A Badger Meter® Brand

Water Quality Monitor

Model Q46T Turbidity Monitor

Badger Meter

ATI-UM-04555-EN-02 (October 2024)

User Manual

CONTENTS

INTRODUCTION

General

The Model Q46/76 is a versatile online monitoring system designed for the continuous measurement of turbidity in water. It is intended for continuous monitoring of potable water filter outlets, raw water inlets or turbidity monitoring of wastewater effluent.

The full scale operating range of the system is 0…400 NTU. Actual display range is user programmable for 0…4, 0…40 or 0…400 and the system can also be programmed to display in units of PSL for applications where polystyrene latex spheres are the standard of measurement. The basic sensing element used in the turbidity system is an optical sensor measuring light scattered at 90° to the transmitted beam. The sensor provides an auto-zeroing function to ensure the highest sensitivity at very low turbidity levels.

Q46/76 monitors are available in two electronic versions: an AC powered monitor with integral alarm relays and dual 4…20 mA output capability, and a 12…24V DC unit with dual output and relays. Options are available to add either a third 4…20 mA output or 3 additional low power SPST relays. In addition, a digital output option for Profibus, Modbus or Ethernet is available.

Standard System

The standard model Q46/76 system includes two components: the Q46 analyzer and an optical sensor with 30 ft cable. For most filter effluent applications, the sensor must be used in a flow chamber to avoid errors due to ambient light. For wastewater effluent applications, a submersible sensor is available. When necessary, Badger Meter's Q-Blast air cleaning assembly can be used with the submersible sensor to reduce manual cleaning.

For connection of the sensor to the electronics, a 30 ft cable is supplied. Up to an additional 100 ft of interconnect cable may be added using junction box (07-0100).

Calibration Panel System

Q46T turbidity systems may be supplied as an assembled panel containing special components to simplify calibration. This assembly is optional and must be specified at the time of ordering. If this option is purchased, you should receive the system already mounted and wired on a 12 in. × 24 in. non-metallic panel. Setup and programming of the electronics is the same as with a standard system but the procedure for calibration is different. See *"Calibration Panel" on page 48* for specific details on the calibration panel assembly.

Features

- Standard Q46D electronic transmitters are designed to be a fully isolated instruments for operation from either 90…260V AC or 12…24V DC power supplies.
- Two 4…20 mA analog outputs are standard, and a third analog output is available as an option. One output may be configured for PID control, while the other output is programmable to track either Turbidity or Temperature.
- Dry standard available for quick calibration verification.
- Digital communication option for Profibus-DP, Modbus-RTU or Ethernet-IP.
- *Output Hold*, *Output Simulate*, *Output Alarm* and *Output Delay* functions. All forced changes in output condition include bumpless transfer to provide gradual return to online signal levels and to avoid system control shocks on both analog outputs.
- Units provide three SPDT relay outputs and two isolated analog outputs. Software settings for relay control include setpoint, deadband, phase, delay and failsafe.
- Selectable *Output Fail Alarm* feature on Relay C allows system diagnostic failures to be sent to external monitoring systems.
- Large, high contrast, custom LCD display with LED back light provides excellent readability in any light conditions. The secondary line of display uses 5 × 7 dot matrix characters for clear message display. Two of four measured parameters may be on the display simultaneously.
- Diagnostic messages provide a clear description of any problem with no confusing error codes to look up. Messages are also included for diagnosing calibration problems.
- Security lock feature to prevent unauthorized tampering with transmitter settings. All settings can be viewed while locked, but they cannot be changed.

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.

Q46/76 System Specifications

Displayed Parameters	Main input, 0.001…400 NTU Sensor temperature, –10.0…50.0° C (23…122° F) Loop current, 4.00…20.00 mA Sensor slope/offset Model number and software version PID controller status
Main Parameter Ranges	Manual selection of one of the following display ranges: 0…4.000, 0…40.00 or 0…400.0 NTU
Power	90…260V AC, 50/60 Hz, 10 VA maximum or 12…24V DC, 500 mA maximum
Display	0.75 in. (19.05 mm) high 4-digit main display with sign 12-digit secondary display, 0.30 in. (7.62 mm) 5 × 7 dot matrix Integral LED back-light for visibility in the dark
Enclosure	NEMA 4X, polycarbonate, stainless steel hardware
Mounting Options	Wall, pipe or panel mount standard. Wall bracket suitable for either 1.50 in. or 2 in. I.D. U-bolts for pipe mounting.
Conduit Openings	Five 1/2 in. NPT openings. Adapter can be removed to provide a 1 in. NPT opening in the bottom of the enclosure. Gland seals provided but not installed.
Relays, Electromechanical	Three SPDT, 6 amp @ 250V AC, 5 amp @ 24V DC contacts Software selection for setpoint, phase, delay, deadband, hi-lo alarm and failsafe A-B indicators on main LCD, and C indicator on lower display
Analog Outputs	Two 4…20 mA outputs. Output one programmable for NTU Turbidity or PID. Output 2 programmable for NTU or Temperature. Max load 450 Ohms for Output 1 and 1000 Ohms for Output 2. Outputs ground isolated and isolated from each other. An additional 3rd analog option is available.
Output Isolation	600V galvanic isolation
Optional Relays	Three SPST, 1 amp @ 24V DC Software selection for setpoint, phase, delay, deadband, hi-lo alarm and failsafe
Ambient Temperature	Analyzer Service, –20…60° C (–4…140° F) Sensor Service, 0…55° C (23…131° F) Storage, –30…70° C (–22…158° F)
Ambient Humidity	0…95%, indoor/outdoor use, non-condensing to rated ambient temperature range
Altitude	Up to 2000 m (6562 ft)
Electrical Certification	Ordinary location, cCSAus (certified to both CSA and UL standards), pollution degree 2, installation category 2
EMI/RFI Influence	Designed to EN 61326-1
Weight	2.4 lb (1.1 kg)
Sensor	Optical 90° scatter
Sensor Materials	PVC and acrylic
Sensor Cable	Submersible: 30 ft (10 m)
Max. Sensor Cable Length	100 ft (30 m) with junction box

Q46/76 Performance Specifications

Accuracy	0.5% of range or 0.03 NTU
Repeatability	0.3% of range or 0.02 NTU
Sensitivity	0.1% of selected range
Non-Linearity	0.1% of selected range
Warm-Up Time	30 seconds to rated performance (electronics only)
Supply Voltage Effects	±0.1% span
Instrument Response Time	60 seconds to 90% of step input at lowest damping

ANALYZER MOUNTING

General

All Q46 Series instruments offer maximum mounting flexibility. A bracket is included with each unit that allows mounting to walls or pipes. Choose a location that is readily accessible for calibrations and keep in mind that it is necessary to use solutions during the calibration process. To take full advantage of the high contrast display, mount the instrument in a location where the display can be viewed from various angles and long distances.

Locate the instrument in close proximity to the point of sensor installation; this allows easy access during calibration. The sensor-to-instrument distance should not exceed 100 ft (30 m). To maximize signal-to-noise ratio however, work with the shortest sensor cable possible. The standard cable length of the turbidity sensor is 30 ft.

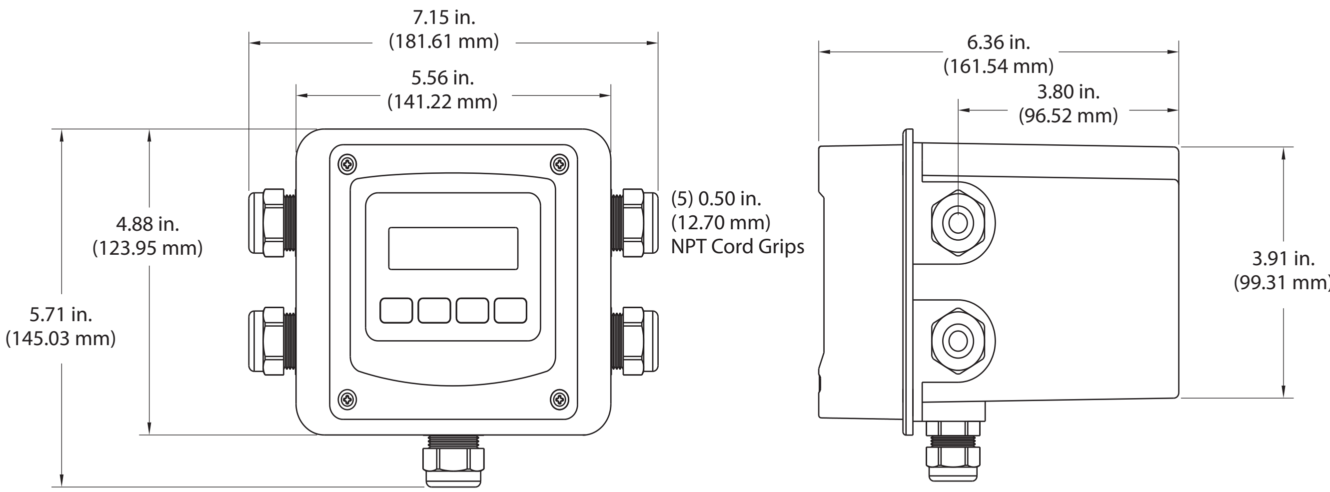


Figure 1: Q46 enclosure dimensions

Wall or Pipe Mount

A PVC mounting bracket with attachment screws is supplied with each transmitter (see *Figure 2* for dimensions). The multipurpose bracket is attached to the rear of the enclosure using the four flat head screws. The instrument is then attached to the wall using the four outer mounting holes in the bracket. These holes are slotted to accommodate two sizes of U-bolts that may be used to pipe mount the unit. Slots accommodate U-bolts designed for 1-1/2 in. or 2 in. pipe. The actual center-to-center dimensions for the U-bolts are shown in *Figure 2*.

NOTE: These slots are for U-bolts with 1/4-20 threads. The 1-1/2 in. pipe U-bolt (2 in. I.D. clearance) is available from Badger Meter in type 304 stainless steel (47-0005).

