Model Q45CT
External DC Power Toroidal Conductivity Transmitter

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PRODUCT WARRANTY

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

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

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

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

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

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

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

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Part 1 - Introduction

1.1 General

The Model Q45CT Conductivity monitor/analyzer provides an extremely versatile measurement system for monitoring and control of conductivity over the range of 20 µS/cm to 2.000 Siemen/cm. The instrument is offered as an externally powered transmitter for VDC 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.

Q45CT Monitors are available in three electronic versions, a loop-powered 2-wire transmitter, a dual “AA” battery operated portable unit with two voltage outputs, and a 5-17 VDC Externally powered unit with two voltage outputs. This manual refers to the externally powered version.

Since this system utilizes the same high performance 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 Q45CT continuous monitoring systems to simplify calibration by using the calibrate-by-reference method.

In all configurations, the Q45CT displays conductivity on the main display, and total dissolved solids (TDS), sensor temperature, and output loop current on the secondary line of the custom display.

WARNING: Not following operating instructions may impair safety.

1.2 Features

- Standard Q45CT electronic transmitters are fully isolated, externally powered for VDC applications.

- High accuracy, high sensitivity system, measures from 20 to 2,000,000 uS through 7 internal automatic ranges. User display ranges include 2000 us, 2000 mS, 20.00 mS, or 200.0 mS, 2000 mS, or 2.000 S.

- 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.

- Configurable for TDS display and signal output on one analog output.

- 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 the four measured parameters may be on the display simultaneously.

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

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

- High accuracy Pt1000 temperature input. Temperature element can be user calibrated.

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

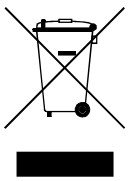
1.3 Q45CT System Specifications

Displayed Parameters	Main input, 0 uS to 2S (2,000,000 uS) Sensor temperature, -10.0 to 210.0 °C (23 to 410 ºF) Voltage Outputs, 0-2.5V Sensor slope Model number and software version
Main Parameter Ranges	Automatic or Manual selection of one of the following display ranges, 0 to 2000 uS 0.0 to 2.000 mS 0.00 to 20.00 mS 0.0 to 200.0 mS 0 to 2000 mS 0.000 to 2.000 S
Display	0.75” (19.1 mm) high 4-digit main display with sign 12-digit secondary display, 0.3" (7.6 mm) 5x7 dot matrix
Keypad	4-key membrane type with tactile feedback, polycarbonate with UV coating
Weight	1 lb. (0.45 kg)
Ambient Temperature	Analyzer Service, -20 to 60 °C (-4 to 140 ºF) 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	Pt1000 RTD with automatic compensation
Sensor	Fully isolated, toroidal electrode sensor design for direct measurement. ¾” NPT process connection.
Sensor Materials	Noryl

Sensor Pressure	150 psig maximum
Sensor Temperature	Noryl, 0 to 105°C (32 to 221ºF)
Sensor Cable	20 ft. (6.1 meter) 6-conductor cable. CPVC jacket rated to 105 °C dry and 70 °C wet.
Max. Sensor-to-Analyzer Distance	200 feet (61 meters), with special ATI junction box
Power	5-17 VDC
Enclosure:	NEMA 4X, polycarbonate, stainless steel hardware, weatherproof and corrosion resistant, HWD: 4.4" (112 mm) x 4.4" (112 mm) x 3.5" (89 mm)
Mounting Options	Wall or pipe mount bracket standard. Bracket suitable for either 1.5” or 2” I.D. U-Bolts for pipe mounting.
Conduit Openings	Two Pg-9 openings with gland seals, One 1” NPT opening with plug.
DC Cable Type	Belden twisted-pair, shielded, 22 gauge or larger

1.4 Q45CT Performance Specifications

Accuracy	0.5% of user range, or better (± 2 µS)
Repeatability	0.2% of user range, or better (± 2 µS)
Sensitivity	0.05% of user ranges (± 2 µS)
Stability	0.2% of user range per 24 hours, non-cumulative
Warm-up Time	7 seconds to rated performance
Supply Voltage Effects	DC version only, ± 0.05% of user range
Instrument Response Time	6 seconds to 90% of step input at lowest setting
Temperature Drift	Span or zero, 0.04% of span/°C



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

Part 2 – Analyzer Mounting

2.1 General

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

Locate the instrument in close proximity to the point of sensor installation - this will allow easy access during calibration. The standard cable length of the conductivity sensor is 20 feet. For sensor cables longer than 20 feet, use the optional junction box (07-0100) and sensor interconnect cable (31-0057).

Refer to Figure 3 and Figure 4 for detailed dimensions of each type of system.

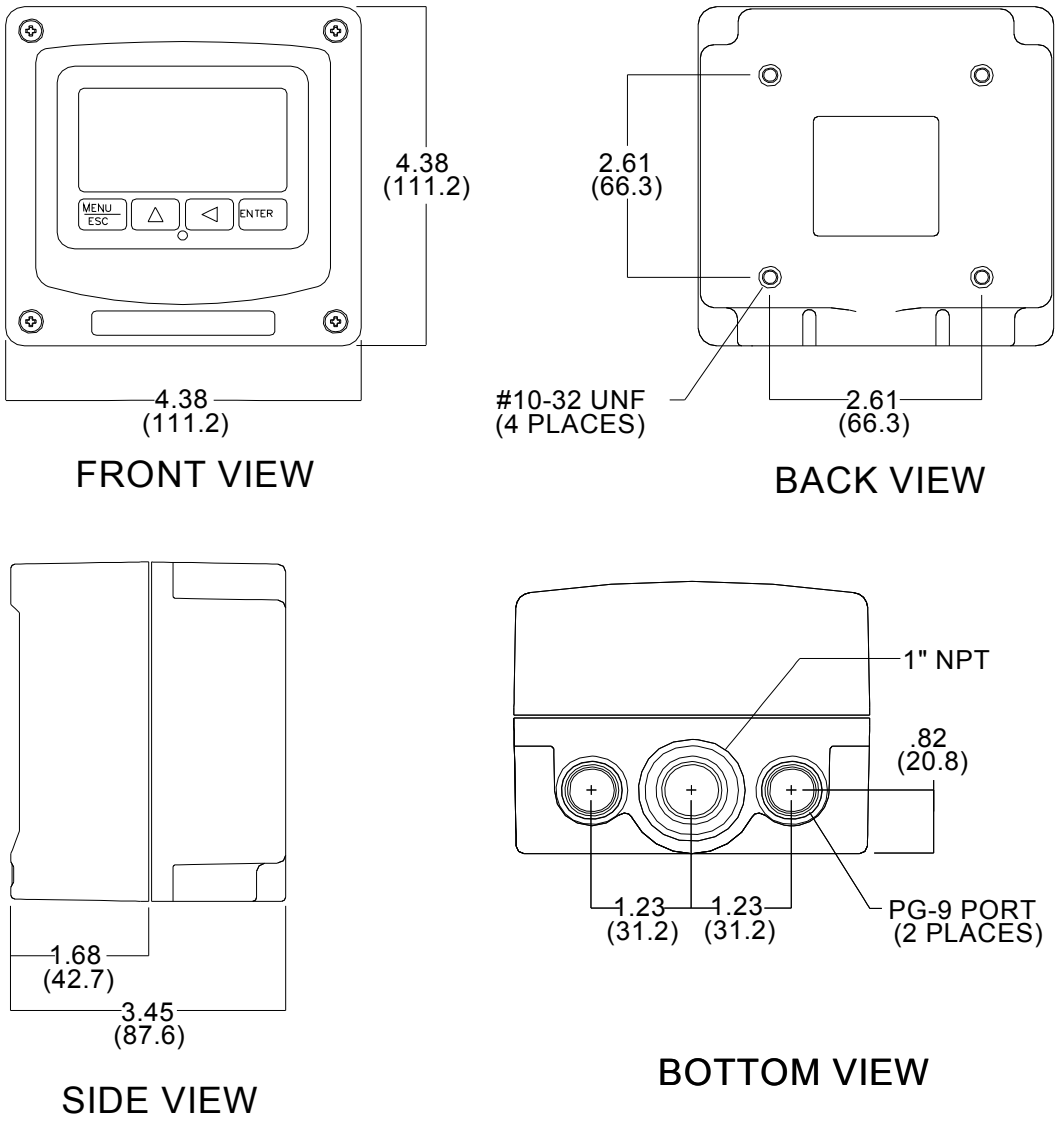


Figure 1 - Q45 Enclosure Dimensions

2.2 Wall or Pipe Mount

A PVC mounting bracket with attachment screws is supplied with each transmitter (see Figure 22 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)

