Model Q45R

Portable
ORP Measurement
System

Operation and Maintenance
Manual

Home Office
Analytical Technology, Inc.
6 Iron Bridge Drive
Collegeville, PA 19426

Ph: 800-959-0299
610-917-0991
Fax: 610-917-0992
Email: sales@analyticaltechnology.com

European Office
ATI (UK) Limited
Unit 1 & 2 Gatehead Business Park
Delph New Road, Delph
Saddleworth OL3 5DE
Ph: +44 (0)1457-873-318

Fax: + 44 (0)1457-874-468
Email:sales@atiuk.com

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 Q45R ORP monitor provides an extremely versatile measurement system for monitoring/recording of ORP over the range of -1000 to +2000 mV.

The system operates on two AA batteries.

The Q45R displays mV ORP, sensor temperature, sensor output millivolts, and output mV signals 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.

1.2 Features

- Standard Q45R electronic transmitters are designed to be a fully isolated, battery powered instrument. The monitor can be quickly converted to either a loop power transmitter or line powered analyzer.

- Two 10-bit, isolated, 0-2.5 VDC analog outputs may be configured to track ORP and temperature, or ORP and ORP. Both analog outputs can be individually programmed to specific ranges.

- Large, high contrast, custom Super-Twist display provides excellent readability 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. An LED backlight can be turned on if necessary for use in very low light conditions.

- 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 3 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.

1.3 Q45R System Specifications

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	Handheld w/ Nylon Carrying Strap
Weight	1 lb. (0.45 kg)
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. Integral LED back-light for visibility in the dark
Keypad	4-key membrane type with tactile feedback, polycarbonate with UV coating
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, -1000 to +2000 mV Sensor temperature, -10.0 to 110.0 °C (14 to 230ºF) Output Values, 0 to 2.5 VDC, Vout #1/#2 Sensor slope/offset Model number and software version
Main Parameter Ranges	-1000 to +2000 mV
Power:	Two generic AA alkaline batteries, low battery indication at 1.60V DC.

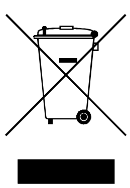
Outputs: Two 0-2.5 VDC isolated outputs are provided on for connection to data recorders, etc.

Battery Life: Approximately 6-12 months with alkaline battery under non-continuous use. Approximately 10 days continuous use (without backlight)

1.4 Q45R Performance Specifications

(Common to all variations)

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
Warm-up Time	7 seconds to rated performance
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 Q25 ORP w/ preamp - 5 wire input, or combination style ORP electrode w/ TC - 2 wire input



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 – **Instrument Handle/Mounting**

2.1 General

The Q45R Portable ORP System comes complete with a specially designed handle that allows the system to be comfortably carried, or quickly strapped to a railing. Although the system is designed to be a portable system, it can be permanently mounted for longer term field use. This is possible due to the very long battery life spans that can be achieved with the system.

2.2 Portable Handle

A removable handle is included with each unit that provides not only comfortable transportation of the system, but the integral locking strap allows the system to be quickly mounted to pipes or rails for longer term use in one area.

