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## Part 1 - Introduction

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### 1.1 General

The Model ORTX-45 ORP monitor/analyzer provides an extremely versatile measurement system for monitoring and control of ORP (oxidation/reduction potential, also known as REDOX) over the range of  $-1000$  mV to  $+2000$  mV. The instrument is offered standard as a loop-powered transmitter for 2-wire DC applications. Since this system configuration operates over only two low-voltage wires, it is ideal for remote monitoring applications where line power is either unavailable or prohibitively expensive to run.

With an optional plug-in card, the instrument may also be configured for 115/230 VAC operation. This configuration is ideal when line power is located close to the point of installation, and only a single isolated 4-20 mA output is required.

An optional plug-in card is also available that provides dual relay output, and two 4-20 mA outputs (one for ORP and one for temperature) to convert the instrument to an ORP controller. This card must be used with the 115/230 VAC option. This option expands the output capability of the controller for applications that require relay-setpoint functionality.

An optional plug-in card is available that converts the instrument into a robust, view-only, portable measurement system that operates on one 9 VDC battery. In this configuration, all of the standard features of the basic 2-wire transmitter are functional with the exception that the instrument does not output a 4-20 mA current. Since this system utilizes the same high performance ORE-45P sensor as the standard configurations, it is a very robust portable monitoring system. It can be used on its own, or it can be used with other permanently installed ORTX-45 continuous monitoring systems to simplify calibration by using the calibrate-by-reference method.

#### **Note:**

Due to the high-degree of flexibility of the \*\*TX-45 system options, it is important to note areas of the operating manual that detail these optional features. The software features for the relay output option and battery option only appear when those modules are connected and the system has been re-powered.

In all configurations, the ORTX-45 displays mV, sensor temperature, and output loop current on the secondary line of the custom display. The instrument may be used directly with either the high performance Quantum series of sensors or with standard combination-style electrodes.

The Model ORTX-45 offers maximum mounting flexibility. A bracket is included with each unit that allows mounting to walls, pipes, panels, or DIN rail. In addition, the system is designed to be integral mounted. Integral mounting is an ideal solution for tight spaces where no mounting exists except for atop the sensor.

Figure 1-1 illustrates the configuration possibilities for the ORTX-45 monitor/analyzer system. At any time, options can be added or removed from the standard unit. The system software automatically recognizes the options on power-up and properly enables those new features. This allows the basic 2-wire module to be stocked as a spare part for any of the measurement systems.

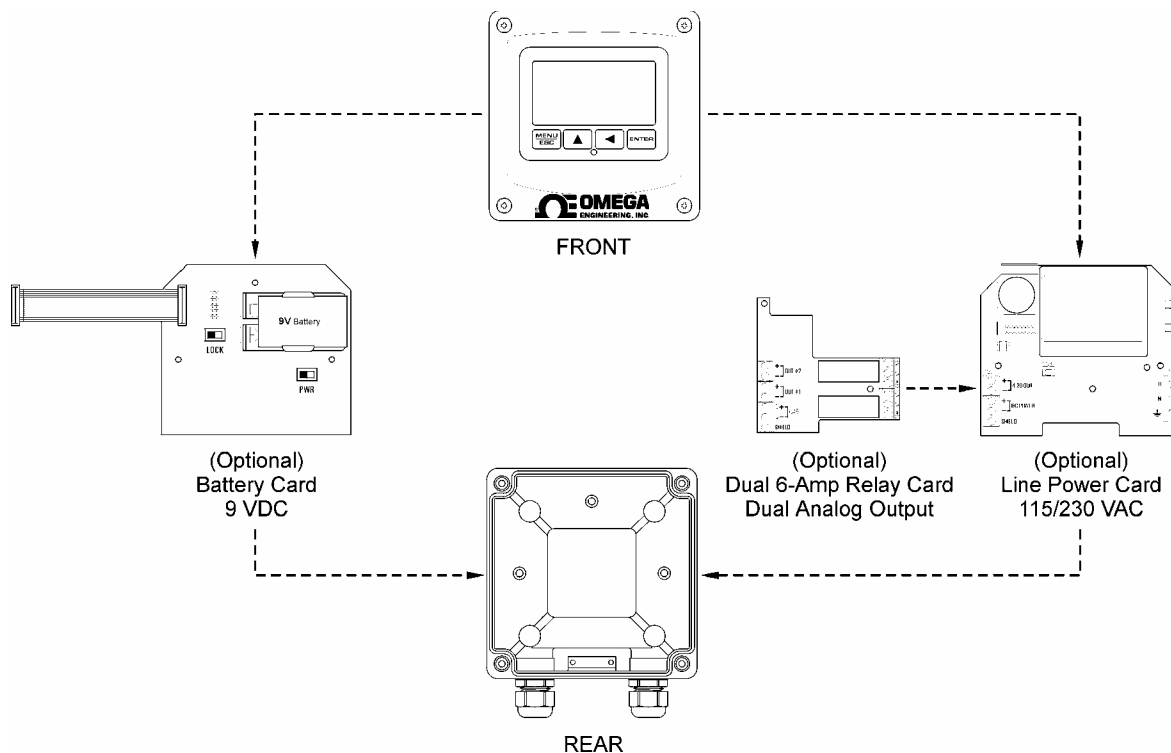


Figure 1-1 ORTX-45 Configurations

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**1.2 System Features**

- Standard main module is designed to be a fully isolated, loop powered instrument for 2-wire DC applications. Protected from surge and brownout. Optional integral power supply card for 115/230 VAC operation, and optional battery power supply card for portable applications are available.
- Output Hold, Output Simulate, Output Alarm, and Output Delay Functions. All forced changes in output condition include bumpless transfer to provide gradual return to on-line signal levels and to avoid system control shocks on the main analog output (ORP).
- Optional plug-card provides dual SPDT relay operation. Software settings for relay control mode include set-point, deadband, phase, delay, and failsafe. Software controls automatically appear in menu list when hardware option card is plugged in and system power is applied.
- Selectable HI-LO alarm “band” mode feature on Relay A. This feature allows the User to select two set points on the same relay, so that a high and low limit alarm can be established on one set of contacts.
- Selectable Output Fail Alarm feature allows system diagnostic failures to be sent to external monitoring systems.
- Selectable Probe Timer feature on Relay B allows connection of probe cleaner hardware or other accessories that require timed periodic relay contacts.
- Large, high contrast, custom Super-Twist display provides excellent readability even in low light conditions. The secondary line of display utilizes 5×7 dot matrix characters for clear display of messages, avoiding cryptic segmented character messages. Two of four measured parameters may be on the display simultaneously.

- Sensor diagnostics monitor glass breakage, sensor leaks, and RTD condition. Diagnostic messages provide a clear description of any problem with no confusing error codes to look up. Messages are also included for diagnosing calibration problems.
- Flexible two-point and sample calibration methods. To provide high accuracy, all calibration methods include stability monitors that check temperature and main parameter stability before accepting data.
- Selectable Pt1000 or Pt100 temperature inputs. Systems can also be hard-configured for three-wire elements. Temperature element can be user calibrated.
- Security lock feature to prevent unauthorized tampering with instrument settings. All settings can be viewed while locked, but they cannot be changed.
- High reliability, microprocessor based system with non-volatile memory back-up that utilizes no batteries. Low mass, surface mount PCB construction containing no user adjustment potentiometers. All factory calibrations stored in non-volatile EEPROM.

