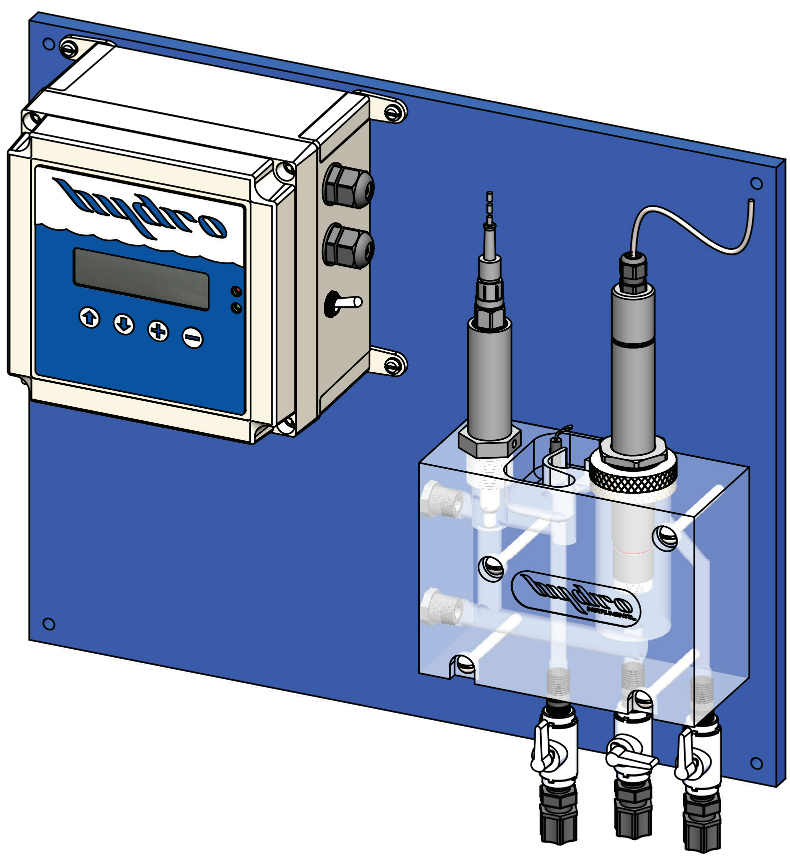
Series 250
Amperometric Residual Chlorine Analyzer

Instruction Manual



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RPH-250 Rev. 1/11/2024

Hydro Instruments
Series 250 Residual Analyzer

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I. FUNCTIONS AND CAPABILITIES

1. Basic Concept

The RPH-250 residual analyzer is a multi-parameter instrument that can be used to measure a variety of disinfectants including: Free Chlorine, Total Chlorine, Chlorine Dioxide and Chlorite.

Certain chemical species produce an electrical signal in the disinfectant sensor. The strength of this signal is a function of their concentration. This signal is read by the RPH-250 monitor as the sample water continuously flows across the disinfectant sensor at a controlled rate.

Parameters that can influence residual readings such as temperature and pH are compensated for either automatically or manually in software. A temperature sensor is used to compensate for changes in temperature. An optional pH electrode can be used for automatic pH compensation or a static pH value can be manually entered. Alternatively, sample water pH can be chemically adjusted / controlled via a separate chemical feed system.

The RPH-250 includes two separate PID control loops, which can be enabled or disabled as desired. The PID control can be setup as flow pacing (i.e. proportional control), residual (i.e. set-point control) or compound loop (i.e. PID) control. The program accepts a proportional 4-20mA input for the flow pacing and compound loop control and uses its own readings for the residual and compound loop control.

2. Chlorine Chemistry

When Chlorine dissolves in water it forms Hypochlorous Acid according to the following reactions:

Chlorine Gas: Cl_2
$Cl_2 + H_2O \leftrightarrow HOCl + HCl$

Sodium Hypochlorite: NaOCl
$NaOCl + H_2O \leftrightarrow HOCl + Na^+ + OH^-$

Calcium Hypochlorite: $Ca(OCl)_2$
$Ca(OCl)_2 + 2H_2O \leftrightarrow 2HOCl + Ca^{++} + 2OH^-$

Hypochlorous Acid is a weak acid that partially dissociates into a Hydrogen Ion and a Hypochlorite Ion as follows:

$HOCl \leftrightarrow H^+ + OCl^-$

The degree of dissociation depends on the pH and the Temperature. Regardless of Temperature, below a pH of 5 the dissociation of HOCl remains virtually zero and above a pH of 10 the dissociation of HOCl is virtually 100%. Figure 1 shows this dissociation curve at several Temperatures. The sum of Hypochlorous Acid and Hypochlorite Ion is referred to as Free Available Chlorine.

When Ammonia Nitrogen is present in the water, some or all of the Free Available Chlorine will be converted into Chloramine compounds according to the following reactions:

$NH_3 + HOCl \longrightarrow H_2O + NH_2Cl$ (Monochloramine)
$NH_3 + 2HOCl \longrightarrow 2H_2O + NHCl_2$ (Dichloramine)
$NH_3 + 3HOCl \longrightarrow 3H_2O + NCl_3$ (Nitrogen Trichloride)

The sum of the Chloramine compounds is referred to as “Combined Chlorine”. The sum of Free Chlorine and Combined Chlorine is referred to as “Total Chlorine”.

3. Measurement

The information provided in this document focuses on Free Chlorine and Total Chlorine measurement. Other disinfectant sensors are available and may have their own separate documentation.

Free Chlorine: Free Chlorine is the sum of Hypochlorous Acid and Hypochlorite Ion. These two forms exist in equilibrium and their concentration depends on the pH and temperature of the sample water as shown in Figure 1.

Total Chlorine: The sum of Free Chlorine and Combined Chlorine is Total Chlorine.

pH: Sample water pH is an important consideration and each disinfectant sensor has a pH range in which it can be reliably used.

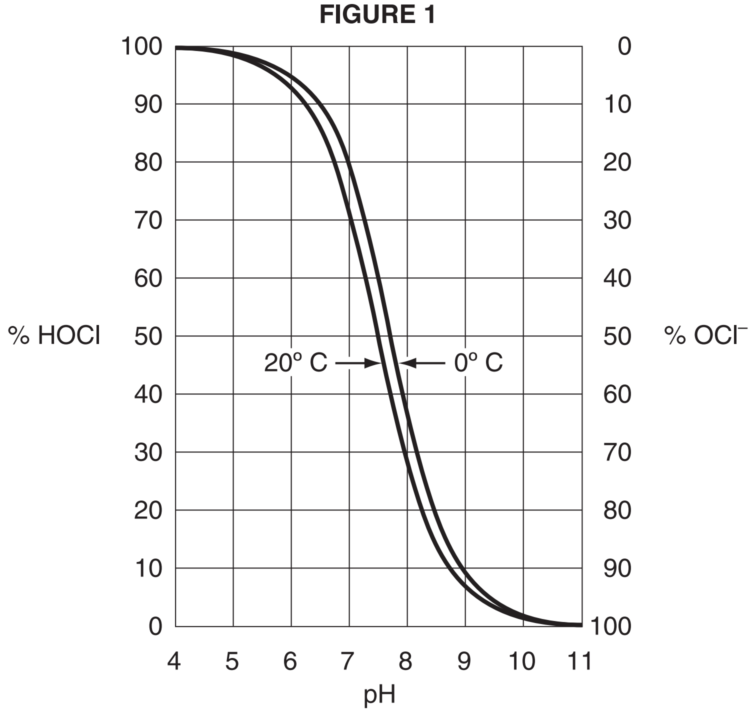
The analyzer can be outfitted with an optional pH electrode and set up to monitor sample water pH or to automatically compensate for pH dissociation via software.

Some disinfectant sensors have a natural pH dependence, meaning the signal tracks with the dissociation curve of the hypochlorous acid. When using a disinfectant sensor that has a natural pH dependence, the pH of the sample water must be kept constant or a pH electrode can be used to automatically compensate.

Some disinfectant sensors have a reduced dependence on pH. These sensors are better suited for applications that have high and/or varying pH levels.

Temperature: A thermistor is used to continuously measure the sample water temperature. Significant temperature fluctuations of the sample water can affect readings. The analyzer software uses the temperature reading to automatically compensate for these effects.

FIGURE 1



Hypochlorous Acid Dissociation Curves

4. Basic Specifications

Power: 100-250 VAC, 50/60 Hz or 24 VDC, 10 W max.

Inputs: (Qty.1) 4-20mA - PV1 for PID control
(Qty.1) 4-20mA - Sample water pressure sensor (Optional)
(Qty.1) Contact input - Sample water flow switch (Optional)

Outputs: (Qty.4) Isolated 4-20 mA

Digital Communication: Modbus RS-485

Relay Contacts: (Qty.4) SPDT, 10 Amps @ 120 VAC or 24 VDC, resistive load, 5 Amps @ 240 VAC, resistive load.

> **IMPORTANT:** When the relay controls an inductive load (e.g. a solenoid motor), external surge protection must be installed. With no surge protection the kickback voltage can irreparably damage the relay. The relay must be protected from this kickback voltage using a diode, metal oxide varistor (MOV) or transient voltage suppressor (TSV).
>
> A diode is the best protection when powering with a DC power supply. The diode should be connected directly across the load and must have a reverse breakdown voltage higher than the power supply being used and must be rated for a higher current than the maximum load current.
>
> A MOV or TSV is the best protection when powering with an AC power supply. The surge suppressor should be located as close to the inductive load as possible. If the suppressor cannot be mounted at the load, it must be mounted to the relay board terminals.

II. RESIDUAL ANALYZER COMPONENTS

1. Monitor

The monitor provides the front end and back end interface for the entire residual analyzer. It features a 2-line x 20-character alphanumeric display. The residual, temperature and other readings are displayed here on the main operating screen.

Navigating through the menus is done with the four push-buttons on the face of the monitor. The buttons functions as follows:

⬆ Moves up one menu.

⬇ Moves down to the next menu.

⊕ Select the flashing option or increase the flashing value.

⊖ Decrease the flashing value.

NOTE: When adjusting a parameter, the value displayed is immediately used and automatically saved.

All I/O connections are made inside the monitor. See Figure 10 for more information.

Data Logger (Optional): Data logger data is written to an internal, removable MicroSDHC card. The MicroSDHC card is included, but is not installed, when this option is supplied.

2. Sensors & Electrodes

Thermistor: The sample water temperature is continuously measured by the analyzers thermistor (i.e. temperature sensor).

Disinfectant Sensor: The disinfectant sensor continuously measures the residual concentration of the target species in the sample water.

pH Electrode (Optional): A pH electrode can be installed into the flow cell and used to monitor sample water pH and compensate for the effects of pH as described in Section I. If the pH electrode is included its readings will be displayed on the main operating screen.

3. Flow Cell

For most disinfectant sensors a single piece Open Flow Cell that is open to atmospheric pressure will be supplied. The open flow cell is designed to maintain a constant pressure across the disinfectant sensor to minimize readings inaccuracies that occur due to changing sample water pressure. This flow cell also uses the cross flow insert beneath the disinfectant sensor to push away air bubbles that could collect on the sensors membrane cap.

For disinfectant sensors that use a self-cleaning mechanism (e.g. the F3 type), the analyzer will instead include a two piece Pressurized Flow Cell arrangement that includes a flow meter with flow adjustment valve. The pressurized flow cell allows for higher flow rates necessary to activate the disinfectant sensors self-cleaning mechanism.

Drawings for the Open Flow Cell and Pressurized Flow Cell can be found in the back of this document.

Sample Water Flow Switch (Optional): The sample water flow switch is a separate accessory that can be installed into the sample water line at the inlet of the flow cell. It is used to indicate if sample water flow to the analyzer has stopped. It is a normally open contact that will close when water flow is applied. Should sample water flow stop, the switch will open and indicate an alarm on the monitor. An alarm relay can be set to remotely indicate that sample water flow has stopped.

III. INSTALLATION

1. Sample Water Connection and Control

The residual analyzer requires a constant supply of sample water at a controlled rate and pressure.

Flow: The sample water flow rate should be controlled at a rate appropriate for the flow cell being used. A flow meter and rate control valve installed upstream of the analyzer may be necessary to achieve and maintain this flow rate.

Open Flow Cell: 4 to 8 GPH (15 to 30 l/h)

Pressurized Flow Cell: 12 to 24 GPH (45 to 90 l/h)

Pressure: Where the sample point has a high water pressure, a pressure-reducing valve must be installed to deliver the sample water to the residual analyzer. Alternatively, if the sample point pressure is too low, then it may be necessary to use a sample pump to deliver the sample water to the residual analyzer.

Open Flow Cell: 5 PSI (0.3 bar) max.

Pressurized Flow Cell: 15 PSI (1 bar) recommended

Other Considerations: The connection to the sample point should be made in such a way to avoid receiving air or sediment from the pipe.

Biological growth inside the sample piping will have some disinfectant chemical demand. This can cause measurement inaccuracies of the sample water (e.g. The chlorine residual could decrease as the sample water passes through the sample water piping). For this reason, it may be necessary to periodically disinfect the sample water piping to prevent biological growth.

It is generally not recommended to use a sample water filter. As the filter collects particles it can develop a chlorine demand causing the chlorine residual in the sample water to be reduced, leading to inaccurate readings. However, in certain installations with significant amounts of solids in the sample water (e.g. iron and manganese) the use of a sample water filter may be necessary. Where a filter is necessary, it will need to be maintained frequently.

2. Sample Water Disposal

Since no reagent chemical is being injected, the disposal of the water leaving the residual analyzer is usually not a significant concern.

