Model Q45H/62HR
External DC Power
High Range Chlorine
Transmitter

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PRODUCT WARRANTY

Analytical Technology, Inc. (Manufacturer) warrants to the Customer that if any part(s) of the Manufacturer's equipment proves to be defective in materials or workmanship within the earlier of 18 months of the date of shipment or 12 months of the date of start-up, such defective parts will be repaired or replaced free of charge. Inspection and repairs to products thought to be defective within the warranty period will be completed at the Manufacturer's facilities in Collegeville, PA. Products on which warranty repairs are required shall be shipped freight prepaid to the Manufacturer. The product(s) will be returned freight prepaid and allowed if it is determined by the manufacturer that the part(s) failed due to defective materials or workmanship.

This warranty does not cover consumable items, batteries, or wear items subject to periodic replacement including lamps and fuses.

Gas sensors carry a 12 months from date of shipment warranty and are subject to inspection for evidence of misuse, abuse, alteration, improper storage, or extended exposure to excessive gas concentrations. Should inspection indicate that sensors have failed due to any of the above, the warranty shall not apply.

The Manufacturer assumes no liability for consequential damages of any kind, and the buyer by acceptance of this equipment will assume all liability for the consequences of its use or misuse by the Customer, his employees, or others. A defect within the meaning of this warranty is any part of any piece of a Manufacturer's product which shall, when such part is capable of being renewed, repaired, or replaced, operate to condemn such piece of equipment.

This warranty is in lieu of all other warranties (including without limiting the generality of the foregoing warranties of merchantability and fitness for a particular purpose), guarantees, obligations or liabilities expressed or implied by the Manufacturer or its representatives and by statute or rule of law.

This warranty is void if the Manufacturer's product(s) has been subject to misuse or abuse, or has not been operated or stored in accordance with instructions, or if the serial number has been removed.

Analytical Technology, Inc. makes no other warranty expressed or implied except as stated above

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Part 1 - Introduction

1.1   General

The Model Q45H/62HR is an on-line monitoring system designed for continuous monitoring of high concentrations of free chlorine in solution. The monitor provides two user selectable display ranges of 0-200.0 or 0-2000 PPM, and the sensing system will operate on water streams with temperatures from 0 to 55°C. The Q45H/62HR System is designed for use in wash water applications where high chlorine levels must be maintained to insure disinfections such as produce washing operations and latex glove sanitization systems.

The basic sensing element used in the high range monitor is a polarographic membrane sensor which measures chlorine directly. Water simply flows past the sensor and directly to drain, with the flow rate and pressure across the sensor controlled by a constant head flow cell assembly. The chlorine measurement does not alter the sample or add any chemicals to the sample stream, so the water flow can return to the system if desired.

It is important to note that high range chlorine sensor response is very sensitive to changes in sample pH. This monitoring system cannot be used in sample stream pH exceeds 8.0 or is below 6.0. The best performance is on water streams with pH of 6.5-7.5 with stability of +/- 0.2 pH.

Q45H/62HR Monitors are available in three electronic versions, a loop-powered 2-wire transmitter, a dual "AA" battery operated portable unit with two voltage outputs, and a 5-17 VDC Externally powered unit with two voltage outputs. This manual refers to the 5-17 VDC External Power transmitter version.

In addition to normal chlorine measurement, the Q45H/62HR is also available with an optional pH input which provides a two-parameter monitoring system. Both free chlorine and pH are displayed simultaneously, and the free chlorine value is automatically compensated for pH changes

1.2   Standard System

The standard model Q45H/62HR system includes three main components, the Q45H analyzer, a clear acrylic flowcell assembly, and a special free chlorine sensor engineered for high concentration operation. An optional pH sensor and flowcell is available for applications where pH is not stable.   **Figure 1 shows a typical installation including the optional pH sensor.**

For connection of the sensor to the electronics, a 25' cable is supplied. An additional 100 feet of interconnect cable may be added using #07-0100 junction box. All required spare parts are also provided with the basic system, including spare membranes, electrolyte, o-rings, and any special hardware.
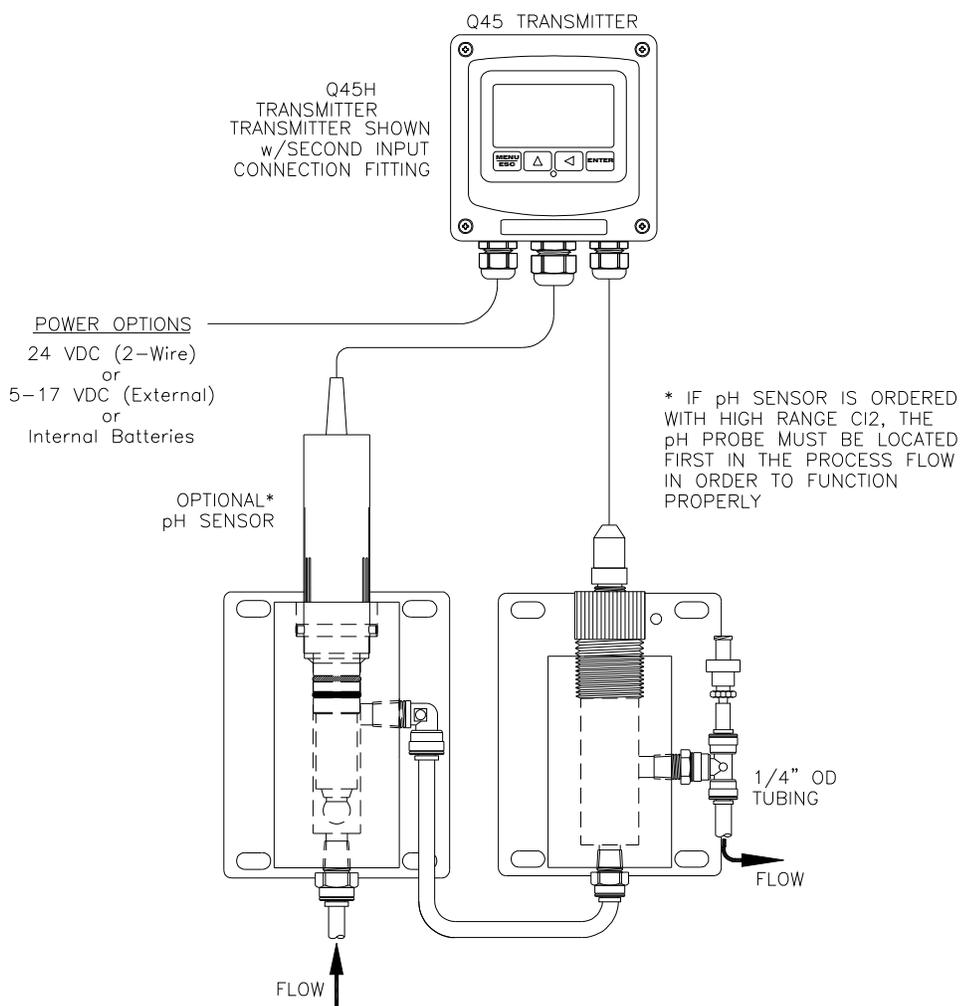
Figure 1 - Typical Chlorine Monitoring System

1.3   Features

- Standard Q45H/62HR transmitters are fully isolated, externally powered for VDC applications.   .

- High measurement range capability, with sensitivity of 1 ppm over a range of 0-2000 ppm. User ranges of 200.0 ppm or 0-2000 ppm.

- Output Hold, Output Simulate, Output Alarm, and Output Delay Functions. All forced changes in output condition include bumpless transfer to provide gradual return to on-line signal levels and to avoid system control shocks on both analog outputs.

- Selectable automatic pH compensation feature. Enables active pH compensation of free chlorine readings – requiring no pumps or buffers to maintain a constant pH level. The pH reading can also be sent to one of the analog outputs for complete pH + chlorine monitoring. The pH correction can be done using ATI's optional pH sensor or using an input signal of 0.4-2.0 VDC (4-20 mA across a 100 ohm resistor) from another pH monitor. Input from another monitor requires the use of a loop isolator.

- Large, high contrast, custom LCD display with LED back light provides excellent readability in any light conditions. The secondary line of display utilizes 5x7 dot matrix characters for clear message display. Two of four measured parameters may be on the display simultaneously

- Diagnostic messages provide a clear description of any problem with no confusing error codes to look up. Messages are also included for diagnosing calibration problems.

- Quick and easy one-point calibration method and sensor zero-cal. To provide high accuracy, all calibration methods include stability monitors that check temperature and main parameter stability before accepting data.

- High accuracy three-wire Pt100 temperature input. Temperature element can be user calibrated.

- Security lock feature to prevent unauthorized tampering with transmitter settings. All settings can be viewed while locked, but they cannot be changed.

1.4   Q45H/62HR System Specifications

Displayed Parameters	Main input, 1 ppm to 2000 ppm Sensor temperature, -5.0 to 55.0 °C (23 to 131 ºF) Sensor Current, 0.0 – 1.7 uA, 0.0 to 17.0 uA Voltage Outputs, 0-2.5 VDC Sensor slope/offset Model number and software version Optional pH Input value. 0.00 to 14.00 pH
Main Parameter Ranges	Manual selection of one of the following display ranges, 0.0 to 200.0 ppm 0 to 2000 ppm
Display	0.75" (19.1 mm) high 4-digit main display with sign 12-digit secondary display, 0.3" (7.6 mm) 5x7 dot matrix.
Keypad	4-key membrane type with tactile feedback, polycarbonate with UV coating
Weight	1 lb. (0.45 kg)
Ambient Temperature	Analyzer Service, -20 to 60 °C (-4 to 140 ºF) Sensor Service, -5 to 55°C (23 to 131 °F) Storage, -5 to 70 °C (-22 to 158 ºF)
Ambient Humidity	0 to 95%, indoor/outdoor use, non-condensing to rated ambient temperature range
Altitude	Up to 2000 m (6562 Ft.)
Electrical Certification	Ordinary Location, cCSAus (CSA and UL standards - both CSA approved), pollution degree 2, installation category 2
EMI/RFI Influence	Designed to EN 61326-1
Output Isolation	600 V galvanic isolation
Filter	Adjustable 0-9.9 minutes additional damping to 90% step input
Temperature Input	Pt100 RTD with automatic compensation
Sensor	3-electrode polarographic membraned sensor for direct measurement of chlorine.
Sensor Materials	PVC and PEEK
Sensor Cable	25 ft. (7.5 meter) cable with 6-pin plug.

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Max. Sensor-to-Analyzer Distance	100 feet (30.5 meters), with junction box
Optional pH Compensation Input	Accepts standard combination pH Sensor. Clear acrylic pH flowcell required for pH sensor.
Flow Cell	Clear acrylic flowcell with ¼" O.D instant tube fittings. Recommended flowrate: 300-500 cc/min.
Power	5-17 VDC
Enclosure:	NEMA 4X, polycarbonate, stainless steel hardware, weatherproof and corrosion resistant, HWD: 4.4" (112 mm) x 4.4" (112 mm) x 3.5" (89 mm)
Mounting Options	Wall or pipe mount bracket standard. Bracket suitable for either 1.5" or 2" I.D. U-Bolts for pipe mounting.
Conduit Openings	Two PG-9 openings with gland seals
DC Cable Type	Belden twisted-pair, shielded, 22 gauge or larger

1.5   Q45H Performance Specifications

Accuracy	1.0 % of selected range or 1 PPM
Repeatability	0.5% of selected range or 1 PPM
Sensitivity	0.05% of selected range
Non-linearity	0.1% of selected range
Warm-up Time	3 seconds to rated performance (electronics only)
Supply Voltage Effects	± 0.05% span
Instrument Response Time	60 seconds to 90% of step input at lowest damping

Equipment bearing this marking may not be discarded by traditional methods in the European community after August 12 2005 per EU Directive 2002/96/EC. End users must return old equipment to the manufacturer for proper disposal.

Part 2 – Analyzer Mounting

2.1 General

All Q45 Series instruments offer maximum mounting flexibility. A bracket is included with each unit that allows mounting to walls or pipes. In all cases, choose a location that is readily accessible for calibrations. Also consider that it may be necessary to utilize a location where solutions can be used during the calibration process. To take full advantage of the high contrast display, mount the instrument in a location where the display can be viewed from various angles and long distances.

Locate the instrument in close proximity to the point of sensor installation - this will allow easy access during calibration. The sensor-to-instrument distance should not exceed 100 feet. To maximize signal-to-noise ratio however, work with the shortest sensor cable possible. The standard cable length of the chlorine sensor is 25 feet.

Refer to Figure 4 and Figure 5 for detailed dimensions of each type of system.