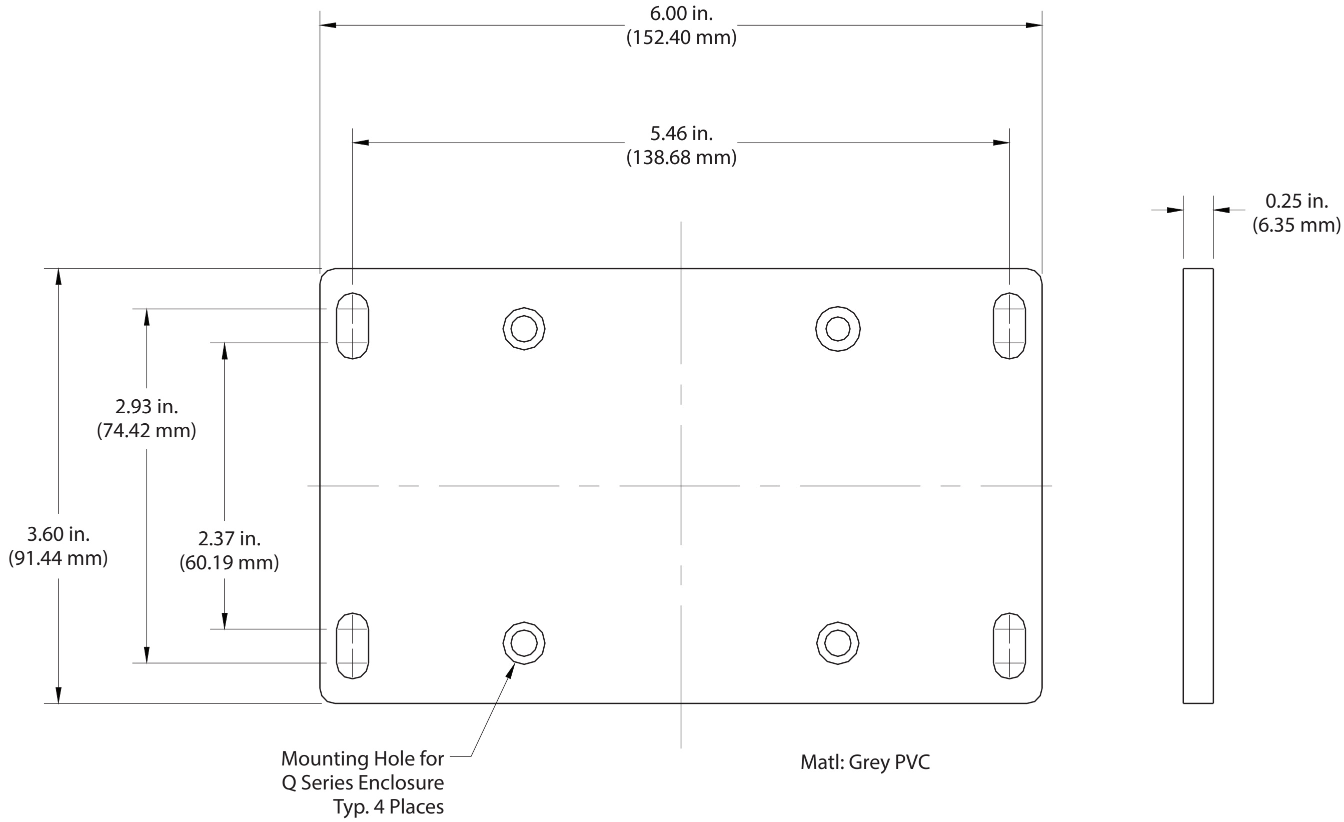


Figure 2: Wall or pipe mount bracket

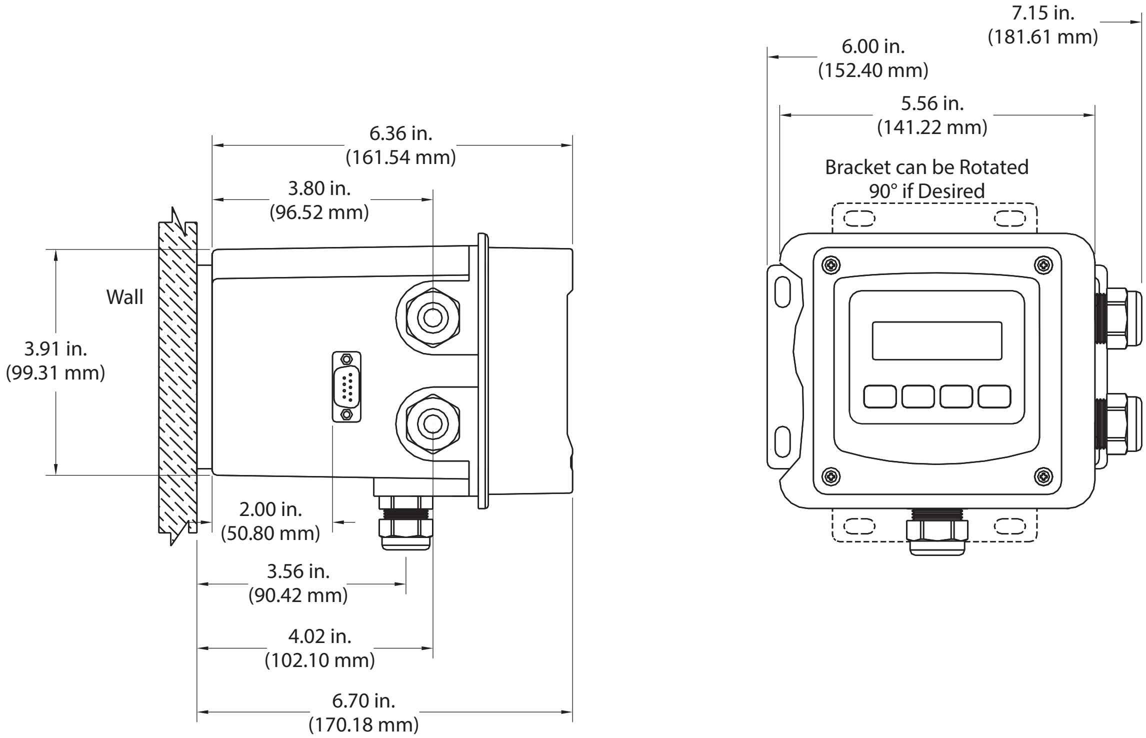
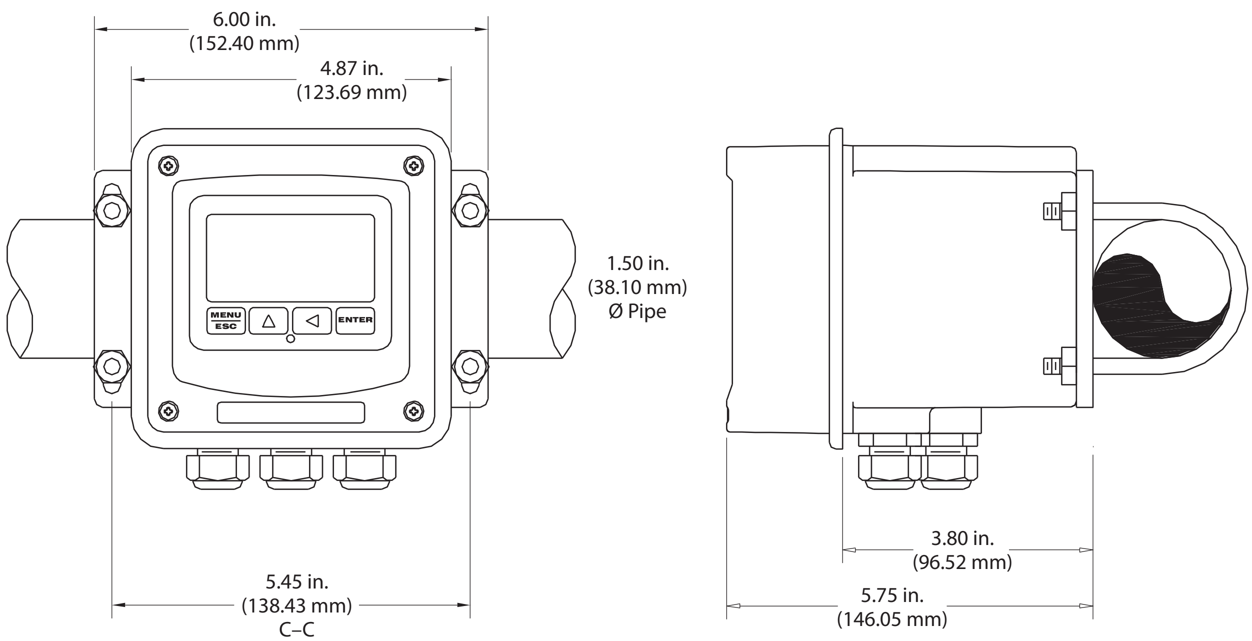


Figure 3: Wall mounting diagram



NOTE: Mounting plate hole spacing can support up to 2 in. Ø pipe max.

Figure 4: Pipe mounting diagram

Panel Mount, AC Powered Monitor

Panel mounting of an AC powered monitor uses the panel mounting flange molded into the rear section of the enclosure.

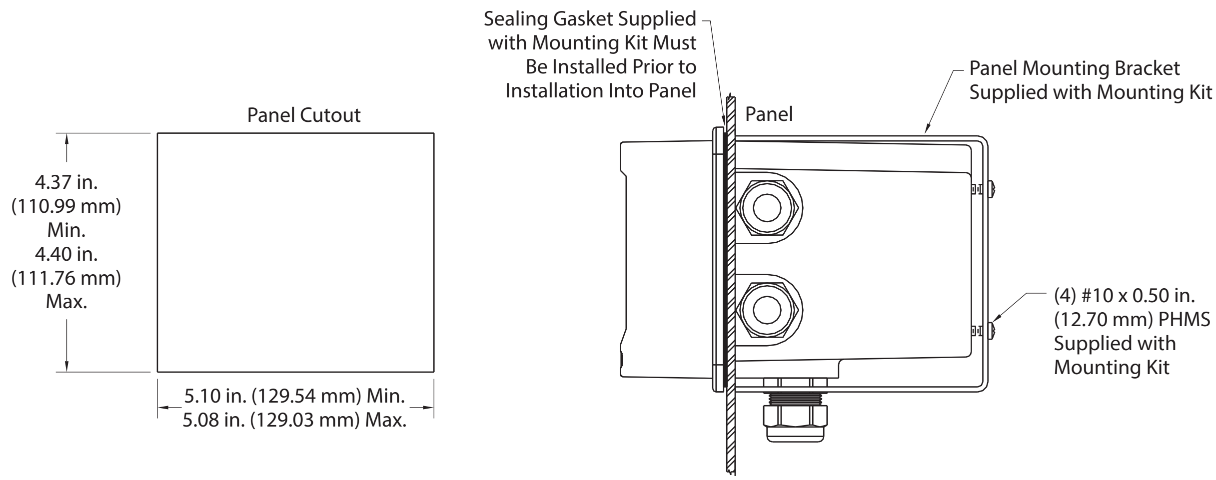


Figure 5: Panel mount diagram

Figure 5 provides dimensions for the panel cutout required for mounting. The panel mounting bracket kit (05-0068) must be ordered separately. This kit contains a metal retainer bracket that attaches to the rear of the enclosure, 4 screws for attachment of this bracket and a sealing gasket to ensure that the monitor flange provides a water tight seal when mounted to a panel.

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

SENSOR INSTALLATION

General

The majority of turbidity applications require the use of a flowcell assembly. This method is best when monitoring very low turbidity values, such as filter effluent. The flowcell used with Badger Meter's turbidity system is designed to eliminate ambient light effects, and to allow sample pressure to be maintained through the flowcell minimizing air bubble formation that can cause measurement errors. A bracket is supplied for mounting the flowcell to any flat surface.

Flowcell Mounting

Figure 6 provides flowcell dimensions.

NOTE: The flowcell should always be mounted horizontally with the inlet on the bottom and outlet on the top.

Select a flowcell location with sufficient clearance below to allow installation of the inlet calibration valve to facilitate adjustment of the system after installation. See *Figure 8 on page 13* for the suggested tubing arrangement.

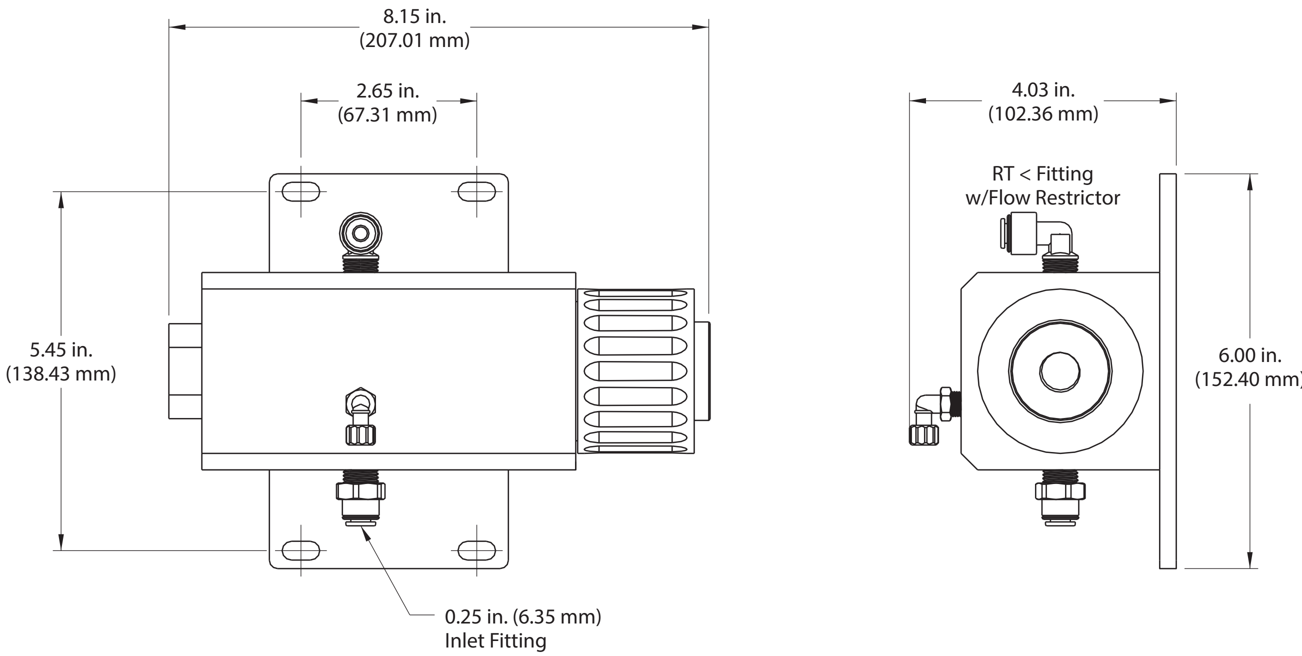


Figure 6: Flowcell dimensions

Figure 7 provides a detail of how the turbidity sensor is installed in the flowcell assembly. During installation of the sensor, be sure that the O-ring is seated properly in the groove at the end of the flowcell assembly. Proper seating of that O-ring is critical to avoiding water leakage.

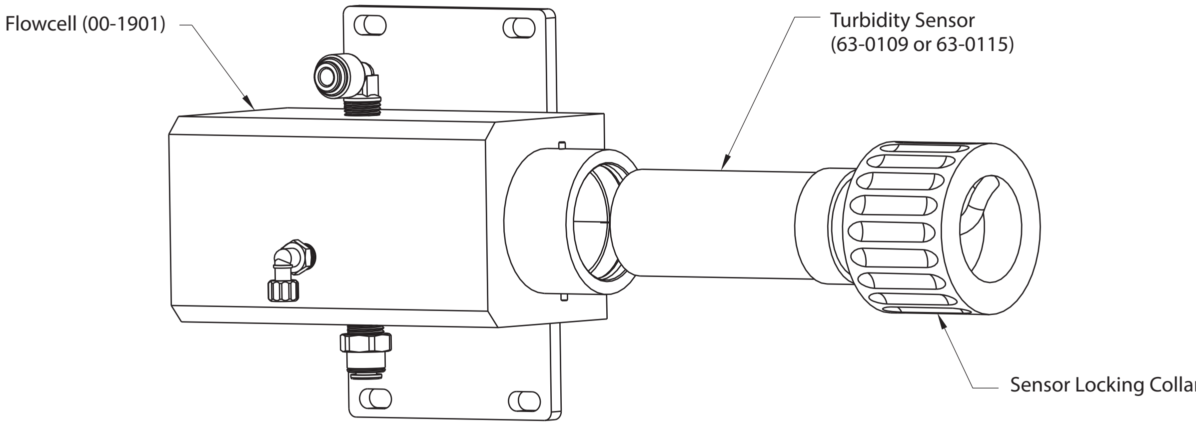


Figure 7: Sensor/flowcell exploded view

Figure 8 shows the recommended installation tubing arrangement for the turbidity system. A 3-way valve is supplied to facilitate calibration of the turbidity monitor. Install the valve as shown below so that turbidity standards can be easily introduced into the flowcell.

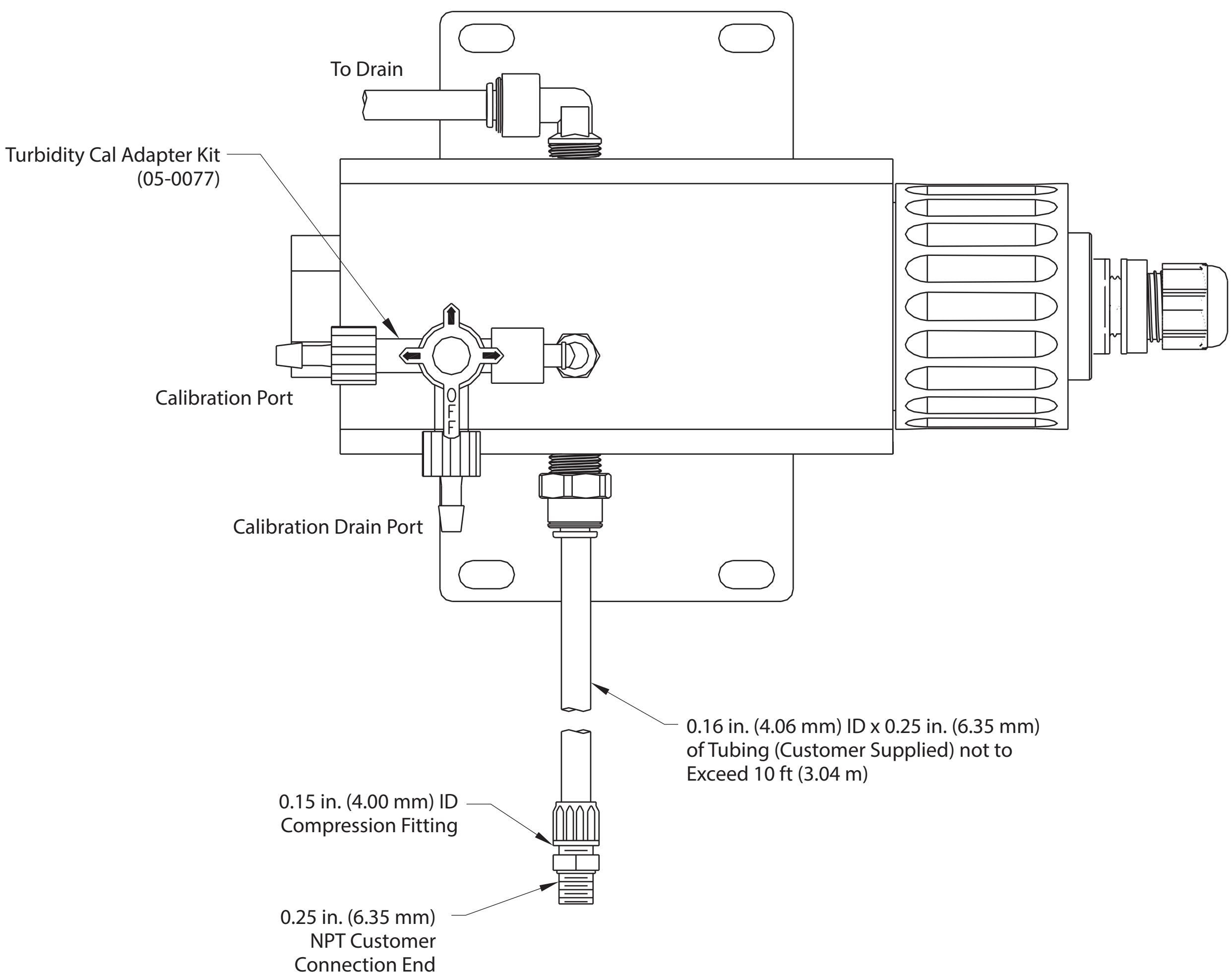


Figure 8: Inlet tubing arrangement

Raw Water Application

Turbidity monitoring of raw water with potentially high turbidity levels can be done using the standard flowcell with a slight modification or by using the flow tee assembly as shown in *Figure 10 on page 15*. If using the flowcell, you need to remove the installed inlet and outlet fittings on the flow chamber, and replace with the larger fittings that came with the flowcell. These fittings accommodate 3/8 in. OD tubing. This flowcell is modified to bypass the flow control orifice and allow samples with high turbidity values to flow through the flowcell without plugging.