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**1.3 Instrument Specifications, ORTX-45 (common to all variations)**

<b>Enclosure</b>	NEMA 4X, IP66, polycarbonate, stainless steel hardware, weatherproof and corrosion resistant, HWD: 4.4" (112 mm) × 4.4" (112 mm) × 3.5" (89 mm)
<b>Mounting Options</b>	Wall, panel, pipe, DIN rail, or integral-sensor (DC only)
<b>Conduit Openings</b>	Standard: 2 - PG-9 openings, 1 - 1" NPT center opening, cordgrips and plug included. Relay option: 3 - PG-11 openings, plugs included
<b>Weight</b>	DC transmitter configuration: 1 lb. (0.45 kg) Line-powered unit: 1.5 lb. (0.68 kg)
<b>Display</b>	Large, high-contrast, Super-Twist (STN) LCD; 4-digit main display with sign, 0.75" (19.1 mm) seven-segment characters; 12-digit secondary display, 0.3" (7.6 mm) 5×7 dot matrix characters
<b>Keypad</b>	4-key membrane type with tactile feedback, polycarbonate with UV coating, integral EMI/static shield and conductively coated window
<b>Ambient Temperature</b>	Service, -20 to 60 °C (-4 to 140 °F) Storage, -30 to 70 °C (-22 to 158 °F)
<b>Ambient Humidity</b>	0 to 95%, non-condensing
<b>Location</b>	Designed for hazardous and non-hazardous areas
<b>EMI/RFI Influence</b>	Designed to EN 61326-1
<b>Output Isolation</b>	600 V galvanic isolation
<b>Filter</b>	Adjustable 0-9.9 minutes additional damping to 90% step input
<b>Temperature Input</b>	Selectable Pt1000 or Pt100 RTD with automatic compensation



### Instrument Specifications, ORTX-45 (NOT common to all variations)

#### »Basic 2-Wire Transmitter:

<b>Power</b>	16-35 VDC (2-wire device)
<b>DC Cable Max. Length</b>	3000 feet (914 meters)
<b>DC Cable Type</b>	Belden twisted-pair, shielded
<b>Insertion Loss</b>	15.5 VDC

#### »115/230 VAC Option:

<b>Power</b>	115/230 VAC $\pm$ 10%, 50/60 Hz 4 kV line isolation
<b>Fuse</b>	250 mA slow-blo on hot line, auto-reset secondary

#### »115/230 VAC Option + Dual Relays Option:

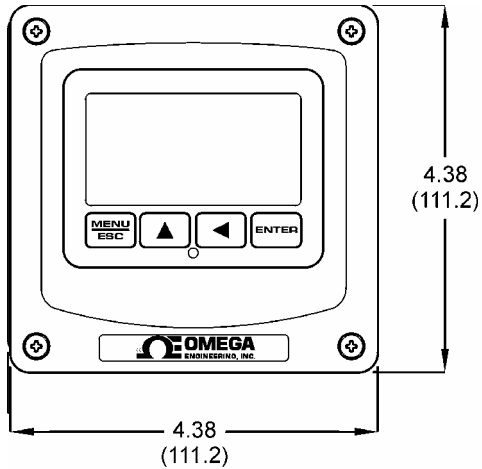
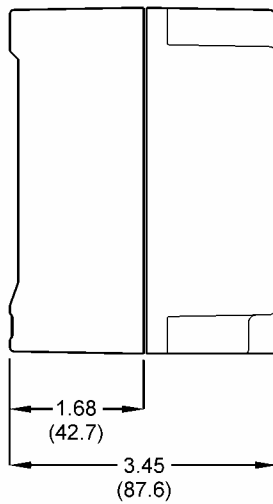
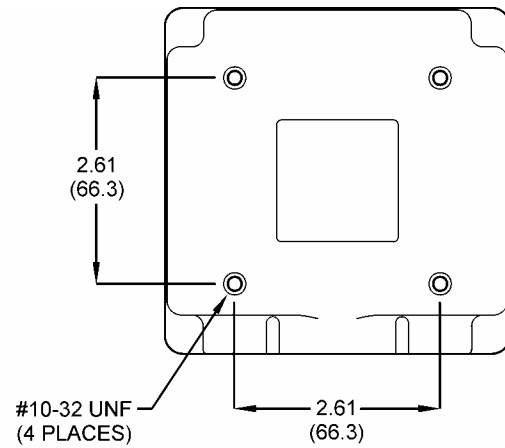
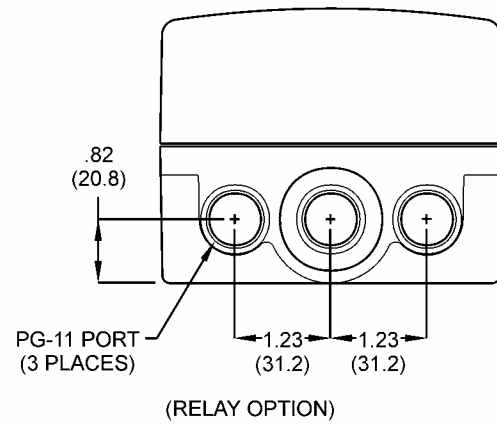
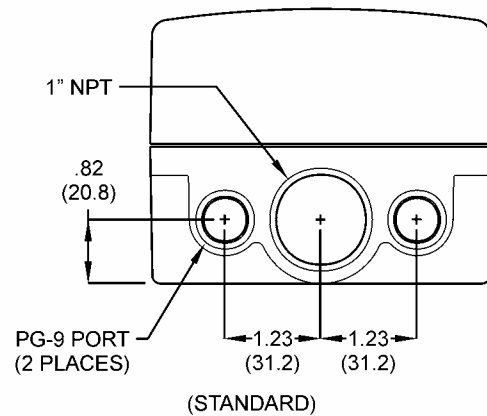
<b>Power</b>	115/230 VAC $\pm$ 10%, 50/60 Hz
<b>Fuse</b>	250 mA slow-blo on hot line, auto-reset secondary
<b>Relays</b>	<b>Electromechanical:</b> Dual SPDT, 6 amp @ 250 VAC, 5 amp @ 24 VDC contacts. <b>Solid State (AC):</b> Dual SPST (N.O.) 0.06-2.0 Amp @12-280 VAC, RMS <b>Solid State (DC):</b> Dual SPST (N.O.) 3 Amp @ 60 VDC  Software selection for setpoint, phase, delay, deadband, hi-lo alarm, and failsafe. A-B indicators on main LCD.