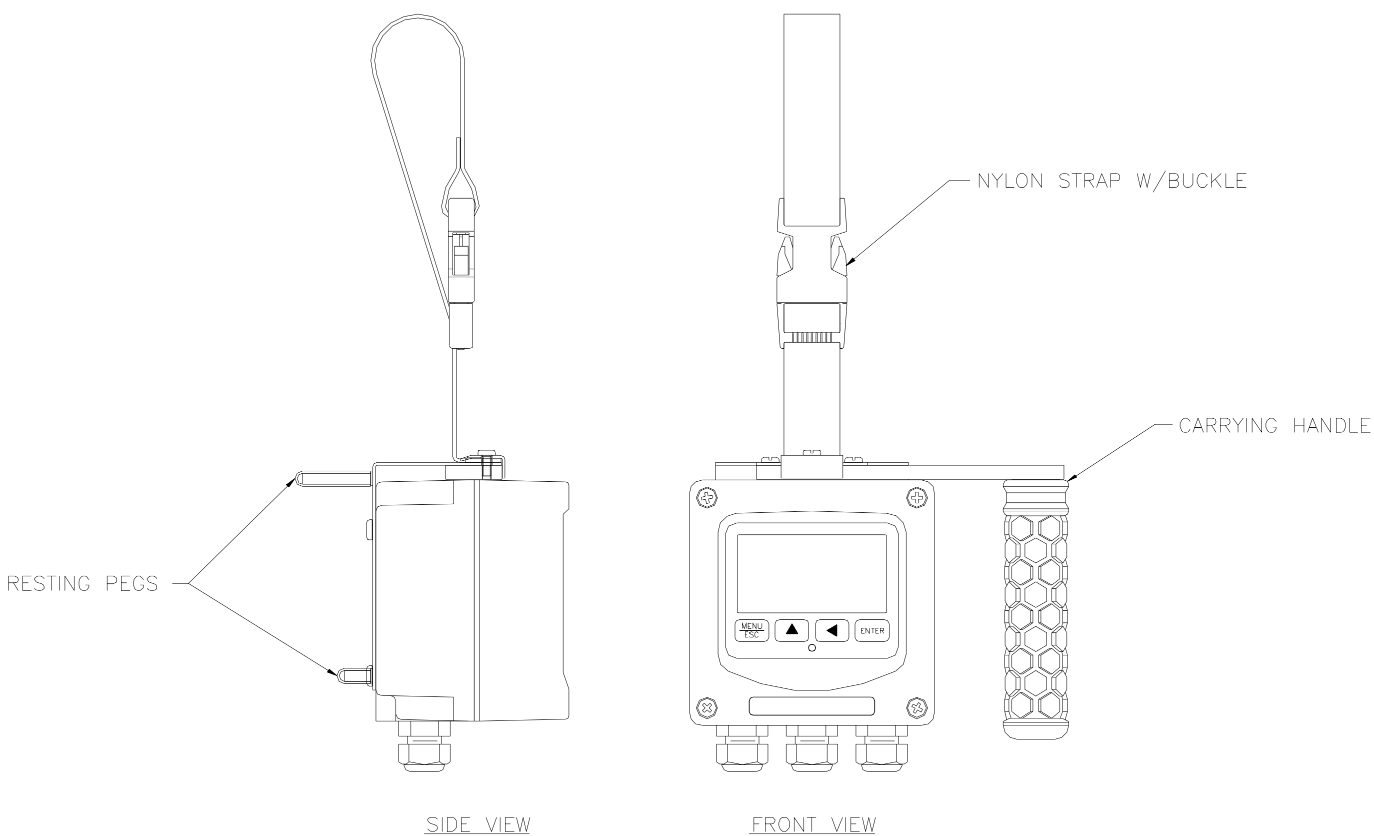


Figure 1 - Portable Handle - Views

Part 3 – Sensor Electrical Installation

3.1 General

The sensor cable can be quickly connected to the Q45 terminal strip by matching the wire colors on the cable conductors. Keep signal cable away from AC power lines, adjustable frequency drives, motors, or other noisy electrical signal lines.

3.2 Direct Sensor Connection

The sensor cable should be routed into the enclosure through the right hand cord grip on the bottom of the enclosure. Make sure the cord-grips are 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.