3. Sample Point Location

There are at least two general concepts to consider when selecting the sample point location. First, is to select a point that allows reliable determination of the chemical residual concentration at the most critical point for the installation. Second, is to take into consideration the chemical injection control timing. A balance between these considerations must be reached.

Each system is unique, but in general the goal of the chemical injection is to achieve some result by maintaining a chemical residual concentration in the system (e.g. To maintain a specific chlorine residual at the exit of the drinking water facility). The location should be selected so that the injected chemical is already fully mixed so that an accurate sample can be sent to the residual analyzer.

Consideration should be given to the sample point location with regards for use as a control signal for chemical injection. If there is a long time delay between chemical injection changes and the change being detected by the measurement cell, then chemical injection control is adversely affected. The delay time should be kept as short as possible. Less than 5 minutes is recommended.

It is recommended for the analyzers sample point to be 20X the pipe diameter downstream of chemical injection, but a minimum of 10X the pipe diameter must be observed.

FIGURE 2 - Disinfection System Installation Overview

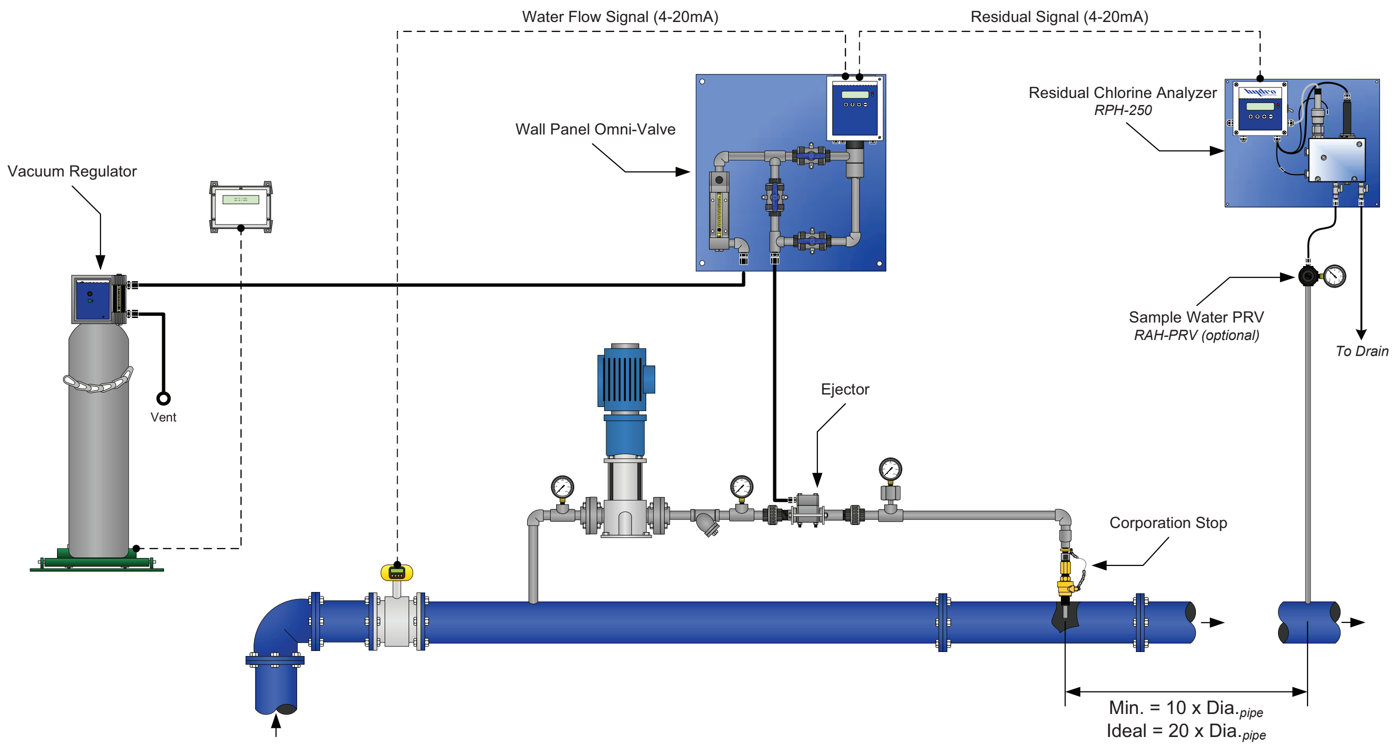


FIGURE 3 - Sample Source Orientation

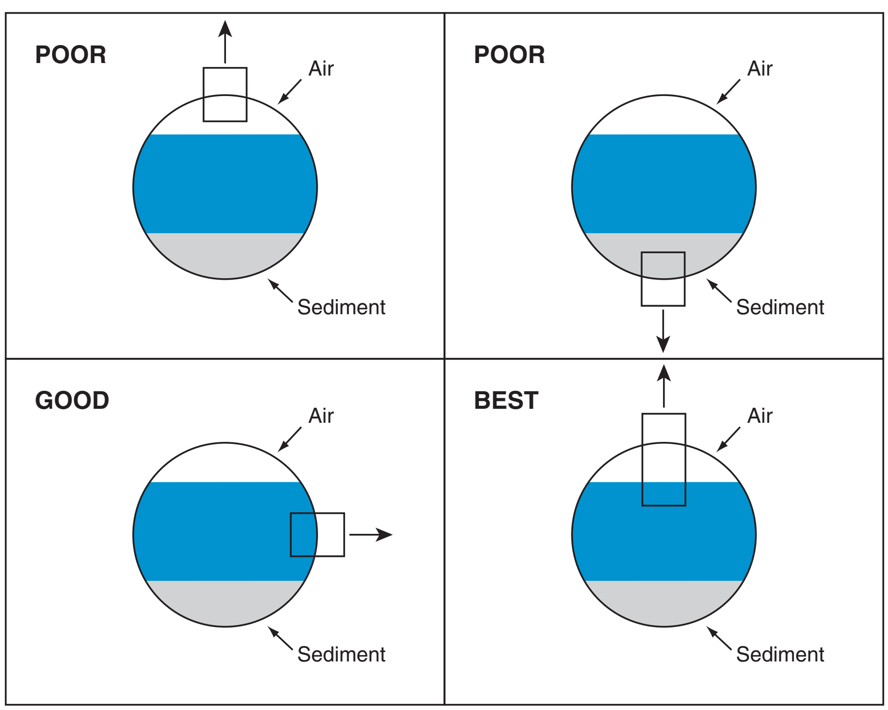
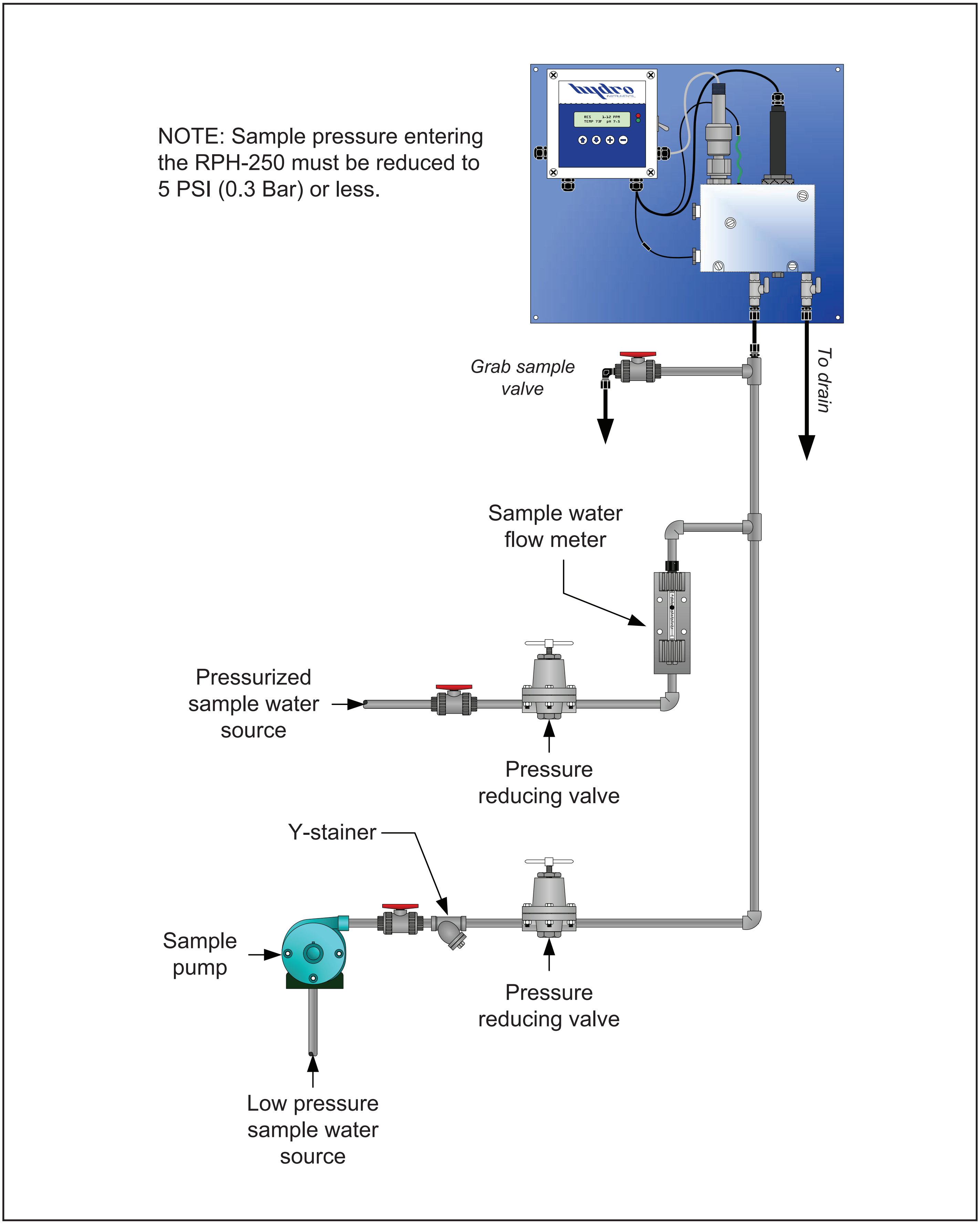


FIGURE 4 - Sampling Examples



IV. DISINFECTANT SENSORS

1. Commissioning The Disinfectant Sensor

Most disinfectant sensors use a membrane cap and are shipped with the membrane cap installed. The membrane cap must be removed and filled with electrolyte before use.

For sensors that do not have a membrane cap such as the F3 type, these sensors have an electrolyte hull that is pre-filled at the factory. For additional information specific to these sensors see the supplemental F3 & D3 Self-Cleaning Sensor Instructions document.

WARNING: When removing the membrane cap do not touch the electrode finger as this may irreparably damage the silver chloride coating.

a. Membrane Cap & Electrolyte

Membrane caps are specific to the type of disinfectant sensor. The correct membrane cap must be used for proper operation. The membrane cap type is stamped into its side.

Electrolyte solutions are specific to the type of disinfectant sensor. The correct electrolyte must be used for proper operation. The electrolyte type is listed on the bottles label.

NOTE: The electrolyte has an expiration date printed on the bottle. Do not use electrolyte that has expired.

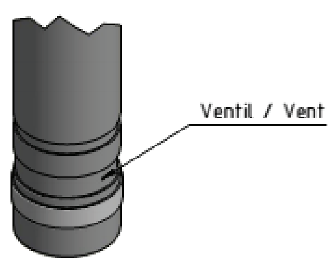
For membrane cap and electrolyte part numbers and their corresponding disinfectant sensors, see Dwg. No. RPH-PROBES in this document.

b. Preparation

i. Remove the protective cap off the membrane cap.

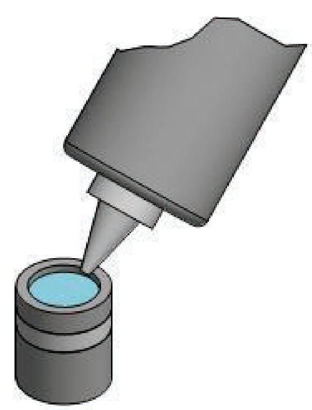
ii. Lift the rubber ring on the membrane cap to expose the vent hole.

iii. Unthread the membrane cap from the disinfectant sensor and place the rubber ring back into its groove.



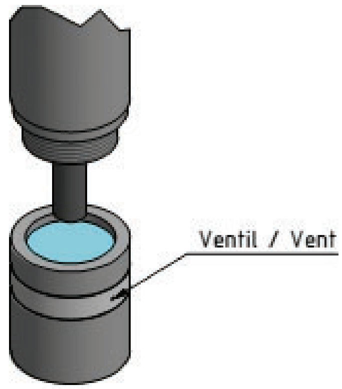
iv. Fill the membrane cap with electrolyte to just below the threads.

NOTE: Do not shake the electrolyte before filling the cap. Air bubbles must not be present in the electrolyte.

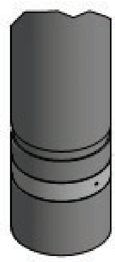


v. Hold the sensor vertically and thread the membrane cap on. Make sure to thread the membrane cap on completely. It will be tight against the sensor body.

NOTE: Some electrolyte will be displaced out of the cap and through the vent hole. Use water to rinse off any electrolyte residue on the sensor.



vi. The sensor is now prepared to be installed into the flow cell.