4.38
(111.2)

4.38
(111.2)

FRONT VIEW

2.61
(66.3)

#10-32 UNF
(4 PLACES)

2.61
(66.3)

BACK VIEW

1.68
(42.7)

3.45
(87.6)

SIDE VIEW

1" NPT

.82
(20.8)

1.23
(31.2)

1.23
(31.2)

PG-9 PORT
(2 PLACES)
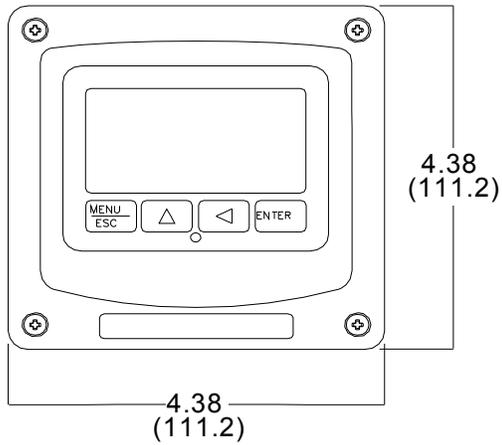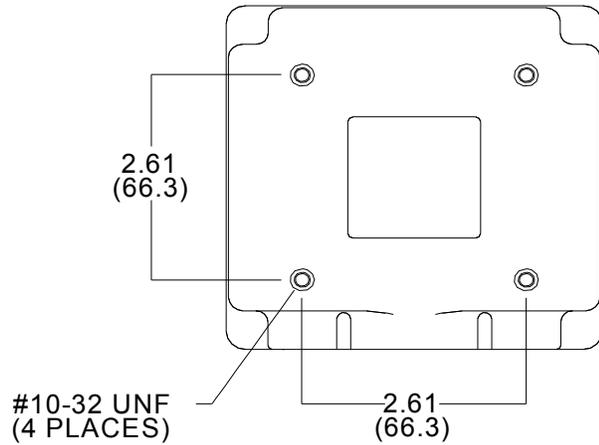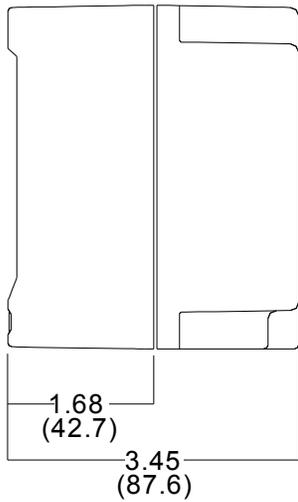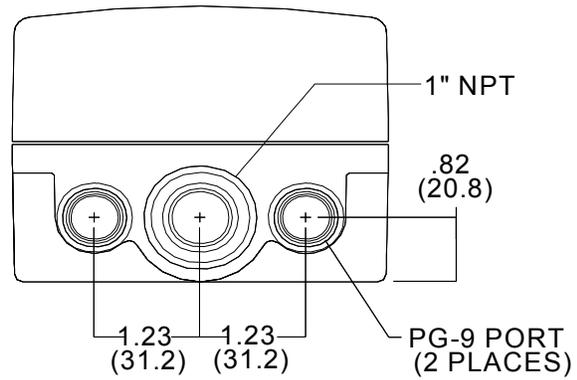
BOTTOM VIEW

Figure 2 - Q45 Enclosure Dimensions

2.2   **Wall or Pipe Mount**

A PVC mounting bracket with attachment screws is supplied with each transmitter (see Figure 3 for dimensions). The multi-purpose bracket is attached to the rear of the enclosure using the four flat head screws. The instrument is then attached to the wall using the four outer mounting holes in the bracket. These holes are slotted to accommodate two sizes of u-bolt that may be used to pipe mount the unit. Slots will accommodate u-bolts designed for 1½"or 2" pipe. The actual center to center dimensions for the u-bolts are shown in the drawing. Note that these slots are for u-bolts with ¼-20 threads. The 1½" pipe u-bolt (2" I.D. clearance) is available from ATI in type 304 stainless steel under part number (47-0005).
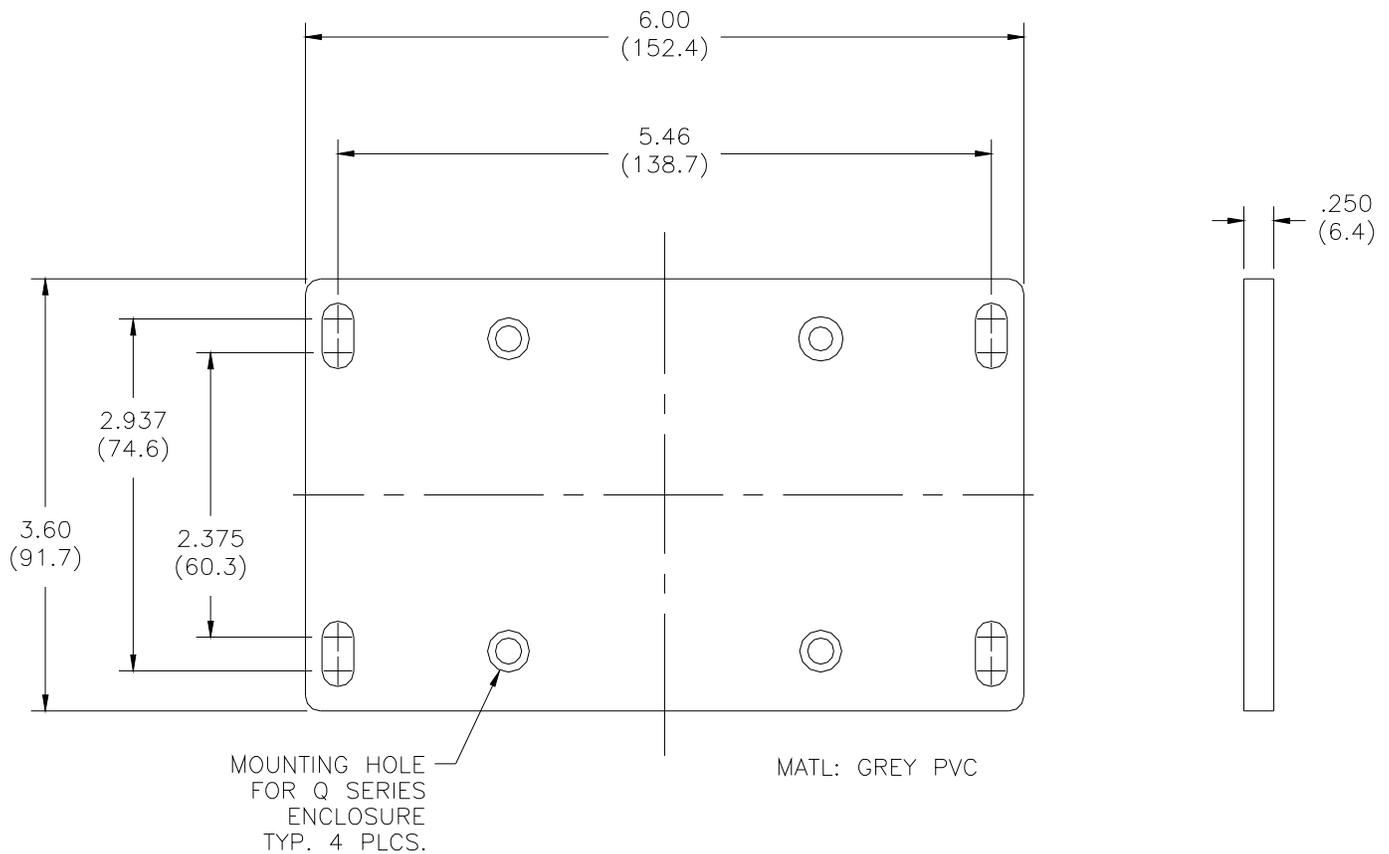
Figure 3 - Wall or Pipe Mount Bracket
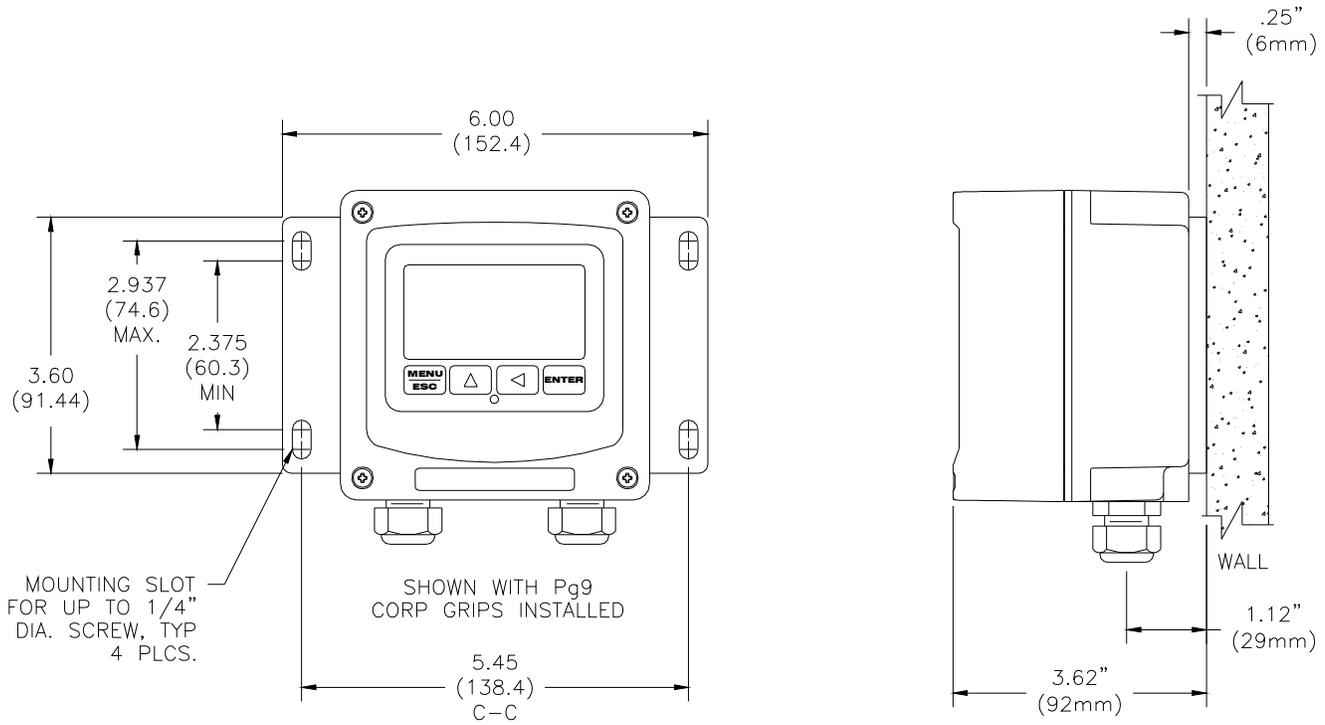
Figure 4 - Wall Mount Diagram
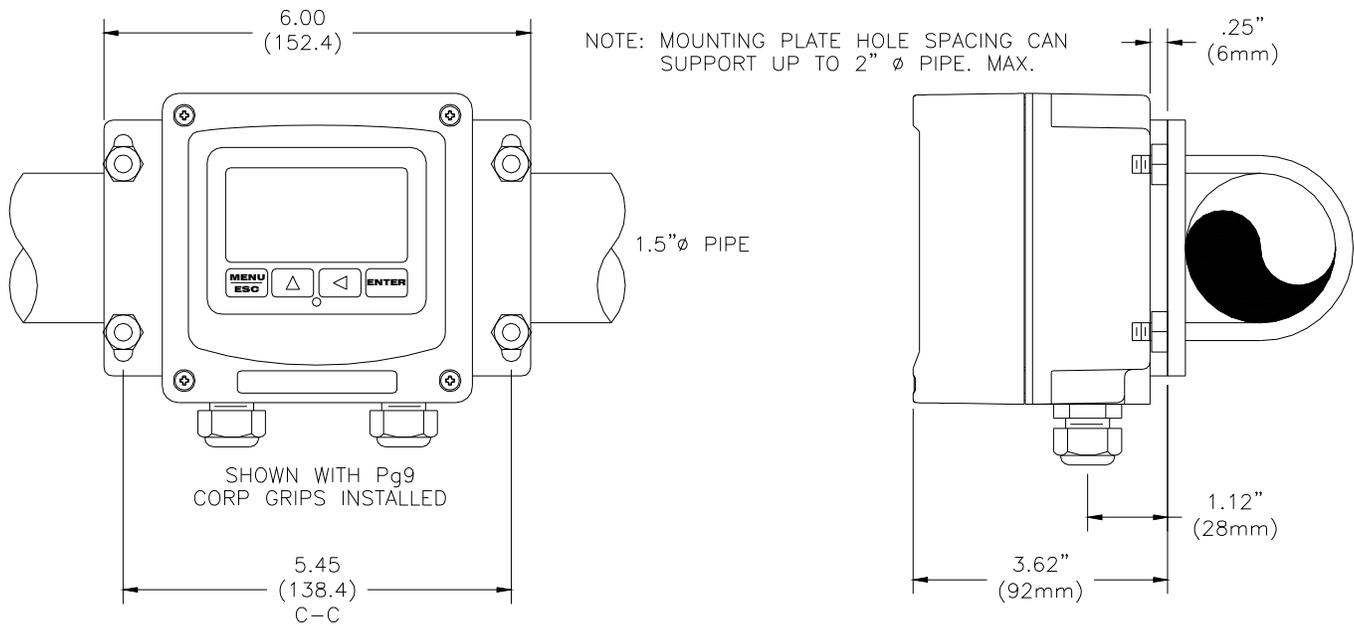
Figure 5 - Pipe Mount Diagram

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Part 3 – Sensor/Flowcell Mounting

3.1 General

Select a location within the maximum sensor cable length for mounting of the sensor flow cell.

3.2 Sensor Flowcell

High range chlorine sensors are mounted in a clear acrylic flowcell. The flowcell is supplied with instant tube fittings for ¼" O.D. tubing. If desired, these fittings may be removed and replaced with any type of fitting with ⅛" NPT thread. Sample flowrate through the flowcell should not exceed 1 liter per minute. Best operation will be achieved if the flow is stable at a rate of about 400 cc/min.

Mechanical installation of the flow cell requires that it be mounted to a wall or other convenient flat surface. Alternatively, the mounting holes on the plate will accommodate a 2" U-bolt for mounting the plate to a 2" pipe. Figure 6 shows the dimensions and mounting hole locations for the flow cell.

3.2 pH Sensor Flowcell

For applications where a pH sensor will be used with the chlorine monitor, a second flowcell must be used. Figure 7 shows dimensions for the pH flowcell, which is supplied with the same type of tube fittings as the chlorine flowcell.

If a pH flowcell is installed, the inlet piping should run through the pH flowcell first and then into the chlorine flowcell. If preferred, separate sample lines can be used to feed each flowcell from a common pipe, but pH and chlorine flowcells must be located in close together. They should always be within 5 feet of each other.

