6 bar
Probe cable length	5 meters
3/4" NPT external thread for insertion mounting	

Note: *See 5.2 SMART PROBES section for all ORP probes configurations*

Probe Cabling Color Code

Color		Functionality
BROWN	+	Power
YELLOW	A	RS485 COM
WHITE	B	RS485 COM
GREEN	–	Power
GREEN / YELLOW	⏚	PROTECTIVE GROUND CONNECTION

4. GENERAL DESCRIPTION & INTENDED USE

HI510 is a universal process controller that supports continuous measurement of process parameters with dedicated digital probes, such as HI1006-1805 for pH & Temperature and HI2004-1805 for ORP & Temperature.
It can be configured for a wide range of applications requiring monitoring and / or control of process parameters.

It's designed to adapt to every user's unique process control requirements, and thus provides a high degree of flexibility for all hardware inputs and outputs, and software-defined functions. This includes from 5V up to 24 Vdc digital inputs, and flexible function assignments for relays regarding process control, cleaning or Hold mode.

Hanna Instruments dedicated smart probes allow for shared management of settings between controller and probe, where the controller manages only settings related to the intended application, as defined by requirements of the industrial process, and the probe manages settings and warnings related to measurements, including temperature compensation and buffer calibration. Smart technology enables optimization of probes for specific applications, such as different temperatures or pH ranges.

The controller is intended to use in industrial environments, and as such is suitable for wall-, pipe- and panel-mounting installations. It has a low profile vulcanized rubber keypad for all operations, blue LEDs to indicate when relays are energized, multi-color LEDs for detailed inspection of status, and EMI protected RS485 interface to probe, and remote control and monitoring port. It also provides an intuitive interface for control setup, relay activation, alarm signaling or hold status, and a help and diagnostic feature that guides users to identify the problems and suggests possible action(s) to be taken. Safety features include fuse-protected relays and a hold-to-safe-values mode.

Programming is done through the keypad or the RS485 connection, which requires a PC running the HI92500 Windows compatible software.

MAIN FEATURES

PROCESS INPUT	• Smart probes with RS485 connection. Automatic probe recognition and upload of settings configuration and measurement data
MENUS	• Easily navigable main menu and submenus
ANALOG OUTPUTS	• Two or four, depending on the controller model, galvanically isolated, (0-20 or 4-20mA)
ALARM RELAY	• Activates on errors and programmable alarm conditions
CONTROL RELAYS	• Up to five programmable SPDT contact outputs 5A-250 Vac, 5A-30 Vdc
CLEANING FUNCTION	• Integral water or chemical cleaner control • Simple or advanced cleaning is configurable to be triggered manually, triggered at a set time interval, scheduled for a specific day of the week or triggered by a digital input • Blowers, water jets, washers (user supplied)
BACKLIT DOT MATRIX LCD DISPLAY	• With virtual key function
ENCLOSURE	• Rugged molded housing with hinged front panel

4.1. ADDITIONAL FEATURES

HOLD MODE	• Automatic mode for entering calibration, Setup and cleaning cycle • Can be triggered manually or via an external digital input
?DIAG key (?DIAG)	• User help key, opens a guide for diagnosing a problem or troubleshooting
SECURITY ACCESS CODE	• Protected calibration and setup settings
LANGUAGES	• Allows language used for settings and messages to be changed to a supported one, according to user preferences e.g. Francais, Magyar, Italiano, Nederland, Portugues, Deutsch, Español • Default operating language, English
REMOTE CONTROL	• HI92500 remote PC-based application, using RS485 connection • Allows remote access for monitor and control of process parameters
USB-C PORT	• USB for exporting (or importing) data with a flash drive

DATA LOGGER & EVENT LOGGER	• The controller automatically logs the process control information in an interval log, and various event alarms and errors in an event log • Logged data can be retrieved and events visualized on the screen, in Log Recall menu • Interval logs store up to 8600 records, maximum number is 100. • Logging interval can be set in the General settings menu • The logged data includes: pH (or ORP) and temperature measurements, last calibration data, setup configuration, event data, event code, start date and time, end date and time, previous value, mV value of the parameter • Event log can store up to 100 records of events, alarms, errors related data • Log files can be uploaded to a USB flash drive via USB-C port
MANUAL MODE	• Used to exercise relays and analog outputs • Useful for setting up the system, filling up the pump circuit, checking the cabling wiring, and during general maintenance • Default option when the industrial application requires manual input • As a safety feature, a 60-minutes timeout is implemented before relays turn off and analog outputs return to their previous value before entering Manual Mode

CALIBRATION	• pH single point process calibration, or calibration up to three-points, using two buffer sets:
	  • Hanna Instruments – 1.68, 4.01, 7.01, 10.01, 12.45 pH
	  • NIST – 1.68, 4.01, 6.86, 9.18, 12.45 pH
	• ORP calibration using a single point process calibration
	• Last calibration is stored in the probe and can be visualized in the Cal Data window
	• Calibration reminder can be scheduled (1 to 99 days, Off)

Note: *As a safety feature, when in Setup or Calibration mode, without making any changes or pressing any key, the controller will return to Measure mode and restart control.*

5. HI510 MODELS & DEDICATED SMART PROBES

5.1. CONTROLLER MODELS

There are two HI510 models: the HI510-0320 model, with three relays and two analog outputs, and the HI510-0540 model, with five relays and four analog outputs.

5.2. SMART PROBES

Hanna Instruments smart probes enable accurate and automated collection of data. The pH and ORP configuration schemes detailed below list all the combination, flat tip, PVDF-body, polymer filled electrodes with matching pin and operating pressure of up to 6 bar (87 psi).

pH electrodes

HI10 [w] – [x] [y] [z]		
w =	**06**	PTFE junction
	16	Ceramic junction
x =	**1**	LT (Low Temperature) glass sensor -5 to 80 °C (23 to 156 °F) 0 to 12 pH
	3	HT (High Temperature) glass sensor, titanium matching pin 0 to 100 °C (32 to 212 °F) 0 to 14 pH
	4	HF (Fluoride-resistant) glass sensor*
y =	**8**	**Smart probe**, with RS485 connection
z =	5, 10, 15, 25, 50 cable length (meters)	

*F^- < 2g/L, temperature < 60 °C, pH > 2

ORP electrodes

HI20 [w] – [x] [y] [z]		
w =	**04**	PTFE junction
	14	Ceramic junction
x =	**1**	Platinum sensor
	2	Gold sensor
y =	**8**	**Smart probe**, with RS485 connection
z =	5, 10, 15, 25, 50 cable length (meters)	

6. FUNCTIONAL & DISPLAY DESCRIPTION

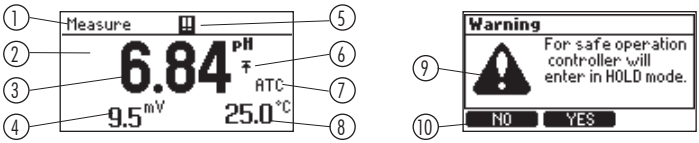
6.1. FRONT PANEL

- The front panel includes a graphic display and keypad with tactile feedback.
- The first LCD line displays information regarding controller status, the second LCD line displays measurement readings, and the third LCD line displays the temperature value or additional messages.
- Two LEDs, ALARM and STATUS, indicate alarm and status conditions.
- HOLD LED lights up yellow indicating controller HOLD status.
- Depending on the model, up to five additional LEDs light up blue, indicating relay status.

1 Alarm & Control relay LEDs
2 Keypad
3 Cable glands
4 Graphic Display (LCD)
5 Hold LED
6 USB-C Port
7 Status LED
8 Captive spring loaded screws

Figure 1: Front Panel & Keypad Description

6.2. MAIN DISPLAY FUNCTIONS



① Title & Status area

② Main reading display area

③ Main reading value

④ Raw reading area (mV)

⑤ Warning (**!**) or Alarm (**!!**) icon, press ?DIAG key (?DIAG) for description

⑥ Displayed parameter alarm status (high or low)

⑦ Temperature Compensation status

⑧ Temperature reading area

⑨ Warning icon

⑩ Virtual key option

6.3. KEYPAD DESCRIPTION

There are six functional keys and three virtual keys that change function with the display above.

Functional Keys

- The Menu direct key (☰) permits access to calibration and Setup parameters.
- The diagnostic (?DIAG) direct key (?DIAG) is a help and diagnostics key that opens a guide for Setup or diagnosing a problem or troubleshooting.
- The back functional key (⮌) returns the user to previous hierarchical menu level. It also performs an exit or escape function.
- The directional arrow keys (▲ ▼ ▶) move the user through the menu and submenu in either direction. They may be used to increment one position, or to move continuously through a menu or string of values by holding the key in the depressed position.

Virtual Keys

The three virtual keys (■) (■) (■) perform the functions displayed on the bottom of the display screen. Virtual keys can be used to set or modify parameters values or to access, export or delete log files.

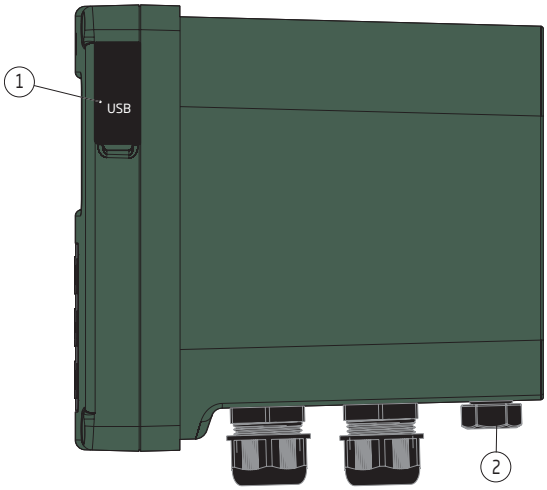
6.4. CONTEXTUAL HELP

- HI510 offers an interactive contextual help mode that assists the user at any time.
- To access the help screen, press the diagnostic (?DIAG ?DIAG) key. The instrument will display additional information related to the current screen. To read all the available information, scroll the text using the ▲▼ keys.
- To exit help mode, press the back (⮌) key and the controller returns to the previous screen.

6.5. USB-C PORT

The USB-C port is located on the right side of the controller. Users can connect a USB flash-drive (either directly or through an adapter) or a cable, to this port.

Note: *The flash drive should not be pulled out of the USB-C port while it is still in operation.*



1 USB-C Port
2 Venting element

Figure 2: USB-C Port & Venting Element

6.6. OPENING THE ENCLOSURE

The front panel is hinged at the front of the enclosure for easy access to wiring locations. To open the enclosure, loosen the four captive screws enough for the springs to push them out.
Selection of mounting location should be such that allows the front panel to swing open fully and that there is adequate room around the mounting location for wire routing.

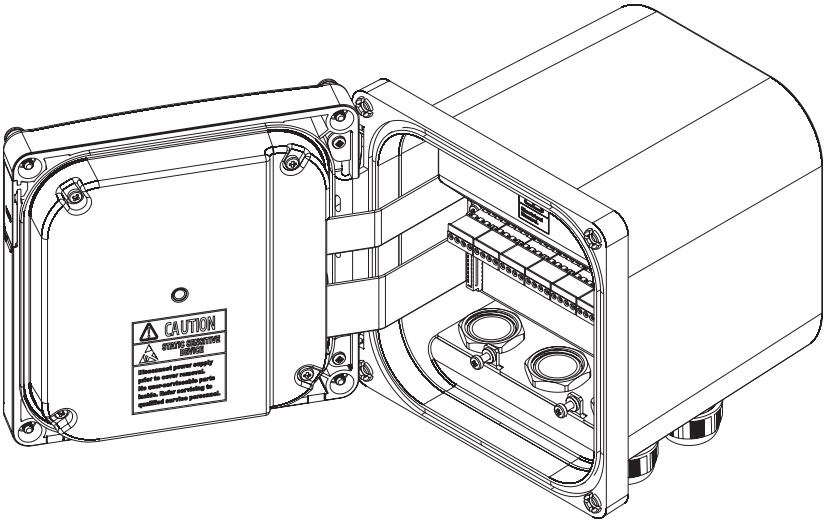


Figure 3: HI510 Enclosure Opened

Figure 4: Hinged Front Panel

7. INSTALLATION

7.1. GENERAL GUIDELINES

- HI510 Process Controller is suitable for outdoor use, but installation in direct sunlight or in areas of extreme temperature is not recommended.
- Based on controller specifications, installation thermal conditions are in the -20 °C to 50 °C (-4 to 122 °F) range.
- The controller should be installed in an area where vibrations and electromagnetic interference are minimized.
- Unused cable conduit entries must be securely sealed with Type 4X or IP66 conduit plugs, to maintain the ingress protection rating.
- Easy access to the controller should be available at all times.
- Safety precautions must be observed at all times! See SAFETY MEASURES section for details.
- The versatile HI510 enclosure design supports surface or wall-mount, panel-mount and pipe-mount installations.

7.2. WALL MOUNT (OR SURFACE MOUNT)

Wall-Mount Support Surface & Inside Depth Dimensions

- at least 208 mm (8.2 ") wall support surface, if the mounting plate is mounted horizontally.
- at least 108 mm (4.3 ") wall support surface, if the mounting plate is mounted vertically.

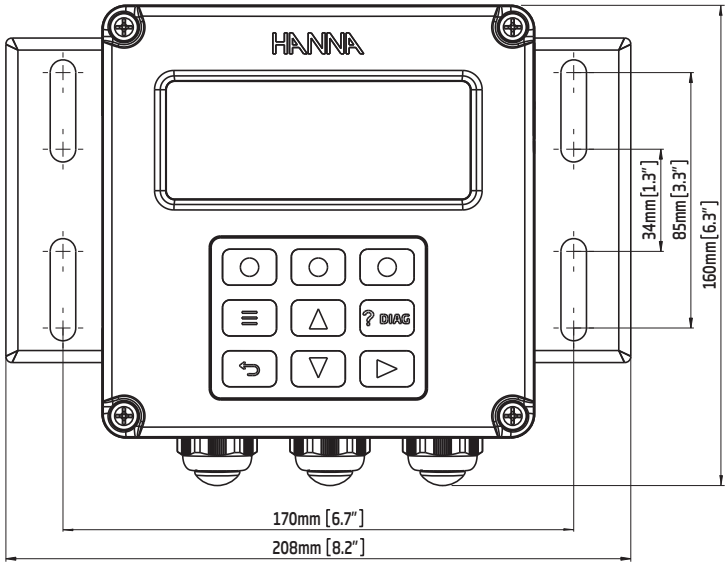


Figure 5: Wall-Mount Panel, Slots Dimensions

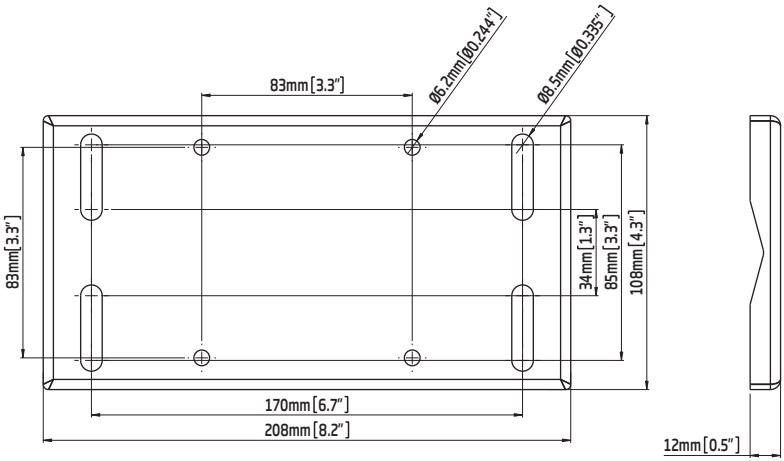


Figure 6: Wall-Mount Panel Thickness, Mounting Bolts & Slots Dimensions

The minimum depth required by HI510 fastened to a 12 mm (0.5 ") mounting plate is 163 mm (6.4").

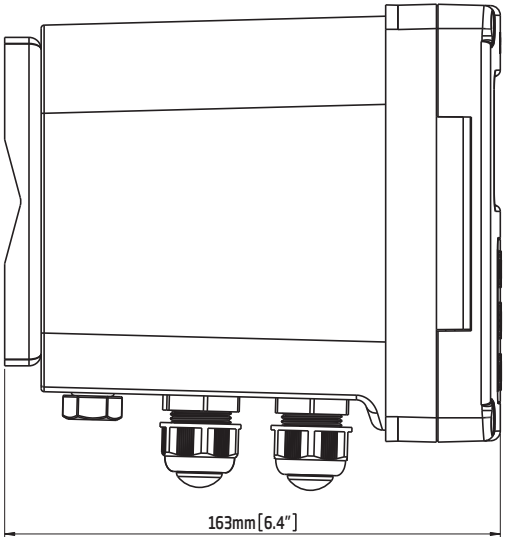


Figure 7: HI510 Controller Fastened to Wall-Mount Panel

Wall-Mount Hardware & Steps

The controller can be mounted on a wall using a wall-mount panel that can be fixed in a horizontal or vertical position.

Use the wall-mount panel and appropriate hardware. See table, description column, for details.

The mounting kit does not include the fasteners required for attaching the wall-mount panel to the wall. Selection of fasteners type and length must be based on wall type (concrete, brick, metal, wood), and wall thickness.

Note: *The four slots in the wall-mount plate are for user-supplied mounting fasteners between Ø 6.0 mm (1/4") and Ø 8.0 mm (5/16").*

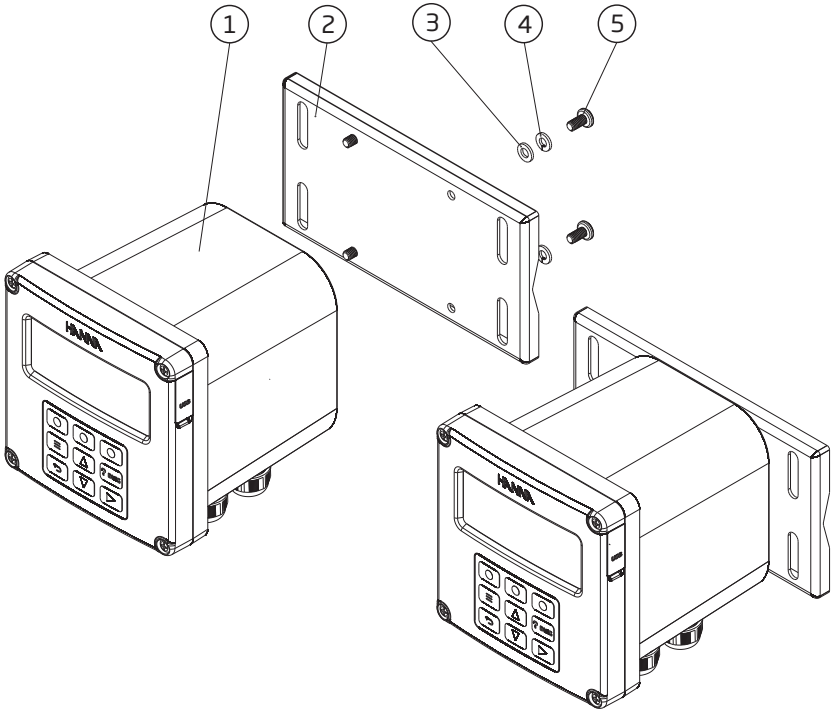


Figure 8: Wall-Mount Schematic

Wall-Mount Hardware

Label	Description	Quantity
1	Process controller	1 pc.
2	Zinc-plated, wall-mount panel	1 pc.
3	Plain washer for M6 screw	4 pcs.
4	Spring washer for M6 screw	4 pcs.
5	M6 x12 mm screw (DIN 7985)	4 pcs.

To wall mount the controller:

1. Select the position desired for the controller and following the dimensions indicated in Figure 6, drill the holes required for attaching the wall-mount panel to the surface. The drill size depends on the fasteners dimension required by wall type and thickness.
2. Fasten the wall-mount panel to the controller following Figure 8 schematic, and using supplied screws and washers.
3. Fasten the mounting panel to the wall (surface), using four bolts.
4. For horizontal wall mount, use a leveling tool to adjust the controller in correct horizontal position.

7.3. PANEL MOUNT

Inside Depth, Width & Height Dimensions

- 122 mm (4.80") minimum inside depth i.e. the dimension it extends behind the panel
- 138 mm (5.4 ") width x 138 mm (5.4 ") height
- panel thickness can go up to 10 mm (0.39 "), depending on material

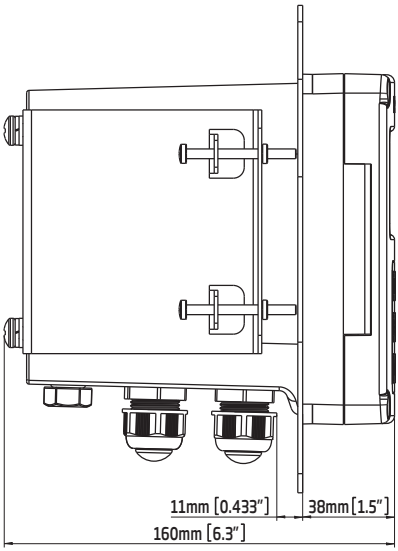


Figure 9: Panel Mount, Inside Depth

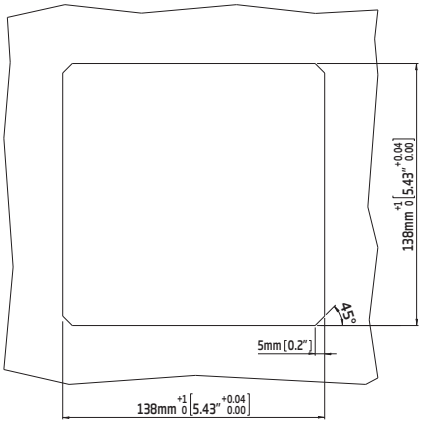


Figure 10: Panel-Mount Cutout

Panel-Mount Hardware & Steps

The controller can be mounted in a panel. Use two brackets and appropriate, supplied hardware that includes external gasket and several types of screws. See table, description column, for details.

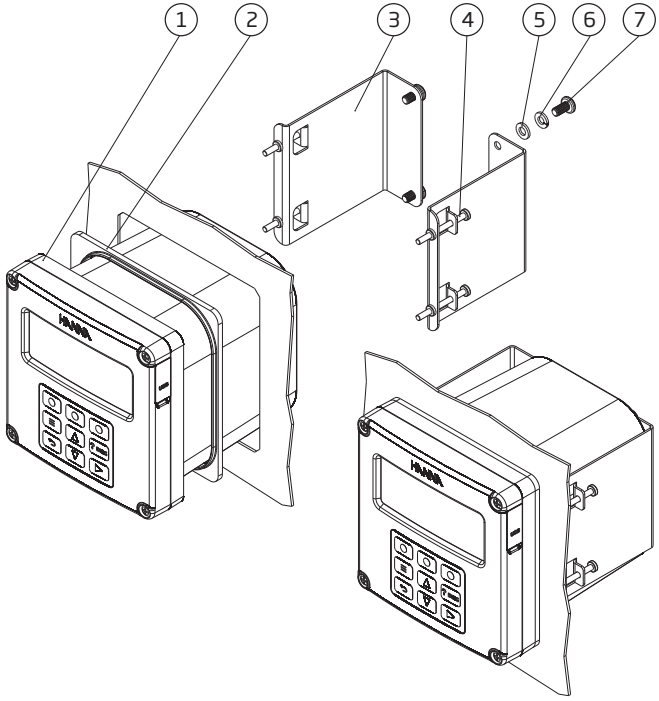


Figure 11: Panel-Mount Schematic

Panel-Mount Hardware

Label	Description	Quantity
1	Process controller	1 pc.
2	External gasket	1 pc.
3	Panel bracket, 100 mm (3.93") long	2 pcs.
4	M4 x 45 mm screw (DIN 7985)	4 pcs.
5	Plain washer for M6 screw	4 pcs.
6	Spring washer for M6 screw	4 pcs.
7	M6 x 12 mm screw (DIN 7985)	4 pcs.

To mount the controller on a panel:

1. Select the position desired for the controller on the panel, and make the cutout following dimensions indicated in Figure 10. Smooth the cutout edges so as not to damage the gasket or to scratch the controller during assembly.
2. Unscrew all six M20 cable glands using an M24 socket or wrench (Figure 12, part A).
3. Keep the venting element (Figure 2, label 2) in position.
4. Slide the gasket onto the controller and place controller into panel cutout from the front of the panel.
5. Using screws and washers, screw the brackets to the controller from back side. Screw M6 x12 mm screws into bracket and tighten against the back of the panel.
6. Screw the six cable glands (Figure 12, part B) back in place.
7. Connect the protective ground wires ⏚ (Figure 12, part C).

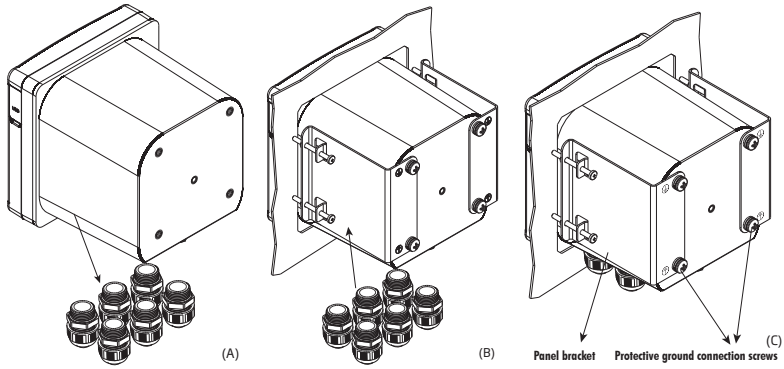


Figure 12: Panel-Mount Steps, Parts (A) (B) (C)

7.4. PIPE MOUNT

Pipe-Mount Hardware & Steps

The controller can be mounted vertically or horizontally on a pipe. Use a mount plate and U-bolts together with supplied hardware that includes hex nuts and several types of screws. See table, description column, for details.