2. Installation Into Flow Cell

The Sensor must be installed into the Flow Cell at an appropriate height to allow the sample water to flow across the membrane as well as prevent air bubble formation.

a. Open Flow Cell

See parts drawing RPH-OFC for details.

i. Install the AFC-INS-CRF Cross Flow Insert into the flow cell.

ii. Install the Probenut and O-Ring into the Threaded Holder but do not fully tighten.

iii. Slide the holder assembly onto body of sensor until it is approximately 3in. (7.6cm) up from the bottom. Tighten the Probenut and Holder so it stays in place on the sensor.

iv. Place the assembly into top of the flow cell. There should be a small gap, about ¼ in. to ⅜ in., between the tip of the sensor and the recess of the Cross Flow Insert.

b. Pressurized Flow Cell

See parts drawing RPH-PFC for details.

i. Slide the Probenut and O-Ring onto body of sensor until it is approximately 4in. (10.2cm) up from the bottom.

ii. Place the assembly into top of the flow cell and tighten the Probenut to hold the sensor in place. There should be a small gap, about ¼ in. to ⅜ in., between the tip of the sensor and the top of the Flow Control Plug, part no. PFC-FCP.

3. Cable Connections

Grounding: Analyzers are supplied with a sample water ground pin to prevent electrical interferences that may be present in the sample water. The sample water ground pin is tied into the incoming AC ground.

Disinfectant Sensors with mA Outputs: The disinfectant sensor is powered from the MB129 circuit board with an isolated 24VDC output, terminal (VO+). This isolated output must be used to power the sensor to prevent electrical interferences and may not be connected to anything else.

The disinfectant sensor outputs a 4-20mA signal that is received by the MB129 circuit board, terminal (AI1).

4. Sensor Conditioning

The disinfectant sensor requires conditioning prior to generating stable values.

Before calibration is carried out, the analyzer should be operated with disinfectant in the sample water for a period of time.

For newly installed disinfectant sensors, allow the sensor to run in for the prescribed start-up time. This time will vary based on the type of sensor being used and can take 1 to 48 hours.

Startup Times	
Sensor Type	**Start-up Time**
F1	Approx. 1 hour
F2	Approx. 2 hours
F3	1 to 48 hours
T1	Approx. 2 hours

NOTE: After membrane cap and/or electrolyte replacement, allow the sensor to run in for the prescribed start-up time. Refer to the 'RPH Disinfectant Sensor Selection' Guide for more sensor start-up times.

5. Decommissioning and Storage

If the analyzer is going to be taken out of operation for a period of time, the disinfectant sensor(s) will need to be prepared for storage.

a. Remove the membrane Cap

b. Rinse the electrolyte out of the membrane cap with warm water.

c. Rinse the electrode finger with warm water.

   NOTE: The electrolyte must be completely removed from the membrane cap and electrode finger.

d. Allow to dry in air.

e. Loosely screw the membrane cap onto the sensor to protect the electrode finger during storage. Make sure that the membrane is not in contact with the electrode finger.

   NOTE: If the membrane cap has been in use for a period of time, it is recommended that a new membrane cap be installed when the sensor is placed back into service.

V. PH ELECTRODES

1. Commissioning The pH Electrode

The pH electrode is shipped in a cap containing a solution of pH buffer and potassium chloride. The electrode should only be removed from this solution when it is ready to be installed and used.

2. Installation Into Flow Cell

a. Mounting

See parts drawing RPH-OFC or RPH-PFC for details.

i. Remove the electrode from its buffer cap and place it into its mounting gland. Secure it into place by gently threading it into the gland, rotating clockwise until it stops.

b. Wiring

Analyzers ordered with a pH electrode will have its connection pre-wired and only the electrode needs to be connected to its quick-disconnect cap & cable assembly after mounting.

i. Connect the quick-disconnect cap & cable assembly to the top of the pH electrode by gently threading the cap on, rotating clockwise until it stops.

3. Cable Connections

If a pH electrode is not being used a jumper wire must be connected between the AI3 & AIC terminals on the MB128 circuit board. Failure to install the jumper will cause the A/D converter to be inaccurate.

NOTE: If a pH electrode is being used for automatic pH compensation, it is normal for the chlorine residual reading to be effected when the pH probe is removed from the flow cell.

5. Decommissioning and Storage

If the analyzer is going to be taken out of operation for a period of time, the pH electrode should be store in pH storage solution or in a pH 4 buffer if storage solution is not available.

NOTE: Do not store the pH electrode in deionized (DI) water as this will damage the electrode.

6. Additional Information

For additional information see the pH & ORP Electrode - General Instructions document.

VI. CALIBRATION AND PROGRAMMING

1. Modes of the RPH-250 Residual Analyzer

a. **Operation Mode:** This is the mode used during normal operation of the RPH-250 Analyzer. It provides a display of the current residual reading, water temperature reading, pH and any alarm conditions that may exist.

b. **Configuration and Calibration Mode (Programming):** This mode is used to set up the display options, operational parameters and other features.

c. **PID Control Mode:** This mode enables and configures the PID Control program in the software. The program can perform proportional, set-point (residual) or compound loop control. One or more of the analog outputs (AO1 to AO4) can be programmed to transmit a 4-20 mA control signal.

2. Switching Between Modes

a. **Operation Mode:** This is the standard mode, which appears during initial powering of the device. To return to this mode from any other screen simply press the ↑ button repeatedly.

b. **Configuration and Calibration Mode:** This mode is accessed from the Operation Mode by pressing the ↓ button until the password screen is reached. Then enter the password “250” and then press the ↓ button.

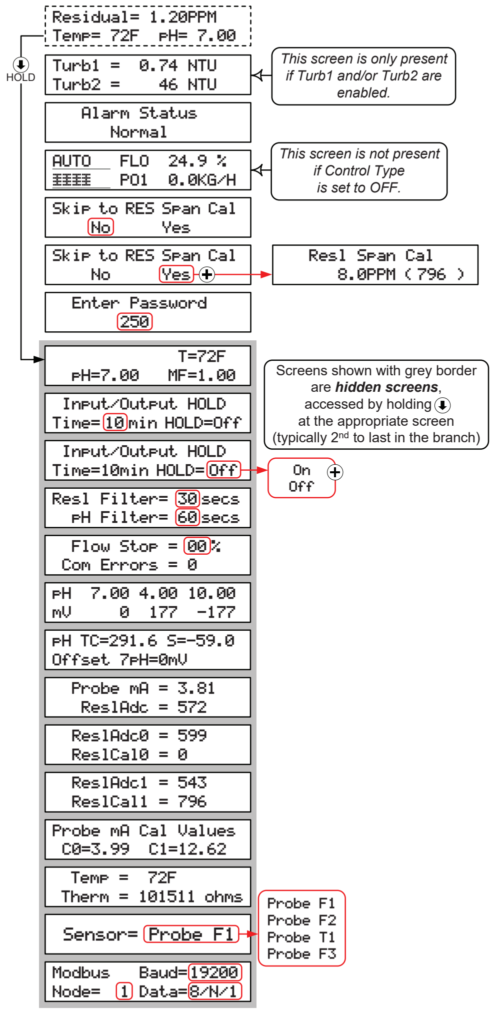
c. **PID Control Mode:** When enabled, this program will display several general status and control screens in the Operation Mode. To access the screens, which allow this program to be set-up, press the ↓ button (in the Operation Mode) until the password screen is reached. Then enter the password “220” and press the ↓ button.

3. Operating the Keypad

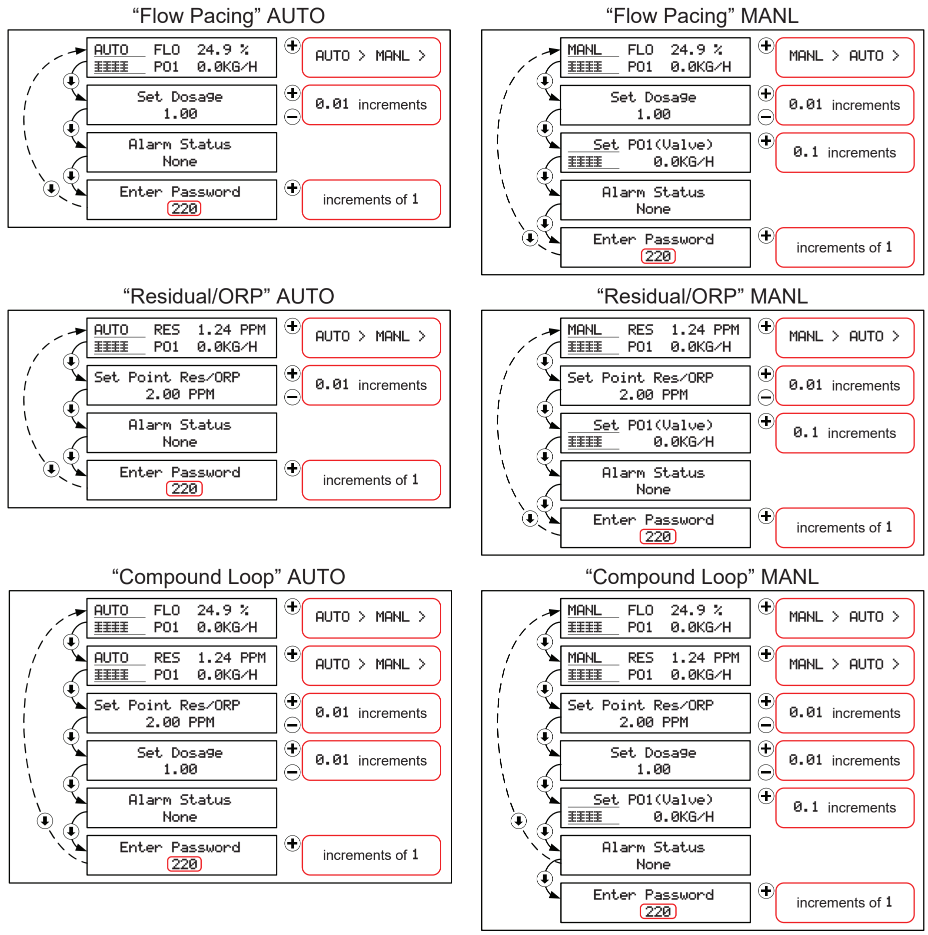
1. **Navigation:** To move from one screen to another, simply press the ↑ and ↓ buttons to reach the desired screen. Navigation between screens is possible in either direction.
2. **Adjustment of Displayed Parameters:** To adjust a displayed parameter in the Configuration Mode, simply use the ⊕ and ⊖ buttons to increase or decrease. Once a parameter has been set to the desired position, pressing either ↑ or ↓ button to leave the screen will cause the new parameter to be stored. To select a blinking option (such as “Temperature Cal – Yes/No”), use the arrow buttons as needed to make the desired selection blink then press the ⊕ button.

FIGURE 5 - Operation Menus

(Operation Menu Flow Chart)



(Control Type Dependent Operation Screens)



VII. EXPLANATION OF OPERATION SCREENS

Main: This screen will display the residual value as well as the sample water temperature. If "Manual", "Auto" or "Monitor" is selected as the "pH Compensation Mode", the main screen will also display the pH value.

Alarm Status: Displays any existing alarm conditions.

Turbidity: This screen is present when one or more of the two Turbidity channels is enabled. It displays Turbidity reading(s).

Control Operational: This menu appears when the PID Control program is enabled. It displays the PID Control Status (Manual or Auto), the Process Variable(s) and the Process Output. To change between "Auto" and "Manual" control status, press the (+) button. When Compound Loop Control is in use, there will be two Control Operation screens.

Set Dosage: This menu appears when the PID Control program is enabled and the Control Mode is selected as either Proportional or Compound Loop Control. This is an adjustable factor that is multiplied to the incoming flow signal.

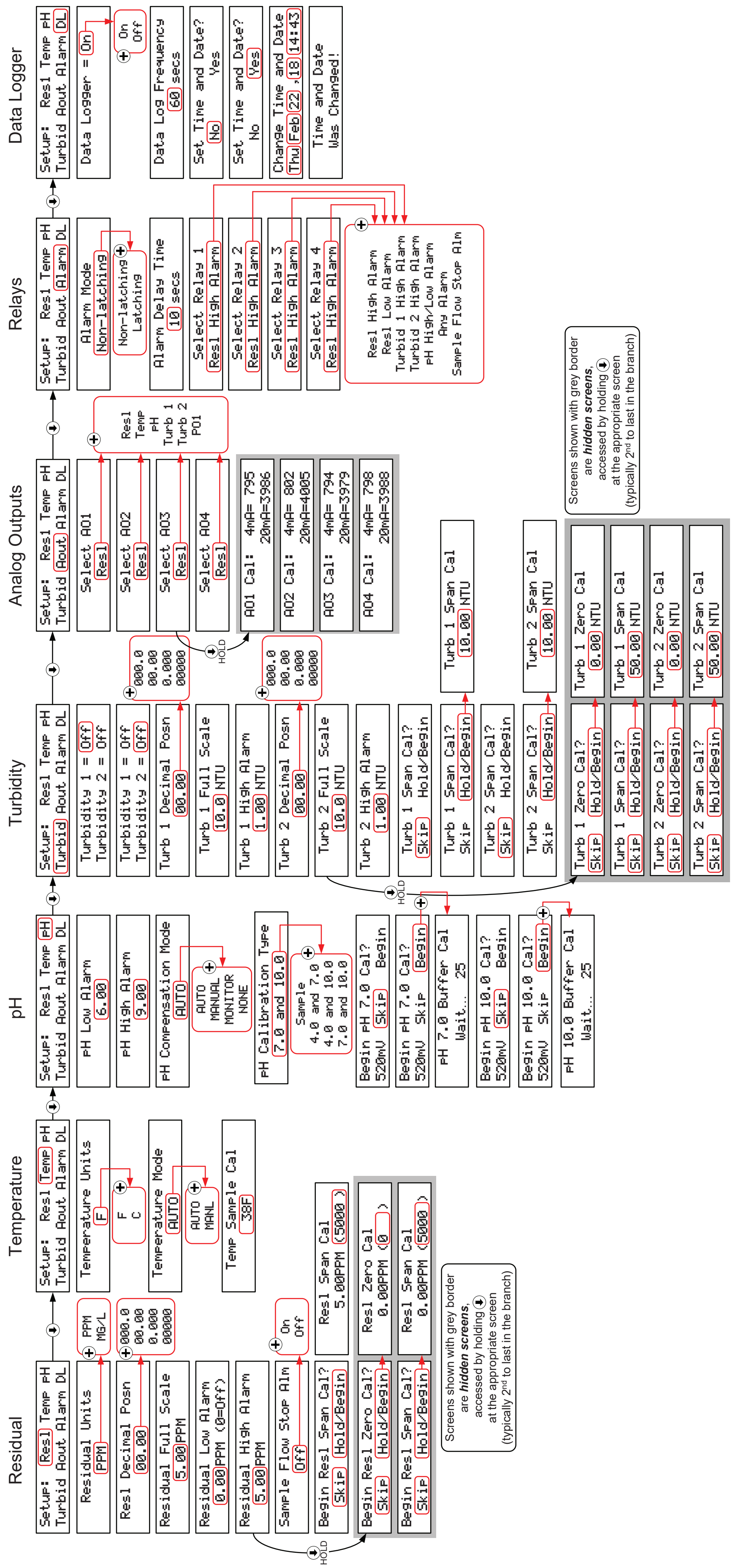
Set Point RES/ORP: This menu appears when the PID Control program is enabled and the Control Mode is selected as either Residual or Compound Loop Control. This is an adjustable factor that represents the desired value for residual (or ORP).