<b>Analog Outputs</b>	Dual 4-20 mA current loops, one for main parameter and one for temperature. Max load 500 Ohms on main and 500 Ohms on temperature.
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#### »Battery Option:

<b>Power</b>	Generic 9 VDC alkaline battery
<b>Auto-OFF Time</b>	2 hours after no keypress
<b>Low Battery Indication</b>	6.75 VDC
<b>Battery Life</b>	Normal Use (2-4 hours per week), 4-6 months Continuous operation, 10-14 days

Inches (mm)

**FRONT VIEW****SIDE VIEW****BACK VIEW****BOTTOM VIEW***Figure 1-2 Specifications - Views*

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**1.4 Performance Specifications, ORTX-45  
(common to all variations)**

<b>Displayed Parameters</b>	Main input, -1000 to +2000 mV Loop current, 4.00 to 20.00 mA Sensor temperature, -10.0 to 110.0 °C (14 to 230 °F)
<b>Main Parameter Range</b>	-1000 mV to +2000 mV
<b>Input Impedance</b>	Greater than $10^{13}$ Ohms
<b>Repeatability</b>	0.1% of span or better
<b>Sensitivity</b>	0.05% of span
<b>Non-linearity</b>	0.1% of span
<b>Stability</b>	0.05% of span per 24 hours, non-cumulative
<b>Temperature Drift</b>	Span or zero, 0.02% of span/°C
<b>Warm-up Time</b>	7 seconds to rated performance
<b>Instrument Response Time</b>	6 seconds to 90% of step input at lowest setting
<b>Max. Sensor-Instrument Distance</b>	3000 ft. (914 meters) w/ preamp, 30 ft. (9.1 meters) w/o preamp
<b>Sensor Types</b>	Omega ORP w/ preamp, 5 wire input (Model ORE-45P), or combination style ORP electrode w/ TC - 2 wire input

## Part 2 - Mounting

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### 2.1 General

All \*\*TX-45 Series Instruments offer maximum mounting flexibility. A bracket is included with each unit that allows mounting to walls, pipes and DIN rail. In all cases, choose a location that is readily accessible for calibrations. Also consider that it may be necessary to utilize a location where solutions can be used during the calibration process. To take full advantage of the high contrast display, mount the instrument in a location where the display can be viewed from various angles and long distances.

The two-wire version of the instrument is ideal for remote mounting applications where line power is unavailable and expensive to run, or in locations where only low-voltage wiring is allowed. The 115/230 VAC powered version of the instrument is designed to be used where line power is already available. The portable version can be used for survey measurements or for calibration checks of a larger number of permanently installed units.

Locate the instrument in close proximity to the point of sensor installation - this will allow easy access during calibration. Sensor-to-instrument distances of over 3000 feet are possible with the high performance Omega ORE-45P sensor, but this is not generally recommended since it may hamper access to sensor during calibration. The sensor-to-instrument distance for combination style electrodes must not exceed 30 feet.

For long distance installations (50 feet or more), standard sensor cable (10 feet) in combination with a junction box and interconnect cable is recommended. Sensors with extremely long cables can be cumbersome to remove for cleaning or service. It is much more convenient to remove or replace a sensor with only 10 feet of cable when a junction box is used. It is also far more economical.

In general, the location should be relatively dry and clean with little or no vibration, and the ambient temperature must be within the operating temperature limits of the instrument. Avoid areas where the instrument may be frequently splashed with corrosive process materials. Particularly in the integral mount version, excessive vibration or heat from the process line may degrade the reliability of the system.

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**Note: Never leave the instrument case open for extended periods of time. This can allow corrosive materials to attack the circuitry of the system.**

Due to the high flexibility of the instrument design, some of the mounting features change based on the option boards that may be installed. For example, the panel mounting implementation is different for the 115/230 VAC controller because the rear of the enclosure must be used. A special flange must be used to seal the entire enclosure to the panel. In the 2-wire transmitter configuration, just the front of the enclosure can be mounted. In addition, the 115/230 VAC must not be integral mounted. Carefully study all mounting configurations.

## **2.2 Wall Mounting**

Any of the instrument configurations may be wall mounted (see Figures 2-1 and 2-2 for details). The multi-purpose bracket is attached to the rear of the enclosure using the four provided pan head screws. The protrusion side of the multi-purpose bracket should face into the depression on the rear of the instrument enclosure. The instrument is then attached to the wall using the four outer mounting holes in the bracket.

## **2.3 Pipe Mounting**

For the pipe mounting configuration, the multipurpose bracket is attached to the rear of the enclosure with the four provided screws. The protrusion on the bracket must face outward. The bracket may be rotated for proper alignment prior to mounting (see Figures 2-1 and 2-2 for details).

Once the bracket is fastened to the rear of the enclosure, the provided pipe clamp must be completely opened and slipped through the two slots in the multi-purpose mounting bracket. The clamp is then looped around the pipe, re-attached, and tightened.