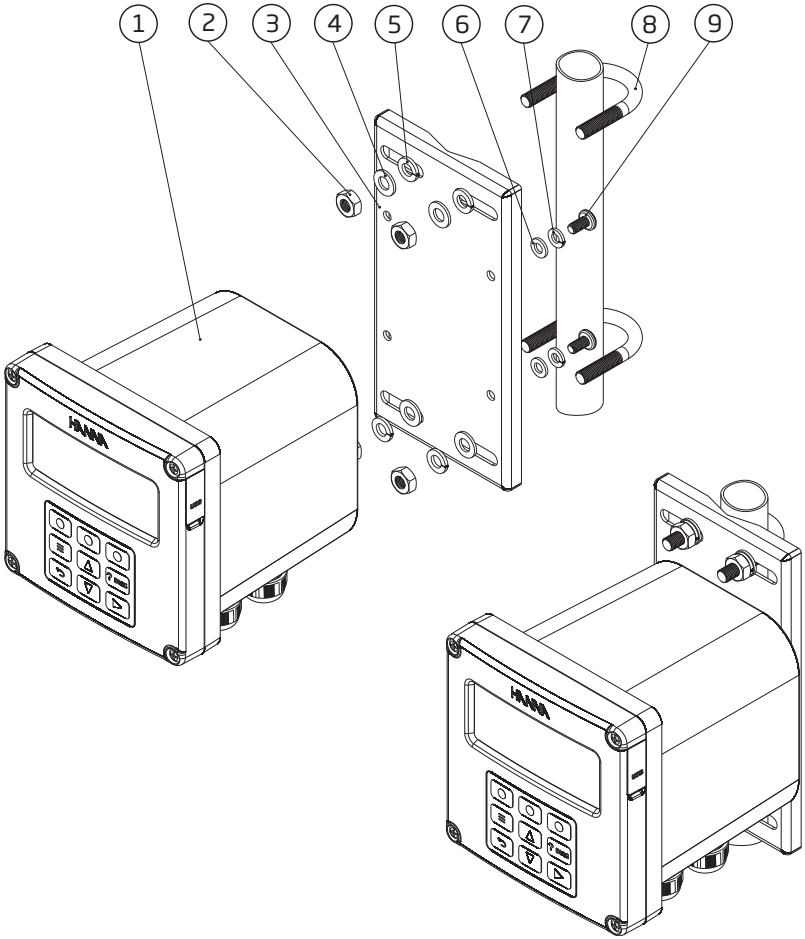


Figure 13: Pipe-Mount Schematic & Vertical Pipe Mount

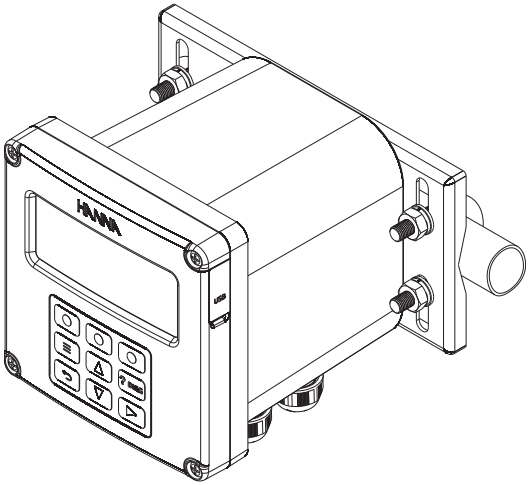


Figure 14: Horizontal Pipe Mount

Pipe-Mount Hardware

Label	Description	Quantity
1	Process controller	1 pc.
2	Hex nut M8	4 pcs.
3	Mount plate	1 pc.
4	Plain washer for M8 screw	4 pcs.
5	Spring washer M8 screw	4 pcs.
6	Plain washer for M6 screw	4 pcs.
7	Spring washer for M6 screw	4 pcs.
8	U-Bolt 1"	2 pcs.
	U-Bolt 1 ½"	2 pcs.
	U-Bolt 2 ½"	2 pcs.
9	M6 x12 mm screw (DIN 7985)	4 pcs.

To mount the controller on a pipe:

1. Fasten mounting plate to controller, using hardware detailed in the hardware table.
2. Measure the pipe diameter and select the appropriate U-bolt size. The mounting kit includes three U-bolt sizes, for pipe size from 3/4" to 2 ½".
3. Attach the controller to the pipe and secure it using the U-bolts, washers, and nuts.

8. WIRING THE HI510 PROCESS CONTROLLER

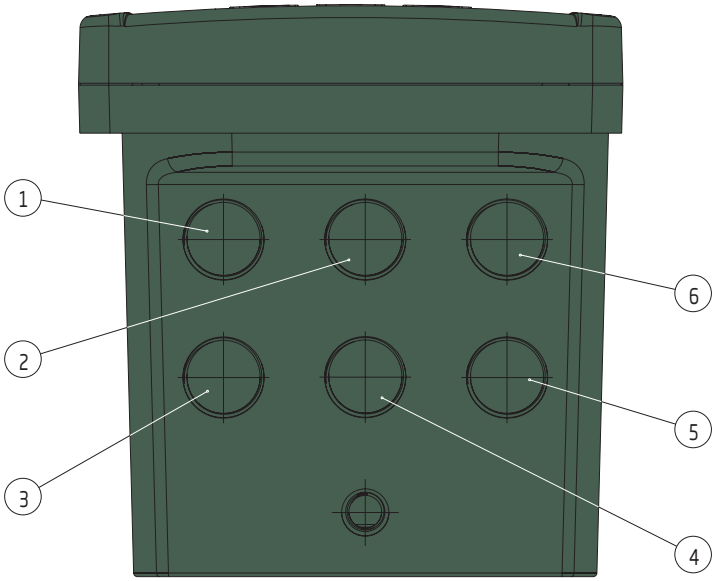
8.1. GENERAL INFORMATION

HI510 universal process controller is easy to wire. To access the wiring locations, loosen the four captive screws, on the front of the hinged panel, enough for the springs to push them out. Grasp the front bezel on the right side and swing the bezel open to the left.

A two-deck connection system is used to wire up the controller. A lower deck connection board (see Figure 18 Terminal 1), protected by an extra cover, is used for wiring relays and power source. An upper deck board (see Figure 18 Terminal 2) is used for low-power signal connections e.g. probes, digital inputs and analog outputs. Both boards have a fixed part and plug in / push out connectors for wire connections. Connectors and wires are protected by an IP65 enclosure.

8.2. PREPARING CONDUIT OPENINGS

- There are six conduit openings used for sealing the connection cables. Conduit openings accept 6-12 mm (0.237-0.472 ") cables.
- To keep the enclosure IP65 protected, block the unused openings with IP65 conduit plugs.



1. PC Communication
2. Probe
3. Alarm Relay
4. Control Relays
5. Power
6. Analog Outputs & Digital Inputs

Figure 15: Conduit Openings

Assembly drawing of an exposed cable gland, with the seal entering from the external part, and with the parts shown on each side of the enclosure wall

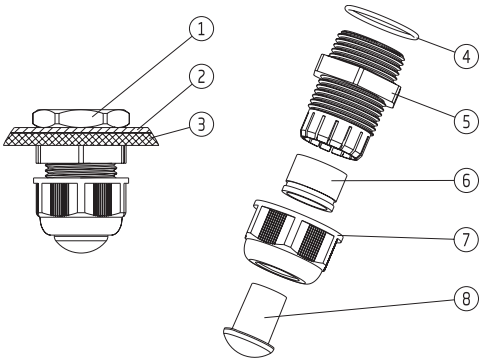
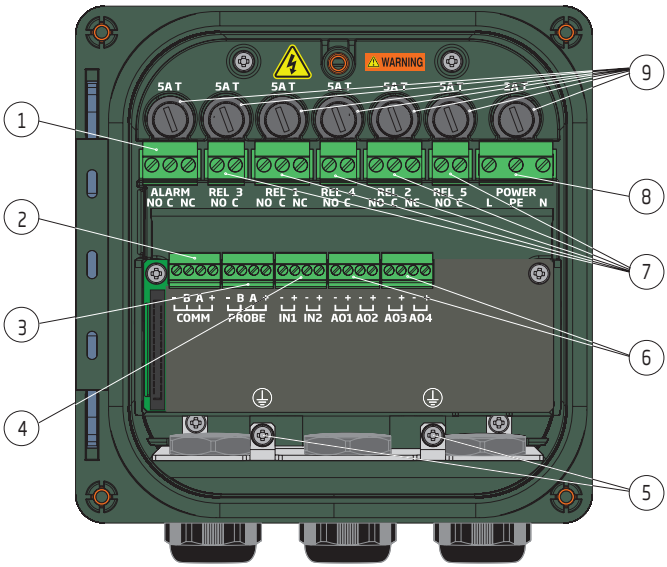


Figure 16: Exposed Cable Gland Schematic

Label	Description
1	Metallic nut
2	Metallic base plate
3	Enclosure wall
4	Cable gland seal
5	Cable gland body
6	Cable seal
7	Cable gland nut
8	Blank plug

8.3. WIRING THE CONTROLLER

- Easy access to HI510 installation terminals — push in and plug out — enable quick wiring.
- High voltage connections, i.e. power (8), alarm (1) and control relays (7) are made to the Terminal 1 block under cover.
- Low voltage connections, i.e. RS485 (2), probe (3), Digital Inputs (4) and Analog Outputs (6) are made to the raised terminal block (Terminal 2).
- Follow the lead markings (+ positive / – negative) to ensure that output leads are wired to the correct position on the main board.
- Run the connector cable through the designated opening and using a screwdriver, connect the connector cable leads to the appropriate connector jack and plug them in the corresponding socket.



1. Alarm Relay Connector
2. RS485 Communication Port
3. Probe Connector
4. Digital Inputs Connectors
5. Protective Ground Connections
6. Analog Outputs Connectors
7. Relay Connectors
8. Power Connector
9. Fuses

Figure 17: Signal Board & Output

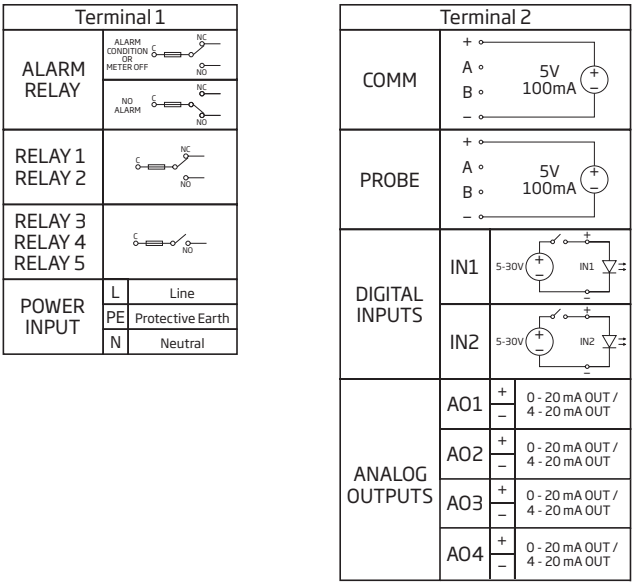


Figure 18: Input Values

8.3.1. Control Relay Wiring

Up to five control Relays are supplied with the controller. Following the printed lead markings (NO / Normally Open, NC / Normally Closed, C / Common), users have to ensure that the relay leads on each of the relays are wired to the correct position on the power supply board.

1. Run the connection cables through conduit openings 3 and 4.
2. Using a screwdriver, connect the cable leads to the appropriate jack connectors and plug them in the corresponding sockets.

Note: *Wire gauge is load dependent. Users should not exceed relay contact's rating of 5A/250Vac or 5A/30V DC, resistive load.*

8.3.2. Alarm Relay Wiring

The alarm relay provides a contact closure which can be used as a switch to turn an external device on or off.

Note: *Alarm contacts are form C rated 5A at 250 Vac, 2A at 30 Vdc, resistive load. Fuse protected: 5A, 250V slow blow fuse.*

Fail Safe Alarm Feature

The controller is equipped with the Fail Safe alarm feature to protect the process against critical errors arising from power interruptions, power surges and human errors.
The Fail Safe alarm feature resolves these predicaments on two fronts: hardware and software.

Hardware

To eliminate problems of blackout and line failure, the alarm function operates in a "Normally Closed" state and hence the alarm is triggered if the limits set are exceeded or when the power is down.
This is an important feature since with most controllers the alarm terminals close only when an abnormal situation arises; however, due to line interruption, no alarm condition occurs.

Software

Software is employed to set off the alarm in abnormal circumstances, e.g. if the control-dosing relay is On for too long a period.
In both cases, the Alarm LED will also provide a visual warning signal.
To enter in Fail Safe mode:

- connect the external alarm circuit between the FS•C (Normally Open) and COM terminals
- an alarm will warn the user when the pH goes over the alarm thresholds, the power breaks down, and in case of a broken wire between the controller and the external alarm circuit.

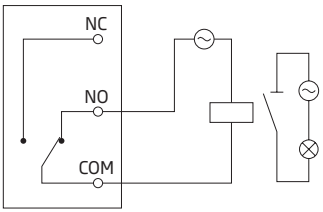


Figure 19: Connecting Alarm Circuit Between FS•C & COM Terminals

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

8.3.3. Connecting the Power Supply

Qualified personnel should perform wiring only. The personnel must have read and understood the instructions in this manual when making power connection.

- Run the power cable through the power cable gland (Figure 15, label 5). Remove the removable power connector from the power board.
- Using a screwdriver, connect the cable leads to the jack power connector.

  Note: *each leads location is marked on the power supply board.*
- Insert the power connector in the power socket. See Figure 17. Replace safety cover over terminal 2.

8.4. TERMINAL 2 WIRING

8.4.1. PROBE

1. Run the probe cable through the center front conduit opening.
2. Connect the probe leads to the removeable terminal connector marked Probe using the lead locations marked.
3. After leads are fixed in the terminal connector, carefully put the wired terminal connector into place on the board.
4. Position excess cable through the cable gland before tightening nut.
5. Remove the earth screw and hardware located below the Probe connector and attach earth lead.

8.4.2. COMM

1. Run the communication cable through the left front conduit opening.
2. Connect the cable leads to the removeable terminal connector marked COMM, using the marked lead locations.
3. After leads are fixed in the terminal connector, carefully put the wired terminal connector into place on the board. Connect the End Of Line Resistor (EOLR) as required by RS485 bus connection.
4. Feed excess cable through the cable gland before tightening nut.

8.4.3. Digital Input

The HI510 controller has two digital inputs. Digital input IN1 and IN2 may be used to activate a signaled HOLD and / or a cleaning function.

1. Run the Input cable through the right front conduit opening.
2. Connect the cable leads to the removeable terminal connector marked IN1 or IN2, using the marked lead locations. Pay attention to polarity. See Figure 18 for power requirements.
3. After leads are fixed in the terminal connector, carefully put the wired terminal connector into place on the board.
4. Feed excess cable through the cable gland before tightening nut.

8.4.4. Analog Output

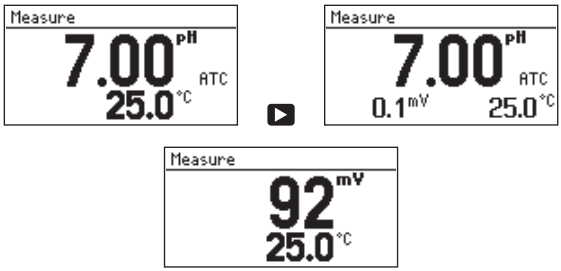
The HI510 controller has up to four analog outputs. For setup information on these see Setup Outputs.

1. Run the Analog Output cable through the right front conduit opening along with Digital input IN1 and IN2 cables.
2. Connect the cable leads to the removeable terminal connector marked AO1 – AO4, using the marked lead locations. Pay attention to polarity.
3. After leads are fixed in the terminal connector, carefully put the wired terminal connector into place on the board.
4. Feed excess cable through the cable gland before tightening nut.

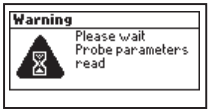
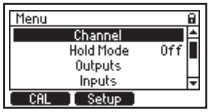
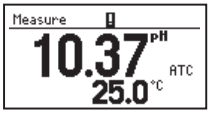
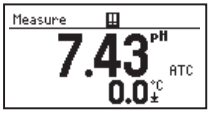
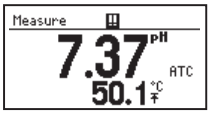
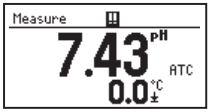
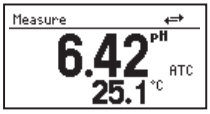
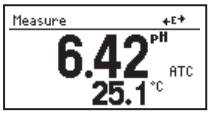
9. DISPLAY DESCRIPTION

9.1. MAIN DISPLAY

- The HI510 has a large backlit display that shows pH and Temperature or ORP (mV) and Temperature measurements in large digits.
- Screenshots below show examples of the main measurement screen for either the pH & Temperature or ORP & Temperature probe connected to the controller. It displays sensor measurement data (value and measurement unit) and temperature compensation.



9.2. ICON DESCRIPTION & FUNCTION

Symbol	Screenshot	Function
⚠		A warning symbol that requires user consent.
⌛		A warning symbol asking the user to be patient as information is read.
🔒 🔓		Displayed in the top right corner of the title & status area, indicates instrument password protection status.
!		Displayed in the middle of the title & status area, indicates a warning. Press the ?DIAG key (?DIAG) for a description of the warning and suggestion for possible action.
!!		Displayed in the title & status area, indicates an active alarm state. Press the ?DIAG key (?DIAG) for a description of the alarm and suggestion for possible action.
⭱		Displayed next to the reading (e.g. temperature reading), indicates Alarm High on the parameter.
⭳		Displayed next to the reading (e.g. temperature reading), indicates Alarm Low on the parameter.
⊗		An error symbol asking users to contact Hanna Instruments Technical Support.
⇆		Indicates the controller is connected to the PC application via RS485.
+E+		Indicates the controller is connected to the PC application via RS485 and is in editing mode.

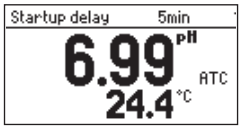
10. GENERAL OPERATIONS

10.1. POWERING THE CONTROLLER

Measure is the normal operating mode of the controller. Depending on the probe wired, and the location of the probe, the display will show measured values with appropriate measurement units.
At start-up, while the controller performs internal checks, the display will show the Hanna Instruments logo, controller name, date, and firmware version.
In Measure mode, with the probe connected, the controller detects the probe and the probe type.
With no probe connected or a new probe connected, at start-up the controller can display one of the warning messages detailed below.

Warning Message	Description
"No probe connected"	• No probe has been connected • A connection issue has been detected
"Different probe. Please set control parameters."	A different probe type (different probe series) has been connected.
"New probe. Update control settings if necessary."	A new probe (same series) has been connected.

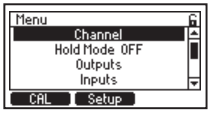
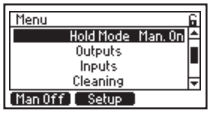
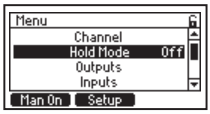
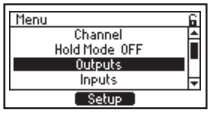
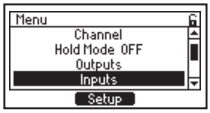
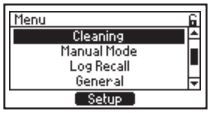
A "Startup delay" message, associated with a programmable countdown timer indication, is displayed at power on.

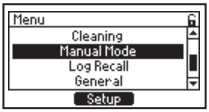
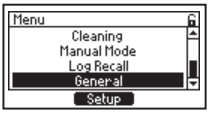


11. MENU

The MENU key (☰) is used to access menus for programming control functions and calibrating the controller. By pressing the ☰ key from the live readings display, the menu will open, revealing eight top level parameters, detailed below. Press the ▲▼ arrow keys to navigate through the list. Functions such has HOLD, probe calibration, control setting, alarm, analog, relay and input setup as well as language choice can be made through menu.

- Press the ☰ key to open up the eight top-level menu items.
- Press the ▲▼ keys to navigate up and down Menu items.
- Press the ⮌ key to return to previous hierarchical structure.
- Press the virtual key **Setup**, to enter a parameter screen or a parameter menu.

Parameter	Screenshot	Function
CHANNEL		Enables users to configure or view probe calibration Enables users to Set or view probe, control and alarm related functions, to set probe, control and alarm parameters
HOLD MODE	 	Activates or deactivates manual Hold function Enables users to configure or view input Hold parameters
OUTPUTS		Enables users to configure analog outputs and relays
INPUTS		Enables users to configure or view digital inputs status
CLEANING		Starts or stops cleaning cycle and enables users to configure or view cleaning parameters

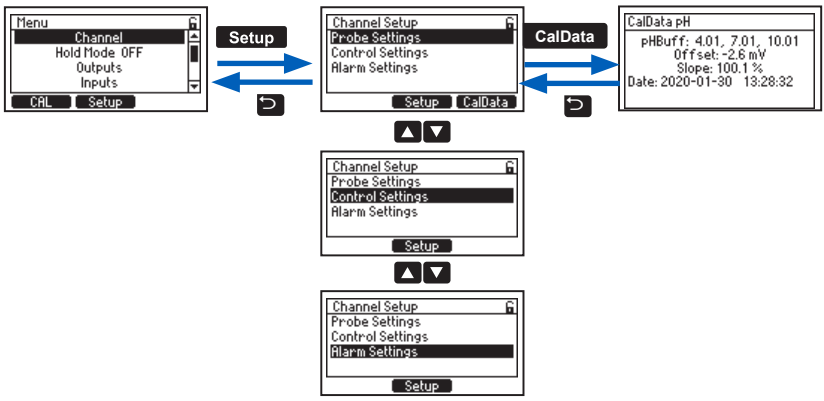
Parameter	Screenshot	Function
MANUAL MODE		Enables users to directly drive the relays or analog outputs
LOG RECALL		Enables users access to logged data, file transfer to USB stick
GENERAL		Enables users to configure or view general settings e.g. log interval, password, date and time, language selection, setting RS485 communication parameters, setting controller ID

11.1. CHANNEL, CAL

Channel is the first item under Menu selections.

When Channel is selected, **CAL** and **Setup** virtual keys are visible.

- Selecting **Setup** opens a submenu structure that includes Probe Settings, Control Settings, and Alarm Settings.
- Selecting **CAL** opens the probe calibration menu.



Navigation

- From Main Menu, press the ▲▼ keys to move to Channel setup.
- With Probe Settings selected, press **Setup**, to enter the screen (or **CAL**, to enter calibration).
- Press the ▲▼ keys to navigate between the three Channel Setup options.
- With option selected, press **Setup** again, to enter the parameters screen.

11.1.1. Probe Calibration Mode

Navigation:

- From Main Menu, use the ▲▼ keys to move to Channel.
- With Channel selected, press **CAL**, to enter calibration.

Calibration mode allows users to calibrate the installed probe.

Note: *See Probe Settings section for TempOffset section.*

11.1.1.1. pH Calibration (pH Probes)

The electrode should be calibrated:

- Before installation
- Whenever the pH probe is replaced
- When higher accuracy is required
- After periodic maintenance
- After calibration TimeOut has expired

Preparation Guidelines

Calibrations performed in standard buffers follow the preparation guidelines detailed below.

- Pour a minimum 50 mL of the buffer solutions into clean beakers. If possible, use plastic beakers to minimize any EMC interferences.
- For accurate calibrations and to minimize cross-contamination, use two beakers for each buffer solution: one for rinsing the probe and one for calibration.
- Select required calibration buffer group. See Probe Settings section.
- Up to three pH buffers may be used for a calibration. At least two buffers are required to determine a pH slope.

Note: *It is recommended to select buffers that bracket the expected process pH.*

HI510 process controller allows two types of calibration procedures:

- Standard calibrations — calibrations performed in standard buffer solutions
- Process calibrations — available only if the probe has been calibrated in buffers previously

Standard Calibration

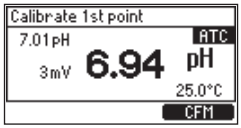
One-, two- or three-point calibration can be performed using one of the buffer solutions selected from one of the two groups:

- Hanna Instruments buffers set: 1.68, 4.01, 7.01, 10.01, 12.45 pH
- NIST buffers set: 1.68, 4.01, 6.86, 9.18, 12.45 pH

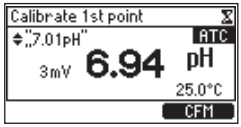
When the electrode is immersed into buffer solution, the controller automatically recognizes the buffer value. It is generally recommended to use 7.01 or 6.86 pH buffer as first calibration point.

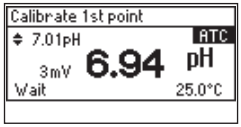
One-Point

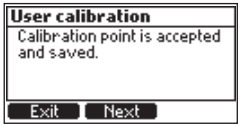
- Press **CAL**, to enter calibration mode.
- At prompt, with the password enabled, input the passcode.
- The first suggested buffer solution "7.01 pH" (if using Hanna Instruments buffer group) or "6.86 pH" (if using NIST buffer group) is displayed in the upper left of the display window.
- Immerse the pH probe approximately 4 cm (1½") into buffer solution and stir gently. The controller automatically recognizes the standard and the recognized buffer value is displayed on the LCD.
- Press **CLR**, to delete a previous calibration or **Process**, to enter process calibration.



- When the reading is stable, **CFM** is displayed. Press **CFM**, to save.
- "Wait" is displayed at the bottom of the LCD screen until calibration is saved.
- After the first point is accepted, "Calibration point is accepted and saved" is displayed.
- Select **Next**, to continue with a two-point calibration or **Exit**, to save the calibration and return to the menu.

