

Model Q45D/60

Portable Dissolved Oxygen Measurement System

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

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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.

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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 Q45D/60 is a highly versatile portable monitoring/recording system designed for the measurement of dissolved oxygen in solution. The full scale operating range of the system is 0-40.0 ppm and the sensing system will operate on water streams with temperatures from 0 to 50°C.

The system operates on two AA batteries, and will run continuously for approximately 240 hours.



Warning: If unit is to be stored for more that 6 months REMOVE the batteries from the holder to avoid potential damage from battery leakage

The basic sensing element used in the dissolved oxygen monitor is a galvanic membrane sensor which measures dissolved oxygen directly.

1.2 Features

- Standard Q45P 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 pH and temperature, or pH and pH. 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 back light 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 Q45D/60 Portable System Specs

Displayed Parameters	Main input, 0.00 to 19.99 ppm, 20.0 to 40.0 ppm% Saturation, 0 to 200% Sensor temperature, 0 to 50.0 °C (32 to 122 °F) Sensor Signal -40 to +2000 mVDC Output Values, 0 to 2.5 VDC, Vout #1/#2 Sensor slope/offset Model number and software version
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.
Keypad	4-key membrane type with tactile feedback, polycarbonate with UV coating.
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	Handheld w/Nylon Carrying strap
Weight	1 lb. (0.45 kg)
Ambient Temperature	Instrument Service, -20 to 60 °C (-4 to 140 °F) Sensor Service, -5 to 55 °C (23 to 131 °F) Storage, -30 to 70 °C (-22 to 158 °F)
Ambient Humidity	0 to 95%, indoor/outdoor use, non-condensing to rated ambient temperature range
Altitude	Up to 2000 m (6562 ft)
Electrical Certification	Ordinary Location, cCSAus (CSA and UL standards - both 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	2-electrode galvanic membrane sensor for direct measurement of dissolved oxygen,
Sensor Materials	Noryl and stainless steel
Sensor Cable	25 ft. (7.5 meter) cable with 6-pin plug.
Max. Sensor-to-Analyzer Distance	100 feet (30.5 meters), with junction box
Instrument Power	Two generic AA 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 240 hours of operational use on a set of batteries (without backlight).

1.4 Q45D Performance Specifications

Accuracy	0.2% of span or better
Repeatability	0.05% of span or better
Sensitivity	0.05% of span
Non-linearity	0.1% of span
Stability	0.05% of span per 24 hours, non-cumulative
Temperature Drift	Span or zero, 0.01% of span/°C
Warm-up Time	3 seconds to rated performance
Instrument Response Time	6 seconds to 90% of step input, in a given range, at lowest setting

Part 2 – Instrument Handle/Mounting

2.1 General

The Q45D/60 Portable Dissolved Oxygen 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 lifespans 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.

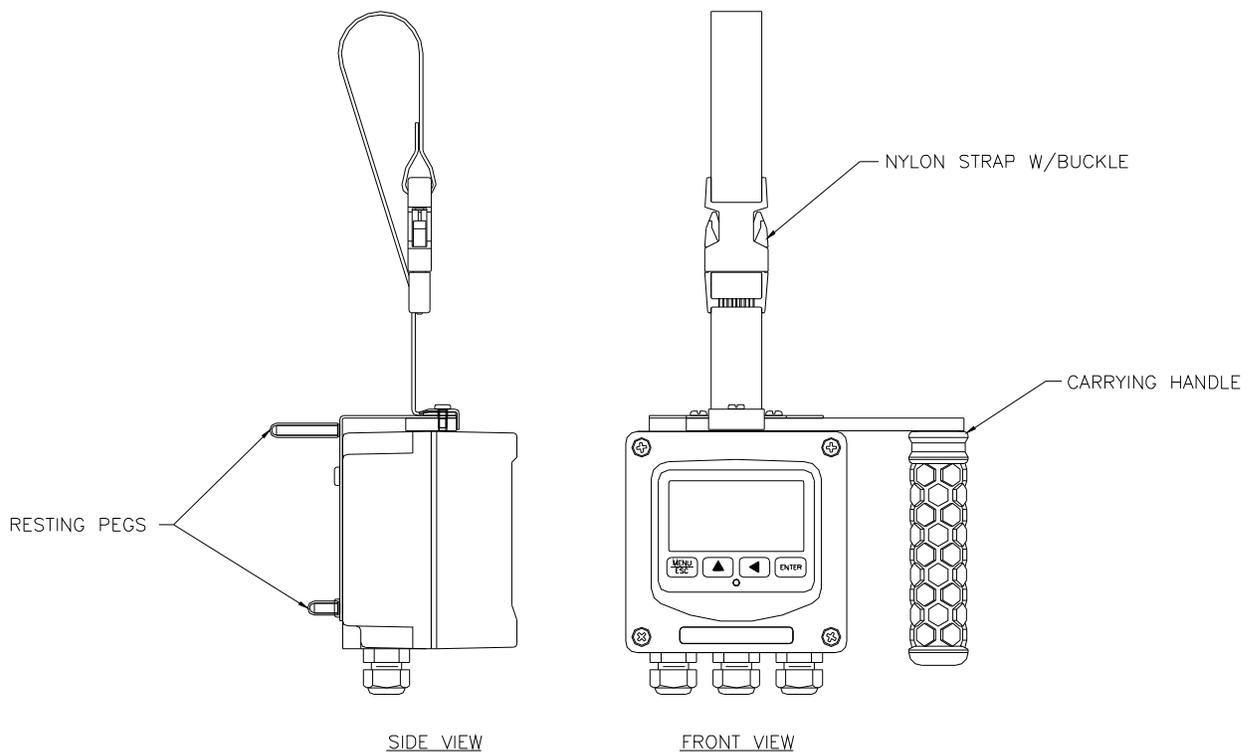


Figure 1 - Portable Handle - Views (ATI-0688)

Part 3 –Electrical Connection

3.1 General

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

3.2 DirectSensorConnection

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.