Set PO1: This menu appears when the PID Control program is enabled and the control status is set to "Manual". On this screen, the control output can be changed by pressing the (+) and (−) buttons.

Skip to RES Span Cal?: This screen allows a direct jump to the residual span cal screen (bypassing the password). To pass this screen, press the (⬇) button twice or press the (+) button when the word "No" is blinking.

Enter Password: This screen allows access to the configuration or PID Control menus. Enter the desired password and then press the (⬇) button.

FIGURE 6 - Configuration Menus



VIII. EXPLANATION OF CONFIGURATION MENUS

Main: The Configuration Mode is structured as a "tree branch" program. The main screen is the trunk from which each branch can be accessed (Figure 6). Seven options appear on this screen, with one option blinking. To change which option is blinking, press the ⬇ button. To select the blinking option, press the ⊕ button. To access the configuration mode from the operation mode scroll down and enter "250" as the password when prompted.

Res: This branch accesses the settings for the residual (as related only to the analyzer). To calibrate the instrument residual, follow the steps below.

- **Residual Units:** Select PPM or MG/L.
- **Residual Decimal Position:** Select desired decimal place for residual.
- **Residual Full Scale:** Enter desired full scale (range). This setting is what a 20 mA residual output signal represents. An output of 4mA always represents a residual of zero.
- **Residual Low Alarm:** Enter low residual alarm trip-point (if desired).
- **Residual High Alarm:** Enter high residual alarm trip-point (if desired).
- **Sample Flow Stop Alarm:** Enable (On) or Disable (Off) the flow stop alarm. If the optional sample flow stop switch is installed this option can be enabled. If the optional sample flow stop switch is not installed this option should be disabled. In the event that the analyzers sample water flow stops the analyzer will indicate a "Sample Flow Stop" alarm. An alarm relay can be set to remotely indicate this alarm status.

  NOTE: While the "Sample Flow Stop" alarm is active all 4-20mA outputs will be frozen and will only return to a live reading once the "Flow Stop" alarm is no longer active.
- **Begin Residual Zero Cal?:** The residual zero calibration has been performed at the factory prior to shipment and generally should not be required in the field. To access this calibration menu, follow the steps noted on Figure 6. To pass by this screen, press the ⬇ button twice or press the ⊕ button when the word "Skip" is blinking. To perform a residual zero cal, press the ⬇ button to make the word "Begin" blink. Then press the ⊕ button.
- **Residual Zero Cal:** Enter residual value of "zero" sample water. When the residual value on the screen matches the known residual of the "zero" sample water, press the ⬇ button. A confirmation screen should appear indicating that the calibration was performed.
- **Begin Residual Span Cal?:** To pass by this screen, press the ⬇ button twice or press the ⊕ button when the word "Skip" is blinking. To perform a residual span cal, press the ⬇ button to make the word "Begin" blink. Then press the ⊕ button.
- **Residual Span Cal:** Enter residual value of "span" sample water. When the residual value on the screen matches the known residual of the "span" sample water, press the ⬇ button. A confirmation screen should appear indicating that the calibration was performed.

Temp: This branch accesses the settings for the temperature. To calibrate the temperature, follow the steps below.

- **Temperature Units:** Select "F" (Fahrenheit) or "C" (Celsius).
- **Temperature Mode:** Select "Manual" or "Auto". Automatic enables the temperature to be automatically detected via the thermistor.
- **Manual Temperature:** This screen appears when Temperature Mode "Manual" has been selected. Enter the sample water temperature using the ⊕ and ⊖ buttons.

- **Temp Sample Cal:** This screen appears when Temperature Mode "Auto" has been selected. The temperature displayed represents what the program interprets the current temperature reading to be. If necessary, adjust the displayed temperature using the ⊕ and ⊖ buttons.

  <u>NOTE</u>: Displaying the temperature on the main operating screen is optional and can be changed by accessing a hidden menu as detailed in the note on Figure 6.

pH: This branch accesses the pH compensation settings and pH electrode calibration.

- **pH Compensation Mode:** Choose your pH compensation method by pressing the plus key until the desired pH compensation method is displayed. Your choices of pH compensation are:
  - **None:** In this mode, the analyzer will assume the pH of the sample water is either stable or has been buffered low enough such that dissociation is not a concern. Note that in this mode, the pH value is not displayed on the main operations mode screen. If this mode is chosen, no pH electrode is needed.
  - **Auto:** In this mode, the pH value of the sample water is monitored using a pH electrode (available through Hydro Instruments) and compensation is performed automatically in the controller's software.
  - **Manual:** In this mode, the pH value of the sample water can be entered and will remain fixed unless changed.
  - **Monitor:** In this mode, the sample water pH will be continuously monitored by the pH electrode but it will have no effect on the residual reading.

    If Auto or Monitor modes have been chosen; on the following screen you can select your calibration type. Select the calibration method based on recommendations below.
- **pH Calibration Type:** The residual analyzer allows the user to select from four different calibration methods including: ('Sample', '4.0 and 7.0', '4.0 and 10.0', '7.0 and 10.0'). The calibration type to use is completely up to the user. However Hydro Instruments recommends using the following selection criteria:
  - If pH buffers are not available, then use the "Sample" calibration. This is only a one point calibration (your sample) and will automatically calculate an ideal calibration slope. This provides reasonable accuracy if the sample pH is close to seven and pH of the process is relatively stable.
  - If sample pH is less than seven, use the '4.0 and 7.0' calibration method.
  - If sample pH is greater than seven, use the '7.0 and 10.0' calibration method.
  - If sample stream is subject to wide swings in pH, use the '4.0 and 10.0' calibration method.

Notes to increase calibration accuracy:

- Before placing the pH electrode into a buffer for calibration, blot the bottom of the probe with a clean micro fiber cloth.

  CAUTION: Take care not to scratch the probe surface as this will damage the probe and affect your readings.
- Allow the pH meter to sit in the buffer solution for a few seconds prior to calibration. The longer it sits in the buffer solution, the closer it will be to the ideal value. Generally 15-30 seconds for a new probe. When calibrating the pH electrode the controller software will count down from 25 seconds to ensure good calibration.
- Keep the pH sensor and buffer solution still when calibrating your instrument. Vigorous movement of the sensor can disrupt readings and lead to inaccurate calibrations, should the pH electrodes reading be disrupted during calibration the countdown will reset.
- Select a pH range for calibration that will be similar to your operating conditions. For example, if the operating range is 7.80 to 8.10 then perform a 7.00 and 10.00 calibration.
- When calibrating your sensor, always use a fresh buffer solution and discard the buffer after use.
- Be aware of the temperature of the buffers being used. Generally buffer manufactures write on their label at what temperature the pH is its true value (generally 77°F, 25°C). Temperature can influence dissociation and thus if your calibration is done with a buffer not at its prescribed temperature, your calibration will be inaccurate. It is best to calibrate with buffers that have an accurate pH close to your operating conditions.
- Air bubbles and other liquids can form around the outside of the sensor and affect the accuracy of the reading. Be sure to remove any air bubbles upon installation.

- ***'4.0 and 7.0', '7.0 and 10.0', & '4.0 and 10.0' pH calibration methods:***

  These are two point calibrations carried out with two known pH buffer solutions.

  Cal 7.0? (or Cal 4.0?): Calibrate the lower pH for the selected method and span, following notes below.

  Cal 10.0? (or Cal 7.0?): Calibrate the upper pH for the selected method and span, following notes below.

  1. In the Temperature calibration screen, set the Temperature mode to manual and enter the actual buffer solution temperature.

     NOTE: pH buffer calibrations are somewhat temperature dependent. pH buffers are usually accurate at 25ºC. Error in pH readings can occur if buffer temperatures are drastically different from their prescribed temperature (+/- 5ºC). If the temperature difference is greater than this margin, consider adjusting buffer temperature or performing a sample calibration.
  2. Once the calibration method is selected, the first buffer solution required will be displayed on the screen. Place the pH electrode into the appropriate buffer and select 'Begin'.
  3. The software waits for the reading to stabilize for 25 seconds before accepting or rejecting it as a valid calibration point. The countdown timer will appear on the screen in real-time. Note: The pH value will not be displayed.

4. If the calibration point is accepted, an "accepted" screen will appear. Press down to clear the screen and the next buffer solution required will appear.
5. Place the pH electrode in the appropriate buffer solution and select 'Begin'.
6. The software will wait for a stable reading over 25 seconds. If the second calibration point is accepted, an "accepted" screen will appear. Press down to clear and the pH calibration is complete.
7. Place the pH electrode back into the sample solution and change the Temperature back to the original operating conditions.

Sample Calibration: This calibration is carried out with the pH electrode left installed in its holding cell with the sample water flowing through it. However, be sure that the Temperature displayed on your unit is accurate before calibrating the pH.

1. If this calibration option has been selected, the following screen will require the operator to enter the pH of the sample water in which the calibration will be done.
2. Use a hand held pH meter to measure the pH of the sample water and then enter the pH of the sample on the screen.
3. Before proceeding check that no air bubbles have formed on the tip of the pH electrode. Select 'Begin'; the software will wait for a stable reading over 25 seconds before accepting or rejecting the calibration point. If the calibration point is accepted, press the down key and the pH calibration is complete.

   NOTE: If at any point your pH calibration is rejected, the entire calibration procedure will need to be repeated. If the problem persists, see the troubleshooting section below.

AOut: This branch accesses the settings for the four 4-20mA output channels. (AO1, AO2, AO3, and AO4)

- **Select AO#:** Each of the four analog output channels can be independently set to represent one of the following parameters.
  - **Residual:** When "resl" is selected, the analog output will send a 4-20 analog signal representative of the residual value (4 mA being zero residual and 20 mA being full scale residual).
  - **PO1:** When "PO1" is selected, the analog output will send a 4-20 analog signal representative of the PID Control Program Process Output (4 mA being zero and 20 mA being PO1 full scale).
  - **pH:** When "pH" is selected, the analog output will send a 4-20 analog signal representative of the pH value (4 mA being zero pH and 20 mA being 14 pH).
  - **Temp:** When "Temp" is selected, the analog output will send a 4-20 mA analog signal representative of the sample water temperature (4 mA being 0º C / 32º F and 20 mA being 50º C / 122º F).
  - **Turb1/Turb2:** When Turb1 or Turb2 is selected the analog output will send a 4-20mA analog signal representative of the corresponding Turbidity reading.

  NOTE: The AO# output calibration menus are hidden and can be accessed as detailed in Figure 6.

  - **AO# 4mA Cal:** This screen allows for calibration of the AO# 4mA output. Using a meter to read the output, fine adjustments can be made using the ⊕ and ⊖ buttons.

- ◦ **AO# 20mA Cal:** This screen allows for calibration of the AO# 20mA output. Using a meter to read the output, fine adjustments can be made using the ⊕ and ⊖ buttons.

Alarm: This branch accesses the settings for the four alarm relays. (Relay 1, Relay 2, Relay 3, Relay 4)

- **Alarm Mode:** Select "Latching" or "Non-Latching". A latching relay will require manual acknowledgement of any alarm condition (by pressing the ⊖ button on the Main Operation Mode screen). When Non-Latching is selected, alarms will clear themselves whenever the alarm condition no longer exists.
- **Alarm Delay:** Enter desired delay time. Any alarm condition must then exist for this period of time before tripping the relay. This delay can help avoid false alarms and is recommended to be set at 5 seconds or longer.
- **Select Relay #:** The analyzer is equipped with four alarm relays. Each of these relays can be individually set to represent any of the following alarm conditions:
  - Low Residual
  - High Residual
  - Turbidity 1 high alarm
  - Turbidity 2 high alarm
  - pH high/low alarm
  - Any alarm

DL: This branch accesses the settings for the optional data logger.