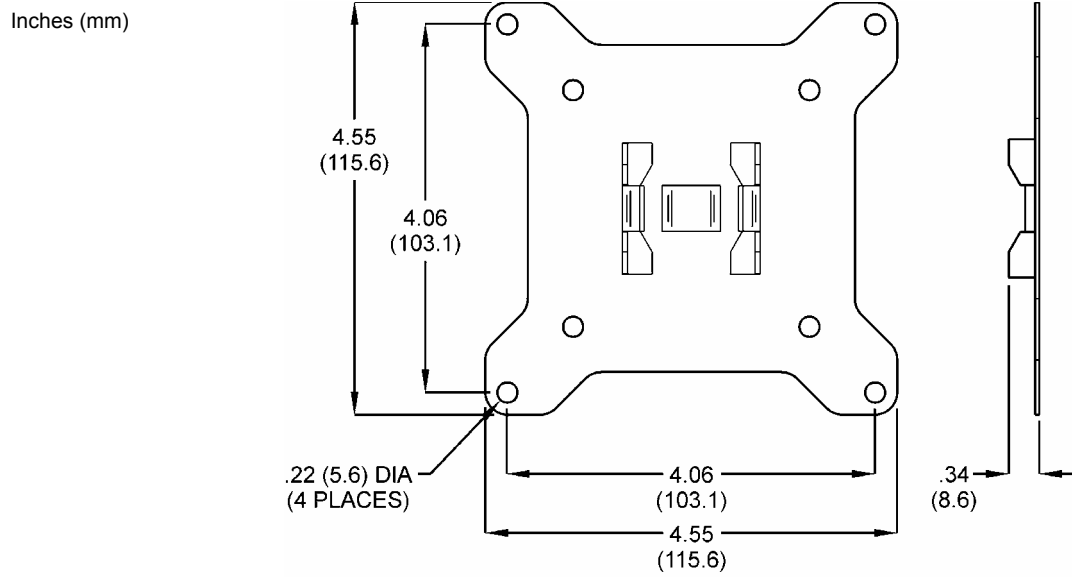


Figure 2-1 Multi-Purpose Bracket

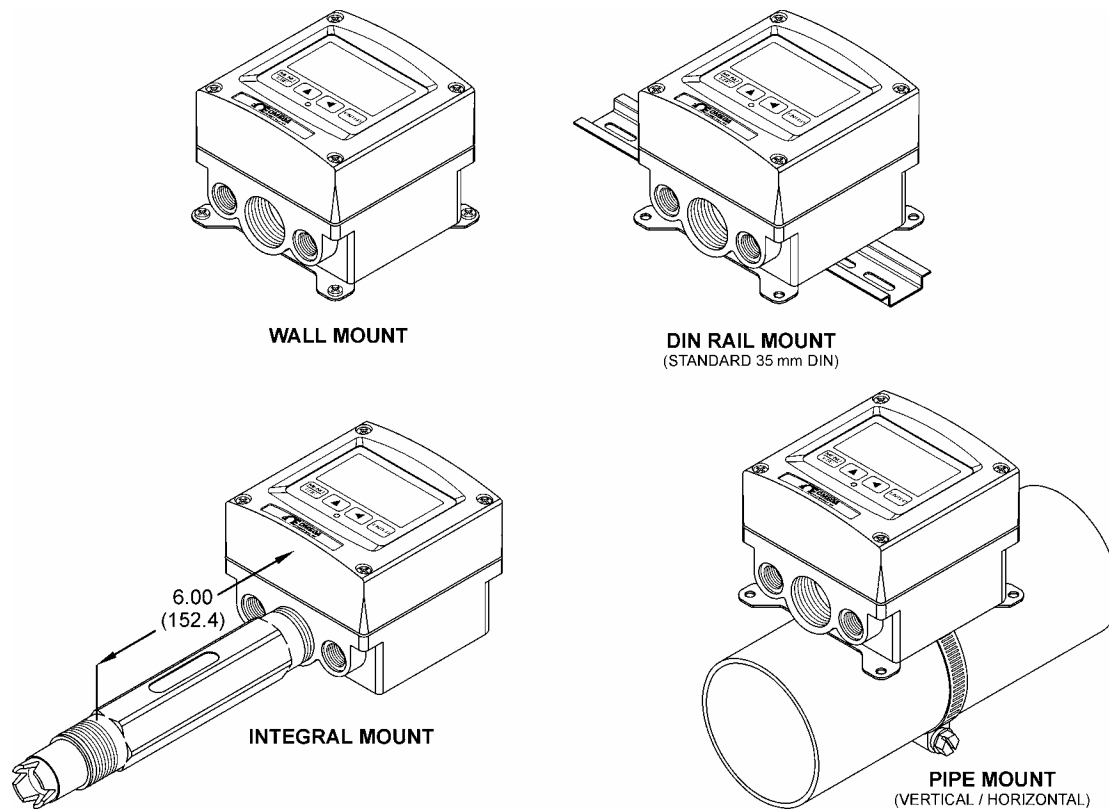


Figure 2-2 ORTX-45 Mounting Configurations

## 2.4 DIN Rail Mounting

For the DIN rail mounting configuration, the multipurpose bracket is attached to the rear of the enclosure with the four provided screws. The protrusion on the bracket must face outward. The bracket may be rotated for proper alignment prior to mounting (see Figures 2-1 and 2-2 for details).

Once the bracket is fastened to the rear of the enclosure, the unit must be slid onto the DIN rail. It does not lock into place. Therefore, if the unit is removed for service or replacement, it must be slid off of the DIN rail, or the front half of the controller can be removed and replaced since all of the electronics in the 2-wire configuration reside in the front half.

## 2.5 Integral Mounting

Only the 2-wire configuration may be mounted directly on the back of the Model ORE-45P sensor (see Figures 2-2 and 2-3 for details).

**Note: Do not attempt to integral mount the 115/230 VAC configuration. This configuration is not designed to be mounted directly to the sensor.**

For an integral mount connection, the sensor cable must be cut substantially to fit into the instrument enclosure. Cut and strip the sensor cable as shown in Figure 2-3. Screw the sensor fully into the enclosure base before completing wiring connections.

## 2.6 Panel Mounting

The instrument may also be panel mounted in two different ways:

In the 2-wire configuration, the front half of the enclosure may be separated and mounted by itself, as shown in Figure 2-4. Note that the rear of the instrument enclosure is not utilized in this mounting scheme. Holes must be drilled at the perimeter of the panel cut-out that allow the enclosure screws to pass through and be retained on the back side. User-supplied #8-32 nuts are used to fasten the instrument from the back. The FIP instrument gasket remains intact during this mount to seal to the panel.

Inches (mm)

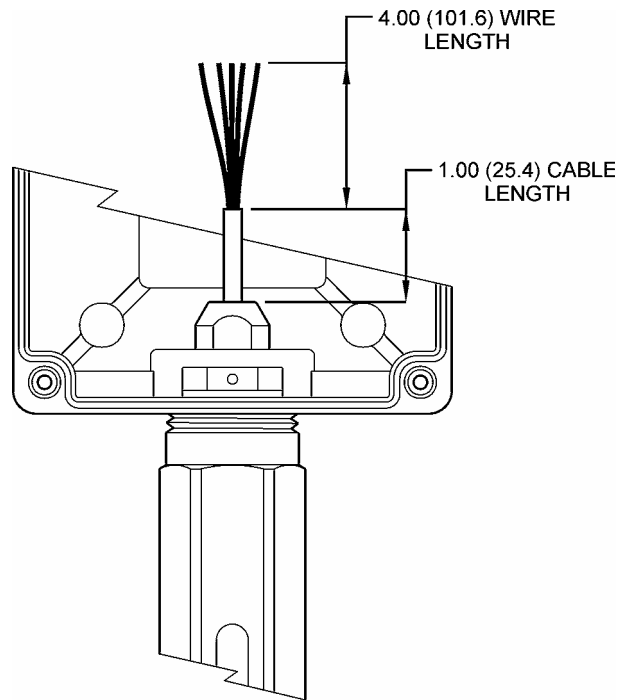


Figure 2-3 2-Wire Integral Mount Detail

Inches (mm)

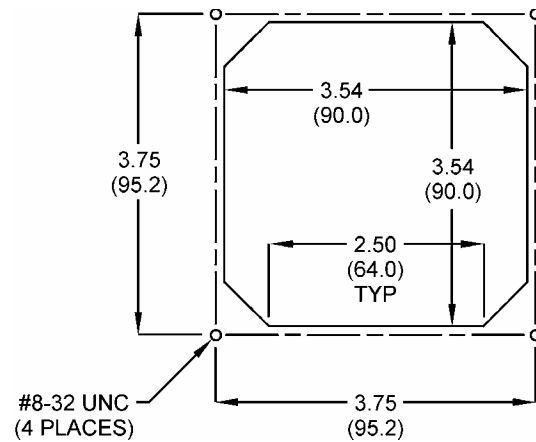
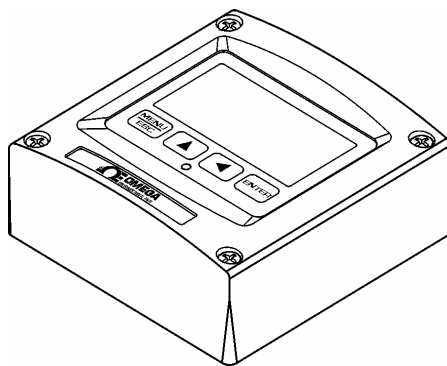