In-Line Installation

Turbidity sensors may be installed directly into a flowing pipe system provided that the water does not contain a lot of entrained air. A 1-1/2 in. flow tee assembly is available for this purpose. It is best to install the sensor in a vertical pipe section with water flowing upward. This assures that air pockets cannot develop at the sensor. If installed in a horizontal run of pipe, place the sensor at the 3 or 9 o'clock position. Never mount the sensor on the top or bottom of the pipe. It is also good practice to install a bypass system around the sensor for maintenance and calibration purposes.

NOTE: In-line installation is not recommended when normal turbidity levels are below 0.5 NTU.

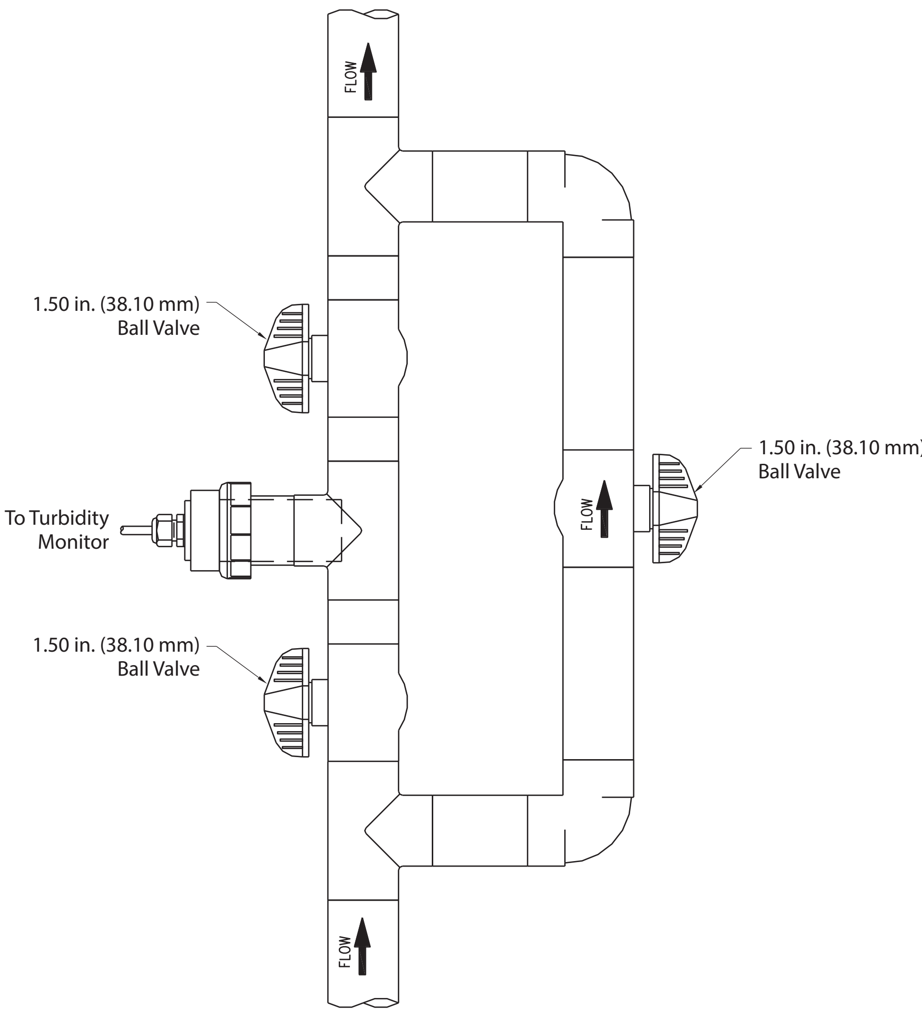


Figure 9: 1-1/2 in. in-line installation

NOTE: Vertical configuration is recommended but horizontal configuration is acceptable, provided sensor is mounted in the 3 or 9 o'clock position.

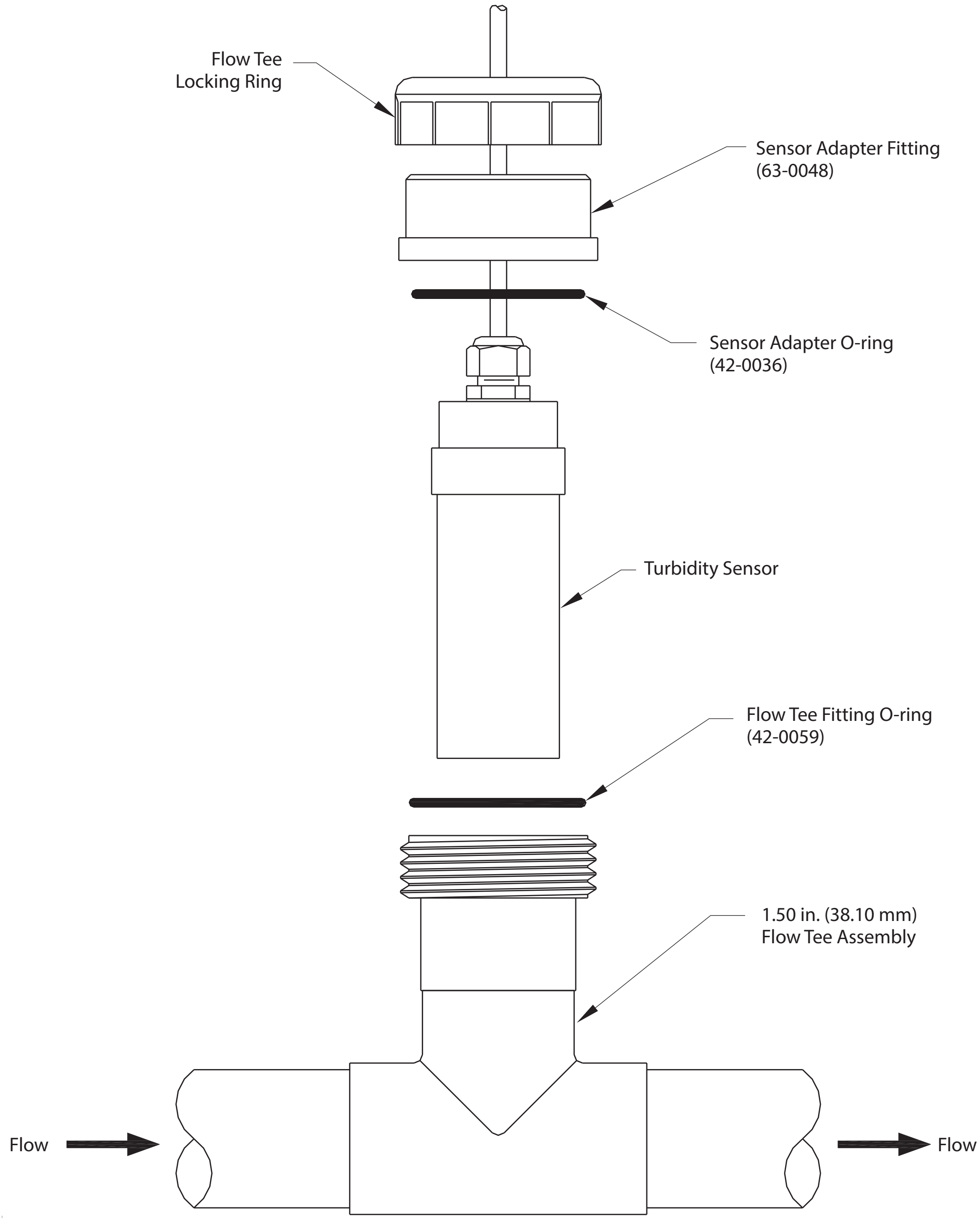


Figure 10: Flow tee exploded view

Submersible Installation

The standard turbidity sensor may also be used for submersion installations.

NOTE: Turbidity sensors may be affected by bright ambient light conditions. If submerged sensors are to be used outdoors, always use the Auto-Clean version of the sensor as it contains a light shield to minimize these effects.

A special adapter is available for mounting the turbidity sensor to a 1 in. pipe. *Figure 11* shows a typical submersion mounting using Badger Meter's submersion mounting kit (00-1690). This complete kit adapts to typical handrails. The pipe adapter only is part number 00-1689 and is available separately when the handrail mounting kit is not required.

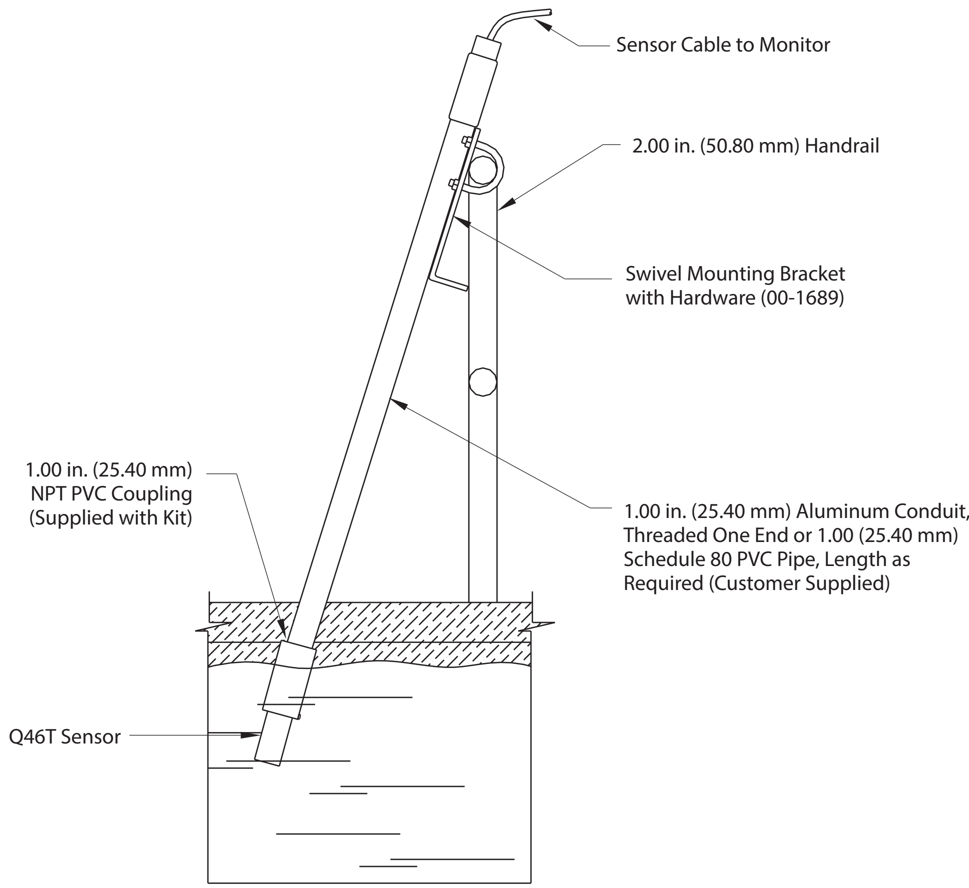


Figure 11: Submersion mounting assembly

ELECTRICAL INSTALLATION

General

The Q46 is powered in one of two ways, depending on the version purchased. The 12…24V DC powered analyzer requires a customer supplied DC power supply. The 90…260V AC version requires line power. Please verify the type of unit before connecting any power.

⚠ WARNING

DO NOT CONNECT AC LINE POWER TO THE DC VERSION. SEVERE DAMAGE COULD RESULT.

IMPORTANT NOTES:

1. Use wiring practices that conform to national, state and local electrical codes. For proper safety as well as stable measuring performance, it is important that the earth ground connection be made to a solid ground point on TB7. The AC power supply in the transmitter contains a single 630 mA slo-blo fuse (Wickmann/Littlefuse part number 372-0630). The fuse F1 is located adjacent to TB7 and is easily replaceable.
2. Do NOT run sensor cables or instrument 4…20 mA output wiring in the same conduit that contains AC power wiring. AC power wiring should be run in a dedicated conduit to prevent electrical noise from coupling with the instrumentation signals.
3. This analyzer must be installed by specifically trained personnel in accordance with relevant local codes and instructions contained in this operating manual. Observe the analyzer's technical specifications and input ratings. Proper electrical disconnection means must be provided prior to the electrical power connected to this instrument, such as a circuit breaker (rated 250V AC, 2 A minimum). If one line of the line power mains is not neutral, use a double-pole main switch to disconnect the analyzer.
4. Repeated problems with lightning strikes damaging sensitive instrumentation are often attributed to poorly bonded earth grounds in the instrument power source. The protection schemes incorporated into this analyzer cannot operate to maximum efficiency unless the ground connection is at its absolute lowest impedance.

There is no standard ground resistance universally recognized. Many agencies recommend a ground resistance value of 5 Ohms or less. The NEC recommends an impedance to ground of less than 25 Ohms and less than 5 Ohms where sensitive equipment is installed. Power sources feeding sensitive instruments like the Q46H/79PR should have the lowest possible impedance to ground.

Electrical Connections

Verify the power supply requirement before installing. Also verify that power is fully disconnected before attempting to wire.

Q46 systems are supplied with 5 cable gland fittings for sealing cable entries. Connect appropriate power to the matching designations on terminal strip TB7.

⚠ WARNING

DISCONNECT LINE POWER VOLTAGE BEFORE CONNECTING LINE POWER WIRES TO TERMINAL TB7 OF THE POWER SUPPLY. THE POWER SUPPLY ACCEPTS ONLY STANDARD THREE-WIRE SINGLE PHASE POWER. THE POWER SUPPLY IS CONFIGURED FOR 115V AC OR 230V AC OPERATION AT THE FACTORY AT TIME OF ORDER, AND THE POWER SUPPLY IS LABELED AS SUCH. DO NOT CONNECT VOLTAGES OTHER THAN THE LABELED REQUIREMENT TO THE INPUT.

The analog outputs from the system are present at Terminals TB1 and TB2. The loop-load limitation in this configuration is 450 Ohms maximum for Output 1 and 1000 Ohms maximum for Output 2.

NOTE: These two outputs are completely isolated from each other to ensure that ground loops do not result from the connection of both outputs to the same device such as a PLC or DCS.

A ribbon cable connects the power supply assembly with the microprocessor assembly located in the front section of the enclosure. This cable may be unplugged from the front section of the monitor if service is needed, but should normally be left in place during installation.

The power strip, TB7, allows up to 12 AWG wire. A wire gauge of 16 AWG is recommended to allow for an easy pass-through into the 1/2 in. NPT ports when wiring.

AC or DC power should be brought into the enclosures through the bottom gland seal on the right side of the enclosure. This entry is directly above the power terminal blocks. Terminal blocks are pluggable and can be removed for easy wire connection. See *Figure 12 on page 19* for TB7 terminal locations.