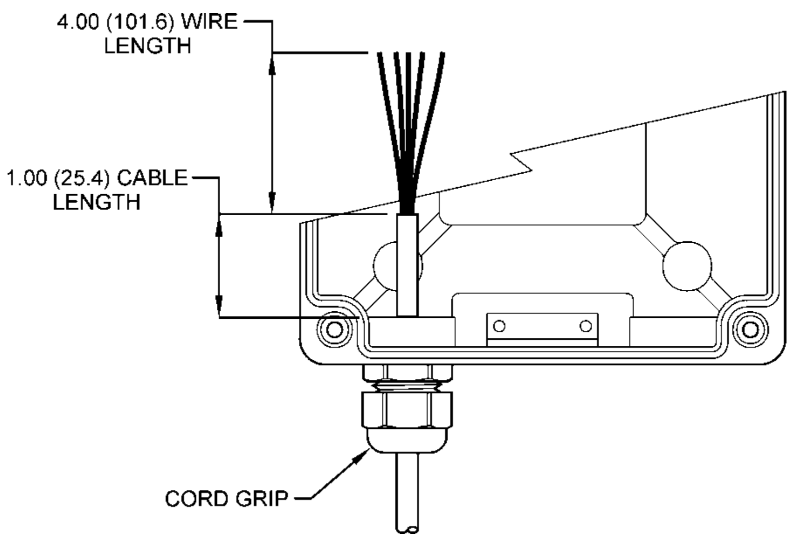


Figure 2 - Bulkhead Connection

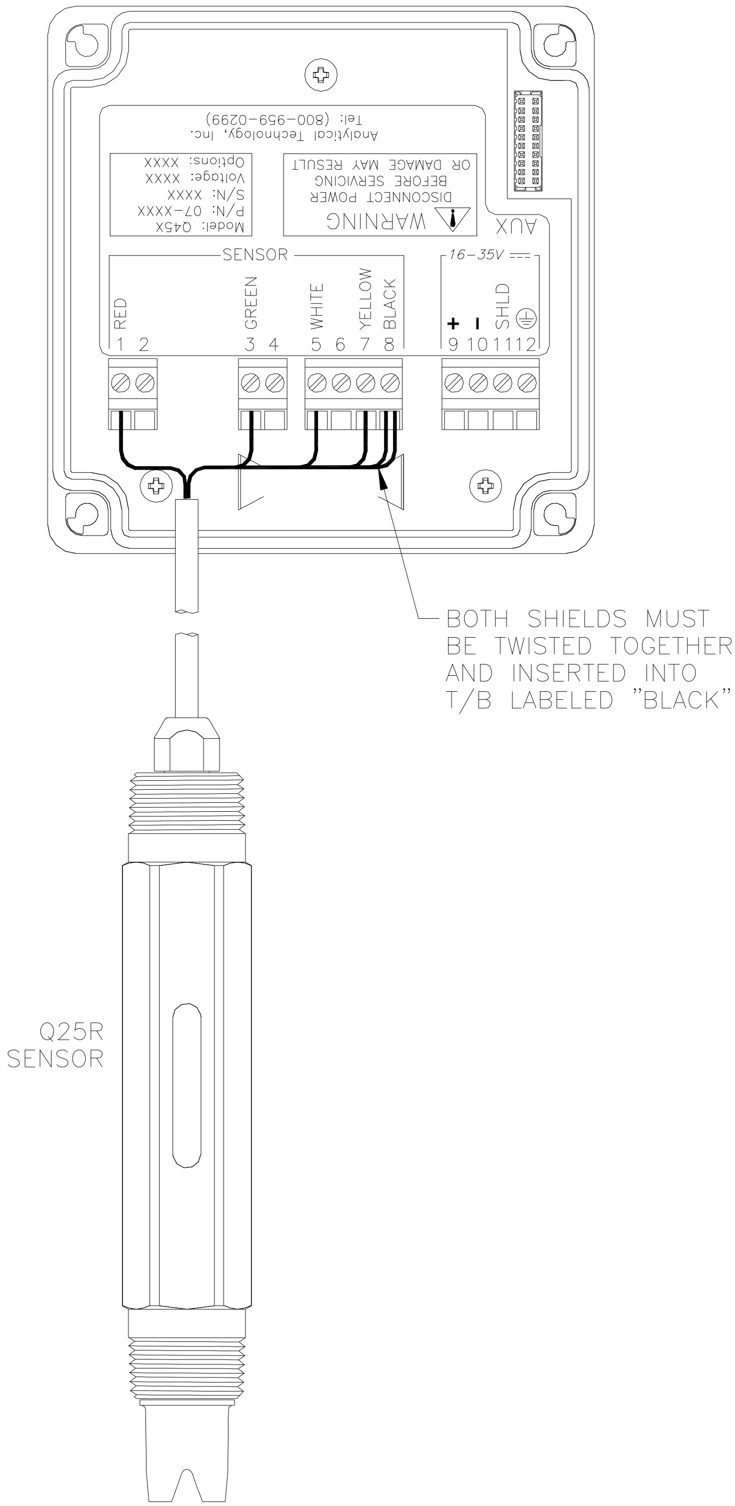


Figure 3 - Sensor Connection

3.3 Combination Electrode Connection

The Q45R may also be used with non-amplified simple combination electrodes (see Figure 4). 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 4.11). 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.

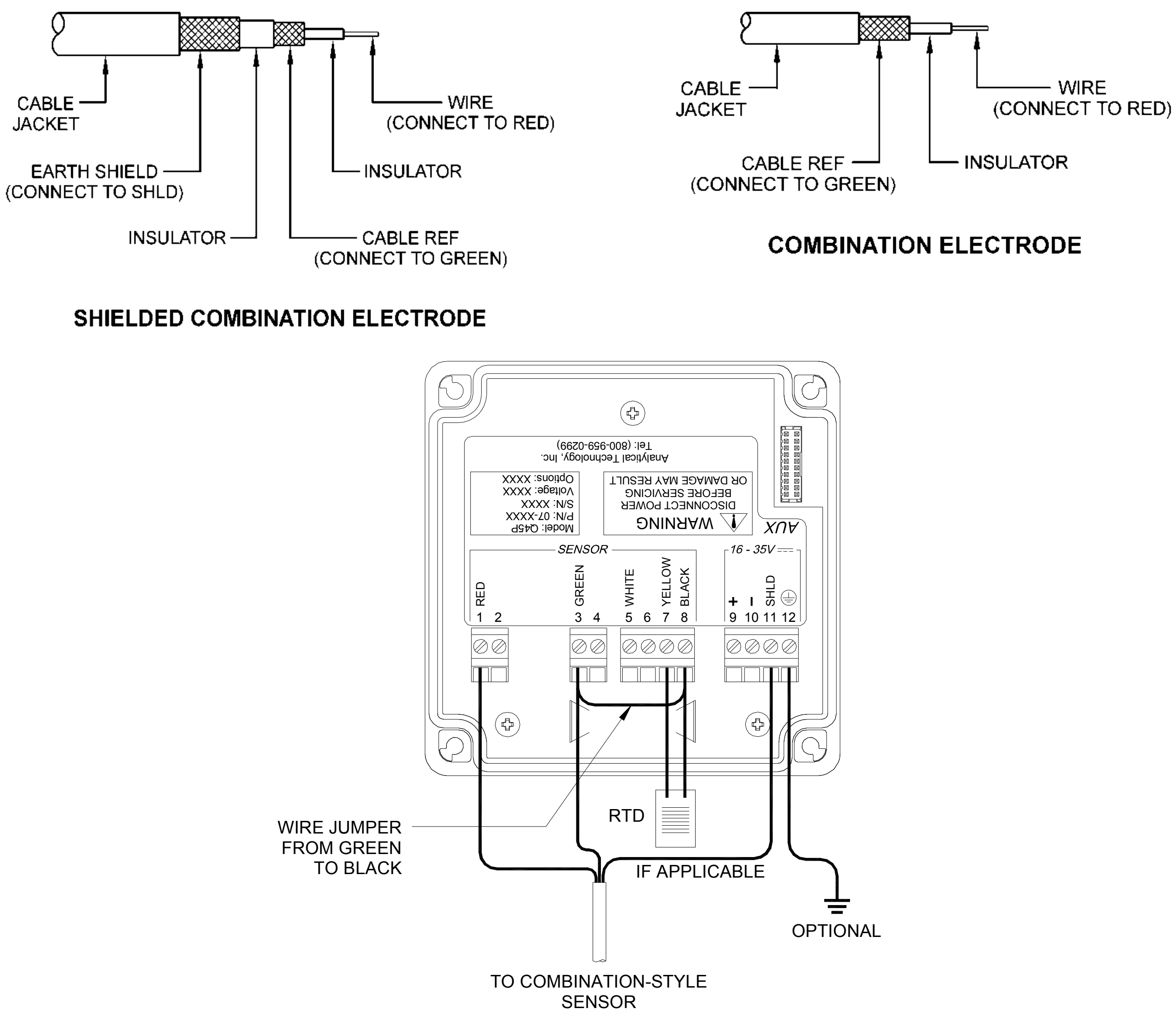


Figure 4 - Sensor Connections, Combination Electrodes

3.4 External Temperature Compensation

All 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 5. 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.