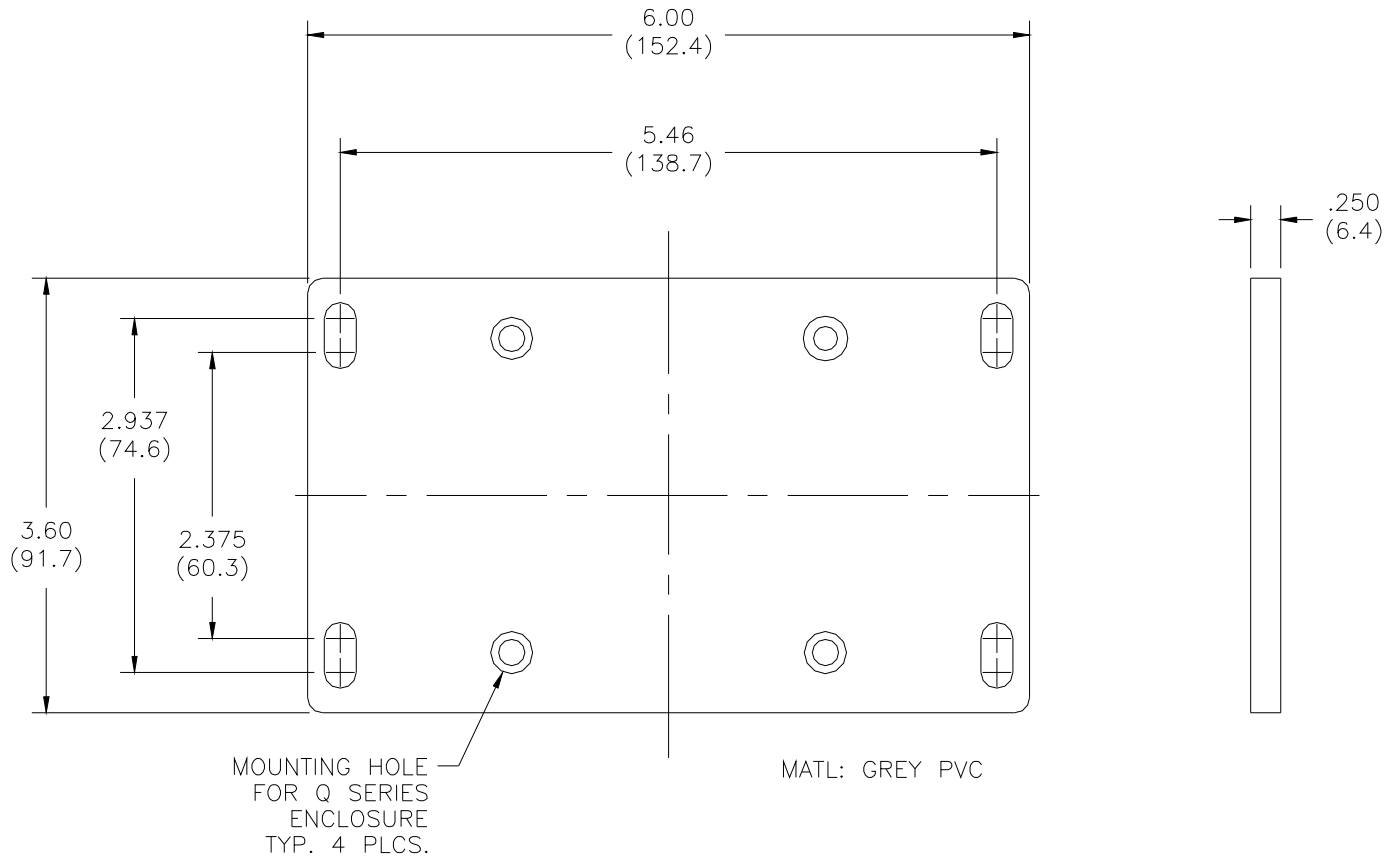


Figure 2 - Wall or Pipe Mount Bracket

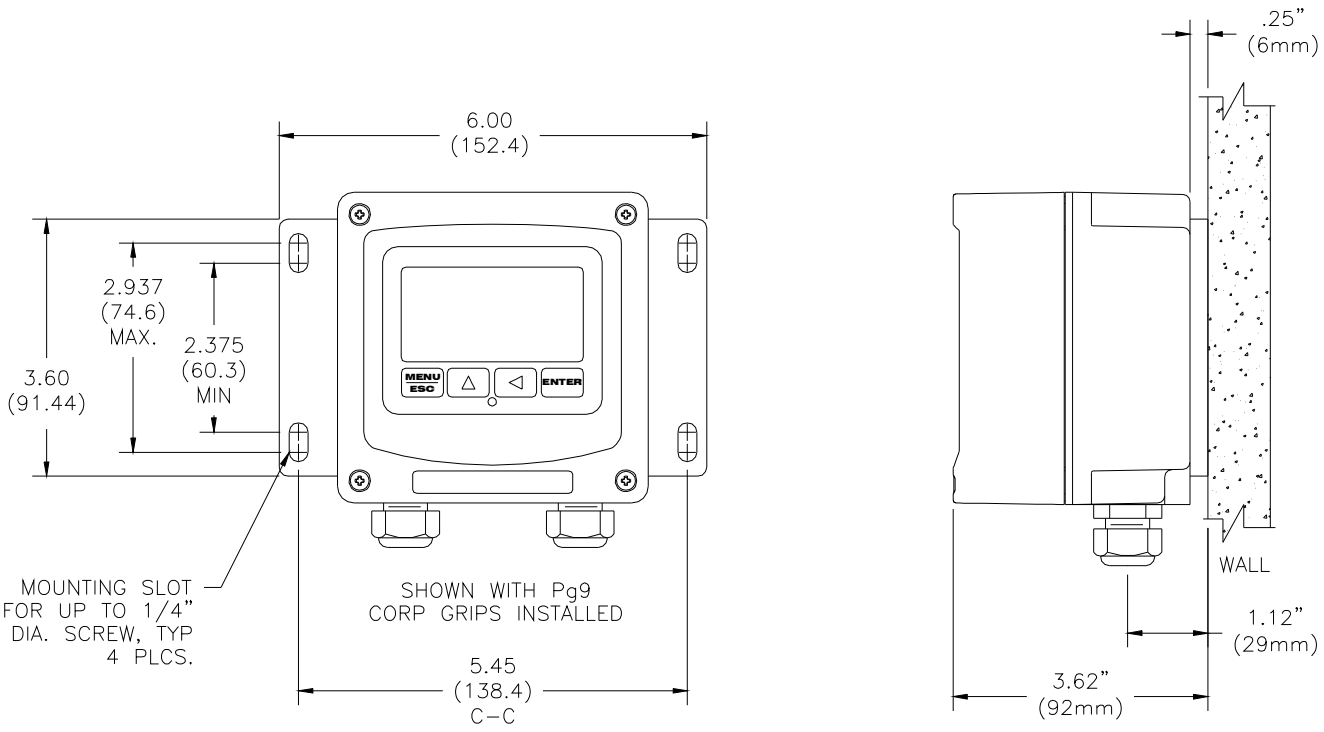


Figure 3 - Wall Mounting Diagram

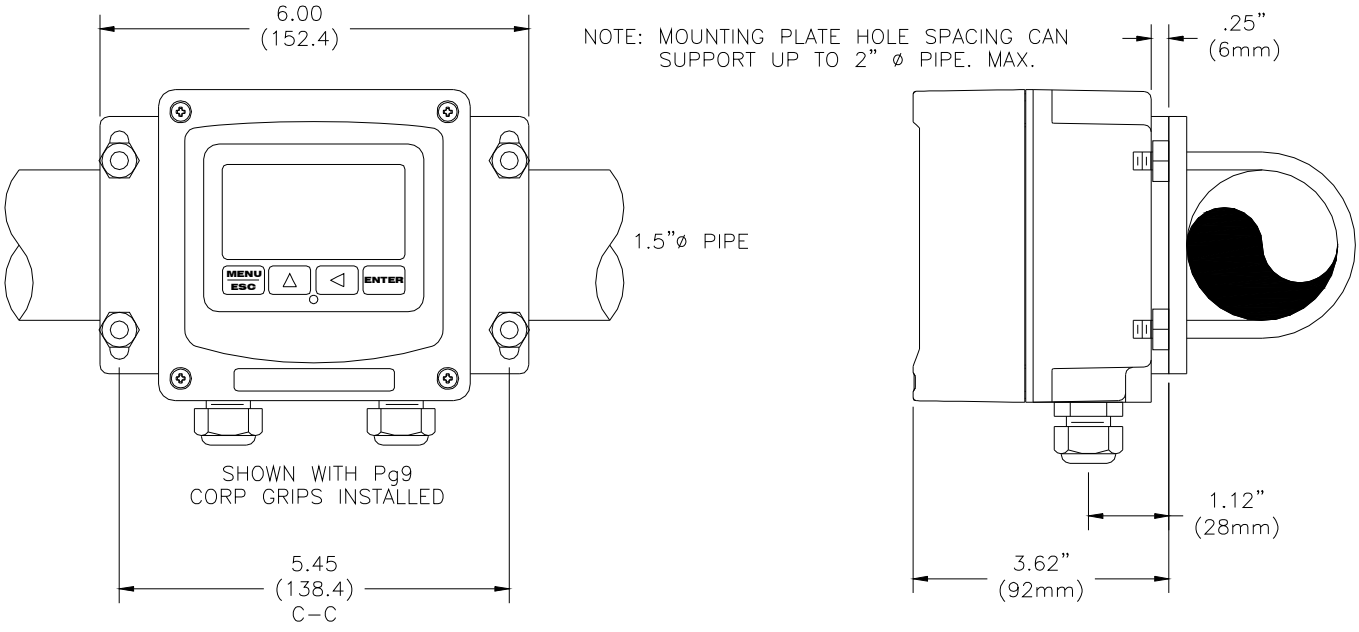


Figure 4 - Pipe Mounting Diagram

Part 3 – Sensor Mounting

3.1 General

Select a location within the maximum sensor cable length for mounting of the sensor. In non-tee applications, it is recommended that the sensor face be kept at least 2” away from any nearby walls, pipes, etc. when mounted.