3.61"
92mm

2.66"
68mm

3/4" NPT
THREADS

SEALED FLOWCELL
ASSEMBLY
(00-1596)

VACUUM BREAKER

4.576"
116mm

4.03"
102mm

1/4" OD
OUTLET

1/8" NPT x 1/4" TUBE
INSTANT FITTING

MOUNTING SLOT FOR
#10-32 SCREW
4 PLCS.
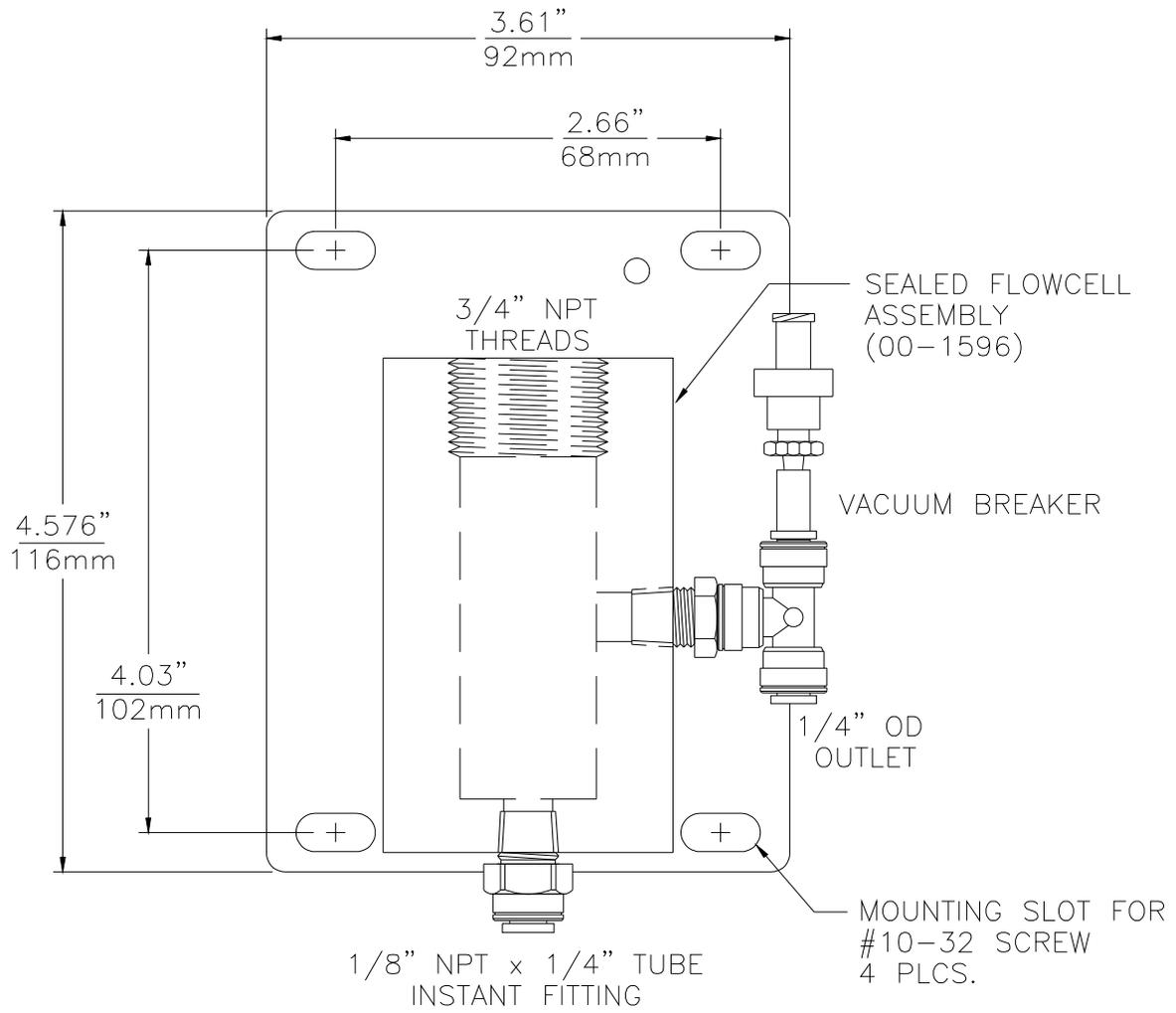
Figure 6 - Sealed High Range Sensor Flowcell
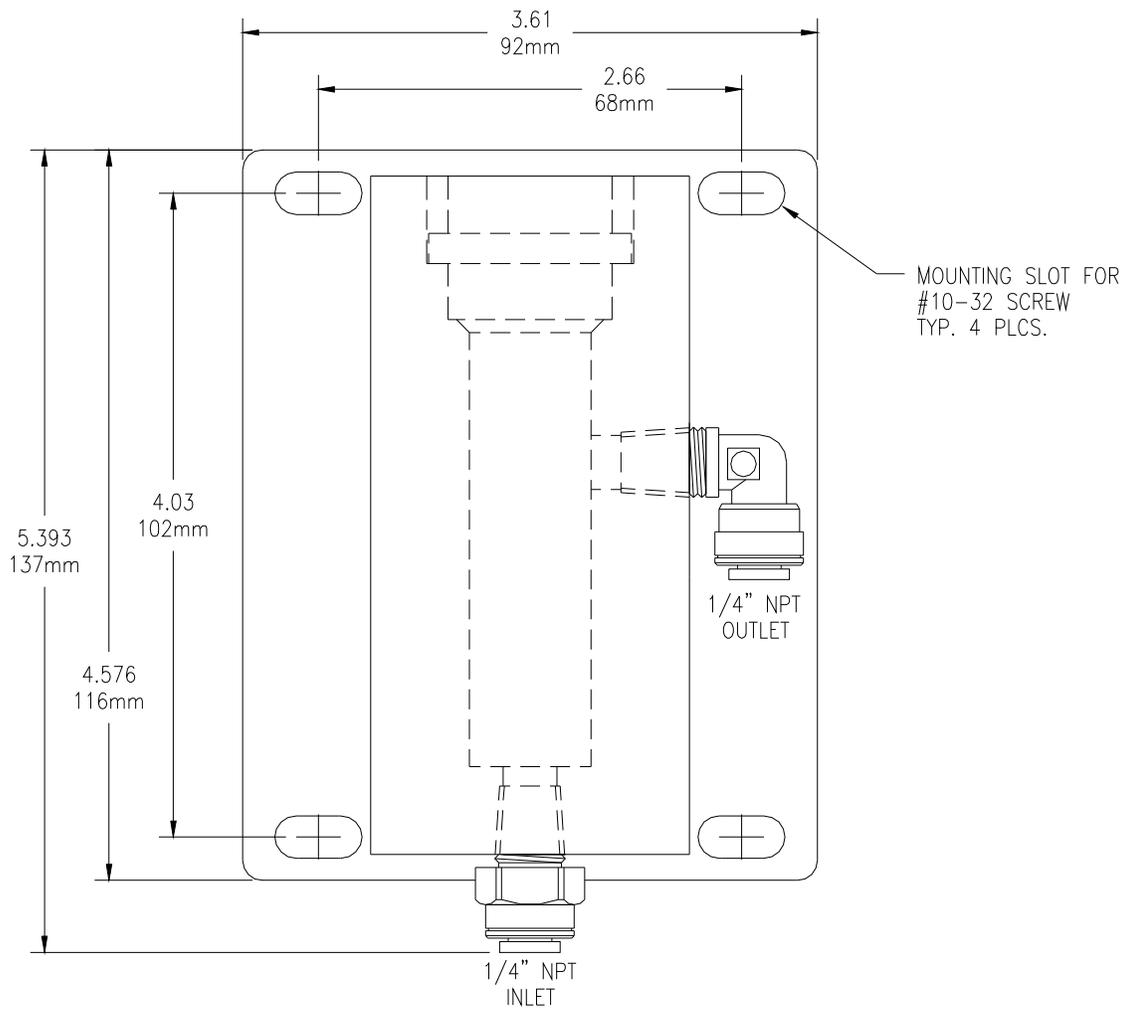
Figure 7 - Sealed pH Sensor Flowcell

Part 4 – Electrical Installation

4.1 General

The Q45 5-17 VDC Externally Powered Transmitter is designed for low power operation for solar power applications. Please verify the type of unit before connecting any power.

WARNING: Do not connect AC line power to the PCB module. Severe damage will result.

Important Notes:

1. Use wiring practices that conform to all national, state and local electrical codes. For proper safety as well as stable measuring performance, it is important that the earth ground connection be made to a solid ground point from terminal 15 (Figure 8).

2. Do NOT run sensor cables or instrument output wiring in the same conduit that contains AC power wiring. AC power wiring should be run in a dedicated conduit to prevent electrical noise from coupling with the instrumentation signals.

3. This analyzer must be installed by trained personnel in accordance with relevant local codes and instructions contained in this manual. Observe the analyzer's technical specifications and input ratings.

4.2 External Power

Q45H-62HR units ordered with the external connection option are designed for applications where power is to be supplied from an external source, and the two voltage outputs are to be wired to an external device. Figure 9 identifies the terminal connections for external powers.
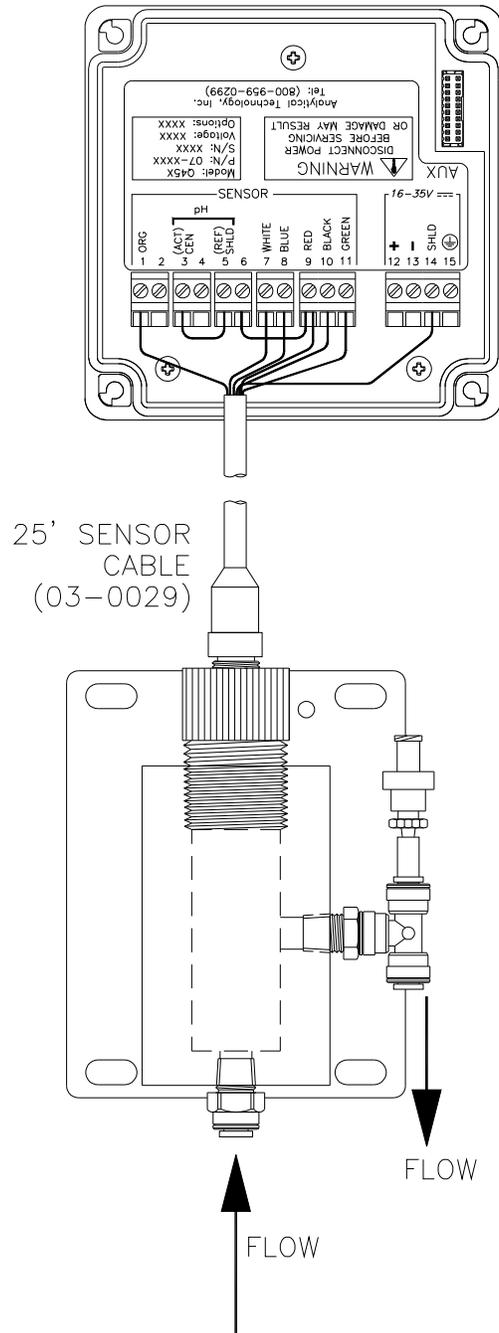
Figure 8 - Loop-Power Connection

Note: Earth ground into Terminal 15 is HIGHLY recommended. This connection can greatly improve stability in electrically noisy environments.

The external power board contains 3 switch assemblies as shown in the drawings.

The first **(S1)** is an On/Off slide switch. This switch must be in the ON position for operation. Turn it to OFF if you do not intend to operate the monitor in the next week or two.

The second switch assembly **(S2)** contains two switches, the one on the left marked LOCK and the one on the right marked MODE. The function of these two slide switches are as follow:

LOCK   This switch is used to define how the monitor will turn on and off. This switch is normally in the OFF position. With the lock switch off, the monitor will be turned on manually using the MENU key on the front of the monitor. With the lock switch in the ON position, the monitor will always be on when there is enough power to run the monitor. The ON position is normally used when operating from an external power supply intended for continuous operation.

MODE   This switch reserved for Battery Powered Operation. **(No Function when used with External Power Transmitter)**

The third switch assembly is a single slide switch **(S3)** which defines whether the 0-2.5 VDC signals from the monitor are isolated or non-isolated. Output isolation is not required when outputs are connected to a data logging device. However, if the outputs are connected to external devices, putting this switch in the ISO position will protect against possible ground loops. The isolation circuit will slightly increase the power requirement of the monitor.
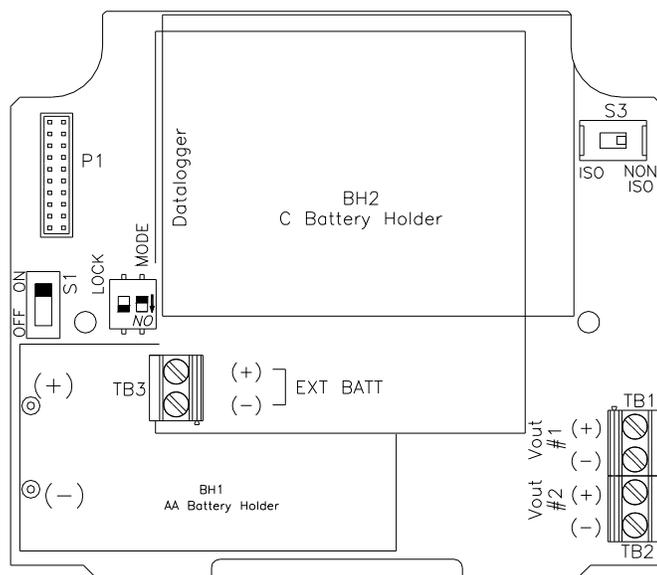
Figure 9 - External Power Board

4.3   Voltage Outputs

There are two sets of analog voltage outputs on the board that may be used to send isolated data back to remotely located recorders, PLC's, etc. Output #1 is used only for Cl2, and Output #2 can be used for either °C/°F or PPM.

4.4   Sensor Wiring

The sensor cable can be quickly connected to the Q45 terminal strip by matching the wire colors on the cable to the color designations on the label in the monitor. A junction box is also available to provide a break point for long sensor cable runs. Route signal cable away from AC power lines, adjustable frequency drives, motors, or other noisy electrical signal lines. Do not run sensor or signal cables in conduit that contains AC power lines or motor leads.

4.5   Direct Sensor Connection

Sensor connections are made in accordance with Figure 8. The sensor cable can be routed into the enclosure through one of cord-grips supplied with the unit. Routing sensor wiring through conduit is only recommended if a junction box is to be used. Some loose cable is needed near the installation point so that the sensor can be inserted and removed easily from the flowcell.

Cord-grips used for sealing the cable should be snugly tightened after electrical connections have been made to prevent moisture incursion. When stripping cables, leave adequate length for connections in the transmitter enclosure as shown below. The standard 25 ft. sensor cable normally supplied with the system is already stripped and ready for wiring. This cable can be cut to a shorter length if desired to remove extra cable in a given installation. Do not cut the cable so short as to make installation and removal of the sensor difficult.