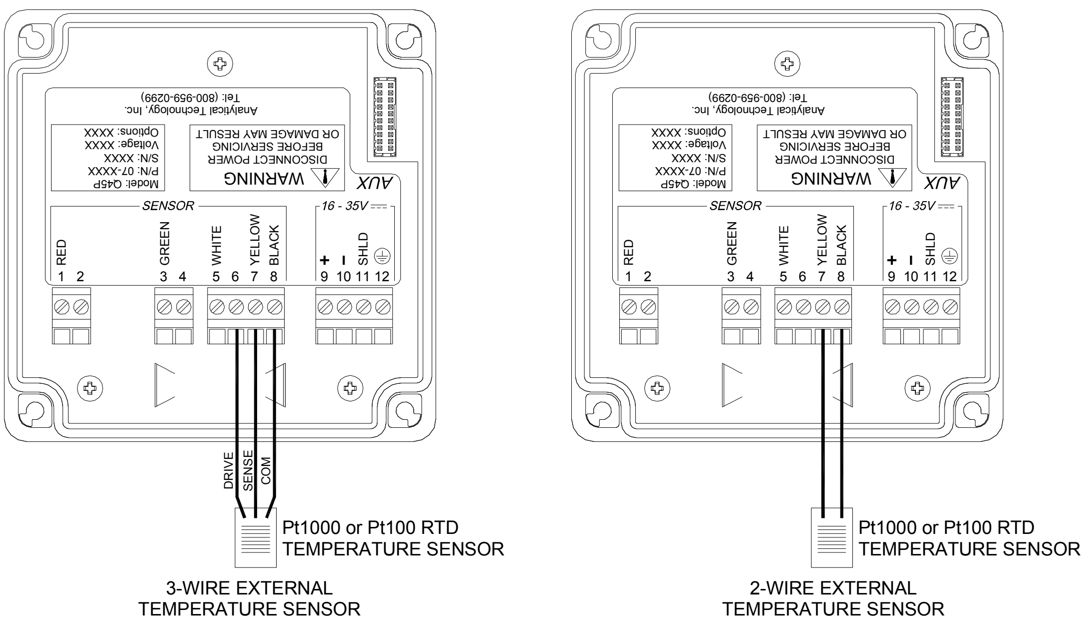


Figure 5 - External Temperature Compensation

Part 4 – Configuration

4.1 General

To turn the system ON, simply press and hold the MENU key for approximately 5 seconds and the display will come on. To turn the unit off, press and hold the ENTER key until the display shuts off (about 3 seconds). Note that the unit must be in the MEASURE menu in order for the 3-second key press to operate. The instrument will turn off automatically after 30 minutes if no keys are pressed – optimizing battery life. This mode of operation is ideal for portable operation where intermediate readings are being taken. Assuming the instrument is used perhaps an hour per day, this would result in a battery lifespan of about 6-12 months. For continuous operation with no automatic shut-off, turn the Auto-OFF feature to OFF in the DIAG menu. This mode is intended for use when the instrument outputs are used for transmitting data. In this mode, the instrument will run continuously until the battery reaches the shut-down level. With standard AA alkaline batteries, this would produce approximately 10 days of operation. It should be noted that rechargeable AA batteries reduce operational times dramatically, as they typically contain much less energy than standard batteries.

The PWR switch disconnects the AA batteries and is only used to disconnect the battery if the system is not to be used for a long period of time (> 3 months of storage). Otherwise, leave this switch in the ON position. The red dip switch is only for factory use.

The "**B**" will flash on the display next to the main measurement indication when the instrument requires battery replacement. If the battery is not replaced, eventually the unit may not turn on in the normal operating mode. Once the low battery condition is indicated, the instrument will only stay powered for 10 minutes.

4.2 Battery / Power Circuit Board

PQ45H monitors are powered by internal AA alkaline batteries Figure 5 shows this board assembly with batteries installed.

The battery circuit board contains 3 switch assemblies as shown in the drawings

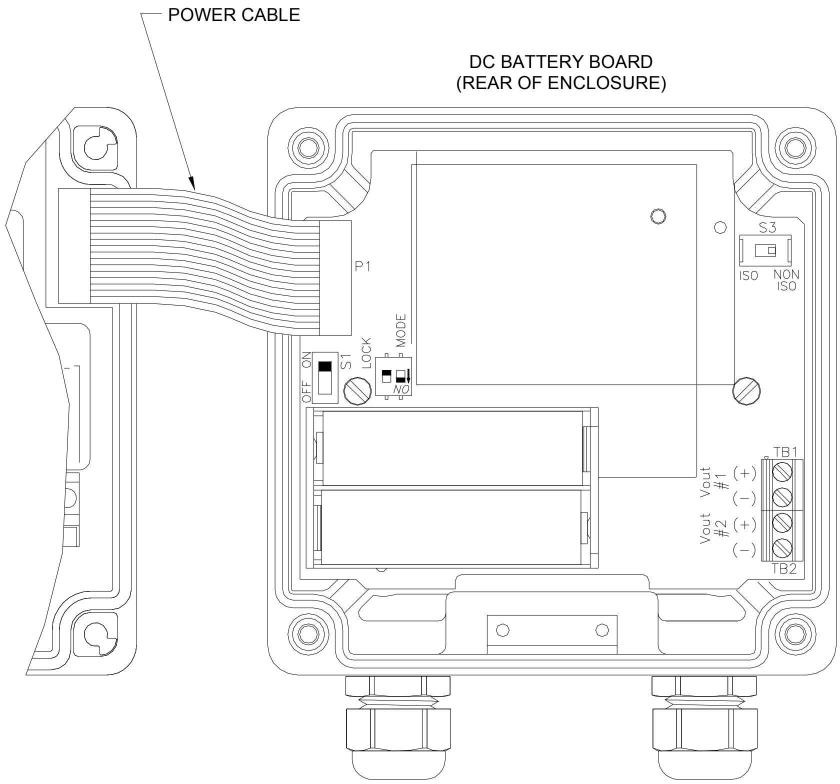


Figure 6 - Battery Board Connection

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 is used to set the voltage at which monitor will shut off when powered by internal batteries. Alkaline batteries can normally be run down to about 0.8 volts. When using alkaline batteries, the mode switch is in the OFF position (factory default). If rechargeable NiMH batteries are substituted, place the MODE switch in the ON position. Note that rechargeable NiMH batteries have only about 35% of the capacity of an alkalines, so operation will be limited to about 10 days on a charge. However, NiMH batteries can be recharged hundreds of times.

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 the internal data logger. However, if the outputs are connected to external devices through the external connection cable, putting this switch in the ISO position will protect against possible ground loops. The isolation circuit will slightly increase the power requirement for the monitor, resulting in a bit less battery life.