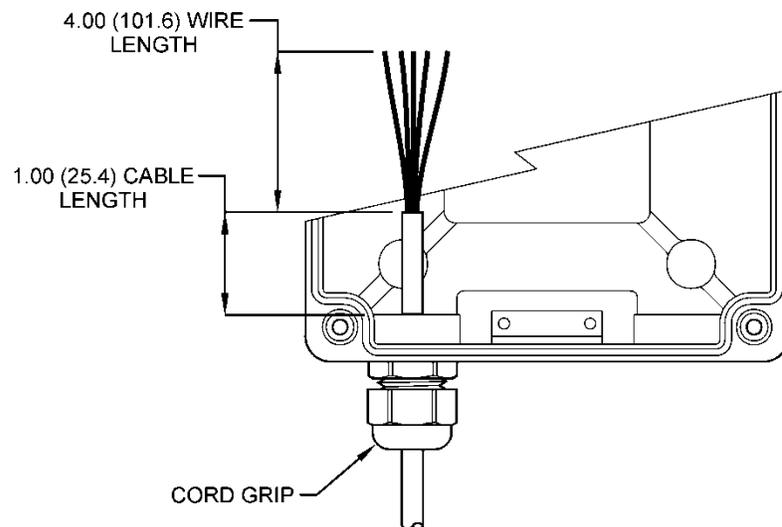


Figure 2 - Sensor Cable Preparation

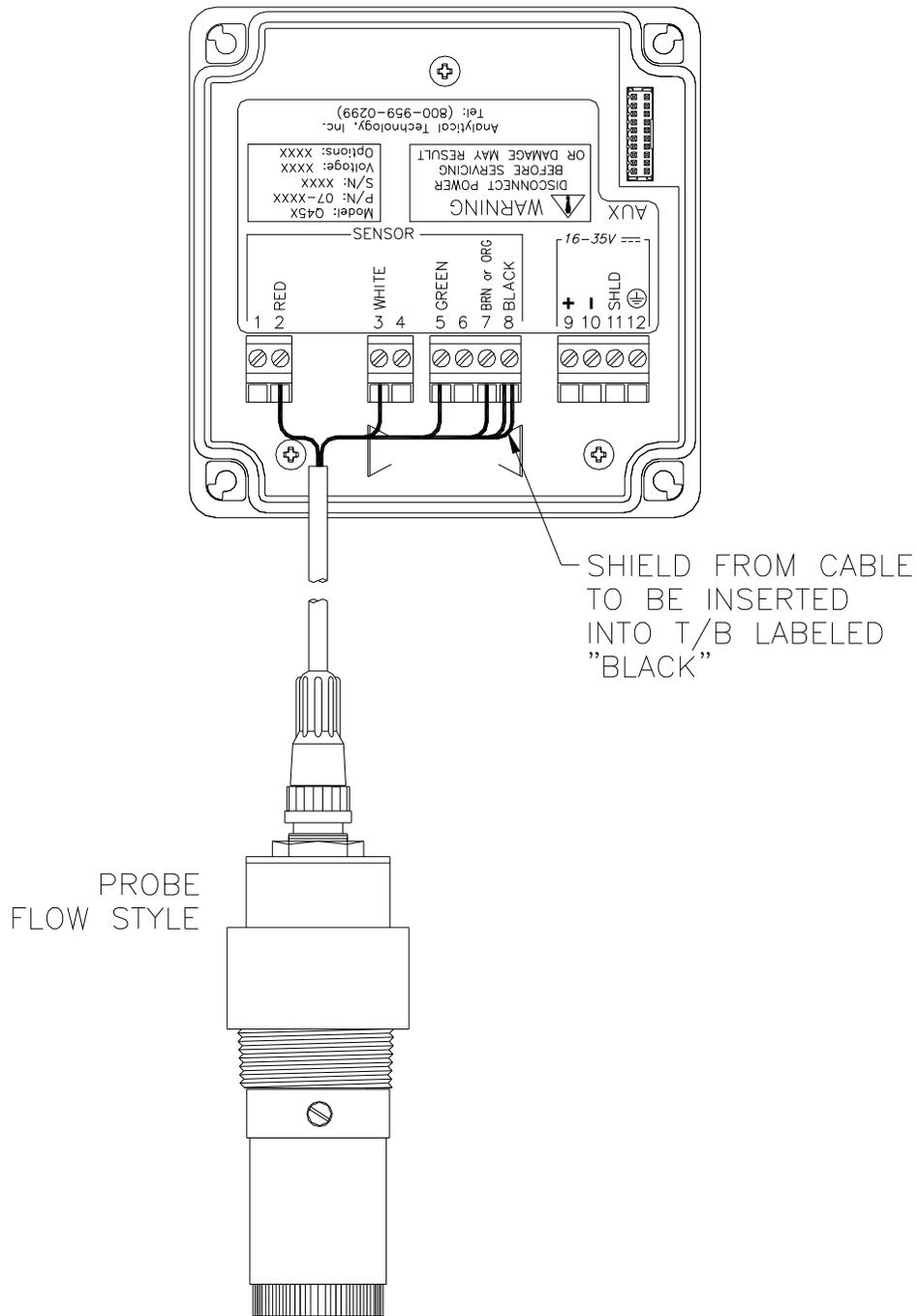


Figure 3 - Flow Type Connections (ATI-0658)

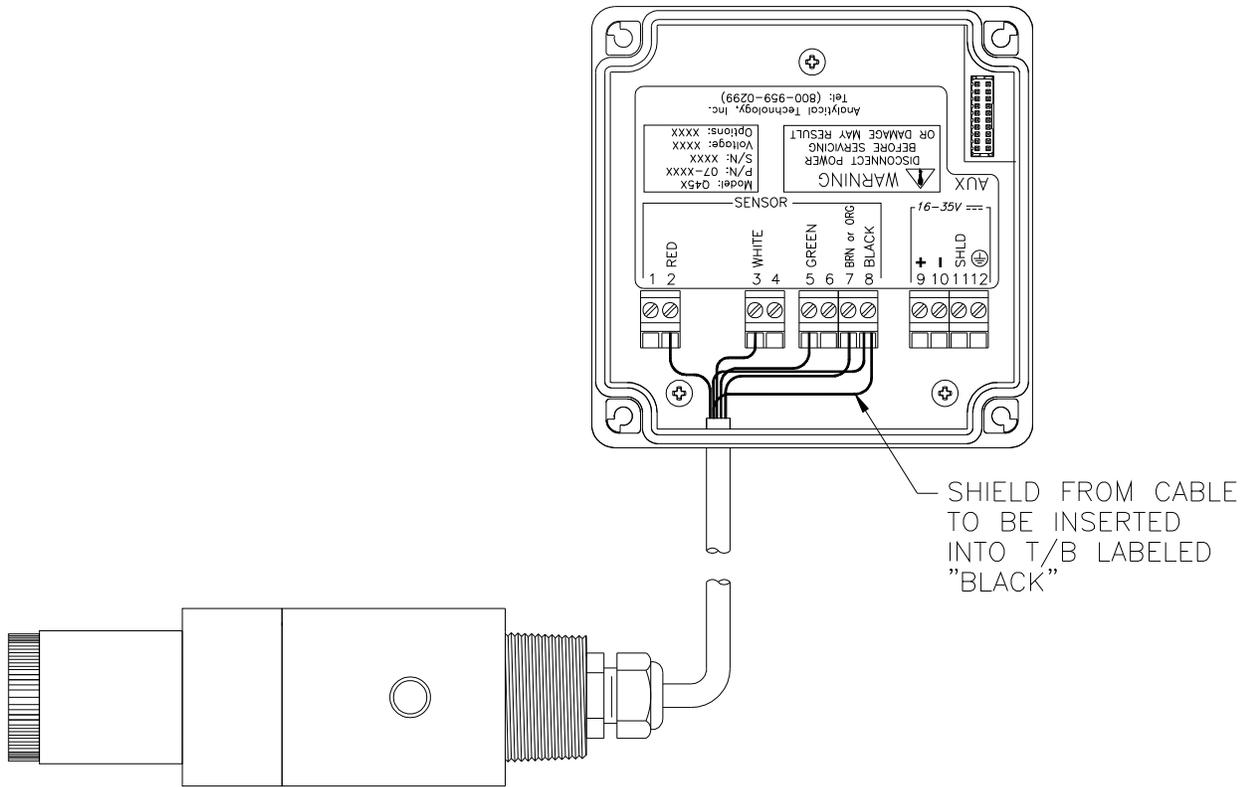


Figure 4 - Submersible Sensor Connection (ATI-0671)

Part 4 – Sensor Assembly

4.1 Oxygen Sensor Preparation

The oxygen sensor supplied with the Q45D is shipped dry. It will not operate until it is prepared by adding electrolyte and a membrane. Preparation of the sensor for operation must be done carefully. The procedure should be done by a qualified technician, and it should only be done when the system is ready for operation. Until then, it is best to leave the sensor in the condition in which it is received.