.
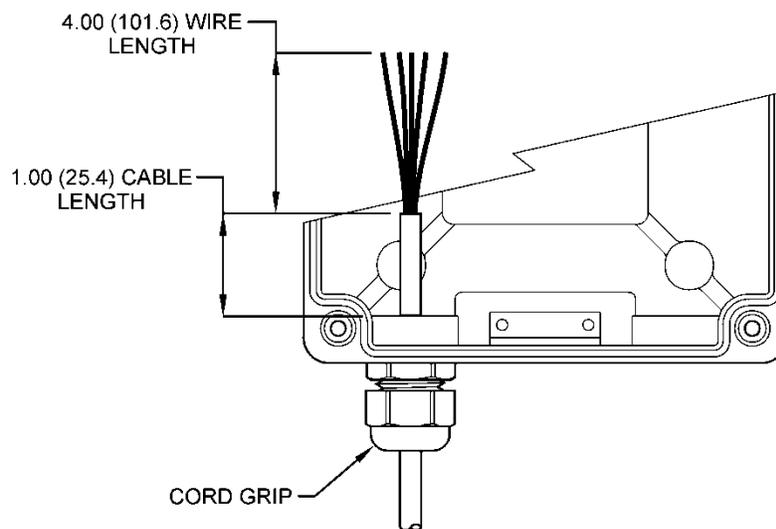
Figure 10 - Sensor Cable Preparation

4.6   Junction Box Connection

For installations where the chlorine sensor is to be located more than 25 feet from the monitor (max. 100 feet), a junction box must be used. The junction box is shown in Figure 11, and is supplied with a ½" conduit hub on one end and a sensor cable gland on the other end. Note that system using the optional pH sensor may not use remote sensors. **If a pH sensor is used with the system, the chlorine and pH sensors must both be within 25 feet of the monitor.**
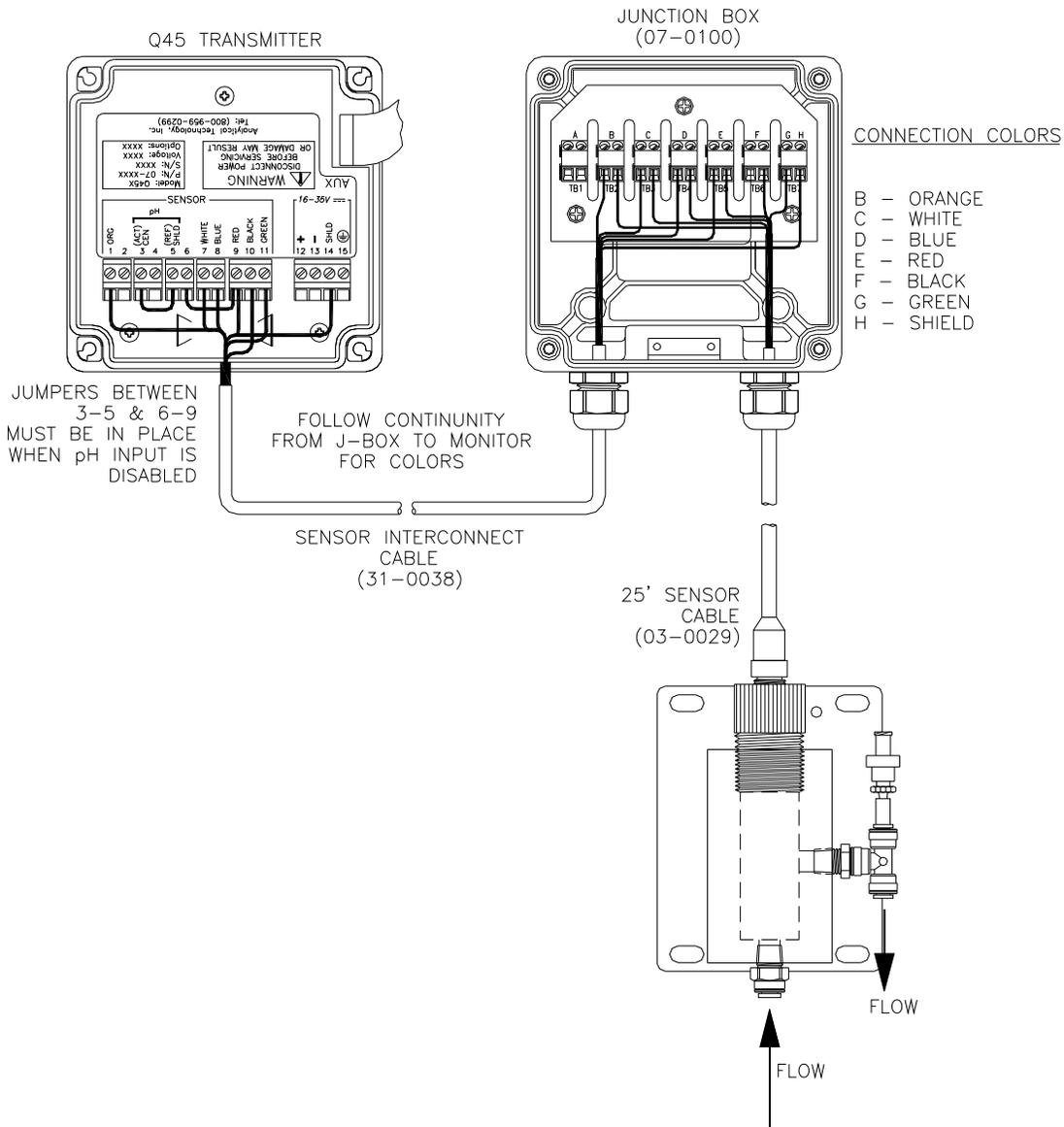
Figure 11 Junction Box Interconnect Wiring

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4.7   Optional pH Compensation Input

The Q45HR may be configured for pH compensation to maintain excellent accuracy in applications where the pH can vary. To utilize the feature, a pH sensor must be properly connected to terminals 5 and 6 of the instrument. The pH input for compensation comes from a 63-0101 combination pH sensor. If available, the 4-20 mA output from a separate pH transmitter may also be used for compensation by placing a 75 ohm resistor between terminals 3 & 5, and then connecting the 4-20 mA signal to the same two terminals.   When using the input from a separate pH transmitter, input isolation is critical and an isolator may be required for proper operation. In addition, the pH input feature must be enabled, and the pH input signal must be properly calibrated. **Remove factory installed jumpers between terminals 3 & 5, and 6 & 9 prior to connection of pH sensors.**

SENSOR CONNECTIONS

3 — CENTER COND.
5 — SHIELD (BRAID)
7 — GREEN

OPTIONAL pH SENSOR
(63—0101)
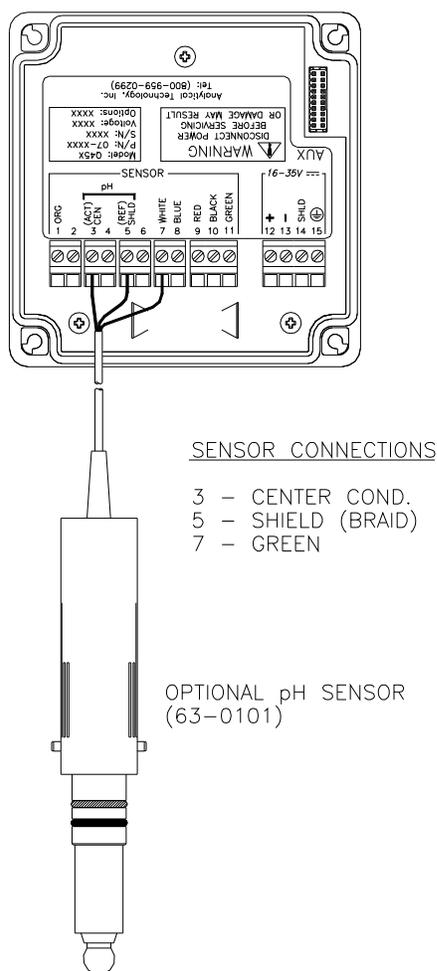
Figure 12 - Optional pH Sensor Connection

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Part 5 – Sensor Assembly

5.1 Chlorine Sensor Preparation

The high range chlorine sensor supplied with the Q45H/62HR is shipped dry. It will not operate until it is prepared by adding electrolyte and a membrane. Preparation of the sensor for operation must be done carefully. The procedure should be done by a qualified technician, and it should only be done when the system is ready for operation. Until then, it is best to leave the sensor in the condition in which it is received.
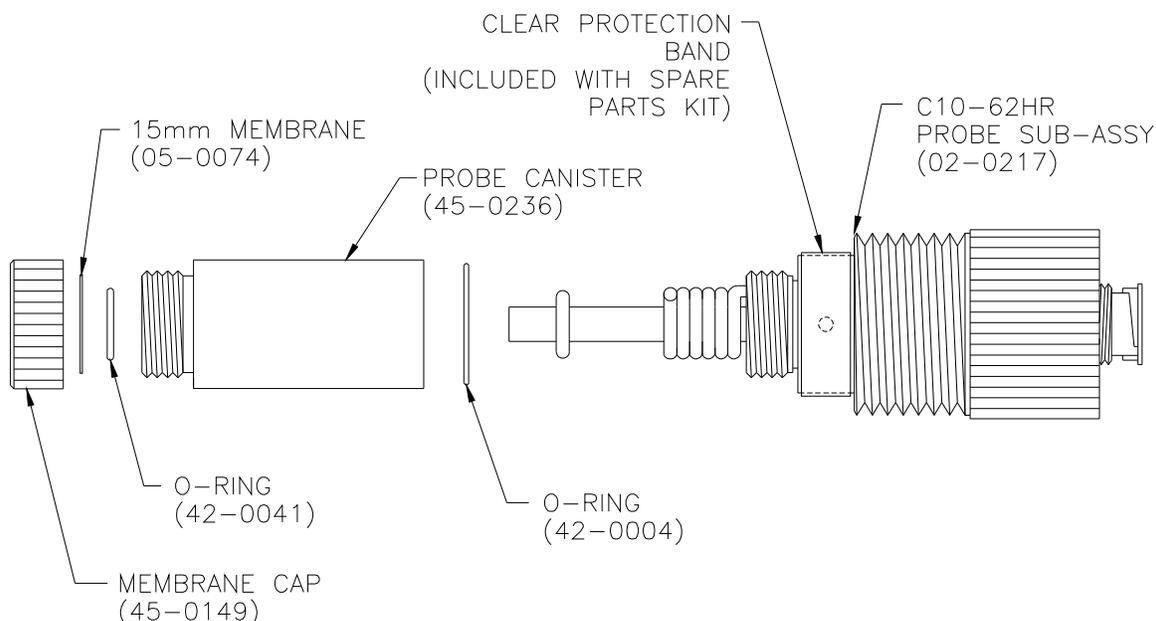
Figure 13 Chlorine Sensor Assembly

Follow the procedure below to prepare the chlorine sensor for operation:

1. Unscrew the electrolyte chamber from the assembled sensor.

2. Remove the front nut from the bottom of the chamber and discard the protective membrane. An O-ring is contained in the groove on both the bottom of the chamber. Be sure that this o-ring remains in place.

3. From the package of membranes supplied with the sensor, place a new membrane into the front nut. **The membrane is white in color and is separated from other membranes by a light blue paper spacer.**

CRITICAL: Membranes used on the high range chlorine sensor are not the same on both sides. Examine the membranes carefully and you will see that one side is shiny and the other side is dull (and feels slightly rough). The shiny side of the membrane must face out toward the measured sample.

4. Screw the front nut on to the chamber until you feel the o-ring compress. Hand tight compression is all that is needed. Do not use tools to tighten. The membrane should be flat across the bottom of the chamber without wrinkles.

5. Fill the chamber with electrolyte until the level reaches the bottom of the internal threads.

6. Slowly screw the chamber onto the sensor body.   A small amount of electrolyte will run out of the hole under the elastic vent hole cover at the top of the sensor.   Holding the sensor with a paper towel around the top will absorb any electrolyte coming out of the vent. The electrolyte is not harmful and will not cause skin irritation on most people.   If desired, wear plastic gloves to avoid contact.

The sensor is now ready for operation. The membrane should be stretched tightly across the tip of the sensor.

CAUTION: When handling the assembled sensor, do not set the sensor on its tip or damage to the membrane will result. Severe impacts on the tip of the sensor from dropping or other misuse may cause permanent damage to the sensor.

5.2   Optional pH Sensor

The optional pH sensor available for use with the Q45H system is a conventional combination pH sensor with special solution ground. The sensors are shipped with a protective rubber boot containing a small amount of salt solution to keep the glass elements in good condition and ready for use.

No special preparations are required for use of this electrode.   The protective boot should remain in place until the system is to be placed into continuous service. **Do not remove the protective boot and allow the sensor to sit in the air for an extended period of time. The pH electrodes MUST stay wet.**

When ready for startup, simply install the pH sensor into the special pH sensor flowcell and turn on the sample flow.

Part 6 – Configuration

6.1 User Interface

The user interface for the Q45 Series instrument consists of a custom display and a membrane keypad. All functions are accessed from this user interface (no internal jumpers, pots, etc.).
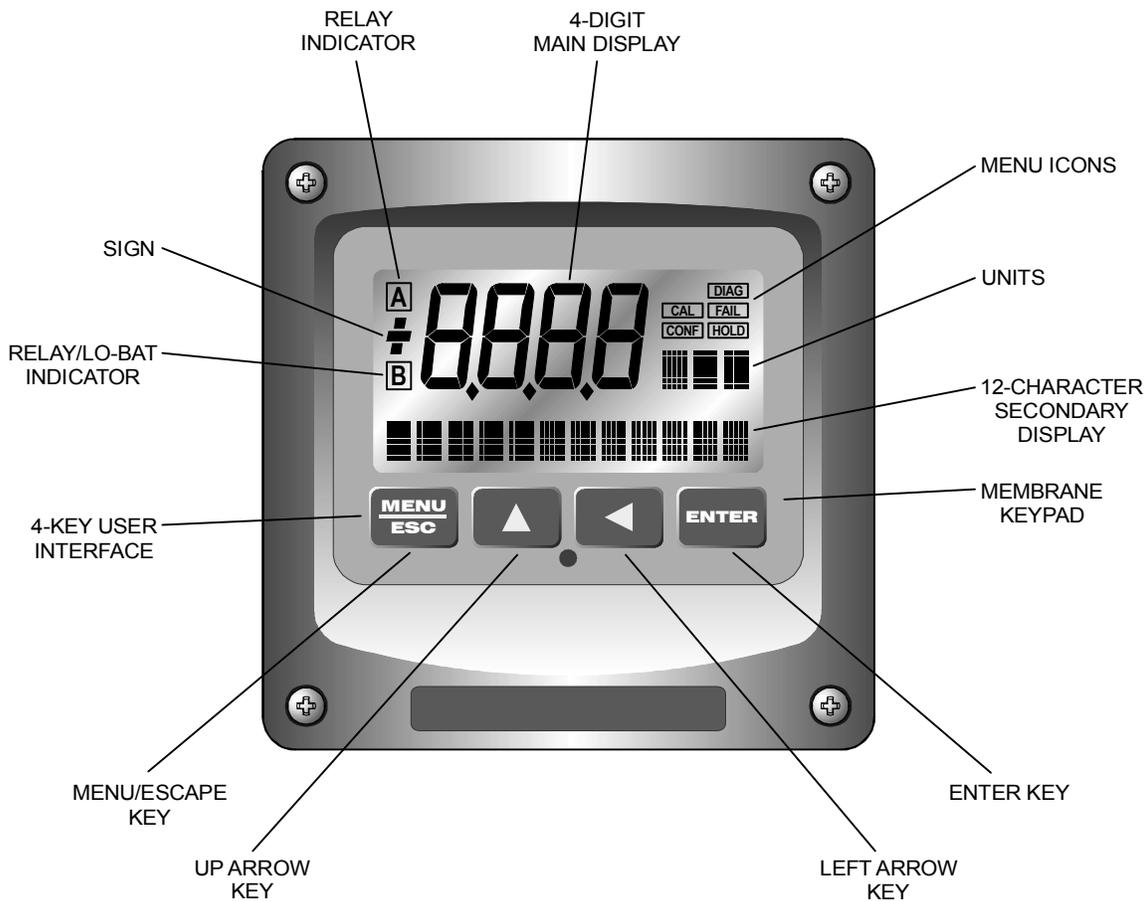
Figure 14 User Interface

6.11   Keys

All user configurations occur through the use of four membrane keys. These keys are used as follows:

MENU/ESC	To scroll through the menu section headers or to escape from anywhere in software. The escape sequence allows the user to back out of any changes in a logical manner. Using the escape key aborts all changes to the current screen and backs the user out one level in the software tree. The manual will refer to this key as either MENU or ESC, depending upon its particular function.
UP (arrow)	To scroll through individual list or display items and to change number values.
LEFT (arrow)	To move the cursor from right to left during changes to a number value.
ENTER	To select a menu section or list item for change and to store any change.