4.3 Battery Power Circuit Board

The Q45 portable instrument is primarily operated by software settings. However, there are also a few hardware details on the battery circuit board to note.

The battery board is a circuit board that sits in the rear of the Q45 enclosure, and connects to the Q45 AUX port through a ribbon cable. The battery board contains the battery clip for the two AA batteries and the output terminal strip for the two 0-2.5 VDC outputs. Along the left side below the ribbon cable is an ON/OFF slide switch. This switch can be used to turn the instrument completely OFF when not intending to use the unit for an extended period. When storing for more than 30 days, remove the batteries.

4.4 Voltage Outputs

There are two analog voltage outputs on the battery board with a terminal strip located in the lower right corner. The outputs are 0-2.5 VDC and may be used to send isolated data to remotely located recorders, PLC's, etc. Output #1 is used only for ORP and Output #2 can be used for either temperature or pH (if the optional pH sensor is used).

4.5 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.).

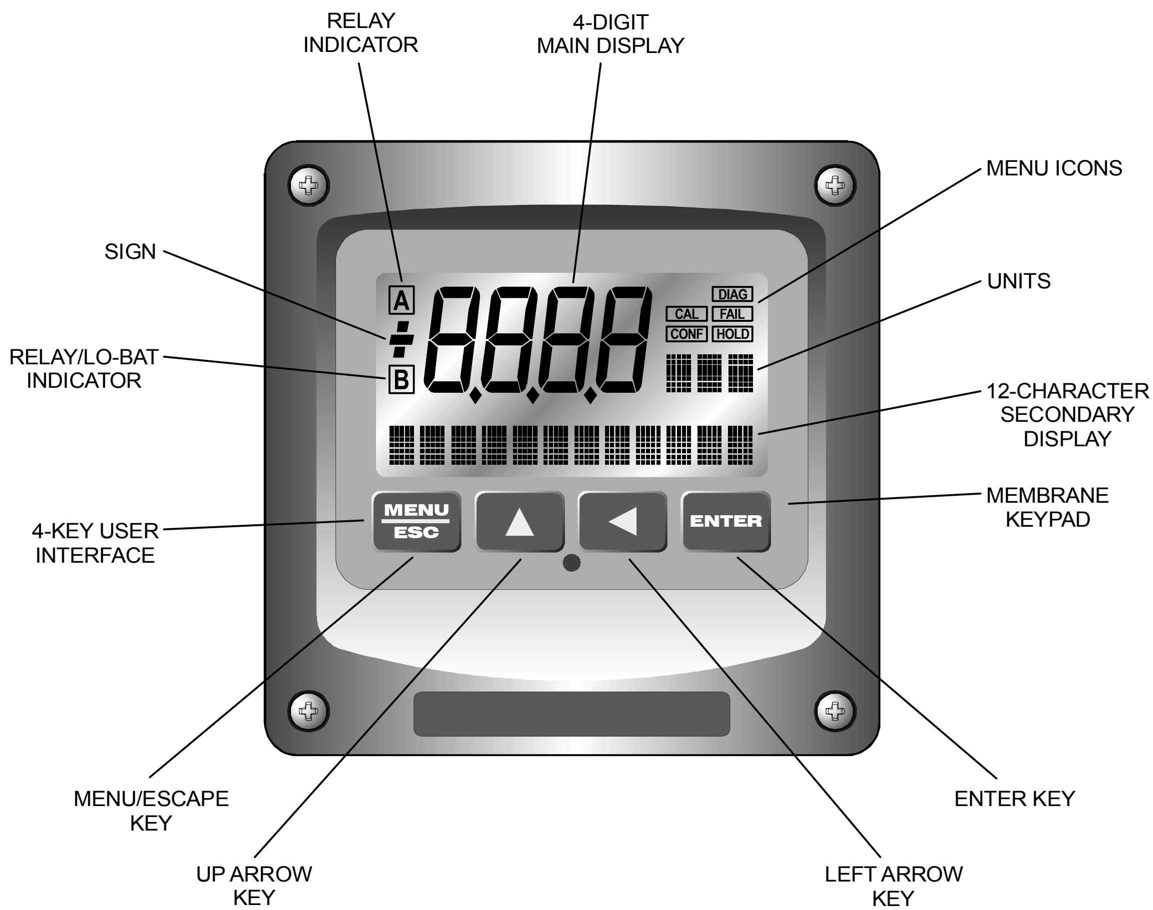


Figure 7 - User Interface

4.6 Keys

All user configuration occurs 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.

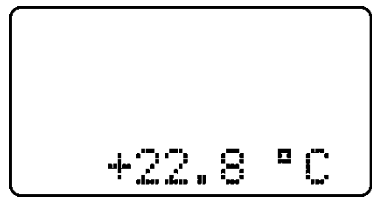
4.7 Display

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.

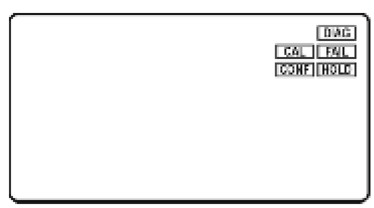
Lower Line

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 6.3.



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.



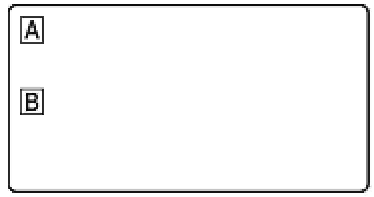
HOLD

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.

Icon B The left screen area contains one 'B' icon that indicates the battery power is low.



4.8 Software

The software of the Q45R 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.**

4.8 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 8 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 ORP 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.

