Model Q45P

pH Monitor/Analyzer

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PRODUCT WARRANTY

Analytical Technology, Inc. (Manufacturer) warrants to the Customer that if any part(s) of the Manufacturer's products 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, except oxygen sensors, are covered by this warranty, but are subject to inspection for evidence of extended exposure to excessive gas concentrations. Should inspection indicate that sensors have been expended rather than failed prematurely, 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 Q45P pH monitor/analyzer provides an extremely versatile measurement system for monitoring and control of pH over the range of 0.00 to 14.00 pH. The instrument is offered standard as a loop-powered transmitter for 2-wire DC applications. Since this system configuration operates over only two low-voltage wires, it is ideal for remote monitoring applications where line power is either unavailable or prohibitively expensive to run

With the optional 115/230 VAC power supply, the instrument may also be configured for AC operation. This configuration is ideal when line power is located close to the point of installation, and dual relay outputs and two 4-20 mA outputs (one for pH and one for temperature) are required.

An optional battery card is available that converts the instrument into a robust, portable measurement system that operates on one 9 VDC battery. In this configuration, all of the standard features of the basic 2-wire transmitter are functional with the exception that the instrument has two voltage output. The 9 V unit is available either with or without a built-in data logger. Since this system utilizes the same high performance Q25 sensor as the standard configurations, it is a very robust portable monitoring system. It can be used on its own, or it can be used with other permanently installed Q45 continuous monitoring systems to simplify calibration by using the calibrate-by-reference method.

In all configurations, the Q45P displays pH, sensor temperature, sensor output millivolts, and output loop current on the secondary line of the custom display. The instrument may be used with either the high performance Q25 series sensors or with combination-style electrodes.

WARNING: Not following operating instructions may impair safety.

NOTE: Due to the high degree of flexibility of the Q45 system options, it is important to note areas of the operating manual that detail these optional features. The software features for the relay output option and battery option only appear when those modules are connected and the system has been re-powered.

1.2 Features

- Standard Q45P electronic transmitters are designed to be a fully isolated, loop powered instruments for 2-wire DC applications. Optional integral power supply card for 115/230 VAC operation, and optional battery power supply card for portable datalogging applications are available.

- 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.

- AC power option provides dual SPDT relay operation and one additional isolated analog output. Software settings for relay control include setpoint, deadband, phase, delay, and failsafe. Software controls automatically appear in menu list when hardware option card is plugged in and system power is applied.

- Two analog outputs on the relay version may be configured to track pH and temperature. Both analog outputs can be individually programmed to fail to specific values.

- Selectable Output Fail Alarm feature allows system diagnostic failures to be sent to external monitoring systems.

- Selectable Probe Timer feature on Relay B allows connection of probe cleaner hardware or other accessories that require timed periodic relay contacts.

- Large, high contrast, custom Super-Twist display provides excellent readability even in low 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.

- Sensor diagnostics monitor glass breakage, sensor leaks, and RTD condition. 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 two-point and sample calibration methods include auto-buffer recognition from 13 built-in buffer tables. To provide high accuracy, all calibration methods include stability monitors that check temperature and main parameter stability before accepting data.

- Selectable Pt1000 or Pt100 temperature inputs. Systems can also be hard-configured for three-wire elements. 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.

- High reliability, microprocessor-based system with non-volatile memory back-up that utilizes no batteries. Low mass, surface mount PCB construction containing no adjustment potentiometers. All factory calibrations stored in non-volatile EEPROM.

1.3 Q45P System Specifications

(Common to all variations)

Enclosure	NEMA 4X, polycarbonate, stainless steel hardware, weatherproof and corrosion resistant, HWD: 4.4" (112 mm) × 4.4" (112 mm) × 3.5" (89 mm)
Mounting Options	Wall, panel, pipe/header.
Weight	DC transmitter configuration: 1 lb. (0.45 kg) Line-powered unit: 1.5 lb. (0.68 kg)
Display	Large, high-contrast, Super-Twist (STN) LCD; 4-digit main display with sign, 0.75" (19.1 mm) seven-segment characters; 12-digit secondary display, 0.3" (7.6 mm) 5×7 dot matrix characters
Keypad	4-key membrane type with tactile feedback, polycarbonate with UV coating, integral EMI/static shield and conductively coated window
Ambient Temperature	Service, -20 to 60 °C (-4 to 140 ºF) Storage, -30 to 70 °C (-22 to 158 ºF)
Ambient Humidity	0 to 95%, indoor/outdoor use, non-condensing to rated ambient temperature range
Electrical Certification	Ordinary Location, cCSAus (CSA and UL standards - both approved by CSA), 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	Selectable Pt1000 or Pt100 RTD with automatic compensation
Displayed Parameters	Main input, 0.00 to 14.00 pH Sensor temperature, -10.0 to 110.0 °C (14 to 230ºF) Loop current, 4.00 to 20.00 mA Sensor slope/offset Model number and software version
Main Parameter Ranges	0.00 to 14.00 pH

(NOT common to all variations)

Standard 2-Wire (Loop-powered) Transmitter:

Power	16-35 VDC (2-wire device)
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
Insertion Loss	16 VDC

115/230 VAC + Dual Relay Option:

Power	115/230 VAC ± 10%, 50/60 Hz, 10 VA max
Enclosure, AC Powered	NEMA 4X, polycarbonate, stainless steel hardware, weatherproof and corrosion resistant, HWD: 4.9" (124 mm) x 4.9" (124 mm) x 5.5" (139 mm)
Mounting Options	Wall or pipe mount bracket standard. Bracket suitable for either 1.5" or 2" I.D. U-Bolts for pipe mounting. Panel mount adapter optional.
Conduit Openings	Three ½" NPT openings. Gland seals supplied but not installed.
Relays, Electromechanical:	Two SPDT, 6 amp @ 250 VAC, 5 amp @ 24 VDC contacts. Software selection for setpoint, phase, delay, deadband, hi-lo alarm, and failsafe. A-B indicators on main LCD.
Analog Outputs	Two 4-20 mA outputs. Output one programmable for pH. Output 2 programmable for Temperature or pH. Max load 550 Ohms for each output. Outputs ground isolated and isolated from each other.

1.4 Q45P Performance Specifications

(Common to all variations)

Input Impedance	Greater than 10^{13} Ohms
Accuracy	0.1% of span or better (± 0.01 pH)
Repeatability	0.1% of span or better (± 0.01 pH)
Sensitivity	0.05% of span (± 0.01 pH)
Stability	0.05% of span per 24 hours, non-cumulative (± 0.007 pH)
Warm-up Time	7 seconds to rated performance
Supply Voltage Effects	± 0.05% span
Instrument Response Time	6 seconds to 90% of step input at lowest setting
Temperature Drift	Span or zero, 0.02% of span/°C
Max. Sensor-Instrument Distance	3,000 ft. (914 meters) w/ preamp, 30 ft. (9.1 meters) w/o preamp
Sensor Types	Model Q25P pH w/ preamp - 5 wire input, or combination style pH electrode w/ TC - 2 wire input

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 standard cable length of the pH sensor is 15 feet. For sensor cables longer than 30 feet, use the optional junction box (07-0100) and sensor interconnect cable (31-0057).

Due to the flexibility of the instrument design, some of the mounting features change based on the configuration that was ordered. For example, the 2-wire transmitter version is different for the 115/230 VAC controller because the rear of the enclosure is much deeper when the AC powered unit is used. In addition, the AC powered unit has an integrated panel mount flange requiring a single cutout for flush mounting. In the 2-wire transmitter configuration, just the front of the enclosure can be mounted, but the cutout also requires accurate location of 4 mounting holes. Refer to Figures 2-1 and 2-2 for detailed dimensions of each type of system.

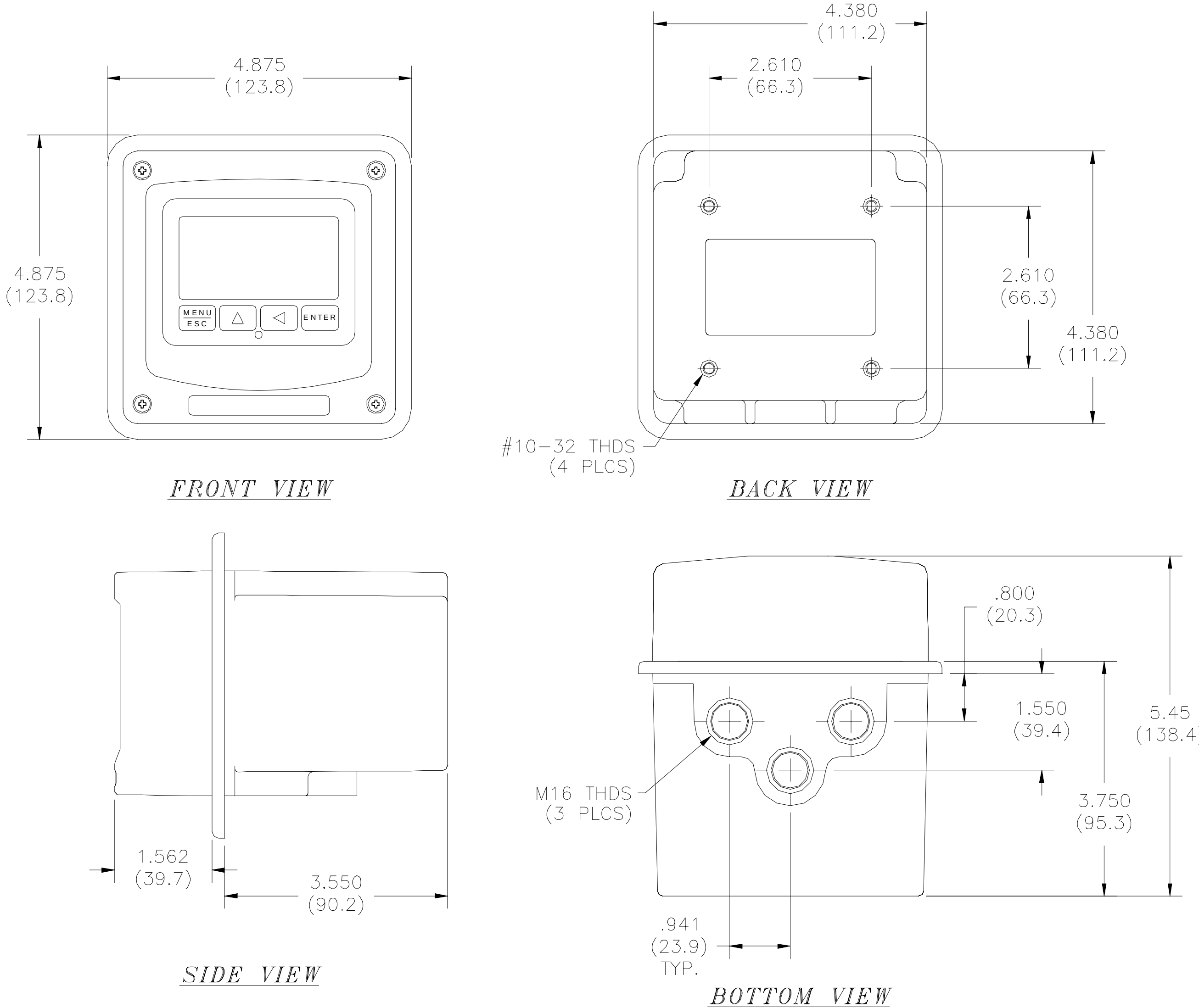


Figure 2-1 Q45 Enclosure Dimensions, AC Powered Units (ATI-0706)

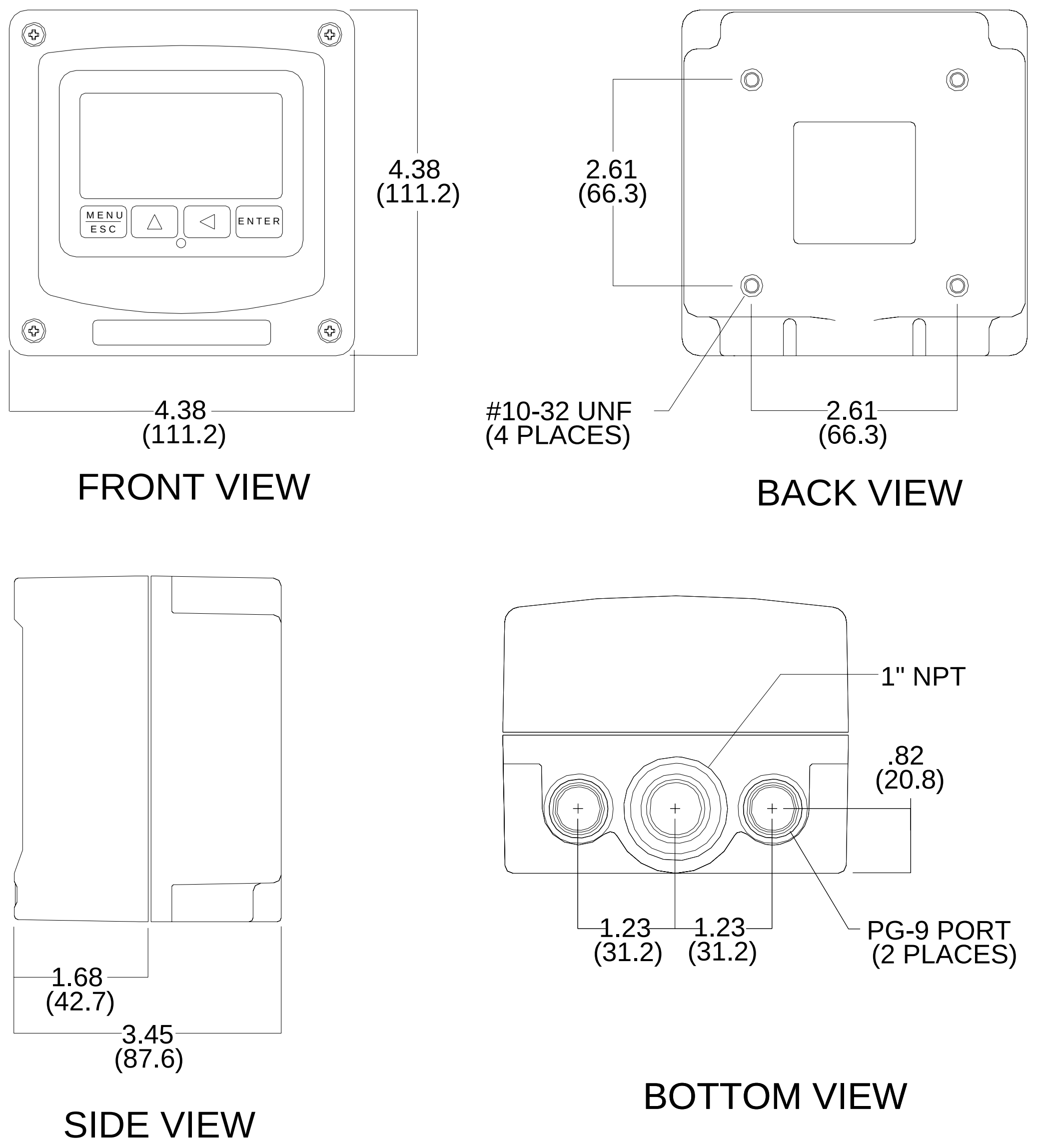


Figure 2-2 Q45 Enclosure Dimensions, 2-Wire and Battery Units (ATI-0655)