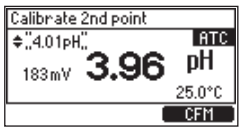


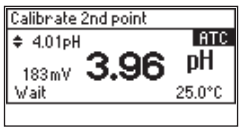


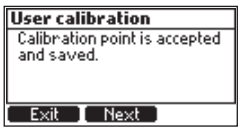


Two-Point

- After completing the one-point calibration, press **Next** to continue calibrating in a second buffer.
- Immerse the pH probe in the second calibration buffer. The buffer solution is 4.01 pH, displayed flashing, but will change to the buffer used once recognized.
- When the buffer is recognized and the reading is stable, the buffer value stops flashing and **CFM** is displayed.
- Press **CFM**, to save.
- "Wait" is displayed at the bottom of the LCD screen until calibration is saved.
- After the second point is accepted, "Calibration point is accepted and saved" is displayed. Select **Next**, to continue with a three-point calibration or **Exit**, to return to the menu.

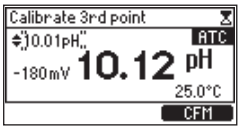


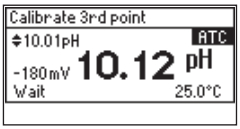


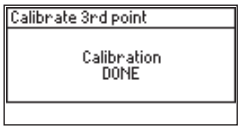


Three-Point

- Follow Two-Point calibration steps and press **Next** when prompted.
- Immerse the pH probe in the third calibration buffer. The buffer solution will be recognized and displayed flashing.
- When the reading is stable, the buffer value stops flashing and **CFM** is displayed. Press **CFM**, to save.
- "Wait" is displayed at the bottom of the LCD screen until calibration is saved. A confirmation screen is displayed next, with "DONE" displayed on last LCD line.







Notes:

One-point calibration evaluates electrode offset whereas a two- or three-point calibration evaluates both electrode offset and slope.

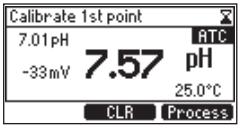
*If **Next** is selected, to continue with a two- or three-point calibration, the buffer value proposed next is displayed flashing, until the probe is immersed in the selected buffer solution. User can select from any of the buffer solutions not yet used for calibration.*

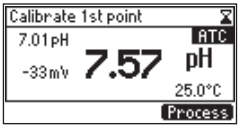
11.1.1.2. pH Process Calibration

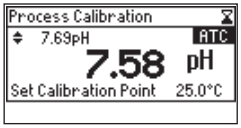
Prior to performing a process calibration, use a calibrated portable pH meter to determine the pH of the process and write down the value.

pH process calibration is a single point calibration, performed while the probe remains installed in the process. The value can be set ± 0.5 pH around measured pH.

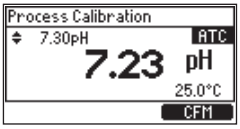
- Press **CAL**, to enter calibration mode.
- At prompt, enter the passcode.
- Once unlocked, press **CAL** again.
- Press **Process**, to enter process calibration.





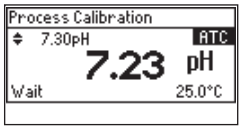


- Press the ▲▼ keys to adjust the value to the one determined with the hand held meter.

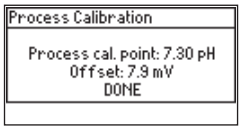


- When the reading is stable, **CFM** is available. Press **CFM**, to save the calibration.

• "Wait" is displayed at the bottom of the LCD screen until the calibration point is memorized.



• "DONE" confirmation message is displayed for a few seconds.



Note: *Process calibration evaluates electrode offset.*

11.1.1.3. ORP Calibration (ORP Probes)

ORP calibration is a single point calibration that can be performed with the probe installed in the process or with the probe removed from the process.

Preparation Guidelines

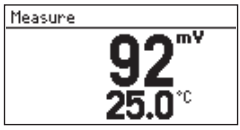
When the probe is removed from the process:

- Rinse the probe with deionized water and pat it dry with a lint-free cloth prior to calibration.
- Submerge the electrode tip (4 cm/1½") into the sample to be tested.
- Do not let the probe touch the bottom or sides of the container.
- Remove the air bubbles from under the probe tip. Stir the sample at a slow to moderate rate and wait a few seconds for the reading to stabilize.

Note: *ORP calibration standards may be used with the probe directly (HI7021 or HI7022).*

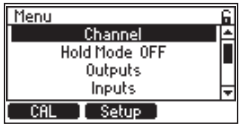
When the probe is kept installed in the process:

- Use a calibrated portable ORP meter to determine the value of the process and write down the value.



Note: *mV measurements are generated by the ORP electrode and displayed with 1 mV resolution.*

Channel is the first item under Menu selections. When Channel is selected, **CAL** and **Setup** virtual keys are visible.

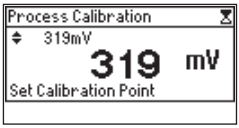


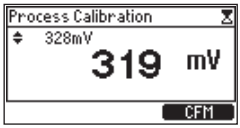
Calibration

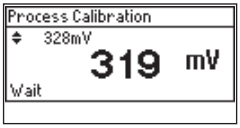
An ORP calibration is a single point calibration. The calibration point value is displayed, and the value can be adjusted ± 60 mV around the measured mV.
If an ORP calibration standard is used, the probe is removed from the process, cleaned off then placed in a beaker with the standard.

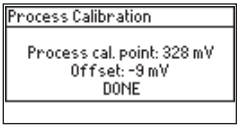
1. Press **CAL** when the instrument is in mV measurement mode. The mV value is displayed.
2. Press the ▲▼ keys to adjust the value.
3. After the reading has stabilized and the mV offset is inside the offset window, **CFM** virtual key is displayed. Press **CFM**, to confirm ORP calibration.

The instrument will return to the main menu.



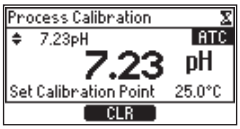


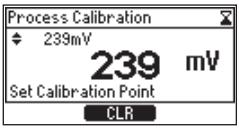




11.1.1.4. pH (ORP) Clear Calibration

1. Press **CAL**, to enter calibration mode.
2. **CLR** option is displayed for a few seconds.

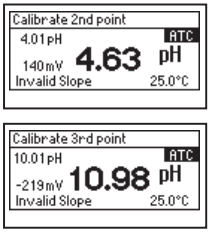
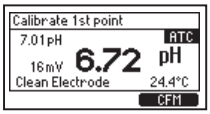
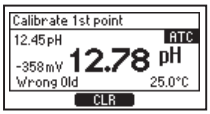
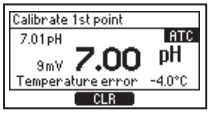




3. Press **CLR**, to clear previous calibration.

4. Press **Yes**, to confirm calibration.

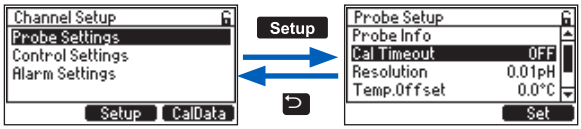
11.1.1.5. pH Calibration Messages & Warnings

Message	Recommended Action	Screenshot
"Invalid Slope" The electrode slope is outside accepted slope limit. Calibration can not be confirmed.	Verify the probe is in the buffer selected and that the buffer is fresh.	
"Clean Electrode" The offset, evaluated at first calibration point, is outside the accepted window; or the slopes, evaluated between calibration points, are outside the accepted lower limit. Calibration can be confirmed.	Clean the probe to improve the pH electrode's response. See PROBE CONDITIONING & MAINTENANCE section for details. Repeat the calibration after cleaning.	
"Wrong Old" The slope evaluated based on a comparison between new and old calibration points is outside the accepted limits.	Clear calibration and proceed with a new one.	
"Temperature Error" The temperature of the buffer solution is outside accepted temperature solution interval.	Check buffer temperature and repeat the measurement.	

11.1.2. Probe Settings (Accessible with Probe Connected Only)

Navigation

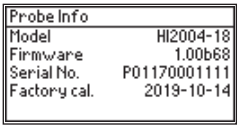
- To access the Probe Settings submenu, press **Setup** from Channel Setup.



- Press the ▲▼ keys to navigate between parameters.
- Select from virtual keys **View**, **Set** or **Modify**.
- Press the ⮌ key to return to the menu without saving.
- At prompt, enter the passcode.
- At prompt, press **YES**, to place unit in HOLD.

Probe Info (all Probe Types)

Option: probe specific

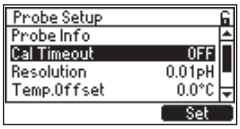


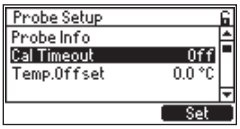
Calibration Timeout (all Probe Types)

Option: Disabled, 1 to 99 days

With Cal Timeout selected, press **Set**, to modify. Press the ▲▼ keys to modify the flashing value and **CFM** to save.

Cal Timeout is used to send a reminder to recalibrate the probe. A ! will be displayed in the Title & Status area. Pressing the ?DIAG key will indicate calibration message.

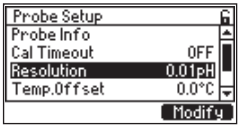


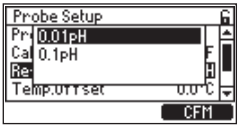


Resolution (pH Probe Only)

Option: 0.01 pH, 0.1 pH

With Resolution selected, press **Modify**. Press the ▲▼ keys to navigate between the two possible options.





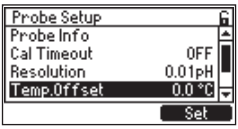
Note: *Resolution only affects the displayed pH measurement.*

Temp. Offset (all Probe Types) & Temperature Calibration Procedure

Option: -5.0 to 5.0 °C, -9.0 to 9.0 °F

With Temp. Offset selected, press **Set**. Press the ▲▼ keys, to modify the flashing value and **CFM**, to save. A positive value adds to the displayed temperature. A negative value decreases the displayed temperature value.

To obtain the temperature offset, see step 3, Temperature Calibration procedure.



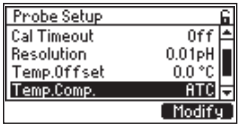
Temperature Calibration Steps

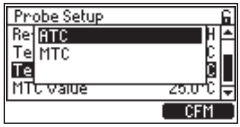
1. Place the probe and a reference thermometer (with 0.1° resolution) into a stirred container of water.
2. Observe the temperature on display until it stops changing. This may take several minutes.
3. Calculate the Temp.Offset (reference thermometer temperature minus probe temperature).
4. Press the MENU key (☰) from the Measure mode.
5. Select **Setup** from Channel parameter.
6. Press **Setup**, with Probe Settings selected.
7. Press the ▲▼ keys to scroll to Temp.Offset, then **Set**.
8. At prompt, enter the passcode.
9. At prompt, press **YES**, to place unit in HOLD.
10. Adjust blinking digits to the Temp.Offset calculated at step 3. Press **CFM**.
11. Press the ⮌ key to exit, and at prompt, confirm the change.

Temperature Compensation (pH Probes Only)

Option: ATC, MTC

With Temp Comp. selected, press **Modify**. Press the ▲▼ keys to select between Automatic (ATC) or Manual Temperature Compensation (MTC).

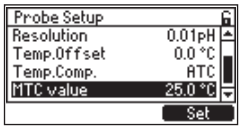




MTC Value (Probe Specific)

Default value is 25°C

With MTC value selected, press **Set**, to modify the value. Press the ▲▼ keys to modify the flashing value, down to minimum or up to maximum probe limits (e.g -5.0 °C and 80 °C) and press **CFM**, to save. This temperature is used if Temp.Comp. is set to MTC (Manual Temperature Compensation).



Cal. Buffer Group (With pH Probe Only)

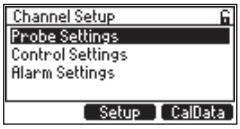
Option: Hanna, NIST

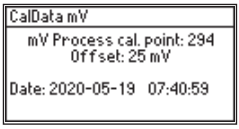
With Cal.BufferGroup selected, press **Modify**. Use the ▲▼ keys to select between Hanna or NIST buffers. Press **CFM,** to save selection.

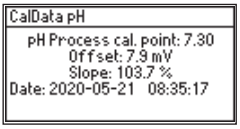
CalData

To access the CalData display option:

- Press **Menu** while in Measure mode, followed by **Channel Setup**. The **CalData** key is displayed.
- Press **CalData** and the last detailed calibration data will be displayed along with the date and time of the calibration.





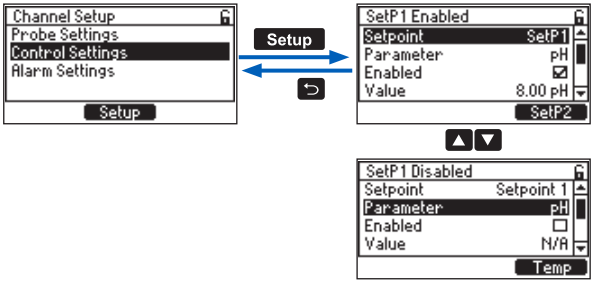


11.1.3. Control Settings

Settings that are part of a process control system are set in this submenu.

Navigation

- Press MENU (☰) from the Measure mode.
- Select **Setup** from Channel parameter.
- Select **Setup** with Control Settings highlighted.
- Press the ▲▼ keys to move between parameters.



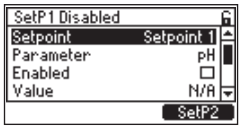
Note: *We suggest users make configuration changes from the beginning of the menu structure going forward, because the menu references parameters that were set earlier in the submenu.*

Navigation

- With Control Settings selected, press **Setup**, to enter the menu.
- Press the ▲▼ keys to move between options.
- At prompt, enter the passcode.
- At prompt, press **YES** to place unit in HOLD.

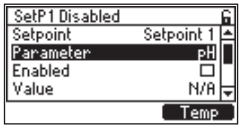
Setpoint

Option: Setpoint 1, Setpoint 2
With Setpoint selected, press **SetP1** (setpoint 1). Start with **SetP1** selection. Repeat the entire process with **SetP2**, if desired.



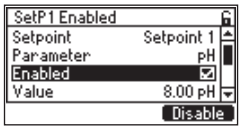
Parameter (Probe Specific)

Option: pH, ORP (probe connected), Temperature
With Parameter selected, press **pH (ORP)** or **Temperature**, and press the ⮌ key to save or ▼ key to move to next parameter.



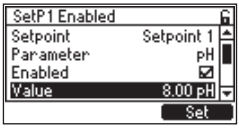
Enabled

Set point option has to be enabled to set up the Control function.
With Enabled selected, press **Enable** or **Disable**. A check mark will appear to confirm selection. Press the ⮌ key, to exit or ▼ key to move to next parameter.



Value

This parameter defines the Set point value. With Value selected, press **Set**. Press the ▲▼ keys to edit the required value within minimum / maximum probe limits (e.g. 0.00 to 12.00 pH), displayed blinking. Press **CFM**, to save.



Mode

Option: ON/OFF, Proportional, PID

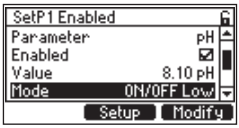
The Mode parameter defines the type of control the controller will use: ON/OFF, Proportional or PID. The **Setup** virtual key is used after selecting **Mode**, to set additional settings. See SECTION 14 for detailed information on Control Modes & Algorithms.

Navigation

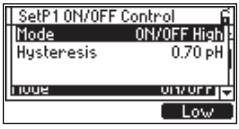
- To open the drop-down list for Mode, press **Modify**.
- Press the ▲▼ keys to select mode type: ON/OFF, Proportional or PID.
- Press **Select**, to save.
- After selecting **Mode**, press **Setup**.

Setup for ON/OFF control

- For the drop-down list to be displayed, press **Setup**.



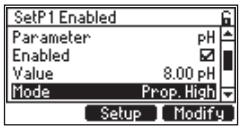
- Press the ▲▼ keys to move between Mode and Hysteresis.



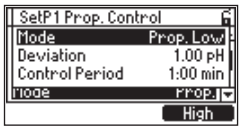
- Select Mode and press the virtual keys to choose ON/OFF Low or ON/OFF High.
- Press the ▼ key, to select Hysteresis.
- With Hysteresis (default value 1.00 pH) highlighted, press **Set.** The present value will blink permitting editing, within minimum 0.02 pH and maximum 1.80 pH, using the ▲▼ keys.
- Press **CFM**, to save.
- Press the ↩ key, to exit Setup.

Setup for Proportional control

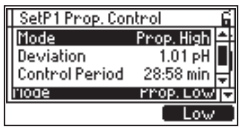
- For the drop-down list to be displayed, press **Setup**.



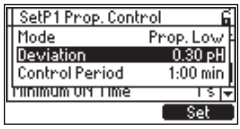
- Press the ▲▼ keys to move between Mode, Deviation, Control Period and Dead Band.



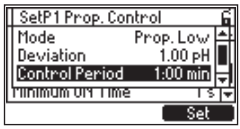
- Select Mode and press the virtual keys to choose Prop. Low or Prop. High.



- Press the ▼ key to select Deviation.
- With Deviation (default value 1.00 pH) highlighted, press **Set**. The present value will blink permitting editing, within minimum 0.02 pH and maximum 9.00 pH, using the ▲▼ keys.

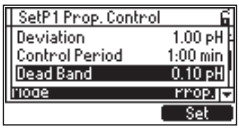


- Press **CFM**, to save.
- Press the ▼ key, to select Control Period.
- With Control Period (default value 1.00 minute) highlighted, press **Set**. The present value will blink permitting editing, within minimum 10 s and maximum 30.00 minutes, using the ▲▼ keys.



- Press the ▼ key, to select Dead Band.

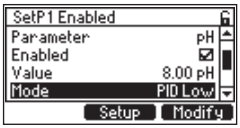
- With Dead Band (default value 0.02 pH) highlighted, press **Set**. The present value will blink permitting editing, within minimum 0.00 pH and maximum Deviation value divided by 5, using the ▲▼ keys.

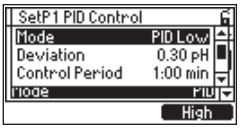


- Press **CFM**, to save
- Press the ⮌ key, to exit Setup.

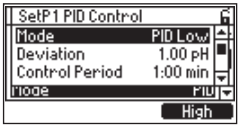
Setup for PID control

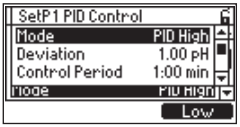
- For the drop-down list to be displayed, press **Setup**.
- Press the ▲▼ keys to move between Mode, Deviation, Control Period, Reset Time, Rate Time, Dead Band and Dead Band Gain.



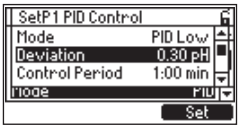


- Mode: press the virtual keys, to choose PID Low or PID High.

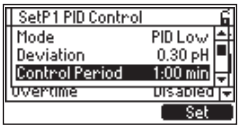




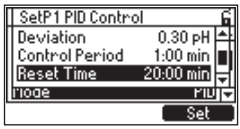
- Press the ▼ key, to select Deviation.
- With Deviation highlighted, press **Set.** The present value will blink permitting editing using the ▲▼ keys.



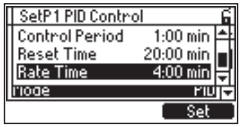
- Press **CFM**, to save.
- Press the ▼ key, to select Control Period.
- With Control Period highlighted, press **Set**. The present value will blink permitting editing using the ▲▼ keys



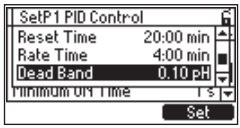
- Press **CFM**, to save
- Press the ▼ key, to select **Reset Time**.



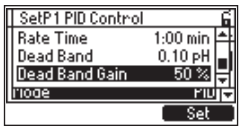
- With Reset Time (default 16:40 h) highlighted, press **Set**. The present value will blink permitting editing, within minimum 1 minute and maximum 16:40 h, using the ▲▼ keys. The default value disables the Integrative contribution.
- Press the ▼ key, to select **Rate Time**.
- With Rate Time (default value 0 s) highlighted, press **Set**. The present value will blink permitting editing, within minimum 0 s and maximum 16:40 h, using the ▲▼ keys. The default value disables the Derivative contribution.



- Press **CFM**, to save.
- Press the ▼ key, to select Dead Band.
- With Dead Band (default 0.20 pH) highlighted, press **Set**. The present value will blink permitting editing, within minimum 0.00 pH and maximum Deviation value divided by 5, using the ▲▼ keys.



- Press **CFM**, to save.
- Press the ▼ key, to select Dead Band Gain.
- With Dead Band Gain (default 0%) highlighted, press **Set**. The present value will blink permitting editing, within minimum 0% and maximum 100%, using the ▲▼ keys.



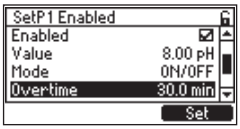
- Press **CFM**, to save.

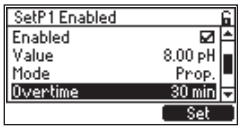
Overtime (Setpoint must be enabled first)

Option: Disabled, 10 to 120 minutes

The overtime (safety timer) parameter is provided to set the maximum continuous time a relay running a pump or valve is energized. For a control that is running an On/Off algorithm and its output is a relay, this time is the continuous time the relay is On before an alarm is issued. The timer will run during the On relay period and is reset when the Set point is reached. If the timer period expires, the relay will deactivate and an Alarm condition will occur.

With Overtime selected, press **Set**. Press the ▲▼ keys to edit the present value, displayed blinking.



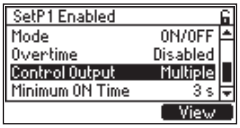


Control Output (Setpoint Must Be Enabled First)

Option: Read only

Displays the current relay (e.g. Relay1) associated with selected Set point.

If **Multiple** is displayed, press **View**, to display assigned relays or outputs.

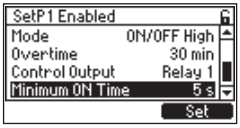


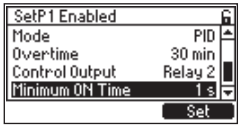
Minimum ON Time

Option: 1 to 10 seconds

Allows users to control the speed of the relay status change when previously set conditions are met. This timer prevents the relay and connected device from "chattering" by forcing a minimum on and off time.

The flashing of the selected value indicates that it can be modified by using the ▲▼ keys. Press **Set**, to confirm value





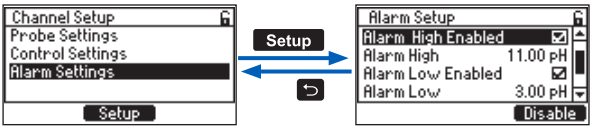
Note: *The controller validates the configured Setup when attempting to exit menu and directs the user to any invalid parameters. At prompt to save changes, press virtual key* ***YES****.*

11.1.4. Alarm Settings

This menu is used to define the operating limits of the process. The setting thresholds configured in this submenu control the Alarm relay. If Alarm becomes active, control stops. Both pH (or ORP) and Temperature are configured in this submenu.

Navigation

- Press MENU key (☰) from the Measure mode.
- Press **Setup** from Channel parameter.
- Press **Setup** with Alarm Settings highlighted, and the alarm submenu will open.
- Press the ▲▼ keys to move between options.
- Press the back key (⮌) to return to the menu without saving.



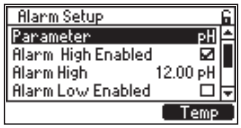
Note: *It may be necessary throughout the Setup:*
at prompt, enter the passcode
at prompt, press ***YES****, to place unit in HOLD.*

Note: *We suggest users make configuration changes from the beginning of the menu structure going forward, because the menu references parameters that were set earlier in the submenu. When completed, return to the "other" parameter and set that up also. Alarm can be configured for both measurement and Temperature.*

Parameter (Probe Specific)

Option: pH (ORP), Temperature
With Parameter selected, press the corresponding virtual key to toggle between the options.

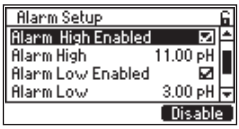
Note: *The second Parameter can be set up also.*



Alarm High Enabled

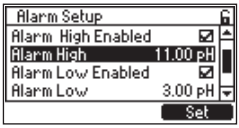
Option: Enabled, Disabled
With Alarm High Enabled selected, press the corresponding virtual key to toggle between enable or disable options.

The check mark confirms parameter is enabled. Press the ⮌ key, to save.



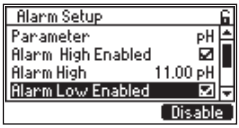
Alarm High

Allows users to set the upper-limit value for the alarm.
To modify the value, with Alarm High selected, press **Set**. The flashing digit indicates that value can be modified. Press the ▲▼ keys, to modify. Press **CFM**, to save. Once confirmed, the value stops flashing. Press the ⮌ key to return to the menu.



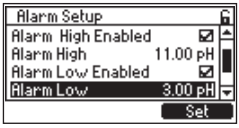
Alarm Low Enabled

Option: Enabled, Disabled
With Alarm Low Enabled selected, press the corresponding virtual key to enable or disable. The check mark confirms parameter enabled. Press the ⮌ key, to save.



Alarm Low

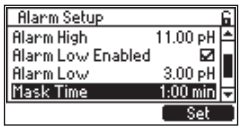
Allows users to set the lower-limit value for the alarm.
To modify the value, with Alarm Low selected, press **Set**. The blinking of the selected value indicates that value can be modified by using the ▲▼ keys. Press **CFM**. Once confirmed, the value stops flashing. Press the ⮌ key, to return to the menu.



Mask Time

Option: 0 to 30 minutes (0-59 seconds, 1.00 to 30.00 minutes)
Mask time is an Alarm delay timer. The process measurement remains in the alarm state for ***n*** units of time before activating the alarm.

Press **Set**, to modify the value. The flashing value indicates that it can be modified. Press the ▲▼ keys followed by **CFM**, to save. Once confirmed, the value stops flashing. Press the ↩ key to return to the menu.

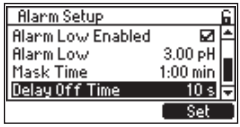


Delay Off Time

Option: 5 to 999 seconds

Delay Off Time is an off delay timer. Once the alarm becomes active it stays active for ***n*** units of time, even if the alarm condition is not met.