- **On/Off:** Depending on whether the data logger feature is enabled or disabled, this menu will present the option to change the status.
- **Data Log Frequency:** Whenever the data logger feature is enabled, the frequency with which data is recorded is adjustable on this menu.
- **Set New Date/Time:** If it is necessary to set or change the date and time in the data logger software, select "YES" on this menu.
- **Set Data Log Clock:** This menu allows the date and time to be set. Whenever this menu is accessed, the current date and time must be entered. A confirmation screen will appear afterward.

FIGURE 7 - PID Control Configuration Menus

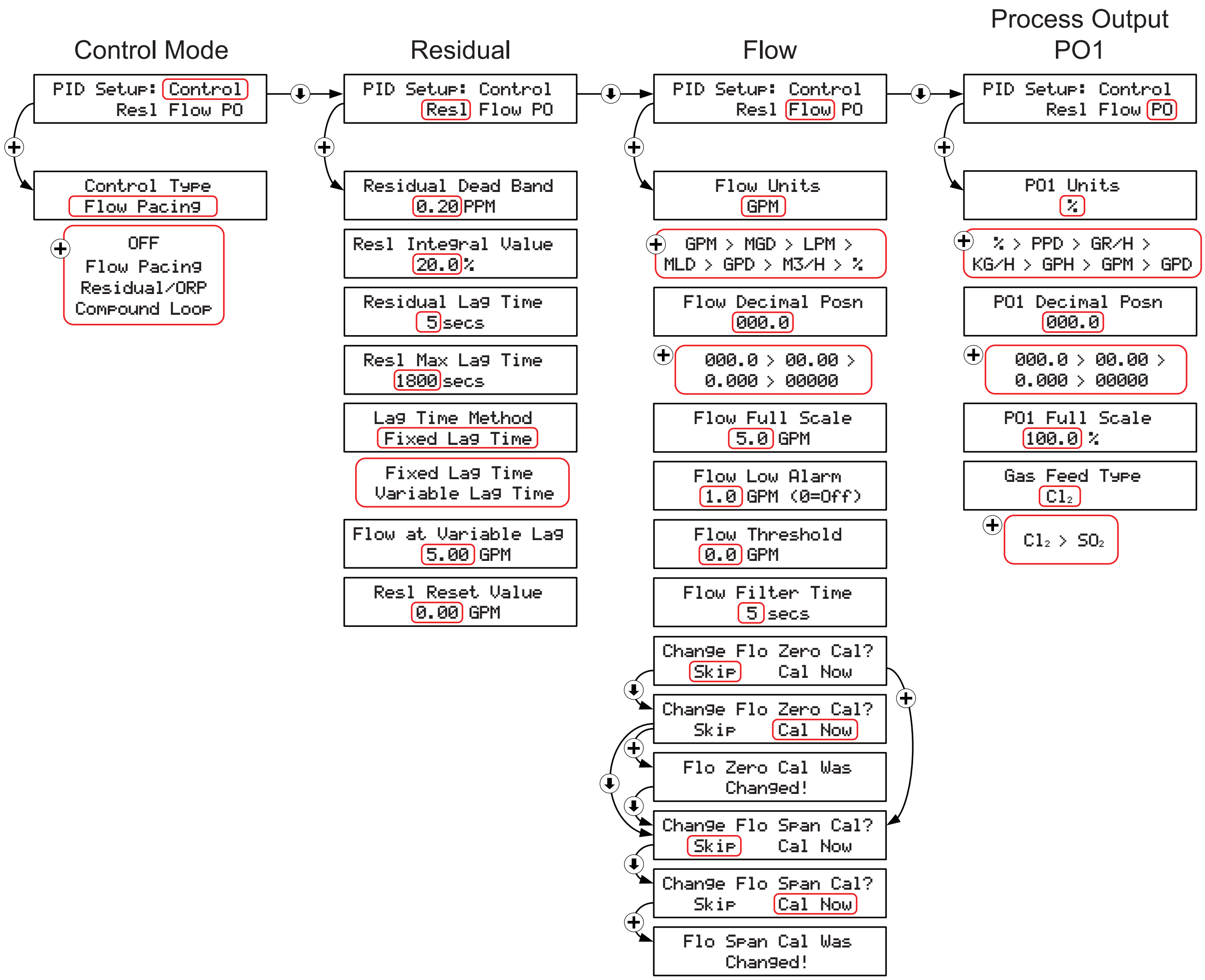
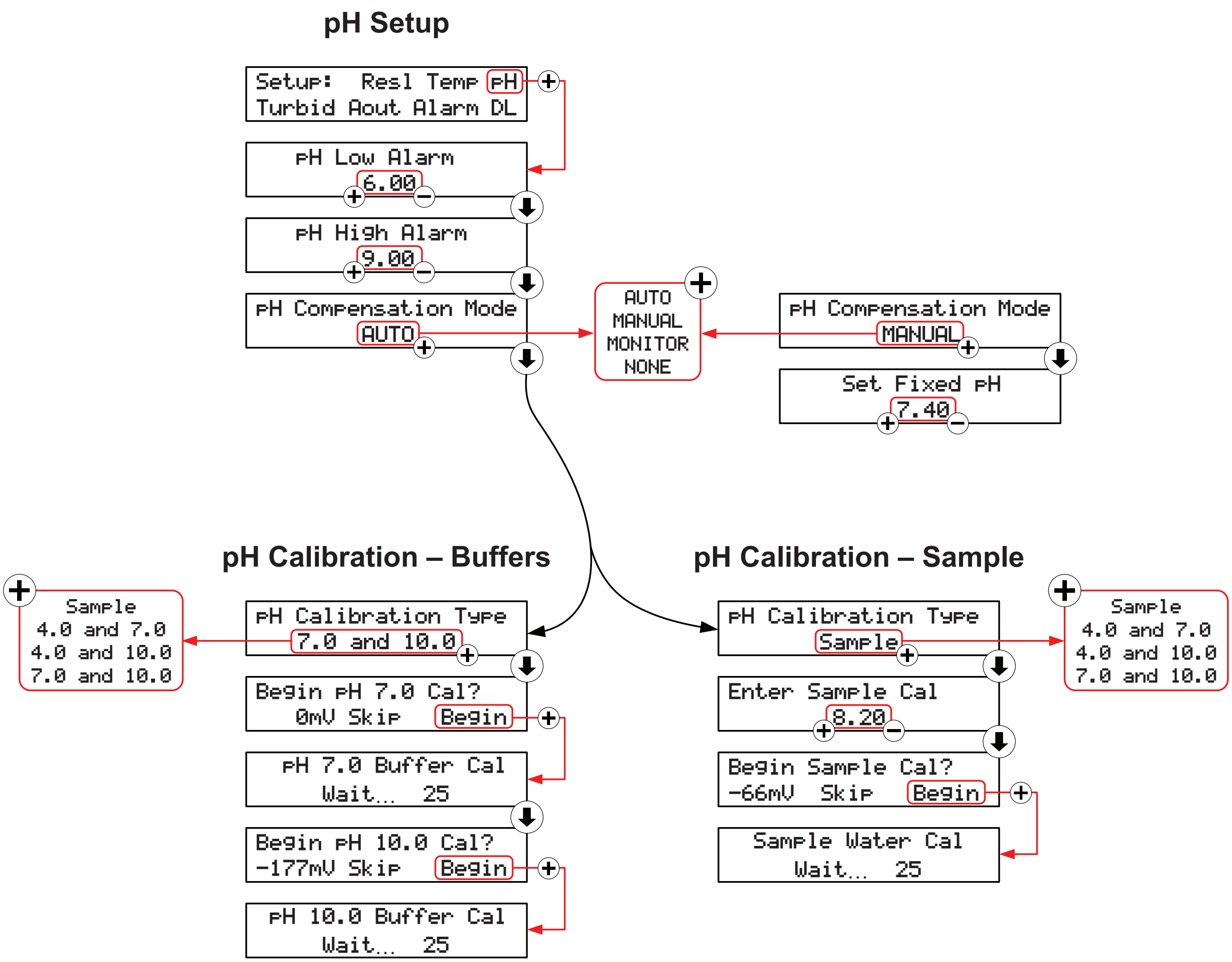


FIGURE 8 - pH Calibration Menu



pH Calibration Signal – Buffers or Smaple

pH	Ideal Signal @ 25°C / 77°F	Acceptable Range Calibration
4	177 mV	177 mV ±20%
7	0 mV	0 mV ±25 mV
10	-177 mV	-177 mV ±20%

IX. EXPLANATION OF PID CONTROL MENUS

Main: The PID Control Mode is structured as a “tree branch” program. The main screen is the trunk from which each branch can be accessed. Four options appear on this screen, with one option blinking. To change which option is blinking, press the ⬇ button. To select the blinking option, press the ⊕ button. To access the control mode from the operation mode scroll down and enter “220” as the password when prompted.

Control: This branch accesses the settings for the control method.

- **Control Type:** Select desired control type.
  - **OFF:** When “OFF” is selected, the PID Control program will be deactivated.
  - **Flow Pacing:** This control type will provide a process output (PO1) proportional to the AI1 proportional input signal (and multiplied by the Dosage setting). This control method does not factor the residual in any way.
  - **Residual/ORP:** This control type will provide a process output (PO1) that is adjusted as needed to maintain the “Set Point” residual value.
  - **Compound Loop:** This control type will provide a process output (PO1) that is adjusted as needed to maintain the “Set Point” residual value and also factors in changes registered through the proportional input signal (and multiplied by the Dosage setting). This control method type will not appear as an option unless the needed input signals are detected.

Resl: This branch accesses the settings for the residual (as related to Set-Point or PID Control).

- **Residual Dead Band:** This is a dead band around the Set Point. As long as the residual is within (+ or -) this amount from Set Point, the program will consider the Set Point met. This is used to avoid excessive, continual adjustments.
- **Residual Integral Value:** A factor used in the calculation of needed adjustments to the process output. This value ranges from 0 – 100%. Essentially, the program makes a calculation of how much the output needs to be adjusted in order to reach Set Point and this factor. Increasing the Integral will increase the rate of each individual adjustment (and vice versa).
- **Residual Lag Time:** This is the time that elapses between a change in chemical feed rate and the change in residual observed by the analyzer. The PID Control program will wait-out this amount of time between each adjustment to PO1. Instruments should be installed to minimize lag time in order to optimize control (ideally limit this time to less than 5 minutes).
- **Residual Max Lag Time:** A maximum Lag Time, which can be used in Compound Loop Control only. When in use, this sets limits the maximum lag time that can be calculated by the variable lag time formula.
- **Lag Time Method:** Select “Fixed” or “Variable”. If “Fixed” is selected, only the “Residual Lag Time” will be used. If “Variable” is selected, the lag time used will vary as the flow varies, but will be limited to the Max Lag Time.
- **Flow at Variable Lag:** Enter desired flow level. If “Variable” is selected, the lag time will be calculated as follows: Flow at Variable Lag divided by the current flow rate and then multiplied by the Residual Lag Time.
- **Residual Reset Value:** If the water flow rate value falls below this level, then the control will ignore residual readings and consider only proportional control based on water flow rate.

<u>NOTE</u>: In applications where flows vary, lag times may also change. In these instances, the use of the variable lag time settings will improve control timing.

<u>NOTE</u>: If "Fixed" is selected as "Lag Time Method", the settings of "Residual Max Lag Time" and "Flow at Variable Lag" are ignored.

Flow: This branch accesses the settings for the proportional (flow) input.

- **Flow Units:** Select desired units (MGD, GPM, GPD, LPM, MLD, %, M^3/H).
- **Flow Decimal Position:** Select desired decimal position.
- **Flow Full Scale:** Enter the proportional input full scale. This setting should be what a 20 mA proportional input (AI1) signal represents.
- **Flow Low Alarm:** Enter low flow alarm trip point (if desired).
- **Flow Threshold:** This setting allows the user to set a value (above zero) to be treated as zero for the proportional input (AI1) signal. In proportional (Flow Pacing) control, this would mean the output signal (PO1) would remain at zero (4mA) until the proportional input reached this value.
- **Flow Filter Time:** This is an adjustable span of time over which the input signal will be continually averaged. It is recommended to be set to at least 5 seconds.
- **Flow Filter K:** Used in a digital filter for input signals. A value of zero provides no dampening. Optimum range is between 0.5 and 0.9.
- **Begin Flow Zero Cal?:** To pass by this screen, press the ⬇ button twice or press the ⊕ button when the word "Skip" is blinking. To perform a flow zero cal, press ⬇ button to make the word "Begin" blink. Then press the ⊕ button.
- **Flow Zero Cal:** Input a steady 4.000 mA signal to AI1. Adjust the displayed "Flow" value until it reads zero. Then press the ⬇ button. A confirmation screen should appear indicating that the calibration was performed.
- **Begin Flow Span Cal?:** To pass by this screen, press the ⬇ button twice or press the ⊕ button when the word "Skip" is blinking. To perform a flow span cal, press the ⬇ button to make the word "Begin" blink. Then press the ⊕ button.
- **Flow Span Cal:** Input a steady 20.000 mA signal to AI1. Adjust the displayed "Flow" value until it reads flow full scale value. Then press the ⬇ button. A confirmation screen should appear indicating that the calibration was performed.

<u>NOTE</u>: Although it is recommended (for maximum accuracy and precision) that the flow zero and span calibrations be performed at 4 and 20 mA, they can be performed at values between 4 and 20 mA.

PO1: This branch accesses the settings for the PID Control output signal.