2.2 Wall or Pipe Mount

A PVC mounting bracket with attachment screws is supplied with each transmitter (see Figure 2-3 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

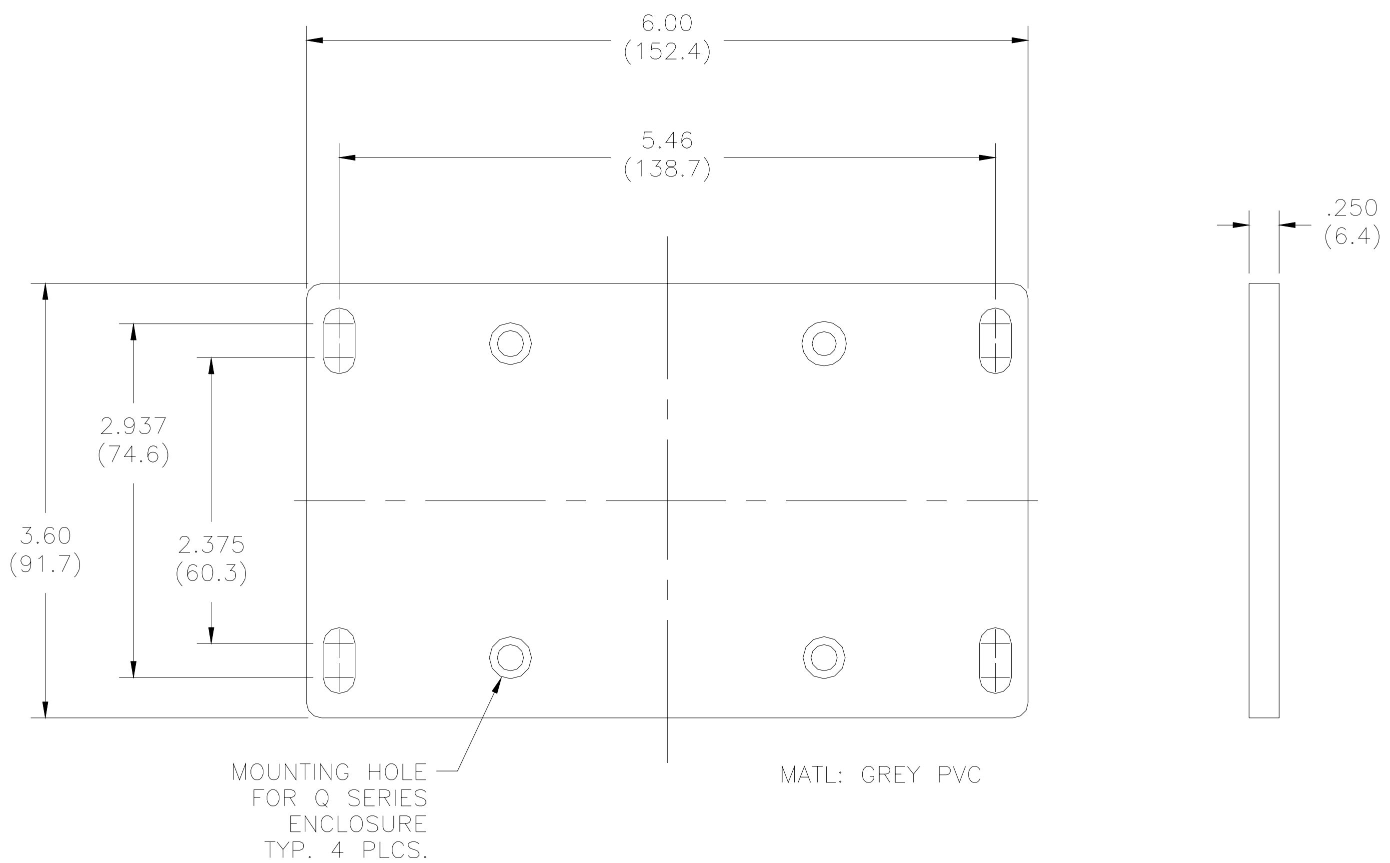


Figure 2-3 Wall or Pipe mount Bracket (ATI-0707)

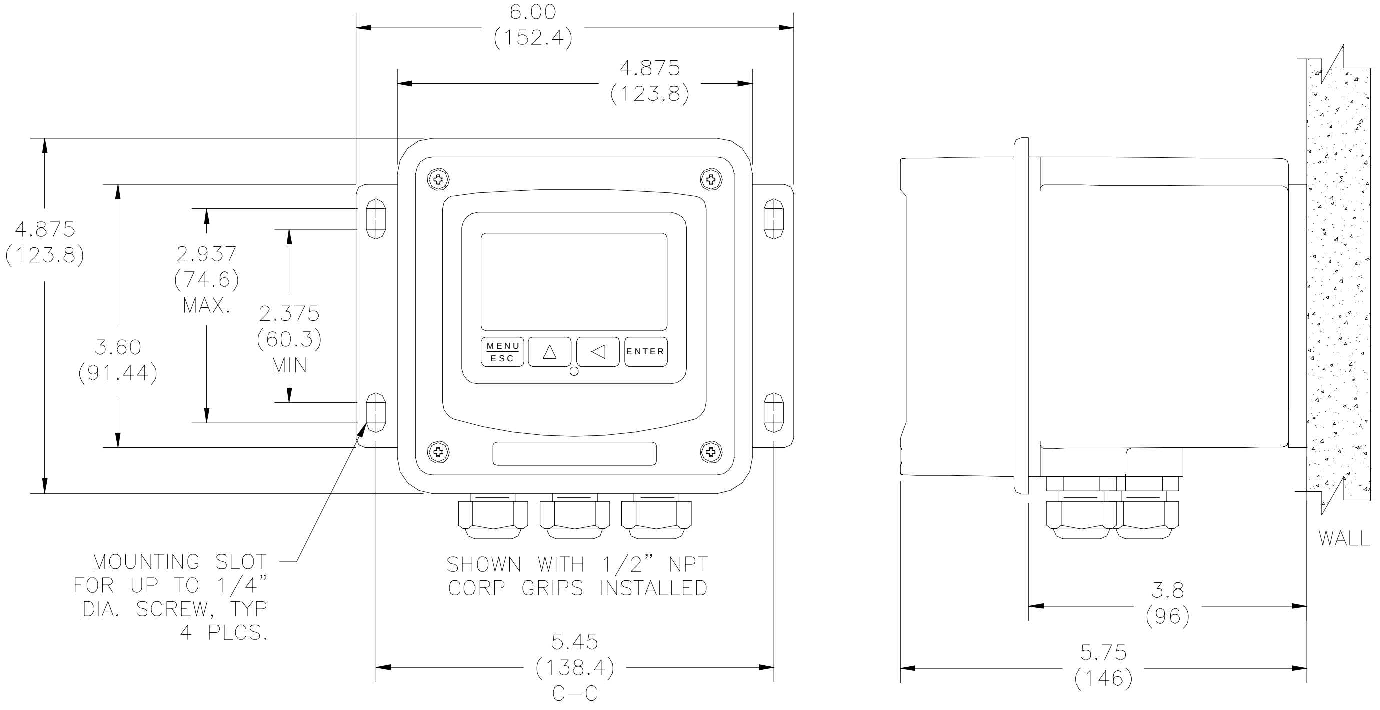


Figure 2-4 Wall Mounting Diagram (ATI-0709)

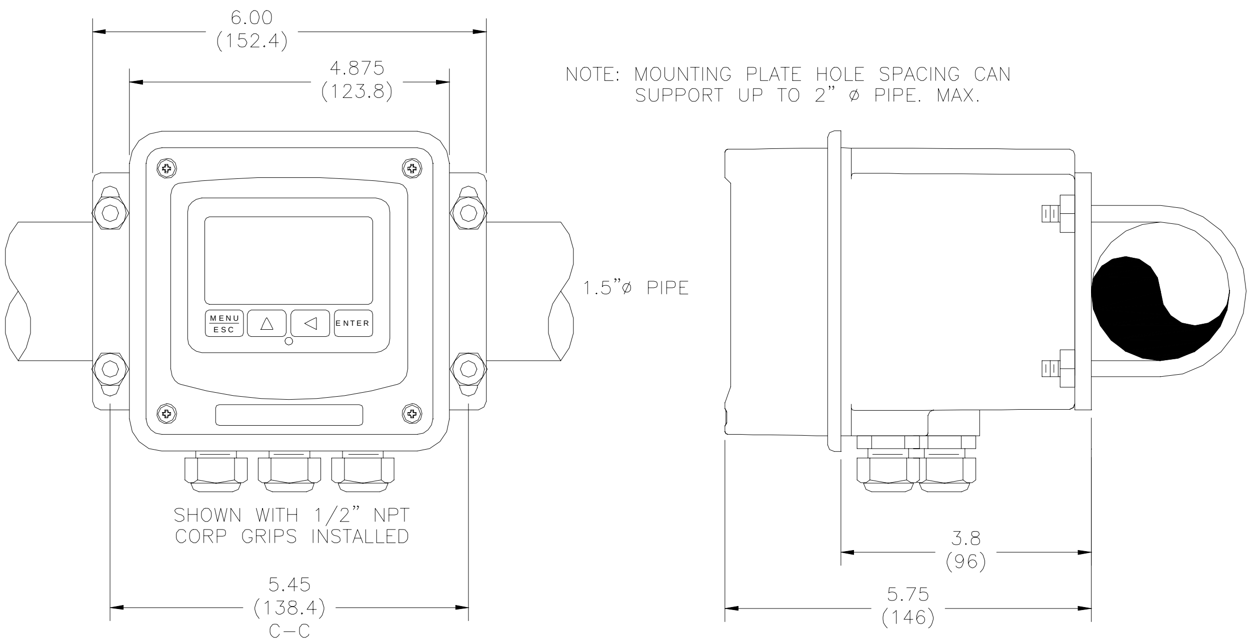


Figure 2-5 Pipe Mounting Diagram (ATI-0710

2.3 Panel Mount, 2-wire Transmitter

The instrument may be panel mounted in two different ways: In the 2-wire configuration, the front half of the enclosure may be separated and mounted by itself, as shown in Figure 2-6. Note that the rear of the instrument enclosure is not utilized in this mounting scheme. Holes must be drilled at the perimeter of the panel cut-out that allow the enclosure screws to pass through and be retained on the back side. User-supplied #8-32 nuts are used to fasten the instrument from the back. The FIP instrument gasket remains intact during this mount to seal to the panel.

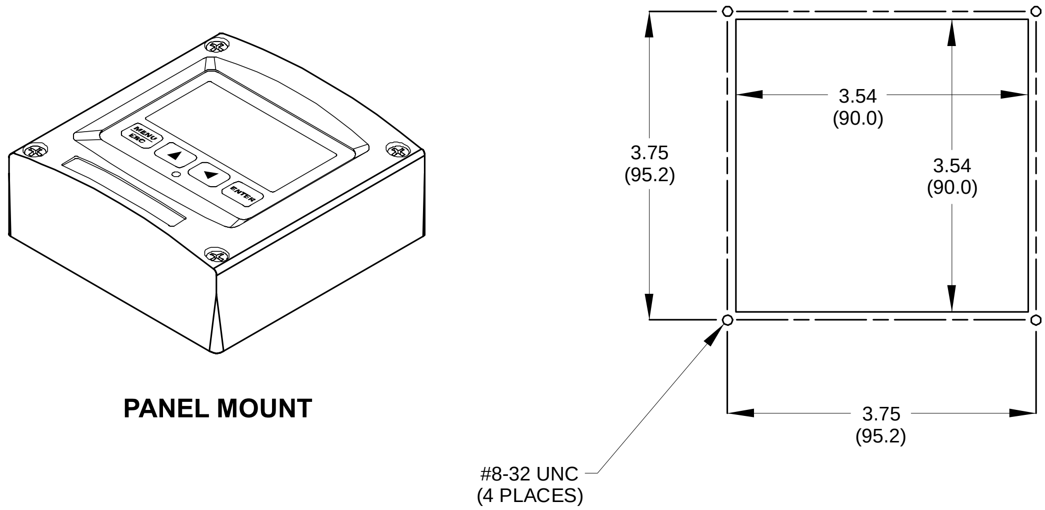


Figure 2-6 2-Wire Panel Mount and Cut-out (ATI-0661)

2.4 Panel Mount, AC Powered Monitor

Panel mounting of an AC powered monitor uses the panel mounting flange molded into the rear section of the enclosure. Figure 2-7 provides dimensions for the panel cutout required for mounting.