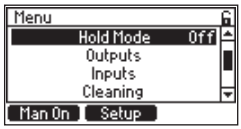
Press **Set** to modify. The flashing value indicates that it can be modified by pressing the ▲▼ keys followed by **CFM**, to save. Once confirmed, the value stops flashing. Press the ↩ key, to return to the menu.

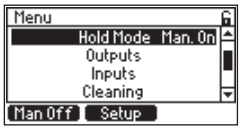


Note: *The controller validates the configured Setup when attempting to exit menu and directs the user to any invalid parameters. At prompt to save changes, press* ***YES.***

11.2. HOLD MODE

Hold Mode is the second item under Menu selections. When Hold Mode is selected **Man On** or **Man OFF** virtual keys are visible.





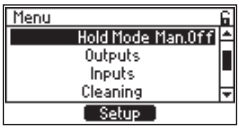
11.2.1. Turning On Manual Hold

The Hold Mode submenu is used to turn on or off a manual Hold. It can also be used to configure a remote hold feature that uses a digital Input Trigger.

Selecting **Man On** initiates the procedure detailed below.

1. Select **Man On** (or **OFF**)
2. At prompt, enter the passcode
3. Select **Man On** (or **OFF**) again

4. The state next to the Menu item will change to **Man On** (or **OFF**)



5. Press the ⮌ key, to exit the parameter

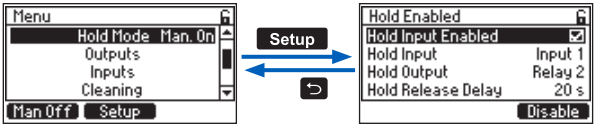
When in Manual Hold:

- Hold is displayed in the Title & Status area
- The primary measurement value is displayed blinking
- The HOLD LED is on
- Any relay configured for Hold; relay LED will be on with associated relay enabled
- All the alarm signals (LED, alarm relay) are suspended
- Analog Outputs will be at configured state (see Analogs)

11.2.2. Configuring External Hold Trigger

Navigation

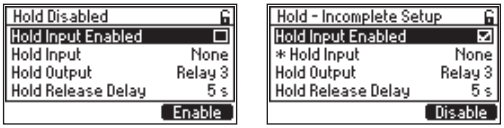
- From Menu, use ▲▼ keys to select Hold Mode Man. On.
- With Hold Mode Man. On selected, press **Setup**, to enter the screen.



Hold Input Enabled

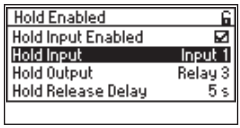
Option: Enabled, Disabled

With function selected, press **Enable** or **Disable**, to toggle between the two options. The check mark confirms Hold Input enabled.



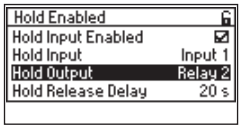
Hold Input

Hold mode can be triggered using external trigger inputs. This is a read-only parameter that indicates what Inputs are configured to initiate Hold mode. If an input is selected, the selected input is displayed. To change the input assignment for Hold Input, return to the top level Menu structure and select Inputs. To return to the menu without changing, press the ⮌ key.



Hold Output

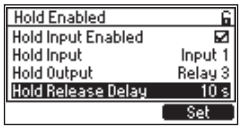
This is a read only parameter that indicates what relay outputs (if any) are configured to Hold mode. To return to the menu without changing, press ⮌ key.



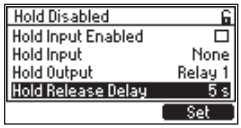
Hold Release Delay

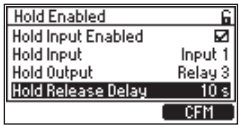
Option: 0 to 99 seconds

Hold Release Delay is a timer that allows control function to remain in a HOLD state for additional time after the HOLD is released. This time will be counted down and displayed on the Title & Status area. With Hold Release Delay selected, press **Set** to modify.



The time value flashes, indicating that it can be modified. Press the ▲▼ keys to adjust the value. Press **CFM**, to save or press the ⮌ key, to return to the menu without saving.





Note: *The controller validates the configured Setup when attempting to exit Menu and directs the user to any invalid parameters. At prompt to save changes, press* ***YES****.*

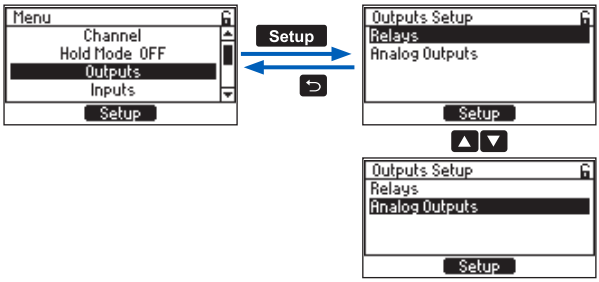
11.3. OUTPUTS

Outputs is the third item under Menu selections.

Navigation

- From Main menu, press the ▲▼ keys to select Outputs.
- When Outputs are selected, **Setup** virtual key is visible.

- With Outputs selected, press **Setup** to open a submenu structure that includes Relays and Analog Outputs.



- Press the ▲▼ keys to toggle between them and press **Setup**, to open the selected parameter.
- At prompt, enter the password.
- At prompt, with the password enabled, press **YES**, to place unit in HOLD and start modifying parameters.

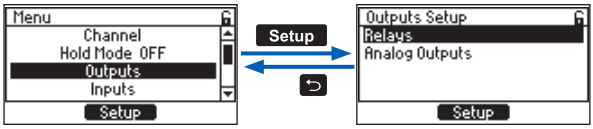
Both **Relays** and **Analog Outputs** can be used as part of a process control system.
Relay contacts are connected to control elements e.g. valves, pumps, motors used for process value regulation. They are also used to interface with automated probe cleaning devices.
Analog Output signals are interfaced with supervisory control and automation systems or to a simple chart recorder to capture process measurements.

Note: *Controller model determines the number of relays and analogs.*

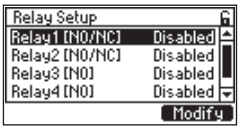
11.3.1. Relays

Navigation

- With Outputs menu item selected, press **Setup**.
- With Outputs selected, press the ▲▼ keys to select Relays.



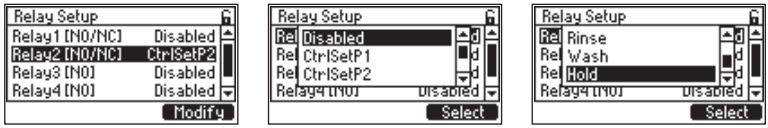
- Press **Setup** to open the list of Relays (with the type listed beside it). The relays can be assigned to the Set points, Hold or Cleaning functions.



- Press the ▲▼ keys to move between the items.

- Press the ⮌ key to return to the menu without saving.

Multiple relays can be allocated to the same function. To select the relay operating mode, press **Modify**.



Note: *HI510-320 has 3 relays and 2 Analog Outputs (AO) & HI510-540 has 5 relays and 4 Analog Outputs (AO).*

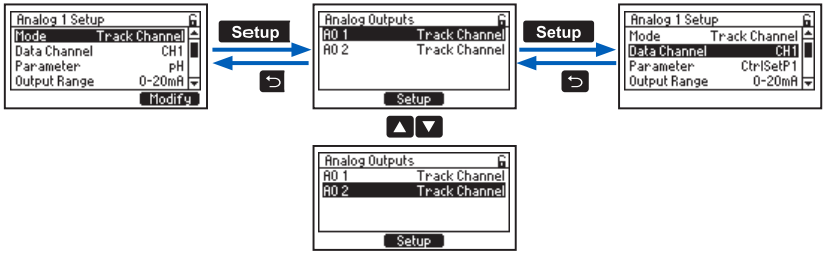
Note: *The controller validates the configured Setup when attempting to exit Menu and directs the user to any invalid parameters. At prompt, to save changes, press **YES**.*

11.3.2. Analog Outputs

Note: *Controller model determines the number of relays and analogs.*

Navigation

- From Analog Outputs, press **Setup**.
- Press the ▲▼ keys to navigate between parameters.



- Press the ⮌ key to return to the menu without saving.
- At prompt, enter the passcode.
- At prompt, with the password enabled, select **YES** to place unit in HOLD and start modifying parameters

Note: *We suggest users make configuration changes from the beginning of this Menu structure going forward, because the menu references parameters that were set earlier in the submenu.*

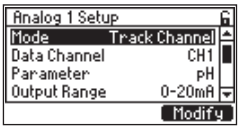
Mode

Option: Disabled, Track Channel

With Mode selected, press **Modify**.

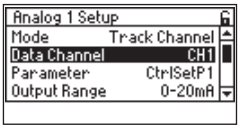
- Disabled – analog output has not been allocated to any function

• Track Channel – the analog output follows a specific parameter



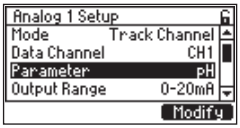
Data Channel

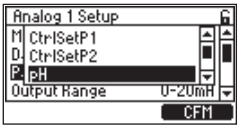
Option: CH1 for one channel
Data channel is always CH1.



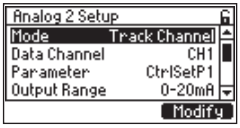
Parameter

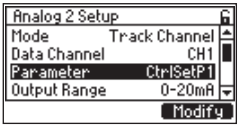
Option: CtrlSetP1, CtrlSetP2, pH or ORP (main probe reading), Temperature
With Parameter selected, press **Modify** and select the parameter from the available options. Press **CFM**, to save.





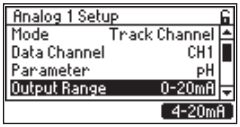
When analog output is assigned to CtrlSetPx, it will follow specific Set point control output.

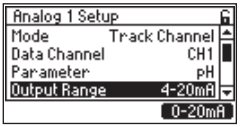




Output Range

Option: 0-20mA, 4-20mA
With Output Range selected, press the corresponding virtual key, to toggle mA output range: 0-20mA or 4-20mA.

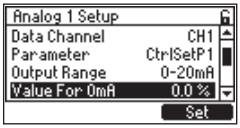


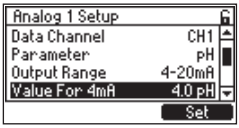


Value for 0mA or 4mA

Option: Selected parameter (pH, temperature, mV), CtrlSetP1 or CtrlSetP2

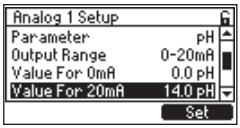
With Value at 0mA (or 4mA) selected, press **Set.** The value will flash indicating it can be modified. Press the ▲▼ keys to increase or decrease the value. Press **CFM**, to save.

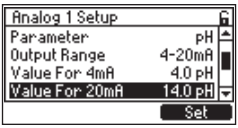


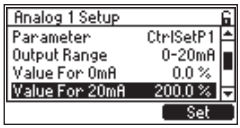


Value for 20mA

Option: Selected parameter (pH, mV, temperature,), CtrlSetP1 or CtrlSetP2
With value at 20mA selected, press **Set**. The value will flash indicating it can be modified. Press the ▲▼ keys to increase or decrease the value. Press **CFM**, to save.



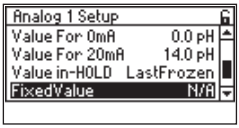




Value in HOLD

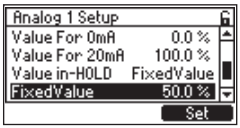
Option: Last frozen value, Fixed value
With Value in HOLD selected, select between FixedValue or LastFrozen.
Last frozen value – output is held at present level, prior to hold.
Fixed value – output driven to a configured value during hold.

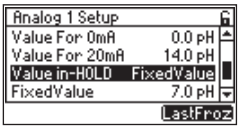
Note: *Value is set in the next parameter; Fixed Value.*



Fixed Value

With Fixed Value selected, press **Set**. The value will flash indicating it can be modified. Press the ▲▼ keys to increase or decrease the value. Press **CFM**, to save the value. Press the ⮌ key to return to the menu.

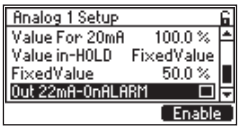




Out 22mA – On Alarm

Option: Enabled, Disabled

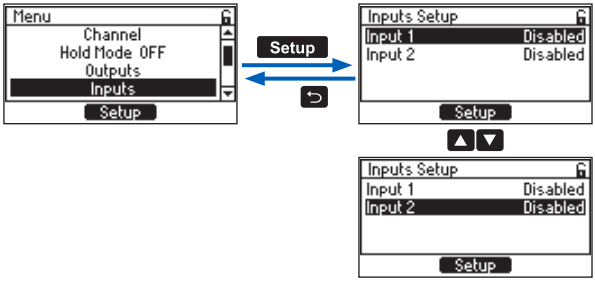
With Out 22mA -On Alarm selected press the corresponding virtual key to enable or disable. When enabled, it drives the analog output to 22mA in an alarm condition.



Note: *The controller validates the configured Setup when attempting to exit Menu and directs the user to any invalid parameters. At prompt to save changes, press* ***YES****.*

11.4. INPUTS

Inputs is the fourth item under Menu selections.
When Inputs is selected, **Setup** virtual key is visible. Selecting **Setup** opens a submenu structure that includes Input 1 and Input 2.



Both inputs are configured the same way. Verify the wiring before configuration.

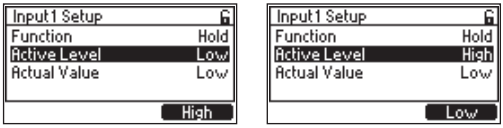
Navigation

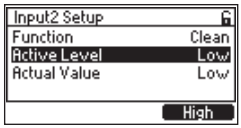
- From Main Menu, use the ▲▼ keys to select Inputs.
- Press the ▲▼ keys to toggle between inputs options.
- With option selected, press **Setup**, to open the selected input.

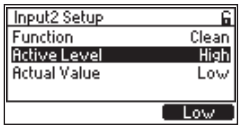
Note: *If required,*

At prompt, enter the passcode.
At prompt, select ***YES*** *to place the unit in HOLD.*

Each of the two inputs, Input 1 and Input 2, can be configured disabled or used to trigger Hold Mode or a Cleaning cycle from a remote trigger switch. The active level of the input can be set High or Low.

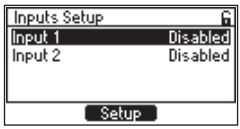




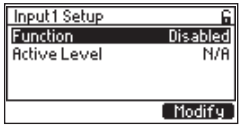


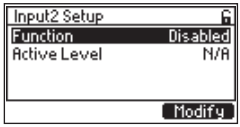
For modifying the operating mode for either input please follow the four-step procedure below:

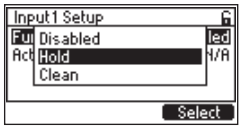
1. With Input 1 (or Input 2) selected, press **Setup**.
2. Press the ▲▼ keys to navigate between the two possible options.

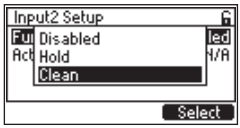


3. Press **Modify**, for the Function drop-down list to display.









4. Press the ▲▼ keys to move between the three options and **Select**, to confirm.

Note: *The controller validates the configured Setup when attempting to exit Menu and directs the user to any invalid parameters. At prompt to save changes, press virtual key* ***YES****.*

11.5. CLEANING

Cleaning is the fifth item under Menu selections.

The cleaning menu is used to program a time-controlled cleaning function that uses the configured relays to activate valves, pumps or compressed air to automate probe cleaning.

Two types of cleaning may be programed; Simple and Advanced.

Simple Cleaning: is suitable for any application in which the automated use of water flushing or a directed air stream is sufficient as a cleaning medium. In this case, a jet of water or air is directed toward the probe tip, and deposits are loosened and swept away. The flushing typically occurs directly in the process.

Advanced Cleaning: supports the use of two programmable relays. One for the rinse or flushing with water, and a second to activate a valve or pump for chemical cleaning agent.

Cleaning Cycles: can be initiated manually by digital input, timer (programmed interval), or by scheduling. The frequency and duration of the cleaning cycle can be programmed to meet the

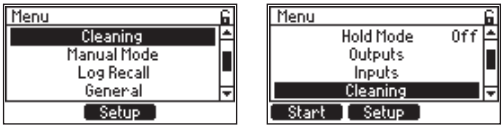
requirements of the particular application.
When Advanced cleaning is selected, it is possible to stop a cleaning cycle manually by long pressing (a few seconds) the ▼ ▶ keys simultaneously. The cleaning is stopped but the cycle will complete the rinse and recovery phases before returning to the measurement or process control.
Calibration cannot be started when Simple or Advanced cleaning is in progress. Conversely, cleaning can not be triggered while calibration is being performed.
Automatically cleaning the process probe can be seen as a disruption of the normal measuring or control modes. As the cleaning cycle starts, the controller is placed in HOLD mode.

Rinse Relay Configuration During Cleaning Cycle

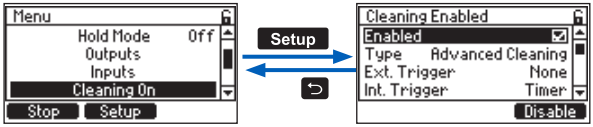
For a Simple cleaning, the configured rinse relay is activated, through the rinse time, followed by a recovery time as the probe system is reacclimated to the process; the cleaning cycle ends and the controller returns to the normal Measure and Control service.
For Advanced cleaning, the configured rinse relay is activated and remains on throughout the cleaning. After the pre-wash rinse time has expired, the second wash relay is on for the wash time. As this time expires, the post-wash rinse timer starts followed by a recovery timer as the probe system is reacclimated to the process; then the cleaning cycle ends and the controller returns to the normal Measure and Control service. This rinse or wash cycle can be repeated multiple times, as desired.

Navigation

- From Main Menu, press the ▲ ▼ keys to highlight Cleaning. With Cleaning item highlighted, press **Start** to start a cleaning cycle.



- With Cleaning item selected, press **Setup** to enter screen.

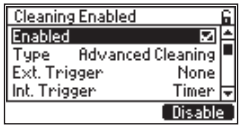


- At prompt, enter the passcode.
- At prompt, press **YES** to place unit in HOLD.
- Enabled* option has to be active (check mark displayed) for the rest of the configurable parameters to be modified.
- Press the ▲ ▼ keys to move between parameters.
- Press the ⮌ key to return to the menu without saving.

Enabled*

Option: Enabled, Disabled

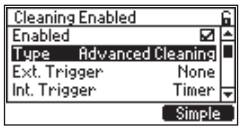
With Enabled selected, press the corresponding virtual key to enable (activate) cleaning mode or disable cleaning mode.



Type

Option: Simple, Advanced

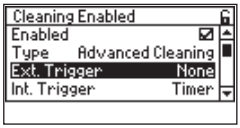
With Cleaning Type selected, press **Advanced** or **Simple**, to toggle options.

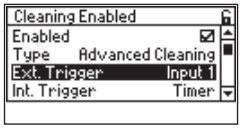


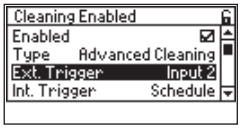
Ext. Trigger

Option: None, Input 1, Input 2

This is a read-only parameter that indicates what Input, if any, has been assigned to start cleaning. Press **View**, to view the configured trigger inputs.



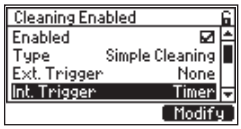


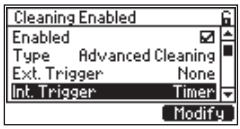


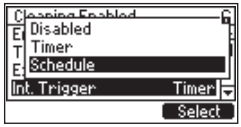
Int. Trigger

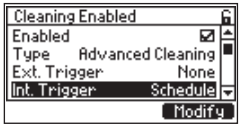
Option: Disabled, Timer, Schedule

With Int. Trigger selected, press **Modify**, for the drop-down options list. Press the ▲▼ keys to scroll between options and press **Select**, to save.









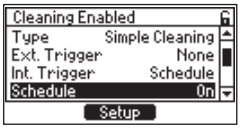
Timer

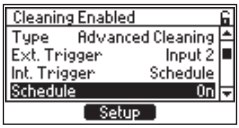
When set on Timer, the cleaning cycle will proceed following the time period set in the parameter Cleaning Interval.

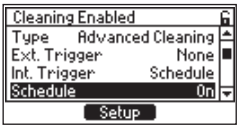
Schedule

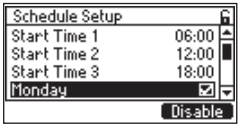
If Int. Trigger is selected, **options** are Disabled or Timer, N/A will be seen.
If Int. Trigger is set to Schedule, **options** are ON or Off.

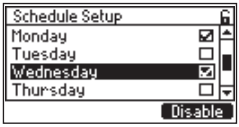
- With Schedule On selected, press **Setup** to configure a cleaning schedule.
- Set up to three start times per day for the cleaning cycle to start.
- Enable the days of the week for the cleaning cycle to be done.
- Press the ↩ key to save and exit schedule.

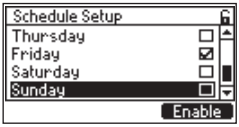






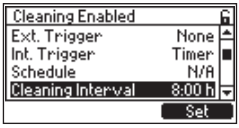






Cleaning Interval

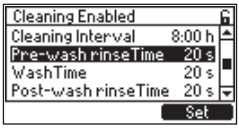
Option: 1 to 1440 min. (as 1 to 59 min. and 1:00 to 24:00 h), if Timer is selected as an Int.Trigger N/A, if Schedule is selected as Int. Trigger
With Cleaning Interval selected, press **Set**, to modify. The flashing digit can be modified by pressing the ▲▼ keys. Press **CFM**, to save.



11.5.1. Advanced Cleaning

Pre-Wash Rinse Time

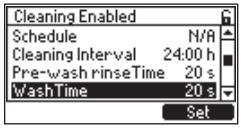
Option: 5 to 300 seconds
With Pre-Wash Rinse Time selected, press **Set**, to modify. The flashing digit can be modified by pressing the ▲▼ keys. Press **CFM**, to save.

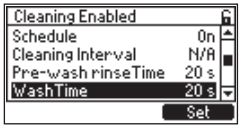


Wash Time

Option: 5 to 300 seconds

With Wash Time selected, press **Set**, to modify. The flashing digit can be modified by pressing the ▲▼ keys. Press **CFM**, to save.

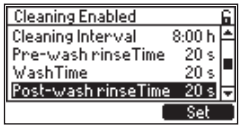




Post-Wash Rinse Time

Option: 5 to 999 seconds

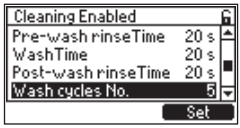
With Post-Wash Rinse Time selected, press **Set**, to modify. The flashing digit can be modified by pressing the ▲▼ keys. Press **CFM**, to save.



Wash Cycles No.

Option: 1 to 10 cycles

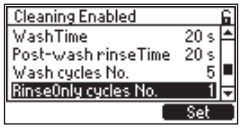
With Wash Cycles No. selected, press **Set**, to modify. The flashing digit can be modified by pressing the ▲▼ keys. Press **CFM**, to save.



Rinse Only Cycles No.

Option: 1 to 10 cycles

With Rinse Only Cycles No. selected, press **Set**, to modify. The flashing digit can be modified by pressing the ▲▼ keys. Press **CFM**, to save.

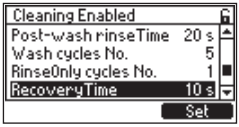


Recovery Time

Option: 1 to 120 seconds

Time period for the probe to be reacclimated to the process before starting control.

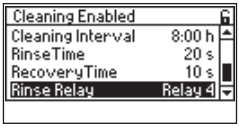
- With Recovery Time selected, press **Set.**
- The flashing digit can be modified by pressing the ▲▼ keys.
- Press **CFM**, to save.



Rinse Relay

Option: Allows users to display allocated rinse relay

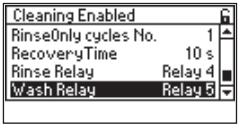
This is a view only parameter that indicates what relay(s) are configured for the rinse function.



Wash Relay

Option: Allows users to see allocated wash relay

This is a view only parameter that indicates what relay(s) are configured for the wash function.

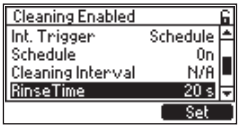


11.5.2. Simple Cleaning

Rinse Time

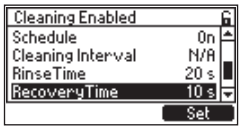
Option: 5 to 300 seconds

With Rinse Time selected, press **Set**, to modify. The flashing digit can be modified by pressing the ▲▼ keys. Press **CFM**, to save.



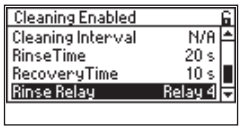
Recovery Time

Option: 1 to 120 seconds



Rinse Relay

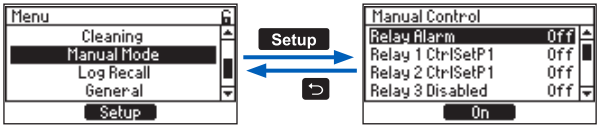
Option: Allows users to display allocated rinse relay



Note: *The controller validates the configured Setup when attempting to exit Menu and directs the user to any invalid parameters. At prompt to save changes, press* **YES**.

11.6. MANUAL MODE

Manual Mode is the sixth item under Menu selections.
When Manual Mode is selected, **Setup** is visible. Selecting **Setup** opens a submenu structure that displays the Relays (with their configured function) and Analog Outputs.



When relays are turned to on, it can manually test the relay connection and operation (relay contact opening and closing) and also the operation of the associated equipment, and is a useful feature to prime a dosing pump for example. The current loop(s) can be tested by setting a current value and verifying it at the outputs.

Navigation

- From Main Menu, press the ▲▼ keys to select Manual mode.
- With option selected, press **Setup**, to enter the screen.
- Press the ▲▼ keys to move between the five relays and two analog outputs.

Relay Alarm

Option: On, Off
The relay set to be On, keeps its status for maximum 60 minutes before it switches Off; or user leaves Manual Mode.

Relay x

Option: On, Off

The relay set to be On, keeps its status for maximum 60 minutes before it switches Off; or user leaves Manual Mode.