Figure 2-4 2-Wire Panel Mount and Cut-out



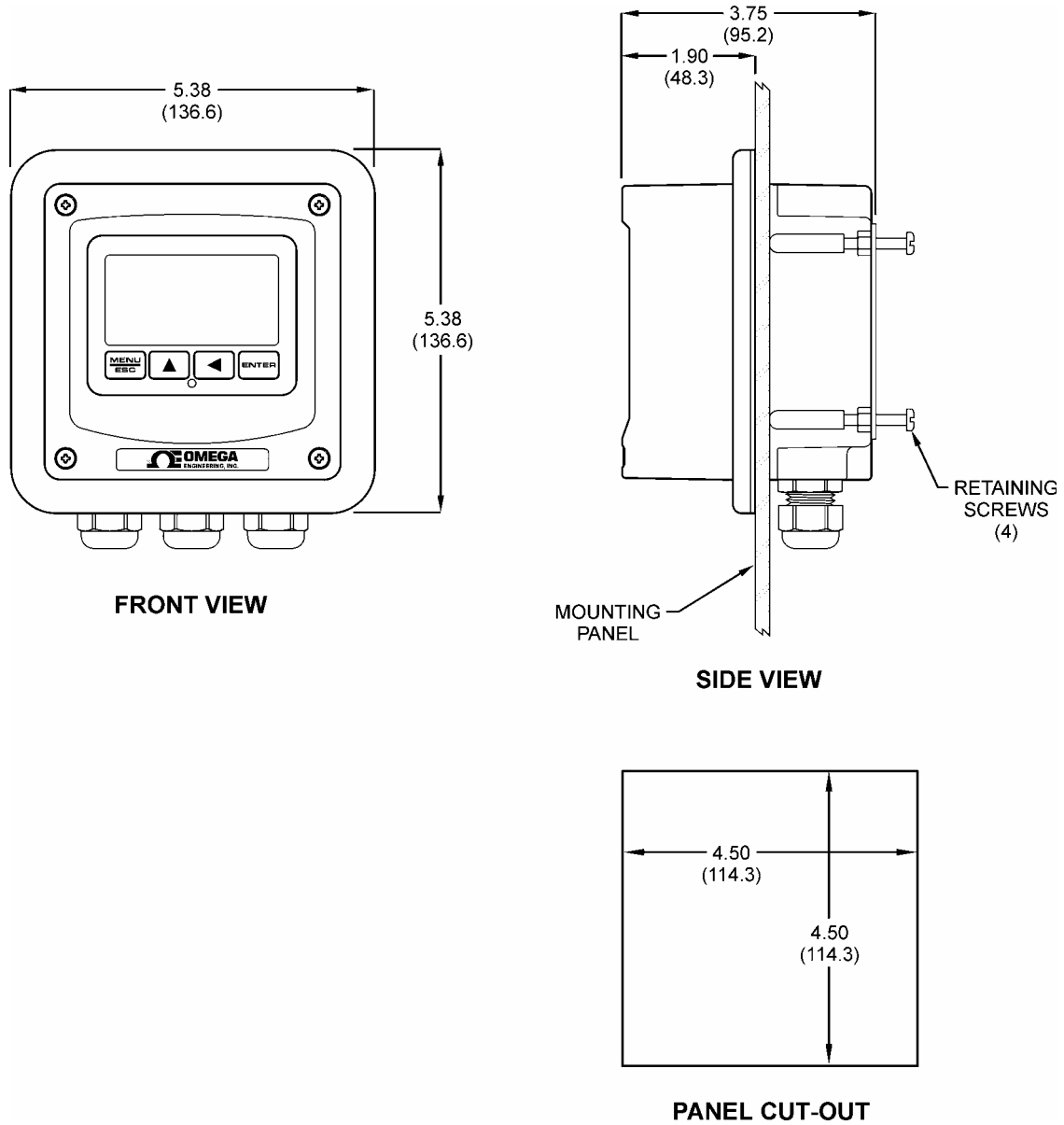
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In the full enclosure configuration (necessary with the 115/230 VAC card option), the entire enclosure is panel-mounted using a special optional sealing flange.

The sealing flange must first be attached to the enclosure. Remove the enclosure hinge by bending one of the hinge legs inward toward the center of the enclosure with a pair of needle nose pliers. Once it is loose, slide the hinge leg out the opposite side. When completed, remove the two hinge retainer screws and hinge plate assembly. Fasten the flange to the rear half of the enclosure using the four hex retainers. The flange gasket material must face towards the rear of the enclosure. Re-install the hinge and hinge plate assembly onto the flange using the two hinge screws. Re-attach hinge pins to the front half of the enclosure by bending the hinge pin leg with a pair of needle nose pliers. The flange is now installed. Seal up the finished enclosure by tightening down the four enclosure screws prior to mounting.

A different cut-out is required for this configuration, as shown in Figure 2-5. Once the cut-out has been completed, insert the flanged enclosure through the cut-out. The mounting bracket is then attached to the rear of the enclosure as shown. Install the four tension screws through the four mounting holes in the bracket, and place the no-slip rubber boots on each screw. Tighten all screws down to seal the enclosure flange onto the panel.

Inches (mm)

*Figure 2-5 115/230 VAC Panel Mount and Cut-out*

## Part 3 - Electrical Installation

---

### 3.1 General

The instrument may be powered in several ways, depending on the option features installed. The 2-wire version is a 16-35 VDC powered transmitter. The integral 115/230 VAC version and relay version require line power. Please verify the type of unit before connecting any power.

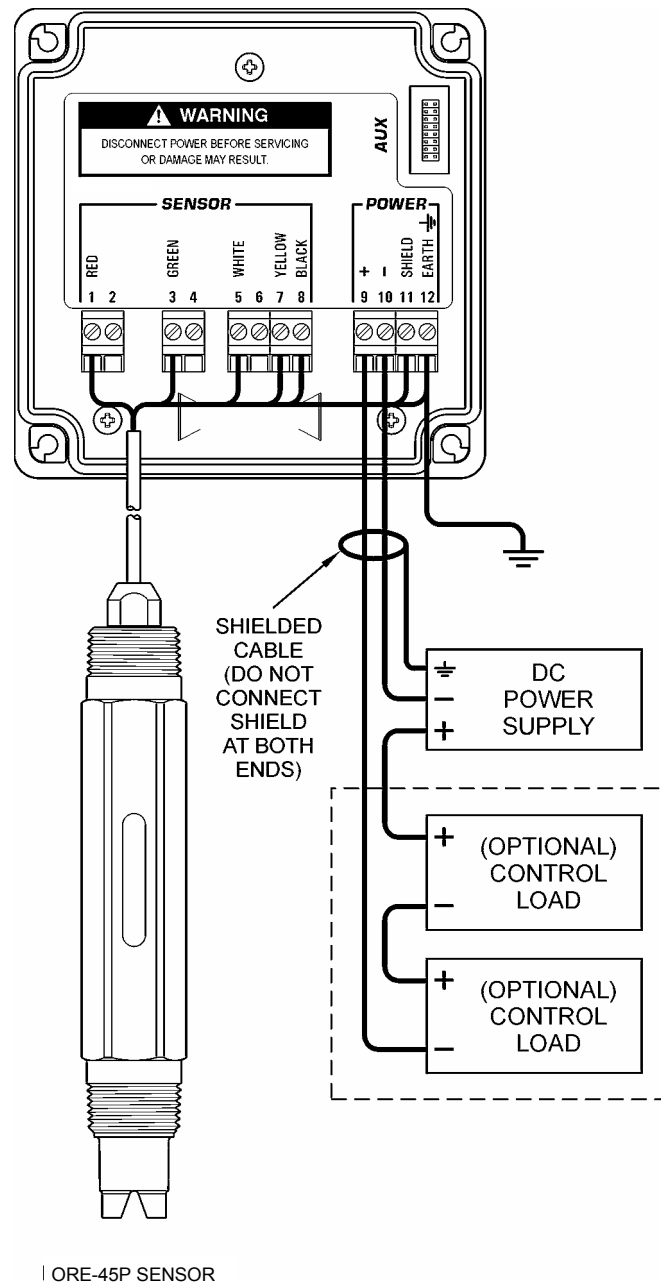
**WARNING: Do not connect AC line power to the 2-wire module. Severe damage will result.**

#### Important Notes:

1. Use wiring practices that conform to all national, state and local electrical codes. For proper safety as well as stable measuring performance, it is important that the earth ground connection be made to a solid ground point from **TB1**. The power supply contains a single ¼-Amp slo-blo fuse on the **H** Terminal.
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.