The panel mounting bracket kit must be ordered separately (part number 05-0068). This kit contains a metal retainer bracket that attaches to the rear of the enclosure, 4 screws for attachment of this bracket, and a sealing gasket to insure that the panel mounted monitor provides a water tight seal when mounted to a panel.

The sealing gasket must first be attached to the enclosure. The gasket contains an adhesive on one side so that it remains in place on the enclosure. Remove the protective paper from the adhesive side of the gasket and slide the gasket over the back of the enclosure so that the adhesive side lines up with the back of the enclosure flange. Once in place, you can proceed to mount the monitor in the panel.

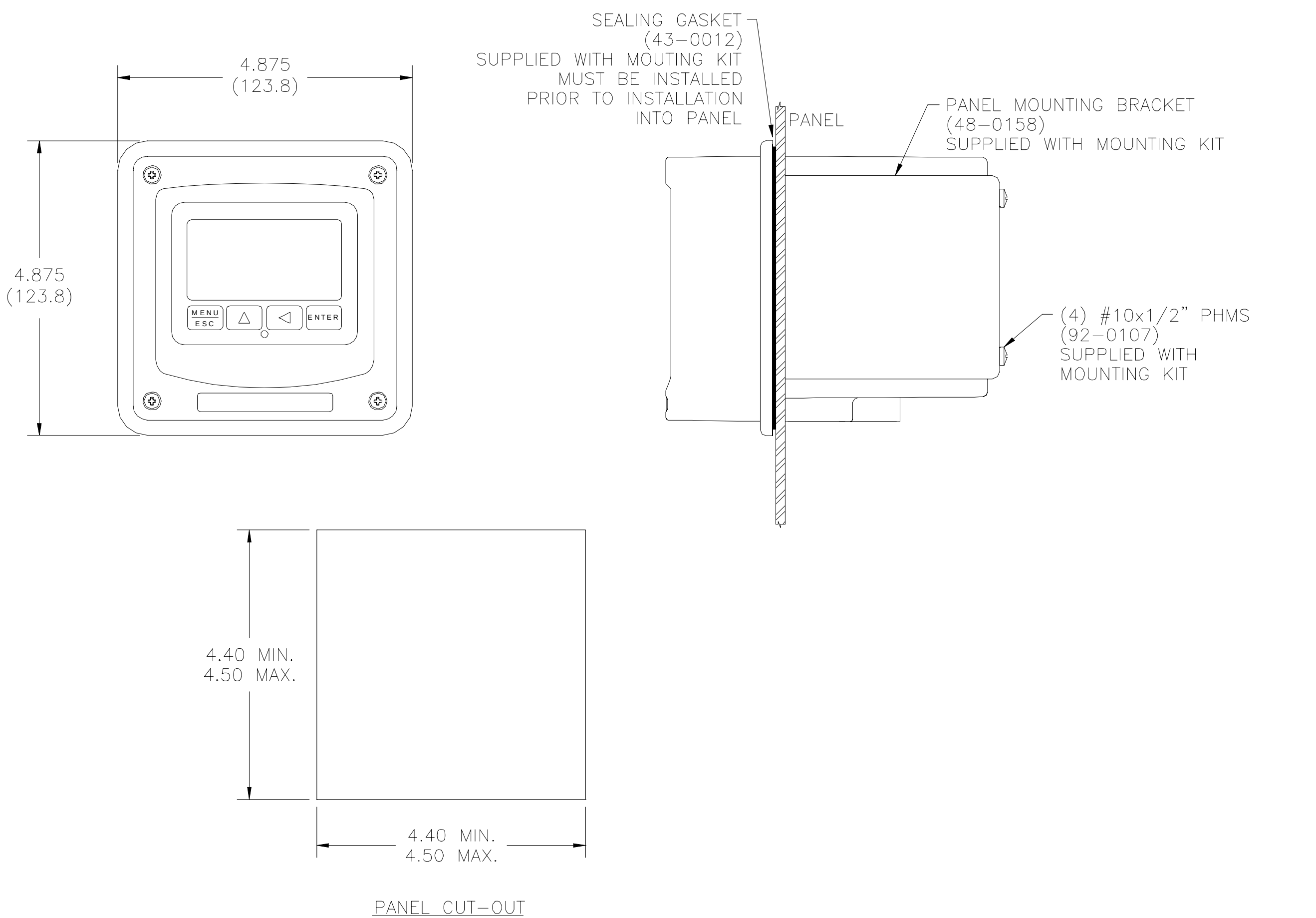


Figure 2-7 115/230 VAC Panel Mount and Cut-out (ATI-0711)

Part 3 – Electrical Installation

3.1 General

The Q45 is powered in one of two ways, depending on the version purchased. The 2-wire version is a 16-35 VDC powered transmitter. The integral 115/230 VAC version requires line power. Please verify the type of unit before connecting any power.

WARNING: Do not connect AC line power to the 2-wire 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 12 (Figure 3-1). The AC power supply contains a single 100mA (115V) or 50mA (230V) slo-blo fuse. The fuse **F1** is located adjacent to **TB5** and is easily replaceable.

2. Do NOT run sensor cables or instrument 4-20 mA 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 specifically trained personnel in accordance with relevant local codes and instructions contained in this operating manual. Observe the analyzer's technical specifications and input ratings. Proper electrical disconnection means must be provided prior to the electrical power connected to this instrument, such as a circuit breaker - rated 250 VAC, 2 A minimum. If one line of the line power mains is not neutral, use a double-pole mains switch to disconnect the analyzer.

3.2 Two-Wire

In the two-wire configuration, a separate DC power supply must be used to power the instrument. The exact connection of this power supply is dependent on the control system into which the instrument will connect. See Figure 3-1 for further details. Any twisted pair shielded cable can be used for connection of the instrument to the power supply. 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.

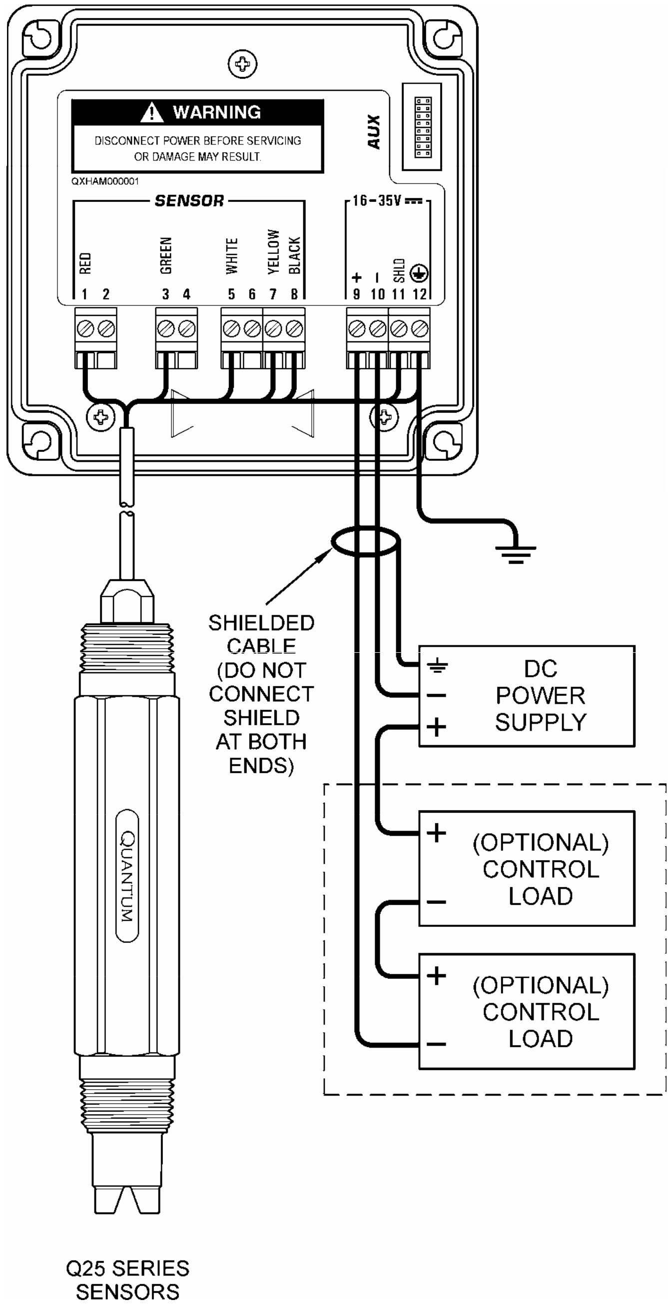


Figure 3-1 Loop-Power Connection, Q45P Transmitter

Notes: 1. Voltage between Terminals 9 and 10 MUST be between 16 and 35 VDC.

2. Earth ground into Terminal 12 is HIGHLY recommended. This connection can greatly improve stability in electrically noisy environments.

3.21 Load Drive

The amount of resistance that the analog output can drive in the 115/230 VAC version is fixed. However, in the two-wire configuration, the load-drive level is dependant on the DC supply voltage provided to the controller.

The two-wire instrument can operate on a power supply voltage of between 16 and 35 VDC. The available load drive capability can be calculated by applying the formula V/I=R, where V=load drive voltage, I=maximum loop current (in Amperes), and R=maximum resistance load (in Ohms).

To find the load drive voltage of the two-wire Q45, subtract 16 VDC from the actual power supply voltage being used (the 16 VDC represents insertion loss). For example, if a 24 VDC power supply is being used, the load drive voltage is 8 VDC.

The maximum loop current of the two-wire Q45 is always 20.00 mA, or .02 A. Therefore,

$$\frac{\text{(Power Supply Voltage - 16)}}{.02} = R_{MAX}$$

For example, if the power supply voltage is 24 VDC, first subtract 16 VDC, then divide the remainder by .02. 8/.02 = 400; therefore, a 400 Ohm maximum load can be inserted into the loop with a 24 VDC power supply.

Similarly, the following values can be calculated:

Power Supply Voltage (VDC)	Total Load (Ohms)
16.0	0
20.0	200
24.0	400
30.0	700
35.0	950

3.3 115/230 VAC w/Relays

In the 115/230 VAC configuration, a DC power supply is mounted into the inside rear of the enclosure. The power supply must be ordered with the proper operating voltage. Verify that the unit requires either 115 VAC or 230 VAC before installing. Also verify that power is fully disconnected before attempting to wire.

AC powered Q45 systems are supplied with 3 cable gland fittings and two ½” conduit adapters. One of the cable glands has a larger hole in the rubber gland and should be used for the power cord entry if a flexible power cord will be used for installation. One of the cable glands with the smaller gland opening should normally be used for the sensor cable. Cable glands and conduit hubs will screw into any of the three threaded holes on the bottom of the enclosure.

Connect HOT, NEUTRAL, and GROUND to the matching designations on terminal strip **TB5**.

WARNING

Disconnect line power voltage BEFORE connecting line power wires to Terminal TB5 of the power supply. The power supply accepts only standard three-wire single phase power. The power supply is configured for 115 VAC or 230 VAC operation at the factory at time of order, and the power supply is labeled as such. Do NOT connect voltages other than the labeled requirement to the input.

The analog outputs from the system are present at terminals TB1 and TB2. The loop-load limitation in this configuration is 500 Ohms maximum for each output. Also note that these two outputs are completely isolated from each other to insure that ground loops do not result from the connection of both outputs to the same device such as a PLC or DCS.

In the line-powered unit, a ribbon cable connects the power supply assembly with the microprocessor assembly located in the front section of the enclosure. This cable can be removed during installation to facilitate wiring if desired. It is best to unplug only one end. The ribbon cable has a marking stripe on one edge that is used to indicate proper orientation. The indicator stripe should be on the bottom edge of the cable when installed as shown in Figure 3-2.