Figure 55, below, shows the dimensions and features of the toroidal sensor.

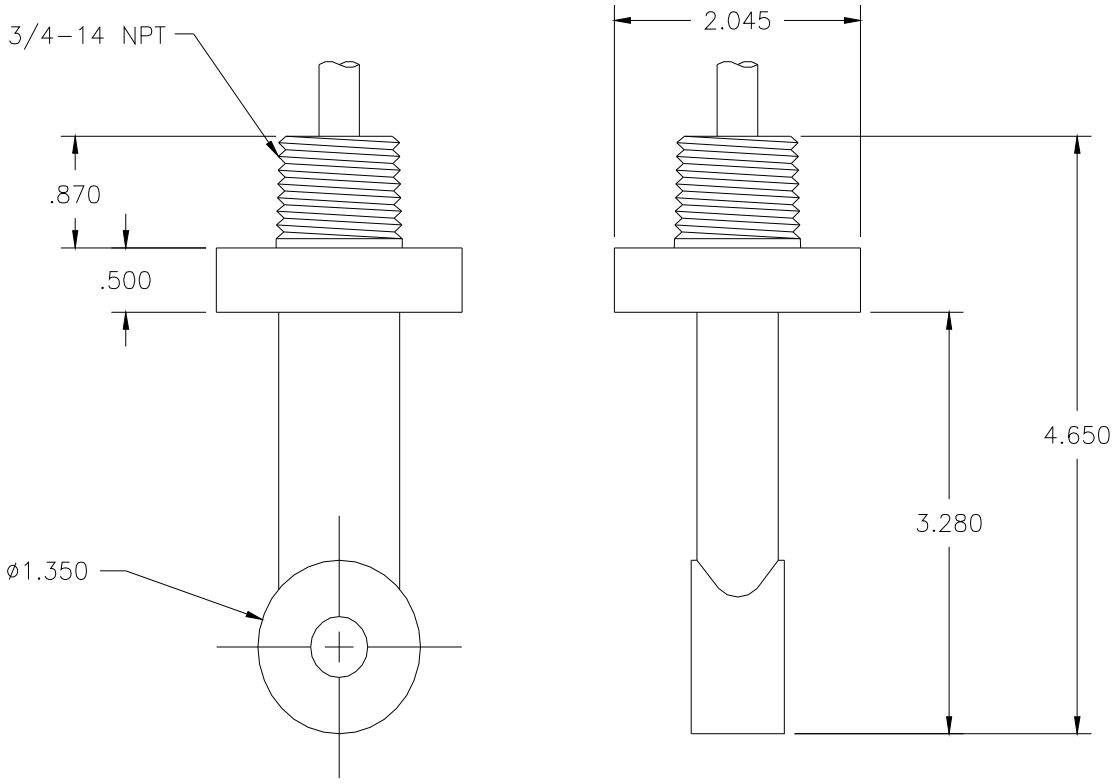


Figure 5 - Submersible Sensor Mounting Assembly

3.2 Tee Mounting

The toroidal sensors are mounted in a 2" pipe using an optional pipe adapter. The tee fitting is keyed so the sensor is oriented in the process as shown in Figure 66, below. The sensor bore opening should be aligned so that flow passes directly through the open sensor bore. A positioning notch is located on the upper sensor collar to aid in this alignment. This orientation is used to ensure a representative sample is being measured and to keep the sensor bore clean.

Note that sensor must be zero-calibrated before final mounting in tee.

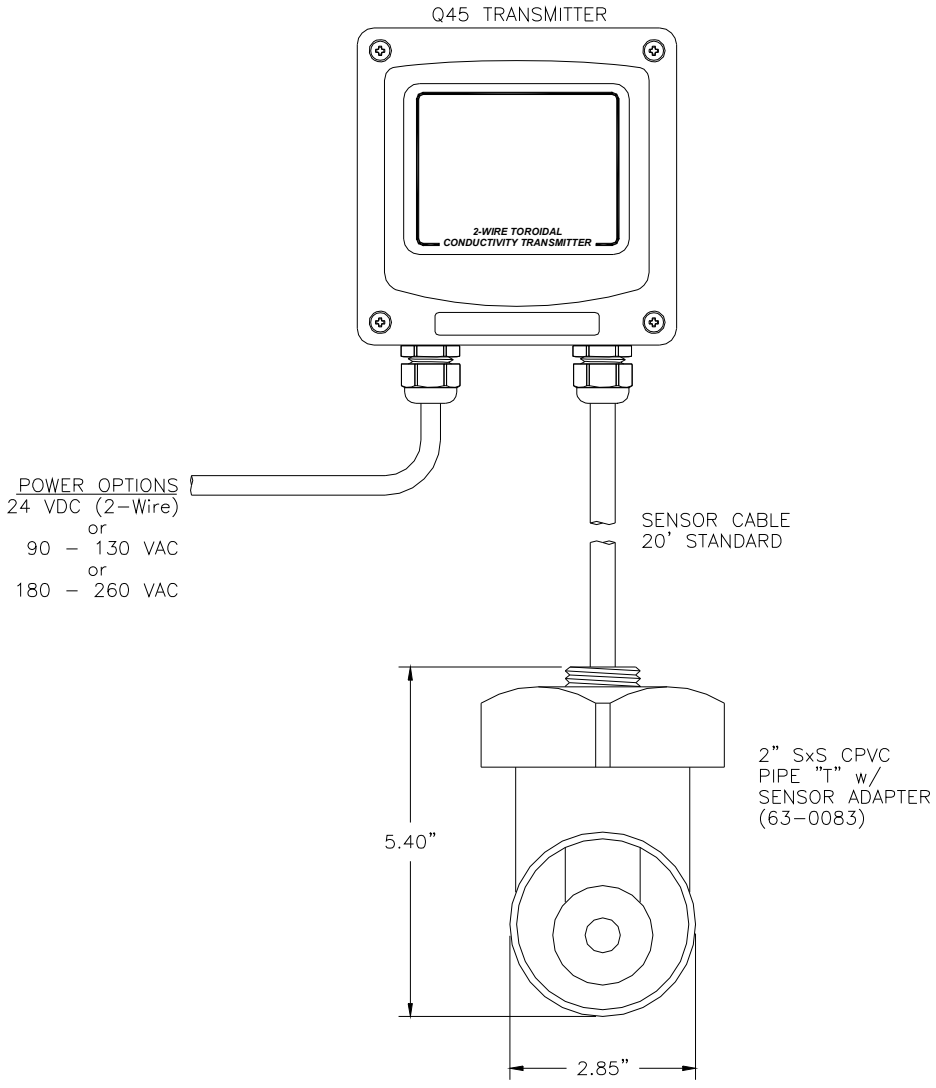


Figure 6 - Sensor Mounting - Tee Assembly

3.3 Submersion Mounting

Some applications are much easier done using the submersible sensor.

Submersible sensors are mounted to a 1" pipe using a standard 1" PVC thread by thread pipe coupling. The mounting pipe can be secured to standard 1½" pipe rail using a mounting bracket kit (00-0628) available from ATI, as shown in Figure 77. Maintain a minimum 2" distance from sensor face to any nearby walls, pipes, etc.