### 3.2 Two-Wire Configuration

In the two-wire configuration, a separate DC power supply must be used to power the instrument. The exact connection of this power supply is dependent on the control system into which the instrument will connect. See Figure 3-1 for further details. Any general twisted pair shielded cable can be used for connection of the instrument to the power supply. Route signal cable away from AC power lines, adjustable frequency drives, motors, or other noisy electrical signal lines. Do not run sensor or signal cables in conduit that contains AC power lines or motor leads.



- Notes:**
1. Voltage between Terminals 9 and 10 MUST be between 16 and 35 VDC.
  2. Earth ground into Terminal 12 is HIGHLY recommended. This connection can greatly improve stability in electrically noisy environments.

*Figure 3-1 Loop Power Connection, Omega ORE-45P Sensor and ORTX-45 Transmitter*

### 3.21 Load Drive Capability

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

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

To find the load drive voltage of the two-wire ORTX-45, subtract 16 VDC from the actual power supply voltage being used (the 16 VDC represents insertion loss). For example, if a 24 VDC power supply is being used, the load drive voltage is 8 VDC.

The maximum loop current of the two-wire ORTX-45 is always 20.00 mA, or .02 A. Therefore,

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

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

Similarly, the following values can be calculated:

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

### 3.3 115/230 VAC Configuration

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

Connect HOT, NEUTRAL, and GROUND to the matching designations on terminal strip **TB1**.

If the unit was ordered with the integral power supply installed, a connection will also be present from terminal strip **TB2** to the ORTX-45 module. If the power supply was ordered separately and installed later, this last connection at **TB2** must be made at this time as shown in Figure 3-2.

The analog output from the system is present at terminal TB1. The loop-load limitation in this configuration is 500 Ohms maximum. If the analog output will not be connected to other instruments, these two terminals must remain shorted for proper operation.

**Note: If not using the 4-20 mA output, a wire short must exist between terminals (+) and (-) for proper operation.**

## WARNING

Disconnect line power voltage **BEFORE** connecting line power wires to Terminal TB1 of the power supply. The power supply accepts only standard three-wire single phase power. The power supply is configured for either 115 VAC or 230 VAC operation at the factory at time of order, and the power supply is labeled as such. Do **NOT** connect voltages other than the labeled requirement to the input.

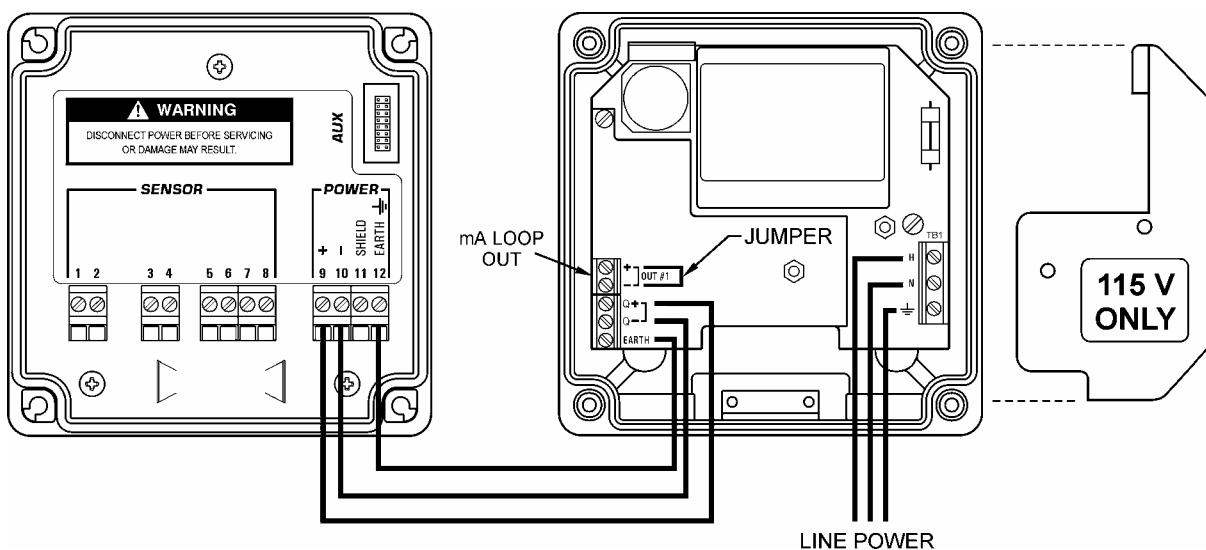


Figure 3-2 Line Power Connection

The power strip, **TB1**, allows up to 14 AWG wire. A wire gauge of 16 AWG is recommended to allow for an easy pass-through into the PG-9 ports when wiring.

### 3.4 115/230 VAC w/ 2 Relays Configuration

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

Connect HOT, NEUTRAL, and GROUND to the matching designations on terminal strip **TB1**.

If the unit was ordered with the integral power supply installed, a connection will also be present from terminal strip **TB2** to the ORTX-45 module. If the power supply was ordered separately and installed later, this last connection at **TB2** must be made at this time.

The analog outputs from the system are present at terminal **TB2**. The loop-load limitation in this configuration 400 Ohms maximum. If the analog output will not be connected to other instruments, these two terminals must remain shorted for proper operation.

**Note:** If not using the 4-20 mA output #1, a wire short must exist between terminals (+) and(-) for proper operation.

## WARNING

Disconnect line power voltage **BEFORE** connecting line power wires to Terminal TB1 of the power supply. The power supply accepts only standard three-wire single phase power. The power supply is configured for either 115 VAC or 230 VAC operation at the factory at time of order, and the power supply is labeled as such. Do **NOT** connect voltages other than the labeled requirement to the input.



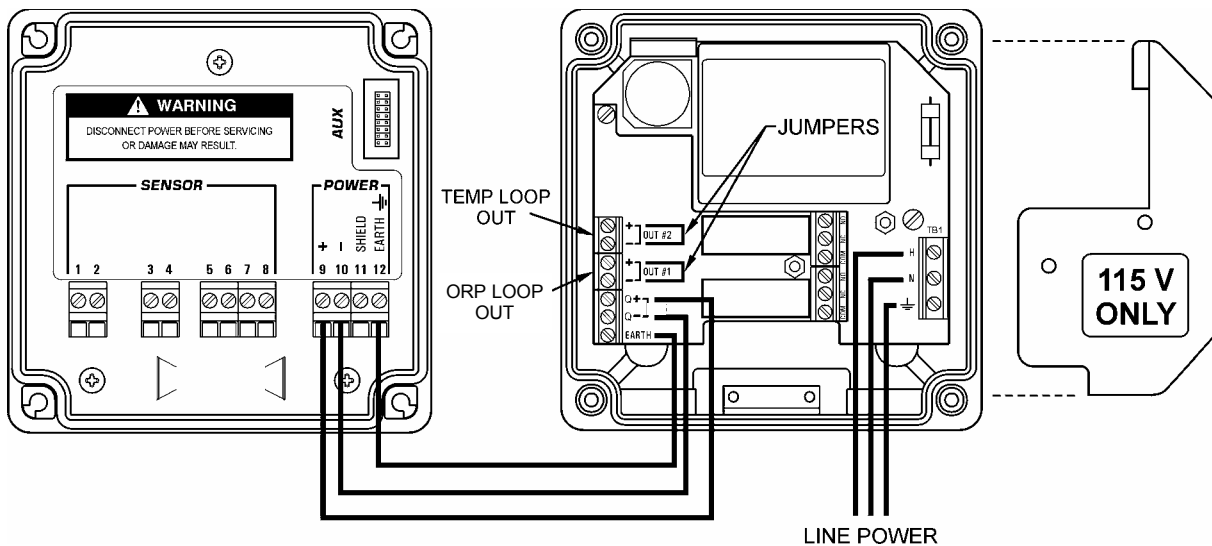


Figure 3-3 Line Power w/ Relays Connection

Also in the line-power w/ relays configuration, a special cable is connected under the power supply that runs to the AUX connector on the main part of the instrument. The cable is retained by a clip mounted under the AUX connector on the shield. Under the power supply, the black wire in the cable should be facing PIN 2. On the AUX connector, the white wire should be in the upper left corner (see Figure 3-4 for further details).