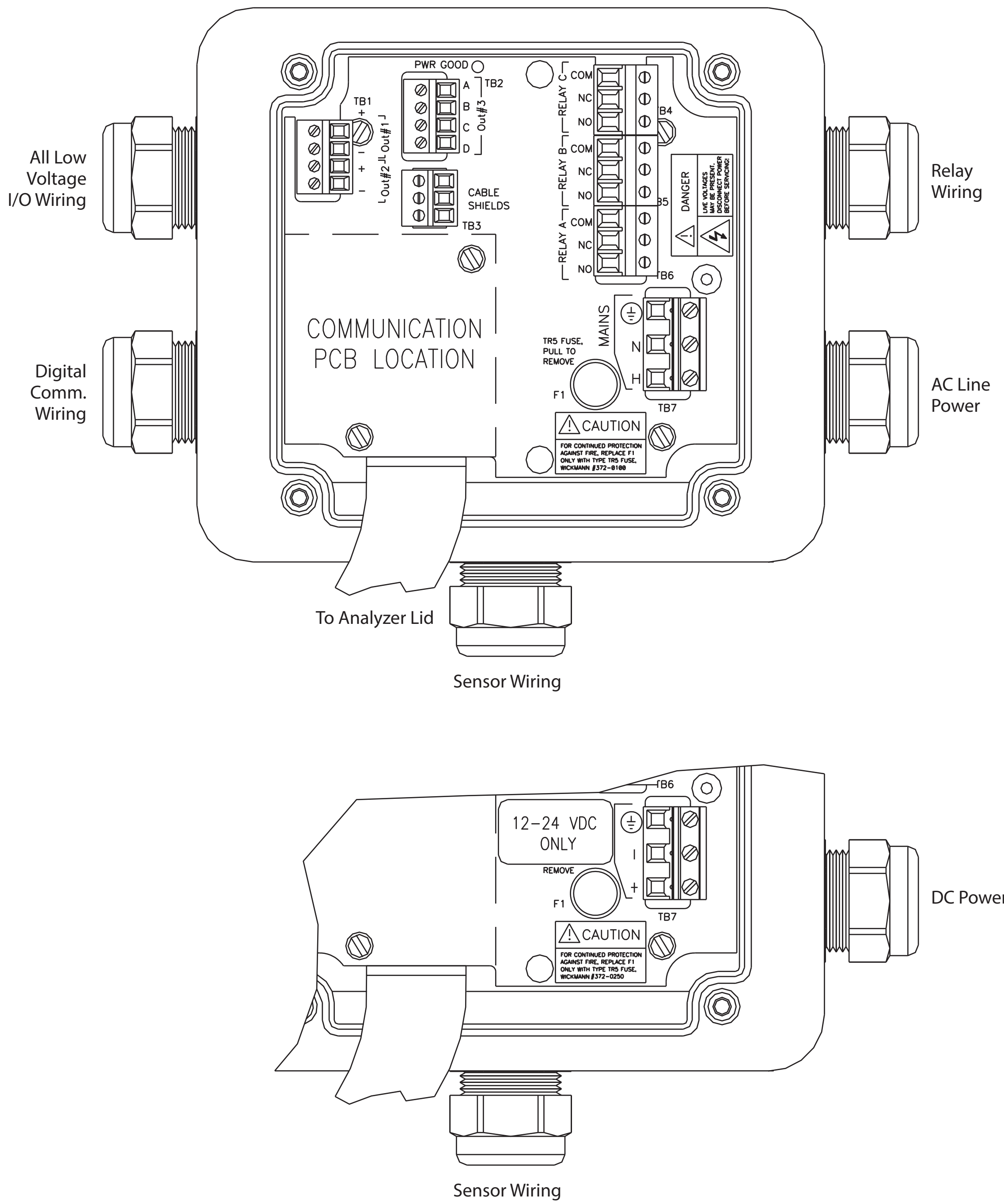


Figure 12: AC power connections

Relay Connection

Three SPDT relays are provided on the power supply board. None of the relay contacts are powered. The user must supply the proper power to the contacts. For applications that require the same switched operating voltage as the Q46 (115 or 230V), power may be jumped from the power input terminals at TB7. Relay wiring is connected at TB4, TB5 and TB6 as shown in *Figure 13*.

NOTE: The relay contact markings are shown in the *NORMAL* mode. Programming a relay for "Failsafe" operation reverses the NO and NC positions in *Figure 13*.

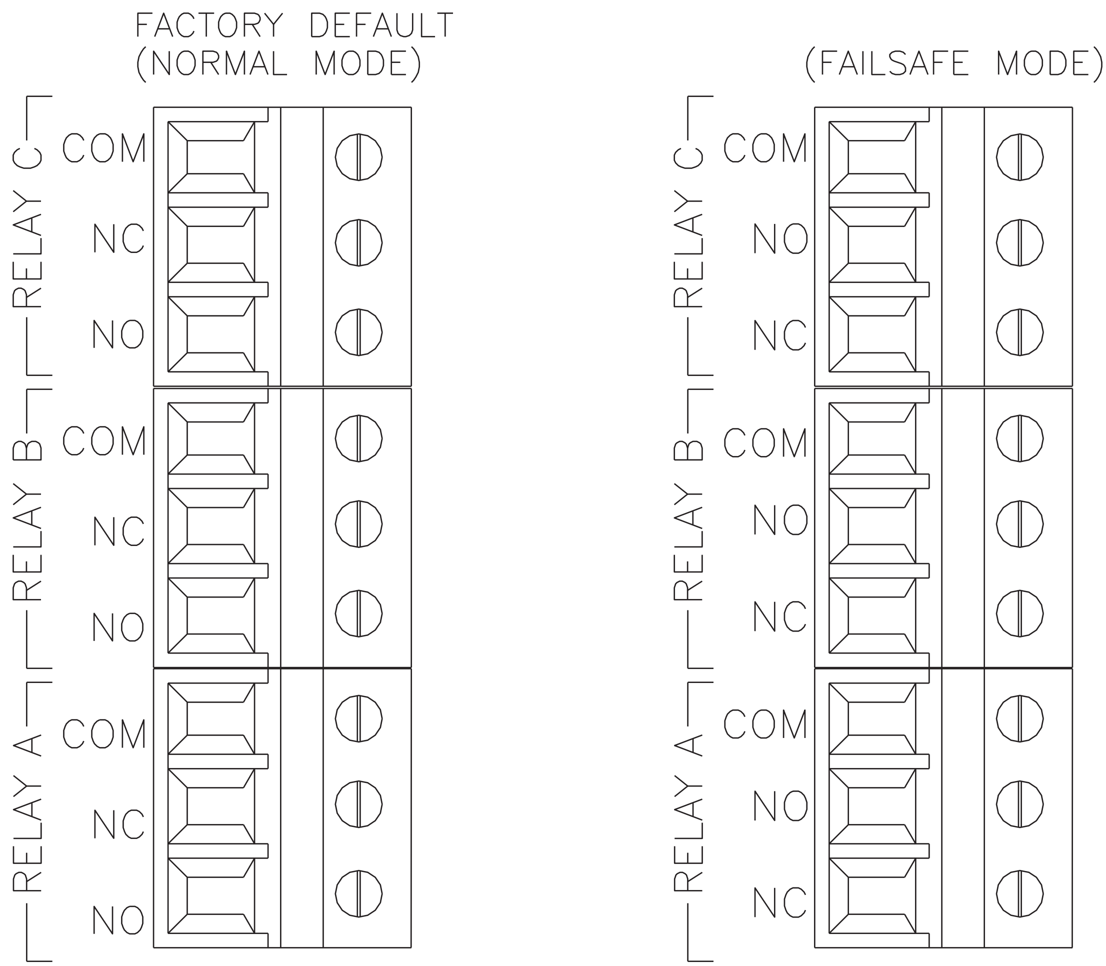


Figure 13: Relay contacts

Optional Output/Relay Connection

TB2 is used to connect the optional 3-relay card (see *Figure 14*) **OR** the optional third analog output *Out#3*, (see *Figure 15*). The Q46 can be configured for only one of these features, and the hardware for either option must be factory installed.

NOTE: The optional 3 relays are for switching LOW POWER DC ONLY.

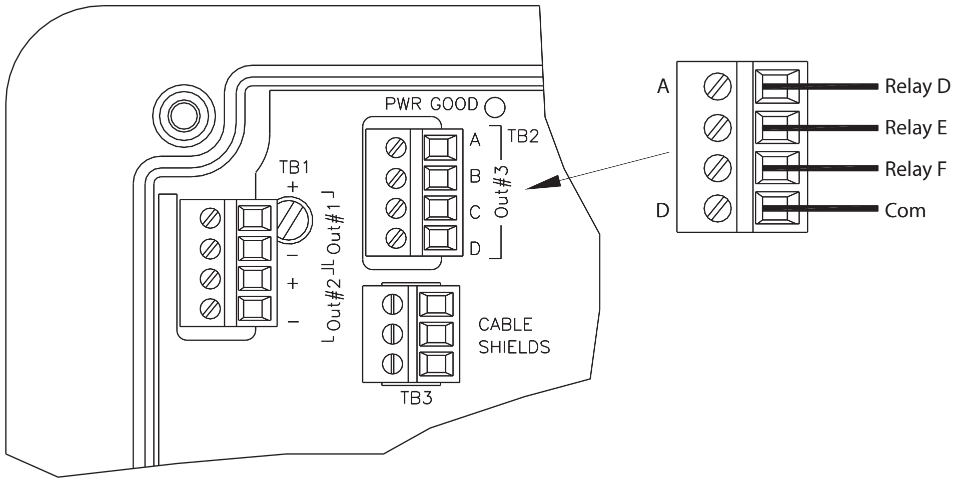


Figure 14: Optional low power relay wiring

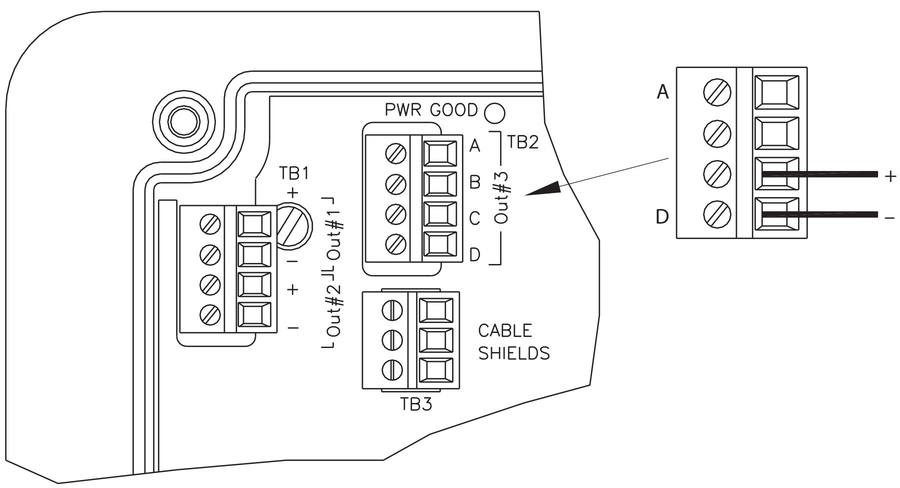


Figure 15: Optional 3rd analog output wiring

Direct Sensor Wiring

Sensor connections are made to a terminal block mounted on the front section of the monitor. The sensor cable can be quickly connected to the Q46 terminal strip by matching the wire colors on the cable to the color designations on the label in the monitor. Route signal cable away from AC power lines, adjustable frequency drives, motors or other noisy electrical signal lines. Do not run sensor or signal cables in conduit that contains AC power lines or motor leads.

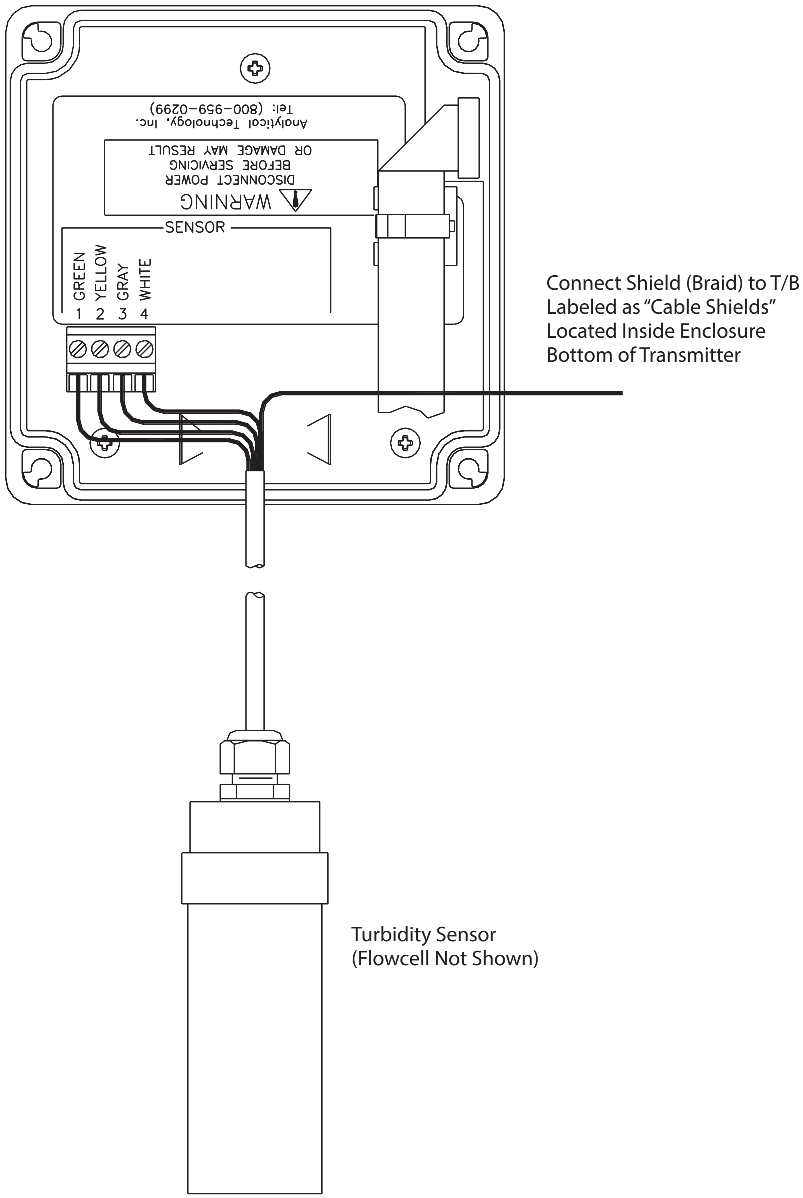


Figure 16: Turbidity sensor connection

Remote Sensor Wiring

Generally it is best to keep the sensor close to the monitor. However, it is possible to mount the sensor as much as 100 ft from the monitor using a junction box and additional interconnect cable.

NOTE: The wire used for remote sensor connection does not contain the same conductor colors as the sensor wire. *Figure 17* provides the information needed to connect a remote sensor using junction box (07-0100).