Submersible oxygen sensors are made up of two separate parts, a submersion holder that also contains the temperature compensating element and a sensing module. The sensing module screws into the holder, with an o-ring providing a water tight connection. Figure 5 below shows the assembly.

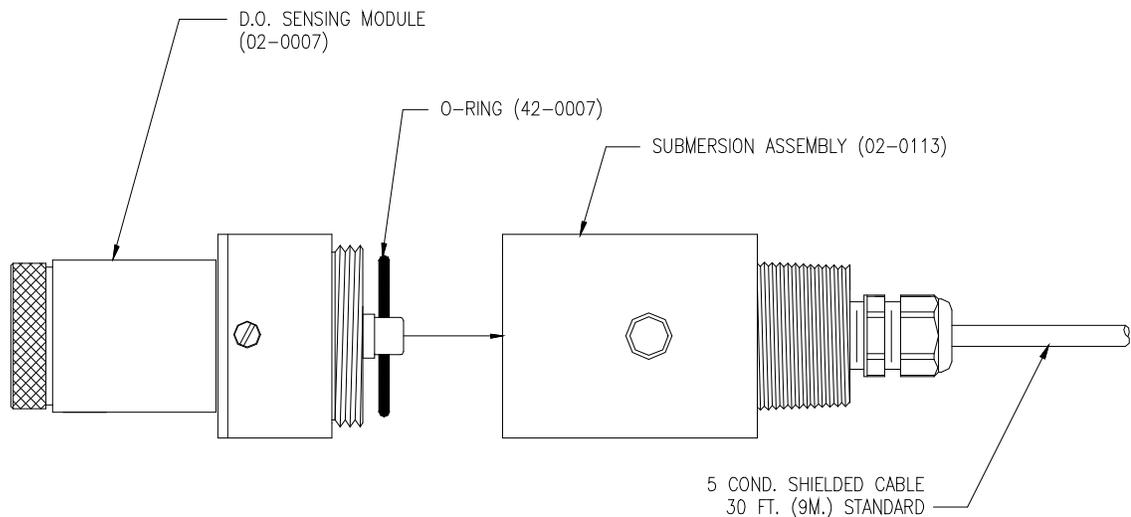


Figure 5 - Submersible Sensor Assembly

Sensing modules contain the main measuring components, and are the main component requiring service. Figure 5 below shows an exploded view of the D.O. sensing module.

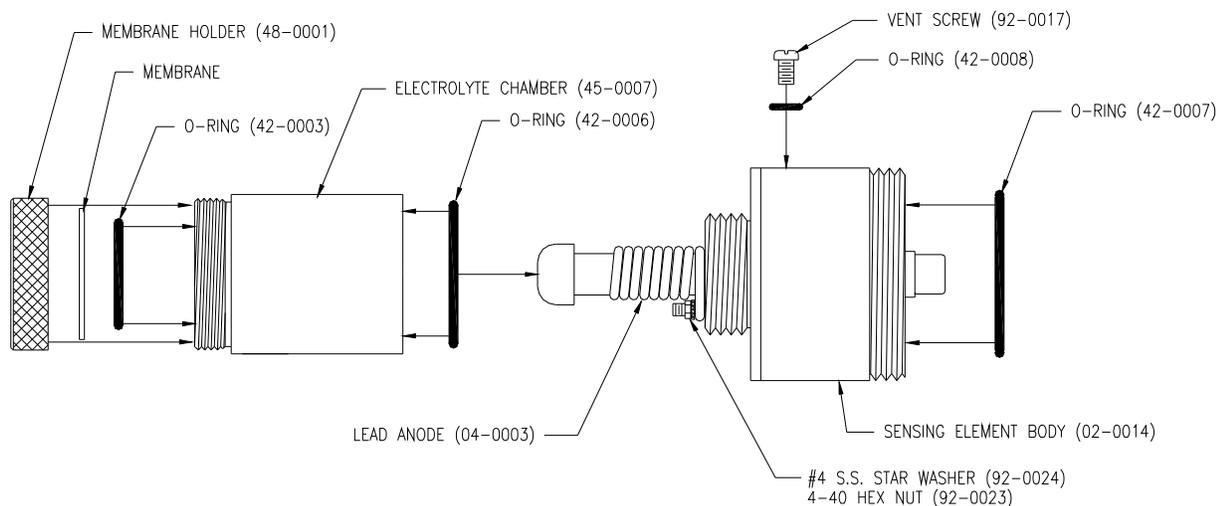


Figure 6 - Submersible Sensing Module Assy

Follow the procedure below to prepare the D.O. sensor module for operation:

1. Unscrew the electrolyte chamber from the assembled sensor and also remove the vent screw from the side of the sensor body.
2. Remove the front nut from the bottom of the chamber and discard the protective membrane. O-rings are contained in grooves on both the bottom and top of the chamber. Be sure that these o-rings remain in place.
3. From the package of membranes (either 2-mil or 5 mil) supplied with the sensor, place a new membrane into the front nut, holding the membrane by its edge to avoid fingerprint oil from contaminating the membrane. **The membrane is clear and is separated from other membranes by a light blue paper spacer.**
4. Screw the front nut on to the chamber until you feel the o-ring compress. Hand tight compression is all that is needed. Do not use tools to tighten. The membrane should be flat across the bottom of the chamber without wrinkles.

5. Fill the chamber with electrolyte until the level reaches the bottom of the internal threads.
6. Slowly screw the chamber onto the sensor body. A small amount of electrolyte will run out of the hole from which the vent screw was removed. Place a paper towel around the sensor to absorb the electrolyte overflow. The electrolyte is harmless and will not irritate skin. Tighten the chamber until the o-ring at the top of the chamber is compressed. Once again, do not use tools to tighten.
7. Shake excess electrolyte from the vent hole on the side of the sensor and replace the vent screw.

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

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

4.2 Flow Type D.O. Sensor

The D.O. sensor designed for use in flow applications is similar in construction to the sensing module described above. The method for sensor preparation is basically the same as described in section 4.1.