Analog Output AO x

Option: 0.0 to 22.0 mA

1. From Manual mode, press the ▲▼ keys to move to AO x.
2. With AO x selected, press **Set**, to modify. The flashing digit can be modified by pressing the ▲▼ keys.
3. Press **CFM**, to save. The analog remains at the current set for 60 minutes until it resumes previous current value.

11.7. LOG RECALL

Log Recall is the seventh item under Menu selections.

Selecting Log Recall from the main menu will open a sub menu containing measurement Log files and Event logs.

Measurement log files

The readings for each measurement are automatically logged at configured time intervals. A new log is started each time the instrument is calibrated or reconfigured. Logged data include pH (with pH mV values), or ORP and temperature values, last calibration data, setup configuration that includes Alarm and Control Setpoints, controller and probe FW. The controller will store up to 100 logs displayed in a list, starting with the most recent one. Each Log can hold up to 8600 records / 860,000 total data points.

Example of how the log looks on the controller below:

004. L2020-04-26 00

Each log is saved as a .csv file, a file for easy transfer:

L20042600030

Where:

L stands for Log, ## is the log number for that day (00 through 99), and the interval is the logging interval used (30 seconds for this example).

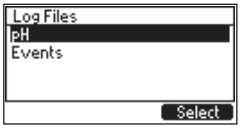
YYMMDD ## Interval

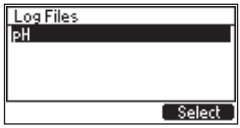
See Log Data Export to USB-C Flash Drive subsection for information to transfer log to a flash drive as a .csv file using the USB Type-C port.

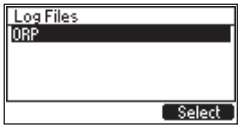
Navigation

- From main Menu, press the ▲▼ keys to select Log Recall.
- With option selected, press **Select**, to enter screen.

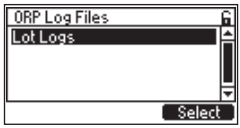
The controller creates a log file for each parameter (pH or ORP).







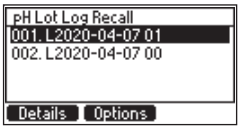
The logged files are saved in parameter specific Lot Log folders.

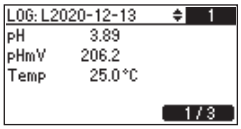


Lot Log

- Lot Log storage can hold a maximum of 100 files with 8600 records/file.
- Logging interval can be set from 10 seconds to 180 minutes by following the path: Menu, General, Log Interval.
- At the selected interval, the following information is recorded:
  Date, Time, pH value, mV value, Temperature, pH alarm, Temperature alarm, Set points alarm, Hold status, Probe reconnect status
- Log file has a header area with the following information:
  Controller information
  Probe information
  Control settings
  Alarm settings
  Log interval
- Once the 100 file limit has been reached, the current log file will overwrite the oldest one.

- To view additional information about the selected data point, press **Details**.



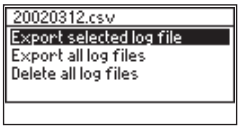


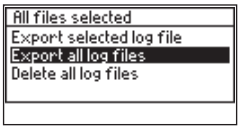
- Press virtual key **Option** to Export or Delete logs.

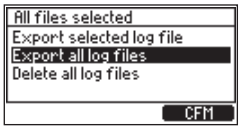
Log Data Export to USB-C Flash Drive

To export logged data to a USB-C flash drive:

- Insert a USB-C flash drive (or USB-A with cable adapter) into the controller USB-C connector, located on the side.
- Press the ▲▼ keys to move between the options.
- With the USB-C flash drive plugged in, press **CFM**, to save an action or the ⮌ key to return to the menu without saving.







- The exported logs will be in a folder named HI510-xxxx (where x are the controller ID)
  Note: *Do not remove the USB flash drive during the file transfer.*

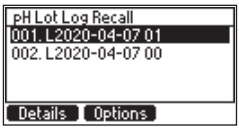
If an error occurs during transfer, the "Error while transferring" message is displayed. Reinstall the flash drive and try again.

Data Management

Press **Options** to:

Export selected log file
Export all log files
Delete all logged files data

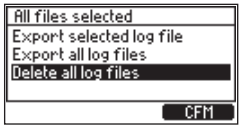
To scroll the options, press the ▲▼ keys.



Delete Logged Data

To delete logged files:

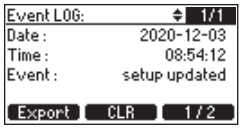
- Press the ▲▼ keys to select the option and press **CFM**. A warning screen will be displayed asking for confirmation.
- Press **Yes** to confirm or **No** to return to previous screen.

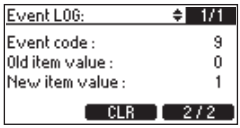


Note: *It is recommended to export log files before deleting the files.*

Event Log & Event Log Types

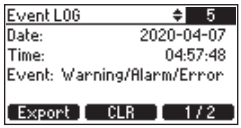
- The log file can hold a maximum of 100 events, that include errors, alarms, warnings, calibration events, configuration changes, and cleaning events.
- Once the 100 events limit has been reached, the oldest logged event is deleted.
- To view next screen, press **1/2**.
- To navigate through events, press the ▲▼ keys.
- With USB-C flash drive plugged in, press the corresponding virtual key, to export event log file.
- To erase all event logs, press **CLR**.

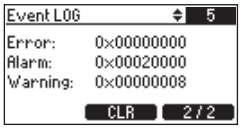




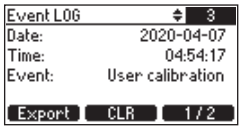
There are six log event types:

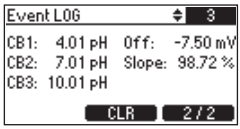
Warning / Alarm / Error



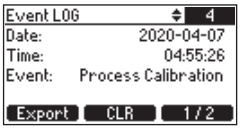


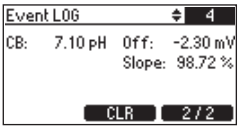
User calibration



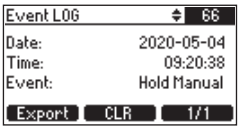


Process calibration

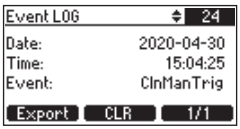


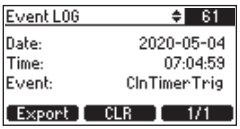


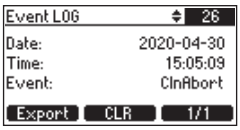
Hold

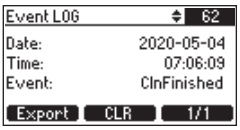


Cleaning

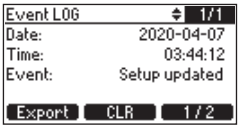




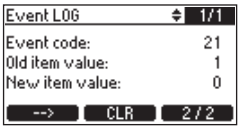


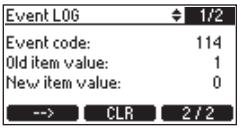


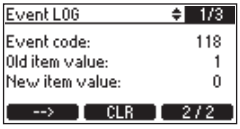
Setup updated

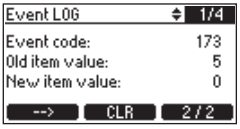


Depending on the number of setup changes, users can access more than one screen by pressing the virtual key for **-->**.









HI510 Log Event Codes & Assigned Parameters

HI510 operates an event logging system whereby when setting new parameter values, a Setup event & event code are generated. Log event stores the Setup event code together with both new and previous values.

Code	Setup Parameter
0	Key beep
1	LCD contrast
2	LCD backlight
3	Time format
4	Date format
5	Decimal point
6	Temperature unit
8	Log interval
9	Error beep
10	Language
11	Password enable
12	RS-485 Address
13	RS- 485 Baud rate
14	Startup dosing delay
15	Remote control
16	Meter ID
17	Setup timeout
19	Password setup
20	Password remote
21	Set point 1 status
22	Set point 2 status
29	Set point 1 control mode
30	Set point 2 control mode
33	Set point 1 parameter
34	Set point 2 parameter
37	Set point 1 overtime
38	Set point 2 overtime
41	Set point 1 minimum on time
42	Set point 2 minimum on time
45	Set point 1 value
46	Set point 2 value
49	Set point 1 control mode
50	Set point 2 control mode

Code	Setup Parameter
53	Set point 1, Dead band gain
54	Set point 2, Dead band gain
57	Set point 1 control period
58	Set point 2 control period
61	On/Off, Set point 1 hysteresis Prop. & PID, dead band for Set point 1
62	On/Off, Set point 2 hysteresis Prop. & PID, dead band for Set point 2
65	Set point 1 deviation
66	Set point 2 deviation
69	Set point 1, reset time
70	Set point 2, reset time
73	Set point 1, rate time
74	Set point 2, rate time
77	Main parameter, Alarm High enable
78	Temperature parameter, Alarm High enable
81	Main parameter, Alarm Low enable
82	Temperature parameter, Alarm Low enable
85	Main parameter, Alarm delay off time
86	Temperature parameter, Alarm delay off time
93	Main parameter, Alarm mask time
94	Temperature parameter, Alarm mask time
97	Main parameter, Alarm High value
98	Temperature parameter, Alarm High value
101	Main parameter, Alarm Low value
102	Temperature parameter, Alarm Low value
116	Cleaning enable
117	Cleaning type
118	Cleaning trigger
119	Cleaning, rinsing post-wash time
120	Cleaning wash time
121	Cleaning, rinsing pre-wash time
122	Cleaning interval

Code	Setup Parameter
124	Cleaning, wash cycles number
125	Cleaning, rinse only cycles
131	Cleaning external trigger
133	Cleaning recovery time
135	Cleaning schedule interval, 1 hour
136	Cleaning schedule interval, 2 hours
137	Cleaning schedule interval, 3 hours
138	Cleaning schedule interval, 1 minute
139	Cleaning schedule interval, 2 minutes
140	Cleaning schedule interval, 3 minutes
141	Cleaning schedule interval 1, enabled
142	Cleaning schedule interval 2, enabled
143	Cleaning schedule interval 3, enabled
144	Schedule day, Monday
145	Schedule day, Tuesday
146	Schedule day, Wednesday
147	Schedule day, Thursday
148	Schedule day, Friday
149	Schedule day, Saturday
150	Schedule day, Sunday
152	Input1 function
153	Input1 active level
154	Input2 function
155	Input2 active level
173	Relay1 function
174	Relay2 function
175	Relay3 function
176	Relay4 function
177	Relay5 function
178	Hold function enable
179	Hold Input enable
180	Hold Output enable
181	Manual hold
182	Hold Delay
183	Analog out 1, mode
184	Analog out 2, mode
185	Analog out 3, mode
186	Analog out 4, mode

Code	Setup Parameter
187	Analog out 1, data channel
188	Analog out 2, data channel
189	Analog out 3, data channel
190	Analog out 4, data channel
191	Analog out 1, parameter to follow
192	Analog out 2, parameter to follow
193	Analog out 3, parameter to follow
194	Analog out 4, parameter to follow
195	Analog out 1, output range
196	Analog out 2, output range
197	Analog out 3, output range
198	Analog out 4, output range
199	Analog out 1, value for maximum output
200	Analog out 2, value for maximum output
201	Analog out 3, value for maximum output
202	Analog out 4, value for maximum output
203	Analog out 1, value for minimum output
204	Analog out 2, value for minimum output
205	Analog out 3, value for minimum output
206	Analog out 4, value for minimum output
211	Analog out 1, value in hold option
212	Analog out 2, value in hold option
213	Analog out 3, value in hold option
214	Analog out 4, value in hold option
215	Analog out 1 out 22mA on alarm
216	Analog out 2 out 22mA on alarm
217	Analog out 3 out 22mA on alarm
218	Analog out 4 out 22mA on alarm
219	Analog out 1, fixed value selection
220	Analog out 2, fixed value selection
221	Analog out 3, fixed value selection
222	Analog out 4, fixed value selection
301 311	Probe parameter 1-11 was changed
0x00080000	Date & Time Warning event code

To exemplify how the log event system works:

For Setup **event code 21**

Set point 1 status; with old value 0 (disabled) and new value 1 (Enabled)

For Setup **event code 22**

Set point 2 status; with old value 22 (disabled) and new value 2 (Enabled)

For Setup **event code 34**

Set point 2 parameter; with old value 0 main reading (pH or ORP) and new value 1 (Temperature)

For Setup **event code 45**

Set point1 parameter; with old value 8.00 and new value 8.39

Event LOG						
Controller Info	Controller ID	1234				
	Serial No.	P0140000111				
	HW Version	RD4				
	Firmware	V0.4b71 X V4.2 2020-06-04				
	Language		1.1			
Decimal separator	X.X					
DATA LOG						
Date	Time	Error	Alarm	Warning	Setup EVT no.	Old item value
2020-06-04	16:04:03	0x00000000	0x00200000	0x00000008	---	---
2020-06-04	16:04:18	0x00000000	0x00018000	0x00000008	---	---
2020-06-04	16:05:30	0x00000000	0x00000000	0x00000008	---	---
2020-06-04	16:08:05	---	---	---	301	0
2020-06-04	16:09:06	0x00000000	0x00000000	0x00000000	---	---
2020-06-04	16:21:43	---	---	---	---	---
2020-06-04	16:22:28	---	---	---	---	---

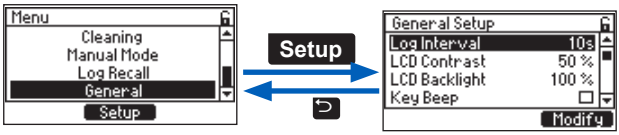
New item value	Buff 1	Buff 2	Buff 3	Process cal. point	Offset	Slope	HOLD	Cleaning
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
99	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	Hold Manual	---
---	---	---	---	---	---	---	Hold Exit	---

11.8. GENERAL

General is the eighth item under Menu selections.

User navigation in General menu parameter

- With General parameter selected, press **Setup**, to enter screen



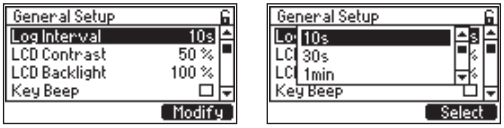
- Press the ▲▼ keys to navigate between parameters.
- Press the ⮌ key to return to the menu without saving.
- At the prompt, enter the passcode.
- At the prompt, select **YES** to place unit in HOLD.
- Press the corresponding virtual key, displayed on the bottom right hand side of the screen, to confirm choice.

Note: *Settings will only be saved by selecting* **YES** *in the Menu exit screen warning.*

Log Interval

Option: 10s, 30s, 1, 2, 5, 10, 15, 30, 60, 120, 180 minutes

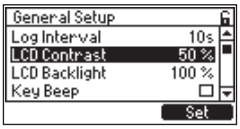
With parameter selected, press **Modify** for the drop-down list to display. Press the ▲▼ keys to navigate between options. Press **Select**, to save.



LCD Contrast

Option: 0 to 100%

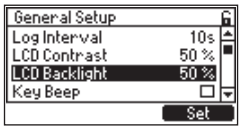
With LCD Contrast selected, press **Set** for the horizontal scroll bar that shows the contrast level. Keep the ▲ key pressed, to increase or the ▼ key pressed, to decrease contrast. Press **CFM**, to save.



LCD Backlight

Option: 0 to 100%

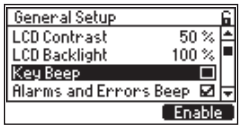
With LCD Backlight selected, press **Set** to open a horizontal scroll bar that is used to adjust the backlight. Keep the ▲ key pressed to increase, or the ▼ key pressed to decrease the backlight intensity. Press **CFM**, to save.



Key Beep

Option: Enabled, Disabled

With Key Beep selected, press the corresponding virtual key to toggle between options. An acoustic signal confirms that the Key Beep parameter has been enabled.



Alarms & Errors Beep

Option: Enabled, Disabled

With Alarms and Errors Beep selected, press the corresponding virtual key to toggle between options. The check mark confirms the enabled parameter.

Warning! *When enabled, if the measurement is in alarm, a very loud beep will come from the controller. Turn on Manual Hold to subdue this Alarm state.*

Date

Option: year / month / day

With Date selected, press **Set** to modify. With selected value flashing, press the ▶ key to navigate to the right between year /month / day. Press the ▲▼ keys to increase or decrease the value. Press **CFM**, to save the value.

Date Format

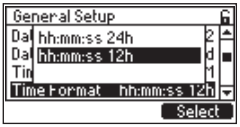
Option: yyyy-mm-dd, dd-mm-yyyy, m-dd-yyyy, yyyy/mm/dd, dd/mm/yyyy, mm/dd/yyyy
With Date Format selected, press **Modify** for the drop-down list to display. Press the ▲▼ keys to navigate between options. Press **Select**, to save.

Time

Option: h / m / s
With Time selected, press **Set** to modify. Press the ▶ key to navigate right between digits, and press the ▲▼ keys to increase or decrease the value. Press **CFM**, to save.

Time Format

Option: hh:mm:ss 24h, hh:mm:ss 12h
With Time Format selected, press **Modify**, for the drop-down list to display. Press the ▲▼ keys to navigate between options. Press **Select**, to save.

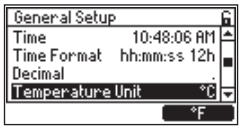


Decimal

Option: "." & ","
This option is a field separator for Log files. It may be set as comma "," or full stop "."depending upon region preferences.
With Decimal selected, press the corresponding virtual key to toggle between options.

Temperature Unit

Option: Celsius (°C), Fahrenheit (°F)
With Temperature Unit selected, press the corresponding virtual key to toggle between options.

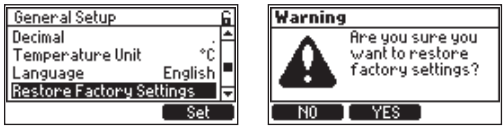


Language

Option: English, Francais, Magyar, Italiano, Nederland, Portugues, Deutsch, Español
This option allows the user to choose the desired language in which all information will be displayed. With Language selected, press **Modify**, for the drop-down list to display. Press the ▲▼ keys to navigate between options. Press **Select**, to save.

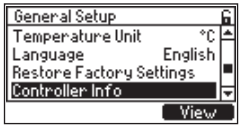
Restore to Factory Settings

This option allows the user to erase all user settings and reset the instrument to the default factory settings.
With Restore to Factory Settings selected, press **Set**, to restore default settings.



Controller Info

With Controller Info selected, press **View**, to display firmware version, language version and serial number.



Controller Password

Option: 00000 to 99999

With Controller Password selected, press **Modify**, for the password input screen. Press the ▲ key to increment the digit (displayed flashing) and the ▼ key to decrement. Press **CFM**, to save. To navigate right between digits, press the ▶ key.

Controller password protects against unauthorized changes. It is required if modifications are made. After the password has been enabled, parameter modifications or probe calibration data are password protected. Entering the password will unlock the controller 🔓. When in measurement mode, the controller is automatically locked again after 10 seconds -> 🔒. For further details, see Enabling & Disabling the Password section.

Enabling & Disabling the Password

For enabling the password please follow the steps:

1. From Main Menu, press the ▲ or ▼ key to navigate to General setup, Controller password.
2. With Controller Password menu item selected, press **Modify.**

3. Press the ▲▼ keys to modify the flashing digit, press the ▶ to move places, repeat. Then press **CFM**, to confirm choice.

4. Re-key the password and press **CFM**, to save the password.

5. Once the password has been enabled, the controller displays the confirmation screen and a check mark will appear.

Note: *After the password has been enabled, Setup changes are password protected. Entering the password unlocks the controller –▷ 🔓. In measure mode, the controller is automatically locked again after 10 seconds –▷ 🔒.*

To disable the password requires the following:

1. Press **Modify** and press the ▲▼ keys to enter the password.
2. Ignore prompt to enter new password and press **Disable.** The password is automatically disabled.

Note: *If the password is entered incorrectly five times, users will require assistance from Hanna Instruments service team.*

Controller ID

Option: 0000 to 9999

With Controller ID selected, press **Set** to modify. Press the ▲ key to enter the digit. Keep the ▲ key (or ▼ key) pressed to increment (or decrement) by one, every second. Press **CFM,** to save.

Remote Control

Option: Enabled, Disabled

This option allows the user to Enable Remote Control. This must be enabled if using the PC application HI92500.

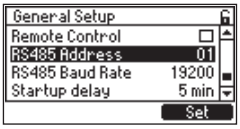
With Remote Control selected, press the corresponding virtual key, to toggle between options. The check mark confirms the enabled parameter.

RS485 Address

Option: 01 to 99

This option allows the user to set the RS485 Address. The controller and the PC application HI92500 must have the same RS485 Address to communicate.

With RS485 Address selected, press **Set**, to modify. Press the ▲ key to enter the digit. Keep the ▲ key (or ▼ key) pressed to increment (or decrement) by one, every second. Press **CFM**, to save.

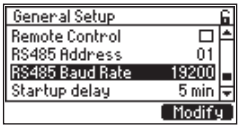


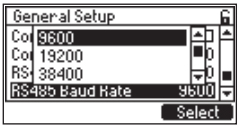
RS485 Baud Rate

Option: 9600, 19200, 38400, 57600, 115200, 256000

This option allows the user to set the desired speed for the serial communication (baud rate) in bps. The controller and the PC application HI92500 must have the same baud rate.

With RS485 Baud Rate selected, press **Modify**, for the drop-down list to display. Press the ▲▼ keys to navigate between options. Press **Select**, to save.



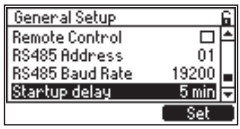


Startup Delay

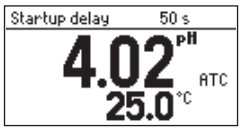
Option: 1 to 30 minutes

Startup Delay is a timer used to prevent Control functions (Relays and pH (ORP) and Temperature configured Analog Outputs) from functioning during controller startup.

With Startup Delay selected, press **Set**, to modify the time. Press the ▲▼ keys to adjust, then **CFM**, to save.



During power up the following will be displayed as the counter counts down in 10 seconds intervals.

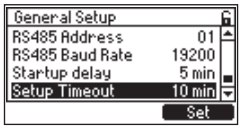


Setup Timeout

Option: 1 to 30 minutes

Setup Timeout is a timer used to bring the controller back to Measure mode from another mode when no keyboard input has occurred. Selected changes will not be saved.

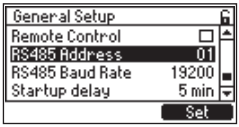
With Setup Timer selected, press **Set**, to modify. Press the ▲ key to enter the digit and increment the value, and the ▼ key to decrement. Press **CFM**, to save.

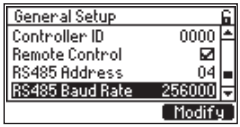


***Setup Note**: The controller validates the configured Setup when attempting to exit Menu and directs the user to any invalid parameters. At prompt, to save changes, press **YES**, to confirm choice.*

12. USE WITH THE HI92500 APPLICATION

1. Use a RS485 USB adapter (HI92150) and connect the cable network RS485 to a PC (Windows XP or newer, OS X or Linux) using PC application HI92500.
2. Connect the other end of the cable network RS485 to controller port RS485 OUT (PC Com.)
3. Power the controller.
4. Ensure RS485 communication parameters i.e. remote control option enabled (check mark visible), RS485 Address and RS485 Baud Rate, are correctly set in General menu.





5. Start running HI92500 PC application.
6. Check location and edit configuration.
7. Select port and baud rate, making sure that is identical to the ones selected on the instrument.
8. Select address. The controller's image will be displayed on the screen.

12.1. HI92500 – HANNA PC SOFTWARE

The HI92500 PC application supports communications between the controller and PC.

The PC compatible software is available for download at http://software.hannainst.com. Select the product code and click Download Now. After download is complete, use the setup.exe file to install the software.

The following is a list of tasks that are possible through the PC application HI92500:

Monitoring remotely, using the virtual LCD (limited to a single remote control in the entire network)
Remote Setup
Saving the Setup configurations to a file
Loading the Setup configuration file to a controller
Real time logging

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

To connect your instrument to a PC, use an USB cable connector. Make sure that your instrument is switched off and plug one connector to the instrument USB socket and the other to the serial or USB port of your PC.