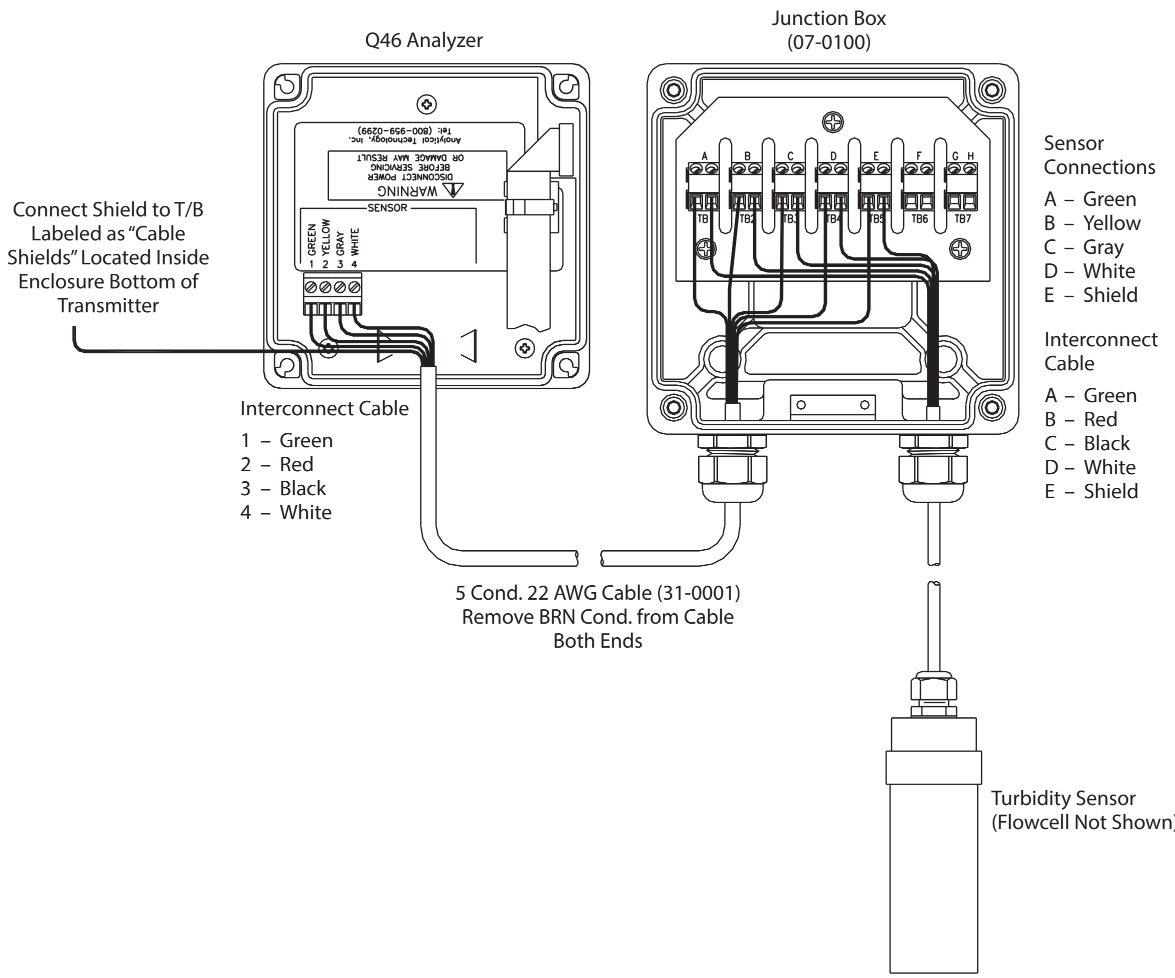


Figure 17: Remote sensor wiring

CONFIGURATION

User Interface

The user interface for the Q46 Series instrument consists of a custom display and a membrane keypad. All functions are accessed from this user interface (for example, no internal jumpers or pots).

When power is first applied, you may notice that the display does not turn on immediately. This is normal. There is a 5 second start routine that runs before the display illuminates. In addition, you may notice an occasional "flicker" of the display, occurring about twice an hour. This is the result of a display processor refresh program that ensures long-term display integrity and always occurs during normal operation of the instrument.

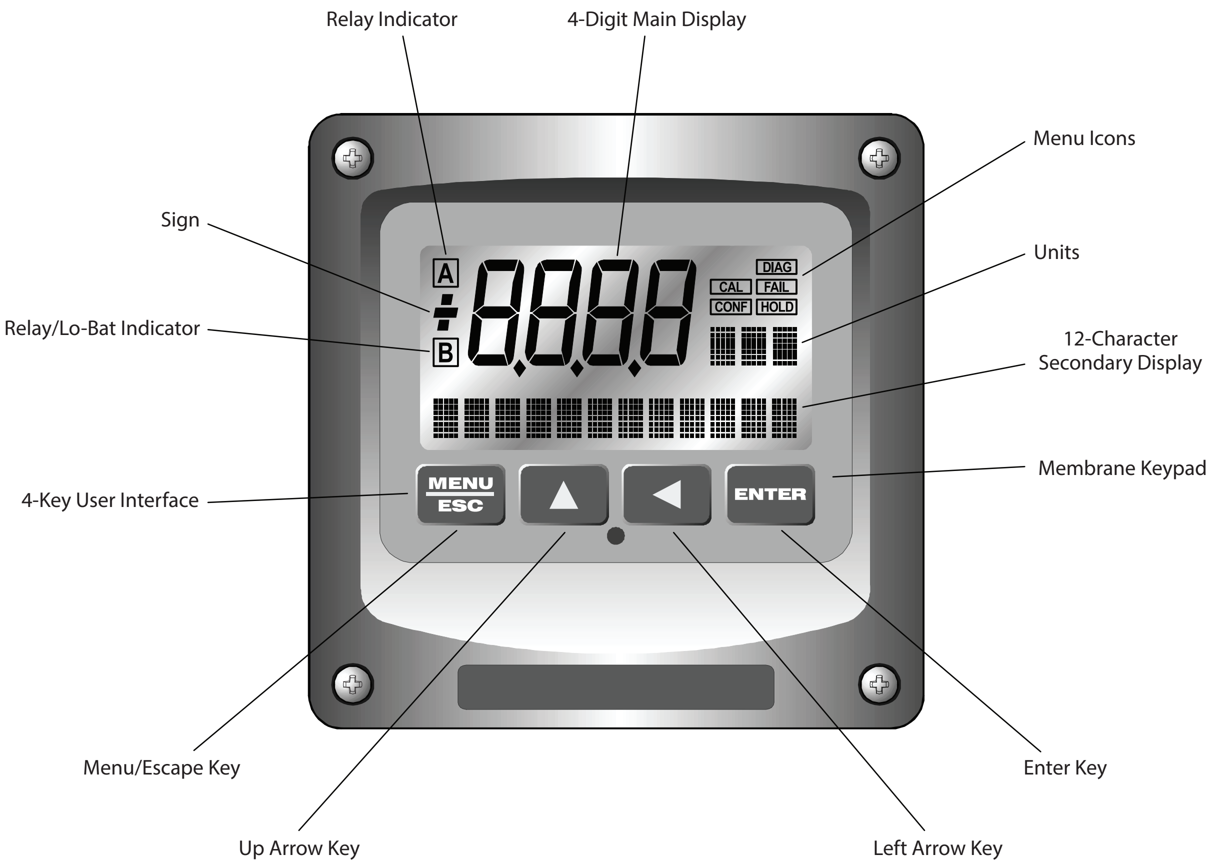


Figure 18: User interface

Keys

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

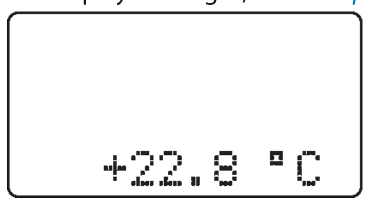
MENU/ESC	To scroll through the menu section headers or to escape from anywhere in software. The escape sequence allows the user to back out of any changes in a logical manner. Using the ESC key aborts all changes to the current screen and backs the user out one level in the software tree. The manual refers to this key as either MENU or ESC, depending upon its particular function. In the battery-powered version of the Q46, 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.

Display

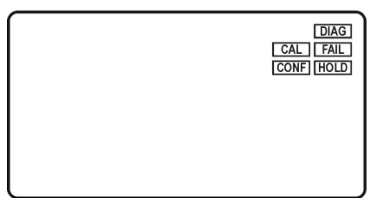
The large custom display provides clear information for general measurement use and user configuration. There are three main areas of the display: the main parameter display, the secondary message line and the icon area.

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 setup 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 displays error messages when necessary. For a description of all display messages, refer *"Display Messages" on page 47*.



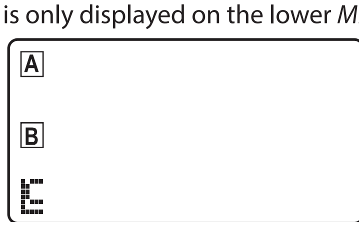
Icon Area The icon area contains display icons that assist the user in setup and indicate important states of system functions. The *CAL*, *CONFIG* and *DIAG* icons are used to tell the user what branch of the software tree the user is in while scrolling through the menu items. This improves software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



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

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

Relay Area A/B The relay area contains two icons that indicate the state of the system relays. Relay C is normally configured for *FAIL* indication, so it is only displayed on the lower *MEASURE* display line.



Software

The software of the Q46T 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.

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 19 on page 27* 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 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.

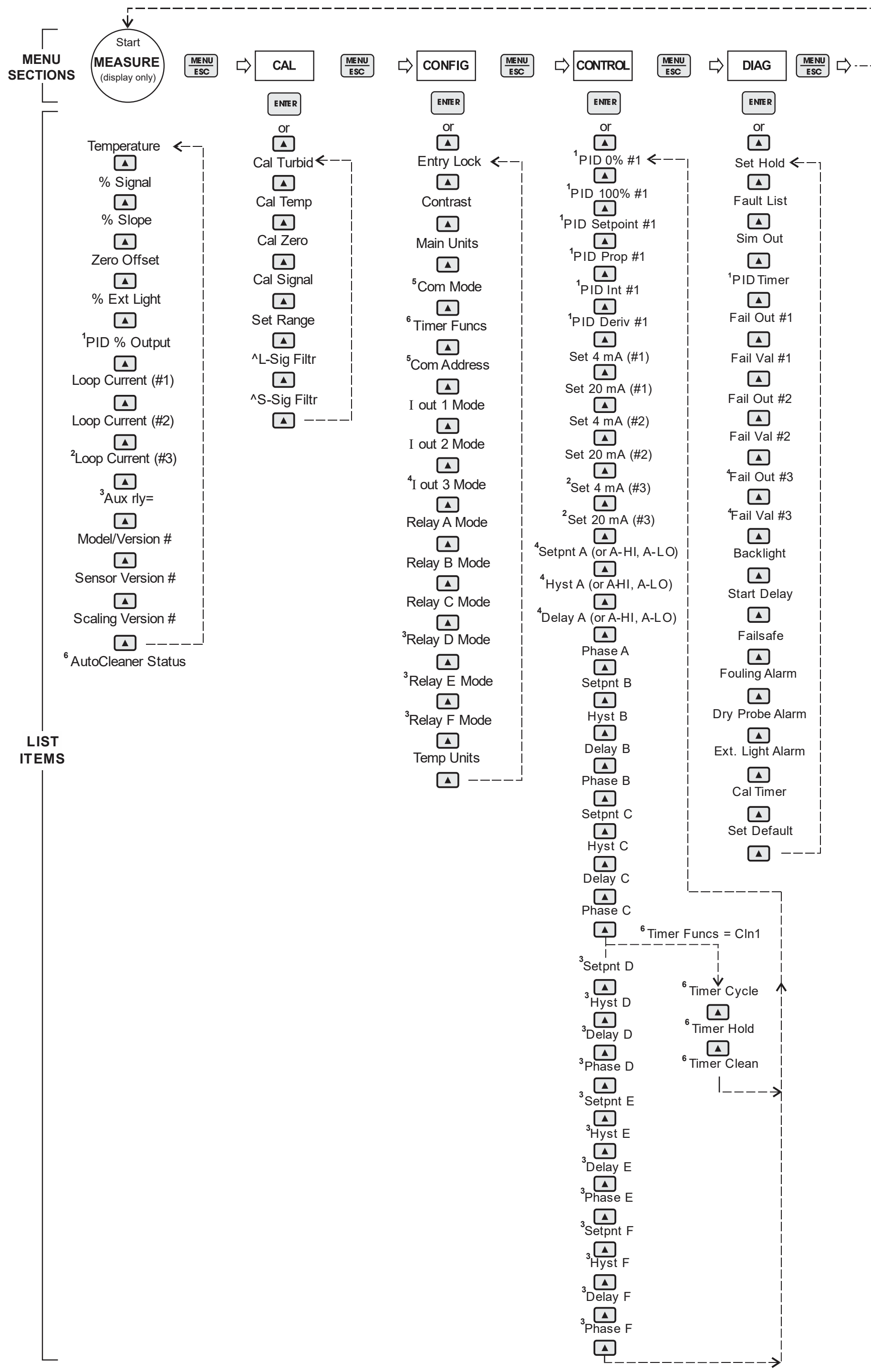
Any data that may be changed flashes. This flashing indicates *User Entry* mode and is initiated by pressing the **ENTER** key. The **UP** arrow key increases a flashing digit from 0…9. The **LEFT** arrow key moves the flashing digit from right to left. Once the change has been completed, pressing **ENTER** 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 begins to flash, indicating that the user may modify that variable using the arrow keys. However, if the instrument is locked, the transmitter displays the message "Locked!" and does 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!" displays 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.



NOTE: (1) If Relay A, B, C, D, E, F is set to *FAIL* mode, relay settings are not displayed in menu.
(2) The annunciator for Relay C is shown in the *MEASURE*/temperature display.

1 PID is enabled.

2 Optional third 4…20 output installed.

3 Optional 3-relay card installed (D, E, F) not displayed if cleaner is enabled.

4 If Relay A is set to *ALARM* mode, the settings are divided into 2 groups of HI and LO points.

5 If *Comm* mode is set to a selection other than none, additional *Comm* menus show.

6 Future Cleaner function.

Figure 19: Software map

Measure Menu [MEASURE]

The default menu for the system is the display-only menu *MEASURE*. This menu is a display-only measurement menu and has no changeable list items. When left alone, the instrument automatically returns 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 Measure 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.
% Signal	Indicates the general condition of the sensor optics. The nominal value is 100% but the value decreases if fouling of the sensor occurs. The value rises if the flowcell is no longer full of water.
Slope = 100%	Sensor output response vs. ideal calibration. This value updates after each calibration. High or low slope can generally indicate problems with the sensor or problems with the standard being used for calibration.
Zero Offset	Sensor zero signal at 0.000 NTU as compared to factory default electronic zero. This value updates after a zero-calibration has been performed.
% Ext Light	Indicates the background ambient light level detected by the sensor. This value is not meaningful when the sensor is inside the flowcell but is useful when submersible turbidity sensors are used in open channels. Extremely high ambient light levels trigger an alarm.
100% 20.00 mA	*PID Status* screen (if enabled) shows the present controller output level on the left and actual transmitter current on the right. The controller can be placed in manual while viewing this screen by pressing and holding the **ENTER** key for 5 seconds until a small flashing "m" appears on the screen. At that point the controller output can be adjusted up or down using the **UP** and **LEFT** arrow keys. To return to automatic operation, press and hold the **ENTER** key for 5 seconds and the "m" disappears.
#1 4.00 mA	Analyzer output current #1 (normally NTU).
#2 12.00 mA	Analyzer output current #2 (normally Temperature).
#3 20.00 mA	Analyzer output current #3 (if option included).
Aux relay = D,E,F	Auxiliary relay annunciators (if option included).
Q46T vX.XX	Transmitter software version number.
TU85XX vX.XX	Sensor firmware version number.
I/F vX.XX	Transmitter scaling card firmware version number.
Tcyc 24.0 hr	Automatic sensor cleaning frequency (displayed only when enabled in *CONFIG* menu).

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.

Calibration Menu [CAL]

The *Calibration* menu contains items for frequent calibration of user parameters. There are seven items in this list: *Cal Span*, *Cal Temp*, *Cal Zero*, *Cal Signal*, *Set Range, ^L-Sig Filtr* and *^S-Sig Filtr*.

Cal Span Provides adjustment of the turbidity value to match the standard being used for calibration. A 20 NTU standard is recommended. See *"Calibration" on page 37* 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.

Cal Zero Provides adjustment of the turbidity value to 0 NTU when filtered sample is running through the flowcell. Sample must be filtered to less than 0.2 micron for adjustment of zero. See *"Calibration" on page 37* for more details.

Cal Signal Provides adjustment of the "signal strength" indicator to 100% after cleaning of sensor. See *"Calibration" on page 37* for more details.

Set Range Provides selection of the operating range. Ranges of 0…4.000, 0…40.00 or 0…400.0 NTU can be selected. The default range is 0…40.00, which is suitable for most filter outlet applications.

^L-Sig Filtr Large Signal Filter. Range of entry is 5…200 seconds, default is 40 seconds. One stage of two stage filter in the sensor. This is the filter time constant that applies to large span input deviations, for example, a 90% step change from 1.00…3.00 NTU.