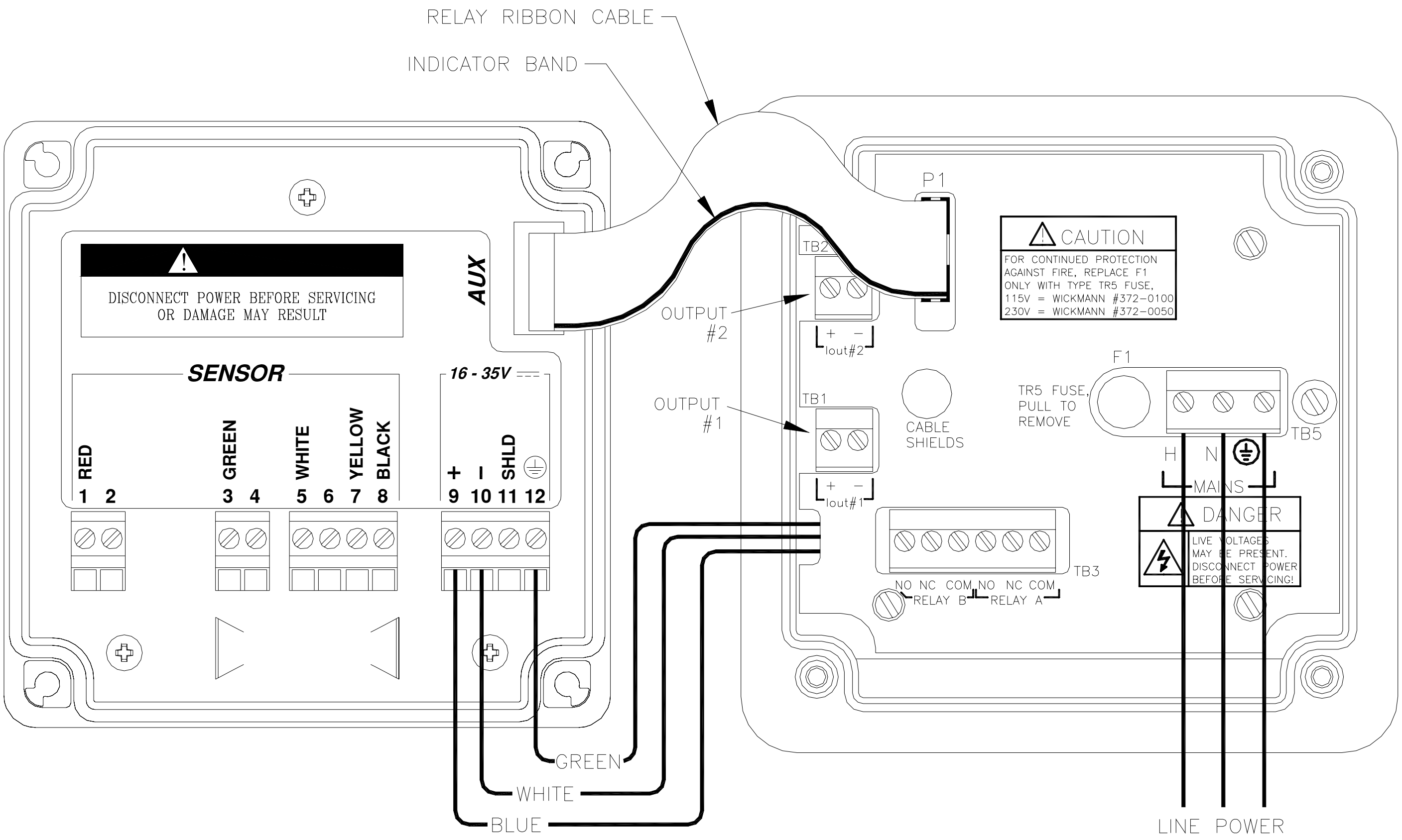


Figure 3-2   Line Power Connection (ATI-0722)

The power strip, **TB5**, allows up to 12 AWG wire. A wire gauge of 16 AWG is recommended to allow for an easy pass-through into the M16 ports when wiring.

Two sets of SPDT relay contacts are provided on the power supply board. None of the relay contacts are powered. The user must supply the proper power to the contacts. For applications that require the same switched operating voltage as the Q45 (115 or 230 V), power may be jumpered from the power input terminals at **TB5.** Relay wiring is connected at **TB3** as shown below. Note that the relay contact markings are shown in the NORMAL mode. Programming a relay for "Failsafe" operation reverses the NO and NC positions in this diagram.

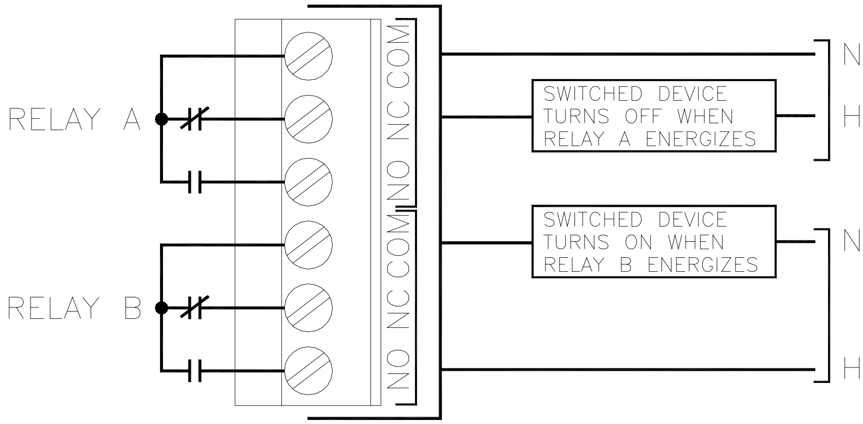


Figure 3-3 Relay Contacts (ATI-0712)

3.4 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.

3.5 Direct Sensor Connection

Sensor connections are made in accordance with Figure 3-1. 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 15 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.

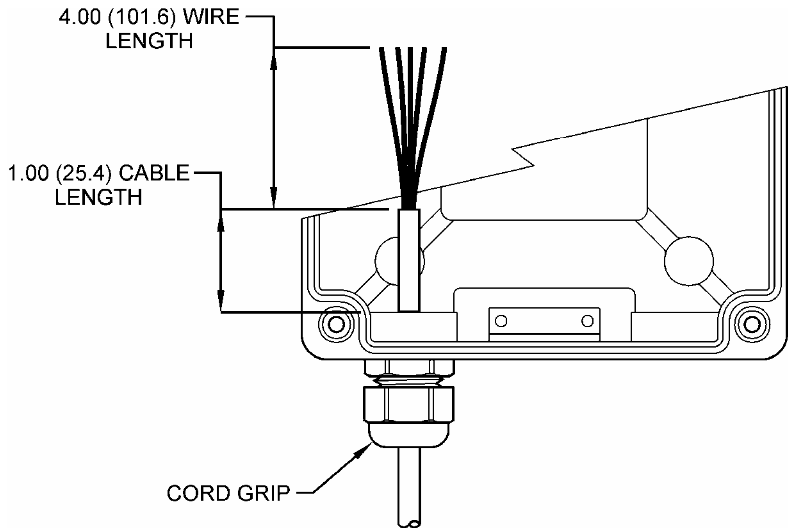


Figure 3-4 Sensor Cable Preparation

3.6 Combination Electrode Connection

The Q45P may also be used with non-amplified simple combination electrodes (see Figure 3-5). Note that a wire jumper must be installed from Terminal 3 to Terminal 8. The user must also select Sensor Type **2** within the Config Menu (see Section 4.24). The maximum sensor-to-instrument cable length will be severely limited (30-50 feet) with electrodes of this type. The length will depend on the specific electrode impedance and the quality of interconnect cable provided by the manufacturer.

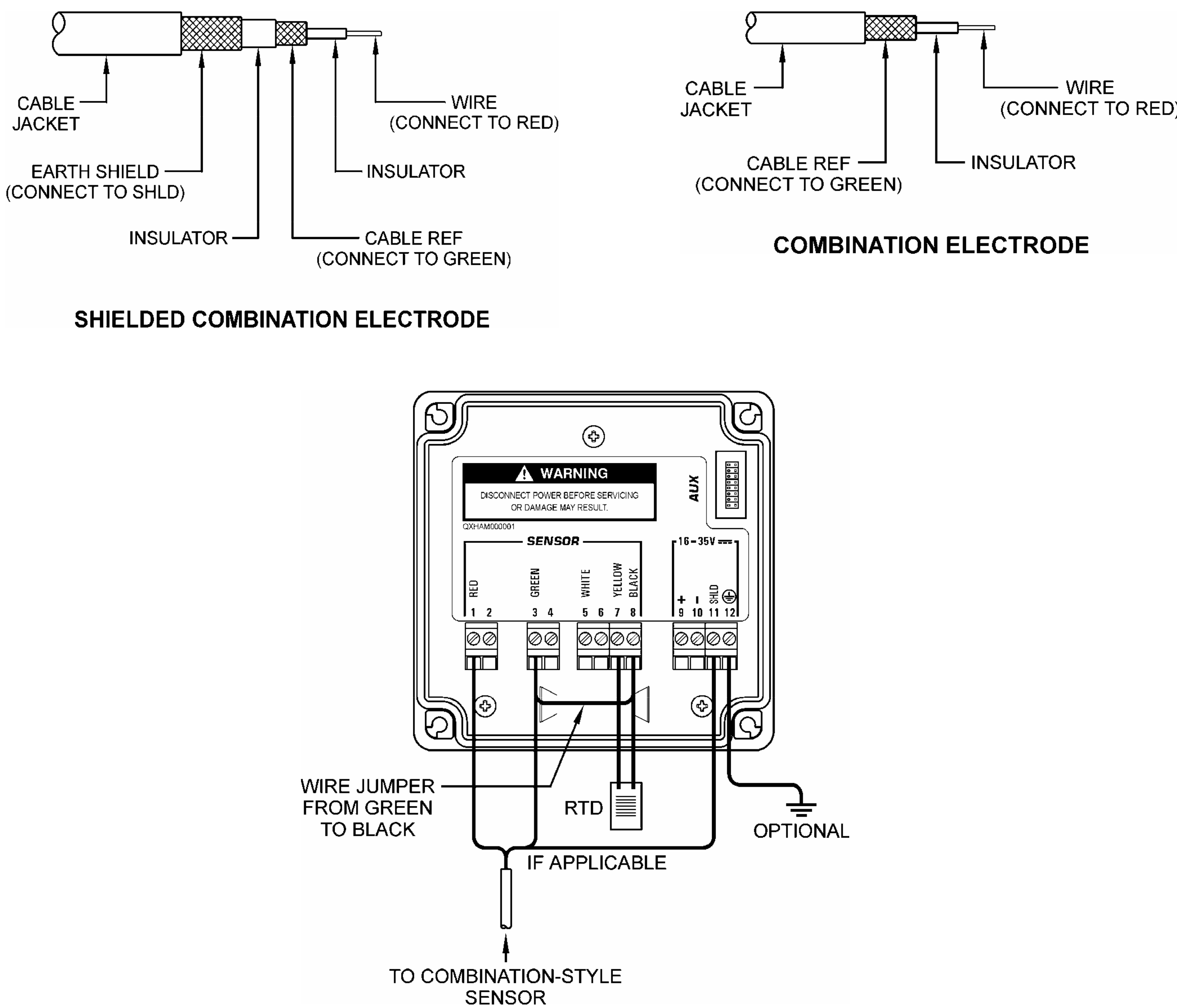


Figure 3-5 Sensor Connections, Combination Electrodes

3.7 External Temperature Compensation

All Quantum Q25 sensors include an integral Pt1000 RTD. The Q45 series instruments also allow user-supplied external Pt1000 or Pt100 elements to be connected to the temperature input, as shown in Figure 3-6. Note that when using the Pt100 connection, sensor cable length will be limited to 40 feet due to the high cable resistance error associated with the lower resistance output of Pt100 RTD elements. In other words, cable resistance represents a higher percentage of error signal when using a lower-resistance RTD.

For sensor cable distances of 400 feet or more, a three-wire RTD connection will produce the highest accuracy measurement. This connection requires the use of a junction box. To configure the instrument for a three-wire connection, the metal PCB shield over the terminal strips must be carefully removed by first removing the three retaining screws, then gently prying the shield upward and slightly pushing the terminal strips through the opening in the shield. Once the shield has been removed, the user must cut a small white jumper J1 in the lower-right section of the top scaling board. Replace the shield and connect the pH sensor. If the two-wire connection is desired at any time after this change has been made, the user must install a wire jumper between terminals 6 and 7 on the transmitter.

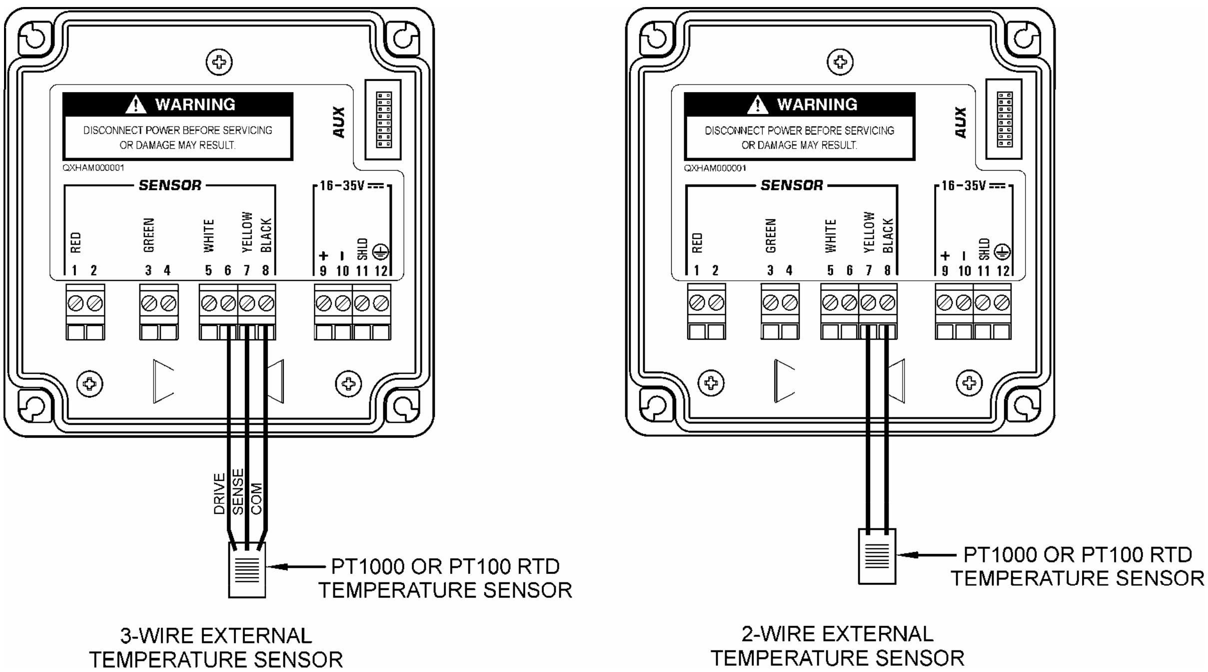
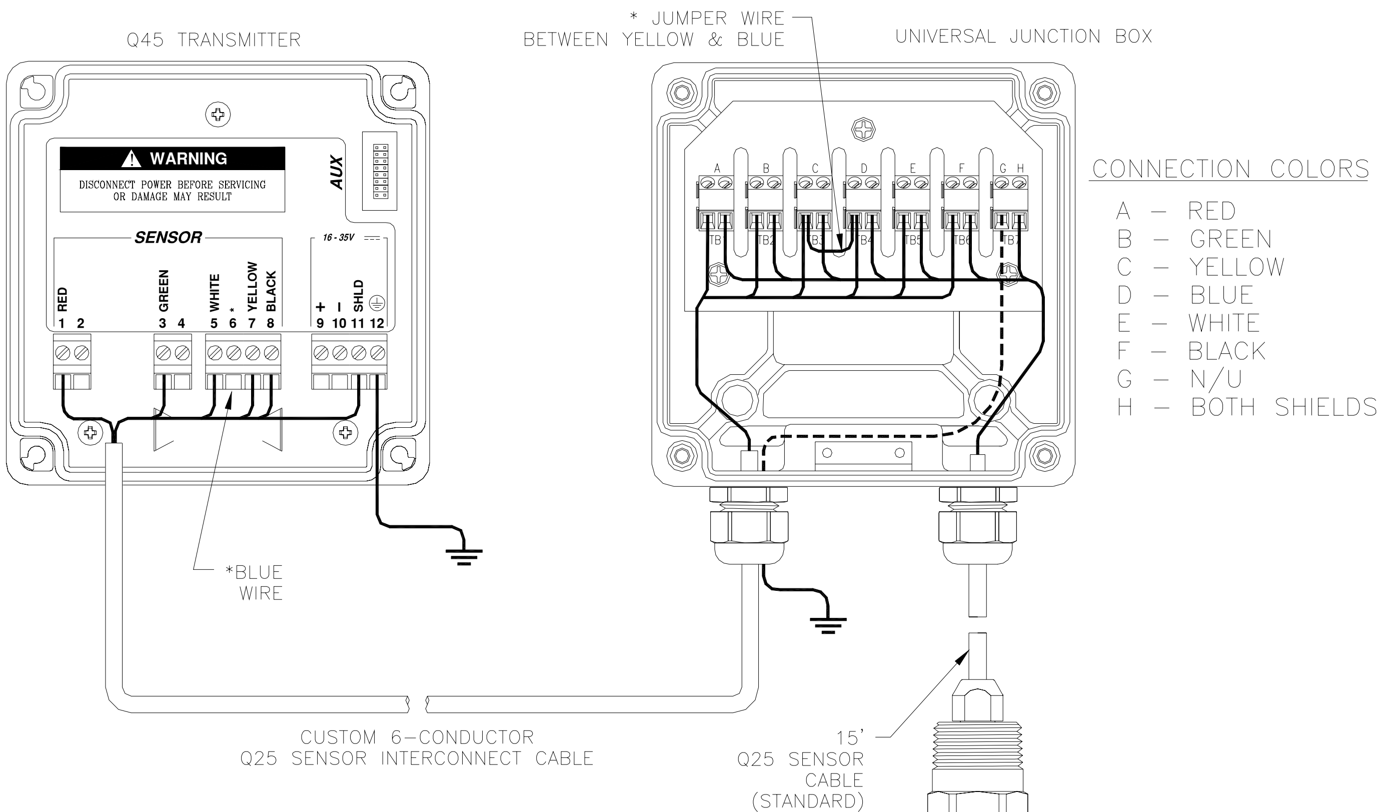
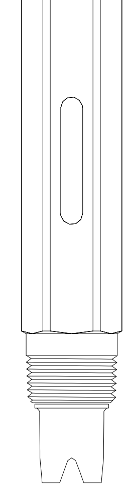