Function/Mode	Control				Cleaning	Edit	Calibration	Manual	Error
	Run	Start up	Hold	Alarm					
Activated by	Start-up Timeout/ End of Alarm_Hold_ Cleaning_Edit_Calibration_ Manual Mode	Power On	External Input/ Soft Key (Manual Hold)/ Alarm Condition/Cleaning_ Edit_Calibration_Manual Mode	Parameters alarms, control setpoints overtime, probe disconnected	Timer/Schedule/Ext. Input/Soft Key (Manual Start)	Soft key	Soft key	Soft key	Hardware error
Ended by	Alarm & Error Conditions/ Hold_Cleaning_Calibration_ Manual Mode Requests	Timeout	Hold conditions no longer present	Alarm condition no longer present	Complete cleaning cycle/ Soft Key (Manual Stop)/ Hold Mode_Edit Mode_Manual Mode request	Soft key / Timeout	Soft key / Timeout	Soft key	Power off
Screen indication	Measure screen: "Measure"	Measure screen: Countdown counter & "Delay to Start"	Measure screen: "HOLD" Menu screen: Hold status	Measure screen: !!	Measure screen:"Cleaning" & "Cleaning phase & countdown timer"	–	Cal screen: cal. related messages on	Man. Mode screen: "Manual Control"	Error screen: "Error" & "Error code"
Screen icons	Measure screen:	Measure screen:	Measure screen:	Measure screen:	Measure screen:	Settings screen:	–	–	–
Main param. reading	✓	✓	Blink	✓	Last reading value except for recovery phase where actual reading value		–	–	–
Lot logging	✓	Event	Event	Event	Event	Event	Event	Event	Event
Event logging	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ctrl. setpoint relay	✓	Off	Off	Off	Off	Off	Off	Off	Off
HOLD relay (if assigned)	Off	Off	On	Off	On	On	On	Off or On	On
RINSE relay	Off	Off	Off	Off	Operating	Off	Off	Off	Off
WASH relay	Off	Off	Off	Off	Operating	Off	Off	Off	–
Ctrl. set point output	0 to 100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Analog Out assigned to Ctrl. SetPoint output	Scaled value of ctrl. output	Scaled value of ctrl. output	Scaled value of ctrl. output	Scaled value of ctrl.output or 22mA, if option enabled	Scaled value of last ctrl. output or a fixed value of ctrl. output	Scaled value of last ctrl. output or fixed value of ctrl. output	Scaled value of last ctrl. output or fixed value of ctrl. output	Any value in the 0 to 22mA range	Scaled value of ctrl output
STATUS LED	●	●	●	✹	●	●	●	●	●
HOLD LED	●	●	●	●	●	●	●	●	●

Operational modes overview, LEDs status table legend:

STATUS	HOLD
Measure mode	HOLD Off
Warning	HOLD On
Errors	
Alarms	

Default values for controller settings:

Setting	pH Probe	ORP Probe	Temperature
Alarm High	Probe maximum range		
Alarm Low	Probe minimum range		
Set point	8.00 pH	500 mV	25°C
Hysteresis for ON/OFF Control	1.00 pH	50 mV	3.0°C
Deviation for Proportional Control	1.00 pH	50 mV	3.0°C
Analog output 0mA limit	Probe minimum-range value		
Analog output 20mA limit	Probe maximum-range value		
Fixed value for AO Hold mode	7.00 pH	0 mV	25°C

14. CONTROL MODES

HI510 is intended to be used to control industrial processes. The instrument and sensor measure the process variable and the HI510 uses control settings to control outputs that are connected to auxiliary equipment to control the process variable to the desired value.
The HI510 uses smart probes to measure the process variable. In the case of a pH probe, the probe also measures temperature. The smart probe stores the probe type, calibration data, Model, Firmware version, Serial number and Factory calibration date in the probe. In the case of a pH probe, it converts the high impedance mV value to a digital signal for clean measurement transport to the controller.
There are three types of algorithm corrections that can be applied to the control function: On/Off, Time proportional and Proportional Integral & Derivative (PID).
The HI510 uses outputs to interact with pumps, valves, and other equipment to control a process. It contains Relays and Analog Outputs for this purpose.

Control Output Element	Output
Relays	On or Off
Analog Outputs (AO)	0-20 or 4-20 mA

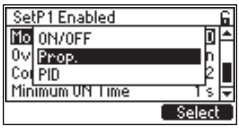
The On relay state occurs when the relay is energized (NO and COM connected, NC and COM disconnected).
The Off relay state occurs when the relay is de-energized (NO and COM disconnected, NC and COM connected).
The Analog outputs can be adjusted to a minimum value of 0mA (default) or 4mA and a maximum value of 20mA. See SECTION 11.3.2 Analog Outputs.

14.1. CONTROL ALGORITHMS

This section describes the controller behavior with a pH smart input. It presents a similar behavior with other smart probe types.
There are three control algorithms implemented in HI510, and each algorithm has both specific and common settings. The common settings – overtime & minimum On time – affect control output after the specific algorithm settings and rules are evaluated.
The **overtime** (safety timer) sets the maximum continuous time that the control element is running at it's maximum value. If this time is exceeded, the control will be stopped and an alarm generated.
The **minimum on time** timer sets a time value to control the speed of the relay status change. This timer prevents the relay and connected device from "chattering" by forcing a minimum on and off time. This is necessary to protect elements that are driven (e.g. actuators, motors, contactors) from electrical and mechanical shocks.

Navigation:
• Press ☰ from the Measure mode.

- Select **Setup** from Channel.
- Select **Setup** with Control Settings highlighted.
- Press the ▲▼ keys to move between parameters.
- Select parameter to be controlled.
- Assign the Set point value and select control mode: On/Off (constant), Proportional, PID.



14.1.1. On/Off Control Algorithm

On/ Off Control is the simplest type of feedback control. The controller drives the relay On or Off, and the Analog Output at the maximum or at the minimum value depending on the position of the controlled variable relative to the Set point.

The control mode can be set High or Low. High control mode is recommended if the process value is too high and users want to decrease it using an acid. Low control mode is recommended if the process value is too low and users want to increase it using a base.

Inputs

- Set point as an absolute controlled parameter value
- Control mode as High or Low
- Hysteresis as a relative parameter, one-side only

Outputs

- Control output as either 0 or 100%

Update rate = 1 second

Enabled by

- Settings
- Controller status

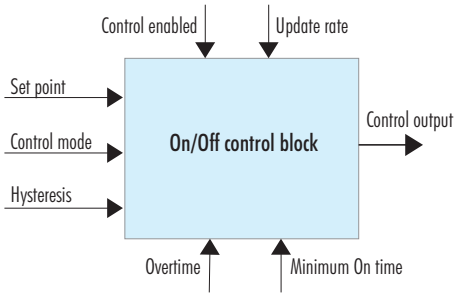


Figure 20: On/Off Control Block Algorithm

On/Off control (Low mode) is modeled as follows:

$$CO_{n-1} = 1 \qquad CO_n \begin{cases} 1 \; if \; PV \le SP + Hysteresis \\ 0 \; if \; PV > SP + Hysteresis \end{cases}$$

$$CO_{n-1} = 0 \qquad CO_n \begin{cases} 1 \; if \; PV < SP \\ 0 \; if \; PV \ge SP \end{cases}$$

CO – Control Out SP – Set point
PV – Process Value

On/Off control of a batch pH process using a pump as external dosing device

A dosing solution can be an acid or a base, depending on the desired results; and control mode can be set High or Low.

With On/Off control type enabled in Setup, the algorithm uses configured "Set point" and "hysteresis" parameters. See MENU section for further details.

With High mode control, the hysteresis is below the Set point. With Low mode control, the hysteresis is above the Set point.

- When in High control mode the controlled process value is too high. The dosing pump will run (adding an acid to bring down the pH) until the process value decreases to the Set point minus hysteresis value. Above the Set point, the relay is activated. The dosing pump turns off and remains off until process value reaches Set point value.
- When in Low control mode, the controlled process value is too low. The dosing pump will start running (adding a base to bring up the pH) until it reaches the Set point plus hysteresis. The pump remains off until the process value decreases to a value equal to Set point.

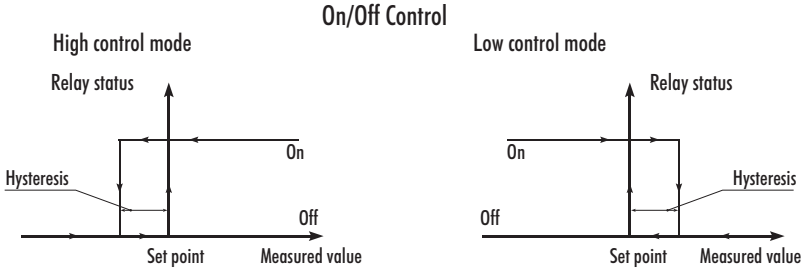


Figure 21: On/Off Control, High /Low Control Mode

Following graphs exemplify how the input parameters work.

Here's an example of hystersis-free control output.

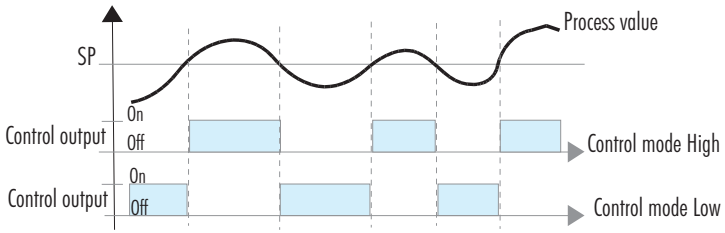


Figure 22: General On/Off Control

By setting hysteresis, an upper and lower control limit is created. The switching around the Set point is therefore reduced.

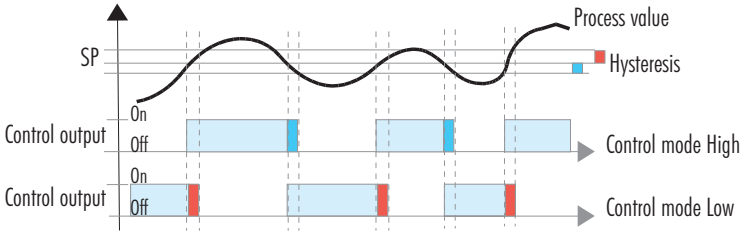


Figure 23: On/Off Control with Hysteresis

Running control On continuously for an extended period of time is prevented by Overtime control action.

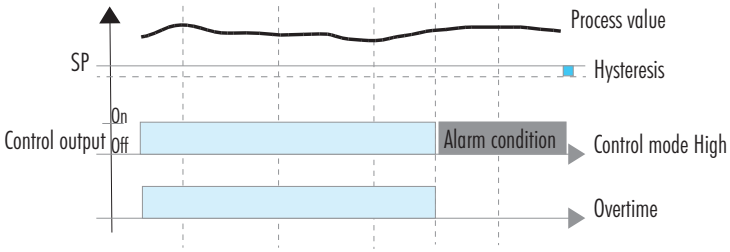


Figure 24: On/Off Control, Overtime Control Action

Realy On time has a guaranteed minimum to prevent stressing the actuators electrically or mechanically.

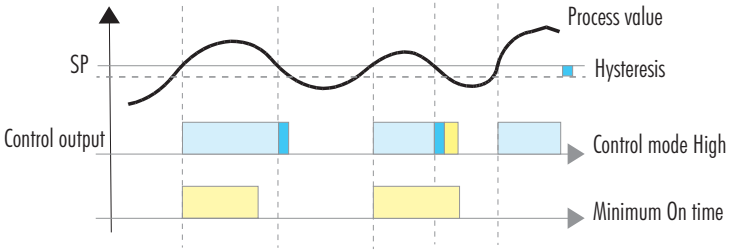


Figure 25: On/Off Control, Minimum On Time

On/Off Control Interaction with Controller Status

Function / Mode	Control				Cleaning	Edit	Calibration	Manual	Error
	Measure	Start up	Hold	Alarm					
Control Output	0 or 100%	0%	0%	0%	0%	0%	0%	0%	0%
Relay assigned to Setpoint Control Output	Off or On	Off	Off	Off	Off	Off	Off	On or Off	Off
Analog Output assigned to Setpoint Control Output	Scaled value of control output	Scaled value of control output	Scaled value of last control output or a fixed value of control output	Scaled value of control output or 22 mA, if option configured	Scaled value of last control output or a fixed value of control output	Scaled value of last control output or a fixed value of control output	Scaled value of control output or a fixed value of control output	Any value in range 0 to 22 mA	Scaled value of control output

14.1.2. Proportional Control Algorithm

With proportional Control (Proportion), the controller drives the relay from continuous On to Off in a defined control period. The Relay On time of the activated control is proportional to the "deviation value", a variance from the Set point. At the full deviation the relay is fully On with the maximum output occurring. As the measurement approaches the Set point through the deviation, the On (relay energized) time is decreased. This type of control can provide tighter control of a process variable compared to On / Off control. It is best used in batch or recirculating systems that retain the solution for a period of time.

Inputs

- Set point as an absolute controlled parameter value
- Control mode as High or Low
- Deviation as a relative parameter
- Control period as time
- Dead Band as a relative parameter value

Where:

Deviation is the interval aligned with the Set point where control output can take values from 0 to 100%. 0% indicates no action and 100% indicates full control output action. If control output is assigned to a relay, 0% control output will keep relay Off during control time, while 100% will drive relay On for this entire time. A low value for this parameter is suitable for low latency processes, allowing the control system to react quickly and strongly.

Control Period is the time interval required for updating control output. High dynamic processes require frequent control updates, meaning shorter Control periods.

Dead Band represents an area where the error between Set point and process value is considered 0. Dead Band area is unidirectional, for Control mode Low is below the Set point, for control mode High is above the Set point.

Outputs

- Control output as 0 to 100%

Update rate = Control period

Enabled by

- Settings
- Controller status

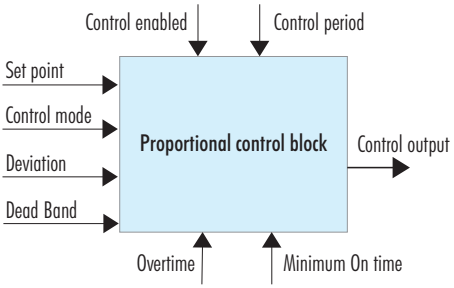


Figure 26: Proportional Control Block

The Proportional Control (Low mode) is modeled as follows:

$$CO_{n-1} > 0$$
$$error = SP - PV$$
$$error \begin{cases} 0 \; if \; SP - PV < 0 \\ DEV \; if \; SP - PV \geq DEV \end{cases}$$
$$CO_n = \frac{error}{DEV}$$
$$t_{on} = CP \bullet CO_n$$
$$t_{off} = CP - t_{on}$$

$$CO_{n-1} = 0$$
$$error = SP - PV$$
$$error \begin{cases} 0 \; if \; SP - PV < DB \\ DEV \; if \; SP - PV > DEV \end{cases}$$
$$CO_n = \frac{error}{DEV}$$
$$t_{on} = CP \bullet CO_n$$
$$t_{off} = CP - t_{on}$$

CO – Control Out	CP – Control Period
PV – Process Value	t_{On} – Time Relay is On over CP
SP – Set point	t_{Off} – Time Relay is Off over CP
DB – Dead Band	t_{n-1} – Time at n-1 CP
DEV – Deviation	t_n – Time at n CP
error = SP - PV	

Proportional control of a batch pH process using a pump as external dosing device

Same as with On/Off control, for Proportional control, a dosing solution can be an acid or a base depending on the desired results; and control mode can be set High or Low.

With Proportional control enabled in Setup, the dosing time depends on the Deviation, the Control period as well as how far the measurement is from the Set point. The controller will vary the On and Off times in the defined control period.

Once enabled, and within the Deviation, the duration of the activated control is proportional to the variance; as the measurement approaches set point, the On (relay energized) period diminishes.

Note: *When configuring the Setup values for this control, it is important to understand the dynamics of the process. This can be determined by manually adding chemicals to the process and seeing how long they take to react. The Control period should be approximately 1½ times it takes the system to react. If this time is too short an additional dose causes overshooting the desired Set point, if it is too long, the Set point may never be reached.*

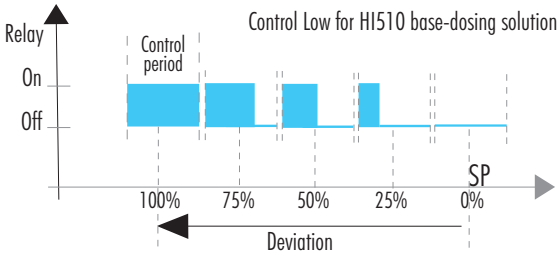


Figure 27: Control Low with Relay On, Set Point & Deviation

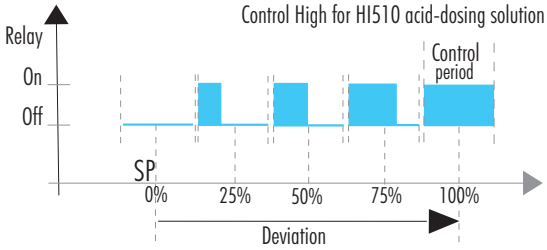


Figure 28: Control High with Relay On, Set Point & Deviation

Following graphs exemplify how the input parameters work.

Relay On time is proportional with Setpoint variance over Control period.

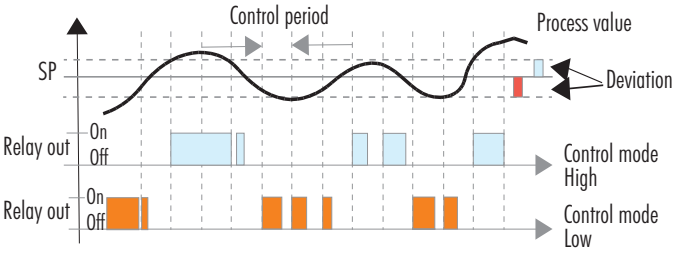


Figure 29: Proportional Control, Relay Out - Control Mode High/Low

Analog Output is proportional with Set point variance over Control period.

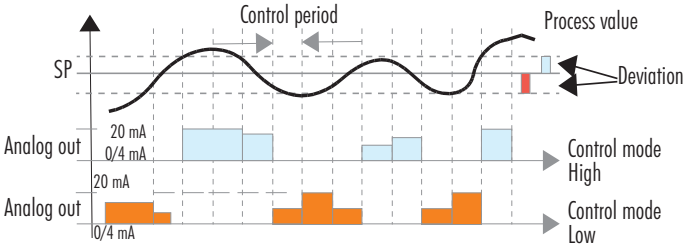


Figure 30: Proportional Control, Analog Out - Control Mode High & Low

Running control On continuously for an extended period of time is prevented by Overtime control action.

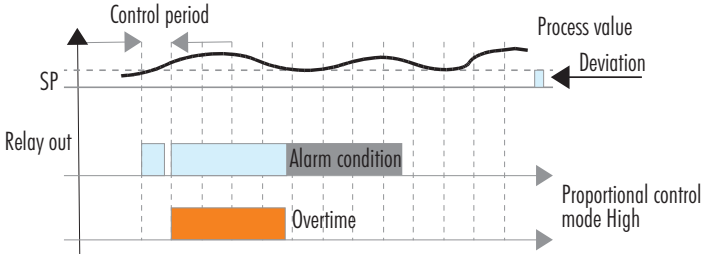


Figure 31: Proportional Control, Relay Out - Proportional Control Mode High, Overtime

Relay On time has a guaranteed minimum to prevent stressing the actuators electrically or mechanically.

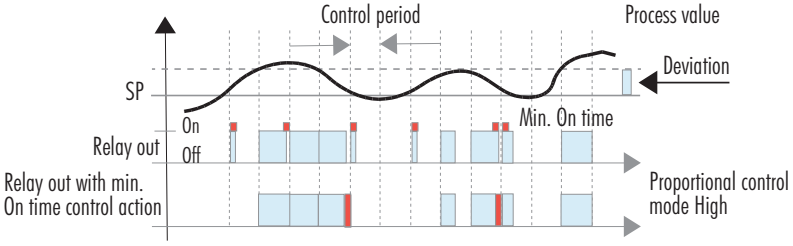


Figure 32: Proportional Control, Relay Out, Proportional Control Mode High, Min. On Time

Dead band minimizes noise influence on control output near Set point.

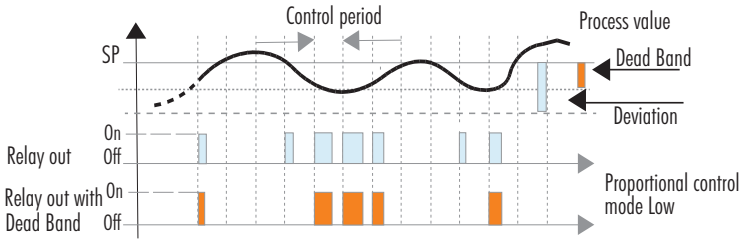


Figure 33: Proportional Control, Relay Out, Proportional Control Mode Low with Dead Band

Proportional Control Interaction with Controller Status

Function / Mode	Hold				Cleaning	Edit	Calibration	Manual	Error
	Measure	Start up	Hold	Alarm					
Control Output	o to 100% On from Control Period	0%	0%	0%	0%	0%	0%	0%	0%
Relay Assigned to Set Point Control Output	On for the time control output is On	Off	Off	Off	Off	Off	Off	On or Off	Off
Analog Output Assigned to Set Point Control Output	Scaled value of control output	Scaled value of control output	Scaled value of last control output or a fixed value of control output	Scaled value of control output or 22 mA, if option configured	Scaled value of last control output or a fixed value of control output	Scaled value of last control output or a fixed value of control output	Scaled value of last control output or a fixed value of control output	Any value in range 0 to 22 mA	Scaled value of control output

14.1.3. Proportional Integral Derivative (PID) Control Algorithm

PID control on the HI510 is a mathematical control loop method that automatically applies algorithm corrections to the control function.

Proportional, Integral and Derivative control actions are brought together to create a single PID control algorithm. PID systems use feedback (through integration) and prediction (through differentiation) algorithms.There are various tuning parameters that must be set by the user. These enable a prediction based on the speed of the process response to the output. With a well-tuned system, overshoot, offset and oscillations are eliminated.

PID can be used for closed loop (such as batch tank) and open loop (such as chemical injection into a pipe) systems.

Inputs

- Set point as the desired value of the controlled parameter
- Control mode as High or Low
- Deviation as a relative parameter
- Control period as time
- Reset time for integrative component as time
- Rate time for derivative component as time
- Dead Band as a relative parameter
- Dead Band Gain as 0 to 100%

Where:

Deviation is the interval aligned with the Set point where control output proportional term can take values from 0 to 100%. 0% indicates no action and 100% indicates full control output action. If control output is assigned to a relay, 0% control output will keep relay Off during control time, while 100% will drive relay On for this entire time. A low value for this parameter is suitable for low latency processes, allowing the control system to react quickly and strongly.

Control Period is the time interval required for updating PID control output. High-dynamic processes require frequent PID calculations updates, meaning shorter Control periods.

Reset time indicates the history of the process control efficiency - sum of errors between Set point and measured process value. A low value for this parameter, will increase the representation of previous errors in the control output. This option is appropriate if deviation parameter is large or/and process has a high latency.

Rate time is a predictive parameter that indicates the speed of evolution of the control errors. It is based on current and previous errors. A large value will increase control response to fast disturbances, but will also make control more vulnerable to noise. Slow processes require rate time to be close to 0.

Dead Band represents an area where the error between Set point and process value is considered 0. The integrative term does not change in this area.

Dead Band Gain is a coefficient applied to PID integrative term in the Dead Band area. 0% indicates that the integrative term is nullified and 100% indicates that the term is part of the control output.

Outputs

- Control output as 0 to 100%

Update rate "-" = Control period

Enabled by

- Settings
- Controller status

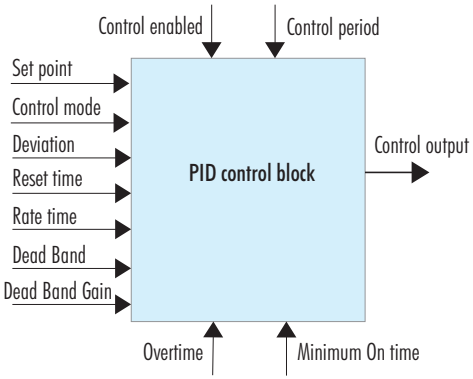


Figure 34: PID Control Block

The transfer function of a PID Control is modeled 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). PB is expressed in percentage of the input range and is related to Kp with:

$$Kp = 100/PB$$

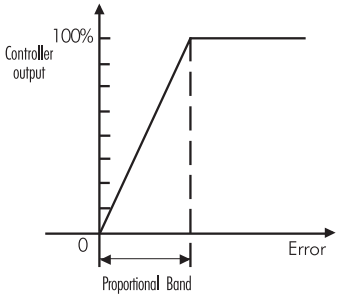


Figure 35: Proportional action by means of Proportional Band

The proportional action is set directly as Deviation (D) in control parameter units. The relation between D and PB is:

$$D = \text{Range} * PB/100$$

$$Ti = Kp/Ki, \text{ Reset time}$$

$$Td = Kd/Kp, \text{ Rate time}$$

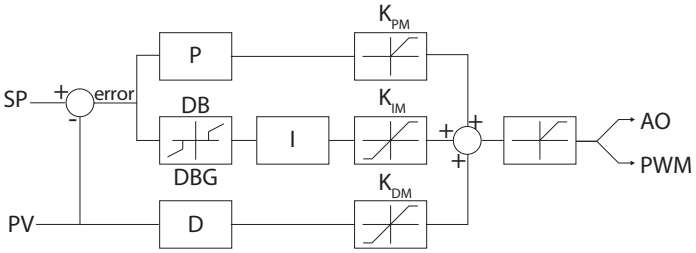


Figure 36: Controller structure representation

SP – Set Point

PV – Process Value

P – PID proportional term

I – PID integrative term

D – PID derivative term

DB – Dead Band

DBG – Dead Band Gain

K_{PM} – Maximum proportional term representation

K_{IM} – Maximum integrative term representation

K_{DM} – Maximum derivative term representation

AO – Analog Out

PWM – Output driving relays

PID control of a batch pH process using a pump as external dosing device

As with On/Off and Proportional control, a dosing solution can be an acid or base depending on the desired results; and the control mode can be set High or Low.

With PID control enabled in Setup, the dosing time depends on the Deviation, Control period, Reset time, Rate time, as well as how far the measurement is from the Set point.

Once enabled, a controller in proportional/integral mode (PI mode) works in a fashion similar to a controller in proportional mode, but also integrates the error over time to reduce the variance error to zero. A controller in PID mode incorporates the three control functions into a single control scheme. The addition of derivative function to the PI mode results in the capacity to attenuate overshoots to some extent, but adds the risk of instability if the process is noisy.

Proportional Function

With the proportional function, control output is proportional to the variance value.

Figure 37 illustrates the process controller behavior with a pH probe. Similar graph may apply for mV measurements.

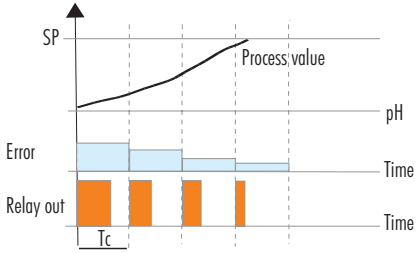


Figure 37: **Proportional Function with pH Probe Connected**

When a relay is assigned to proportional control, the controller calculates the relay activation time at certain moments e.g. t0, t0+Tc, t0+2Tc (Tc=Control period). The On interval (the shaded areas) is dependent on the error value.

Integral Function

With the integral function (Reset time), the controller will reach a more stable output around the Set point, providing a more accurate control than with the On/Off or proportional action only. The integral function uses feedback.

Derivative Function

The derivative function (Rate time) compensates for rapid changes in the system reducing undershoot and overshoot of the pH value. The derivative function utilizes predictive behavior.