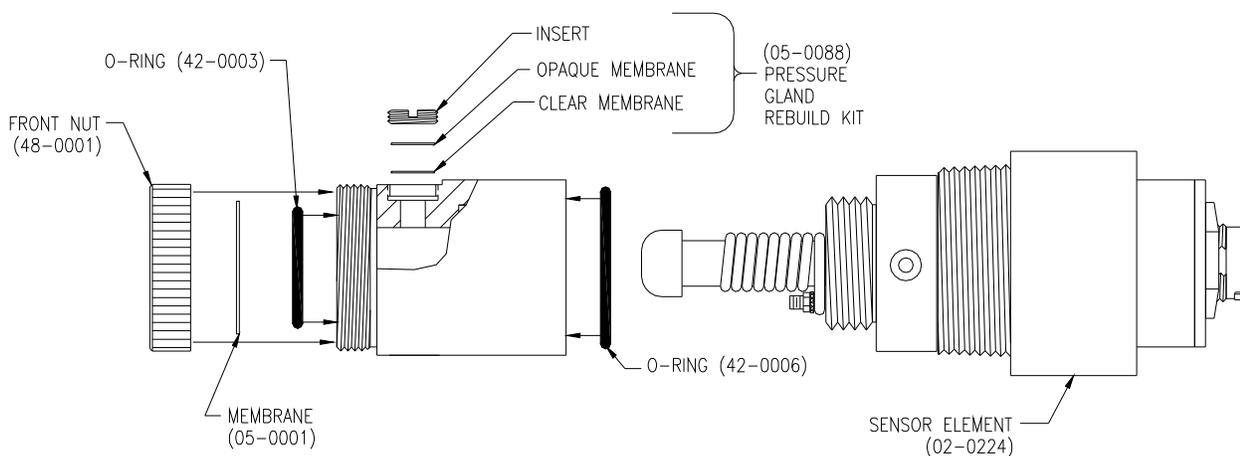


Figure 7 - Flow Type Sensor Assy (ATI-0860)

Part 5 – Operation

5.1 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 240 hours. 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 (1.6V). 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

Q45C2 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.

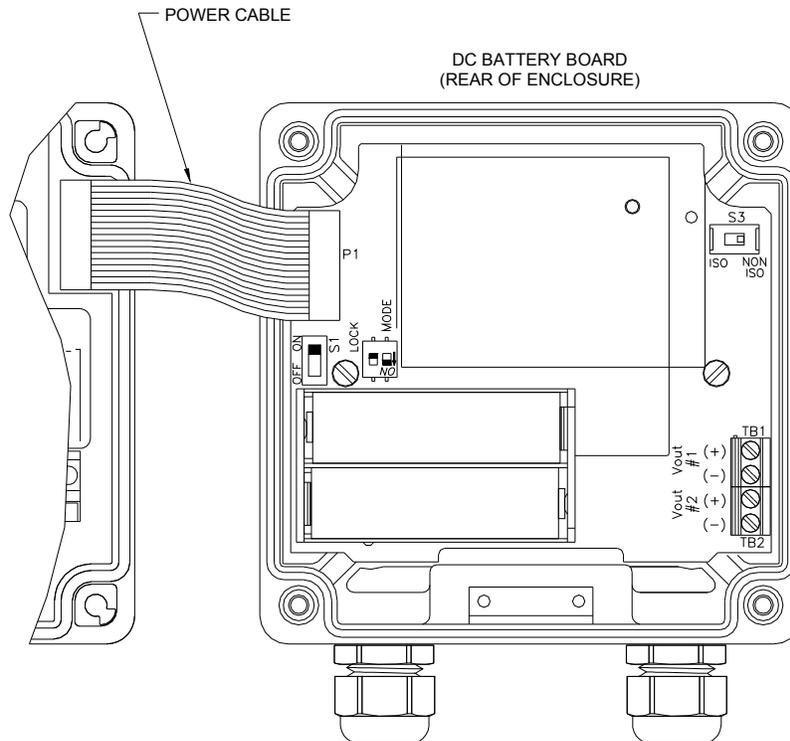


Figure 8 - Battery Board Connections

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. 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.

4.4 Voltage Outputs

There are two sets of analog voltage outputs on the battery board that may be used to send isolated data back to remotely located recorders, PLC's, etc. Output #1 is used only for dissolved oxygen information, and Output #2 can be used for an additional dissolved oxygen output channel, or it can be selected to output temperature information.

4.5 Software Interface

The software 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.).

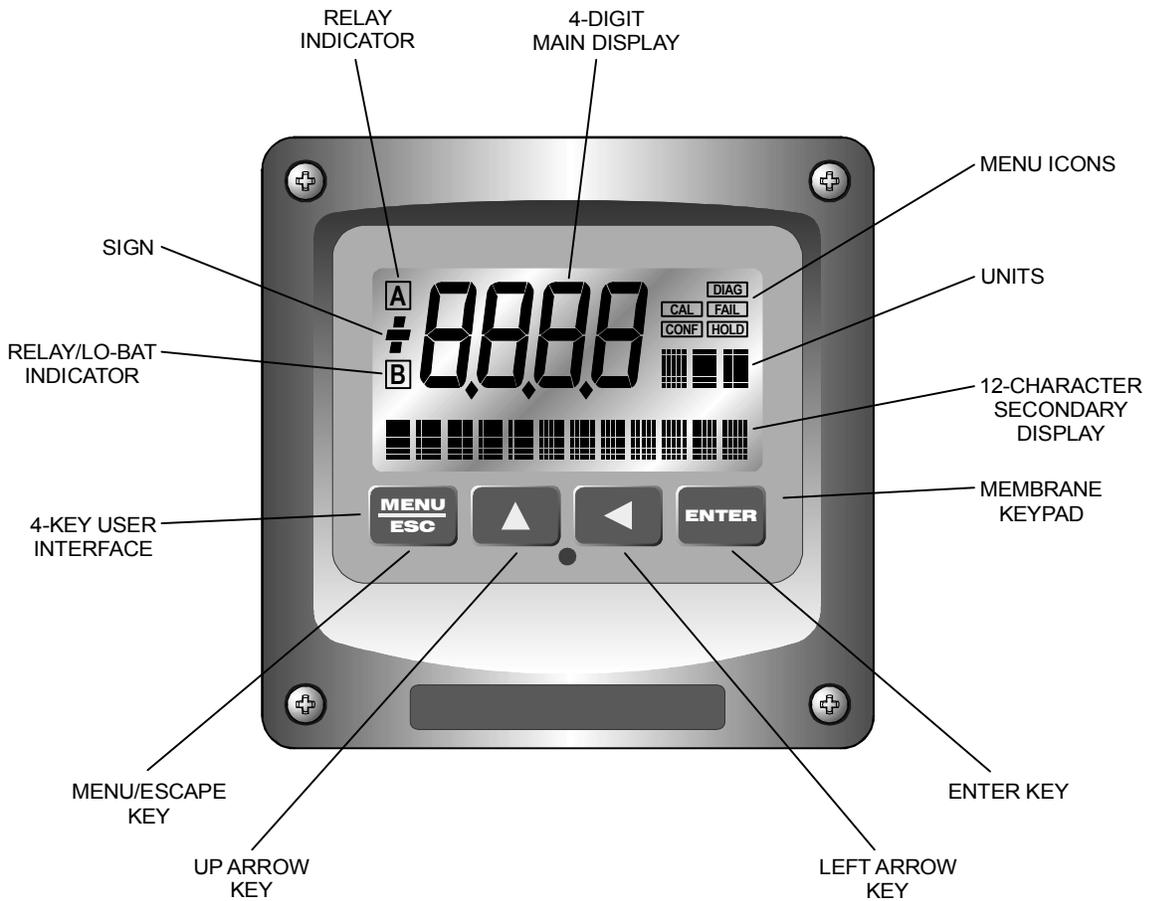


Figure 9 - User Interface (ATI-0654)

4.6 Keys

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

MENU/ESC To scroll through the menu section headers or to escape from anywhere in software. The escape sequence allows the user to back out of any changes in a logical manner. Using the escape key aborts all changes to the current screen and backs the user out one level in the software tree. The manual will refer to this key as either MENU or ESC, depending upon its particular function. In the battery-powered version of the Q45, this is also the ON button.