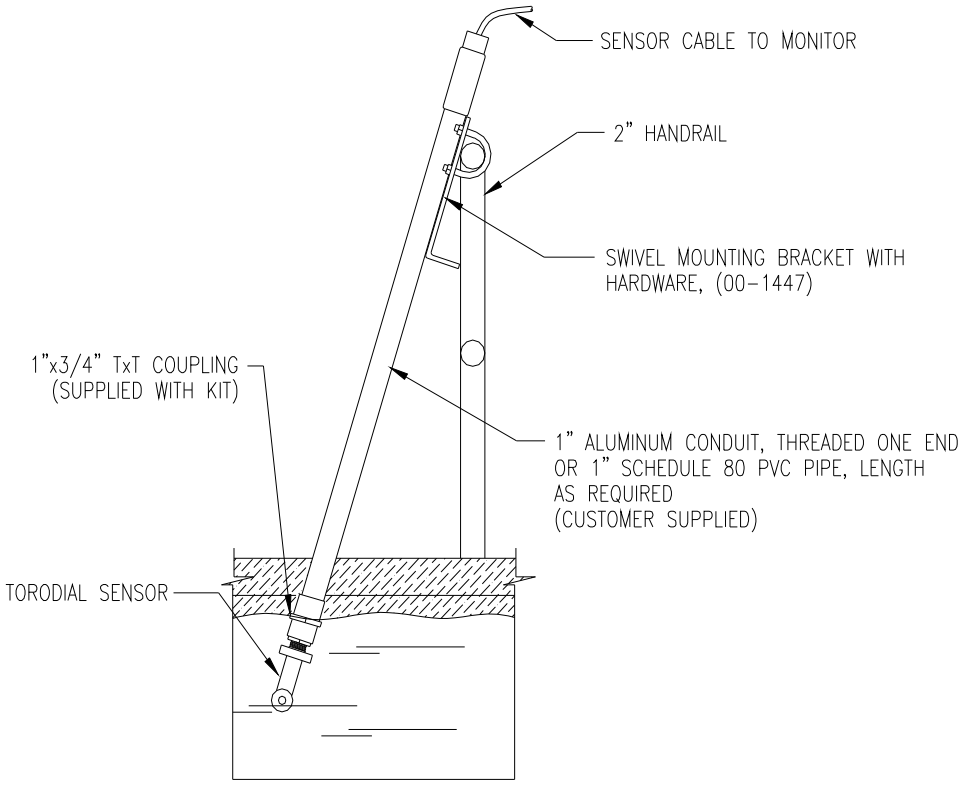


Figure 7 - Submersible Sensor Mounting Assembly

3.4 In-Line Installation

Toroidal Conductivity sensors may be installed directly into a flowing pipe system provided that the water does not contain a lot of entrained air. A 2" flow tee assembly is available for this purpose. It is best to install the sensor in a vertical pipe section with water flowing upward. This assures that air pockets cannot develop at the sensor. If installed in a horizontal run of pipe, place the sensor at the 3 or 9 o'clock position. Never mount the sensor on the top or bottom of the pipe. It is also good practice to install a bypass system around the sensor for maintenance and calibration purposes.