During PID control, the On interval is dependent not only on the variance value but on previous measurements too.

Figure 38 illustrates how the response overshoot can be improved with a proper Rate-time setting.

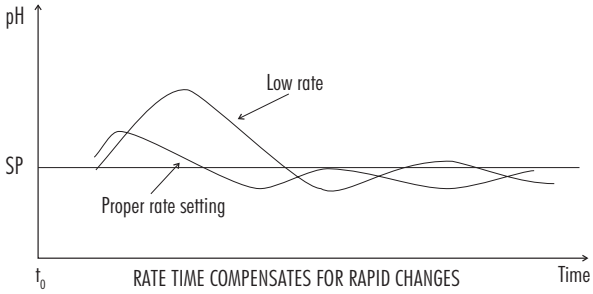


Figure 38: **Derivative Function with pH Probe Connected**

Tuning PID Parameters using relay on/off controlled device

PID parameters have to be adjusted to a user's process variables. Values for PID parameters depend on the installing process characteristics e.g. overall liquid volume, recirculated flow, dosed reagent concentration, flow mixing, process buffering, electrode's response time.
Optimum values for PID parameters can be tuned (adjusted) after an experimental tuning procedure. To get the best possible control, a "trial and error" tuning procedure must be first performed. Below listed five parameters can be adjusted to achieve a fast response time and a small overshoot:

Set point
Deviation
Reset time
Rate time
Control period

Note *Users have to disable the derivative and integrative actions by setting the Rate time to 0 and Reset time to maximum. Control period and Set point need to be at maximum value. Deviaton needs to be set at minimum value.*

Please note that this procedure allows for a rough setting of the PID parameters only; and therefore, would not fit all processes. Reset time and Rate time parameters should be set by technical personnel only.

1. Turn On controller; set the log interval to 10s.
2. Start with a solution that has a pH or mV value different enough from the dosed liquid (e.g. a minimum of 3 pH or 150mV difference).
3. Turn On the dosing device at its maximum capacity and note down the starting time to correlate with controller real time clock taken from the daily log files.
4. The pH or mV will start to vary and subsequently will reach a maximum rate of change (slope).

5. At this stage, stop dosing reagent.
6. Transfer the log file on a USB flash drive.
7. Connect to a PC and download the data from the USB flash drive and prepare the process graphic.
8. On the chart draw a tangent to the maximum slope point until it intersects with the horizontal line corresponding to the initial pH or mV value. Read the system time delay (Tx) on the time axis.
9. The deviation, Reset Time and Rate Time can be calculated from the following:
   Deviation = Tx * max. slope (pH or mV)
   Reset time = Tx / 0.4 (minutes)
   Rate time = Tx * 0.4 (minutes)
10. Set the above parameters and restart the system. If the response has too much overshoot or is oscillating, the system can be fine-tuned by slightly increasing or decreasing the PID parameters one at a time.

The graph, given as an example here, was obtained by dosing an alkaline solution to a weak acid solution in a tank. For this, the initial settings have been:

Maximum slope = 3 pH/5 minutes = 0.6 pH/minute
Control period = Tx = approx. 7 minutes
Deviation = Tx * 0.6 = 4.2 pH
Reset time = Tx / 0.4 = 17.5 minutes
Rate time = Tx * 0.4 = 2.8 minutes

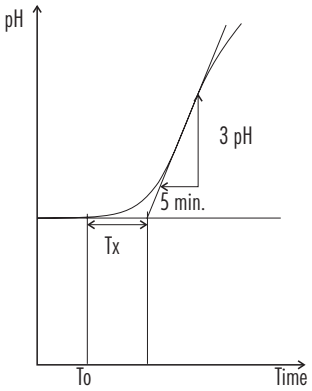


Figure 39: Tunning PID Parameters, Dosing an Alkaline Solution to a Weak Acid

PID Control

Following graphs exemplify how the input parameters work.

Control out is proportional with the Set point variance, the sum of previous control errors and an estimation of the future ones.

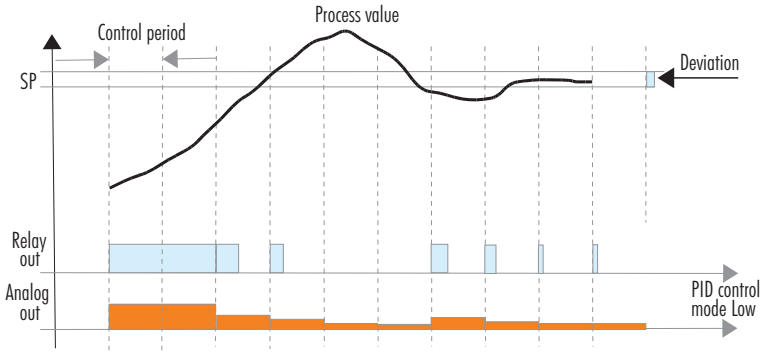


Figure 40: PID Control Mode Low, Relay & Analog Out

Realy On time has a guaranteed minimum to prevent stressing the actuators electrically or mechanically.

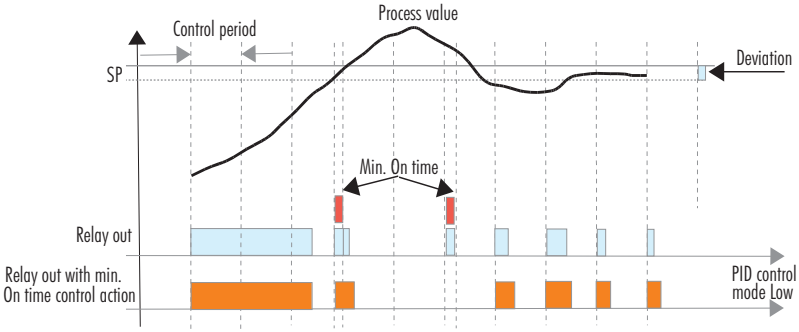


Figure 41: PID Control Mode Low, Relay Out with Minimum On Time

To minimize overshooting, the integrative control part is zeroed as it approaches Set point.

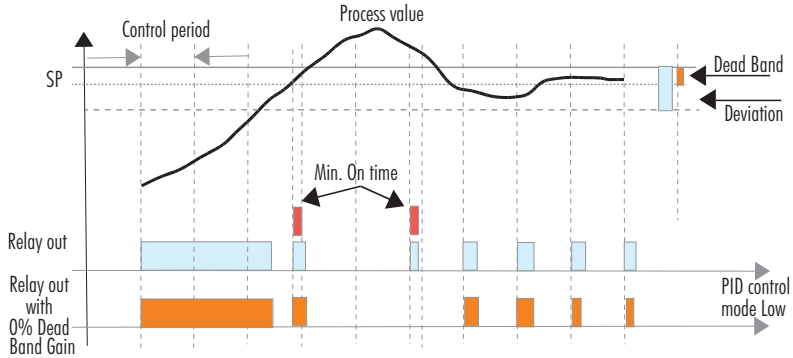


Figure 42: PID Control Mode Low, Relay Out with 0% Dead Band Gain

To minimize overshooting, the integrative control part is diminished as it approaches Set point.

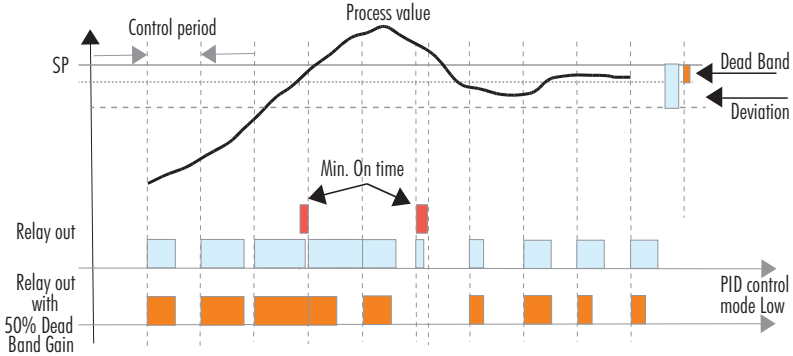


Figure 43: PID Control Mode Low, Relay Out with 50% Dead Band Gain

PID Control Interaction with Controller Status

Function / Mode	Hold				Cleaning	Edit	Calibration	Manual	Error
	Measure	Start-up	Hold	Alarm					
Control Output	0 or 100% On from Control Period	0%	0%	0%	0%	0%	0%	0%	0%
PID Calculations	On	Freeze	Reset to 0 and freeze	Reset to 0 and freeze	Freeze	Reset to 0 and freeze	Reset to 0 and freeze	Reset to 0 and freeze	Reset to 0 and freeze
Relay Assigned to Set Point Control Output	On for time control output is On	Off	Off	Off	Off	Off	Off	On or Off	Off
Analog Output Assigned to Set Point Control Output	Scaled value of control output in mA	Scaled value of control output	Scaled value of last control output or a fixed value of control output	Scaled value of last control output or 22 mA, if option configured	Scaled value of last control output or a fixed value of control output	Scaled value of last control output or a fixed value of control output	Scaled value of last control output or a fixed value of control output	Any value in range 0 to 22 mA	Scaled value of control output

15. CLEANING MODE

Data acquisition is done by digital probes via specific sensors. Due to process conditions, sensors can get clogged. To maintain accurate and reliable data, the HI510 has implemented the cleaning control function as a basic feature.

When in cleaning mode, the controller activates an external device (e.g. a pumps or valves).

Cleaning control block provides a specific sequence on cleaning outputs based on two control algorithms: Simple cleaning and Advanced cleaning.

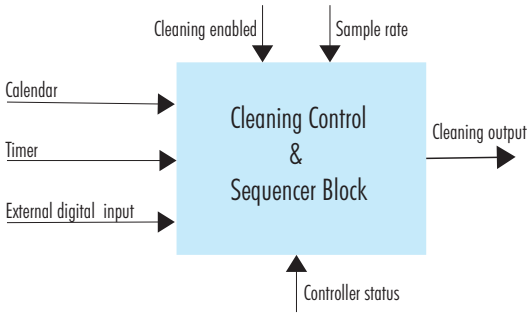


Figure 44: Cleaning Control & Sequencer Block

15.1. CLEANING BLOCK INPUTS & OUTPUTS

Cleaning block inputs and outputs are common to both Simple and Advance cleaning.

The common, to both types of cleaning, inputs are:

- Calendar, cleaning triggered at specific time and week day. Internal RTC will be used as reference.
- Timer, cleaning triggered at a fix interval. The one second time base interval will be used for that.
- External digital inputs, cleaning triggered at transition from inactive to active state on one or more digital inputs, provided the inputs are assigned to do this.
- Controller Status, cleaning can be stopped, suspended or resumed upon controller reaching certain status.
- Cleaning Enabled, main condition that allows (or not) cleaning to run.
- Sample Rate, timing has the one second time base interval used for all time-sequences evaluation.

Outputs are assigned as:

- Rinse for both Simple and Advanced cleaning where one or more relays are assigned to cleaning, rinse phase.
- Wash, for Advanced cleaning where one or more relays are assigned to cleaning, wash phase.

15.2. CLEANING SEQUENCES

Cleaning sequences are specific to each cleaning type and are defined as follows:

For Simple cleaning

- Rinse time, the time that Rinse relay is activated
- Recovery time, the time necessary for the probe sensors to reach stable and accurate measurements

For Advanced cleaning

- Pre-Wash rinse time, the time allocated to rinse the sensors before washing
- Wash time, the time allocated to wash sensors with a washing solution
- Post-Wash rinse time, the time allocated to rinsing the sensors after washing
- Wash cycles number, number of cycles completed with rinsing and washing solutions
- Rinse-Only cycles number, number of cycles completed with rinsing only solutions
- Recovery time, time necessary for the probe sensors to reach stable and accurate measurements

15.3. CLEANING ALGORITHMS

Simple Cleaning

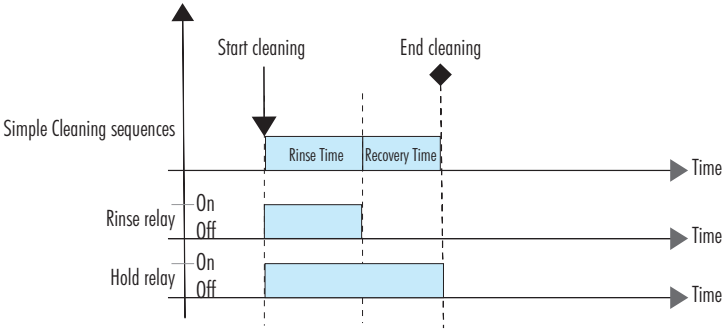


Figure 45: Cleaning Algorithm, Simple Cleaning

Advanced Cleaning

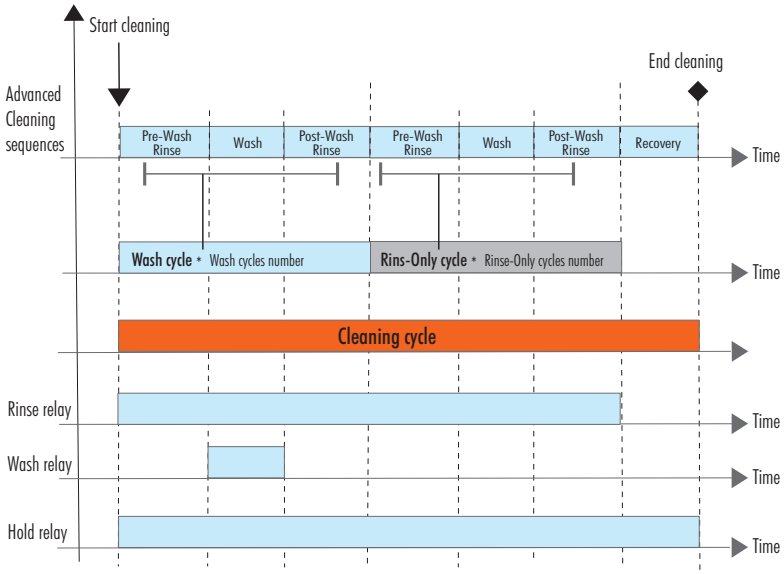


Figure 46: Cleaning Algorithm, Advanced Cleaning

15.4. CLEANING TRIGGERS

External input

The external digital inputs are set to start cleaning process. Transition of external digital inputs from an inactive to active level will start the cleaning.

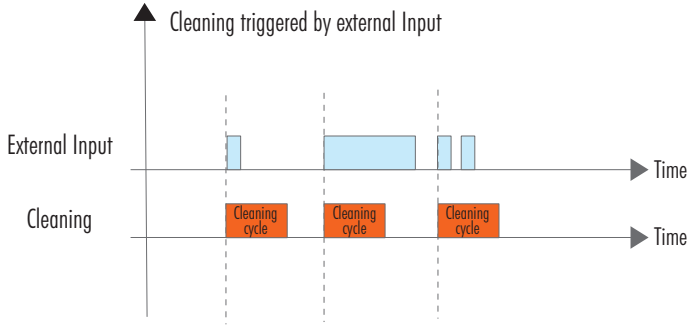


Figure 47: Cleaning Trigger, External Input

Internal timer

Cleaning starts at fix intervals, prompted by an internal timer.

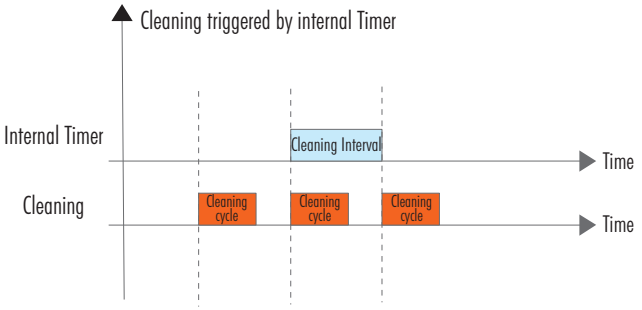


Figure 48: Cleaning Trigger, Internal Timer

Internal schedule

Cleaning starts at exact times, with a maximum of three start times per day.

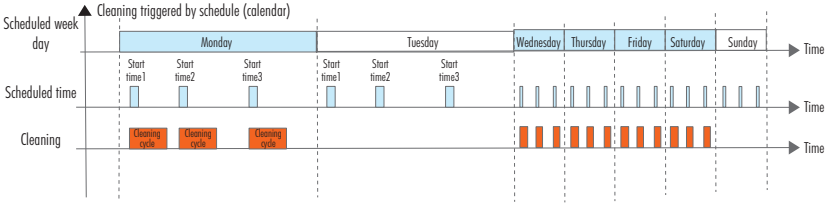


Figure 49: Cleaning Trigger, Internal Schedule

Operator intervention

Cleaning starts by pressing the left virtual key on keypad when in Menu, Cleaning menu item selected. Cleaning should have beeen enabled previously.

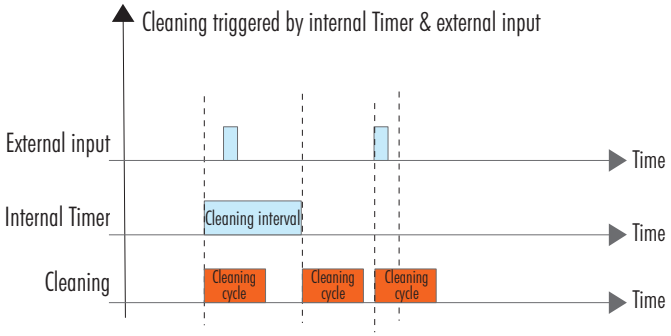


Figure 50: Cleaning Trigger, Operator Intervention

Triggered by a combination of external input & internal timer or schedule

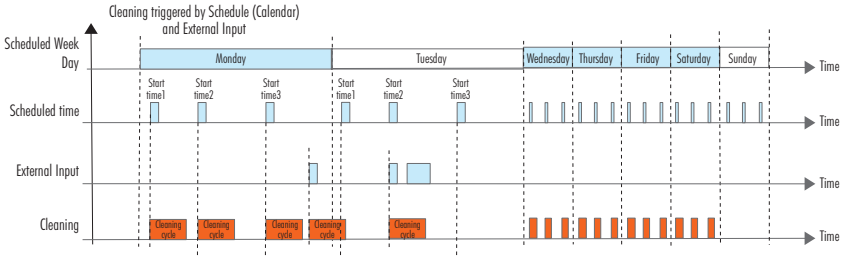


Figure 51: Cleaning Trigger, External Input & Internal Timer

15.5. STOP CLEANING

Navigation

- Press and hold the ▼ ▶ keys together to terminate a cleaning.
- During cleaning with the controller in normal measurement mode, the countdown timer will be displayed on the second LCD line.

A complete rinsing phase (post-rinse time) is always performed before terminating an advance cleaning. If the request to stop the cleaning is issued during rinsing, the rinsing phase is carried out to completion.

Note: *Calibration can't be performed during cleaning; conversely, cleaning can't be triggered during calibration.*

A cleaning cycle can be stopped:

- At the end of a cleaning sequence, with the next cycle being triggered as per configured cleaning triggers.
- At a stop command, with the current cycle being shortened to a maximum time which is the sum of a single rinse and recovery time. Next cycle will start as per configured cleaning triggers.

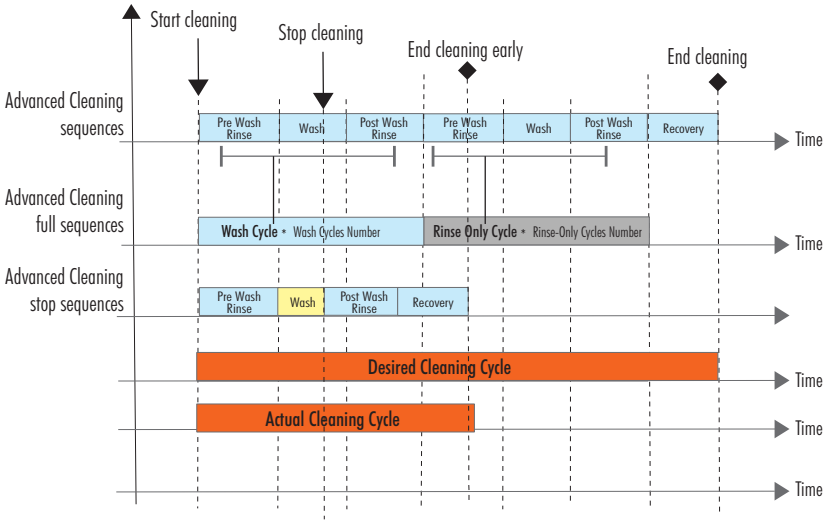


Figure 52: End Cleaning, Stop Sequences

- At a suspend condition, with the current cycle being shortened to a maximum time which is the sum of a single rinse and recovery time. Next cycle to start only after suspend condition is removed.

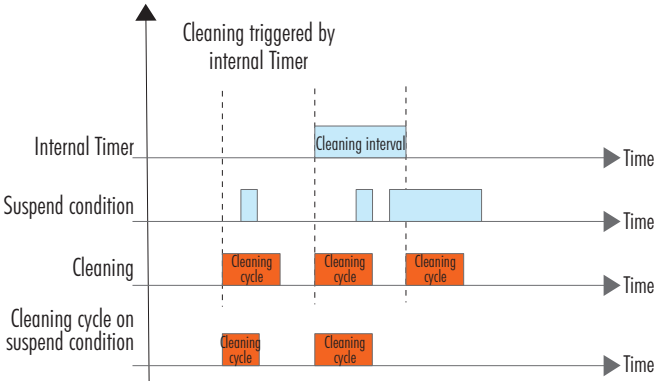


Figure 53: End Cleaning, Suspend Condition

- At a transition to manual mode. Cleaning cycle is stopped instantly. After exiting from manual mode, cleaning will continue with a rinse and a recovery phase.

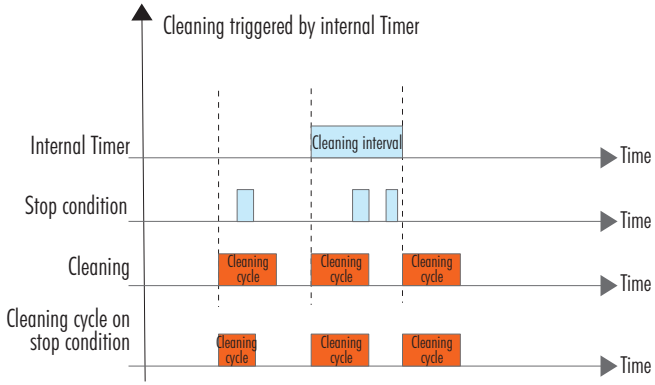


Figure 54: **End Cleaning, Stop Condition**

15.6. OVERVIEW OF CLEANING TYPES

Cleaning	Triggers	Associated Relay	Steps
Simple (water only)	• internal triggers (timer[1], schedule[2]) • external trigger • manual start	any non-assigned relay can be set as Rinse Relay	• instrument enters HOLD mode • configured relay(s) is (are) energized
Advanced (water & detergent)	• internal triggers (timer[1], schedule[2]) • external trigger • manual start	any non-assigned relay can be set for advanced cleaning (i.e. at least one Rinse Relay and Wash Relay)	• instrument enters HOLD mode • rinse is energized (pre-rinsing phase) • wash is energized (detergent phase) • wash is de-energized (post-rinsing phase)

[1] If the trigger is set to timer, entering in a Hold mode that overlaps with the trigger will add a delay to the cleaning cycle.
[2] If the trigger is set to schedule, entering in a Hold mode that overlaps with the trigger of the next start time and exceeds the set time, the trigger will be lost. The trigger will still be activated if the internal clock doesn't get past a minute over start time.

16. HI510 EVENTS MANAGEMENT SYSTEM

HI510 has an intuitive and user friendly events management system that allows for quick and easy event source-identification.

Status and Hold LEDs located on the right side of the controller's front panel as well as Alarm and Relay LEDs located on the left side notify the instrument status.

LED	LED Notification Light	HI510 Status Signaled by LED Notification Light
Status	Green (●) Yellow (●)* Red (●)**	Measure mode Warning Errors or Alarms
Hold	Yellow (●)	Requires user attention
Alarm	Red (●)	Measure mode is interrupted
Relay	Blue (●)	Active status

* Controller requires user attention

** Controller requires specialized technical assistance

16.1. ALARMS, WARNINGS, ERRORS

ALARMS

Definition: An alarm is an event generated when programmed alarm conditions have been met.
HI510 alarm system is made of:

- Default alarms, generated during a measurement cycle when measured values have exceeded or dropped below probe ranges limits
- Configured alarms, generated when measured values have exceeded values configured for each parameter (pH / ORP) and Temperature in Setup, Channel, Alarm Settings
- When enabled in General setup, an acoustic signal (beep / buzz) is generated each time an alarm is triggered. The acoustic signal can be stopped by pressing any key.

WARNINGS

Definition: A warning is an event generated when erroneous conditions appear; and when measured values or parameter values, configured in the main Menu, are outside the expected range.

ERRORS

Definition: An error is a critical event that requires Hanna Instruments technical support.
If errors are detected, the controller enters Hold mode, Hold LED lights up yellow and Alarm LED lights up red.