Figure 3-6 External Temperature Compensation

3.8 Junction Box Connection

For installations where the sensor is to be located more than 30 feet from the monitor (max. 100 feet), a junction box must be used. The junction box is shown in Figure 3-7, and is supplied with Pg 9 gland seals for sensor and interconnect wiring installation.





* When utilizing the 3-wire RTD connection, a wire jumper must be made between the yellow and blue wires in the junction box as shown. The blue wire on the connecting sensor cable must be attached to Terminal 6 in the Q45 Transmitter as shown. In addition, a jumper on the scaling board must also be removed. See previous page for details listed under the External Temperature Compensation section.

Connecting sensor cable lengths can be up to 400 feet with a 2-wire RTD connection, and up to 3,000 feet with a 3-wire RTD connection.

When utilizing the junction box connection, the blue wire on the connecting sensor cable must be attached to Terminal 6 on the Q45 Transmitter, as above. However, the blue wire on the Q25 Sensor cable is not used.

Use ONLY ATI 6-conductor Q25 Sensor interconnect cable between the transmitter and the junction box.

Figure 3-7 Junction Box Interconnect Wiring

Part 4 – Configuration

4.1 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.).

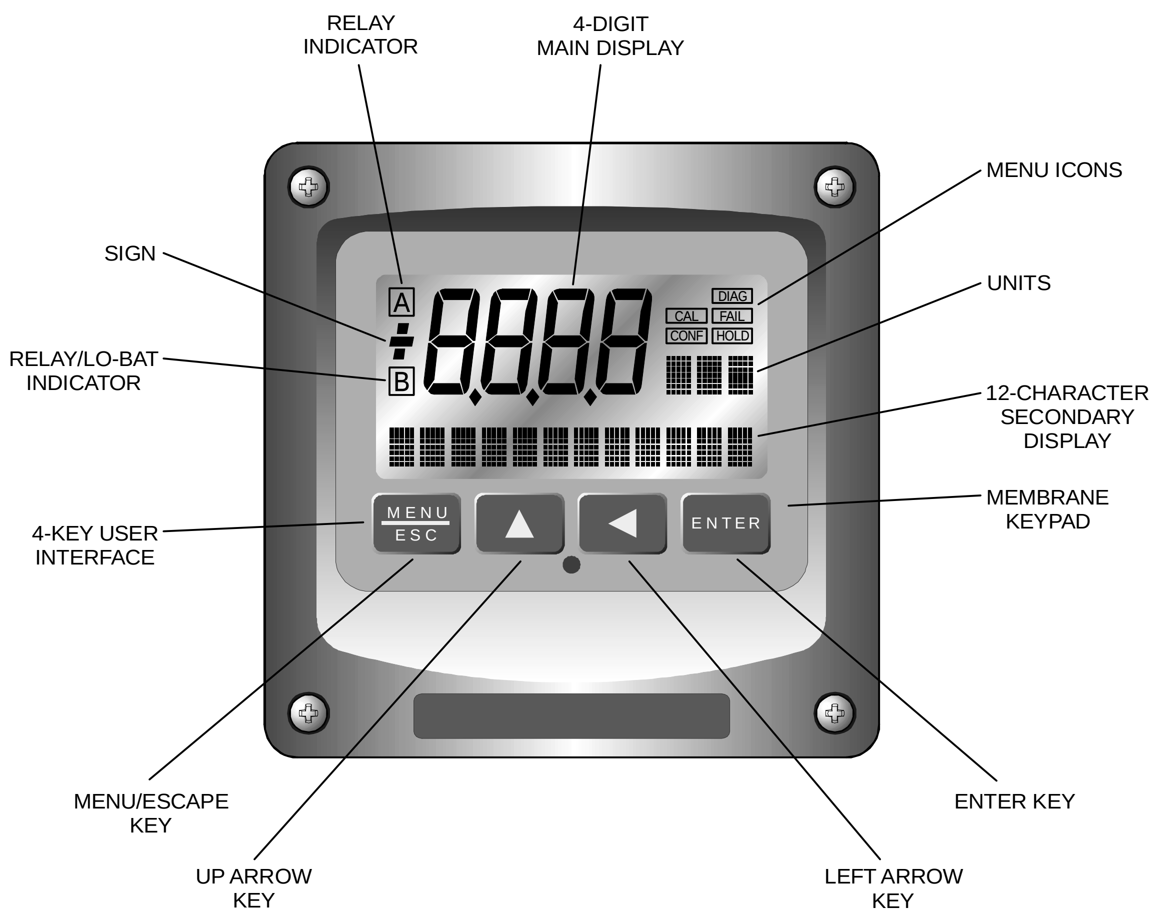


Figure 4-1 User Interface (ATI-0654)

4.11 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. In the battery-powered version of the Q45, this is also the ON button.

UP (arrow) To scroll through individual list or display items and to change number values.

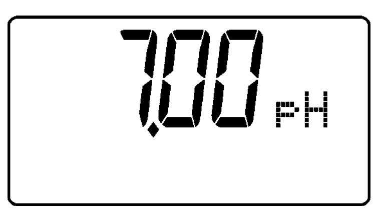
LEFT (arrow) To move the cursor from right to left during changes to a number value.

ENTER To select a menu section or list item for change and to store any change.

4.12 Display

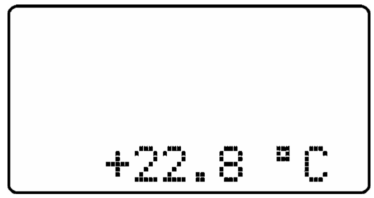
The large custom display provides clear information for general measurement use and user configuration. There are three main areas of the display: the main parameter display, the secondary message line, and the icon area.

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.



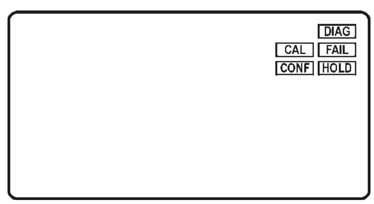
Lower Line

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 Section 7.3.



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

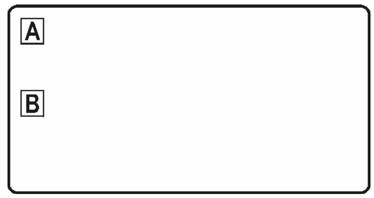
The HOLD icon indicates that the current output of the transmitter has been put into output hold. In this case, the output is locked to the last input value measured when the HOLD function was entered. HOLD values are retained even if the unit power is cycled.

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.

Relay Area A/B

The relay area contains two icons that indicate the state of the system relays (if the relay card is installed). If the battery board is installed instead, the B icon indicates that the battery voltage is at a low level. The battery power option and the relay option cannot be installed together.



4.2 Software

The software of the Q45P 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.**

4.21 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 4-2 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 pH 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 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.

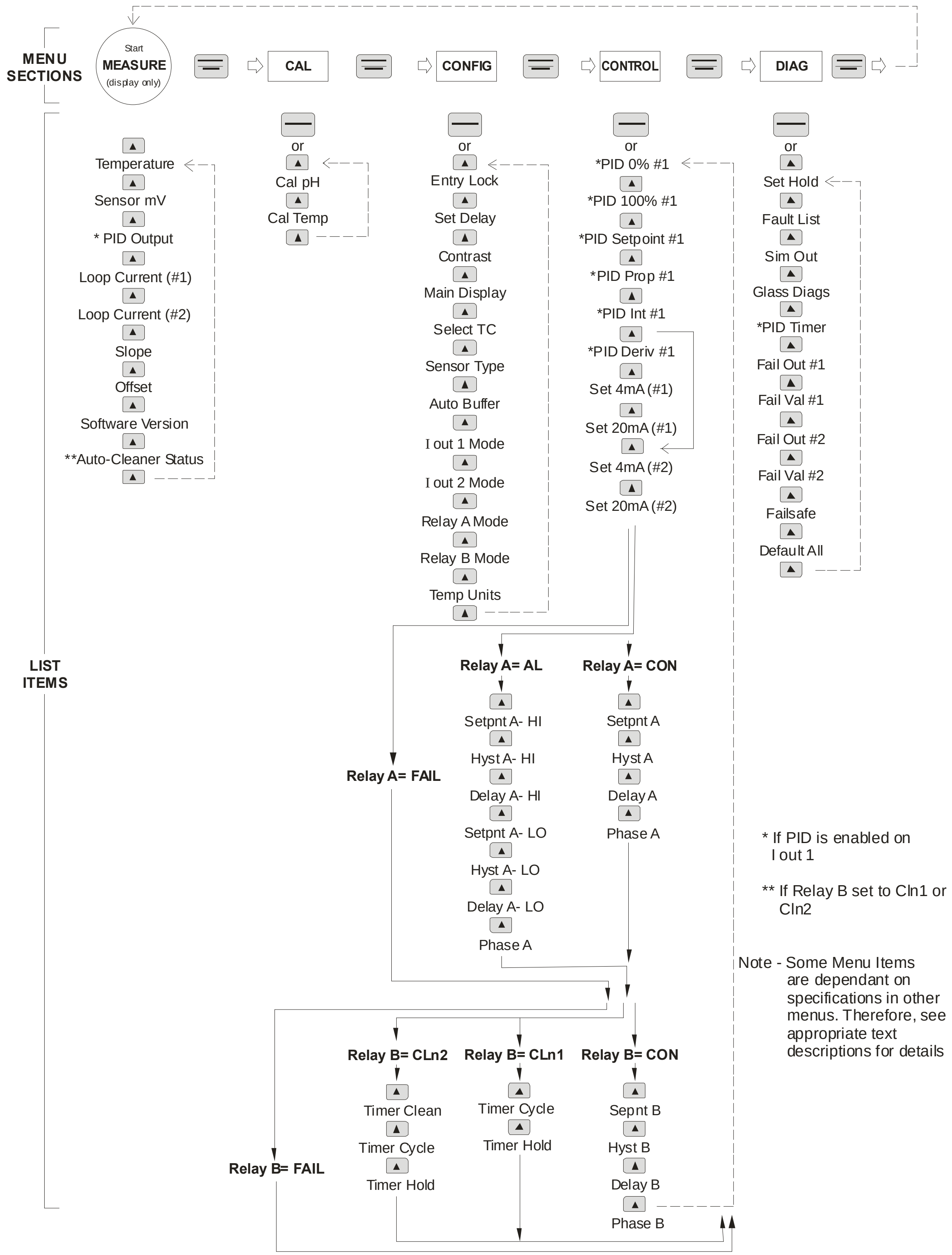


Figure 4-2 Software Map

4.22 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:

TRANSMITTER MEAS SCREENS:

25.7°C 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.

+132 mV Raw sensor voltage. Useful for diagnosing problems.

20.00 mA Transmitter output current.