6.12   Display

The large custom display provides clear information for general measurement use and user configuration. There are three main areas of the display: the main parameter display, the secondary message line, and the icon area.

Main Parameter   During normal operation, the main parameter display indicates the present process input with sign and units. This main display may be configured to display any of the main measurements that the system provides. During configuration, this area displays other useful set-up information to the user.

Lower Line   During normal operation, the lower line of the display indicates user-selected secondary measurements that the system is making. This also includes calibration data from the last calibration sequence and the transmitter model number and software version. During configuration, the lower line displays menu items and set-up prompts to the user. Finally, the lower line will display error messages when necessary. For a description of all display messages, refer to Figure 20 or Figure 21.

```
+22.8 °C
```
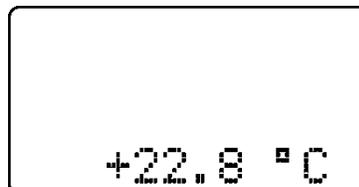
Icon Area   The icon area contains display icons that assist the user in set-up and indicate important states of system functions. The CAL, CONFIG, and DIAG icons are used to tell the user what branch of the software tree the user is in while scrolling through the menu items. This improves software map navigation dramatically. Upon entry into a menu, the title is displayed (such as CAL), and then the title disappears to make way for the actual menu item. However, the icon stays on.

HOLD   The HOLD icon indicates that the current output of the transmitter has been put into output hold. In this case, the output is locked to the last input value measured when the HOLD function was entered.   HOLD values are retained even if the unit power is cycled.

FAIL   The FAIL icon indicates that the system diagnostic function has detected a problem that requires immediate attention. This icon is automatically cleared once the problem has been resolved.

6.2   Software

The software of the Q45H is organized in an easy to follow menu-based system. All user settings are organized under five menu sections: Measure, Calibration [**CAL**], Configuration [**CONFIG**], Control **[CONTROL]** and Diagnostics [**DIAG**].

Note: **The default Measure Menu is display-only and has no menu icon.**

6.21   Software Navigation

Within the CAL, CONFIG, CONTROL, and DIAG menu sections is a list of selectable items. Once a menu section (such as CONFIG) has been selected with the MENU key, the user can access the item list in this section by pressing either the ENTER key or the UP arrow key. The list items can then be scrolled through using the UP arrow key. Once the last item is reached, the list wraps around and the first list item is shown again. The items in the menu sections are organized such that more frequently used functions are first, while more permanent function settings are later in the list. See Figure 155 for a visual description of the software.

Each list item allows a change to a stored system variable. List items are designed in one of two forms: simple single variable, or multiple variable sequences. In the single variable format, the user can quickly modify one parameter - for example, changing temperature display units from °F to °C. In the multiple variable sequence, variables are changed as the result of some process. For example, the calibration of chlorine generally requires more than one piece of information to be entered. The majority of the menu items in the software consist of the single variable format type.

Any data that may be changed will be flashing. This flashing indicates user entry mode and is initiated by pressing the ENTER key.   The UP arrow key will increase a flashing digit from 0 to 9. The LEFT arrow key moves the flashing digit from right to left. Once the change has been completed, pressing ENTER again stores the variable and stops the flashing. Pressing ESC aborts the change and also exits user entry mode.

The starting (default) screen is always the Measure Menu. The UP arrow key is used to select the desired display. From anywhere in this section the user can press the MENU key to select one of the four Menu Sections.

The UP arrow icon next to all list items on the display is a reminder to scroll through the list using the UP arrow key.

To select a list item for modification, first select the proper menu with the MENU key. Scroll to the list item with the UP arrow key and then press the ENTER key. This tells the system that the user wishes to perform a change on that item. For

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single item type screens, once the user presses the ENTER key, part or all of the variable will begin to flash, indicating that the user may modify that variable using the arrow keys. However, if the instrument is locked, the transmitter will display the message **Locked!** and will not enter user entry mode. The instrument must be unlocked by entering the proper code value to allow authorized changes to user entered values. Once the variable has been reset, pressing the ENTER key again causes the change to be stored and the flashing to stop. The message **Accepted!** will be displayed if the change is within pre-defined variable limits. If the user decides not to modify the value after it has already been partially changed, pressing the ESC key aborts the modification and returns the entry to its original stored value.

In a menu item which is a multiple variable sequence type, once the ENTER key is pressed there may be several prompts and sequences that are run to complete the modification. The ESC key can always be used to abort the sequence without changing any stored variables.
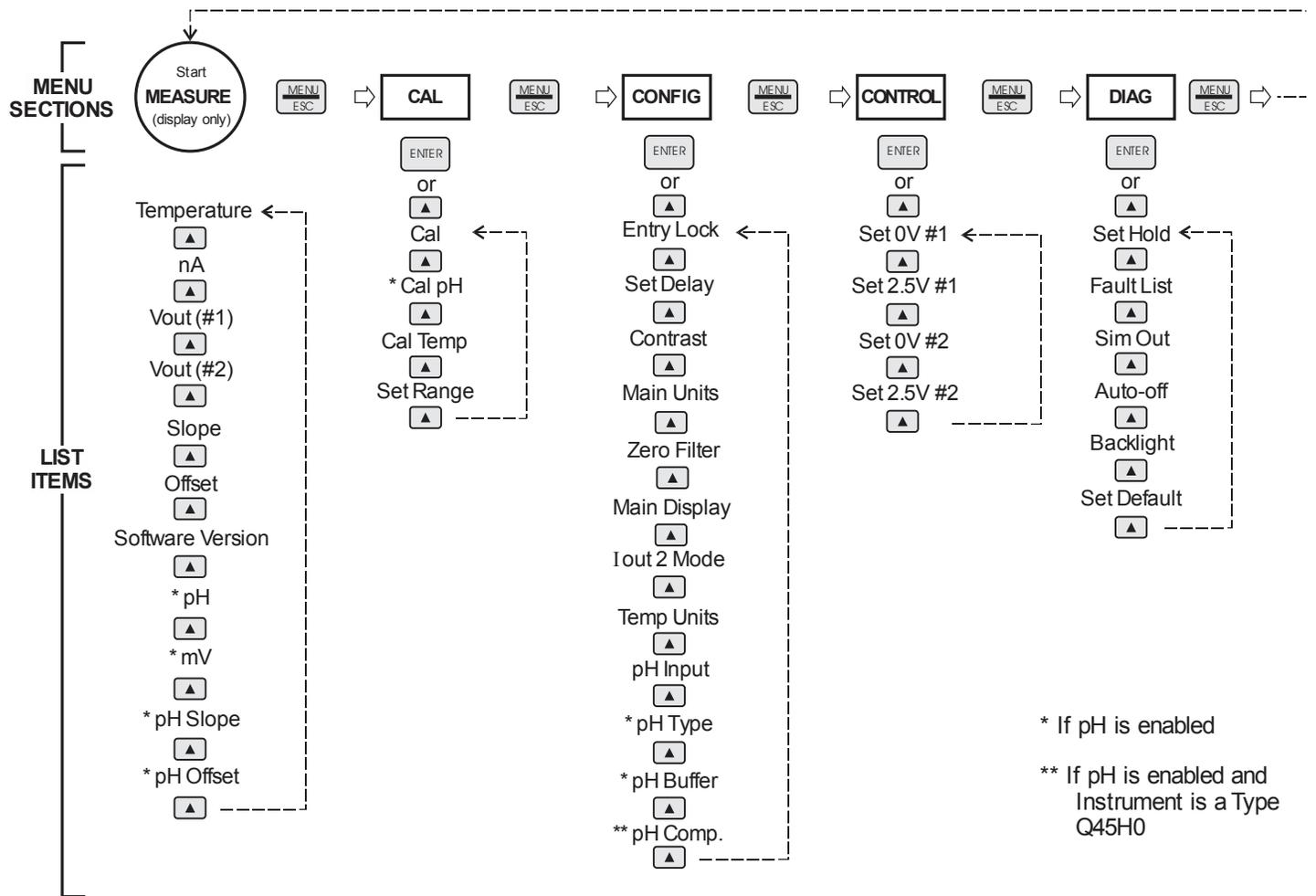
Figure 15 Software Map

6.22   Measure Menu [MEASURE]

The default menu for the system is the display-only menu MEASURE. This menu is a display-only measurement menu, and has no changeable list items. When left alone, the instrument will automatically return to this menu after approximately 30 minutes. While in the default menu, the UP arrow allows the user to scroll through the secondary variables on the lower line of the display. A brief description of the fields in the basic transmitter version is as follows:

<u>**TRANSMITTER MEAS SCREENS:**</u>

25.7C   Temperature display. Can be displayed in °C or °F, depending on user selection. A small "m" on the left side of the screen indicates the transmitter has automatically jumped to a manual 25°C setting due to a failure with the temperature signal input.

32.0 nA   Raw sensor current. Useful for diagnosing problems.

#1 0.00 VDC   Instrument output signal #1.

#2 1.25 VDC   Instrument output signal #2.

Slope = 100%   Sensor output response vs. ideal calibration. This value updates after each calibration. As the sensor ages, the slope reading will decay indicating sensor aging. Useful for resolving sensor problems.

Offset = 0.0 nA Sensor output current at a zero ppm input. This value updates after a zero-calibration has been performed. Useful for resolving sensor problems.

Q45Hs v 4.02   Transmitter software version number.

7.56 pH   Measured pH value on AUX input (if enabled.)

5.00 mV   pH sensor mV output (if enabled)

pH Slp = 100%   pH sensor slope response vs. ideal calibration. This value will update after each calibration. As the pH sensor ages, the slope reading will decay. This is useful for solving sensor problems (if enabled).

pH Off = X.X mV   pH sensor current output at 7 pH input. This value updates after calibration is performed and is useful for resolving sensor problems.

Note: A display test (all segments ON) can be actuated by pressing and holding the ENTER key while viewing the model/version number on the lower line of the display.

The MEASURE screens are intended to be used as a very quick means of looking up critical values during operation or troubleshooting.

6.23 Calibration Menu [CAL]

The calibration menu contains items for frequent calibration of user parameters. There are four items in this list: Cal Chlor, Cal Temp, Set Range, and Cal Zero.

Cal Cl$_2$ The chlorine calibration function allows the user to adjust the transmitter span reading to match a reference solution, or to set the sensor zero point. See Part 7 - Calibration for more details.

Cal pH   If the pH input is enabled, this function will be displayed in the menu listing. This specific function selects whether a 1 or 2 point method is to be used for the optional pH sensor calibration. The selection value in this menu determines how many pH points the user intends to calibrate. For on-line calibrations where the sensor will not be removed and only adjusted, select a 1-point calibration. For calibration in two different buffer solutions and for all first-time calibrations, choose a 2-point calibration. See Part 7 - Calibration for more details.

Cal Temp   The temperature calibration function allows the user to adjust the offset of the temperature response by a small factor of ±5°C. The temperature input is factory calibrated to very high accuracy. However, long cable lengths and junction boxes may degrade the accuracy of the temperature measurement in some extreme situations. Therefore, this feature is provided as an adjustment. See Part 7 - Calibration for more details.

Set Range   This function allows the user to set the display range of the transmitter to a specific application. Once set, all output functions use this display range to establish configuration settings. Press ENTER to initiate user entry mode, and the

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value will flash.   Use the arrow keys to modify value; available ranges are 200.0 ppm and 2000 ppm.   Press ENTER to store the new value. The display range does not affect the internal auto ranging scaler that, therefore, sensitivity is to specification in any user selected range.

6.24   Configuration Menu [CONFIG]

The Configuration Menu contains all of the general user settings:

Entry Lock   This function allows the user to lock out unauthorized tampering with instrument settings.   All settings may be viewed while the instrument is locked, but they cannot be modified.   The Entry Lock feature is a toggle-type setting; that is, entering the correct code will lock the transmitter and entering the correct code again will unlock it.   The code is preset at a fixed value. Press ENTER to initiate user entry mode and the first digit will flash. Use arrow keys to modify value. **See end of manual for the Q45H lock/unlock code.** Press ENTER to toggle lock setting once code is correct.   Incorrect codes do not change state of lock condition.

Set Delay   The delay function sets the amount of damping on the instrument.   This function allows the user to apply a first order time delay function to the chlorine measurements being made.   Both the display and the output value are affected by the degree of damping.   Functions such as calibration are not affected by this parameter.   The calibration routines contain their own filtering and stability monitoring functions to minimize the calibration timing. Press ENTER to initiate user entry mode, and the value will flash.   Use the arrow keys to modify value; range is 0.1 to 9.9 minutes. Press ENTER to store the new value.

Contrast   This function sets the contrast level for the display.   The custom display is designed with a wide temperature range, Super-Twist Nematic (STN) fluid.

The STN display provides the highest possible contrast and widest viewing angle under all conditions. Contrast control of this type of display is generally not necessary, so contrast control is provided as a means for possible adjustment due to aging at extreme ranges. In addition, the display has an automatic temperature compensation network.   Press ENTER to initiate user entry mode, and the value will flash.

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Use arrow keys to modify the value; range is 0 to 8 (0 being lightest). Press ENTER to update and store the new value.

Main Units   This function allows the user to select either PPM or mg/l for the chlorine measurement.

Zero Filter   This function forces the reading to zero when reading is below the entered value. For example, If the entered value were 0.0020 the display at 0.0019 would then indicate 0.0000. This feature is useful in blanking out zero noise.