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

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

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

4.7 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.

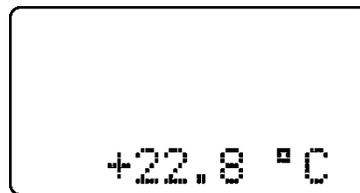
Main Parameter During normal operation, the main parameter display indicates the present process input with sign and units. This main display may be configured to display any of the main measurements that the system provides. During configuration, this area displays other useful set-up information to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



Lower Line

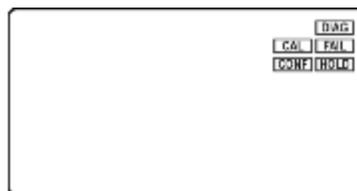
During normal operation, the lower line of the display indicates user-selected secondary measurements that the system is making. This also includes calibration data from the last calibration sequence and the transmitter model number and software version. During configuration, the lower line displays 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 9.31.



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, CONTROL, 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 Q45D 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.

4.9 Software Navigation

Within the CAL, CONFIG, CONTROL, and DIAG menu sections are 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 10 for a visual map of the software.

Each list item allows a change to a stored system variable. List items are designed in one of two forms: simple single variable, or multiple variable sequences. In the single variable format, the user can quickly modify one parameter - for example, changing temperature display units from °F to °C. In the multiple variable sequence, variables are changed as the result of some process.

For example, the calibration of dissolved oxygen 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.

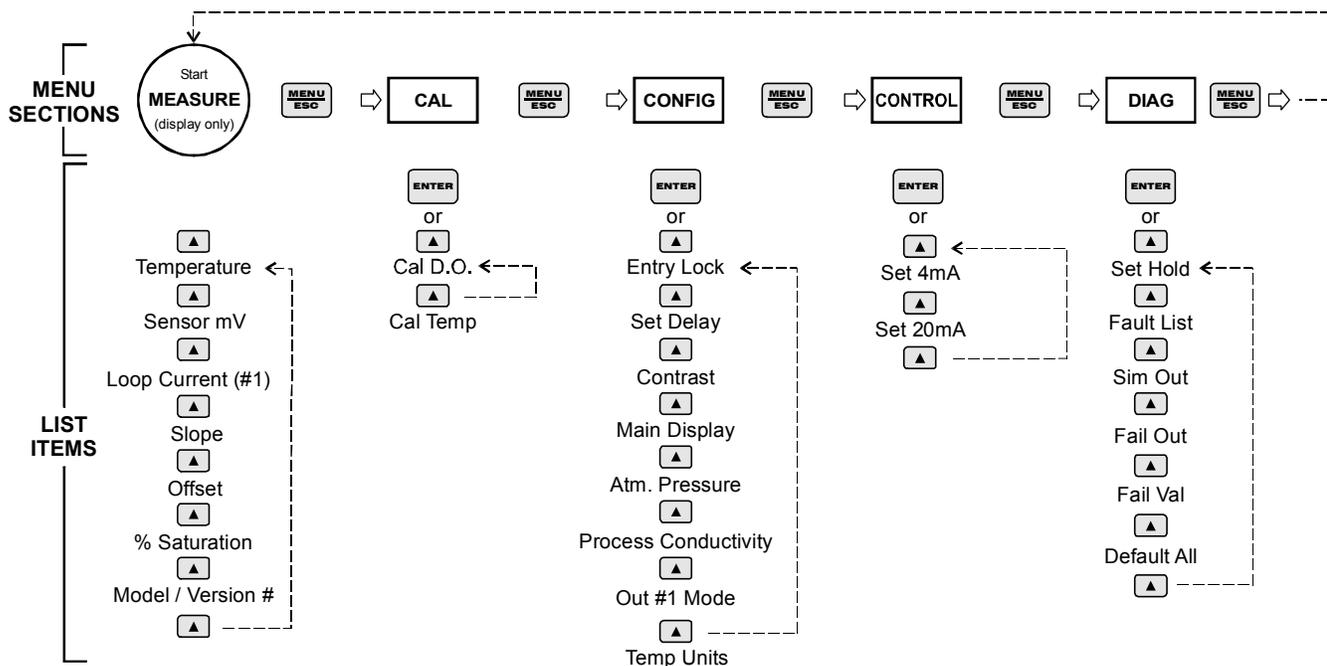


Figure 10 - Software Map

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.

5.0 MeasureMenu[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.
+350 mV	Raw sensor output. Useful for diagnosing problems.
#1 1.05 VDC	Instrument output signal #1.
#2 0.66 VDC	Instrument output signal #2.
Slope = 100%	Sensor output response vs. ideal calibration. This value updates after each calibration. As the sensor ages, the slope reading will decay indicating sensor aging. Useful for resolving sensor problems.
Offset = 0 mV	Sensor output signal at a zero ppm input. This value updates after a zero-calibration has been performed. Useful for resolving sensor problems.
85.4 %sa	Saturated dissolved oxygen value.
Q45D0 v2.10	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.

5.1 CalibrationMenu [CAL]

The calibration menu contains items for frequent calibration of user parameters. There are two items in this list: Cal D.O., and Cal Temp.

Cal D.O. The dissolved oxygen calibration function allows the user to adjust the transmitter zero/span reading to match a reference solution, or to set the sensor zero point. 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 $\pm 5^{\circ}\text{C}$. 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.

5.2 ConfigurationMenu[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 of 1454. Press ENTER to initiate user entry mode and the first digit will flash. Use arrow keys to modify value. 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 dissolved oxygen 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.

Instr Type

This function allows the user to change the type of measurement to be displayed in the primary display area. The user may select “**1 PPM**”, “**2 mg/L**”, or “**3 %Sat**”. There is not a great deal of difference between type 1 and 2 settings as PPM and mg/L measurement units are pretty close to the same. However, programming for type 3 percent saturation changes the measured parameter to read a dissolved oxygen value that represents the percent of oxygen saturation at a given temperature. When this unit of measurement is selected, the main analog output and all alarm and control functions will relate to this measurement. While a PPM measurement is displayed on the lower line, it is no longer the primary variable being measured by the system. Press ENTER to initiate user entry mode, and the selected value will flash. Use the UP arrow key to modify the desired display value. Press ENTER to store the new value.