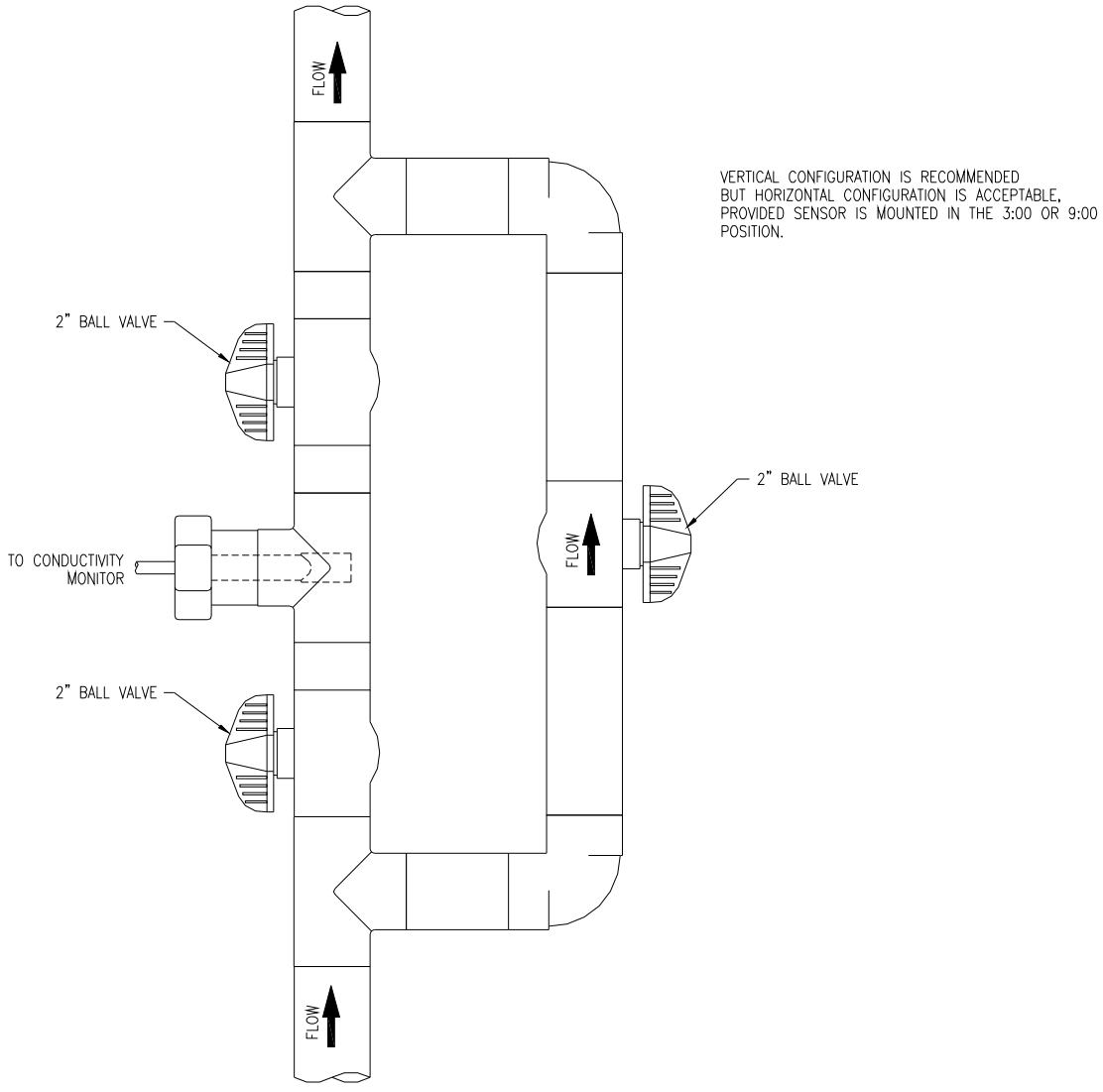


Figure 8 - In-Line Process Piping

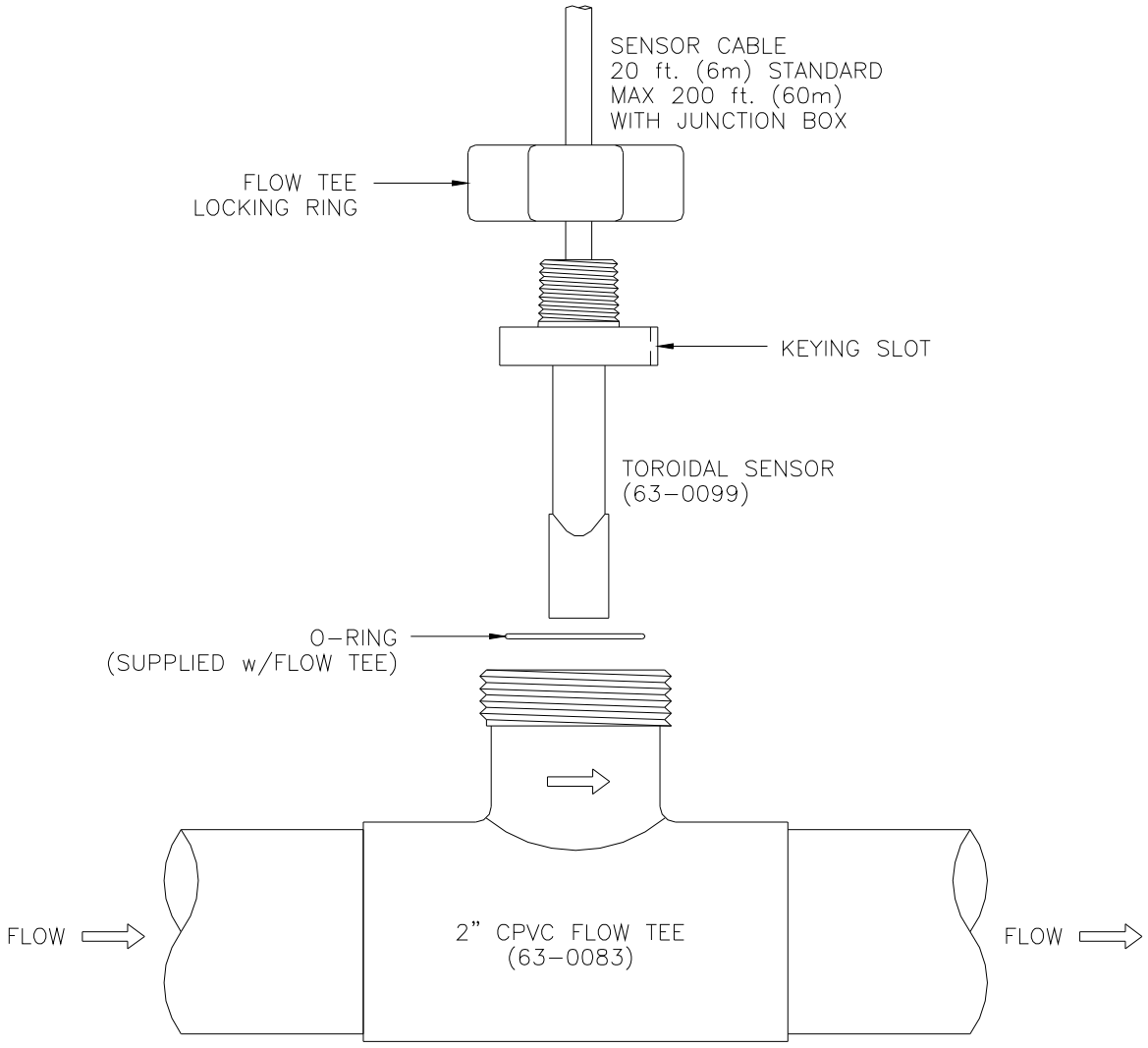


Figure 9 - In-Line Flow Tee (Exploded View)

Part 4 – Electrical Installation

4.1 General

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

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

Important Notes:

1. Use wiring practices that conform to all national, state and local electrical codes. For proper safety as well as stable measuring performance, it is important that the earth ground connection be made to a solid ground point from terminal 13 (see Figure 10).

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

3. This analyzer must be installed by 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.

4.2 External Power

Q45C4 units ordered with the external connection option are designed for applications where power is to be supplied from an external source, and the two voltage outputs are to be wired to an external device. Figure 11 identifies the terminal connections for external powers.

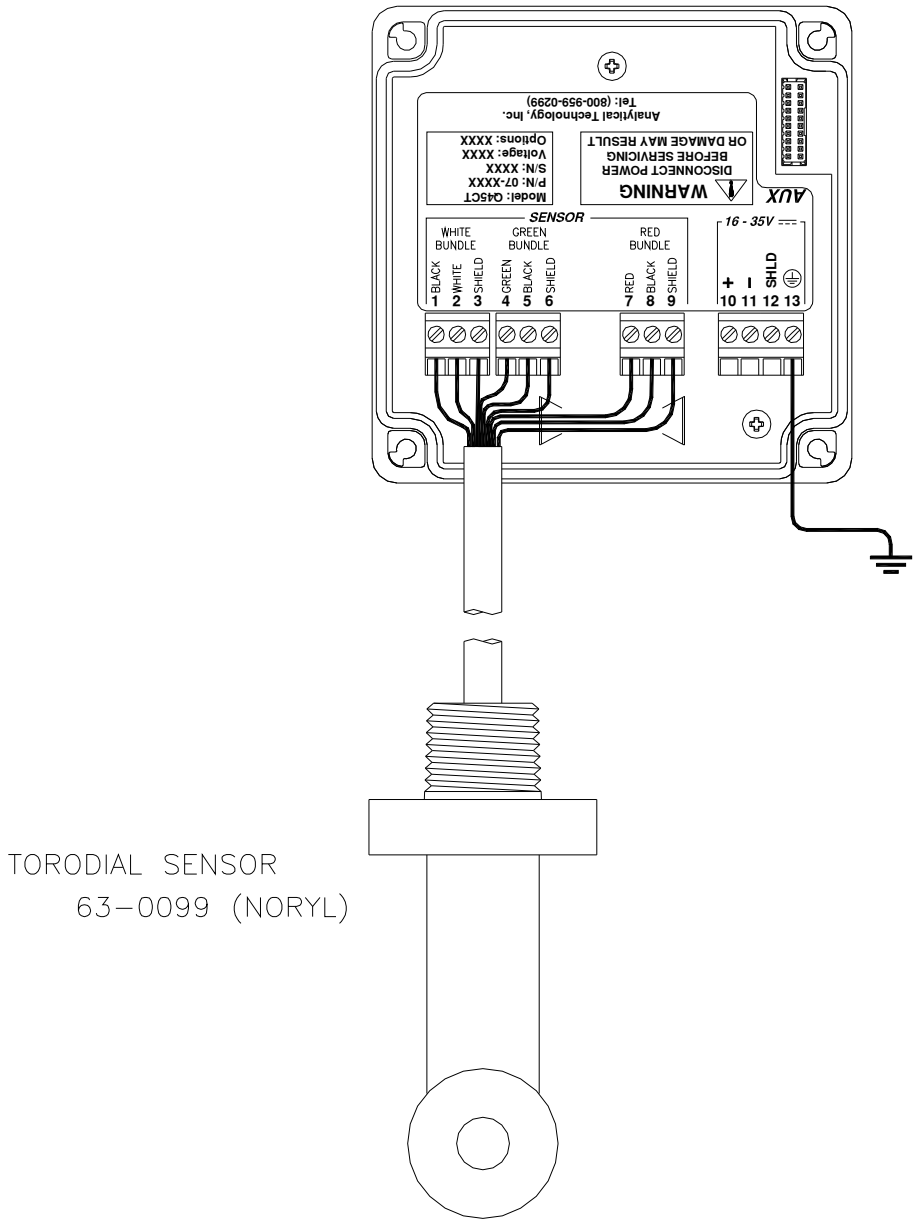


Figure 10 - Loop Power Connection, Q45CT Transmitter

Note: Earth ground into Terminal 13 is HIGHLY recommended. This connection can greatly improve stability in electrically noisy environments.

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

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

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

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

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

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

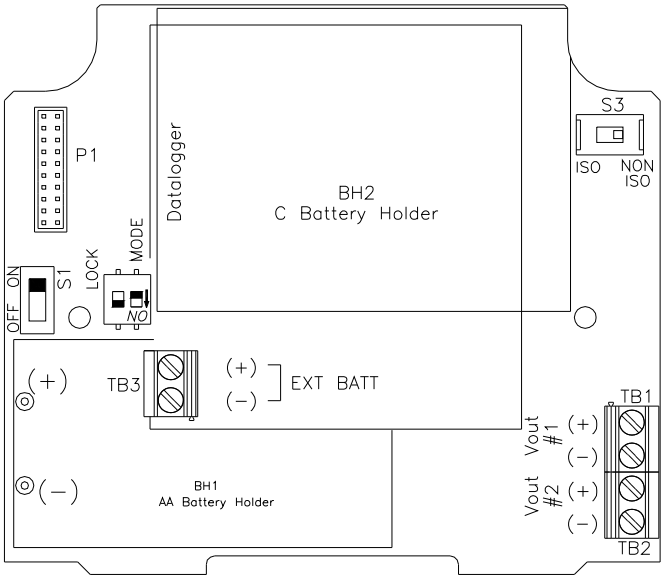


Figure 11 - External Power Board

4.3 Voltage Outputs

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

4.4 Sensor Wiring

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

4.5 Direct Sensor Connection

Sensor connections are made in accordance with Figure 10 or Figure 13. 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 20 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.

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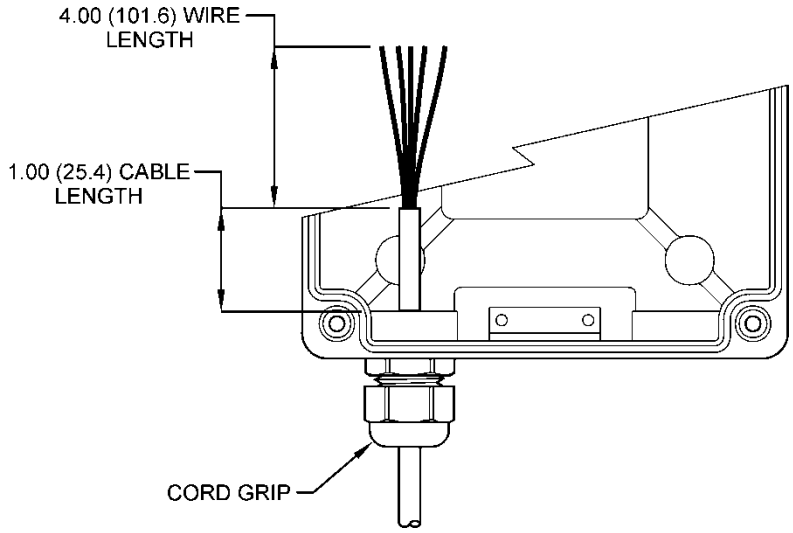


Figure 12 - Sensor Cable Preparation

4.5 Sensor Junction Box

When sensor separation from the monitor is needed and to be greater than 20 feet, the sensor junction box is required (07-0100). Wire according to Figure 1313 with 3 paired, individually shielded 22 AWG cable (31-0068).