Main Display   This function allows the user to change the measurement in the primary display area. The user may select between chlorine, sensor temperature, or output current. Using this function, the user may choose to put temperature in the main display area and chlorine on the secondary, lower line of the display. Press ENTER to initiate user entry mode, and the entire value will flash. Use the UP arrow key to modify the desired display value. Press ENTER to store the new value.

Iout2 Mode   This function sets analog output #2 to either track °F/°C, or PPM. Press ENTER to initiate user entry mode, and the entire value will flash. Use the UP arrow key to modify the desired value; selections include 1-temperature or 2-PPM. Press ENTER to store the new value.

Temp Units   This function sets the display units for temperature measurement. Press ENTER to initiate user entry mode, and the entire value will flash. Use the UP arrow key to modify the desired display value. The choices are **°F** and **°C**. Press ENTER to store the new value.

pH Input   Enables the auxiliary pH input on the instrument. Once enabled, an optional pH sensor can be added to the instrument to provide for additional monitoring of pH (dual instrument, chlorine + pH output.)

                        Once enabled, the pH input value is displayed on the lower line of the MEASURE screens. Press ENTER to initiate user entry mode, and the entire value will flash. Use the UP arrow key to modify the desired display value. The choices are **OFF** and **ON**. Press ENTER to store the new value.

pH Type   Allows the user to select either 1-Comb or 2-Q22P. The 1-Comb selection configures the monitor for a standard pH electrode without using its temperature compensation but in

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turn, uses the temperature compensator from the chlorine sensor. Do not use the Q22 setting for this system.

pH Buffer   This turns on and off the automatic pH recognition feature.

pH Comp   Enables pH compensation of free chlorine measurements using a built in comp table.   An optional pH sensor is required for this compensation method, and "pH Input" menu item above must be selected to be ON. pH type must also be selected. Once enabled, this feature will compensate for reduced chlorine readings that would normally result at elevated pH readings. A built-in compensation table increases the chlorine reading gradually as pH increases – in an effort to maintain a constant chlorine measurement. Press ENTER to initiate user entry mode, and the entire value will flash. Use the UP arrow key to modify the desired display value. The choices are **OFF** and **ON**. Press ENTER to store the new value. See Part 7 - Calibration for more details.

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Table 1

4.00 pH		7.00 pH		10.00 pH	
°C	pH	°C	pH	°C	pH
0	4.00	0	7.10	0	10.27
10	3.99	10	7.06	10	10.15
20	4.00	20	7.02	20	10.05
30	4.01	30	6.99	30	9.95
40	4.03	40	6.97	40	9.87
50	4.05	50	6.98	50	9.80
60	4.08	60	6.98	60	9.75
70	4.12	70	6.97	70	9.73
80	4.16	80	6.99	80	9.73
90	4.21	90	7.01	90	9.75
95	4.24	95	7.01	95	9.77

Table 2

4.00 pH		7.00 pH		9.18 pH	
°C	pH	°C	pH	°C	pH
0	4.00	0	7.10	0	9.46
10	3.99	10	7.06	10	9.33
20	4.00	20	7.02	20	9.23
30	4.01	30	6.99	30	9.14
40	4.03	40	6.97	40	9.07
50	4.05	50	6.98	50	9.01
60	4.08	60	6.98	60	8.96
70	4.12	70	6.97	70	8.92
80	4.16	80	6.99	80	8.89
90	4.21	90	7.01	90	8.85
95	4.24	95	7.01	95	8.83

Table 3

4.65 pH		6.79 pH		9.23 pH	
C	pH	°C	pH	°C	pH
0	4.67	0	6.89	0	9.48
10	4.66	10	6.84	10	9.37
20	4.65	20	6.80	20	9.27
30	4.65	30	6.78	30	9.18
40	4.66	40	6.76	40	9.09
50	4.68	50	6.76	50	9.00
60	4.70	60	6.76	60	8.92
70	4.72	70	6.76	70	8.88
80	4.75	80	6.78	80	8.85
90	4.79	90	6.80	90	8.82
95	4.79	95	6.80	95	8.82

Figure 16 - Automatic pH Buffer Tables

6.25   Control Menu [CONTROL]

The Control Menu contains all of the output control user settings:

Set 0V   #1
Set 2.5V #1
Set 0V   #2
Set 2.5V #2   These functions set the output range for each of the two instrument outputs. The value stored for the 0V point may be higher or lower than the value stored for the 2.5V point.

The entry values are limited to values within the range selected in the "Set Range" parameter under the CAL Menu and must be separated by at least 1% of this range. Use the LEFT arrow key to select the first digit to be modified. Then use the UP and LEFT arrow keys to select the desired numerical value. Press ENTER to store the new value.

Output #1 will always be in units of ppm or mg/l, as it is fixed to track residual chlorine. Output #2 will be in either units of ppm, pH, or °C/°F, depending on whether residual chlorine, pH, or temperature is set for Out#2 in the CONFIG menu.

NOTE: **If the temperature units are changed between °C and °F (see Temp Units in this section), the default settings for this output will be stored (present data is not converted.)**

6.26   Diagnostics Menu [DIAG]

The diagnostics menu contains all of the user settings that are specific to the system diagnostic functions, as well as functions that aid in troubleshooting application problems.

Set Hold   The Set Hold function locks the current loop output values on the present process value, and halts operation of the PID controller. This function can be used prior to calibration, or when removing the sensor from the process, to hold the output in a known state. Once HOLD is released, the outputs return to their normal state of following the process input. The transfer out of HOLD is bumpless on the both analog outputs - that is, the transfer occurs in a smooth manner rather than as an abrupt change. An icon on the display indicates the HOLD state, and the HOLD state is

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retained even if power is cycled. Press ENTER to initiate user entry mode, and entire value will flash. Use the UP arrow key to modify the desired value, selections are **ON** for engaging the HOLD function, and **OFF** to disengage the function. Press ENTER to store the new value.

The Set Hold function can also hold at an output value specified by the user. To customize the hold value, first turn the HOLD function on. Press the ESC key to go to the DIAG Menu and scroll to Sim Output using the UP arrow key. Press ENTER. Follow the instructions under Sim Output (see following page).

Fault List   The Fault List screen is a read-only screen that allows the user to display the cause of the highest priority failure. The screen indicates the number of faults present in the system and a message detailing the highest priority fault present. Note that some faults can result in multiple displayed failures due to the high number of internal tests occurring. As faults are corrected, they are immediately cleared.

Faults are not stored; therefore, they are immediately removed if power is cycled. If the problem causing the faults still exists, however, faults will be displayed again after power is re-applied and a period of time elapses during which the diagnostic system re-detects them.   The exception to this rule is the calibration failure. When a calibration fails, no corrupt data is stored. Therefore, the system continues to function normally on the data that was present before the calibration was attempted.

After 30 minutes or if power to the transmitter is cycled, the failure for calibration will be cleared until calibration is attempted again. If the problem still exists, the calibration failure will re-occur. Press ENTER to initiate view of the highest priority failure. The display will automatically return to normal after a few seconds.

Sim Out   The Sim Out function allows the user to simulate the chlorine level of the instrument in the user selected display range. The user enters a ppm value directly onto the screen, and the output responds as if it were actually receiving the signal from the sensor. This allows the user to check the function of attached monitoring equipment during set-up or troubleshooting. Escaping this screen returns the unit to normal operation. Press ENTER to initiate the user entry mode, and the right-most digit of the value will flash. Use arrow keys to modify desired value.

Auto-Off   Enables the automatic shut-off feature for the instrument. If ON, the instrument will automatically shut-off in 60 minutes after no keys are pressed to save power. With the external powered unit, this function should remain at **OFF.**

BackLight   The Back-light screen is used to set the operating conditions under which the backlight will turn on. The default is AUTO, which configures the light to come on whenever any key is pressed. The light will automatically shut off if no key is pressed for 30 seconds. Other selections are OFF (always off), AL for Alarm, where the light comes on in alarm condition and flashes under a Fail condition, and ON (always on).

Default All   The Default All function allows the user to return the instrument back to factory default data for all user settings. It is intended to be used as a last resort troubleshooting procedure. All user settings are returned to the original factory values. Hidden factory calibration data remains unchanged. Press ENTER to initiate user entry mode and the value **NO** will flash. Use the UP arrow key to modify value to **YES** and press ENTER to reload defaults.

Part 7 – Calibration

7.1 Chlorine Calibration

Once power is applied, the sensor must be given time to stabilize. This is best done by following the zeroing procedure below. Establishing a stable zero is critical to the proper operation of the monitor. A complete calibration will include zeroing and spanning the sensor. It is generally unnecessary to set the zero at every calibration; however, it should be done during the initial installation.

7.11 Chlorine Zero Cal

Chlorine sensors have extremely low offset currents at zero. For this reason, it is normally sufficient to simply leave the zero at the factory default of 0.0 nA. As an alternative, an electronic zero can be set by disconnecting the sensor from the cable and performing steps 1-5 below.

The steps below assume that the sensor has been prepared in accordance with section 5.1, Chlorine Sensor Assembly, earlier in this manual. Note that the 1 hour waiting time in step 2 below is not required if the monitor has been running for 24 hours prior to zeroing. If the unit has been running with the sensor connected, the sensor will normally return to a stable zero within 15 minutes.

1. Connect the sensor to the electronics by plugging the cable plug into the receptacle on the top of the sensor.

2. Place about an inch of water in a small beaker or other convenient container and immerse the tip of the sensor. The water used need not be distilled, but it must not contain residual chlorine. For submersible sensors, submerge the entire sensor in a bucket of unchlorinated water. Allow the sensor to sit undisturbed for at least 15 minutes (or 1 hour if sensor was recently powered).

3. Scroll to the CAL menu section using the MENU key and press ENTER or the UP arrow key. **Cal Chlor** will then be displayed.

4. Press the ENTER key. The screen will display a flashing **1-Ref** for span calibration or a **2-Zer** for zero calibration. Using the UP arrow key, set for a **2-Zer** zero calibration and press ENTER. The system now begins acquiring data for the sensor zero calibration value. As data is gathered, the units for sensor current in nanoamps (nA) and temperature may flash. Flashing units indicate that this parameter is unstable. The calibration data point acquisition will stop only when the data remains stable for a pre-determined amount of time. This can be overridden by pressing ENTER. If the data remains

unstable for 10 minutes, the calibration will fail and the message **Cal Unstable** will be displayed.

5. If accepted, the screen will display the message **PASS** with the new sensor zero reading (offset), then it will return to the main measurement display. If the calibration fails, a message indicating the cause of the failure will be displayed and the FAIL icon will be turned on. The range of acceptable value for sensor offset is -25 nA to +25 nA. Should a FAIL occur, carefully inspect the sensor for a tear in the membrane. It will probably be necessary to rebuild the sensor as described in section 5.1, Chlorine Sensor Assembly. Should the offset value remain high and result in calibration failures, review the Service section of this manual, and then contact the service dept. at ATI for further assistance.

The sensor zero offset value in nA from the last zero calibration is displayed on the lower line of the Default Menus for information purposes.

7.12   Chlorine Span Cal

Span calibration of the system must be done against a laboratory measurement on the same sample that the sensor is measuring. A sample should be collected from the inlet line feeding the flow cell and quickly analyzed for free chlorine. When calibrating a high range chlorine system, a sample with a concentration above 50 PPM is recommended. Use a suitable test kit to determine the actual chlorine calibration. Keep in mind that most high range chlorine test kits will produce results that are accurate only to about 5-10% of the measured value. The chlorine monitor should be calibrated while operating on a chlorinated sample stream in the flow cell assembly.

Follow the steps below to calibrate.

1. Place the sensor into the flow tee and allow sample to begin to flow past the sensor. During calibration, the chlorine concentration must remain stable. If necessary, collect a liter or two in a container and use a pump to circulate the sample through the tee and back to the sample container.

2. Allow the system to operate undisturbed for 15 minutes. Assuming the water contains chlorine, the display will be reading positive sensor current values. If the system is stable, the value on the display will increase to some PPM value and remain at that level. At that point, calibration can continue.

3. If the sensor is on-line, the user may want to set the output HOLD feature prior to calibration to lock out any output fluctuations.

4. Scroll to the CAL menu section using the MENU key and press ENTER or the UP arrow key. **Cal Cl$_2$** will then be displayed.

5. Press the ENTER key. The screen will display a flashing **1-Ref** for span calibration or a **2-Zer** for zero calibration. Using the UP arrow key, set for a **1-Ref** span calibration and press ENTER.

6. The system now begins acquiring data for the calibration value. As data is gathered, the units for ppm and temperature may flash. Flashing units indicate that this parameter is unstable. The calibration data point acquisition will stop only when the data remains stable for a pre-determined amount of time. This can be overridden by pressing ENTER. If the data remains unstable for 10 minutes, the calibration will fail and the message **Cal Unstable** will be displayed.

7. The screen will display the last measured ppm value and a message will be displayed prompting the user for the lab value. The user must then modify the screen value with the arrow keys and press ENTER. The system then performs the proper checks.

8. If accepted, the screen will display the message **PASS** with the new sensor slope reading, then it will return to the main measurement display. If the calibration fails, a message indicating the cause of the failure will be displayed and the FAIL icon will be turned on. The range of acceptable values for sensor slope is 20% to 500%. It may be necessary to rebuild the sensor as described in section 5.4, Chlorine Sensor Assembly. Should the slope value remain out of range and result in calibration failures, review the Service Section of this manual, then contact the service dept. at ATI for further assistance.

The sensor offset value in % from the last span calibration is displayed on the lower line of the Default Menus for information purposes.

7.2   Temperature Calibration

The temperature calibration sequence is essentially a 1-point offset calibration that allows adjustments of approximately ±5 °C.

The sensor temperature may be calibrated on line, or the sensor can be removed from the process and placed into a known solution temperature reference. In any case, it is critical that the sensor be allowed to reach temperature equilibrium with the solution in order to provide the highest accuracy. When moving the sensor between widely different temperature conditions, it may be necessary to allow the sensor to stabilize as much as one hour before the calibration sequence is initiated. If the sensor is on-line, the user may want to set the output HOLD feature prior to calibration to lock out any output fluctuations.

1. Scroll to the CAL menu section using the MENU key and press ENTER or the UP arrow key.

2. Press the UP arrow key until **Cal Temp** is displayed.

3. Press the ENTER key. The message **Place sensor in solution then press ENTER** will be displayed. Move the sensor into the calibration reference (if it hasn't been moved already) and wait for temperature equilibrium to be achieved. Press ENTER to begin the calibration sequence.

4. The calibration data gathering process will begin. The message **Wait** will flash as data is accumulated and analyzed. The **°C** or **°F** symbol may flash periodically if the reading is too unstable.