Zero Filter

The Q45D allows the user to program a value near zero below which the monitor will read zero. Because sensors rarely have a perfect zero stability, this zero filter eliminates occasional displays of numbers that are not meaningful. For instance, setting a zero filter at 0.03 PPM D.O. will cause any measured values of 0.01 or 0.02 PPM to be displayed as 0.00 PPM.

AtmPres

The Q45D instrument utilizes the atmospheric pressure value as an input for the calculation of a theoretical ppm value during a saturation calibration. The input default units are inHg (inches Mercury) since these units are easy to obtain from most local weather services. This value is only required to be entered during initial installation – it does not need to be modified at every calibration.

Press ENTER to initiate user entry mode and the entire value will flash. Use the arrow keys to modify the value; range is 20.00 to 31.50 inHg.

A reference table is provided in Section 9 to convert to inHg from several other common air pressure units. Press ENTER to store the new value.

Proc Cond

The Q45D instrument also utilizes the process conductivity value as an input for the calculation of a theoretical ppm value during a saturation calibration. This value is only required to be entered during initial installation - it does not need to be modified at every calibration. Press ENTER to initiate user entry mode and the value will flash. Use the arrow keys to modify the value; range is 0.00 to 76.00 mS/cm. Press ENTER to store the new value.

Note: If the user will not be changing solution conductivity dramatically during the calibration process, leave a default setting of 00.50 mS/cm.

Out#2 Mode

This function sets analog output #2 to either track temperature (default) or dissolved oxygen. 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 tracking, or 2-ppm for dissolved oxygen tracking. 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.

5.3 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 40.00 ppm 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 dissolved oxygen. Output #2 will be in either units of ppm or C/F, depending on whether dissolved oxygen 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.)

5.4 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 dissolved oxygen level of the instrument to check the output settings. The user enters a ppm value directly onto the screen, and the output responds as if it were actually receiving the signal from the sensor.

This allows the user to check the function of attached monitoring equipment during set-up or troubleshooting. Escaping this screen returns the unit to normal operation.

Press ENTER to initiate the user entry mode, and the right-most digit of the value will flash. Use arrow keys to modify desired value.

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.

Auto-Off

Enables the automatic shut-off feature for the instrument. If ON, the instrument will automatically shut-off in 30 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 8-10 days on a standard 9 VDC alkaline battery.) 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.

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 select either **CAL** or **ALL** with the UP arrow key. The default CAL routine will reset the zero offset to 0.0 nA and reset the slope to 100%. The default ALL routine will reset all program variables to factory default and should be used with care since it will change any user settings that were programmed in the field.

Part 6 – Calibration

6.1 Dissolved Oxygen Calibration

The instrument must be calibrated periodically to maintain a high degree of measurement accuracy. A complete calibration will include zeroing and spanning the sensor. It is generally unnecessary to set the zero at every calibration; however, it should be done during the initial installation.

The output of the dissolved oxygen sensor will degrade over the cartridge lifetime as the electrolyte and electrodes are slowly consumed. Under normal conditions (3 - 5 ppm) the degradation occurs at a very slow rate. To account for this degradation, the Q45D system should be re-calibrated at regular intervals. In addition, the 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 operating at more ambient levels. It is important for the user to establish a periodic cleaning and calibration schedule for sensor maintenance. Before calibrating with a new sensor for the first time, or whenever a sensor has been left unpowered for 10 days or more, first connect the sensor to the transmitter and allow the system to operate for at least 10 hours to properly polarize the cartridge electrodes. Failure to perform this conditioning can result in significantly higher than normal initial readings. Once the cartridge has been properly conditioned, the user must select the proper operating parameters, including atmospheric pressure and solution conductivity.

The system provides three methods of D.O. calibration: 1-Point (sample), and Saturation (air cal), and Zero. These three methods are significantly different.

6.2 Dissolved Oxygen Span Cal (1-spl)

The 1-Point (sample or comparison) method is intended to be primarily used as an on-line calibration; however, the sensor can be removed, cleaned and then calibrated in a bucket of clean water if necessary. During calibration, the system will display the current ppm reading and the user can manually enter a reference value from a lab sample or comparative reference instrument. In the Q45D system, the 1-Point calibration adjusts the slope of the sensor output response.

1. Determine whether the calibration will be done on-line or with the sensor removed and placed into a bucket of clean water. If the sensor is removed from the application, rinse and clean if necessary.
2. If the sensor has been removed and placed into a bucket of water, allow sensor to temperature equilibrate with the solution as much as possible. With the sensor coming from an application which 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.
3. Scroll to the CAL menu section using the MENU key and press ENTER or the UP arrow key. **Cal DO** will then be displayed.
4. Press the ENTER key. The screen will display a flashing **1-spl** for 1-point, a **2-sat** for Saturation calibration, or a **3-zer** for zero calibration. Using the UP arrow key, set for a 1-spl calibration and press ENTER.
5. The system now begins acquiring data for the calibration value. As data is gathered, the units for ppm and temperature may flash. Flashing units indicate that this parameter is unstable. The calibration data point acquisition will stop only when the data remains stable for a pre-determined amount of time. This can be overridden by pressing ENTER. If the data remains unstable for 10 minutes, the calibration will fail and the message **Cal Unstable** will be displayed.
6. The screen will display the last measured ppm value and a message will be displayed prompting the user for the lab value. The user must then modify the screen value with the arrow keys and press ENTER. The system then performs the proper checks.
7. If accepted, the screen will display the message **PASS** with the new slope 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.

6.3 Dissolved Oxygen Span Cal (sat)

This is the recommended method; however, it requires that the sensor be removed from the process and cleaned. Once cleaned, the sensor is placed in air known to be at 100% relative humidity. To accomplish this easily, ATI recommends the use of a calibration bag to provide a stable high humidity environment. As the sensor temperature equilibrates in the air cal bag, the transmitter automatically calculates the new 100% saturation point utilizing the temperature readings and the barometric pressure user data. This method therefore requires no user input during

calibration. Note: It is very important to allow enough time for the sensor to completely temperature equilibrate with the surrounding air. This time is at least 10 minutes.

This method requires that the sensor be removed from the process, cleaned, and covered with a calibration bag. The sensor must also be wet for this procedure.

This method requires no user input during calibration; however, if this is the first time the system is being installed and calibrated, make sure to enter the proper atmospheric pressure data and process conductivity data prior to calibration.

1. Remove the sensor from the application. Rinse and clean if necessary.
2. Cover the sensor cartridge using one of the ATI air calibration bags. The end of the sensor should be wet, and the membrane should not touch the sides of the bag. If there is water in the bag, the membrane must not be submerged - it must be in the air. Secure bag firmly around the sensor with a rubber band and let the sensor hang, membrane downward, while powered.
3. Allow the system to operate undisturbed for at least 20 minutes. If the system is stable, the value on the display will increase to some PPM value and remain at that level. At that point, calibration can continue.
4. Scroll to the CAL menu section using the MENU key and press ENTER or the UP arrow key. **Cal D.O.** will then be displayed.
5. Press the ENTER key. The screen will display a flashing **1-spl** for 1-point, a **2-sat** for Saturation calibration, or a **3-zer** for zero calibration. Using the UP arrow key, set for a **2-sat** span calibration and press ENTER.
6. The display will prompt the user to hold the sensor in air and press ENTER. If the sensor has already been removed, reached temperature equilibrium, and the calibration bag has been installed, press the ENTER key.
7. The system now begins acquiring data for the calibration value. As data is gathered, the units for ppm and temperature may flash. Flashing units indicate that this parameter is unstable.