- **PO1 Units:** Select desired units (PPD, GR/H, KG/H, GPH, GPM, GPD, %).
- **PO1 Decimal Position:** Select desired decimal place.
- **PO1 Full Scale:** Enter the desired output full scale. This is what a 20 mA output signal (selected as PO1) will represent.

  <u>NOTE</u>: A minimum of three integers must be used. Therefore, if the PO1 Full Scale is set below 100, one decimal position must be used (ex: 99.9)

- **Gas Feed Type:** Select either “CL2” or “SO2”. These two selections are basic classifications of what chemical type the PID Control program is controlling. “CL2” represents any chemical that will increase the residual reading and “SO2” represents and chemical that will decrease the residual reading.

X. MAINTENANCE AND CLEANING

The quality of the sample water greatly effects the frequency of maintenance and cleaning that is required. Maintenance and cleaning requirements will be different for each installation. Visually checking the condition of the analyzer regularly and monitoring the disinfectant sensor signal are good ways to determine the required frequency of maintenance and cleaning.

1. Flushing the Measurement Cell

If water will not flow through the measurement cell then follow this procedure to flush it:

a. Turn off the power to the analyzer.

b. Flush and physically brush clean as needed.

c. Repeat as necessary before turning the power back on.

2. Thermistor

The thermistor does not require regular maintenance, but will periodically require replacement. If the thermistor fails, then it will give a very high or very low signal.

To test the thermistor, follow this procedure:

a. Turn off power to the analyzer.

b. Open the analyzer NEMA 4X enclosure and remove the two thermistor wires from the MB128 board (RS1 and AIC).

c. Use an ohm meter to check the resistance of the thermistor. If the ohm meter shows a stable resistance reading around 10 kohms, then the thermistor is operational. If the reading is zero or infinite, the thermistor requires replacement.

After replacement, thermistor recalibrating may be necessary.

If the thermistor fails, the analyzer temperature mode can be set to “Manual” to allow for proper operation until a replacement thermistor is installed.

3. Disinfectant Sensors

a. Maintenance Overview

To ensure optimum performance of the disinfectant sensor, perform the following actions at their prescribed intervals.

Sensor Type	Maintenance Task & Interval
F1	• Change membrane cap once per year. • Change electrolyte every 3-6 months. • Clean electrode every 3-6 months.
F2	• Change membrane cap once per year. • Change electrolyte once per year. • Clean electrode once per year.
F3	• Clean electrode every 3-6 months. • No cleaning head: Clean gold electrodes every 4-12 weeks. • With cleaning head: Clean gold electrodes every 6-12 months.
T1	• Change membrane cap once per year. • Change electrolyte every 3-6 months. • Clean electrode every 3-6 months.

b. Membrane Cap

For details on changing the membrane cap, refer to Section IV in this manual.

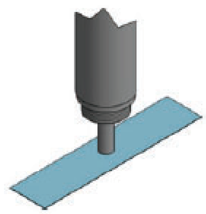
> **IMPORTANT:** If there is insufficient disinfectant (e.g. Chlorine) in the water for a long period of time, typically >24 hours, a biological film can accumulate on the membrane. Should this occur, the membrane cap can no longer be used and must be replaced.

c. Electrolyte

For details on changing the electrolyte, refer to Section IV in this manual.

d. Cleaning the Gold Electrode

i. Hold the special emery paper in place and gently move the gold tip of the sensors electrode finger over it two times. Use the dull side of the emery paper and use a fresh area for each pass.



e. Lifespan of the Disinfectant Sensor

Figure 9 illustrates the average life cycle of a disinfectant sensor.

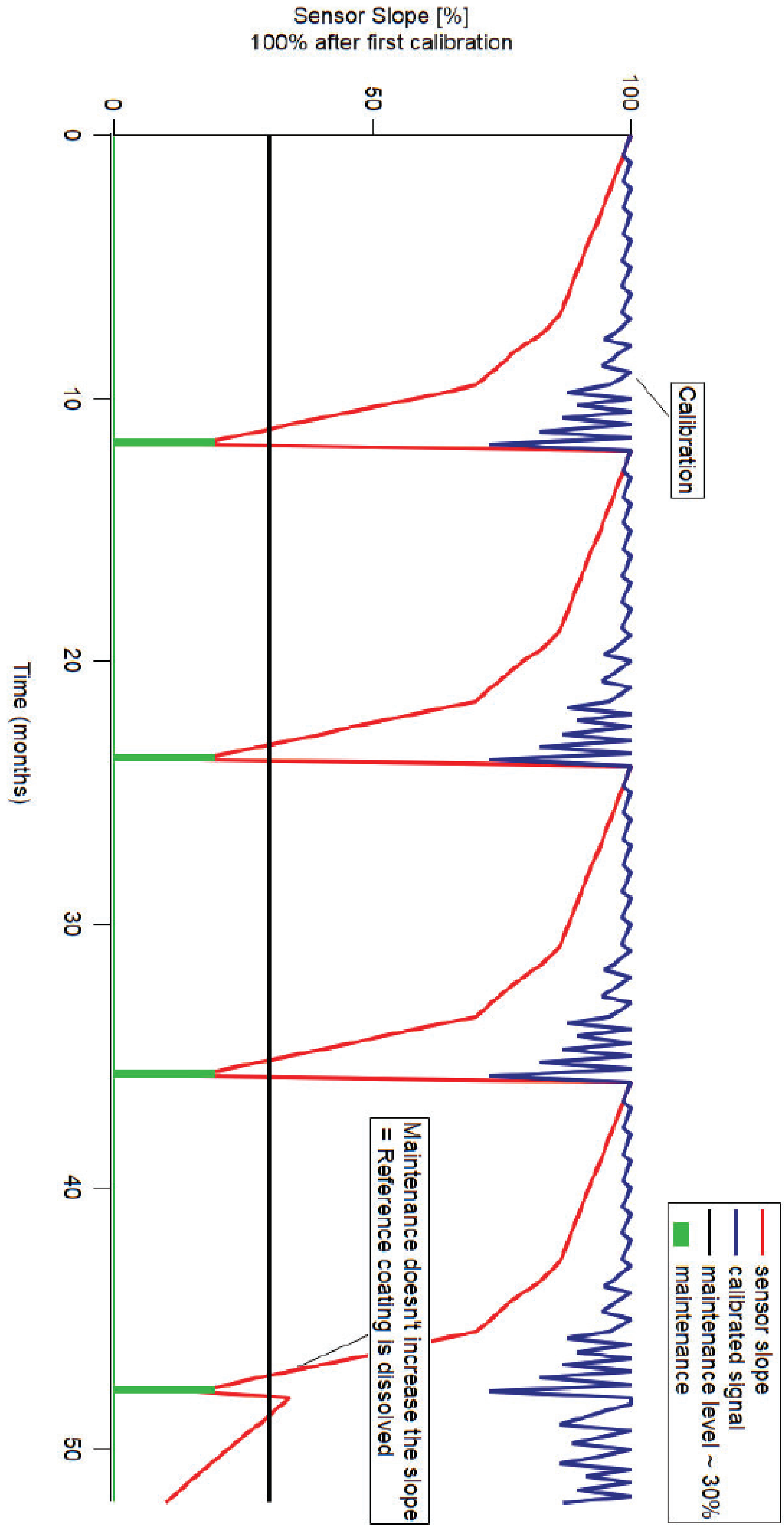
Over time the reference coating on the electrode finger will dissolve, eventually reaching a point where replacing the membrane cap and electrolyte will not be enough to bring the sensor signal back into a reliable range. At this point the disinfectant sensor should be replaced.

4. pH Electrode

Coatings on the electrode surface will result in erroneous readings and calibration and may mimic the effects of a failing electrode. Regular cleaning of the electrode can help prevent this and prolong its lifespan. For more information on pH electrodes, please refer to the pH & ORP Electrodes - General Instructions document.

The pH electrode will periodically require replacement. The frequency of replacement is dependent on the quality of the water. Also, all handling instructions must be followed carefully to avoid damaging the pH probe. Failure of the pH probe will be indicated by an excessively high or low reading. If the probe cannot be recalibrated, then it must be replaced.

FIGURE 9 - Disinfectant Sensor Lifespan



XI. TROUBLESHOOTING

Various factors can affect the disinfectant sensor. If irregularities occur, it may be useful to check the following:

- Sample water pressure and flow rate
- Sensor and electrode cables
- Calibration
- Chemical feed equipment
- Concentration of disinfectant in the sample water
- Sample water pH
- Sample water temperature
- Analytical methods and the suitability of the disinfectant sensor

Problems with Displayed Residual

Residual Readings do not match DPD test

If the displayed residual is not correct, consider the following:

- Run-in time too short - The disinfectant sensor requires a period of time to acclimate to the sample water. This time varies depending on the sensor. See section IV.
- Improper calibration - Perform a residual Span calibration.
- Change in sample water pH.
- Improper pH electrode calibration (if in use) - Calibrate the pH electrode.
- Failed pH electrode.
- Change in sample water pressure and/or flow rate. See Section III.
- Accumulation of air bubbles or foreign matter on the membrane cap.
- Interfering compounds, disruptive substances or cross sensitive species in the sample water. See sensor data sheet for more details.
- Electrolyte needs replaced - Service the sensor with new electrolyte. See Section X for maintenance intervals.
- Membrane cap needs replaced - Service the sensor with a new membrane cap, electrolyte and electrode cleaning. See Section X for maintenance intervals.

Unable to perform residual span calibration

Independently test sample water residual and verify the residual. Check the following:

- No disinfectant in the sample water.
- Run-in time too short - The disinfectant sensor requires a period of time to acclimate to the sample water. This time varies depending on the sensor. See section IV.
- Sample water flow and/or pressure too low. See Section III.
- Disruptive substances in the sample water.
- No electrolyte in the membrane cap - Service the sensor with new electrolyte. See Section X for details.
- Membrane cap needs replaced - Service the sensor with a new membrane cap, electrolyte and electrode cleaning. See Section X for maintenance intervals.
- Short circuit - Locate and eliminate the short circuit / wiring defect.
- Failed disinfectant sensor and/or electronic circuit board - Contact the supplier for replacements.

NOTE: It is important to note that the residual span calibration should never be performed with a very low residual, as compared to the measurement range for which the analyzer was provided. The span calibration should be performed with a residual value of at least 25% of the ordered *range. Ideally, the span calibration should be performed with a residual value of 50% or more of the ordered range. If the normal measurement range is less than 25% of the ordered range, contact Hydro Instruments or an authorized distributor for guidance.*

Residual displayed drops to/remains at zero

Independently test sample water residual and verify the residual. Check the following:

- The membrane is not in contact with the water - Check the height of the sensor and ensure that there is a gap between the membrane and the cross flow diverter.
- Sample water flow and/or pressure too low - Increase sample water flow and pressure.
- No electrolyte in the membrane cap - Refill the membrane cap with electrolyte.
- Membrane cap needs replaced - Service the sensor with a new membrane cap, electrolyte and electrode cleaning. See sensor data sheet for recommended frequency of membrane cap replacement.
- Short circuit - Locate and eliminate the short circuit / wiring defect.
- Failed disinfectant sensor and/or electronic circuit board - Contact the supplier for replacements.

Residual reading unstable

If the displayed residual is not stable, this may be the result of one of the following:

- Sample water flow and/or pressure fluctuations - Stabilize the sample water flow and pressure.
- Accumulation of air bubbles on the membrane cap
- Improper residual calibration - Perform a residual Span calibration.
- Lack of galvanic isolation - Replace the ground pin.
- Sensor maintenance required - Service the sensor with a new membrane cap, electrolyte and electrode cleaning. See Section X for maintenance intervals.

Slow reaction to residual changes

If the displayed residual is slow to react, this may be the result of one of the following:

- Sample water flow and/or pressure too low - Increase sample water flow and pressure.
- Disruptive substances in the sample water
- Sensor maintenance required - Service the sensor with a new membrane cap, electrolyte and electrode cleaning. See Section X for maintenance intervals.

Residual reading is unreliable at low residual levels

- This may be the result of attempting to monitor a residual level at the very low end of the ordered range. For example, if a particular analyzer is ordered and set-up for a measurement range of 0 – 5.0 mg/l and the actual application involves measuring for residuals of 0.1 or 0.2 mg/l, the accuracy of the measurement will suffer. If the normal measurement range is less than 25% of the ordered range, contact Hydro Instruments or an authorized distributor for guidance.
- Electrolyte needs replaced - Service the sensor with new electrolyte. See Section X for maintenance intervals.
- Membrane cap needs replaced - Service the sensor with a new membrane cap, electrolyte and electrode cleaning. See Section X for maintenance intervals.
- Calibration may be required.

  NOTE: It is important to note that the residual span calibration should never be performed with a very low residual, as compared to the measurement range for which the analyzer was *provided. The span calibration should be performed with a residual value of at least 25% of the ordered range. Ideally, the span calibration should be performed with a residual value of 50% or more of the ordered range. If the normal measurement range is less than 25% of the ordered range, contact Hydro Instruments or an authorized distributor for guidance.*

Temperature

Temperature reading is not correct

1. Independently test sample water temperature and verify the temperature.
2. If the displayed temperature is not correct, recalibrate the temperature.
3. If the displayed temperature is extremely high or extremely low, the thermistor has either lost connection to the circuit board or has failed, requiring replacement. This is a 10K Ohm resistor and replacements are available from Hydro Instruments.