5. The message **Adjust value - press ENTER** will be displayed, and the right-most digit will begin to flash, indicating that the value can be modified. Using the UP and LEFT arrow keys, modify the value to the known ref solution temperature.   Adjustments up to ± 5°C from the factory calibrated temperature are allowed. Press ENTER.

Once completed, the display will indicate **PASS** or **FAIL**. If the unit fails, the temperature adjustment may be out of range, the sensor may not have achieved complete temperature equilibrium, or there may be a problem with the temperature element. In the event of calibration failure, it is recommended to attempt the calibration again immediately.

7.3   pH Calibration

The pH calibration menus will not be seen unless the optional pH sensor input is turned ON and a special pH sensor is connected to the input of the instrument. See section 6.24 – pH Input for more details.

The pH calibration functions appear in the CAL menu listing when the optional pH input is enabled in the CONFIG menu. When enabled, the pH input signal is used to compensate the free chlorine signal. Calibration of pH is performed in one of two methods; one-point or two-point. For new sensors or for calibration in two different pH buffers with the sensor removed from the process, choose a two-point calibration. For on-line calibrations with the sensor still mounted in the process, choose a one-point calibration. For two-point calibrations, it is highly recommended to use fresh pH buffers of 4 pH and 7 pH, or 7 pH and 9.18 pH.

The conductivity difference between the process water and the sensor reference solution can cause an effect called a "junction potential". The junction material of the pH sensor is porous ceramic, which allows the sensor reference solution to be in electrical continuity with the process solution. One problem is caused by the reference junction and the diffusion rate of the electrolyte through the junction

material. The inside surface of the junction material is in contact with the reference cell solution, which has a very high ionic strength. The outside surface of the junction material is in contact with the process water, which can have low ionic strength. This concentration gradient creates what is called a "junction potential" which can vary with the flow rate of the process. The magnitude of this potential can be upwards of 30 mV (half a pH unit). The lower the conductivity of the water the larger the effect.

It is not possible to eliminate this effect; however it usually is constant or very slow changing.

A full calibration of the pH sensor consists of an initial 2-point calibration in buffers. This sets the slope and zero offset of the sensor. The sensor should then be left in the process water for enough time for the system to fully stabilize to process conditions. This may take up to a few hours, depending on process conditions. A 1-point calibration must then be carried out. The ideal way to do this is by calibrating to a laboratory sample. After the 1-point calibration only the zero offset will have changed.

Routine calibration of the pH sensor is a 1point calibration.

7.31 Two-Point pH Cal

1. Thoroughly clean the pH sensor and place it into the first pH calibration buffer, stirring is several times before letting it rest in the beaker. Allow sensor to sit in solution long enough to achieve temperature equilibrium with the pH buffer (maybe 5 minutes.) It is important that both pH buffers be fresh and at room temperature.

2. Scroll to the CAL menu section using the MENU key and press ENTER or the UP arrow key.

3. Press the UP arrow key until **Cal pH Type** is displayed.

4. Press the ENTER key. The display will begin to flash. Using the UP arrow key, adjust the displayed number to a **2** pt calibration type. This will allow the user to offset+slope adjust the sensor input for two separate pH point. Once value has been adjusted, press the ENTER key and the message **Accepted!** will be displayed.

5. Scroll to the next menu item by pressing the UP arrow key once. The menu item **Cal pH buf1** will be displayed.

6. Press the ENTER key. The display will begin to flash. Using the UP and LEFT arrow keys, adjust the displayed number to the known value of the pH buffer. The exact temperature compensated number for pH buffers is typically written on the side of the buffers shipping container. Once value has been adjusted, press the ENTER key.

7. The message **Accepted!** will be displayed, or an error describing the cause the failure. If the cal point was accepted, rinse the sensor in distilled or de-ionized water and move it into the second pH buffer. Stir it slightly several times and let the sensor rest in the beaker.

8. Scroll to the next menu item by pressing the UP arrow key once. The menu item **Cal pH buf2** will be displayed.

9. Press the ENTER key. The display will begin to flash. Using the UP and LEFT arrow keys, adjust the displayed number to the known value of the second (higher or lower value) pH buffer. Once value has been adjusted, press the ENTER key.

10. The message **Accepted!** will be displayed, or an error describing the cause the failure. The system is now two-point calibrated for pH.

7.32   One-Point pH Cal

1. For this calibration method, the sensor may be removed, cleaned, and placed into a known pH buffer, or, it may be calibrated on-line against a known reference value. If the sensor is removed, thoroughly clean the pH sensor and place it into the pH calibration buffer, stirring is several times before letting it rest in the beaker. Allow sensor to sit in solution long enough to achieve temperature equilibrium with the pH buffer (maybe 5 minutes.) It is important that the pH buffer be fresh and at room temperature.

2. Scroll to the CAL menu section using the MENU key and press ENTER or the UP arrow key.

3. Press the UP arrow key until **Cal pH Type** is displayed.

    Press the ENTER key. The display will begin to flash. Using the UP arrow key, adjust the displayed number to a **1** pt calibration type. This will allow the user to offset-adjust the sensor input for one pH point. Once value has been adjusted, press the ENTER key and the message **Accepted!** will be displayed.

4. Scroll to the next menu item by pressing the UP arrow key once. The menu item **Cal pH buf1** will be displayed.

5. Press the ENTER key. The display will begin to flash. Using the UP and LEFT arrow keys, adjust the displayed number to the known value of the pH buffer. If the sensor is till mounted in the process, enter the known reference value. The exact temperature compensated number for pH buffers is typically written on the side of the buffers shipping container. Once value has been adjusted, press the ENTER key.

6. The message **Accepted!** will be displayed, or an error describing the cause the failure. The system is now two-point calibrated for pH.

7.4 Adjusting pH Compensation Curve

If the pH input is ON and the pH Comp feature is enabled (see section 6.23), then the chlorine reading will be automatically adjusted for changes in the pH measurement. In general, chlorine readings will fall as the pH increases from 7-10 pH, and the automatic compensation feature allows a relatively constant reading to be maintained without the use of pumps and reagents.   Under most conditions, all that is required to use this feature is to enable it and calibrate all sensors. The change in readings with pH changes are fairly small in the pH 7-8 range, but become more pronounced at high pH values.   The default pH correction curve in the monitor is suitable for a high percentage of applications.

Years of experience have shown that the pH compensation curve is not identical in all applications. As mentioned previously, most are close to default values, but some waters exhibit curves that are significantly different. ATI Q45H/62 free chlorine monitors with software revision 4.05 and higher provide a unique method of adjusting the pH compensation curve to fit special situations.

7.41 Modifying pH Correction Values

There are actually two standard pH correction curves stored in the monitor as shown in Figure 17. Each curve is based on a table of 8 values. Each table entry is a pH value and an associated multiplier. The Lo Gain table is the default correction curve loaded at the factory.

pH	Lo Gain	Hi Gain	Modifications
6.55	0.950	0.950	
7.05	1.000	1.000	
7.55	1.110	1.150	
8.05	1.315	1.450	
8.55	1.770	2.100	
9.05	2.540	3.200	
9.55	4.850	6.500	
10.05	7.300	9.999	

Figure 17 - pH Modification Table

Access to the menu that allows editing of correction factors is hidden. Accidental adjustment of these values can cause large measurement errors, and editing of this data should only be done by those who thoroughly understand the impact of the changes they are making. The edit menu will not normally appear when operators are scrolling through standard menu items.

To access the table editing routines, first go to the CONFIG menu and use the Up arrow to move down to the "pH Comp" selection screen. With the display indicating pH COMP on the bottom line, press and hold the left arrow key for approximately 5 seconds. The display will change to "Edit Table".

From this point on, you have access to 4 menus that allow for adjustment of the pH curve. They are **Edit Table, Load Table, Bkup Table, and AC Go.**

Edit Table: This routine allows you to change the multiplier applied to the chlorine measurement at various pH values. Use the Up arrow to review the current table values. Pressing the Up key will sequence through each of 8 pH values and the corresponding multiplier. Generally, only the multipliers at high pH will ever need adjustment, and then only rarely. If you find the monitor is over correcting, calculate the percentage of over-correction and reduce the multiplier by that percentage. If under-correcting, increase the multiplier.

Load Table: This routine allows the user to load one of two standard tables into the system. One is referred to a Lo-Gain.   This table applies smaller multipliers to high pH situations and is often used for very low conductivity water. The Hi-Gain choice applies to applications where the pH dependence is much steeper at pH values above 9. The Lo-Gain table is the factory default and is loaded when your first install your monitor. Actually editing data

by using the Edit Table routine requires careful testing and calculations.

Bkup Table: This routine allows the user to store an edited table or the table selected in the Load Table routine as the "Default" table. This should always be done if a change is made. If you do not store an edited table as the default, your changes could be lost. Press enter and you will be prompted for either a No or a Yes. Always answer Yes when a new table has been calculated to protect your work. The factory default is the Lo-Gain table, which is stored in the Backup Table location.

AC Go: This routine refers to "Auto Calculate". This routine allows an operator to circulate water with a constant chlorine value through the system, changing the pH and storing the calculated pH correction value under dynamic conditions. This routine should be used with care, and we suggest you consult an ATI technician before attempting this routine. Detailed instructions are available from ATI for using this feature, but only by request.
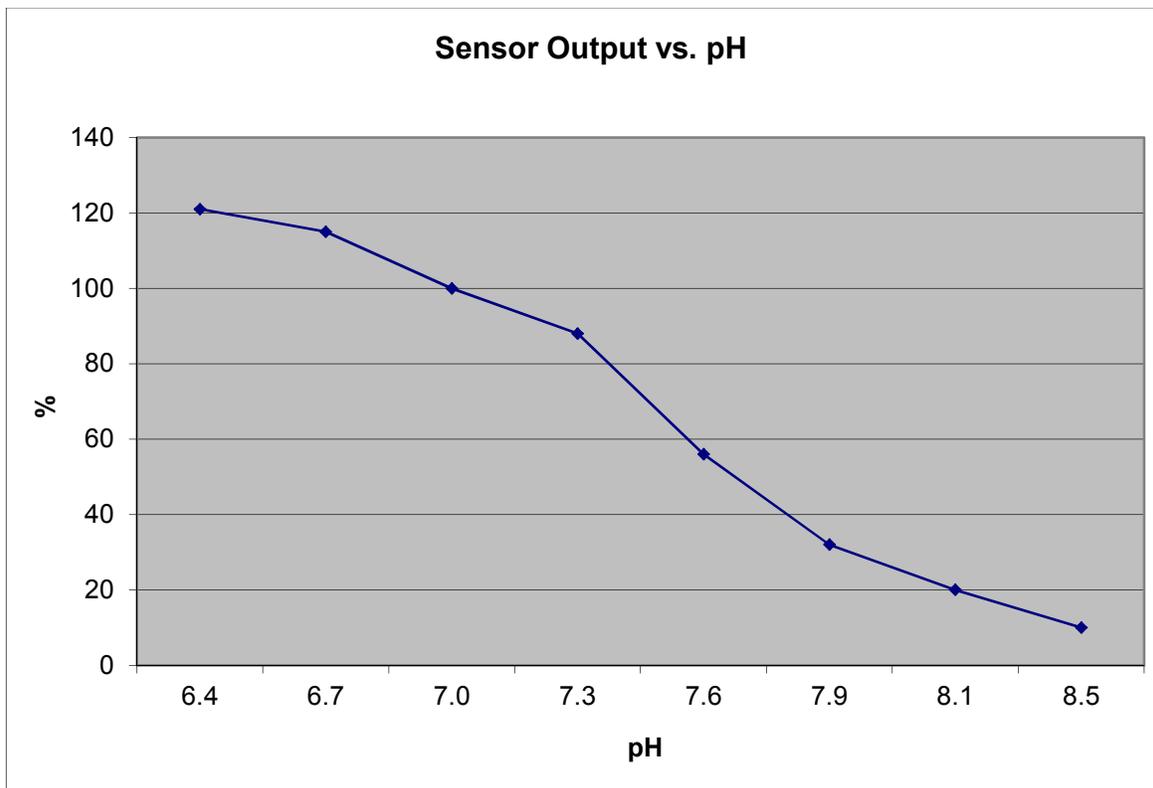

Figure 18 - Typical Chlorine Response to Change in pH

7.42   pH Correction – Table Modification Example

In unusual applications where sample pH can vary widely, and especially when pH values can run in the 8-10 range, default pH correction factors may not fit every application. Assume for this example that you are running a free chlorine residual of 2.0 PPM and your pH is around 8.0 but occasionally spikes up to 9.5 for short periods. The chlorine monitor correctly reads 2.0 at pH 8, but the value drops to 1.7 when the pH gets to 9.5. While not a major error, it does indicate that the pH correction multiplier applied at the 9.5 pH level is slightly lower than is needed for your application.

In order to fine tune the pH correction, you must increase the multiplier factor used at the high pH values. This can be done by editing the pH correction table. Go to the Config Menu and use the up key to move to the "pH Comp" selection. Press and hold the left arrow key for 5 seconds. The bottom line will change to "Edit Table" and the large display will indicate a pH of 6.55 (assuming the default table is running). Press the Enter key and the pH value will begin to flash. If you press the up key once you will see the multiplier for pH 6.55. Continuing to press the up key will go through each pH value and the multiplier associated with it.

When you reach the pH value of 9.55, pressing the key will display a multiplier of 4.850, again assuming no changes have been made previously.   You can calculate your new multiplier value by calculating how much added multiplier is needed to get to the correct chlorine value. In this case:

>   Actual Chlorine = 2.00 PPM
>   Displayed Chlorine = 1.70 PPM

Calculate Deviation % by dividing the difference in values, which is -.30PPM by 2.00 PPM. This is equal to -15% deviation. To correct for a negative deviation of 15%, you must increase the multiplier by the same amount.

The new multiplier then is 4.850 x 1.15 = 5.577.

With the original 4.850 multiplier on the display, press enter and the value will flash. Use the up key to change each digit and the left key to move from digit to digit. When done, press enter.

In this example, you have now changed your 9.55 multiplier, but the multipliers at 8.55 and 9.05 are still unchanged. If you assume that this roughly 15% under compensation is about the same above pH 8, you can go back and also increase these two multipliers by 15% as well. Since the unit is accurate at pH 8, do not change that value or any of the multipliers at lower pH values.

7.43 Storing Modified Table

If you modify the pH correction table, it is very important that you store this table properly so that it can be recovered. It would also be a good idea to write down you modified values in the blank column on page 46. Storing your modified table in the Backup Table memory location allows you to reload your edited table in the event that the table in the instrument becomes corrupted in some way. We call this the happy fingers recovery routine.