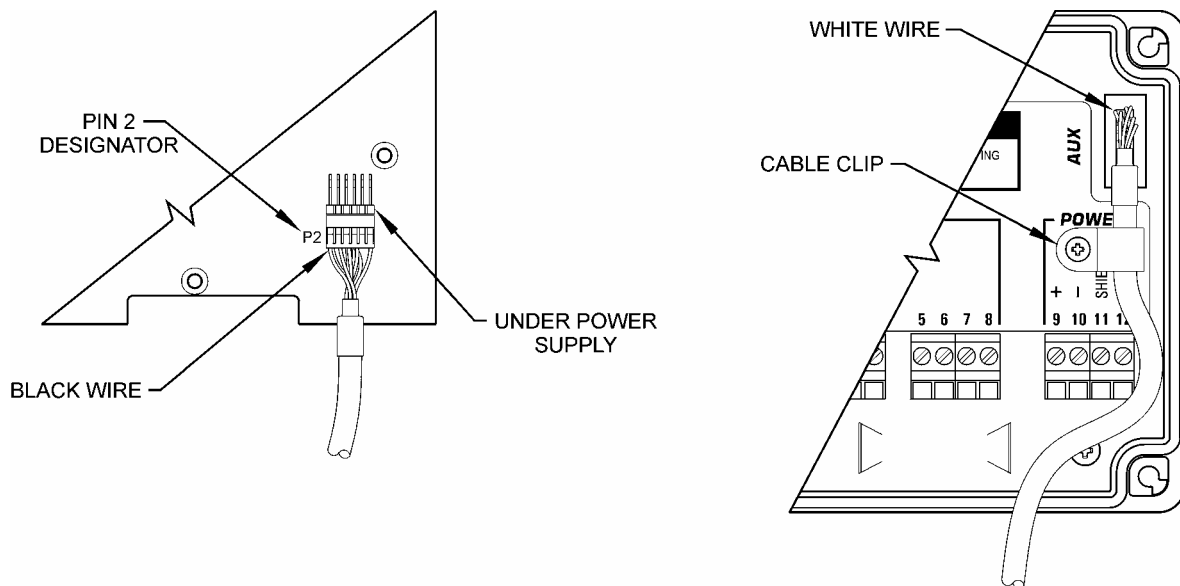


Figure 3-4 Relay Cable Connection

**Relay Contacts**

Two sets of SPDT relay contacts are provided on the relay option 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 ORTX-45 (115 or 230 V), power may be jumpered from the power input terminals at **TB1**.

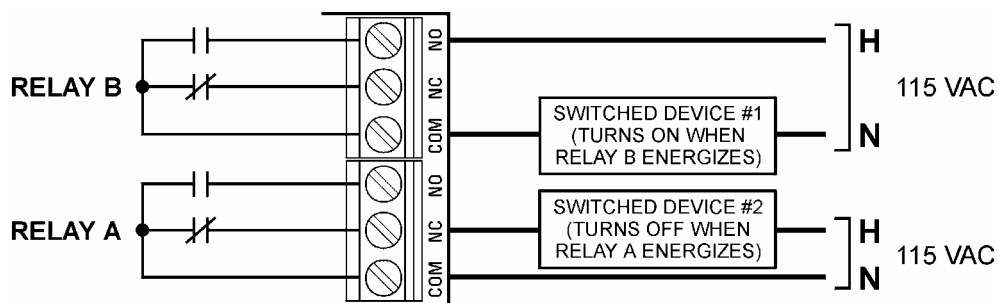


Figure 3-5 Relay Contacts

### 3.5 Battery-Powered (Portable) Configuration

In the battery-powered version, the instrument is converted to a display-only portable unit. The battery option card cannot be used with any other option cards. All of the normal software functions are active in the portable unit. In addition, there are several unique hardware features which are described in detail here.

**Note:** Do not attempt to connect external DC or AC power supplies to the portable unit or severe damage will result.

## Installation

To install the battery board, open the ORTX-45 instrument enclosure and place the board into the rear of the enclosure as shown in Figure 3-6. The board should be oriented such that the header connector P1 is located in the upper left corner of the enclosure. Fasten the circuit board into the enclosure at the three indicated mounting points using the three #4 screws included with the kit. Once the board is fastened, connect the power cable from header connector P1 on the battery board to the header located in the AUX port of the instrument. The blue wire on the ribbon cable should face down and correspond to the white polarity dot designating pin 1 on the header connector P1. Finally, install one alkaline 9 VDC battery into battery holder B1. Since the header connector is below the shield plate, it helps to bend the connector “out” slightly on the ribbon cable before inserting it.