ALARMS

Event & Log Event Code	Description	Logging	Stop Ctrl.	Analog Output (AO)	Alarm Relay & LED	Status LED
ALARM_HIGH_PRIMARY 0x00000040	Generated during measurement when main reading is over Alarm High value	YES	YES	AO assigned to Ctrl.SetPoint – scaled value of Ctrl.SetPoint output AO assigned to parameter – scaled value of parameter or 22mA, if this option is enabled	On ●	☀
ALARM_LOW_PRIMARY 0x00000080	Generated during measurement when main reading is below Alarm Low value	YES	YES		On ●	☀
ALARM_HIGH_SECONDARY (T) 0x00000100	Temperature control set	YES	YES		On ●	☀
	No temperature control	YES	NO.		On ●	☀
ALARM_LOW_SECONDARY (T) 0x00000200	Temperature control set	YES	YES		On ●	☀
	No temperature control	YES	NO		On ●	☀
ALARM_OVER_RANGE_ PRIMARY 0x00000400	Generated during measurement when probe main reading is in overrange status	YES	YES		On ●	☀

Event & Log Event Code	Description	Logging	Stop Ctrl.	Analog Output (AO)	Alarm Relay & LED	Status LED
ALARM_UNDER_RANGE_PRIMARY 0x00000800	Generated during measurement cycle when probe main reading is in under range status	YES	YES	AO assigned to Ctrl.SetPoint – scaled value of Ctrl.SetPoint output AO assigned to parameter – scaled value of parameter or 22mA, if this option is enabled	On ●	☀
ALARM_OVER_RANGE_SECONDARY (T) 0x00001000	Generated during measurem. cycle when probe temperature reading is in over range status	YES	probe use manual T.		–	●
ALARM_UNDER_RANGE_SECONDARY (T) 0x00002000	Generated during measurem. cycle when probe temperature reading is in under range status	YES	probe use manual T.		–	●
ALARM_HOLD_IN 0x00100000	Generated each time HOLD input condition is present (alarm hold)	YES	YES		On ●	☀
	Generated manual (silent hold)	YES	YES			●
	Generated by Menu /User cal. (silent hold)	YES	YES			●
ALARM_OVERTIME Set point 1: 0x00000010 Set point 2: 0x00000020	Generated each time overtime set value is exceeded with 100%	YES	YES		v	☀

WARNINGS

Event & Log Event Code	Description	Hold Mode	Logging	Analog Output (AO) Behavior	Status LED
WARNING_UCAL_EXP 0x00000002	Generated when after probe user calibration, the calibration alarm time out period is overpassed	NO	YES	As it is configured	●
WARNING_UCAL_EXP_SOON 0x00000004	Generated before the calibration alarm time out period is overpased (5% calibration alarm timeout days before)	NO	YES		●
WARNING_CONTROL_DELAY 0x00000008	Generated before start control, if delay is active	NO	YES		●
WARNING_CTRL_SET_ CHANGED 0x00000010	Generated when settings from CH setup menu are changed	NO	YES		●
WARNING_HIGH_PRIMARY 0x00000200	Generated when CH primary parameter is over CH primary parameter ALARM High set value but the mask time has not expired to became an alarm	NO	YES		●
WARNING_LOW_PRIMARY 0x00000400	Generated when CH primary parameter is below CH primary parameter ALARM High set value but the mask time has not expired to became alarm	NO	YES		●

Event & Log Event Code	Description	Hold Mode	Logging	Analog Output (AO) Behavior	Status LED
WARNING_HIGH_SECONDARY 0x00000800	Generated when CH secondary parameter is over CH secondary parameter ALARM High set value but the mask time has not expired to became alarm	NO	YES	As it is configured	●
WARNING_LOW_SECONDARY 0x00001000	Generated when CH secondary parameter is below CH secondary parameter ALARM High set value but the mask time has not expired to became alarm	NO	YES		●
WARNING_CTRL_CAL_ CHANGED 0x00002000	Displayed after Calibration update	NO	YES		●
WARNING_CTRL_CH1_SP1_ SETTINGS_INCOMPLETE 0x00004000	Generated if Set point1 is enabled but no output is assigned	NO	YES		●
WARNING_CTRL_CH1_SP2_ SETTINGS_INCOMPLETE 0x00008000	Generated if Set point2 is enabled but no ouput is assigned	NO	YES		●
WARNING_RTC_SET_TO_ FIRST_VALUE Log event code: 0x00010000	Generated when RTC was initialized	NO	YES		●

Event & Log Event Code	Description	Hold Mode	Logging	Analog Output (AO) Behavior	Status LED
WARNING_FUSB301_FAIL 0x00020000	WARNING USB Controller FAIL	NO	YES	As it is configured	●
WARNING_CTRL_SET_ CHANGED 0x00040000	Control settings changed	NO	YES		●
WARNING_LOG_INTERVAL_ CHANGED 0x00100000	Generated when the Lot logging time-interval has changed	NO	YES		●
WARNING_LOT_LOG_FULL 0x00800000	Generated when current file has reached 8600 records. A new lot log will be generated.	NO	NO		●
WARNING_LOT_LOG_MAX_ INDEX_ASSIGNED 0x01000000	Generated when the Lot logging max. file index (99) was reached (the next lot file will automatically delete the oldest one)	NO	NO		●

ERRORS

Event & Log Event Code	Description	Hold Mode	Logging	Stop Ctrl.	Analog Output (AO) Behavior		Alarm Relay & LED	Status LED
					0-20 mA	4-20 mA		
ERROR_PROBE_NO_FCAL 0x00020000	Probe is not factory calibrated or factory calibration is corrupt	YES	Event	YES	0	4	●	●
ERROR_5V_POWER 0x00000200	Generated when and reading is not in range	YES	Event	YES	0	4	●	●
ERROR_MULTIPLE_POWER 0x00000400 0x00000100 0x00000800 0x00001000 or the sum of them	Generated when there is an error on RS-485 power supply, 3V power supply, probe 1 power supply, or probe 2 power supply is not in range	YES	Event	YES	0	4	●	●
ERROR_AO_POWER 0x00004000	Generated when Analog Outputs (AO) power supply is not in limits	YES	Event	YES	0	4	●	●
ERROR_IO_POWER 0x00010000	Generated when smart Input power supply is not in limits	YES	Event	YES	0	4	●	●

17. PROBE CONDITIONING & MAINTENANCE

General Maintenance

- After prolonged storage or cleaning, calibration of the probe is required.
- After use, rinse the probe with tap water and dry it.
- Inspect all sensor connectors for corrosion and replace if necessary.

pH & ORP Sensor Maintenance

- Remove the sensor protective cap. Do not be alarmed if any salt deposits are present. This is normal with pH / ORP probes and they will disappear when rinsed with water.
- Shake down the probe as you would do with a clinical thermometer to eliminate any air bubbles inside the glass bulb.
- If the bulb and / or junction are dry, soak the electrode in HI70300 Storage solution for at least 30 minutes
- To ensure a quick response, the glass bulb and the junction should be kept moist and not allowed to dry. This can be achieved by installing the electrode in such a way that it is constantly in the flow-cell or the pipe filled with the sample. Store the sensor with a few drops of HI70300 Storage solution or pH 4.01 in the protective cap.

Note: *Never use distilled or deionized water when stored.*

Periodic Maintenance

- Inspect the electrode for any scratches or cracks. If any are present, replace the electrode.
- Inspect the cable. The connection cable must be intact.
- Rinse off any salt deposits with water.

pH Cleaning Procedure

1. Soak the sensor in HI7061 Electrode cleaning solution for general use or application specific cleaning solution for 15 minutes.
2. Rinse with water.
3. Soak the electrode in HI70300 Storage solution for at least 30 minutes, rinse with water and calibrate before using.

Protein, Inorganic, Oil or Grease Cleaning Procedure

1. Soak the sensor in application specific electrode cleaning solution (i.e. HI7073 Protein cleaning, HI7074 Inorganic cleaning for 15 minutes or HI7077 Oil & Fat cleaning solution).
2. Rinse the sensor with water.

IMPORTANT: *After performing any of the cleaning procedures, rinse the electrode thoroughly with water and soak in HI70300 Storage solution for at least 30 minutes before reinstalling it.*

18. TROUBLESHOOTING GUIDE

Symptoms	Problem	Solution
Slow response / Excessive drift	Dirty pH electrode	Soak the electrode tip in HI7061 Electrode cleaning solution for 30 minutes and then follow the Cleaning procedure
Reading fluctuates up and down (noise)	Clogged/Dirty pH electrode junction	Clean the electrode.
pH scale out of range	Dry membrane (or junction)	Soak electrode in HI70300 Storage solution for at least 30 minutes
Controller fails to calibrate (or gives faulty readings)	Broken pH electrode	Replace pH electrode
Error messages are displayed during pH calibration procedure	Wrong (or contaminated) buffer, dirty (or broken) electrode.	Check that buffer solution is correct and fresh Check the electrode
"**Errxx**" message at start up	Internal error	Contact your local Hanna Instruments Office

Note: *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: *It is recommended to keep at least one spare electrode handy. When problems are not resolved with a simple maintenance procedure, change the probe and recalibrate.*

19. BUFFER VALUES AT VARIOUS TEMPERATURES

Temperature has an effect on pH. The calibration buffer solutions are affected by temperature. During typical two- or three-point buffer calibration, the controller utilizes auto buffer recognition.
The following chart is for reference only.

Temperature		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 4.01, 7.01 or 10.01 pH for 4, 7 or 10 pH buffers, respectively.
At 20 °C, the display should show 4.00, 7.03 or 10.06 pH.
At 50 °C, the display should show 4.06, 6.98 or 9.82 pH.

20. APPLICATION CONFIGURATION (PROBE, RS485, INPUT & ANALOG WIRING)

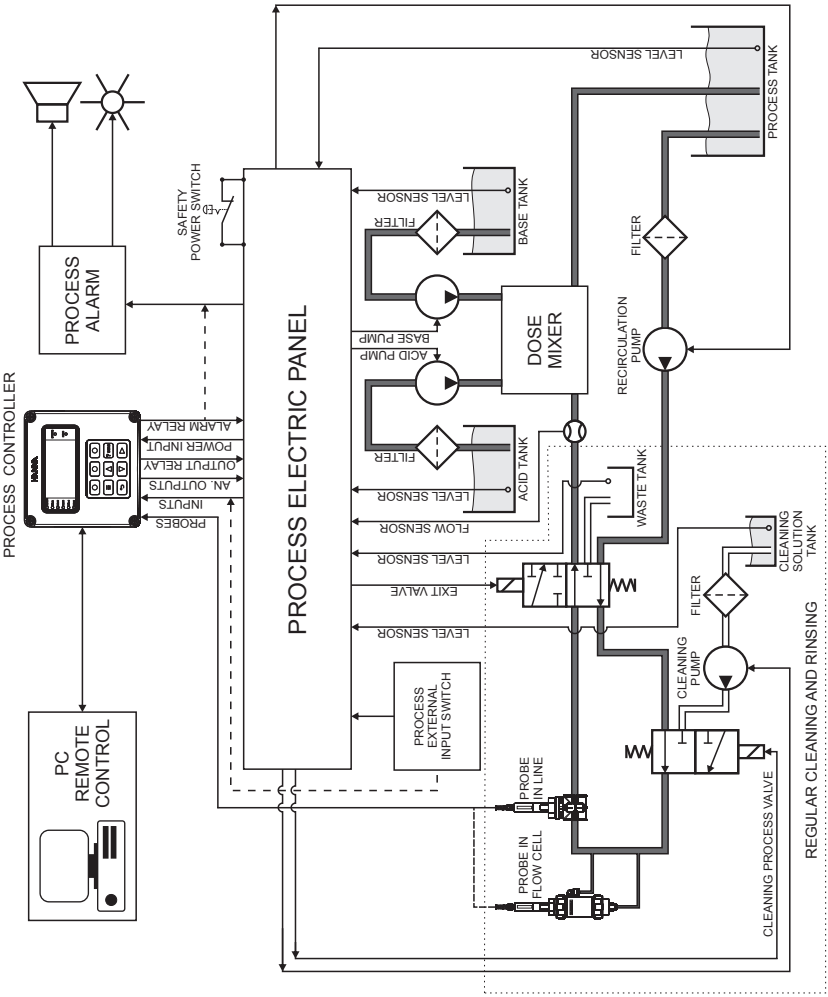


Figure 55: HI510 Configuration

21. GLOSSARY

data acquisition ▸ conversion of analog signals received from the probe sensor to digital representations that can be processed by a computer

dead band ▸ an area where the absolute value of the error between Set point and process value is considered 0

dead band gain ▸ a coefficient applied to PID integrative term in the Dead Band area

deviation ▸ an interval aligned with Set point value, where control output can take values from 0% to 100%. It is measured in process-value units.

fail safe alarm ▸ signaling of the alarm by de-energizing the alarm relay instead of energizing it. Protects against power failures and interruptions of the alarm relay external wires.

hysteresis ▸ interval that must be exceeded by the controlled magnitude in the opposite direction after having activated a relay, before deactivating it, in order to avoid uninterrupted relay activation or deactivation

cleaning ▸ automatic procedure to stop control, clean the electrode and then activate control again

minimum On time ▸ the time that control output is minimum On, necessary to protect elements that are driven

overtime ▸ a safety parameter provided to set the maximum continuous time control is running at it's maximum value

potential matching pin ▸ is a titanium which must be immersed into the measured fluid. It is used together with a differential input to avoid damage of the reference electrode due to ground loop current.

set point ▸ desired value for the controlled parameter.

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

22. LIST OF FIGURES

23. ACCESSORIES

23.1. PH CALIBRATION SOLUTIONS

Code	Description	Quantity
HI7004M or **HI7004L**	4.01pH buffer solution	230 or 500 mL
HI7006M or **HI7006L**	6.86 pH buffer solution	230 or 500 mL
HI7007M or **HI7007L**	7.01pH buffer solution	230 or 500 mL
HI7009M or **HI7009L**	9.18 pH buffer solution	230 or 500 mL
HI7010M or **HI7010L**	10.00 pH1 buffer solution	230 or 500 mL

23.2. ORP SOLUTIONS

Code	Description	Quantity
HI7021M or **HI7021L**	Test solution, 240 mV	230 or 500 mL
HI7091M or **HI7091L**	Pretreatment reducing solution	230 or 500 mL
HI7092M or **HI7092L**	Pretreatment oxidizing solution	230 or 500 mL
HI7022	ORP test solution, 470 mV	500 mL

23.3. ELECTRODE STORAGE SOLUTIONS

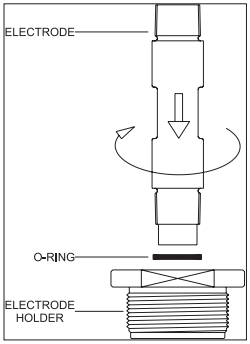
Code	Description	Quantity
HI70300M or **HI70300L**	Storage solution	230 or 500 mL
HI7082	3.5M KCl Electrolyte	4x50 mL

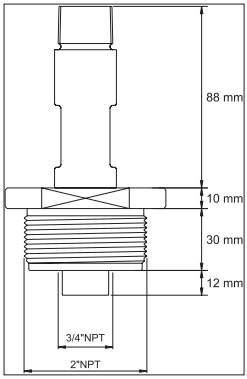
23.4. ELECTRODE CLEANING SOLUTIONS

Code	Description	Quantity
HI7061M or **HI7061L**	General cleaning solution	230 or 500 mL
HI7073M or **HI7073L**	Protein cleaning solution	230 or 500 mL
HI7074M or **HI7074L**	Inorganic cleaning solution	230 or 500 mL
HI7077M or **HI7077L**	Oil & fat cleaning solution	500 mL

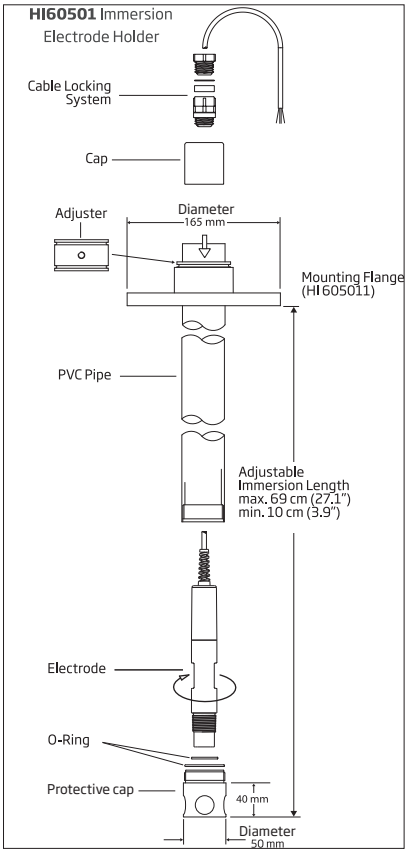
23.5. ELECTRODE HOLDERS

Code: HI60542 **Description:** In-line electrode holder, direct pipe installation





Code: HI60501 **Description:** Immersion electrode holder



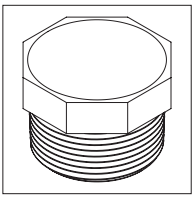
Electrode Holder Specifications

Specifications	HI60542	HI60501
Material	PVC	PVC
O-ring material	NBR	NBR
Min. & max. temperature	-10 °C (14 °F) / 60 °C (144 °F)	
Min. & max. immersion legth	N/A	10 cm (3.9") / 69 cm (27.1")
Max. pressure	8 bar (116 psi) @ 25 °C 3 bar (43.5 psi) @ 50 °C	N/A

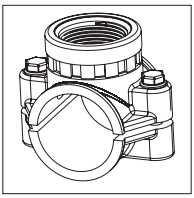
Electrode Holder O-Rings

Code	Description	Quantity
HI60501-0	O-rings for HI60501 electrode holder	1 set
HI605011	PVC mounting flange for HI60501 electrode holder	

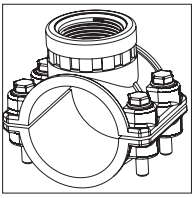
23.6. FLOW CELL & SADDLE FITTINGS



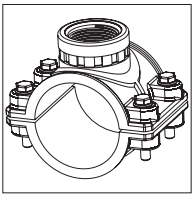
BL120-501
Protective saddle cap, 1¼" thread



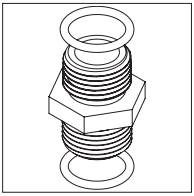
BL120-550
Probe saddle for Ø 50 mm pipe, 1¼" thread



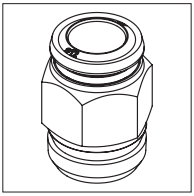
BL120-563
Probe saddle for Ø 63 mm pipe, 1¼" thread



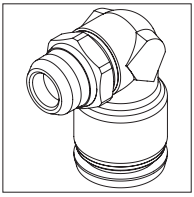
BL120-575
Probe saddle for Ø 75 mm pipe, 1¼" thread



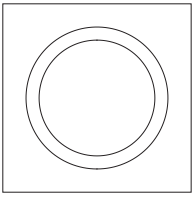
BL120-601
Plastic nipple 2 x ½" with O-rings



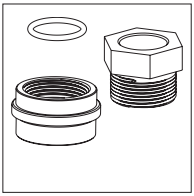
BL120-602
Metal nipple 12 x ½ (2 pcs.)



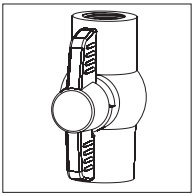
BL120-603
Elbow for glass flow cell



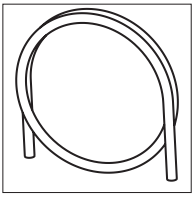
BL120-604
O-rings for glass flow cell



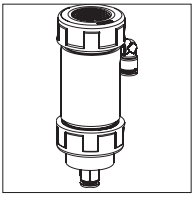
BL120-400
Flow cell probe adapter kit



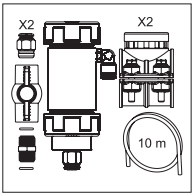
BL120-401
Flow cell valve



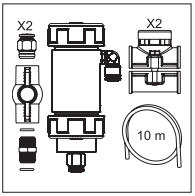
BL120-402
Flow cell tubing (10m)



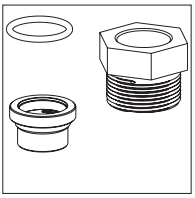
BL120-410
Flow cell for BL120, BL121, BL122, Bl123



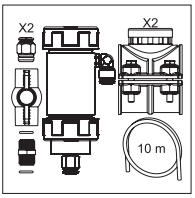
BL120-463
Flow cell kit for
Ø 63 mm pipe



BL120-450
Flow cell kit for
Ø 50 mm pipe



BL120-500
Probe fitting kit

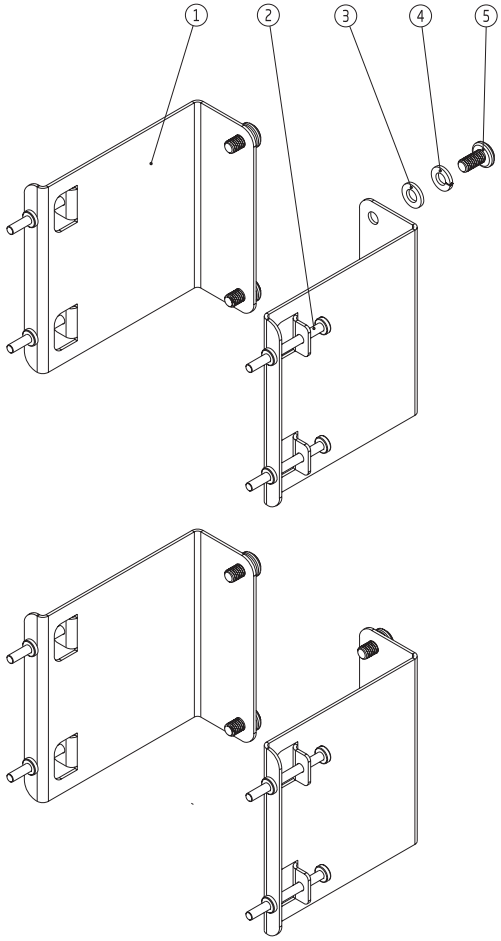


BL120-475
Flow cell kit for
Ø 75 mm pipe

23.7. MOUNTING KIT ACCESSORIES

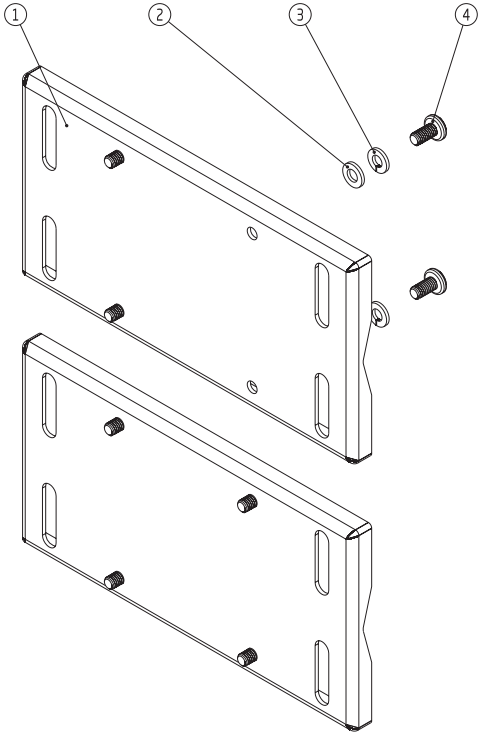
HI510-01 Panel-Mount Kit

Label	Description	Supplied Quantity
1	Panel bracket	2 pcs.
2	M4 x 45 screw, Phillips head	4 pcs.
3	Plain washer for M6 screw	4 pcs.
4	Spring washer, M6	4 pcs.
5	M6 x 12 mm screw (DIN7985)	4 pcs.



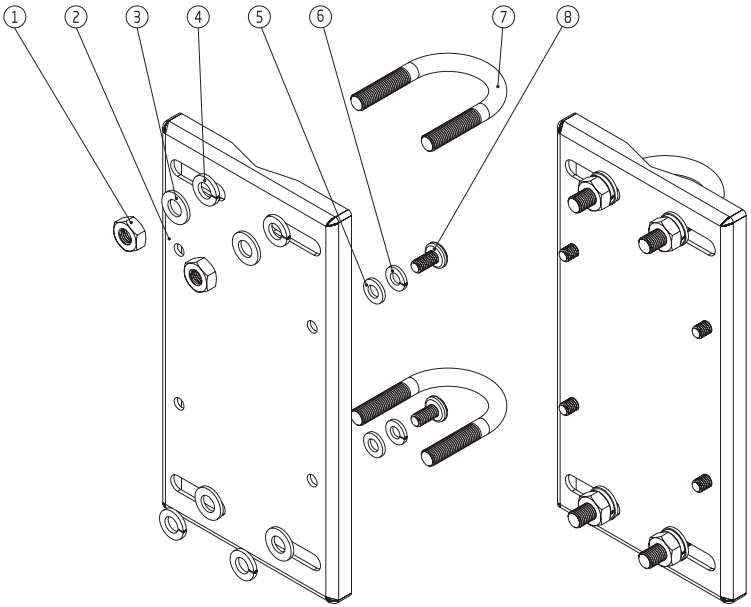
HI510-02 Wall-Mount Kit

Label	Description	Supplied Quantity
1	Zinc plated, zinc case holder	1 pc.
2	Plain washer for M6 screw	4 pcs.
3	Spring washer, M6	4 pcs.
4	M6 x 12 mm screw (DIN7985)	4 pcs.



HI510-03 Pipe-Mount Kit

Label	Description	Supplied Quantity
1	Hex nut, M8	4 pcs.
2	Zinc plated, zinc case holder	1 pcs.
3	Plain washer for M8 screw	4 pcs.
4	Spring washer, M8	4 pcs.
5	Plain washer for M6 screw	4 pcs.
6	Spring washer, M6	4 pcs.
7	U-Bolt 1″	2 pcs.
	U-Bolt 1½″	2 pcs.
	U-Bolt 2½″	2 pcs.
8	M6 x 12 mm screw (DIN 7985)	4 pcs.



CERTIFICATION

All Hanna Instruments conform to the **CE European Directives**.

CE RoHS compliant

Disposal of Electrical & Electronic Equipment. The product should not be treated as household waste. Instead hand it over to the appropriate collection point for the recycling of electrical and electronic equipment which will conserve natural resources.

Ensuring proper product and battery disposal prevents potential negative consequences for the environment and human health. For more information, contact your city, your local household waste disposal service, the place of purchase or go to www.hannainst.com.

RECOMMENDATIONS FOR USERS

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

WARRANTY

The HI510 is warranted for two years against defects in workmanship and materials when used for its intended purpose and maintained according to instructions. Damage due to accidents, misuse, tampering or lack of prescribed maintenance is not covered.
If service is required, contact your local Hanna Instruments Office. If under warranty, report the model number, date of purchase, serial number 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 (RGA) 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.

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