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

Q45P v2.07 Transmitter software version number.

Toff 0.9mn Auto-Clean status screen (if enabled on relay-based unit.)

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.

For the relay-based analyzer version, or the portable battery powered version of the transmitter, the screens are basically the same, with additions to show two analog output instead of one (#1 and #2.)

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

4.23 Calibration Menu [CAL]

The calibration menu contains items for frequent calibration of user parameters. There are three items in this list: Cal pH, Cal Temp, and Cal TC Factor.

Cal pH The pH calibration function allows the user to adjust the transmitter offset and span reading to match reference buffers, or to adjust the sensor offset to match the sample reading. See Part 5 - 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 5 - Calibration for more details.

4.24 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 Q45P 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 pH 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. 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 Display

This function allows the user to change the measurement in the primary display area. The user may select between pH, sensor temperature, or output current. Using this function, the user may choose to put temperature in the main display area and pH 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.

Select TC

This function allows the user to select either a Pt1000 or Pt100 platinum RTD temperature element. The Pt1000 element is the standard element in all high performance Q25 sensors; it is the recommended temperature sensing element for all measurements. The Pt100 selection is provided as an alternative for use with existing combination-style sensors. Press ENTER to initiate user entry mode, and the entire value will flash. Use the UP arrow key to modify the desired value. Press ENTER to store the new value.

Sensor Type

This function sets the sensor input type. This selection is critical for control of the internal diagnostics and compensation factors. Press ENTER to initiate user entry mode, and the entire value will flash. Use the UP arrow key to modify the desired value. Selections are **1** for Q25P glass sensor, **2** for combination electrode, **3** for Q25P antimony electrode, and **4** for pure water sensor using special compensation table. Press ENTER to store the new value.

Auto Buffer

This is a multiple variable function that allows the user to choose which pH buffer sets that will be utilized in the 2-point calibration mode. The Q45P contains 3 sets of built-in buffer tables with compensation values ranging from 0 to 95 °C. During 2-point calibration, the instrument will automatically identify which buffer is being used and compensate for the value based on the built-in tables. This allows very quick, highly accurate calibrations by the user. The order in which the buffers are used during calibration is unimportant, since the system automatically chooses the correct buffer.

The default setting for this feature is **OFF**, which disables the auto-recognition function. Press ENTER to change this setting. The buffer table set options are: 1: [4/7/10], 2: [4/7/9.18], and 3: [4.65/6.79/9.23]. See Figure 4-5 for buffer tables. Once the buffer set is selected, press ENTER and the message **Accepted!** will be displayed on the lower line.

4.00 pH	
ºC	pH
0	4.00
10	3.99
20	4.00
30	4.01
40	4.03
50	4.05
60	4.08
70	4.12
80	4.16
90	4.21
95	4.24

7.00 pH	
ºC	pH
0	7.10
10	7.06
20	7.02
30	6.99
40	6.97
50	6.98
60	6.98
70	6.97
80	6.99
90	7.01
95	7.01

10.00 pH	
ºC	pH
0	10.27
10	10.15
20	10.05
30	9.95
40	9.87
50	9.80
60	9.75
70	9.73
80	9.73
90	9.75
95	9.77

4.65 pH	
ºC	pH
0	4.67
10	4.66
20	4.65
30	4.65
40	4.66
50	4.68
60	4.70
70	4.72
80	4.75
90	4.79
95	4.79

6.79 pH	
ºC	pH
0	6.89
10	6.84
20	6.80
30	6.78
40	6.76
50	6.76
60	6.76
70	6.76
80	6.78
90	6.80
95	6.80

9.18 pH	
ºC	pH
0	9.46
10	9.33
20	9.23
30	9.14
40	9.07
50	9.01
60	8.96
70	8.92
80	8.89
90	8.85
95	8.83

9.23 pH	
ºC	pH
0	9.48
10	9.37
20	9.27
30	9.18
40	9.09
50	9.00
60	8.92
70	8.88
80	8.85
90	8.82
95	8.82

Figure 4-5 Automatic pH Buffer Tables

Iout#1 Mode ets ar her t ables t

tracking or 2-PID for pH PID control. Press ENTER to store the new value.

AC OPERATED UNITS ONLY

***Iout#2 Mode**

This function sets analog output #2 for either temperature (default) or pH. 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-C/F for temperature or 2-pH for pH. Press ENTER to store the new value.

AC OPERATED UNITS ONLY

***Rly A Mode**

Relay A can be used in three different ways: as a setpoint control, as a fail alarm, or as a HI-LO alarm band. The three settings for Rly A Mode are **CON**, **FAIL** and **AL**.

The **CON** setting enables normal control operation for Relay A, with settings for setpoint, hysteresis, delay and phasing appearing in the CONFIG menu automatically. See Figure 6-3 for further details.

The **FAIL** setting enables the fail alarm mode for Relay A. Relay A will then trip on any condition that causes the FAIL icon to be displayed on the LCD. Using this mode allows the User to send alarm indications to other remote devices.

The **AL** setting allows two setpoints to be selected for the same relay, producing a HI-LO alarm band. In this mode, Relay A will trip inside or outside of the band, depending upon the Phase selected. See Figure 4-4 for further details.

AC OPERATED UNITS ONLY

***Relay B Mode**

Relay B can be used in a number of ways: as a setpoint control, as an alarm, or as the control logic for an automatic sensor cleaning system. The settings for Relay B Mode are **CON, FAIL, CLn1 and CLn2**. The first two modes function identically to the corresponding modes on Relay A.

The CLn1 and CLn2 modes of operation enable the timer feature for the automatic sensor cleaner. Once enabled, a periodic automatic cleaning cycle will occur where a jet of air is blown past the sensor membrane to dislodge any contaminants which may have accumulated. During the cleaning cycle, the outputs of the system are held (analog outputs and relays) so that the cleaning cycle is invisible to recording instrumentation which may be connected. These outputs are released in a “bumpless” manner once the system automatically returns to the monitoring mode. The timer consists of three menu items which will appear in the CNTRL menu: Timer B CLEAN, Timer B CYCLE, and Timer B HOLD. The CLEAN function engages the relay B contact for a set time to operate the cleaning pump. The CYCLE function sets the time until the next CLEAN cycle. The HOLD setting sets the amount of delay that occurs after a cleaning cycle to let the outputs return to normal. See these specific function descriptions listed below for more detail.

NOTE: When CLn1 is enabled, the setting for Timer Clean defaults to 1 minute and this value is locked. When CLn2 is enabled, the setting for Timer Clean can be changed. CLn1 should be selected when the ATI Auto-Clean system is used, and CLn2 should be selected if an alternate cleaning system is used.

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.

4.25 Control Menu [CONTROL]

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

Set PID 0%
Set PID 100%
[Iout1=PID]

If the PID is enabled, this function sets the minimum and maximum controller end points. Unlike the standard 4-20 mA output, the controller does not "scale" output values across the endpoints. Rather, the endpoints determine where the controller would normally force minimum or maximum output in an attempt to recover the setpoint (even though the controller can achieve 0% or 100% anywhere within the range.)

If the 0% point is lower than the 100% point, then the controller action will be "reverse" acting. That is, the output of the controller will increase if the measured value is less than the setpoint, and the output will decrease if the measured value is larger than the setpoint. Flipping the stored values in these points will reverse the action of the controller to "direct" mode.

The entry value is limited to a value within the range specified in "Set Range", and the 0% and the 100% point 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.

PID Setpnt
[Iout1=PID]

The measured value which the controller is attempting to maintain by adjusting output value. It is the nature of the PID controller that it never actually gets to the exact value and stops. The controller is continually making smaller and smaller adjustments as the measured value gets near the setpoint.

PID Prop
[Iout1=PID]

Proportional gain factor. The proportional gain value is a multiplier on the controller error (difference between measured value and setpoint value.) Increasing this value will make the controller more responsive.

PID Int
[Iout1=PID]

Integral is the number of “repeats-per-minute” of the action of the controller. It is the number of times per minute that the controller acts on the input error. At a setting of 2.0 rpm, there are two repeats every minute. If the integral is set to zero, a fixed offset value is added to the controller (manual reset.) Increasing this value will make the controller more responsive.

PID Deriv
[Iout1=PID]

Derivative is a second order implementation of Integral, used to suppress “second-order” effects from process variables. These variables may include items like pumps or mixers that may have minor impacts on the measured value. The derivative factor is rarely used in water treatment process, and therefore, it is best in most cases to leave it at the default value. Increasing this value will make the controller more responsive.

Set 4 mA
Set 20 mA
[Iout1=pH]

These functions set the main 4 and 20 mA current loop output points for the transmitter. The units displayed depend on the selection made in the CONFIG menu for Iout #1 Mode. Also, when the Relay Option Board is installed, the units will also display #**1 or #2** – since there are actually two analog outputs present in this version.

The value stored for the 4 mA point may be higher or lower than the value stored for the 20 mA point. The entry values are limited to values within the range specified in “Set Range”, and the 4 mA and the 20 mA point 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.

AC POWERED UNITS ONLY

***Set 4 mA #2**
***Set 20 mA #2**
[temp/pH]

These functions set the second 4 mA and 20 mA current loop output points for the transmitter. The output may be set to track temperature (default) or pH. The values stored for the 4 mA point may be higher or lower than the value stored for the 20 mA point.

The entry value is limited to a value between 0° and 55 °C if it is set for temperature and must be within 0-14 pH if set to track pH. The 4 mA and the 20 mA point must be at least 20 units away from each other. Press ENTER to initiate user entry mode, and the value will flash. Use arrow keys to modify value. Press ENTER to store the new value.

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.)

NOTE: If the battery board option is installed, the menu will be shown as **Set 0 V #2** – since the battery board has two 0-2.5 VDC voltage output signals instead of current outputs.

ALARM CONFIGURATIONS APPLY TO AC POWERED UNITS ONLY

***A Setpoint**

This function establishes the pH trip point for relay A. The entry value is limited to a value within the range specified in "Set 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.

***A Hysteresis**

This function establishes the hysteresis, or "deadband", for Relay A. Hysteresis is most often used to control relay chattering; however, it may also be used in control schemes to separate the ON/OFF trip points of the relay. Press ENTER to initiate user entry mode, and the value will flash. Use the arrow keys to modify value. Press ENTER to store the new value.

***A Delay**

This function places an additional amount of time delay on the trip point for relay A. This delay is in addition to the main delay setting for the controller. The entry value is limited to a value between 0 and 999 seconds. Press ENTER to initiate user entry mode, and the value will flash. Use arrow keys to modify value; range is 0 to 999 seconds. Press ENTER to store the new value.

***A Phasing**

This function establishes the direction of the relay trip. When phase is HI, the relay operates in a direct mode. Therefore, the relay energizes and the LCD indicator illuminates when the pH value **exceeds** the setpoint. When the phase is LO, the relay energizes and the LCD indicator illuminates when the pH level drops **below** the setpoint. The failsafe setting does have an impact on this logic. The description here assumes the failsafe setting is OFF. 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 **HI** for direct operation or **LO** for reverse operation. Press ENTER to store the new value.

See Figure 4-3 below for a visual description of a typical control relay application.

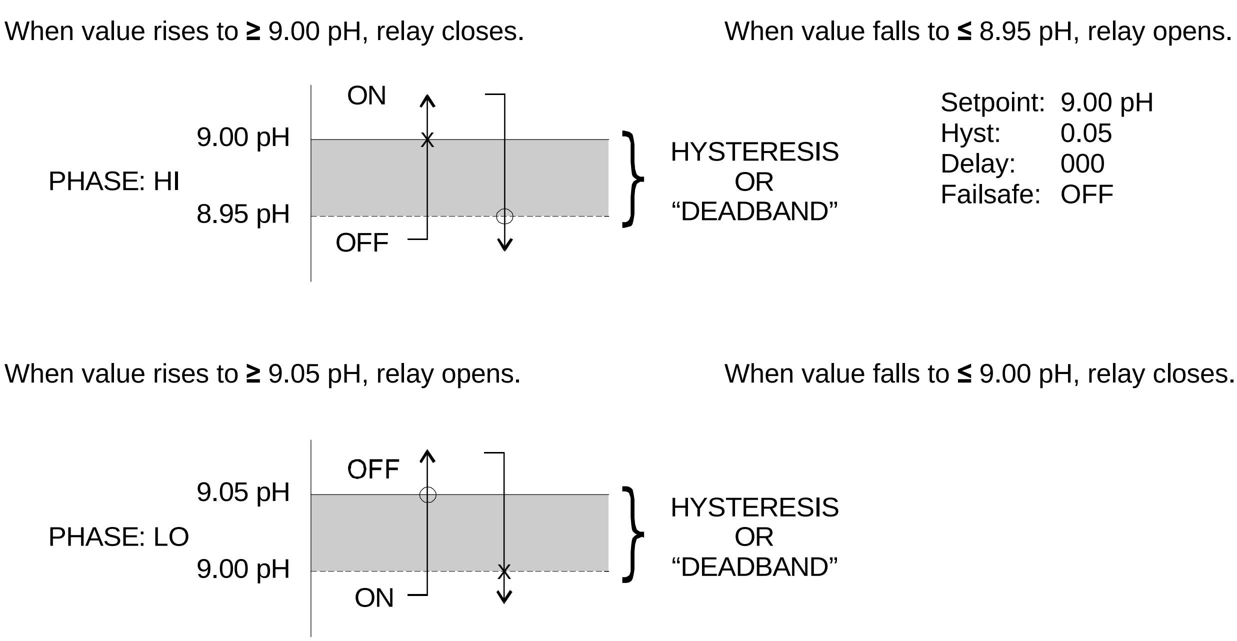


Figure 4-3 Control Relay Example, Hysteresis and Two Opposite Phase Options

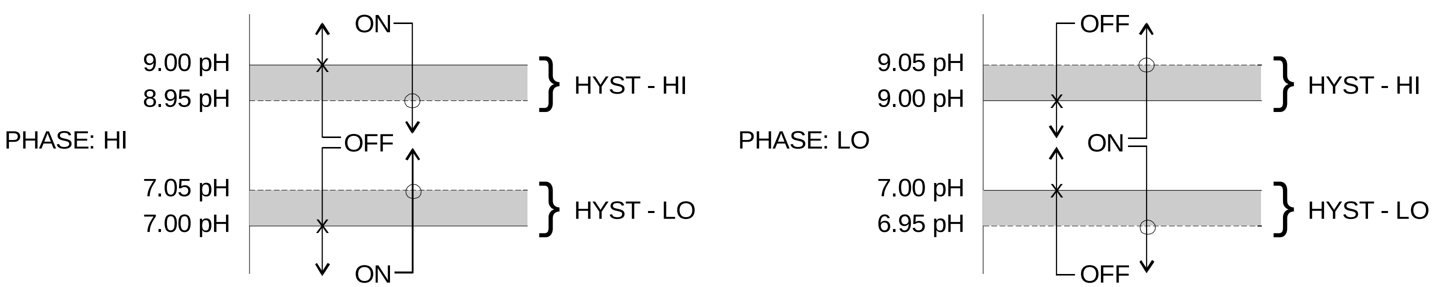
***Setpnt A-HI**
***Hyst A-HI**
***Delay A-HI**
***Setpnt A-LO**
***Hyst A-LO**
***Delay A-LO**

If Relay A Mode is set to Alarm Mode, **AL**, then the following settings will appear in the Config Menu list automatically. In this mode, two setpoints can be selected on the same relay, to create an alarm band. Phase HI selection causes the relay to energize outside of the band, and Phase LO causes the relay to energize inside of the band. This feature enables one relay to be used as a control relay while the other is used as a HI-LO Alarm relay at the same time. Setpoint A-LO must be set lower than Setpoint A-HI. When AL mode is first selected, Setpoint A-LO is defaulted to 0.