CAUTION: When using a junction box and sensor interconnect cable, the RED SHIELD must be isolated from the WHITE and GREEN SHIELDS. Failure to maintain isolation with the RED SHIELD will result in measurement instability.

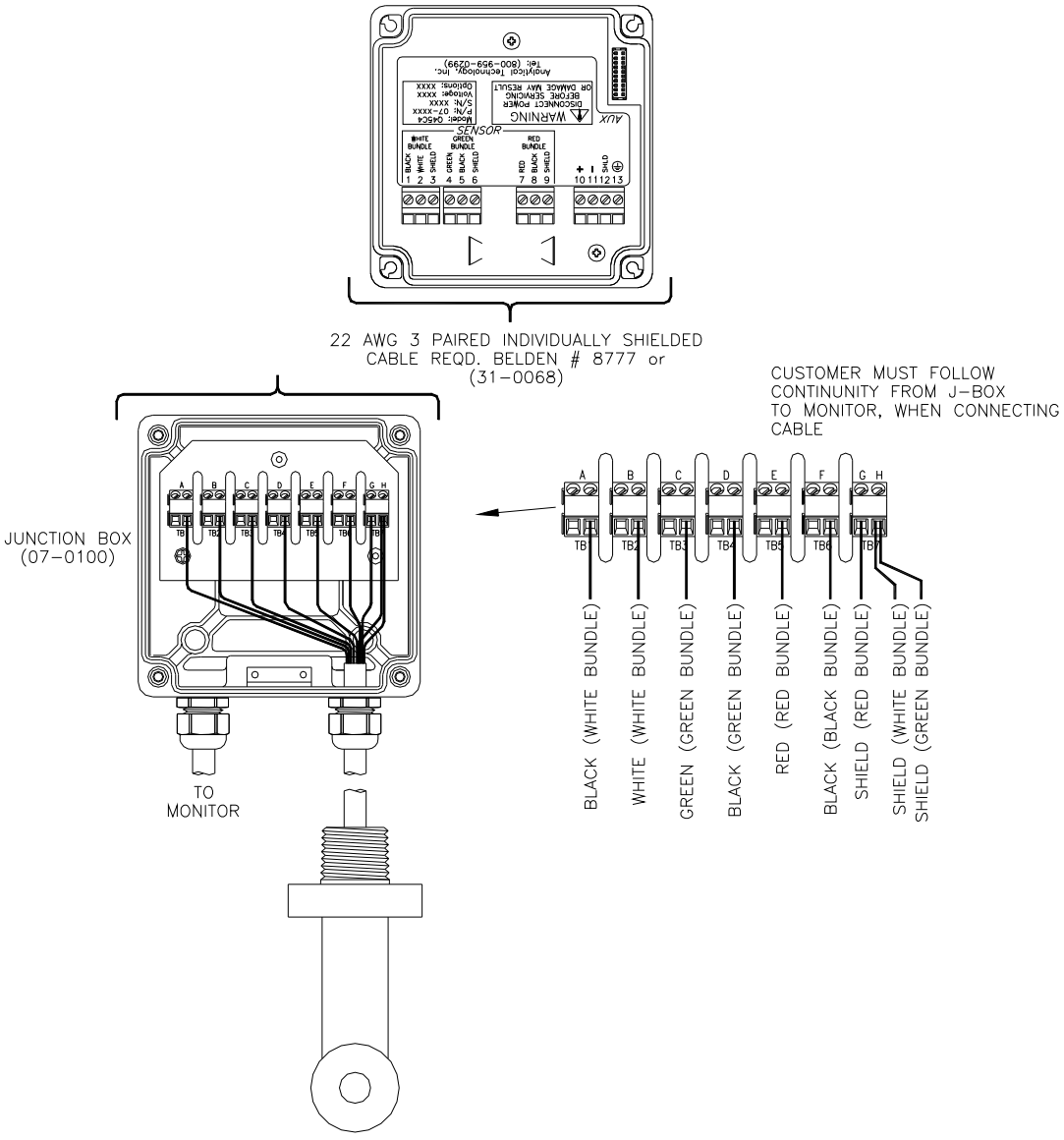


Figure 13 - Junction Box Wiring

Part 5 – Configuration

5.1 User Interface

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

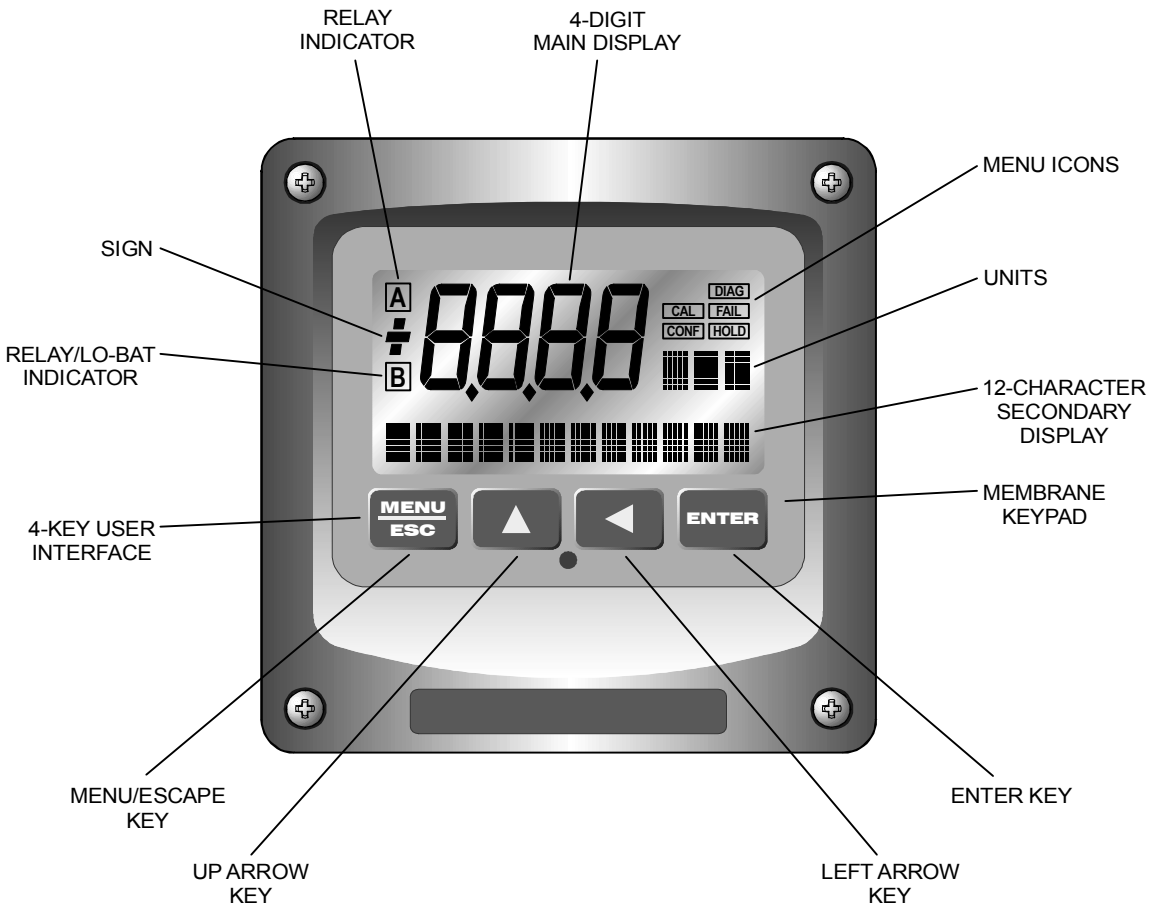


Figure 14 - User Interface

5.11 Keys

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

MENU/ESC To scroll through the menu section headers or to escape from anywhere in software. The escape sequence allows the user to back out of any changes in a logical manner. Using the escape key aborts all changes to the current screen and backs the user out one level in the software tree. The manual will refer to this key as either MENU or ESC, depending upon its particular function.

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

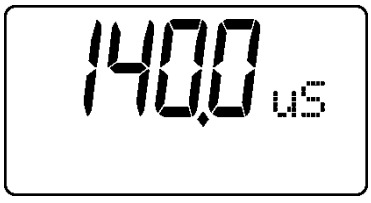
LEFT (arrow) To move the cursor from right to left during changes to a number value.

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

5.12 Display

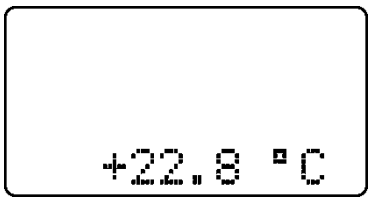
The large custom display provides clear information for general measurement use and user configuration. There are three main areas of the display: the main parameter display, the secondary message line, and the icon area.