^S-Sig Filtr Small Signal Filter. Range of entry is 5…220 seconds, default is 120 seconds. One stage of two stage filter in the sensor. This is the filter time constant that applies to small span input deviations, for example, movement of ±0.1 NTU around a reading of 1.00 NTU.

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 locks the transmitter and entering the correct code again unlocks it. The code is preset at a fixed value. Press **ENTER** to initiate *User Entry* mode and the first digit flashes. Use the arrow keys to modify value. See *page 52* for the Q46T lock/unlock code. Press **ENTER** to toggle lock setting once code is correct. Incorrect codes do not change state of lock condition.

Contrast This function sets the contrast level for the display. The custom display is designed with a wide temperature range and contains an LED back light so that the display is can be seen in the dark.

Press **ENTER** to initiate *User Entry* mode, and the value flashes. Use the arrow keys to modify the value; range is 0…8 (0 being lightest). Press **ENTER** to update and store the new value.

Main Units Selects the engineering units for the measurement. Turbidity is normally displayed in "NTU" but can also be displayed in units of "PSL". This alternate unit is used in Japan where "polystyrene latex spheres" are the particles used for calibration instead of Formazin. To change from the default NTU units, press **ENTER**, use the **UP** arrow key to select *PSL* and then press **ENTER**.

Com Mode Sets digital communication mode of analyzer. Optional digital communication card must be plugged into the power supply slot for this function to work. Press **ENTER** to initiate *User Entry* mode and the entire value flashes. Use the **UP** arrow key to modify the desired value; selections include 1-None, 2- P-DP for Profibus DP, 3 – Modbus, 4 – Ethernet IP. Press **ENTER** to store the new value.

Com Address Sets bus address for digital communication mode of analyzer. Optional digital communication card must be plugged into the power supply slot for this function to work.

Press **ENTER** to initiate *User Entry* mode, and the entire value flashes. Use the **UP** arrow key to modify the desired value. Range is 1…125. Press **ENTER** to store the new value.

Iout#1 Mode This function sets analog output #1 to either track NTU turbidity or enables the PID controller to operate on the turbidity input. Press **ENTER** to initiate *User Entry* mode and the entire value flashes. Use the **UP** arrow key to modify the desired value; selections include 1-NTU turbidity or 2-PID for PID control. Press **ENTER** to store the new value.

Iout#2 Mode This function sets analog output #2 for either temperature (default), NTU turbidity or for Aux Units (mg/l or PSL). Press **ENTER** to initiate *User Entry* mode, and the entire value flashes. Use the **UP** arrow key to modify the desired value; selections include 1-°C/°F for temperature, or 2-ppm NTU or 3-mg/l or PSL. Press **ENTER** to store the new value.

Iout#3 Mode **OPTIONAL.** This function sets analog output #3 for either temperature (default), NTU or Aux Units. Press **ENTER** to initiate *User Entry* mode, and the entire value flashes. Use the **UP** arrow key to modify the desired value; selections include 1-°C/°F for temperature or 2-ppm NTU or 3-mg/l or PSL. Press **ENTER** to store the new value.

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

The *CON* setting enables normal control operation for Relay A, with settings for setpoint, hysteresis, delay and phasing appearing in the *CONTROL* menu automatically. See *Figure 21 on page 33* for further details.

The *AL* setting allows two setpoints to be selected for the same relay, producing a HI-LO alarm band. In this mode, Relay A trips inside or outside of the band, depending upon the phase selected. See *Figure 22 on page 39* for further details.

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

Relay B Mode
Relay C Mode Relay B can be used in two ways: as a setpoint control or as a fail alarm. The settings for Relay B mode are *CON*, *FAIL* and they are the same as those modes in relay A.

***Relay D Mode**
***Relay E Mode**
***Relay F Mode** **OPTIONAL.** Relays D, E and F can be used in two ways: as a setpoint control or as a fail alarm. The two settings for Relay D, E and F mode are *CON* and *FAIL*.

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

Control Menu [CONTROL]

The *Control* menu contains all of the output control user settings.

NOTE: PID menu items does not appear unless output 1 is configured for *PID* mode in the *CONFIG* menu.

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

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

If the 0% point is lower than the 100% point, then the controller action "reverse" acts. That is, the output of the controller increases if the measured value is less than the setpoint, and the output decreases if the measured value is larger than the setpoint. Flipping the stored values in these points reverses the action of the controller to "direct" mode.

The entry value is limited to a value within the range specified in *Set Range*, and the 0% and the 100% point must be separated by at least 1% of this range. Use the **LEFT** arrow key to select the first digit to be modified. Then use the **UP** and **LEFT** arrow keys to select the desired numerical value. Press **ENTER** to store the new value.

PID Setpnt
[Iout1 = PID]

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

PID Prop
[Iout1 = PID]

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

PID Int
[Iout1 = PID]

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

PID Deriv
[Iout1 = PID]

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

Set 4 mA
Set 20 mA
[Iout1 = NTU]

These functions set the main 4 and 20 mA current loop output points for the transmitter. The units displayed depend on the selection made in the *CONFIG* menu for *Iout #1* mode. **Do not set the 20 mA setting above 400 NTU.**

The value stored for the 4 mA point may be higher or lower than the value stored for the 20 mA point. The entry values are limited to values within the range specified in *Set Range*, and the 4 mA and the 20 mA point must be separated by at least 1% of this range. Use the **LEFT** arrow key to select the first digit to be modified. Then use the **UP** and **LEFT** arrow keys to select the desired numerical value. Press **ENTER** to store the new value.

***Set 4 mA #2**
***Set 20 mA #2**
[temp/D.O.]

These functions set the second 4 mA and 20 mA current loop output points for the transmitter. The output may be set to track temperature (default), NTU or the selected Aux Units of mg/l or PSL. The values stored for the 4 mA point may be higher or lower than the value stored for the 20 mA point.

The entry value is limited to a value between 0…55° C if it is set for temperature, within the range specified in *Set Range* if the output is set to track NTU. The 4 mA and the 20 mA point must be at least 20 units away from each other. Press **ENTER** to initiate *User Entry* mode, and the value flashes. Use the arrow keys to modify value. Press **ENTER** to store the new value.

***Set 4 mA #3**
***Set 20 mA #3**
[temp/NTU/Aux]

OPTIONAL. These functions set the optional third 4 mA and 20 mA current loop output points for the analyzer. The output may be set to track temperature (default), NTU or Aux Units. The values stored for the 4 mA point may be higher or lower than the value stored for the 20 mA point.

The entry value is limited to a value between 0…55° C if it is set for temperature. The 4 mA and the 20 mA point must be at least 20 units away from each other. Press **ENTER** to initiate *User Entry* mode and the value flashes. Use the arrow keys to modify value. Press **ENTER** to store the new value.

***A Setpoint**

This function establishes the trip point for relay A. The entry value is limited to a value within the range specified in *Set Range*. Use the **LEFT** arrow key to select the first digit to be modified. Then use the **UP** and **LEFT** arrow keys to select the desired numerical value. Press **ENTER** to store the new value.

***A Hysteresis**

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

***A Delay**

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

***A Phasing**

This function establishes the direction of the relay trip. When phase is HI, the relay operates in a direct mode. Therefore, the relay energizes and the LCD indicator illuminates when the oxygen value **exceeds** the setpoint. When the phase is LO, the relay energizes and the LCD indicator illuminates when the oxygen level drops **below** the setpoint. The failsafe setting does have an impact on this logic. The description here assumes the failsafe setting is OFF. Press **ENTER** to initiate *User Entry* mode, and the entire value flashes. Use the **UP** arrow key to modify the desired value; selections include **HI** for direct operation or **LO** for reverse operation. Press **ENTER** to store the new value. See *Figure 20* for a visual description of a typical control relay application.

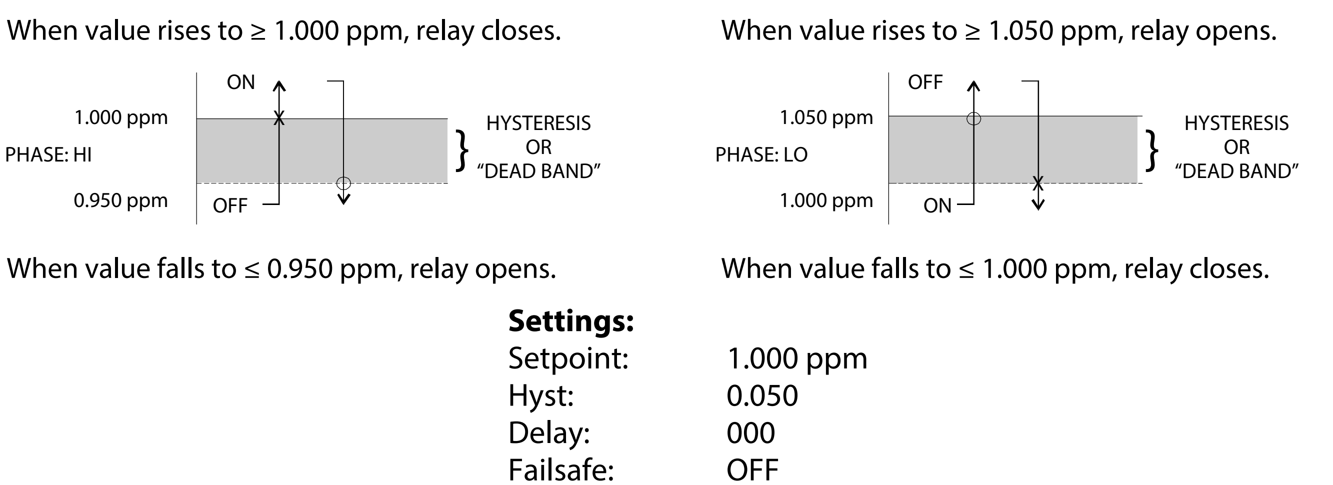
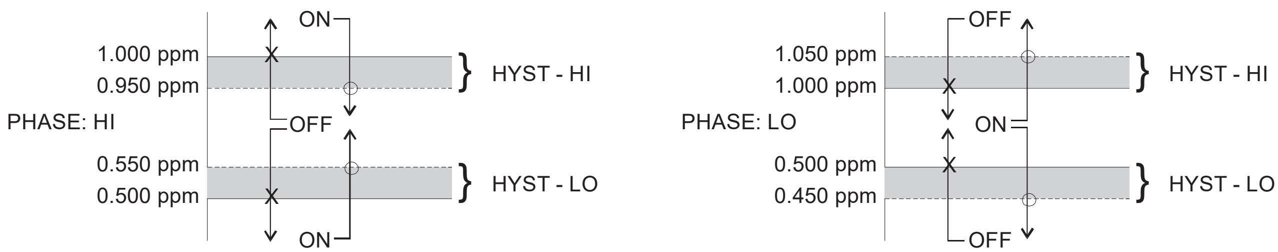


Figure 20: Control relay example, hysteresis and phase options

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

If Relay A mode is set to Alarm mode, *AL*, then the following settings appear in the *Config* menu list automatically. In this mode, two setpoints can be selected on the same relay, to create an alarm band. *Phase HI* selection causes the relay to energize outside of the band, and *Phase LO* causes the relay to energize inside of the band. This feature enables one relay to be used as a control relay while the other is used as a HI-LO Alarm relay at the same time. *Setpoint A-LO* must be set lower than *Setpoint A-HI*. When *AL* mode is first selected, *Setpoint A-LO* is defaulted to 0. *Figure 21* is a visual description of a typical alarm relay application.



When value rises to ≥ 1.000 ppm, relay closes, until value falls back to ≤ 0.950 ppm. When value falls to ≤ 0.500, relay closes until value rises to ≥ 0.550 ppm.

When value falls to ≤ 1.000 ppm, relay closes, until rises back to ≥ 1.050 ppm. When value rises to ≥ 0.500, relay closes until value falls to ≤ 0.450.

Settings:						
	Setpoint	A-HI:	1.000 ppm	Setpoint	A-LO:	0.500 ppm
	Hyst	A-HI:	0.050	Hyst	A-LO:	0.050
	Delay	A-HI:	000	Delay	A-LO:	000

Figure 21: Alarm relay example

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

If Relay B mode is set to *CON* (see **Relay B mode**), then Relay B functions identically to Relay A. Relay B settings appear in the *CONFIG* menu list automatically.

C Setpoint
C Hysteresis
C Delay
C Phasing

If Relay C mode is set to *CON* (see **Relay C mode**), then Relay C functions identically to Relay A. Relay C settings appear in the *CONFIG* menu list automatically.

D, E, F Setpoint
D, E, F Hyster
D, E, F Delay
D, E, F Phasing

If Relay D, E or F mode is set to *CON* (see **Relay D, E, F modes**), then the Relay functions identically to Relay A. Relay settings appear in the *CONFIG* menu list automatically.

Diagnostics Menu [DIAG]

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

Set Hold The *Set Hold* function locks the current loop output values on the present process value, and holds relays in current status. 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 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 the entire value flashes. Use the **UP** arrow key to modify the desired value, selections are **ON** for engaging the *HOLD* function and **OFF** to disengage the function. Press **ENTER** to store the new value.

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

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: 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 faults still exists, however, faults display 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 clears until calibration is attempted again. If the problem still exists, the calibration failure reoccurs. Press **ENTER** to initiate view of the highest priority failure. The display automatically returns to normal after a few seconds.

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

Press **ENTER** to initiate *User Entry* mode, and the entire value flashes. Use the **UP** arrow key to modify desired value; range of value is 0…9999 seconds. Press **ENTER** to store the new value.

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

The starting display value is the last read value of the input. The output is 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 remains the same even when the **ESC** key is pressed. Disengage the *HOLD* function to return to normal output.

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

Press **ENTER** to initiate *User Entry* mode, and the entire value flashes. Use the **UP** arrow key to modify desired value; selections are **ON**, **OFF**. Press **ENTER** to store the new value.

Fail Val #1 Sets the output failure value for Iout#1. When *Fail Out* above is set to **ON**, this function sets value of the current loop under a *FAIL* condition. The output may be forced to any value between 4…20 mA.

Press **ENTER** to initiate *User Entry* mode, and the entire value flashes. Use the **UP** arrow key to modify desired value; selections are between **4 mA**…**20 mA**. Press **ENTER** to store the new value.

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

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

***Fail Out #3** **OPTIONAL.** This function sets the fail-mode of current loop output #3 under a *FAIL* condition. The settings and operation are identical to *Fail Out* for output #1.

***Fail Val #3** **OPTIONAL.** This function sets the value of current loop output #3 under a *FAIL* condition. The settings and operation are identical to *Fail Out* for output #1.

Backlight This function has three options. **ON** – On all the time, **OFF** – Off all the time, **AL** – Alarm (Default). This function flashes the backlight on and off whenever the "FAIL" icon is displayed.

Start Delay This function is designed to minimize control or alarm issues arising from temporary power loss. When power goes down, the monitor records the analog output values and the status of relays and PID functions. When power is restored, the analog values and relays are held at the pre-power loss values for a defined period of time. This "start delay" may be programmed for periods from 0…9.9 minutes. This function is set to 0.0 minutes by default and must be activated by the user if desired by setting a positive time value.

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

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

Fouling Alarm Activates or disables the fouled sensor detector. This circuit detects the buildup of solids on the face of the sensor that can degrade the turbidity measurement. The options are **ON**–alarm is active or **OFF**–alarm is disabled. The default is ON.

Dry Probe Alarm Similar to the fouling alarm, this alarm is generated when the sensor is no longer in liquid. Loss of sample flow can cause this alarm to activate if the flowcell is drained of sample. The options are **ON**–alarm is active or **OFF**–alarm is disabled. The default is ON.

Ext Light Alarm The sensor can provide an alarm in the event that ambient light is high enough to cause measurement problems. This alarm is not useful for flowcell applications but can be of value if a submersible sensor is in use. Options are **ON**–alarm active or **OFF**–alarm disabled. The default is OFF.