8. The calibration data point acquisition will stop only when the data remains stable for a pre-determined amount of time (approximately 15-20 seconds.) This can be overridden by pressing ENTER. If the data remains unstable for 10 minutes, the calibration will fail and the message **CalUnstable** will be displayed. If accepted, the screen will display the message **PASS** with the new sensor slope 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.

The range of acceptable values for sensor slope is 20% to 250%. It may be necessary to rebuild the sensor as described in section 4.1, Dissolved Oxygen Sensor Assembly. Should the slope value remain out of range and result in calibration failures, review the Service Section of this manual, then contact the Service Dept. at ATI for further assistance.

6.4 Dissolved Oxygen Zero Cal

Dissolved oxygen sensors have extremely low offset outputs at zero. For this reason, it is normally sufficient to simply leave the zero at the factory default of 0 mV. As an alternative, an electronic zero can be set by disconnecting the sensor from the cable and performing the steps below.

These steps below assume that the sensor has been prepared in accordance with section 4.1, Dissolved Oxygen Sensor Assembly, earlier in this manual. Note that the 10 hour waiting time in step 2 below is not required if the monitor has been running for 24 hours prior to zeroing. If the unit has been running with the sensor connected, the sensor will normally return to a stable zero within 15 minutes.

1. Remove the sensor from the application if necessary. Clean and rinse if required.
2. Place about an inch of zero solution in a small beaker or other convenient container and immerse the tip of the sensor. Allow the sensor to sit undisturbed for at least 1 hour. Suspend sensor, DONOT LET SENSOR SIT ON TIP.
3. Scroll to the CAL menu section using the MENU key and press ENTER or the UP arrow key. **Cal D.O.** will then be displayed.
4. Press the ENTER key. The screen will display a flashing **1-spl** for 1-point, a **2-sat** for Saturation calibration, or a **3-zer** for zero calibration. Using the UP arrow key, set for a **3-Zer** zero calibration and press ENTER.

5. The system now begins acquiring data for the sensor zero calibration value. As data is gathered, the units for sensor millivolts (mV) 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 **CalUnstable** will be displayed.
6. If accepted, the screen will display the message **PASS** with the new sensor zero reading (offset), then it will return to the main measurement display. If the calibration fails, a message indicating the cause of the failure will be displayed and the FAIL icon will be turned on. The range of acceptable value for sensor offset is -40 mV to +40 mV. Should a FAIL occur, carefully inspect the sensor for a tear in the membrane. It will probably be necessary to rebuild the sensor as described in section 4.1, Dissolved oxygen Sensor Assembly. Should the offset value remain high and result in calibration failures, review the Service section of this manual, and then contact the service dept. at ATI for further assistance.

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

6.5 Temperature Calibration

The temperature calibration sequence is essentially a 1-point offset calibration that allows adjustments of approximately ± 5 °C. The sensor temperature may be calibrated on line, or the sensor can be removed from the process and placed into a known solution temperature reference.

In any case, it is critical that the sensor be allowed to reach temperature equilibrium with the solution in order to provide the highest accuracy.

When moving the sensor between widely different temperature conditions, it may be necessary to allow the sensor to stabilize as much as one hour before the calibration sequence is initiated. If the sensor is on-line, the user may want to set the output HOLD feature prior to calibration to lock out any output fluctuations.

- 1) Scroll to the CAL menu section using the MENU key and press ENTER or the UP arrow key.
- 2) Press the UP arrow key until **Cal Temp** is displayed.
- 3) Press the ENTER key. The message **Place sensor in solution then press ENTER** will be displayed. Move the sensor into the calibration reference (if it hasn't been moved already) and wait for temperature equilibrium to be achieved. Press ENTER to begin the calibration sequence.
- 4) The calibration data gathering process will begin. The message **Wait** will flash as data is accumulated and analyzed. The °C or °F symbol may flash periodically if the reading is too unstable.
- 5) The message **Adjust value - press ENTER** will be displayed, and the right-most digit will begin to flash, indicating that the value can be modified. Using the UP and LEFT arrow keys, modify the value to the known ref solution temperature. Adjustments up to ± 5 °C from the factory calibrated temperature are allowed. Press ENTER.
- 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 General

The Q45D/60 Dissolved oxygen System will generally provide unattended operation over long periods of time. With proper care, the system should continue to provide measurements indefinitely. For reliable operation, maintenance on the system must be done on a regular schedule. Keep in mind that preventive maintenance on a regular schedule is much less troublesome than emergency maintenance that always seems to come at the wrong time.

7.2 Analyzer Maintenance

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

7.3 Sensor Maintenance

Sensor maintenance is required for accurate measurements. The primary requirement is simply to keep the sensor membrane clean. The membrane is a polymer material that is resistant to anything that will be encountered in water streams. However, deposits or biological growth can form on the surface of the membrane, and these deposits will reduce the sensitivity to oxygen. Normally, these coatings can be removed by simply wiping the membrane with a soft cloth or paper towel.

Should a coating form on the membrane that does not wipe off, it is best to change the membrane. Chemical cleaning may work as well, but a new membrane is a more reliable solution. To change a membrane, follow the Sensor Assembly procedure in this manual. Do not reuse the electrolyte from the sensor when changing a membrane. Always refill with fresh electrolyte. The electrolyte is stable and does not have a limited shelf life.

Even if no buildup is apparent on the membrane, it should be changed on a regular schedule. The recommended membrane change interval is every 6 months.

The actual membrane life is often in excess of one year, but periodic preventive maintenance will simply avoid having to do service on an emergency basis.

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

7.4 Lead Anode Replacement

Galvanic D.O. sensors consume the lead electrode during normal operation. As oxygen is measured, lead is converted to lead oxide, and after a period of time, the lead is expended. The lead electrode in ATI's D.O. sensor cartridge can be easily replaced, and replacement should be done automatically every 12 months.

The lead electrode is the thick lead wire wrapped around the sensor body see Figure 6. It is connected through a stainless steel post with a nut and star washer. To change the lead electrode, remove the nut and washer and unwrap the old lead. Loop the end of a new lead electrode around the post and replace the nut and washer. Tighten the nut firmly but do not over tighten as damage to the sensing module can result. Wrap the remainder of the lead around the sensor body. There is no need to secure the other end of the lead.

Part 8 – Service

8.1 General

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

8.2 External Sources of Problems

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

1. Carefully examine sensor wiring connections for loose wiring or bad wire stripping.
2. Check sensor membrane for fouling. Look closely for signs of grease or oil which may be present. Replace membrane and electrolyte, allow to stabilize, and re-check. The procedure in Dissolved Oxygen Sensor Assembly, in section 4.1, must be followed when replacing the membrane.