Figure 4-4 is a visual description of a typical alarm relay application.

When value rises to ≥ 9.00 pH, relay closes, until value falls back to ≤ 8.95 pH.

When value falls to ≤ 9.00 pH, relay closes, until rises back to ≥ 9.05 pH.



When value falls to ≤ 7.00 pH, relay closes, until rises back to ≥ 7.05 pH.

When value rises to ≥ 7.00 pH, relay closes, until value falls back to ≤ 6.95 pH.

Setpoint	A-HI:	9.00 pH	Setpoint	A-LO:	7.00 pH
Hyst	A-HI:	0.050	Hyst	A-LO:	0.05 pH
Delay	A-HI:	000	Delay	A-LO:	000

Figure 4-4 Alarm Relay Example

***B Setpoint**
***B Hysteresis**
***B Delay**
***B Phasing**

If Relay B Mode is set to **CON** or **FAIL** (see **Relay B Mode)**, then Relay B will function identically to Relay A. Relay B settings appear in the CONFIG menu list automatically.

4.26 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. 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 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.

Note: When the Relay Option Board is installed, the Set Hold function holds BOTH current levels, as well as ALL relay settings.

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 pH level of the instrument in the user selected display range. The user enters a pH 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.

The starting display value will be the last read value of the input. The output will be under control of the SIM screen until the ESC key is pressed.

Note: If the HOLD function is engaged before the Sim Output function is engaged, the simulated output will remain the same even when the ESC key is pressed. Disengage the HOLD function to return to normal output.

NOTE: If the HOLD function is engaged before the Sim Output function is engaged, the simulated output will remain the same even when the ESC key is pressed. Disengage the HOLD function to return to normal output.

Glass Diags

This function allows the user to shut off the glass breakage/leak diagnostics. It does not affect the state of the remaining system diagnostics. This capability is provided to eliminate nuisance trips in electrically noisy applications,

such as some plating operations. If ON, Relay B is automatically configured as a fail alarm relay. The relay trips on any fail condition. Therefore, the normal settings for control Relay B will disappear from the CONFIG menu since they cannot be used.
Note that the probe timer function can also alter the operation of Relay B. If the electrode diagnostic function is enabled, that function takes precedence over the probe timer.

Note that the probe timer function can also alter the operation of Relay B. If the electrode diagnostic function is enabled, that function takes precedence over the probe timer.

PID Timer

This function sets a timer to monitor the amount of time the PID controller remains at 0% or 100%. This function only appears if the PID controller is enabled. If the timer is set to 0000, the feature is effectively disabled. If the timer value is set to any number other zero, a FAIL condition will occur if the PID controller remains at 0% or 100% for the timer value. If one of the relays are set to FAIL mode, this failure condition can be signaled by a changing relay contact.

Press ENTER to initiate user entry mode, and the entire value will flash. Use the UP arrow key to modify desired value; range of value is 0-9999 seconds. Press ENTER to store the new value

Fail Out

This function enables the user to define a specified value that the main current output will go to under fault conditions. When the Relay Option Board is installed, the display will read **Fail Out #1**. When enabled to **ON**, the output may be forced to the current value set in **Fail Val** (next item.) With the Fail Out setting of ON, and a Fail Val setting of 6.5 mA, any alarm condition will cause the current loop output to drop outside the normal operating range to exactly 6.5 mA, indicating a system failure that requires attention.

Press ENTER to initiate user entry mode, and the entire value will flash. Use the UP arrow key to modify desired value; selections are **ON**, **OFF**. Press ENTER to store the new value.

Fail Val

Sets the output failure value for Iout#1. When **Fail Out** above is set to **ON, t**his function sets value of the current loop under a FAIL condition. When the Relay Option Board is installed, the display will read **Fail Out #1**. The output may be forced to any current value between 4-20 mA.

Press ENTER to initiate user entry mode, and the entire value will flash. Use the UP arrow key to modify desired value; selections are between **4mA**, and **20mA**. Press ENTER to store the new value.

AC POWERED UNITS ONLY

Fail Out #2 This function sets the fail-mode of current loop output #2 under a FAIL condition. The settings and operation are identical to Fail Out for output #1.

Fail Val #2 This function sets the value of current loop output #2 under a FAIL condition. The settings and operation are identical to Fail Out for output #1.

AC POWERED UNITS ONLY

***Failsafe** This function allows the user to set the optional system relays to a failsafe condition. In a failsafe condition, the relay logic is reversed so that the relay is electrically energized in a normal operating state. By doing this, the relay will not only change state when, for example, a pH limit is exceeded, but also when power is lost to the controller.

When failsafe is selected to be ON, the normally-open contacts of the relay will be closed during normal operation. In an attempt to make this configuration less confusing, the LCD icon logic is reversed with this setting, and the icon is OFF under this normal condition. Therefore, when the trip condition occurs, the closed N.O. contacts will be opened (relay de-energized), and the LCD icon will illuminate. In addition, a power fail would also cause the same contacts to open.

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 5 – Calibration

5.1 Overview and Methods

Since the sensor slope (mV/pH output) will degrade over time, the instrument must be calibrated periodically to maintain a high degree of measurement accuracy. Frequency of calibration must be determined by the application. High temperature applications or applications involving extreme pH operating conditions may require more frequent calibration than those that operate at more neutral pH levels and ambient level temperatures. It is important for the user to establish a periodic cleaning and calibration schedule for sensor maintenance to maintain high system accuracy.

Before calibrating the instrument for the very first time after initial installation, it is important to select the proper operating parameters in the configuration menus for items like Sensor Type and Auto Buffers.

If Auto Buffers is not enabled, select buffers with values that are close to the normal operating pH of the process. For example, if the process is operating normally at 8 pH, buffer values of 9.18 pH and 7.00 pH are preferred over buffers of 4.00 pH and 7.00 pH. If possible, select one of the buffers to be near 7.00 pH.

NOTE: Buffers must be at least 2 pH units apart to ensure accurate calibration.

The system provides two methods of pH calibration: 2-point and 1-point. These two methods are significantly different. See Sections 5.13 and 5.14 for a brief description of their uses.

5.11 Sensor Slope

The sensor slope is a number (expressed as a percentage) which represents the current condition of the sensor electrodes. The slope display is updated after every calibration. When new, the sensor slope should be between 95% and 105%. A 100% slope represents an ideal sensor output of 59.16 mV/pH, from standardization (7.00 pH at 25°C). Over time, the glass electrodes in the sensor will age with use. This results in a reduction of the slope (mV/pH output) of the sensor. Thus a sensor slope of 85% is equivalent to an output of 50.29 mV/pH from standardization. The instrument will not allow calibrations on a sensor with a slope less than 80%. The slope information from the most recent calibration can be viewed at any time in the Measure Menu (see Section 4.22).

5.12 Sensor Offset

Sensor offset is a number that indicates sensor output (expressed in mV) in 7.00 pH buffer at 25 ºC. Ideally, the sensor will output 0 mV under these conditions. A sensor offset reading of +10 mV indicates that the sensor will output +10 mV when placed into a perfect 7.00 pH buffer at 25 ºC. In other words, sensor offset shifts the entire mV/pH curve up or down. Sensor offset is generally produced by a small voltage drop at the sensor reference junction. Large offsets are most typically the result of foulants on the reference junction, an aged reference junction, or a weak reference fill solution. The instrument does not allow calibrations on a sensor with an offset greater than +90 mV or less than –90 mV. Sensor offset information from the most recent calibration can be viewed at any time in the Measure Menu (See Section 4.22).

5.13 2-Point Calibration Explained

The 2-point calibration method involves the movement of the sensor through two known pH buffer values. Therefore, the sensor must be removed from the application to utilize this method. Two-point calibration adjusts both the slope and the offset of the sensor. It is the recommended method of calibration for highest accuracy. In addition, this calibration method utilizes an automatic buffer recognition and compensation method.

IMPORTANT: the 2-point calibration mode MUST be performed when a new sensor is first put into operation so that accurate calibration data is available for possible later 1-point calibrations.

5.14 1-Point Calibration Explained

The 1-point calibration method is generally known as the "grab sample" calibration method. In the 1-point calibration method, the sensor may be removed from the application and placed into one buffer. It may also be left in the measurement process and calibrated by reference. 1-point calibration adjusts only the sensor offset. Since the sensor slope degrades much slower than the sensor offset, this method may be used as a frequent calibration method between more involved 2-point calibrations. For example, a user may choose to perform on-line 1-point calibrations weekly and 2-point calibrations monthly.

5.2 Performing a 2-Point Calibration

The 2-point calibration method utilizes an automatic buffer recognition and compensation system. For this system to operate properly, the user must first configure the proper buffers in the Auto Buffers screen (see Section 4.24). If the buffers are not present in this menu, the user can override the automatic values and enter arbitrary values. However, the highest accuracy is provided when the user selects and uses buffers from this pre-defined table list. With the pre-defined buffers, the temperature variations in the buffer are automatically compensated for during the calibration process. If the buffer data is manually entered, the calibration buffer sample must be very temperature stable to achieve the same degree of accuracy.

Procedure

1. Remove sensor from application. Rinse and clean if necessary.

2. Allow sensor to temperature equilibrate with the buffer as best as possible. With the sensor coming from an application solution that differs greatly in temperature from the buffer, the user may have to wait as much as 20 minutes for this to occur.

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

4. Press the ENTER key. The screen will display a flashing 1 for 1-point or a 2 for 2-point calibration. Using the UP arrow key, set for a 2-point calibration and press ENTER.

5. The display will prompt the user to place the sensor in the first buffer and press ENTER. If the sensor has been placed into this buffer already, once the temperature has stabilized, press ENTER to continue.

6. The present pH value will be displayed and the secondary line of the display will flash **Wait** for approximately 10-15 seconds. At this time the system is attempting to recognize the first buffer value from the two values entered into the Set Buffers selection.

7. The screen will display the buffer value to be used for calibration. If the user chooses to change this value, the arrow keys can be used to modify the value. Any value between 0.00 and 14.00 pH can be entered. After adjusting this value, or to accept the automatic value, press ENTER.

8. The system now begins acquiring data for the calibration value of this buffer point. As data is gathered, the units for pH and temperature may begin to flash. Flashing units indicates that this parameter is unstable. The 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.

9. Once the first calibration value has been established, the screen will prompt the user to move the sensor to the second buffer. At this point, rinse sensor with water and move the sensor into the second buffer solution. Allow temperature to stabilize, then press ENTER.

10. The present pH value will be displayed and the secondary line of the display will flash **Wait** for approximately 10-15 seconds. At this time the system is attempting to recognize the second buffer value from the two values entered into the Set Buffers selection.

11. The screen will display the buffer value to be used for calibration. If the user chooses to change this value, the arrow keys can be used to modify the value. Any value between 0.00 and 14.00 pH can be entered. The second buffer must be at least 2 pH units away from the first. After adjusting this value, or to accept the automatic value, press ENTER.

12. The system now begins acquiring data for the calibration value of this buffer point. As data is gathered, the units for pH and/or temperature may again flash, indicating unstable parameters.

13. If accepted, the screen will display the message **PASS** with the new slope and offset readings, 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 sensor offset value in % from the last span calibration is displayed on the lower line of the Default Menus for information purposes.

5.3 Performing a 1-Point Calibration

The 1-point, or sample calibration method does not utilize the automatic buffer recognition and compensation system. This calibration method is intended to be primarily used as an on-line calibration method, in which the actual calibration point will not be a buffer value. However, the sensor can be removed and calibrated in a separate buffer. During calibration, the system will display the current pH reading and the user can manually enter a reference value from a lab grab-sample or a comparative reference instrument.

Procedure

1. Determine whether the calibration will be done on-line or with the sensor removed and placed into a buffer. If the sensor is removed from the application, rinse and clean if necessary.

2. If the sensor has been removed and placed into a buffer, allow sensor to

temperature equilibrate with the buffer as much as possible. With the sensor coming from an application which differs greatly in temperature difference, the user may have to wait as much as 20 minutes. 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.