Cal Timer Defines the period of time **AFTER** completion of a calibration sequence in which the analog output remains in "hold". After this period, the output is released and returns to normal.

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. 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 resets the zero offset to 0.0 nA and reset the slope to 100%. The default *ALL* routine resets all program variables to factory default and should be used with care since it changes any user settings that were programmed in the field.

CALIBRATION

Turbidity Calibration

Turbidity monitors start to measure aqueous samples as soon as power is applied and sample is flowing through the flow chamber. Calibration of a turbidity system is normally required at startup, but factory settings are very close to actual, so it is often OK to start up the monitor without adjustment. Calibration requires only adjustment of the span of the instrument.

The turbidity sensor zero has been adjusted at the factory and user adjustment is normally not required. It is possible to adjust the zero of the Q46/76 by passing a sample through a filter with a pore size of 0.2 micron or smaller. Sample must be run through the filter for at least 30 minutes to be sure that all particles from the normal sample are diluted out of the flowcell. The procedure below allows the adjustment of the system to zero on the filtered sample if desired, but this adjustment is normally unnecessary.

Cal Zero

Prior to attempting a zero calibration, it is best to remove the sensor from the flowcell and wipe the optical surfaces with a soft cloth to remove any buildup that could affect sensor performance. Once the sensor is clean, put it back into the flowcell and place a 0.2 micron filter in line with the incoming sample.

NOTE: This should only be done if the incoming water prior to filtration has a turbidity of less than 1 NTU. Proceed as follows.

1. After the filtered water has been running for 30 minutes, press the **Menu** key to access the *CAL* menu. Press the **UP** key until access to *Cal Zero*.
2. Press the **ENTER** key and the bottom line displays a message asking that the sensor be placed in zero sample. Zero sample is already flowing so just press **ENTER** again. The display flashes a *Wait* message. After a short period, you are prompted to enter a value and the first digit of the display flashes. Normally, just press **ENTER** to accept the default 0.000 NTU. However, it is possible to use this routine to offset you zero slightly in order to force low values to match a portable value. For example, assume the monitor is reading 0.044 on your sample and a lab measurement is 0.090. If you run this procedure on this sample and enter 0.090, the monitor calculates a zero offset and force the reading to the 0.090 value to match the lab. This can only be done for values less than 0.150 NTU.
3. After a short period, the monitor zeros the sensor and flashes an *Accepted* message indicating that the zero was successful. If the zero offset is too high, a *Cal Fail* message appears and the FAIL icon on the display lights up.
4. Once the zero adjustment is complete, remove the filter from the incoming sample line.

Cal Turbidity

Calibration of a Q46/76 turbidity monitor requires the use of a turbidity standard. Formazin standards are commonly used. Standards less than 10…20 NTU are not recommended.

Stock turbidity solution of 4000 NTU is available from Badger Meter (part number 51-0077). This stock solution is good for 1 year and may be diluted to 20 NTU for calibration. A 1 liter volumetric flask and an accurate 5 ml pipette should be used for dilution of the 4000 NTU standard.

To set the span of the turbidity monitor, dilute the 4000 NTU stock solution by 200:1 to give you a 20 NTU standard or dilute the 400 NTU standard by 20:1. It is a good idea to remove the sensor from the flowcell and wipe the end of the sensor with a soft cloth or paper towel prior to calibration if the unit has been running for a few weeks. Once your standard is prepared, proceed as follows:

1. **Turn off sample flow.** The 3-way valve shown is supplied with a calibration kit. Remove the cap from the calibration port and connect the valve as shown in *Figure 8 on page 13*. The valve can be left in place if desired as long as the Off handle is pointing to the fitting so that the flowcell is seeded during normal operation. As part of the system, a 60 cc syringe and 18 in. of silicon tubing is provided for use in feeding standard into the flowcell.
2. Prior to feeding standard, the flowcell must be drained. Turn the yellow valve handle so that the OFF position is facing to the left. This allows water from the flowcell to drain out the bottom port of the valve.

   NOTE: You may need to elevate the drain tube from the flowcell so the flowcell drains.
3. Remove the plunger from the syringe and set it aside. Connect the silicon tubing from the syringe to the left port of the valve and turn the valve handle so the "Off" is facing down. Use the syringe body like a funnel, holding the bottom of the syringe slightly above the flowcell. Pour 20 NTU calibration solution into the funnel until you have fed about 80…100 cc into the flowcell. Then move the valve so the "Off" is facing to the right. That seals the standard in the flowcell.
4. Press the **Menu** key to access the *CAL* menu. Press the **UP** arrow to access *Cal Turbid*.
5. Press the **ENTER** key and you are prompted to *Select Range*. If you are already in the 40 NTU range, simply press **ENTER**. If necessary, use the **UP** key to select the 0…40 range and then press **ENTER**. If you changed range, a *Wait* message is displayed while the new range is selected.
6. The lower line of the display now prompts you to place the sensor in a standard. Since the flowcell is already full of 20 NTU standard, simply press **ENTER** and you are prompted to adjust the NTU value. Use the **UP** and **LEFT** arrow keys to adjust each digit of the display to the value of your calibration solution (normally 20.00).
7. After the proper value is entered, press the **ENTER** key and the display flashes *Accepted*. Should the sensor determine that the entered value is outside its normal offset limits, a *Cal Fail* message flashes. Should this occur, a check of the calibration solution is required. Also check the sensor optical surface and wipe with a clean cloth before attempting another span adjustment.
8. After calibration, simply turn on the sample flow. The 20 NTU standard flushes out by the normal sample and the reading returns to actual sample value after a few minutes.

NOTE: The monitor calculates a slope % during the update. If the value you enter results in a slope of less than 70% or more than 130%, an error message indicates this condition.

During calibration, the 4…20 mA output is held constant. As soon as you enter the *Cal Turbid* routine, the output hold is activated. The output remains in hold until the new value has been entered and accepted. After that, the output hold is released.

You may wish to maintain the output hold function for an additional period of time to allow the calibration fluid to be flushed out of the flowcell before releasing the output. If so, go to the *DIAG* menu and adjust the *Time* in the last routine. That routine defines the additional output hold time after conclusion of the calibration. A setting of 3…5 minutes is recommended if you want to avoid recording spikes at the end of a calibration.

Secondary Dry Standard

Periodic calibration using primary liquid standards are the best method of calibration. However, a dry secondary standard can be used more frequently to verify that the turbidity sensor calibration is stable. The dry standard is simply an optical assembly that provides a repeatable NTU value when a clean and dry sensor is inserted. The actual value is unique to a combination of sensor and dry standard and should be marked on a tag attached to the sensor.

The dry standard (60-0060) is an optional item and is not supplied with Q46/76 monitors. If this device was purchased with the monitor, the NTU value for the sensor must be established. This is very simple to do. After completion of a wet calibration as explained in *"Cal Turbidity" on page 38*, simply remove the sensor from the flowcell and dry it completely. Then place the sensor into the dry standard cylinder. Allow it to sit undisturbed for 2 or 3 minutes until the display shows a stable turbidity value. Record the serial number of the dry standard and the NTU value for that sensor on a tag. Attach that tag to the sensor for future reference. Three waterproof tags, markers and attachment lanyards are supplied with the dry standard. Additional tags and markers are available.

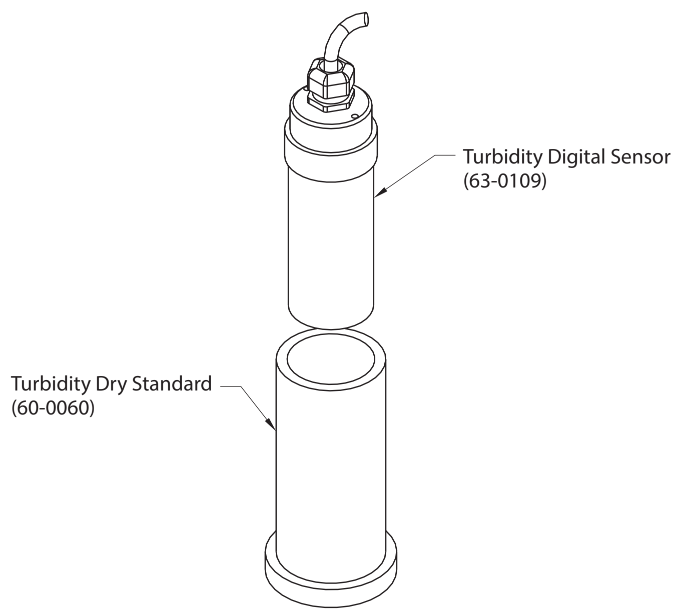


Figure 22: Dry standard diagram

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 online, 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* displays.
3. Press the **ENTER** key. The message "Place sensor in solution then press ENTER" displays. 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 begins. The message "Wait" flashes 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" displays, and the rightmost digit begins to flash, indicating that the value can be modified. Using the **UP** and **LEFT** arrow keys, modify the value to the known ref solution temperature. Adjustments up to ±5° C from the factory calibrated temperature are allowed. Press **ENTER**.

Once completed, the display indicates "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.

PID CONTROLLER DETAILS

PID Description

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

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

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

PID Algorithm

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

ISA PID Equation

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

Where:

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

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

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

Although the three components of the PID are described in the setting area *"Control Menu [CONTROL]" on page 31*, here are more general descriptions of what each of the PID elements contribute to the overall action of the controller.

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

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

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

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

Many of the classical tuning techniques have the user start with all values at 0, and then increase the *P* term until oscillations occur. The *P* value is then reduced to 1/2 of the oscillatory value, and the *I* term is increased to give the desired response. This can be done with the Q46D controller, with the exception that the *I* term should start no lower than 1.0.

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

Classical PID Tuning

Unlike many high speed position applications where PID loops are commonly used, the chemical feed application employed by this instrument does not require intense mathematical exercise to determine tuning parameters for the PID. In fact, the risk of instability is far greater with overly tuned PID control schemes. In addition, many of the classical mathematical exercises can be damaging or wasteful in the use of chemicals when the process is bumped with large amounts of input error to seek a response curve. Because of this, the general adjustment guidelines described in *"PID Algorithm" on page 41* are sufficient for almost all application tuning for this instrument. Beyond this, many sources are available for classical tuning methods.

Manual PID Override Control

The Q46 electronics are equipped designed to allow the user to take manual control of the PID output. This is often useful when starting up a control loop or in the event that you wish to bump the system manually to measure system response time.

To access the manual PID control, you must be in the *MEASURE* mode of operation and you must have the PID output displayed on the lower line. This line indicates "XX.X% XX.X mA" with the X values simply indicating the current values. With this display on the screen, press and hold the **ENTER** key for about 5 seconds. A small "m" shows up between the % value and the mA value. This indicates you are now in *Manual* mode.

Once in manual, you may increase the PID output by pressing the **UP** arrow or you may decrease the output by pressing the **LEFT** arrow. This allows you to drive the PID output to any desired setting.

To revert to normal PID control, press and hold the **ENTER** key again until the "m" indicator disappears.

Common PID Pitfalls

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

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

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

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

SYSTEM MAINTENANCE

General

The Q46/76 turbidity monitor generally provides 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.

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.

Sensor Maintenance

Sensor maintenance is limited to simple cleaning of the optical surfaces. In general, wiping with a soft cloth is all that is needed. The optical surfaces can also be cleaned with a household glass cleaner or a surface cleaner. **Never use abrasive pads on the optical surfaces.**

In some applications, the sensor might accumulate iron and manganese deposits that precipitate from the water after chlorination. Should this occur, cleaning the sensor by soaking in solution of a commercial iron remover such as “Red-B-Gone” quickly removes deposits.

The lenses on the sensor are made of acrylic. Be careful not to scratch these surfaces when handling the sensor. Severe scratches can cause irreparable damage.

TROUBLESHOOTING

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 saves 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 are very helpful when discussing the problem with the factory technical support group.

External Sources of Problems

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

1. Verify the analyzer is earth grounded. For all configurations of the analyzer, an earth ground connection MUST be present for the shielding systems in the electronics to be active. Grounded conduit provides no earth connection to the plastic enclosure, so an earth ground wiring connection must be made at the power input terminal strip. Use the special "shield terminal" stub on the power supply board for optimum sensor cable shield grounding.
2. Verify the proper power input is present. Check instrument label to verify your unit is either 100…240V AC or 12…24V DC.
3. Verify the loads on any 4…20 mA outputs do not exceed the limits in the Instrument Specifications. During troubleshooting, it is many times helpful to disconnect all these outputs and place wire-shorts across the terminals in the instrument to isolate the system and evaluate any problems which may be coming down the analog output connections.
4. Do not run sensor cables or analog output wiring in the same conduits as power wiring. If low voltage signal cables must come near power wiring, cross them at 90° to minimize coupling.
5. If rigid conduit has been run directly to the Q46 enclosure, check for signs that moisture has followed conduit into the enclosure.
6. Check for ground loops. Although the sensor is electrically isolated from the process water, high frequency sources of electrical noise may still cause erratic behavior in extreme conditions. If readings are very erratic after wiring has been checked, check for a possible AC ground loop by temporarily placing the sensor into a bucket of water.
7. On relay based systems, check the load that is connected to the relay contacts. Verify the load is within the contact rating of the relays. Relay contacts which have been used for higher power AC current loads may become unsuitable for very low signal DC loads later on because a small amount of pitting can form on the contacts.

   NOTE: If the load is highly inductive (solenoids, motor starters, large aux relays), the contact rating is de-rated to a lower level. Also, due to the large amount of energy present in circuits, driving these types of loads when they are switched on and off, the relay wiring placement can result in electrical interference for other devices. This can be quickly resolved by moving wiring, or by adding very inexpensive snubbers (such as Quencharcs) to the load.
8. Carefully examine any junction box connections for loose wiring or bad wire stripping. If possible, connect the sensor directly to the analyzer for testing.
9. Check sensor for fouling. Look closely for signs of grease or oil which may be present. Sensor fouling can be corrected by cleaning optical surfaces with a soft cloth.

Analyzer Tests

1. Disconnect power and completely disconnect all output wiring coming from the analyzer. Remove sensor wiring, relay wiring and analog output wiring. Re-apply power to the analyzer. Verify proper voltage (115 or 230V AC) is present on the incoming power strip of the analyzer, and that the analyzer power label matches the proper voltage value.
2. If analyzer does not appear to power up (no display), remove power and check removable fuse for continuity with a DVM.
3. Using a DVM, check the voltage across the BLUE and WHITE wires coming from the power supply board in the base of the enclosure. FIRST, disconnect any wiring going to *Iout#1*. Then, verify voltage across these wires is about 16…18V DC when still connected to the terminal strip on the front half of the enclosure. If the BLUE and WHITE wires are not connected to the terminal strip on the front half of the enclosure, the voltage across them should measure about 29V DC.
4. If analyzer does power up with a display, use the "Simulate" feature to check operation of the analog outputs (and relays contacts with a DVM.)
5. Check sensor power circuits. With a DVM, verify between –4.5…–5.5V DC from sensor connection terminals WHITE (+) to BLACK (–). Then verify between 4.5…5.5V DC from GREEN (+) to BLACK (–).
6. Check TC drive circuit. Place a wire-short between the RED and BLACK sensor terminals. With a DVM, measure the voltage between the BLACK (–) and BROWN (+) sensor terminals to verify that the TC drive circuit is producing about –4.6…–5.5V DC open-circuit. Remove DVM completely and connect a 1000 Ohms resistor across the BLACK to BROWN terminals. The temperature reading on the front LCD should display approximately 0° C and the dissolved oxygen reading should display approximately 0 ppm.

Display Messages

The Q46 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*.