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.



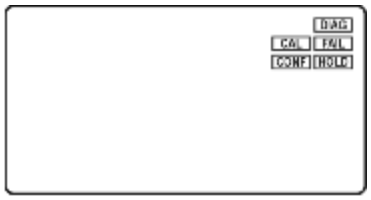
Lower Line

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 7.4.



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, CNTRL, 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.

5.2 Software

The software of the Q45CT 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.**

5.21 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 15 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 sequence. 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 conductivity 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.

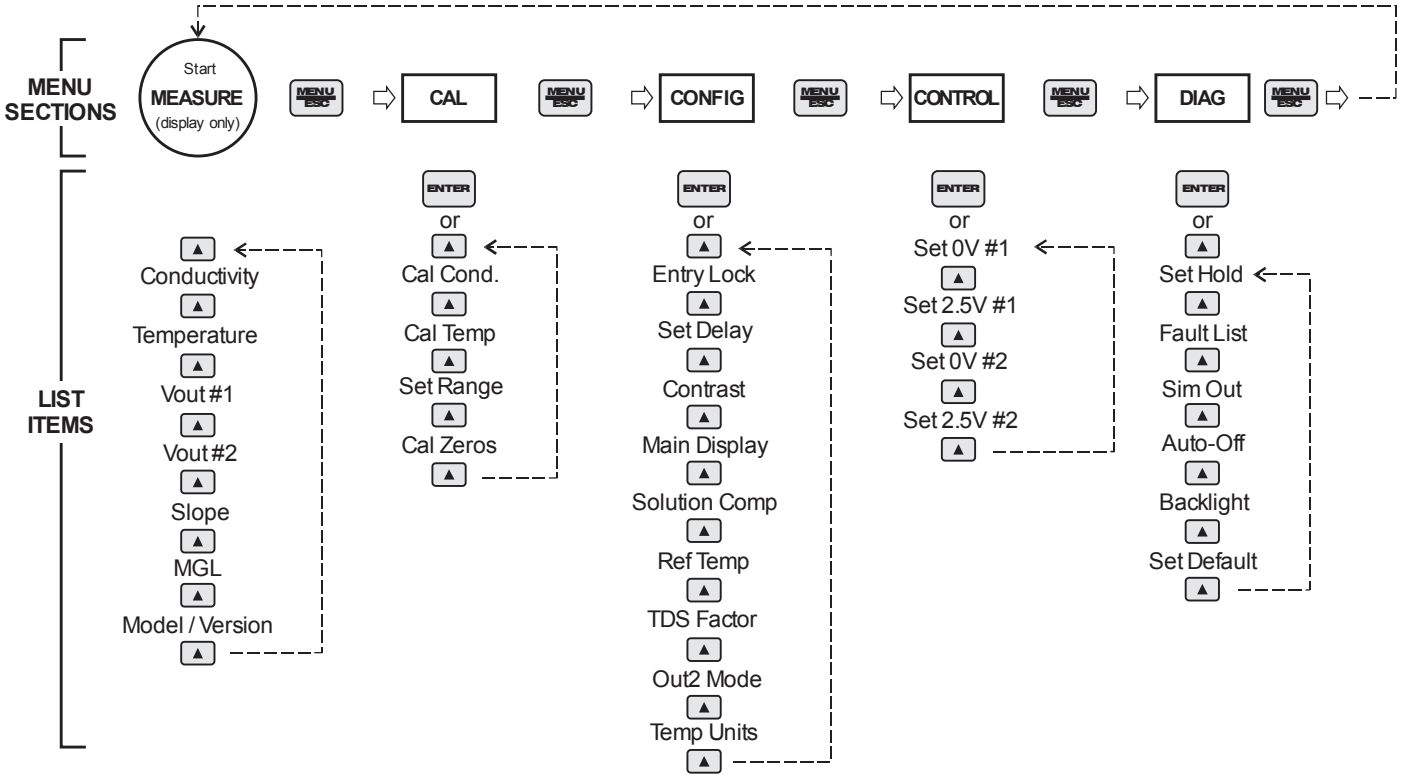


Figure 15 - Software Map

5.22 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.

#1 0.00 VDC Instrument output signal #1.

#2 1.25 VDC Instrument output signal #2.

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

TDS = 200 ppm Total Dissolved Solids (TDS). Displays TDS of process.

Q45C2 v4.01 Transmitter software version number.

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

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

5.23 Calibration Menu [CAL]

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

Cal Cond The conductivity 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 6 - 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 6 - Calibration for more details.

Set Range This function allows the user to set the display range of the transmitter for a specific application. Once set, all output functions use this display range to establish configuration settings. Press ENTER to initiate user entry mode, and the value will flash. Use the arrow key to modify the range for the desired range and then press ENTER.

Cal Zeros This function calibrates all range zero-points to the specific sensor being used. This function is only required to be performed once at initial start-up or when the sensor has been replaced. See Part 6 - Calibration for more details.

5.24 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 Q45CT 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 conductivity 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 conductivity, sensor temperature, or output current. Using this function, the user may choose to put temperature in the main display area and conductivity 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.

Solu Comp This function sets the correction slope value for the linear temperature compensation method and is used when the "Temp Mode" is set to **Lin**. Linear compensation is the method recommended for most aqueous solutions, and the value is typically 2.00 %/°C (25°C reference temperature) for neutral water. This is the factory default and it provides the best compensation for most aqueous solutions. Other typical ranges include:

Acids:	1.0 to 1.6%/°C
Bases:	1.8 to 2.0%/°C
Salts:	2.2 to 3.0%/°C

NOTE: If the temperature units are changed between °C and °F (see Temp Units in this Section), the default setting for this output will change between 2.00 %/°C and 1.11%/°F accordingly.

Other compensation slopes for uncommon solutions may be found in chemical handbooks (such as the CRC). Press ENTER to initiate user entry mode, and the entire value will flash. Use the arrow keys to modify the desired value; entry range is 0.000%/°C (no compensation) to 4.000%/°C. Press ENTER to store the new value.

Ref Temp The reference temperature function sets the basis point for the linear temperature compensation methods. In most cases this setting should be left at the default of 25.0 °C.

Press ENTER to initiate user entry mode, and the entire value will flash. Use the arrow keys to modify the desired value; range is 0.0°C to 50.0°C. Press ENTER to update and store the new value. This setting appears in the Software Menu only if "Temp Mode" is set to **Lin**.

TDS Factor This function sets the linear relationship of the TDS (total dissolved solids) reading to the conductivity measurement. The actual units for the slope are in mg/L/µS. The default value is 00.49 mg/L/µS.

Press ENTER to initiate user entry mode, and the entire value will flash. Use the arrow keys to modify the desired value; range is 00.00 mg/L/µS to 99.99 mg/L/µS. Press ENTER to update and store the new value.

Out 2 Mode This assigns output #2 to either µS (by selecting 1) or for temperature output (by selecting 2)

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.

5.25 Control Menu [CONTROL]

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

Set 0V #1
Set 2.5V #1
Set 0V #2
Set 2.5V #2

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

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

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

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

5.26 Diagnostics Menu [DIAG]

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

Set Hold

The Set Hold function locks the current loop output values on the present process value, and halts operation of the PID controller. This function can be used prior to calibration, or when removing the sensor from the process, to hold the output in a known state. Once HOLD is released, the outputs return to their normal state of following the process input. The transfer out of HOLD is bumpless on the both analog outputs - that is, the transfer occurs in a smooth manner rather than as an abrupt change. An icon on the display indicates the HOLD state, and the HOLD state is retained even if power is cycled. Press ENTER to initiate user entry mode, and entire value will flash. Use the UP arrow key to modify the desired value, selections are **ON** for engaging the HOLD function, and **OFF** to disengage the function. Press ENTER to store the new value.

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

CAUTION: There is no time-out on the hold feature. Once placed into hold mode, return to normal operation must be done manually.

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.

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

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

Set Default The Set Default function allows the user to return the instrument back to factory default data for all user settings or for just the calibration default. It is intended to be used as a last resort troubleshooting procedure. All user settings or the calibration 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 6 – Calibration

6.1 Overview and Methods

Calibration of the Q45CT is required to accurately match the sensor characteristics to the monitor/analyzer. Since the output of the conductivity sensor does not degrade over time, it is typically only required that the sensor be calibrated at initial installation and then cleaned periodically to maintain proper system accuracy.

It is important for the user to establish a periodic cleaning and calibration-check schedule for sensor maintenance to maintain high system accuracy. Since the conductivity of a solution is greatly affected by temperature, proper settings for thermal compensation are critical for accurate operation. Before calibrating the instrument for the very first time, it is important to select the proper operating parameters in the configuration menus for temperature compensation methods. Also at initial installation, a temperature calibration must be performed before conductivity can be calibrated.