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

4. Press the ENTER key. The screen will display a flashing 1 for 1-point or a 2 for 2-point calibration. Using the UP arrow key, set for a 1-point calibration and press ENTER.

5. The system now begins acquiring data for the calibration value. As data is gathered, the units for pH 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.

6. The screen will display the last measured pH value [or the auto buffer value, if activated] 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.

7. If accepted, the screen will display the message **PASS** with the new offset 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.

5.4 Temperature Calibration

The temperature input is factory calibrated for the highest accuracy. Temperature calibration is not recommended; however, it is provided for applications in which very long cable lengths are needed. For example, at 50 feet, readings may be off ±0.2 °C.

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 (see Page 58) feature prior to calibration to lock out any output fluctuations.

Procedure

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 message **Adjust temp value then 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.

5. 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.

6. 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.

Part 6 – PID Controller Details

6.1 PID Description

PID control, like many other control schemes, are used in chemical control to improve the efficiency of chemical addition or control. By properly tuning the control loop that controls chemical addition, only the amount of chemical that is truly required is added to the system, saving money. The savings can be substantial when compared to a system which may be simply adding chemical at a constant rate to maintain some minimal addition under even the worst case conditions. The PID output controller is highly advantageous over simple control schemes that just utilize direct (proportional only) 4-20 mA output connections for control, since the PID controller can automatically adjust the "rate" of recovery based on the error between the setpoint and the measured value – which can be a substantial efficiency improvement..

The PID controller is basically designed to provide a "servo"action on the 4-20 mA output to control a process. If the user requires that a measured process stay as close as possible to a specific setpoint value, the controller output will change from 0% to 100% in an effort to keep the process at the setpoint. To affect this control, the controller must be used with properly selected control elements (valves, proper chemicals, etc.) that enable the controller to add or subtract chemical rapidly enough. This is not only specific to pumps and valves, but also to line sizes, delays in the system, etc.

This section is included to give a brief description of tuning details for the PID controller, and is not intended to be an exhaustive analysis of the complexities of PID loop tuning. Numerous sources are available for specialized methods of tuning that are appropriate for a specific application.

6.2 PID Algorithm

As most users of PID controllers realize, the terminology for the actual algorithm terms and even the algorithms themselves can vary between different manufacturers. This is important to recognize as early as possible, since just plugging in similar values from one controller into another can result in dramatically different results. There are various basic forms of PID algorithms that are commonly seen, and the implementation here is the most common version; The ISA algorithm (commonly referred to as the "ideal" algorithm.)

$$output = P\left[e(t) + \frac{1}{I}\int e(t)d(t) + D\frac{de(t)}{dt} \right]$$

Where:

output =	controller output
P =	proportional gain
I =	integral gain
D =	derivative gain
t =	time
e(t) =	controller error (e=measured variable – setpoint)

Figure 6-1 Q45H ISA (Ideal) PID Equation

The most notable feature of the algorithm is the fact the proportional gain term affects all components directly (unlike some other algorithms - like the "series" form.) If a pre-existing controller utilizes the same form of the algorithm shown above, it is likely similar settings can for made if the units on the settings are exactly the same. Be careful of this, as many times the units are the reciprocals of each other (i.e. reps-per-min, sec-per-rep.)

PID stands for "proportional, integral, derivative." These terms describe the three elements of the complete controller action, and each contributes a specific reaction in the control process. The PID controller is designed to be primarily used in a "closed-loop" control scheme, where the output of the controller directly affects the input through some control device, such as a pump, valve, etc.

Although the three components of the PID are described in the setting area (section 4.25), here are more general descriptions of what each of the PID elements contribute to the overall action of the controller.

P Proportional gain. With no "I" or "D" contribution, the controller output is simply a factor of the proportional gain multiplied by the input error (difference between the measured input and the controller setpoint.) Because a typical chemical control loop cannot react instantaneously to a correction signal, proportional gain is typically not efficient by itself – it must be combined with some integral action to be useful. Set the P term to a number between 2-4 to start. Higher numbers will cause the controller action to be quicker.

I Integral gain. Integral gain is what allows the controller to eventually drive the input error to zero – providing accuracy to the control loop. It must be used to affect the accuracy in the servo action of the controller. Like proportional gain, increasing integral gain results in the control action happening quicker. Set the I term to a number between 3-5 to start (1-2 more than P). Like proportional gain, increasing the integral term will cause the controller action to be quicker.

D Derivative gain. The addition of derivative control can be problematic in many applications, because it greatly contributes to oscillatory behavior. In inherently slow chemical control process', differential control is generally added in very small amounts to suppress erratic actions in the process that are non-continuous, such as pumps and valves clicking on and off. However, as a starting point for chemical process control, its best to leave the "D" term set to 0.

Based on these descriptions, the focus on tuning for chemical applications really only involves adjustment of "P" and "I" in most cases. However, increasing both increases the response of the controller. The difference is in the time of recovery. Although combinations of high "P's" and low "I" will appear to operate the same as combinations of low "P's" and high "I's", there will be a difference in rate of recovery and stability. Because of the way the algorithm is structured, large "P's" can have a larger impact to instability, because the proportional gain term impacts all the other terms directly. Therefore, keep proportional gain lower to start and increase integral gain to achieve the effect required.

Many of the classical tuning techniques have the user start with all values at 0, and then increase the P term until oscillations occur. The P value is then reduced to ½ of the oscillatory value, and the I term is increased to give the desired response. This can be done with the Q45H controller, with the exception that the I term should start no lower than 1.0.

If it appears that even large amounts of integral gain (>20) don't appreciably increase the desired response, drop I back to about 1.0, and increase P by 1.00, and start increasing I again. In most chemical control schemes, I will be approximately 3 times the value of P.

6.3 Classical PID Tuning

Unlike many high speed position applications where PID loops are commonly used, the chemical feed application employed by this instrument does not require intense mathematical exercise to determine tuning parameters for the PID. In fact, the risk of instability is far greater with overly tuned PID control schemes. In addition, many of the classical mathematical exercises can be damaging or wasteful in the use of chemicals when the process is bumped with large amounts of input error to seek a response curve. Because of this, the general adjustment guidelines described in section 6.2 are sufficient for almost all application tuning for this instrument. Beyond this, many sources are available for classical tuning methods.

6.4 Common PID Pitfalls

The most common problem occurring in PID control applications involves the false belief that proper settings on only the PID controller can balance any process to an efficient level.

Close-loop control can only be effective if all elements in the loop are properly selected for the application, and the process behavior is properly understood. Luckily, the nature of simple chemical control process' are generally slow in nature. Therefore, even a de-tuned controller (one that responds somewhat slow) can still provide substantial improvements to setpoint control. In fact, damaging oscillatory behavior is far more likely in tightly tuned controllers where the user attempted to increase response too much.

When deciding on a PID control scheme, it is important to initially review all elements of the process. Sticking valves, undersized pumps, or delays in reaction times associated with chemical addition can have a dramatic effect on the stability of the control loop. When controlling a chemical mix or reaction, the sensor should be placed in a location that ensures proper mixing or reaction time has occurred.

The easiest processes to control with closed-loop schemes are generally linear, and symmetrical, in nature. For example, controlling level in tank where the opening of valve for a fixed period of time corresponds linearly to the amount that flows into a tank. Chemical control process' can be more problematic when the nature of the setpoint value is non-linear relative to the input of chemical added. For example, pH control of a process may appear linear only in a certain range of operation, and become highly exponential at the extreme ranges of the measuring scale. In addition, if a chemical process is not symmetrical, that means it responds differentially to the addition and subtraction of chemical. It is important in these applications to study steady-state impact as well as step-change impact to process changes. In other words, once the process has apparently been tuned under normal operating conditions, the user should attempt to force a dramatic change to the input to study how the output reacts. If this is difficult to do with the actual process input (the recommended method), the user can place the control in manual at an extreme control point such as 5% or 95%, and release it in manual. The recovery should not be overly oscillatory. If so, the loop needs to be de-tuned to deal with that condition (reduce P and/or I.)

Part 7 – System Maintenance

WARNING: EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2.

7.1 System Checks

1. If the FAIL icon is flashing on the display, check the Fault List to determine the cause of the failure. To access the Fault List, press the MENU/ESC key until the DIAG menu appears. Then press the UP arrow key until the Fault List appears. Press the ENTER key to access the Fault List, and the highest priority fault message will be displayed. For a list of all messages and possible causes/solutions, refer to Section 7.3.

2. In **ALL** environments, connect an earth ground jumper to earth terminal connection on transmitter.

3. Perform a two-point calibration with two fresh buffers prior to sensor installation.

4. Check sensor cable color to terminal strip markings.

5. For highly unstable behavior, remove sensor from the process and measure the process solution in a plastic beaker. If the reading now stabilizes, place wire in beaker solution and actual process solution to determine if a ground loop exists.

6. Verify that the black rubber shipping boot has been removed from the end of the sensor prior to submersion. If the sensor has been left to dry out, allow sensor to be submerged in buffer or water to re-hydrate for at least 4 hours. The saltbridge may need replacement if the sensor has dried out for too long.

7. If the instrument 4-20 mA output is connected into other control systems, disconnect output loop from system load and run through a handheld DMM to monitor current. Verify that the system operates correctly in this mode first.

7.2 Instrument Checks

1. Remove sensor completely and connect 1100 Ohms from the yellow to black sensor input leads. Make sure the unit is configured for a Pt1000 thermal element and that the temperature is not in manual locked mode. Also, connect a wire jumper from the red cable lead input to the green cable lead input. The temperature reading should be approximately 25°C, the pH reading should be approximately 7.00 pH, and the sensor mV reading should be between -20 and +20 mV.

2. With a DMM, measure the DC voltage from the white sensor lead connection to the black sensor lead connection. With the positive DMM lead on the white wire, the meter should read between -4.5 and -5.5 VDC.

3. For the line powered version, verify the proper line voltage power. With power disconnected, verify continuity across the line fuse.

4. For the DC transmitter variation, verify that power supply has required voltage based on size of resistance in current loop. Large resistive loads can reduce available power for transmitter.

(NOTE: See sensor manual for specific sensor tests to be performed.)

7.3 Display Messages

The Q45 Series instruments provide a number of diagnostic messages that 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 (see this section).

The following messages will appear as prompts:

MESSAGE	DESCRIPTION	POSSIBLE CORRECTION
Max is 200	Entry failed, maximum 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.	Clean sensor, get fresh cal solutions, allow temperature and pH readings to fully stabilize, do not handle sensor or cable during calibration.
Slope HIGH	Sensor slope from calibration is greater than 110%.	Get fresh cal solutions, allow temperature and pH readings to fully stabilize, check for correct buffer values
Slope LOW	Sensor slope from calibration is less than 80%.	Clean sensor, get fresh cal solutions, allow temperature and pH readings to fully stabilize, check for correct buffer values.
Offset HIGH	Sensor offset from calibration is less than –90 mV or greater than +90 mV	Clean or replace saltbridge, replace reference cell solution, clean sensor, get fresh cal solutions, allow temperature and pH readings to fully stabilize, check for correct buffer values.
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.
TC-F25 lock!	The TC selection is in F25 mode, locked at 25 ºC	Calibration and TC adjustment cannot be performed while the TC is in F25 mode. To allow access to TC calibrations, change TC mode from F25 (fixed 25) to SENS (sensor).

The following messages will appear as items on the Fault List:

MESSAGE	DESCRIPTION	POSSIBLE CORRECTION
Sensor High	The raw signal from the sensor is too high.	Check wiring connections to sensor.
Sensor Low	The raw signal from the sensor is too low.	Check wiring connections to sensor.
pH too High	The pH reading is > 14.00 pH.	The pH reading is over operating limits.
pH too Low	The pH reading is < 0.00 pH.	The pH reading is under operating limits.
Temp High	The temperature reading is > 110 ºC.	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	The temperature reading is under operating limits. Check wiring and expected temp level. Perform RTD test as described in sensor manual. Recalibrate sensor temperature element if necessary.
TC Error	TC may be open or shorted.	Check sensor wiring and perform RTD test as described in sensor manual.
Meas Break	Leakage detected on measuring electrode of sensor.	Measuring electrode glass may be cracked or broken. Electrical noise may falsely trip this diagnostic. Turn off glass diagnostic feature and see if sensor operates correctly. If it does not, sensor must be replaced.
Ref Break	Leakage detected on reference electrode of sensor.	Reference glass electrode may be cracked or broken. Electrical noise may falsely trip this diagnostic. Turn off glass diagnostic feature and see if sensor operates correctly. If it does not, sensor must be replaced.

MESSAGE	DESCRIPTION	POSSIBLE CORRECTION
pH Cal Fail	Failure of pH calibration.	Clean sensor, get fresh cal solutions, regenerate sensor (if necessary) and redo calibration. If still failure, sensor slope may be less than 80% or offset may be out of range. Perform sensor tests as described in sensor manual. Replace sensor if still failure.
TC Cal Fail	Failure of temperature calibration.	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 sensor manual. Replace sensor if still failure. Note that TC offset may also be adjusted using the Cal TC Factor function (See Section 6.5) which involves no calibration reference solutions.
Eeprom 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.
mV Cal Fail	Failure of factory temperature calibration.	Consult factory.

Spare Parts

Part No.	**Description**
07-0001	Q45P pH transmitter, 24 VDC
07-0003	Q45P pH monitor, 115 VAC /Relays
07-0118	Q45P pH monitor, 230 VAC / Relays
07-0100	Junction box
31-0057	Sensor interconnect cable
07-0219	Power Supply, NEMA 4X, 115 VAC in, 24 VDC out
07-0225	Power Supply, NEMA 4X, 230 VAC in, 24 VDC out
23-0018	Fuse, 100mA, 250V (115VAC)
23-0019	Fuse, 50mA, 250V (230VAC)

Lock/Unlock Code: 1451