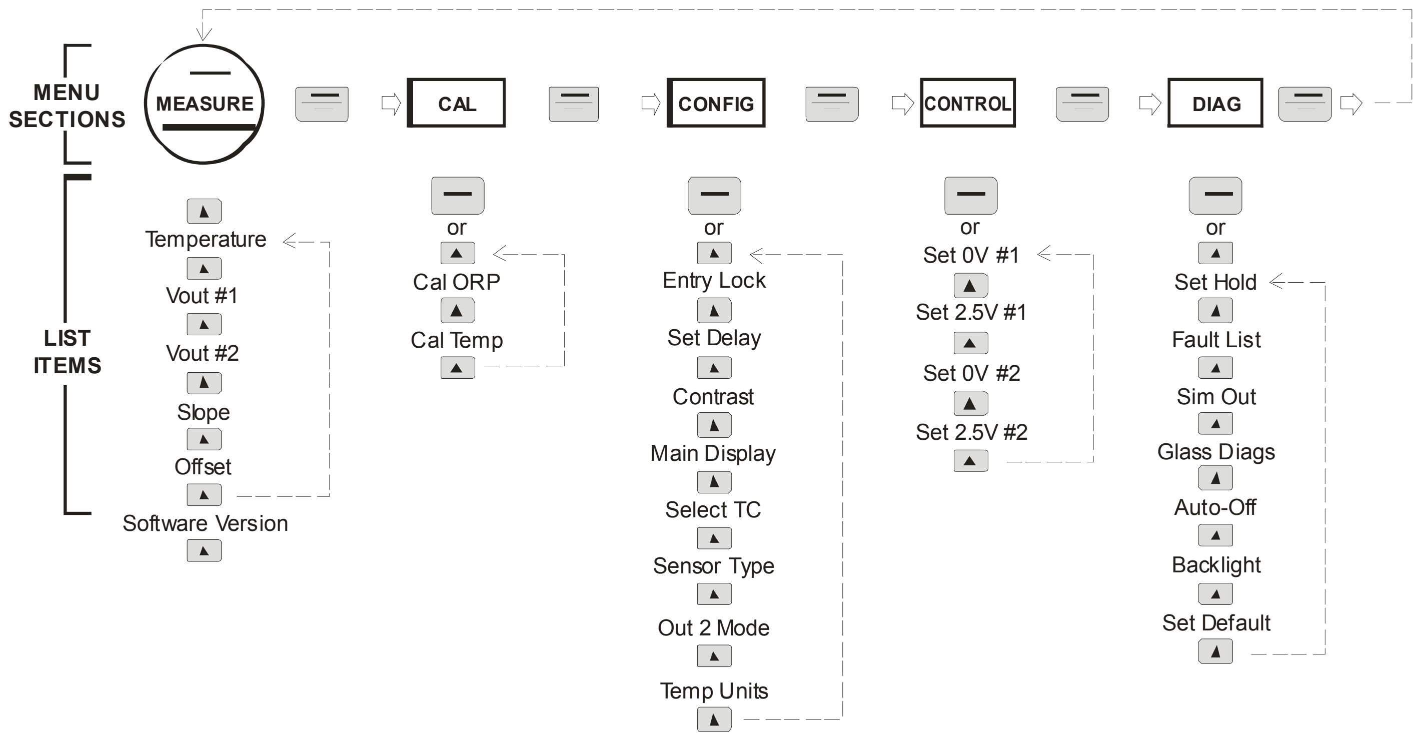


Figure 8 - Software Map

4.9 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 idle, 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 Vout	Instrument Output Signal #1
#2 Vout	Instrument Output Signal #2
Slope = 100%	Sensor output response vs. ideal calibration. This value updates after each calibration. As the sensor ages, the slope reading will decay indicating sensor aging. Useful for resolving sensor problems.
Offset = 0.0 mV	Sensor output current at a zero ppm input. This value updates after a zero-calibration has been performed. Useful for resolving sensor problems.
Q45R vX.XX	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.

4.10 Calibration Menu [CAL]

The calibration menu contains items for frequent calibration of user parameters. There are three items in this list: Cal ORP or Cal Temp.

Cal ORP The ORP 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.

4.11 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 Q45R 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 ORP mV, sensor temperature or output mV. Using this function, the user may choose to put temperature in the main display area and ORP 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 Q25R sensor, **2** for combination electrode. Press ENTER to store the new value.

Out#2 Mode This function sets analog output #2 for either temperature (default) or mV ORP. 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-mV for ORP. Press ENTER to store the new value.

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

4.12 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 -1000 to +2000 mV ORP, 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 ORP, as it is fixed to track ORP. Output #2 will be in either units of mV or C/F, depending on whether ORP or temperature is set for Out#2 in the CONFIG menu.

4.13 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 voltage 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.

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 mV level of the instrument to check the output settings. The user enters a mV 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.

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.

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. If OFF, the meter will stay powered continuously until either the internal power switch on the battery board is turned OFF, or the battery voltage drops to the cut-off point (approximately 30 days on a two C-cell alkaline batteries). Press ENTER to initiate user entry mode, and the entire value will flash. Use the UP arrow key to modify the desired display value. The choices are **OFF** and **ON**. Press ENTER to store the new value

BackLight The Back-light screen is used to set the operating conditions under which the backlight will turn on. The default is OFF, (Always Off). Other selections are AUTO, where the light comes on whenever any key is pressed. The light will automatically shut off if no key is pressed for 30 seconds, AL for Alarm, where the light comes on in alarm condition and flashes under a Fail condition, and ON (always on). Do not select ON as battery life will be greatly reduced.

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

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 other extreme operating conditions may require more frequent calibration than those that operate at more 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.

ORP calibration solutions can be one of two types: standard mV solutions, or standard pH buffers with quinhydrone powder added. For all 2-point calibrations, mV solutions must be at least 100 mV apart. When using quinhydrone powder, add slowly to the pH buffer until just after the quinhydrone ceases to dissolve (approximately 1 tsp. quinhydrone per pint of buffer). Use the following table as a guideline for reference mV values at nominal pH values:

4 pH		
20 ºC	25 ºC	30 ºC
+268 mV	+263 mV	+258 mV

7 pH		
20 ºC	25 ºC	30 ºC
+92 mV	+86 mV	+79 mV

CAUTION: Quinhydrone is highly acidic. Follow all safety instructions on Material Safety Data Sheets.