When using conductivity calibration standards for a wet calibration, take care not to inadvertently contaminate the reference solution; always thoroughly clean the sensor, rinsing off in tap water, and then finish rinsing in pure or de-ionized water. In addition, note that calibration solutions less than 200 µS or greater than 100 mS can be very unstable. Moving the sensor back and forth between different value conductivity reference solutions can quickly contaminate the solutions and render them inaccurate.

6.11 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 a reference solution. It may also be left in the measurement process and calibrated by reference. The 1-point calibration adjusts the sensor slope to match the exact calibration point. Readings beyond that point are then extrapolated from the determined slope of the calibration line. Since the sensor slope does not degrade over time, frequent re-calibration is unnecessary. Calibration accuracy can be optimized by calibrating with a reference solution which is close to the values typically measured.

6.12 Zero Cal Calibration Explained

The sensor offset must be set for the system only on initial sensor installation, or when the cable length has been altered. The Zero Cal method establishes all of the sensor offset points for the instrument’s 6 ranges of operation.

6.2 Performing a Sensor Zero Calibration

The sensor offset **MUST** be set for the system on initial sensor installation, or when the cable length has been altered. However, it can easily be adjusted at any time by re-calibrating the sensor in air. The sensor zero-calibration generally has little effect in measurements above about 50 mS, but it can have a significant effect in measurements below about 1 mS. If the sensor zero cal is to be performed, it must be done **BEFORE** the 1-point reference calibration.

To begin the sensor zero cal, verify that the sensor is connected and clean and dry. It should be placed in the air with the electrodes at least 1 foot away from any nearby objects. Holding it is not recommended – place on table or just hang.

Procedure

1. Remove sensor from process and clean thoroughly. Dry sensor and position on table or hang in air (in air is best.) If on table, let end of sensor hang over edge of table.

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

3. Press the ENTER key. The screen will prompt the user to position the sensor in air.

4. Press the ENTER key. The screen will automatically scroll through all ranges and establish and store the proper zero points.

6.3 Performing a 1-Point Calibration

This calibration method is intended to be used as an on-line calibration method or a wet-cal with reference solutions. During calibration, the system will display the current conductivity reading, and the user can manually enter a reference value from a reference solution bottle or a comparative reference instrument.

For wet calibrations, the user may use pre-made calibration references (also available from ATI) or a NaCl solution may be made using pure, dried NaCl crystals and one liter of high purity, de-ionized, CO_2-free water as mixed in the table shown in Figure 16. All table data is at 25°C - therefore, the sensor must be at this temperature to calibrate properly using the table data. If another reference calibration solution is being used, be sure to note temperature of reference solution before calibration. Since the sensor must ideally be at the specified temperature, wet calibrations can be difficult to perform accurately.

NaCl Reference Solution for Calibration (25°C)	
µS/cm	**NaCl (gm)**
100	0.05
200	0.10
500	0.25
1000	0.50
2000	1.01
3000	1.53
4000	2.06
5000	2.61
8000	4.34
10000	5.56
20000	11.59

Figure 16 - NaCl Reference Solution for Calibration

During the 1-point calibration, the system will automatically pick the correct range for the calibration reference if the Q45CT is in the **AUTO** range (see Section 6.11). If the Q45CT is in a normal display mode, the user must be careful to calibrate with a solution that falls into the manual range selected. If the calibration solution is outside the manual range, an error will result.

Procedure

1. If a zero calibration on the sensor is also to be performed, that must be done **FIRST**. The zero calibration process can have an impact on the result of the 1-point calibration. So if a zero cal is required, do that procedure and return here.

2. Determine whether the calibration will be done on-line or with the sensor removed and placed into a reference solution. If the sensor is removed from the application, rinse and clean. When calibrating a toroid sensor in a beaker of reference solution, there must be plenty of clearance between the sensor and any nearby objects – at least 2 inches. Also, gently stir sensor back and forth to remove any bubbles that may be present in the inner bore.

3. If the sensor has been removed and placed into a solution, allow the sensor to temperature equilibrate with the solution as much as possible. With the sensor coming from an application that differs greatly in temperature, 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.

4. Scroll to the CAL menu section using the MENU key and press ENTER or the UP arrow key. Scroll until **Cal Cond** is displayed. Press ENTER.

5. The screen will prompt the user to place the sensor into the reference solution (ideally this has already been done to achieve temperature equilibrium.) Once sensor is ready, press ENTER.

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

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

8. If accepted, the screen will display the message **PASS** with the slope value, 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.

6.4 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 Section 5.12) 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 calibration data gathering process will begin. The message **Wait** will flash as data is accumulated and analyzed. The **°C** or **°F** symbol may flash periodically if the reading is too unstable.

5. The message **Adjust 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.

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 7 – System Maintenance

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 7.4.

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

3. Perform a sensor zero calibration and a one-point calibration 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, check process mount for possible entrapped air. If sensor was mounted in-line in plastic tee, measuring lower conductivity water, ensure no high voltage sources (pumps, AFDs, motor starters, etc) are present within about 1 foot of tee.

7.2 Instrument Checks

1. Remove sensor completely and connect 1100 Ohms from the GREEN to BLACK (green bundle) on the analyzer input leads. The temperature reading should display approximately 25 °C and the conductivity reading should display approximately 0.0 uS.

2. Reconnect the sensor and leave dry in air. With a DMM, measure the AC voltage between RED and BLACK sensor leads. The DMM should read between 100 mVrms and 300 mVrms @ about 10 kHz. The display should show some value close to 0 uS if the sensor has been properly zero calibrated.

3. 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.

7.3 Sensor Tests

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

A. Disconnect the nine sensor wires from the terminal strip on the transmitter. Check sensor covering for any mechanical damage to plastic covering.

B. Connect a DVM between the RED and BLACK wires in the red jacket pair. With the DVM set to measure resistance, you should measure between 0.4 and 2.0 Ohms.

C. Connect a DVM between the WHITE and BLACK wires in the white jacket pair. With the DVM set to measure resistance, you should measure between 0.4 and 2.0 Ohms.

D. Connect a DVM between the WHITE wire from the white jacket pair, and the RED wire from the red jacket pair. With the DVM set to measure resistance, you should measure an open circuit.

E. Connect a DVM between the GREEN and BLACK wires in the green jacket pair. You should find a resistance value that depends on the temperature. The table below lists the resistance values.

Temperature °C	Resistance Ω
0	1000
5	1019
10	1039
15	1058
20	1078
25	1097
30	1117
35	1136
40	1155
45	1175
50	1194

Figure 17 - Pt1000 RTD Table

7.4 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.

The following messages will appear as prompts:

MESSAGE	DESCRIPTION		POSSIBLE CORRECTION
Cal Unstable	Calibration problem, data too unstable to calibrate.		Clean sensor, get fresh cal solutions, allow temperature and conductivity readings to fully stabilize, do not handle sensor or cable during calibration.
Slope HIGH	Sensor slope from calibration is greater than 400%.		Get fresh cal solutions, allow temperature and conductivity readings to fully stabilize, check for correct buffer values
Slope LOW	Sensor slope from calibration is less than 20%.		Clean sensor, get fresh cal solutions, allow temperature and conductivity readings to fully stabilize, check for correct buffer values.
Offset HIGH	Sensor offset from calibration is too high		Clean sensor, get fresh cal solutions, allow temperature and conductivity readings to fully stabilize, check for correct solution 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 won't calibrate because there is something wrong with the connection to the temperature element in the sensor.		Perform Sensor Tests and Instrument Tests to confirm operation of TC in sensor. Check all connections between sensor and instrument.

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.
Cond too High	The conductivity reading is > 2000 mS.	The conductivity reading is over operating range limits. Move to a higher range or select "Auto" from Main Display in CONFIG menu.
Temp High	The temperature reading is > 210 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.
Cond Cal Fail	Failure of conductivity calibration.	Clean sensor, get fresh cal solutions and redo calibration. Verify conductivity value of application or reference solutions. Perform sensor tests as described in sensor manual. Replace sensor if still failure.
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.
Range Cal Fail	Failure of factory temperature calibration.	Consult factory.

Spare Parts

Part No.	Description
Spare Electronics	
03-0336	Q45CT Front Lid Assembly
07-0045	Q45CT Transmitter Assy, External Power (5-17 VDC)
03-0361	External Power PCB Assy
Spare Sensors	
63-0099	Toroidal Conductivity Sensor, Noryl
Spare Flowcells	
63-0083	2” Flow Tee, Polypropylene
Misc Components	
07-0100	Junction box
31-0068	Sensor interconnect cable
09-0047	Conductivity Standard - 447 microSiemens, 500 mL
09-0048	Conductivity Standard - 1,500 microSiemens, 500 mL
09-0049	Conductivity Standard – 8,974 microSiemens, 500 mL
09-0050	Conductivity Standard - 80,000 microSiemens, 500 mL

Lock/Unlock Code: 1458