Once you have finished all modifications, press the menu key to return to the beginning of the "Edit Table" selection. Press the up key twice and "Bkup Table" will be displayed, with NO on the main screen. Press enter and use the up key to change the NO to YES, then press Enter. Your edited table is now the default running table. The changes you made to the edited table will also be saved if you turn power off or perform a Default All or Default Cal reset. However, if the edited table is somehow changed, you can always go to the Load Table routine and restore your edited table if necessary.

Part 8 – System Maintenance

8.1 General

The Q45H/62HR Chlorine System will generally provide unattended operation over long periods of time. With proper care, the system should continue to provide measurements indefinitely. For reliable operation, maintenance on the system must be done on a regular schedule. Keep in mind that preventive maintenance on a regular schedule is much less troublesome than emergency maintenance that always seems to come at the wrong time.

8.2 Analyzer Maintenance

No unusual maintenance of the analyzer is required if installed according to the guidelines of this operating manual. If the enclosure door is frequently opened and closed, it would be wise to periodically inspect the enclosure sealing gasket for breaks or tears.

8.3 Sensor Maintenance

Sensor maintenance is required for accurate measurements. The primary requirement is simply to keep the sensor membrane clean. The membrane is a micro-porous polymer that is resistant to anything that will be encountered in water streams. However, deposits can form on the surface or in the pores of the membrane, and these deposits will reduce the sensitivity. Certain constituents in water, mainly iron and manganese, will for precipitates when the water is chlorinated. These precipitates can sometimes form a coating on the membrane.

Because membranes are micro-porous, they can be relatively difficult to clean effectively. Immersing the tip of the sensor in 1N nitric acid solution will sometimes remove deposits that cause low sensitivity, but this is not always the case. The recommended practice is to simply replace the membrane when it becomes fouled. To change a membrane, follow the Sensor Assembly procedure (in section 5.1) of this manual. Do not reuse the electrolyte from the sensor when changing a membrane. Always refill with fresh electrolyte. The electrolyte is stable and does not have a limited shelf life.

Refer again to the explanation of the sensor slope number after an accepted span calibration on the lower MEASURE screen. In normal operation, the slope of the sensor output will decrease over time as the membrane becomes fouled. This reduction indicates that the sensor is losing sensitivity to chlorine. It is good practice to replace the membrane if the slope number falls to 30-40%. The value will not go below 20%.

Even if no buildup is apparent on the membrane, it should be changed on a regular schedule. The recommended membrane change interval is every 3 months. For high purity water applications, this can probably be extended if desired, but a more frequent changing interval is a small price to pay for avoiding membrane failure at the wrong time.

While the sensor is disassembled for membrane changing, examine the condition of the o-rings on both ends of the electrolyte chamber. If the o-rings show any signs of damage, replace them with new ones from the spare parts kit. It is good practice to change these o-rings once a year, regardless of their condition.

8.4   Sensor Acid Cleaning

Over an extended operating period, chlorine sensors can slowly accumulate deposits on the surface of the platinum electrode. Typically, this type of buildup occurs over years of operation, but can sometimes occur more quickly in high levels of manganese, iron, or other metals are dissolved in the water. The platinum electrode can be "acid cleaned" using nitric acid solutions.

> # WARNING
>
> **THIS ACID CLEANING PROCEDURE INVOLVES THE USE OF HIGHLY CORROSIVE ACID SOLUTIONS. IT SHOULD ONLY BE COMPLETED BY TRAINED PERSONNEL USING PROTECTIVE EYEWEAR AND GLOVES. IF THERE IS ANY DOUBT ABOUT YOUR ABILITY TO SAFELY ACCOMPLISH THIS PROCEDURE, RETURN THE SENSOR TO ATI FOR FACTORY CLEANING!**

To acid clean the electrode assembly, remove the electrolyte chamber from the sensor so that the so that both electrodes are exposed. Then follow the procedure below.

1. Place a small amount of 50% nitric acid solution in a beaker. Put in just enough so that the gold tip of the sensor can be submerged without any contact with the silver coil just above the tip.

2. Allow the sensor to soak in this acid solution for 2 minutes. Remove the sensor body and rinse the gold tip thoroughly with distilled water. Discard the nitric acid safely and according to all environmental regulations.

3. Fill the beaker with distilled water to the level sufficient to submerge both the tip and the silver coil. Do not allow the connector at the back of the sensor to be submerged. Allow the electrodes to soak in distilled water for 30 minutes.

4. Put a new membrane and fresh electrolyte in the electrolyte chamber and reassemble the sensor. Connect to the chlorine monitor electronics and allow the sensor to stabilize for at least 24 hours. The sensor can be placed in the flow cell with chlorinated water running through it during stabilization. However, the readings will not be useful for 24 hours.

8.5   Flow Cell Maintenance

The maintenance on the flow cell is simple cleaning. The flow cell is clear to make examination of the condition of the sensor easier without interfering with operations.   The flow cell may be cleaned by wiping or by washing with detergents or dilute acids. Do not try to clean with solvents as the acrylic may craze or crack.

Part 9 – Troubleshooting

9.1 General

The information included in this section is intended to be used in an attempt to quickly resolve an operational problem with the system. During any troubleshooting process, it will save the most time if the operator can first determine if the problem is related to the analyzer, sensor, or some external source. Therefore, this section is organized from the approach of excluding any likely external sources, isolating the analyzer, and finally isolating the sensor. If these procedures still do not resolve the operational problems, any results the operator may have noted here will be very helpful when discussing the problem with the factory technical support group.

9.2 External Sources of Problems

To begin this process, review the connections of the system to all external connections.

1. Verify the analyzer is earth grounded. For all configurations of the analyzer, an earth ground connection MUST be present for the shielding systems in the electronics to be active. Grounded conduit provides no earth connection to the plastic enclosure, so an earth ground wiring connection must be made at the power input terminal strip. Verify metal shield is present over incoming power connections. This shield is for safety purposes, but also blocks electrical spikes from relay and power wiring.

2. Verify the proper power input is present (5-17 VDC).

3. Verify the loads on any 4-20 mA outputs do not exceed the limits in the Instrument Specifications. During troubleshooting, it is many times helpful to disconnect all these outputs and place wire-shorts across the terminals in the instrument to isolate the system and evaluate any problems which may be coming down the analog output connections.

4. Do not run sensor cables or analog output wiring in the same conduits as power wiring. If low voltage signal cables must come near power wiring, cross them at 90° to minimize coupling.

5. If rigid conduit has been run directly to the Q45 enclosure, check for signs that moisture has followed conduit into the enclosure.

6. Check for ground loops. Although the membrane sensor is electrically isolated from the process water, high frequency sources of electrical noise may still cause erratic behavior in extreme conditions. If readings are very erratic after wiring has been checked, check for a possible AC ground loop by temporarily disconnecting feed and drain lines from the flow cell while there is still water on the inside. The reading should be initially stable and then fall very slowly in a smooth fashion as chlorine is depleted in the static sample.

7. Carefully examine any junction box connections for loose wiring or bad wire stripping. If possible, connect the sensor directly to the analyzer for testing.

8. Check sensor membrane for fouling. Look closely for signs of grease or oil which may be present. Replace membrane and electrolyte, allow to stabilize, and re-check. The procedure in Chlorine Sensor Assembly, (in section 5.1), must be followed when replacing the membrane.

9. Check pH of water sample. High pH conditions can cause low sensitivity. If pH is above 8.2, contact ATI for information on carbon dioxide buffer systems.

10. Check to see that the chlorine in the water is free chlorine and not combined chlorine. The free chlorine sensor has almost no sensitivity to monochloramine.

9.3   Analyzer Tests

1. Disconnect power and completely disconnect all output wiring coming from the analyzer. Remove sensor wiring, relay wiring, and analog output wiring. Re-apply power to the analyzer.

2. Using the Simulate feature, check operation of analog outputs and relays with a DMM.

3. Check cell drive circuit. With a digital voltmeter (DVM), measure the voltage between terminals ORANGE and BLUE on the back of the monitor to verify that the millivolt value is actually -200 mV.

4. Check TC drive circuit. Place a wire-short between the GREEN and BLACK terminals. With a digital voltmeter (DVM), measure the voltage between the BLACK and RED terminals on the back of the monitor to verify that the TC drive circuit is producing about 4.8-5.1 VDC open circuit. Remove DVM completely and connect a 100 Ohm resistor from the BLACK to RED terminals. The temperature reading should display approximately 0°C and the chlorine reading should display approximately 0 ppm.

9.4   Display Messages

The Q45 Series instruments provide a number of diagnostic messages which indicate problems during normal operation and calibration. These messages appear as prompts on the secondary line of the display or as items on the Fault List.

MESSAGE	DESCRIPTION	POSSIBLE CORRECTION
Max is 200	Entry failed, maximum user value allowed is 200.	Reduce value to ≤ 200
Min is 200	Entry failed, minimum value allowed is 200.	Increase value to ≥ 200
Cal Unstable	Calibration problem, data too unstable to calibrate. Icons will not stop flashing if data is too unstable. User can bypass by pressing ENTER.	Clean sensor, get fresh cal solutions, allow temperature and conductivity readings to fully stabilize, do not handle sensor or cable during calibration.
Out of Range	Input value is outside selected range of the specific list item being configured.	Check manual for limits of the function to be configured.
Locked!	Transmitter security setting is locked.	Enter security code to allow modifications to settings.
Unlocked!	Transmitter security has just been unlocked.	Displayed just after security code has been entered.
Offset High	The sensor zero offset point is out of the acceptable range of -20 to +20 nA.	Check wiring connections to sensor. Allow sensor to operate powered a minimum of 12 hours prior to first zero cal.
Sensor High	The raw signal from the sensor is too high and out of instrument range.	Check wiring connections to sensor.
Sensor Low	The raw signal from the sensor is too low.	Check wiring connections to sensor.
Chlor High	The chlorine reading is greater than the maximum of the User-selected range.	The chlorine reading is over operating limits. Set measuring range to the next highest level.
Temp High	The temperature reading is > 55ºC.	The temperature reading is over operating limits. Check wiring and expected temp level. Perform RTD test as described in sensor manual. Recalibrate sensor temperature element if necessary.
Temp Low	The temperature reading is < -10 ºC	Same as "Temp High" above.
TC Error	TC may be open or shorted.	Check sensor wiring and perform RTD test as described in sensor manual. Check j-box connections.

Figure 19 - Q45H Display Messages

MESSAGE	DESCRIPTION	POSSIBLE CORRECTION
Chlor Cal Fail	Failure of chlorine calibration. FAIL icon will not extinguish until successful calibration has been performed, or 30 minutes passes with no keys being pressed.	Clean sensor redo zero and span calibration. If still failure, sensor slope may be less than 25% or greater than 250%. Perform sensor tests as described in section 9.5. Replace sensor if still failure.
TC Cal Fail	Failure of temperature calibration. FAIL icon will not extinguish until successful calibration has been performed, or 30 minutes passes with no keys being pressed.	Clean sensor, check cal solution temperature and repeat sensor temp calibration. TC calibration function only allows adjustments of +/- 6 ºC. If still failure, perform sensor tests as described in section 9.5. Replace sensor if still failure. .
EPROM Fail	Internal nonvolatile memory failure	System failure, consult factory.
Chcksum Fail	Internal software storage error.	System failure, consult factory.
Display Fail	Internal display driver fail.	System failure, consult factory.
Range Cal Fail	Failure of factory temperature calibration.	Consult factory.

Figure 20 - Q45H Display Messages Cont'd

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9.5   Sensor Tests

1. Check the membrane condition. A membrane that is not stretched smoothly across the tip of the sensor will cause unstable measurements. If necessary, change membrane and electrolyte.

2. Check the sample pH. High range chlorine sensors will not perform properly if the pH exceeds 8.0. It is preferable for the pH to be between 6.5 and 7.5, and be stable within +/- 0.2 pH.

3. Residual chlorine sensors can be tested with a digital voltmeter (DVM) to determine if a major sensor problem exists. Follow the steps below to verify sensor integrity:

    A. Disconnect the five sensor wires from the back of the chlorine monitor. Those wires are color coded white, brown, red, black, and green. Note that the brown wire may be replaced with an orange wire in some cables.

    B. Remove the electrolyte chamber from the sensor and dry the electrodes with a paper towel.

    C. Connect a DVM between the white and brown (or orange) wires. Reading resistance, you should find an open circuit value of infinite resistance. There must be no measurable resistance at all between these wires. Any resistance at all indicates either water in the cable connector or the breakdown in an electrode seal.

    D. Connect a DVM between the red and white wires. The red wire is part of the RTD circuit and the white wire is part of the measuring cell. There should be no connection. Reading resistance, you should find an open circuit value of infinite resistance. Any resistance at all indicates either water in the cable connector or the breakdown in an electrode seal.

    E. Connect the DVM between the red and black wires. These are the RTD leads, and you should find a resistance value that depends on the temperature. The table below lists the resistance values for various temperatures. Reading resistance between the red and green wires should give exactly the same values as between red and black.

Temperature °C	Resistance Ω
0	100.0
5	101.9
10	103.9
15	105.8
20	107.8
25	109.7
30	111.7
35	113.6
40	115.5
45	117.5
50	119.4

Figure 21 - Pt100 RTD Table

If you suspect that water has gotten into a cable connection on a flow type sensor or into the plug connection of a submersible sensor, disconnect the cable and allow the parts of the sensor to sit in a warm place for 24 hours. If water in the connector is the problem, it should dry out sufficiently to allow normal sensor operation. However, steps 4 and 5 above will have to be repeated after drying to see if the problem is gone.

4. Acid clean the sensor electrodes in accordance with the procedure on the previous page.

Spare Parts

Part No.	Description
Spare Electronics	
07-0308	Electronics assembly, External Power
03-0376	Q45H-62HR Front Lid Assy
03-0361	External Power PCB Assembly
Spare Sensors	
00-1471	Chlorine sensor, flow type, high range
63-0101	pH Sensor
Spare Sensor Components	
02-0217	Sensing element body, (for #00-1471)
03-0029	Sensor interconnect cable with connector, 25 ft.
45-0236	Electrolyte chamber
45-0149	Membrane holder, PEEK
05-0074*	Membranes, pkg. of 10
05-0076*	Spare Parts Kit for 00-1471 sensor
09-0011*	Free chlorine electrolyte, 4 oz (120 cc)
Flowcells	
00-1596	Sealed Flowcell Assembly
Misc Components	
07-0100	Junction box
31-0038	Interconnect cable for junction box to monitor wiring
05-0110	Sealed Flowcell Vacuum Breaker

Note: Instrument is supplied with sufficient spare parts for 6-12 months of operation. For 2 year spare parts inventory, 3 each of the items marked with an asterisk are required.

Lock/Unlock Code: 1456