Thermistor is damaged or missing

1. Replace thermistor.
2. The temperature compensation mode can be set to “Manual” to allow for continued analyzer operation until the thermistor is replaced.

pH

pH reading does not match independent pH meter measurement

- Recalibrate the pH electrode. Recalibration can be performed at a single point (“grab cal”) or at two points using known pH buffers.
- If the pH being displayed is dramatically incorrect or fluctuating drastically and cannot be corrected through a two-point calibration, check all pH cable connections as well as the cable connector to the probe. If all connections are verified and the problem cannot be corrected through re-calibration, replace the pH electrode (Hydro part number PHE-250).
- If the raw pH sensor mV values are outside an acceptable range, then replace the pH probe. See Figure 8 for details. For more information refer to the pH & ORP - General Instructions document.

Display and Circuit Boards

Display is blank

- Verify the power is turned on to the unit. If it is, check the incoming VAC and outgoing DC voltage at the analyzers power supply board. The input should be 100-250 VAC. The output should be 24 VDC.
- A blank display may indicate a failure of the display, the power supply board or the primary circuit board. Consult Hydro Instruments or an authorized representative for assistance.

4-20 mA Output channel values are not accurate

- Verify the output selection is correct. For example, if the output signal on a 5 mg/l analyzer measuring 2.5 mg/l is something other than 12mA, verify that the output you are measuring is configured to “Resl”.
- Check the output calibrations at 4mA and 20mA by accessing the appropriate output channel calibration as detailed in the note on Figure 6.

NOTE: The output calibration numbers from the factory calibration are recorded on the inside of the electronics enclosure for reference.

Communication Errors

- The MB220 Display board is communicating with the other boards by Modbus over the ribbon cable. If the ribbon cable is not properly connected to each board, then the MB220 Display board may lose communication with one or more circuit boards. If so, you would see a "COMM ERROR" message such as "Node 1 Error". Node numbers are identified in Table 1 below. As can be seen there, the MB129 board is Node 1. If such an error occurs, check to ensure that the ribbon cable is properly connected to all relevant circuit boards per Figure 11.

TABLE 1: Circuit Board Descriptions and Node Numbers

Node Number (Comm Error)	Circuit Board	Board Description	Application
1	MB129	Probe Analog Input board	Probe
2	MB128	Temp, pH, & Flow Board	pH, Temp and 4-20mA input
3	MB114	Four Analog Outputs Board	4-20mA outputs
4	MB104	Four Relay Board	Relay outputs
5	MB122	Two In, Two Out Board	4-20mA outputs
6	MB181	Eight Contact Inputs Board	Flow Stop Switch

XII. DATA LOGGER (OPTIONAL)

1. **Description:** When enabled in the analyzer software, the data logger records the measured residual, sample water temperature, turbidity, and pH value (if being measured) at a selectable frequency. This data is recorded on the Micro SDHC memory card and can be retrieved using any text-reading program. The Micro SDHC memory card is installed in the slot on the MB220 board as indicated on Figure 11. To use the data logger the controller must be provided with the MJ500 Real Time Clock board (which mounts directly on the MB220 board as shown on Figure 11).

2. **Operation:** To enable, enter the configuration menu on the residual analyzer control software and select the option "DL". The first menu option that appears will be the On/Off menu. The menus which follow allow for adjustment of the data logger frequency and for changes to the clock (date and time). See Figure 6.
   a. **Frequency:** The frequency is the time interval between data recordings. The frequency is adjustable in seconds, with a minimum setting of 5 seconds.
   b. **Data Logger Clock:** The clock is factory-set before shipment. However, because the clock is set on Eastern Standard time it may be necessary to change the date and time upon start-up.

3. **Stored Data Files:** The data will be written to text files on the Micro SDHC memory card. The formatting and handling of these files is as described below:
   a. **File Format:** The following is an example data file to illustrate the format used. As you can see, there is a three line header for each file. The fourth and fifth lines are headers for the data. You will see that each header and data entry is delimited by a comma.
   b. **File Name:** Each data file will be named according to the date on which it was created. For example if created on May 24, 2016, the file name would be May24_16.txt
      i. If the Micro SDHC memory card already has a file started earlier on the same day, then data will be written onto the existing file.
      ii. The text files are limited to 5 MB. Once this limit has been reached, a new file will automatically be created to allow data to continue to be written.

   c. **Importing data into Microsoft Excel:** The data files can be imported into Microsoft Excel as follows:

      NOTE: The following information assumes use of Microsoft Excel 2007 or newer.

      i. Select the "Data" tab.
      ii. Among the "Get External Data" tabs on the tool bar, select "From Text"
      iii. A pop up window will appear allowing you to search for and select the data file that you wish to import. After you have selected the file, click on "IMPORT".
      iv. Another pop up window "Text Import Wizard – Step 1 of 3" will then appear.
         1. Here under "Original Data Type" you must select "Delimited".
         2. Lower down you are asked to select "Start import at row:___". In order to eliminate the 3 line file header, you can select "4" here to start the data import on row 4 of the file.
         3. Then click "Next".

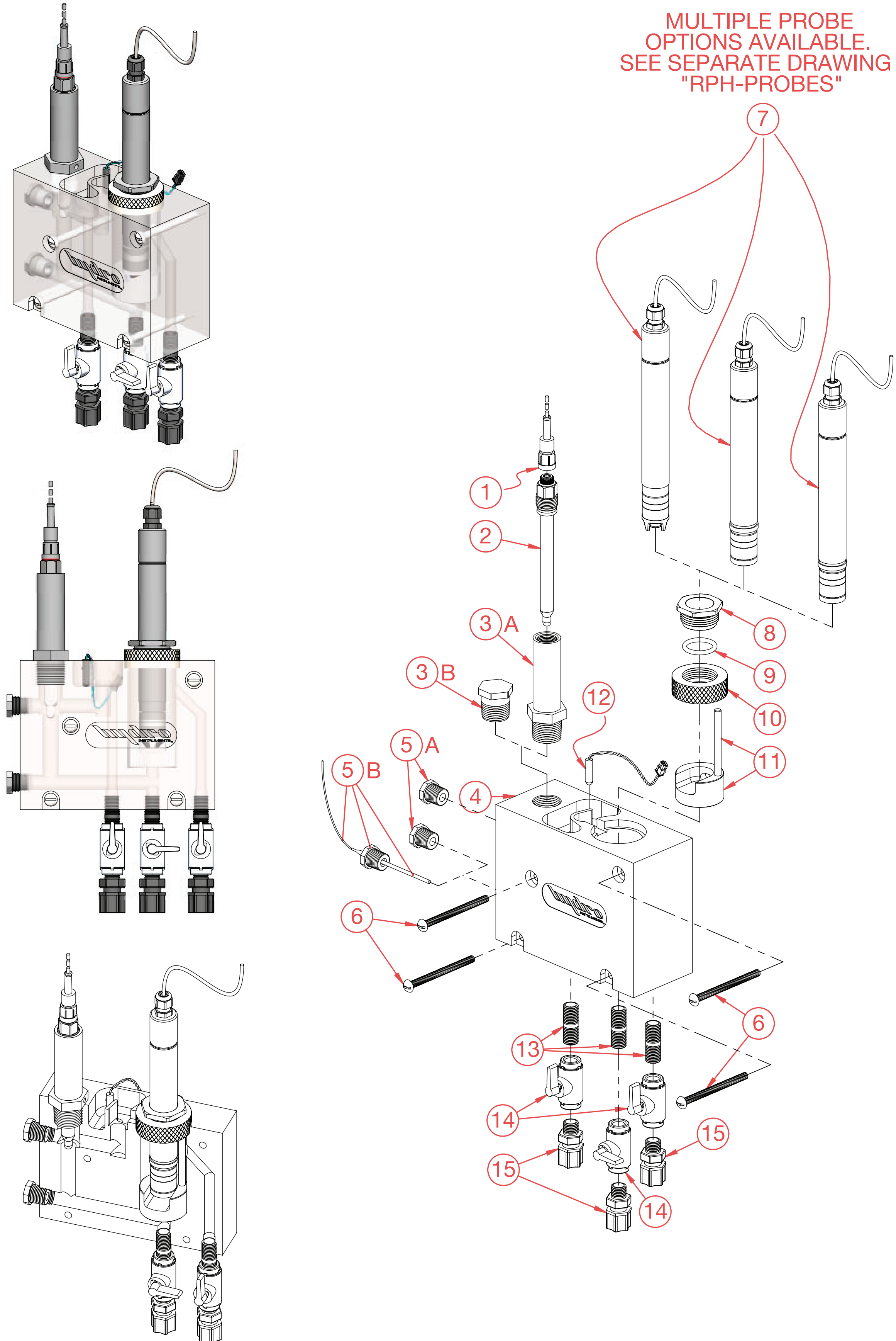
v. On the next pop up window "Text Import Wizard – Step 2 of 3" you need to select the type of delimiter being used in the data file. The data entries in these files are delimited by commas and so you must select "Comma". After selecting Comma and only Comma, then click "Next".

vi. On the next pop up window "Text Import Wizard – Step 3 of 3" you can accept the "Column data format" setting of "General" and then click "Finish".

vii. On the next (and final) pop up window "Import Data", it is asking you whether you will import to the worksheet that is open or if you want to import it to a new worksheet. Make your selection and then click "OK". Now the data should have been imported into the Excel spreadsheet.

TABLE 2: Hydro Instruments RPH-250 Data Log File

Date	Time	Resl	Temp	pH	Turb1	Turb2	Flow	MF	Raw Resl
MM/DD/YEAR	HH:MM:SS	PPM	C		NTU	NTU			mA
05/24/2023	11:25:06	0.80	23	7.80	0.50	1.00	0	1.80	10.0
05/24/2023	11:26:06	0.81	23	7.80	0.55	1.02	0	1.80	10.1
05/24/2023	11:27:06	0.80	23	7.81	0.53	1.03	0	1.81	10.0
05/24/2023	11:28:06	0.81	23	7.81	0.54	1.03	0	1.81	10.1
05/24/2023	11:29:06	0.80	23	7.81	0.53	1.02	0	1.81	10.0



RESIDUAL CHLORINE ANALYZER
OPEN FLOW CELL

Date: 2022-12-09-v1
EXPLODED VIEW
Dwg. No.: RPH-OFC, EXP

Item No.	Description	Quantity	Part No.
1	pH Probe Cable	1	PHE-14-S7
2	pH Electrode	1	PHE-14-135
3A	Vented pH Probe Gland	1	PHV-GLAND-1
3B	Port Plug, ¾" NPT	1	850-007
4	Acrylic Flow Cell	1	AFC-BODY
5A	Port Plug, ⅜" NPT	2	850-003
5B	Ground pin assembly	1	RPH-GND
6	¼-20 x 3.25" RHMS (Stainless)	4	
7	Chlorine Probe (See drawing "RPH-250-PROBES")	1	
8	Probe Nut	1	PFC-PROBENUT
9	PM O-Ring	1	OH-VIT-213
10	Threaded Holder	1	AFC-TH
11	Cross Flow Insert with Standoff Post	1	AFC-INS-CRF
12	Thermistor	1	RAH-THERMISTOR
13	¼" NPT Close Nipple	3	880-005
14	¼" NPT Threaded Ball Valve	3	22321
15	PM ¼" NPT ⅜" Tube Tubing Connector	3	BKF-64
PM	Part & Maintenance Kit (PM kit also includes Large Brush and Small Brush)		KT2-RPH-OFC

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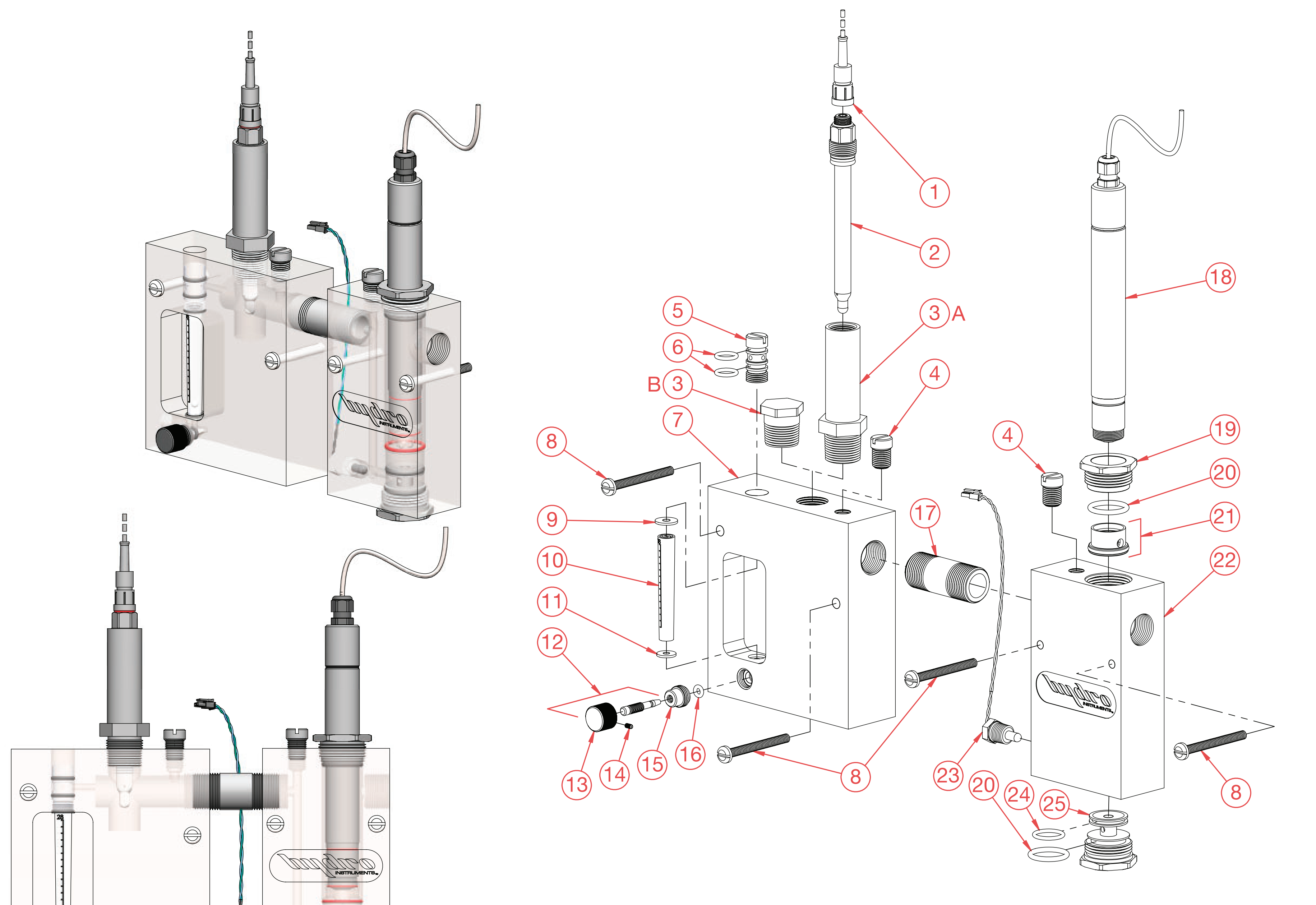
RESIDUAL CHLORINE ANALYZER
OPEN FLOW CELL