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 90% and 110%. A 100% slope represents an ideal sensor output of 1 mV/1 mV for displayed data vs. factory calibration data. The slope of the ORP electrode does not degrade appreciably over the life of the sensor (as compared to a pH sensor), since the measuring element of the sensor is basically an exposed metal electrode. However, a very small slope degradation can occur over a long period of time as the glass reference electrode ages. Slope calibrations can remove this error along with very small inherent gain errors in the sensor preamp and electrodes. The transmitter will not allow calibrations on a sensor with a slope less than 60% or more than 140%. ORP sensor slope is only shown at the completion of a successful calibration.

5.12 Sensor Offset

Sensor offset is a number that indicates sensor output (expressed in mV) in a theoretical 0 mV solution 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 theoretically perfect 0 mV solution at 25 ºC. In other words, sensor offset shifts the entire response curve up or down. Changes in sensor offset are 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 approximately +200 mV or less than –200 mV. Since sensor offset is considered an absolute value from the ideal 0 mV value, readings outside the range of –200 to +200 mV are considered “high offset” errors during calibration. Sensor offset information from the most recent calibration can be viewed at any time in the Default Menu (see Section 4.9).

The system provides two methods of ORP calibration: 2-point and 1-point. These two methods are significantly different. The following are brief explanations of their uses.

5.13 2-Point Calibration Explained

The 2-point calibration method involves the movement of the sensor through two known mV solution 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. Although this method obtains the highest accuracy, it is not recommended for frequent calibrations as the slope of the ORP sensor does not degrade appreciably over time. In addition, problems can occur in some 2-point calibrations when two different mV solutions mix in the saltbridge of the sensor. A precipitant can be formed which can affect offset voltages in the reference junction.

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 the mV solution. 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

Two-point calibration adjusts both the slope and the offset of the sensor. Slope relates to how closely the system matches displayed mV with actual mV. Offset is the actual difference over the entire output curve between actual and displayed mV. Two point calibrations are not recommended for frequent calibrations as the slope of the ORP sensor does not degrade appreciably over time. However, two-point calibration does provide the highest level of accuracy.

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 ORP** 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 mV solution and press ENTER. If the sensor has been placed into this solution already, once the temperature has stabilized, press ENTER to continue.

6. The present ORP value will be displayed and the secondary line of the display will flash **Wait** for approximately 10-15 seconds.

7. The screen will display the measured mV value. If the user chooses to change this value, the arrow keys can be used to modify the value. Any value between -1000 and +2000 mV 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 reference point. As data is gathered, the units for mV 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 solution. At this point, rinse sensor with water and move the sensor into the second reference solution. Allow temperature to stabilize, and then press ENTER.
10. The present mV value will be displayed and the secondary line of the display will flash **Wait** for approximately 10-15 seconds.
11. The screen will display the measured 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 -1000 and +2000 mV can be entered. The second mV solution must be at least 100 mV 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 reference point. As data is gathered, the units for ORP 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 is intended to be used as an on-line calibration method. However, the sensor can be removed and calibrated in a separate solution. During calibration, the system will display the current mV reading and the user can manually enter a reference value from a lab grab-sample or a comparative reference instrument.

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

2. If the sensor has been removed and placed into a mV solution, allow sensor to temperature equilibrate with the solution 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 ORP** 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 ORP 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 mV value and a message will be displayed prompting the user for the lab value. The user must then modify the screen value with the arrow keys and press ENTER. The system then performs the proper checks.

7. If accepted, the screen will display the message **PASS** with the new offset reading, and 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 section 4.13) 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 – System Maintenance

6.1 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 6.3.

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

3. Check sensor cable color to terminal strip markings.

4. 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.

5. 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.

6.2 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 ORP reading should be between -100 and +100 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.

6.3 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 Section 4.13).

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 mV 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.
ORP too High	The ORP reading is > +2000 mV.	The ORP reading is over operating limits.
ORP too Low	The ORP reading is < -1000 mV.	The ORP 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
ORP Cal Fail	Failure of ORP 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 5.4) 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.

Part 7 – Maintenance and Troubleshooting

7.1 Cleaning the Sensor

Keep the sensor as clean as possible for optimum measurement accuracy - this includes both the saltbridge and the measuring electrode glass. Frequency of cleaning depends upon the process solution.

Carefully wipe the measuring end of the sensor with a clean soft cloth. Then rinse with clean, warm water - use distilled or de-ionized water if possible. This should remove most contaminate buildup.

Prepare a mild solution of soap and warm water. Use a non-abrasive detergent (such as dishwashing liquid).

NOTE: DO NOT use a soap containing any oils (such as lanolin). Oils can coat the glass electrode and harm sensor performance.

Soak the sensor for several minutes in the soap solution.

Use a small, extra-soft bristle brush (such as a mushroom brush) to thoroughly clean the electrode and saltbridge surfaces. If surface deposits are not completely removed after performing this step, use a dilute acid to dissolve the deposits. After soaking, rinse the sensor thoroughly with clean, warm water. Placing the sensor in pH 7 buffer for about 10 minutes will help to neutralize any remaining acid.

NOTE: DO NOT soak the sensor in dilute acid solution for more than 5 minutes. This will help to prevent the acid from being absorbed into the saltbridge.

WARNING: ACIDS ARE HAZARDOUS. Always wear eye and skin protection when handling. Follow all Material Safety Data Sheet recommendations. A hazardous chemical reaction can be created when certain acids come in contact with process chemicals. Make this determination before cleaning with any acid, regardless of concentration.