The following messages appear as prompts:

Message	Description	Possible Correction
Max is 200	Entry failed, maximum user value allowed is 200.	Reduce value to ≤ 200.
Min is 20	Entry failed, minimum value allowed is 20.	Increase value to ≥ 20.
Cal Unstable	Calibration problem, data too unstable to calibrate. Icons does not stop flashing if data is too unstable. User can bypass by pressing **ENTER**.	Clean sensor, get fresh cal solutions, allow temperature readings to fully stabilize, do not handle sensor or cable during calibration.
Out of Range	Input value is outside selected range of the specific list item being configured.	Check manual for limits of the function to be configured.
Locked!	Transmitter security setting is locked.	Enter security code to allow modifications to settings.
Unlocked!	Transmitter security has just been unlocked.	Displayed just after security code has been entered.
Offset High	The sensor zero offset point is out of the acceptable range.	Check wiring connections to sensor. Check optical surfaces for fouling.
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.
Temp High	The temperature reading is > 55° C.	The temperature reading is over operating limits.
Temp Low	The temperature reading is < –10° 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 junction box connections.
Cal Fail	Failure of turbidity calibration. *FAIL* icon does not extinguish until successful calibration has been performed or 30 minutes passes with no keys being pressed.	Clean sensor and redo span calibration. If still failure, sensor slope may be less than 80% or greater than 120%. Replace sensor failure persists.
TC Cal Fail	Failure of temperature calibration. *FAIL* icon does 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. Replace sensor if still failure.
EEPROM Fail	Internal non-volatile 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.

CALIBRATION PANEL

General

The Q46T calibration panel is an assembly designed to simplify testing and calibration of the Q46T turbidity monitor. This panel option provides special valuing and turbidity standard feed system so that calibrations can be done quickly and efficiently using either Formazin or synthetic turbidity standards. The assembly is intended for use on filter effluent applications or other samples where turbidity normally does not exceed 40 NTU.

NOTE: This assembly is not a good choice for use in "raw water" applications. The high turbidity values often found in those applications can quickly plug the flow regulator and/or the rotameter.

Each panel assembly provides the following items:

1. An inlet ball valve to turn sample flow on and off.
2. A ball valve to allow process water to be drained from the flowcell.

   NOTE: The inlet and drain valves are on a tee below the flowcell.
3. An acrylic chamber for feeding turbidity standards into the flowcell.
4. A two way calibration standards feed valve to control introduction of standard to the flowcell.
5. A rotameter on the outlet of the panel to provide positive indication of sample flow during normal turbidity operation.
6. An instructional placard on the panel providing complete calibration instructions.

Q46 turbidity panels are supplied with a "speed fit" type of fittings for both inlet and outlet. That same type of fitting is used on the drain valve, although often no tubing is connected. Those fittings are suitable for connection of 1/4 in. O.D. sample tubing. A 10 ft length of tubing and a 1/4 in. NPT tubing adapter are supplied with the panel for installation.

Figure 23 on page 49 shows the layout of the panel along with dimensional data.

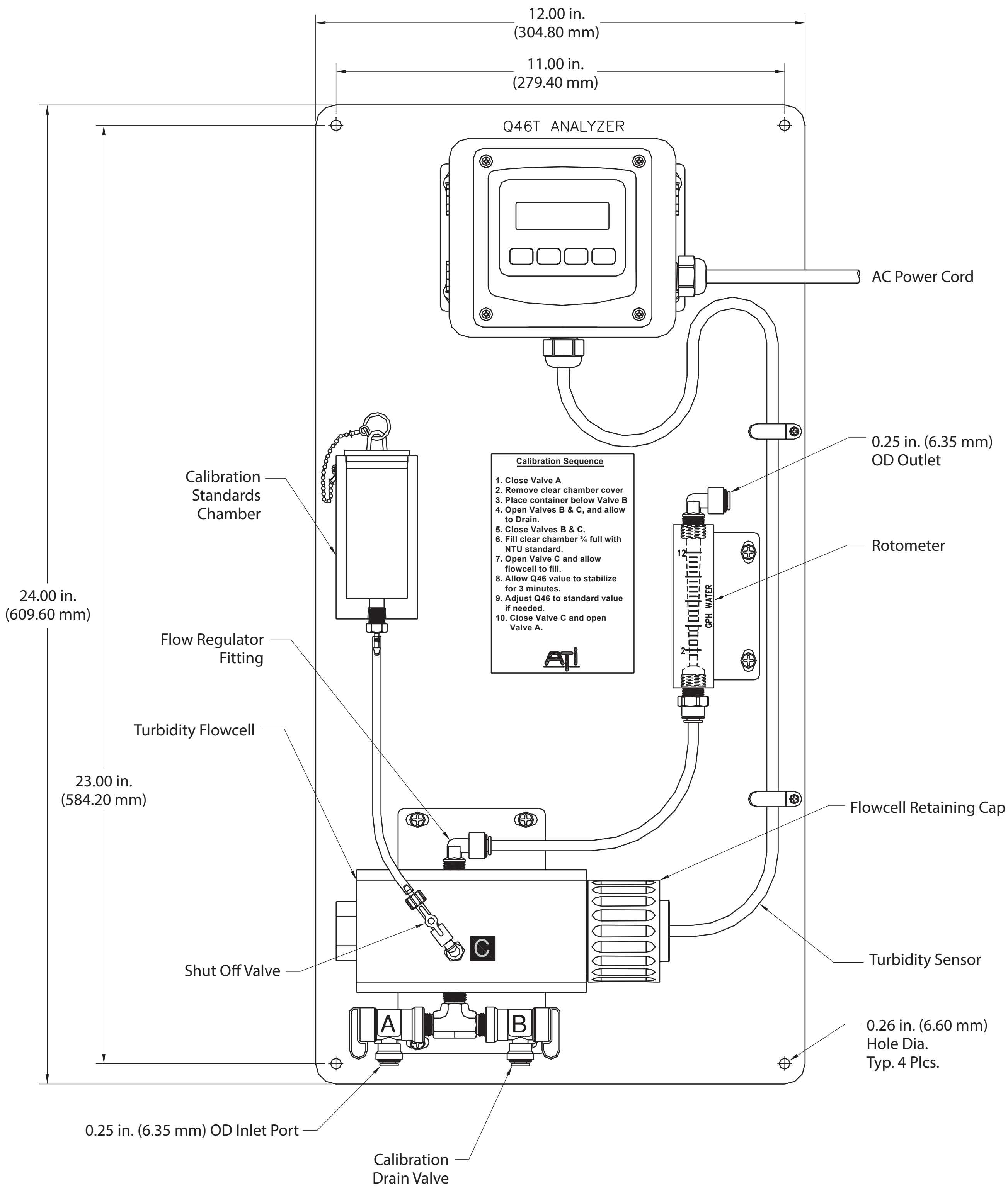


Figure 23: Typical panel assembly

Installation

Installation of the panel system is simple.

1. Mount the panel to the wall or other support using the 4 corner holes.
2. Connect the water sample to the inlet fitting attached to the left hand ball valve below the flowcell. The ball valve should remain closed.
3. Connect your drain tubing to the drain fitting on the rotameter and route the tubing to a suitable drain in your installation site.
4. Check that the sensor is inserted in the flowcell and the retaining ring is in the proper position.

Startup

Once steps 1…4 above are complete, turn on the sample supply to the panel and open the ball valve. Water begins to flow immediately. The flow indicator should show a flow rate of about 6 GPH. There are no adjustments to be made in this part of the system. The flow is controlled by a fixed flow regulating device that is part of the flowcell outlet fitting.

Allow water to flow through the system for 15…30 minutes while everything stabilizes. The turbidity monitor should be showing a reasonably steady value. Assuming the water is filter effluent, turbidity values are normally below 1 NTU.

Calibration

To calibrate the turbidity monitor using the standards feed system, follow these steps:

NOTE: These instructions are included on the placard in the center of the panel assembly.

1. Close valve **A**. This is the sample inlet valve.
2. Remove clear chamber cover. This ensures flowcell can drain completely.
3. Place container below valve **B**. This is to collect water draining from the flowcell.
4. Open valves **B** and **C** and allow flowcell to drain.
5. Close valves **B** and **C** after flowcell is drained completely.
6. Fill clear chamber 3/4 full of turbidity standard.
7. Open valve **C** to allow flowcell to fill with standard.
8. Allow Q46T reading to stabilize for about 3 minutes.
9. Adjust the Q46T to the NTU value of your standard if necessary.

   NOTE: A reading within 5% of the standard value indicates that no adjustment is needed.
10. Close valve **C** and then open valve **A**. Be sure valve **C** is closed first or water is going to eject through the clear chamber.
11. Replace the cover on the clear chamber to avoid dust or dirt contaminating standards.

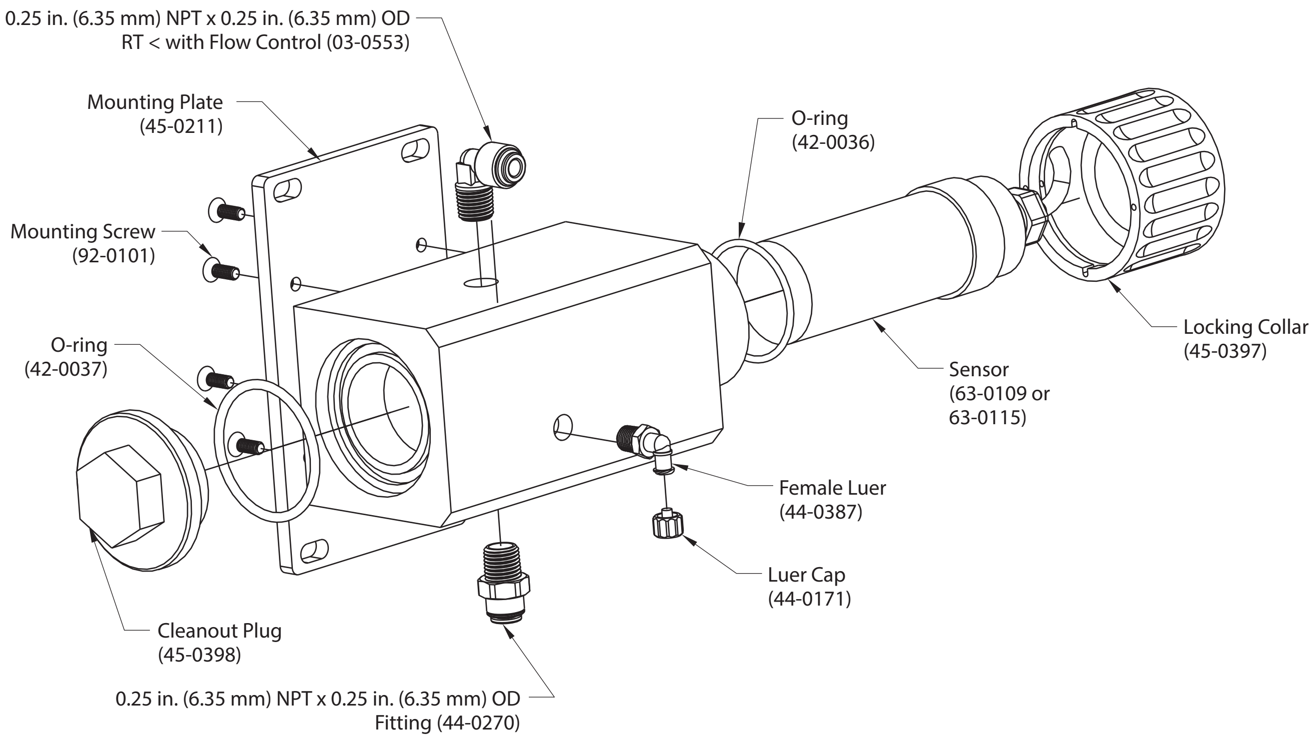
Flow Regulator Maintenance

As mentioned previously, the outlet fitting from the flowcell contains a flow control device. This device is intended to control the sample flow at about 0.45 LPM. It is not a precision device and flow can vary by 10…15% but this does not affect turbidity values.

The flow regulator can accumulate solids from the sample over long periods of time. You may clean this device by removing the fitting from the flowcell and running water through the fitting in the reverse direction. This should dislodge particulate and restore normal operation.

NOTE: This flow control fitting is inexpensive and it is useful to have a spare or two available so that monitor operation can be restored without need to clean the fitting first. The fitting is part number 03-0553.

SPARE PARTS



Part No.	Description
63-0109	Turbidity Sensor, Digital IR
63-0115	Turbidity Sensor, Digital EPA Type
00-1901	Turbidity Sensor Flowcell Assembly (Complete)
42-0036	Flowcell O-ring
42-0037	Flowcell O-ring
44-0171	Male Luer Cap
44-0270	1/4 in. NPT x 1/4 in. OD Fitting
44-0387	1/8 in. NPT x Female Luer Fitting
03-0553	1/4 in. NPT x 1/4 in. OD RT< Fitting w/Flow Control
45-0211	Mounting Plate
45-0398	Cleanout Plug
45-0397	Locking Collar
92-0101	#10-32 x 1/2 in. FHMS S.S.

Part No.	Description
	Analyzer & Accessories
*	AC Powered Monitor Electronics Assembly, 100…240V AC
*	DC Powered Monitor Electronics Assembly 12…24V DC
*	AC Powered Monitor Electronics Assembly w/Profibus, 100…240V AC
*	DC Powered Monitor Electronics Assembly w/Profibus, 12…24V DC
03-0445	Q46T Front Lid Electronics Assembly
03-0407	P/S Assy, 100…240V AC
03-0408	P/S Assy, 100…240V AC with 3rd 4…20 mA Output
03-0409	P/S Assy, 100…240V AC with 3 Relay Exp. Board
03-0410	P/S Assy, 12…24V DC
03-0411	P/S Assy, 12…24V DC with 3rd 4…20 mA Output
03-0412	P/S Assy, 12…24 VDC with 3 Relay Exp. Board
23-0029	Fuse, 630 mA, 250V, TR-5 (for AC and DC Analyzers)
07-0100	Junction Box
31-0001	Interconnect Cable for Junction Box to Monitor Wiring
38-0072	Terminal Block Plug, 3 Position (Relays)
38-0073	Terminal Block Plug, 4 Position (Outputs)
38-0074	Terminal Block Plug, 3 Position (Cable Shields)
38-0081	Terminal Block Plug, 3 Position (Power)
38-0084	Terminal Block Plug, 3 Position (Power) – V DC Version*
NOTE: *Prior to Dec 2018, V DC (power) Terminal Block used the 38-0081	
63-0048	1-1/2 in. Pipe Tee Adapter
00-1217	1-1/2 in. Flow Tee Assy

* Please consult factory for electronic assemblies part numbers.

Lock/Unlock Code: 1472

Part No.	Description
00-1901	Turbidity Flowcell
34-0619	Instructional Placard
44-0164	Male Luer Fitting, 1/8 in. ID
44-0167	Barbed Fitting, 1/8 in. NPT × 1/8 in. I.D.
44-0171	Male Luer Cap
44-0270	Instant Tube Fitting, 1/4 in. NPT × 1/4 in. O.D.
44-0272	Stopcock, 1-way, Luer
44-0276	Tubing, Black Polyethylene, 1/4 in. O.D.
44-0296	Instant Tube Fitting, Right Angle, 1/4 in. NPT × 1/4 in. O.D.
44-0325	Check Valve, Luer
44-0390	Ball Valve, Right Angle, (Inlet & Drain Valves)
45-0416	Clear Calibration Fluid Chamber
47-0136	Stainless Steel Tee, 1/4 in. T×T×T
55-0055	Rotameter (Water Flow)
03-0553	Right Angle Fitting with Fixed Flow Regulator, 0.45 LPM

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