Date: 2022-12-09-v1
BILL OF MATERIALS
Dwg. No.: RPH-OFC, BOM



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RESIDUAL CHLORINE ANALYZER
PRESSURIZED FLOW CELL

Date: 2022-12-01-v1
EXPLODED VIEW
Dwg. No. RPH-PFC, EXP

Item No.	Description	Quantity	Part No.
1	pH Probe Cable	1	PHE-14-S7
2	pH Electrode	1	PHE-14-135
3 A	pH Probe Gland	1	PHV-GLAND
3 B	Port Plug, ¾" NPT	1	850-007
4	¼" NPT Plug	2	PLH-108-250
5	Inlet Plug	1	FM-101A
6	PM O-Ring	2	OH-VIT-112
7	Inlet Flow Cell	1	IFC-250
8	¼-20 x 2.5" PHMS (Stainless)	4	¼-20 x 2½"
9	PM Top Meter Gasket	1	MG-001T
10	Meter Tube	1	MTB-11-L-028
11	PM Bottom Meter Gasket	1	MG-001B
12	Rate Valve Stem & Knob	1	VP-250
13	Rate Valve Knob	1	RV-100A
14	Rate Valve Knob Set Screw	1	#5-40 x ¼"
15	Valve Bonnet	1	VB-100C
16	PM O-Ring	1	OH-VIT-106
17	¾" NPT x 2½" Nipple (Sch 80 PVC)	1	883-025
18	"F3" Style Free Chlorine Probe (* See RPH-250-PROBES drawing for options)	1	F3-XX*
19	Probe Nut	1	PFC-PROBENUT
20	PM O-Ring	2	OH-VIT-213
21	Cleaning Head (for "F3" style probes)	1	CEH-F3
22	Probe Flow Cell	1	PFC-250
23	Therimstor and Plug	1	RPH-Thermistor
24	PM O-Ring	1	OH-VIT-116
25	Flow Control Plug	1	PFC-FCP
PM	Part & Maintenance Kit (PM kit also includes Large Brush and Small Brush)		KT1-RPH-PFC

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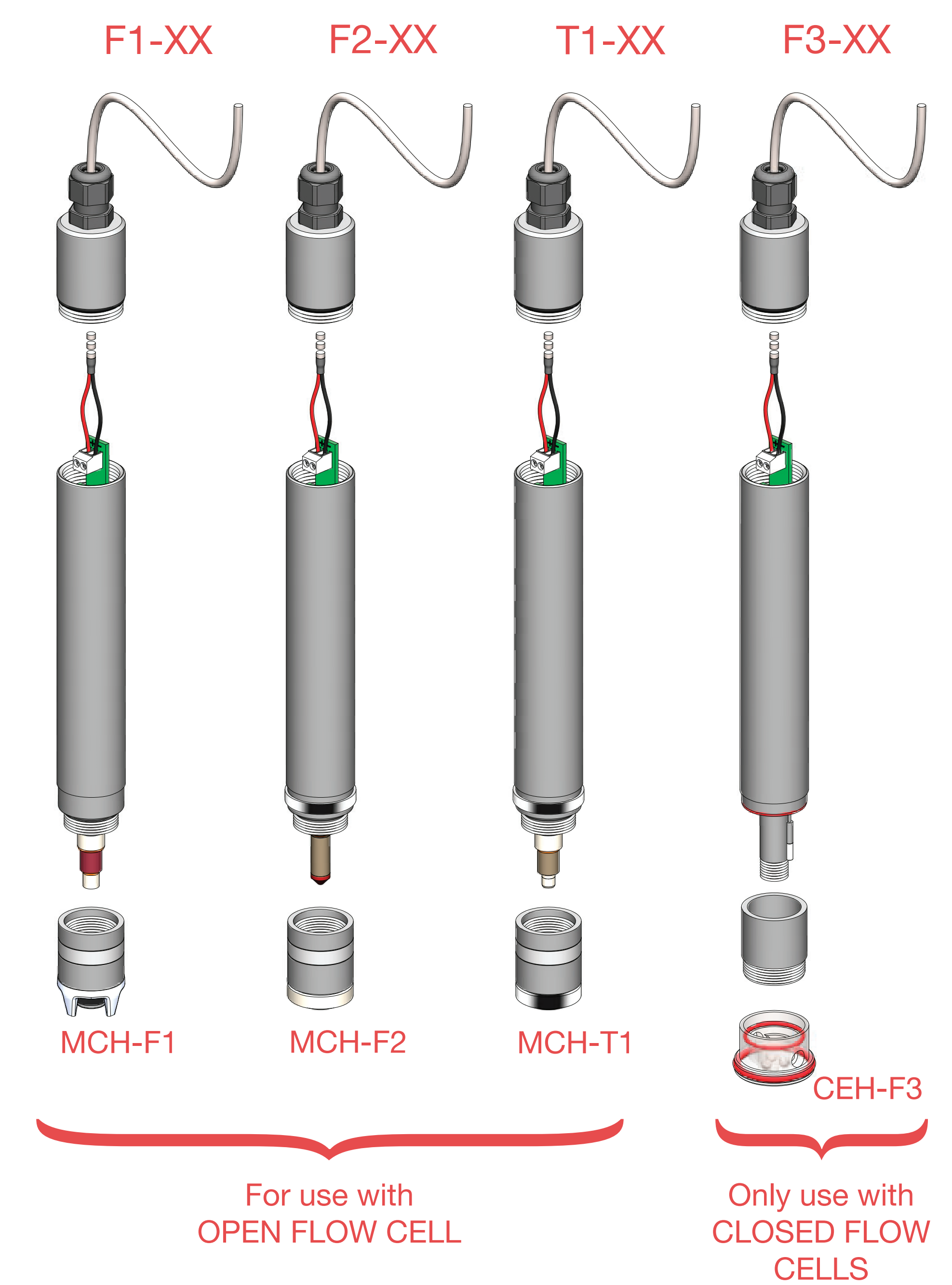
RESIDUAL CHLORINE ANALYZER
PRESSURIZED FLOW CELL

Date: 2022-12-09-v1
BILL OF MATERIALS
Dwg. No. RPH-PFC, BOM



Item No.	Description	Measurement Range	Part No.
	Probes		
F1-XX	"F1" style Free Chlorine probe (6-8 pH, 0-45°C) Membrane-covered, AMPEROMETRIC 2-electrode	0 - 0.50 PPM 0 - 2.00 PPM 0 - 5.00 PPM 0 - 10.0 PPM 0 - 20.0 PPM	F1-05 F1-2 F1-5 F1-10 F1-20
	Membrane cap		MCH-F1
	Electrolyte bottle, 100 ml		REH-F1
F2-XX	"F2" style Free Chlorine probe (4-9 pH, 0-45°C) Membrane-covered, AMPEROMETRIC 3-electrode	0 - 2.00 PPM 0 - 5.00 PPM 0 - 10.0 PPM 0 - 20.0 PPM 0 - 200 PPM	F2-2 F2-5 F2-10 F2-20 F2-200
	Membrane cap		MCH-T1-4E
	Membrane cap (F2-200 only)		MCH-F2
	Electrolyte bottle, 100 ml		REH-F2
T1-XX	"T1" style Total Chlorine probe (4-12 pH, 0-45° C) Membrane-covered, AMPEROMETRIC 3-electrode	0 - 0.50 PPM 0 - 2.00 PPM 0 - 5.00 PPM 0 - 10.0 PPM 0 - 20.0 PPM	T1-05 T1-2 T1-5 T1-10 T1-20
	Membrane cap		MCH-T1-4E
	Electrolyte bottle, 100 ml		REH-T1
F3-XX	"F3" style Free Chlorine probe (5-9 pH, 0-50°C) Open measurement, POTENTIOSTATIC (Does not use a membrane cap)	0 - 1.00 PPM 0 - 2.00 PPM 0 - 5.00 PPM	F3-1 F3-2 F3-5
	Cleaning head		CEH-F3
	Electrolyte bottle, 50 ml		REH-F3

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PROBE OPTIONS FOR PROBE TYPE RESIDUAL ANALYZERS

Date: 2022-08-18-v1
EXPLODED VIEW & BOM
Dwg. No. RPH-PROBES

FIGURE 10 - RPH-250 Circuit Boards

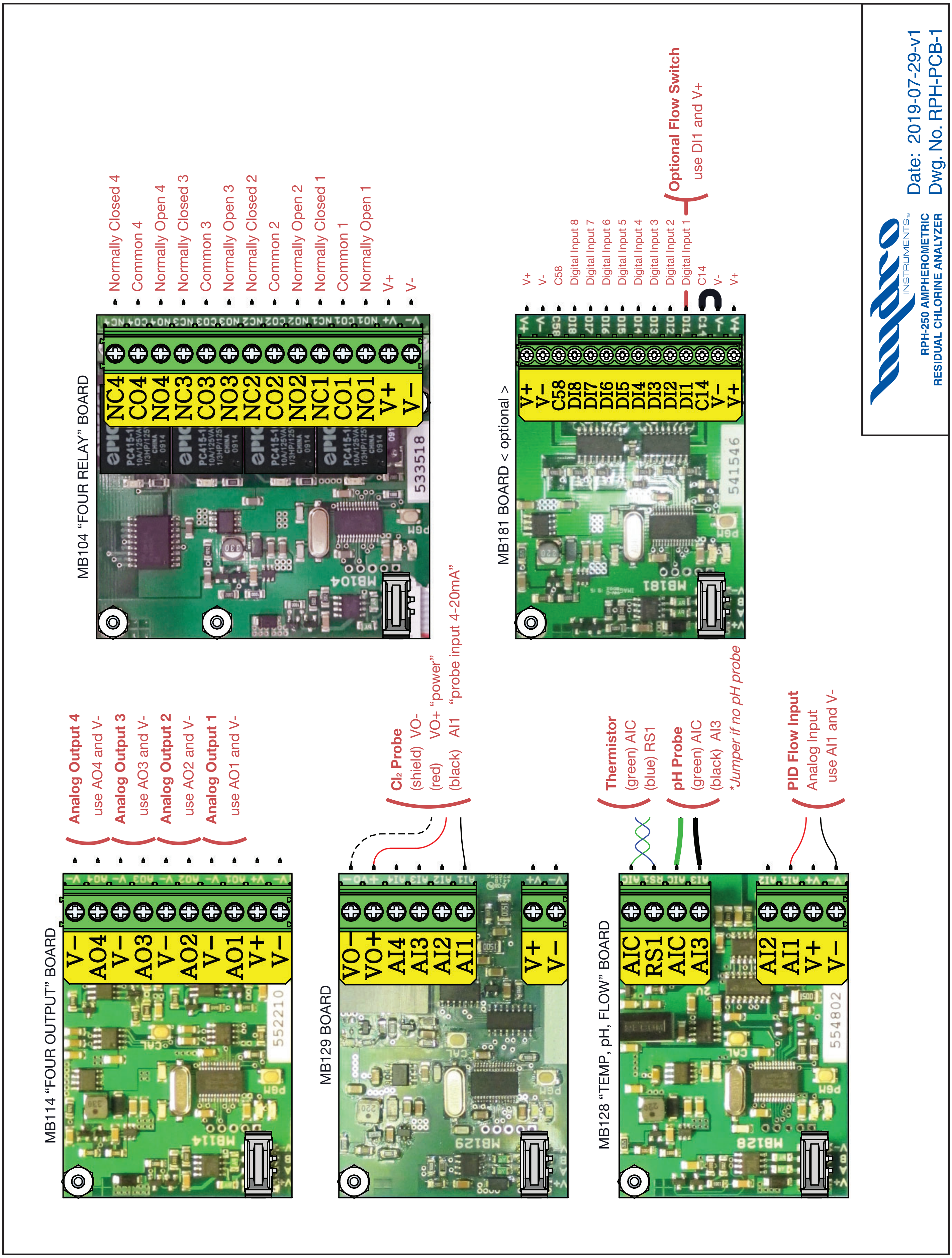

FIGURE 10 - Monitor Internal Wiring and Connections