8.3 Analyzer Tests

1. Turn off power and remove sensor wiring. Re-apply power to the analyzer.
2. Using the Simulate feature, check operation of analog outputs with a DVM.
3. Check TC drive circuit. Connect a 1000 Ohm resistor across the BROWN and GREEN terminals. The temperature reading should display approximately 0°C and the dissolved oxygen reading should display approximately 0 ppm.

8.4 DisplayMessages

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

MESSAGE	DESCRIPTION	POSSIBLE CORRECTION
Max is 200	Entry failed, maximum user value allowed is 200.	Reduce value to ≤ 200
Min is 200	Entry failed, minimum value allowed is 200.	Increase value to ≥ 200
Cal Unstable	Calibration problem, data too unstable to calibrate. Icons will not stop flashing if data is too unstable. User can bypass by pressing ENTER.	Clean sensor and allow sensor to equilibrate in ambient air. Check the mv. display to see if sensor output is stable.
Out of Range	Input value is outside selected range of the specific list item being configured.	Check manual for limits of the function to be configured.
Locked!	Transmitter security setting is locked.	Enter security code to allow modifications to settings.
Unlocked!	Transmitter security has just been unlocked.	Displayed just after security code has been entered.
Offset High	The sensor zero offset point is out of the acceptable range of -40 to +40 mV.	Check wiring connections to sensor. Allow sensor to operate powered a minimum of 4 hours prior to first zero cal.
Sensor High	The raw signal from the sensor is too high and out of instrument range.	Check wiring connections to sensor.
Sensor Low	The raw signal from the sensor is too low.	Check wiring connections to sensor.
D.O. High	The dissolved oxygen reading is greater than the maximum of the User-selected range.	The dissolved oxygen reading is over operating limits. Set measuring range to the next highest level.
Temp High	The temperature reading is $> 55^{\circ}\text{C}$.	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 $< -10^{\circ}\text{C}$	Same as "Temp High" above.
TC Error	TC may be open or shorted.	Check sensor wiring and perform RTD test as described in sensor manual. Check j-box connections.

D.O. Cal Fail	Failure of dissolved oxygen calibration. FAIL icon will not extinguish until successful calibration has been performed, or 30 minutes passes with no keys being pressed.	Clean sensor redo zero and span calibration. If still failure, sensor slope may be less than 25% or greater than 500%. Perform sensor tests as described in section 8.4. Replace sensor if still failure.
T.C. Cal Fail	Failure of temperature calibration. FAIL icon will not extinguish until successful calibration has been performed, or 30 minutes passes with no keys being pressed.	. Clean sensor, check cal solution temperature and repeat sensor temp calibration. TC calibration function only allows adjustments of +/- 6 °C. If still failure, perform sensor tests as described in section 8.4. Replace sensor if still failure. .

Figure 11 - Q45D Display Messages

8.5 Sensor Tests

1. Check the membrane condition. A membrane that is not stretched smoothly across the tip of the sensor will cause unstable measurements. If necessary, change membrane and electrolyte.
2. Dissolved oxygen 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:
3. Disconnect the five sensor wires from the back of the dissolved oxygen monitor. Those wires are color coded white, brown, red, black, and green. Note: The brown wire may be replaced with an orange wire in some cables.
4. Remove the electrolyte chamber from the sensor and dry the electrodes with a paper towel.
5. Connect a DVM between the white and brown (or orange) wires. Reading resistance, you should find an open circuit value of infinite resistance. There must be no measurable resistance at all between these wires. Any resistance at all indicates either water in the cable connector or the breakdown in an electrode seal.
6. Connect a DVM between the red and white wires. The red wire is part of the RTD circuit and the white wire is part of the measuring cell. There should be no connection. Reading resistance, you should find an open circuit value of infinite resistance. Any

resistance at all indicates either water in the cable connector or the breakdown in an electrode seal.

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

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 12 - Pt100 RTD Table

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

Barometric Pressure Conversion		
Inches of Mercury(inHg)	Millimeters of Mercury (mmHg)	Feet Above Sea Level
22.00	558.8	+8790
22.50	571.5	+8053
23.00	584.2	+7347
23.50	596.9	+6671
24.00	609.6	+6023
24.50	622.3	+5402
25.00	635.0	+4806
25.50	647.7	+4233
26.00	660.4	+3682
26.50	673.1	+3156
27.00	685.5	+2653
27.50	698.5	+2150
28.00	711.2	+1675
28.50	723.9	+1217
29.00	736.6	+776
29.50	749.3	+349
30.00	762.0	-64
30.50	774.7	-463
31.00	784.4	-759

Figure 13 - Reference - Barometric Pressure Conv.

Water Saturated Concentration of O₂					
Temperature			Temperature		
°F	°C	PPM	°F	°C	PPM
32	0.0	14.6	74	23.3	8.5
34	1.1	14.1	76	24.4	8.3
36	2.2	13.7	78	25.6	8.2
38	3.3	13.3	80	26.7	8.0
40	4.4	12.9	82	27.8	7.8
42	5.6	12.6	84	28.9	7.7
44	6.7	12.2	86	30.0	7.5
46	7.8	11.9	88	31.1	7.4
48	8.9	11.6	90	32.2	7.3
50	10.0	11.3	92	33.3	7.1
52	11.1	11.0	94	34.4	7.0
54	12.2	10.7	96	35.6	6.9
56	13.3	10.4	98	36.7	6.8
58	14.2	10.2	100	37.8	6.6
60	15.6	9.9	102	38.9	6.5
62	16.7	9.7	104	40.0	6.4
64	17.8	9.5	106	41.1	6.3
66	18.9	9.3	108	42.2	6.2
68	20.0	9.1	110	43.3	6.1
70	21.1	8.9	112	44.4	6.0
72	22.2	8.7	114	45.6	5.9

Figure 14 - Reference - Water Sat Conc. Of O₂

Spare Parts List

<u>Part No.</u>	<u>Description</u>
07-0012	Q45D D.O. monitor electronics assembly, 3VDC
07-0078	Flow Type D.O. sensor
07-0095	Oxygen sensor, submersion type with 30' cable
02-0007	Submersion sensing module, (for #07-0095)
02-0014	Submersion element body, (for #02-0007)
02-0113	Submersion holder, 30' cable (for #07-0095)
02-0224	Flow Type Sensor Element (for 07-0078)
03-0358	Electrolyte Chamber with pressure gland
48-0001	Membrane holder, type 316 stainless steel
45-0010	Membrane holder, noryl
04-0003	Replacement lead electrode
05-0001*	5-mil Membranes, pkg. of 10
05-0011*	Membranes, 2 mil., pkg. of 10
05-0014	Spare Parts Kit, screw & o-ring
05-0015	Spare Parts Kit, screw & o-ring (Flow Sensor)
05-0088	Pressure gland rebuild kit
42-0014	Flowcell O-ring
09-0007*	Dissolved oxygen electrolyte, 4 oz (120 cc)

Note: Instrument is supplied with sufficient spare parts for 6-12 months of operation. For 2 year spare parts inventory, 3 each of the items marked with an asterisk (*) should be ordered.

Lock/Unlock Code: 1454