7.2 Replacing the Saltbridge and Reference Buffer Solution

1. Hold the sensor with the process electrode pointing up. Place a cloth or towel around the saltbridge. Turn the saltbridge counterclockwise (by hand) to loosen and remove the saltbridge. Do NOT use pliers.

2. Pour out the old reference buffer by inverting the sensor (process electrode pointing down). If the reference buffer does not run out, gently shake or tap the sensor.

3. Rinse the reference chamber of the sensor with de-ionized water. Fill the reference chamber of the sensor with fresh Reference Cell Buffer. The chamber holds 6 to 7 mL of solution. MAKE SURE that 6 to7 mL is used when refilling. The chamber should be FULL.

4. Inspect the new saltbridge to verify that there are 2 o-rings inside the threaded section of the saltbridge

5. Place the new saltbridge over the ground assembly of the sensor. Place a cloth or towel around the saltbridge and hand-tighten the saltbridge by turning it clockwise.

NOTE: Every ATI Q25R Sensor includes a spare bottle of Reference Buffer Solution, 7.0 pH. This is NOT typical pH 7 buffer, it is a special "high-capacity" buffer developed to ensure the highest possible stability of the reference portion of the ORP measurement. No substitutions should be made.

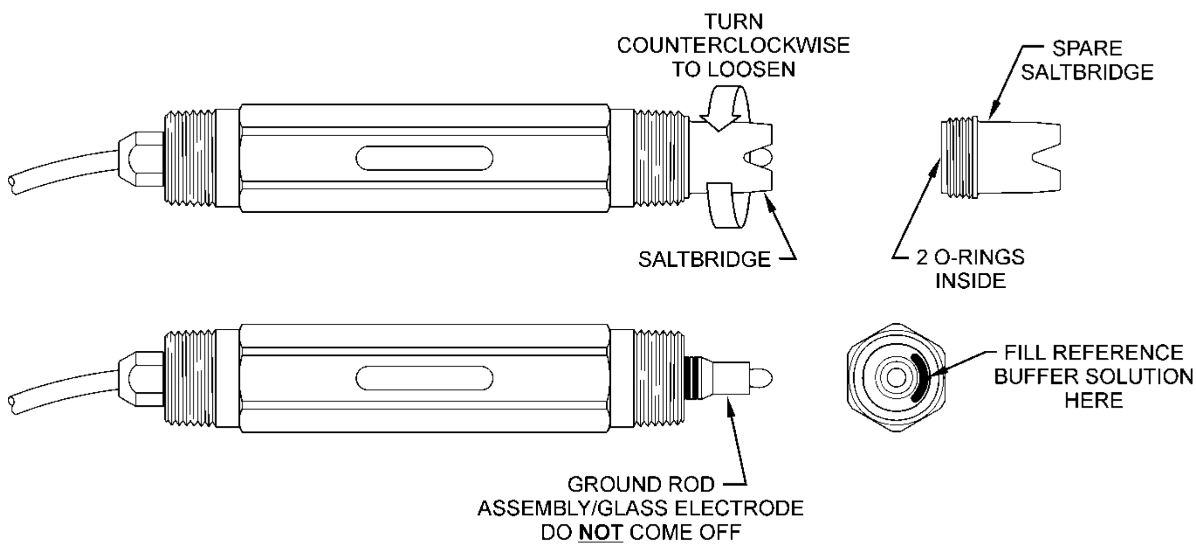


Figure 9 - Replacing the Saltbridge and Reference Buffer

7.3 Troubleshooting

The first step in resolving any measurement problem is to determine whether the trouble lies in the sensor or the transmitter. Since measurement problems can often be traced to dirty sensor electrode glass and/or saltbridge, cleaning the sensor using the method outlined in Section 7.3 should always be the first step in any troubleshooting.

If the sensor cannot be calibrated after cleaning, replace the saltbridge and reference cell buffer 7 pH as outlined in Section 7.3.

If the sensor still cannot be calibrated, perform the following test. A multimeter, 7 pH buffer and another buffer at least 2 pH units away will be needed.

1. With transmitter power on and sensor connected, place the multimeter's positive (+) lead on the white position of the transmitter terminal strip and the negative (-) lead on the black position. The multimeter should read between –4.2 and –6.5 VDC.

2. Disconnect the sensor's red, green, yellow, and white wires from the transmitter or junction box. Re-check Step 1.

3. Place the sensor in the first mV solution. As in calibration, allow the temperatures of the sensor and buffer to equilibrate at room temperature (approximately 25 ºC).

4. Verify that the sensor's temperature element (Pt1000 RTD) is functioning properly by measuring the resistance between the sensor's yellow and black wires. The nominal resistance value at 25 ºC is 1097 ohms. Use the following table as a guide to the approximate resistance value:

ºC	RTD Ω
20	1078
25	1097
30	1117
35	1136

5. Reconnect the yellow and white wires.

6. Connect the multimeter's positive (+) lead to the red wire and its negative (-) lead to the green wire. With the sensor in the first mV solution at approximately 20-30 ºC, measure the DC millivolts. The multimeter should display the value of the millivolt solution within –100 and +100 mV. If it is not, replace sensor reference solution and saltbridge (See Section 7.2) and re-test.

7. With the multimeter connected as in Step 5, rinse the sensor with clean water and place it in the second mV solution. Allow the temperatures to equilibrate as before. Check this solution as in Step 6.

Spare Parts

Part No.	**Description**
07-0008	Q45R ORP transmitter, 3VDC, Dual 0-2.5 VDC outputs
07-0065	ORP Sensor with 30’ cable, Pt
07-0066	ORP Sensor with 30’ cable, Au
05-0060	Saltbridge
05-0057	Regeneration Kit (saltbridge & fill solution)
09-0042	200 mV ORP Solution, 500 mL
09-0043	600 mV ORP Solution, 500 mL

Lock/Unlock Code: 1451