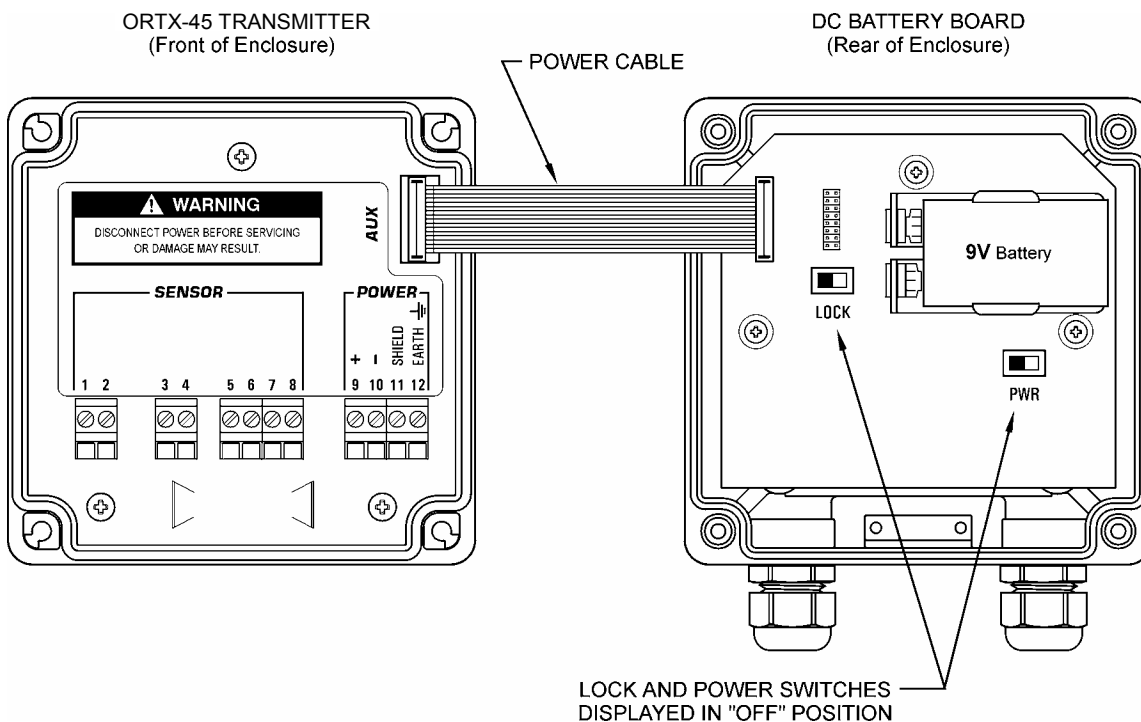


Figure 3-6 DC Battery Board Connection

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**Operation**

Two hardware switches are located on the battery board: the power switch S2-PWR and the lock switch S1-LOCK. The PWR switch disconnects the 9 VDC battery and is only used to disconnect the battery if the system is not to be used for a long period of time (> 3 months or storage). Otherwise, leave this switch in the ON position. The LOCK switch selects between two different modes of operation: the normal/off mode or locked/on mode. When LOCK is in the normal/off mode, the system functions normally and turns on by holding the MENU key on the front keypad for 5 seconds. Thereafter, the system will turn off automatically after 2 hours if no keys are pressed. When LOCK is in the ON mode, the system is permanently on and will not turn off. This mode is used for extended operation.

With the system in normal mode (LOCK = OFF), an alkaline battery will provide approximately 5 months of non-continuous operation. Specifically, this would represent periodic operation of the unit of less than 10 hours per week. When the system is in locked mode (LOCK = ON), an alkaline battery will provide approximately 10-14 days of continuous operation. Installing a 9 VDC lithium battery instead of alkaline will increase operation time in all modes by 4x. These projections are dependant upon which instrument the battery board is operating and the ambient temperature (higher temperatures will shorten battery life span).

The "**B**" icon will flash on the LCD when the instrument requires battery replacement. If the battery is not replaced, eventually the unit will not turn on in the normal operating mode. This low-battery indicator functions only when LOCK = OFF.

**Notes**

Several important points to remember when operating the instrument with the battery board option:

1. To turn the unit ON, press and hold the MENU key for 5 seconds. The unit will turn off automatically after 2 hours if no keys are pressed.
2. NEVER connect an external power source to the instrument power terminals when the battery board is installed. Severe damage can result.
3. The 4-20 mA output is not functional when the battery board is connected. To restore 4-20 mA output functionality, the battery board must be removed.
4. When using the instrument for portable measurements, be aware of the time required to achieve stable readings from particular sensors. In most cases, sensor primary measurements require stable temperature readings for accurate temperature compensation. The user must allow adequate time for the sensor to temperature equilibrate with the solution being measured. Due to the heavy-duty construction of the ORE-45P sensor, they may require up to 15 minutes to fully temperature equilibrate with solutions at temperatures that are considerably different from the initial sensor temperature.
5. Set the PWR switch to OFF if the unit will not be operated for an extended period of time, or if it is to be stored.

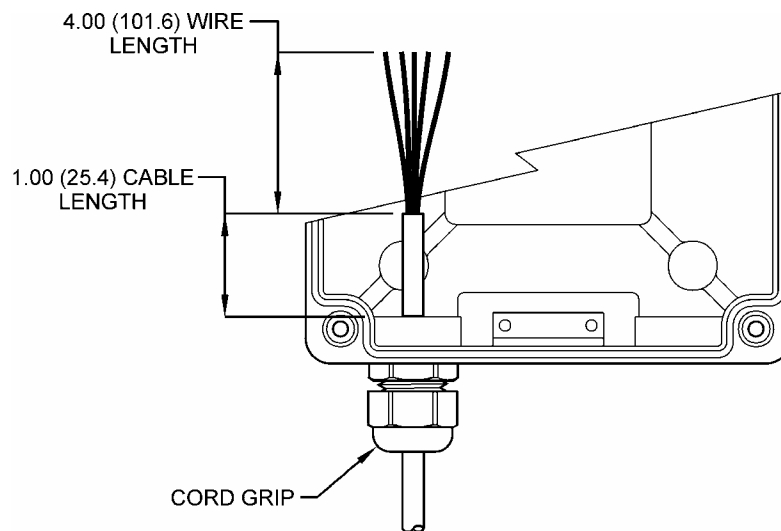
## Part 4 - Sensor Connection

### 4.1 General

The sensor cable can be routed into the enclosure through one of the provided cord-grip retainers, or through a properly sized conduit connection. Adapters are available to convert the PG-9 type opening into a 1/2" NPT type opening.

If the cord-grip devices are used for sealing the cable, make sure the cord-grips are snugly tightened after electrical connections have been made to prevent moisture incursion. If not using the integral mount method, the center conduit hole of the enclosure should be plugged with the provided 1" NPT plug.

When stripping cables, leave adequate length for connections in the transmitter enclosure, as shown below.



*Figure 4-1 Bulkhead Connection*

If the instrument is ordered with the Relay Option Board installed, the enclosure includes three PG-11 cord grips to allow for the additional wiring going into the enclosure.

#### 4.2 ORE-45P Sensor Connection

The sensor cable can be quickly connected to the ORTX-45 terminal strip by matching the wire colors on the cable conductors. 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. See Figure 4-2 for details on connecting the high-performance Omega sensor (Model ORE-45P).

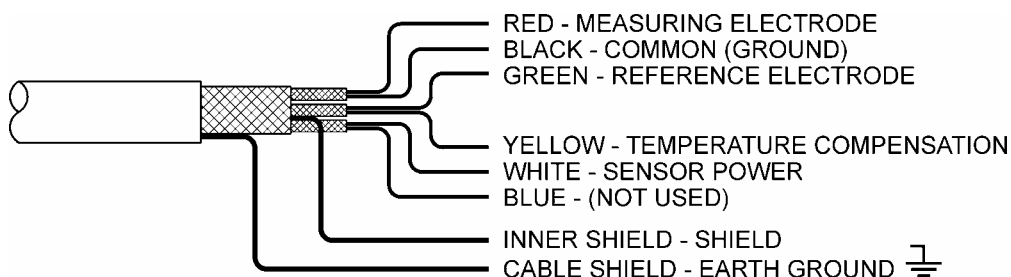


Figure 4-2 Sensor Cable Connections, Omega ORE-45P

**Note:** Only the custom 6-wire shielded interconnect cable must be used when connecting the Model ORE-45P sensor to the instrument. This high-performance, double shielded, polyethylene jacketed cable is specially designed to provide the proper signal shielding for the sensor used in this system. No substitutions can be made. Substituted cables may cause problems with system performance.

For optimum electrical noise rejection performance, connect the innermost cable shield to the terminal marked **Shield** on the instrument; connect the outermost shield to the terminal marked **Earth**. In addition, the earth terminal should also be grounded to a nearby source of electrically clean ground. Do not allow shield wires to short together.

### 4.3 Combination Electrode Connection

The ORTX-45 may also be used with non-amplified simple combination electrodes (see Figure 4-3). Note that a wire jumper must be installed from Terminal 3 to Terminal 8. The user must also select Sensor Type **2** within the Config Menu (see Section 5.24). The maximum sensor-to-instrument cable length will be severely limited (30-50 feet) with electrodes of this type. The length will depend on the specific electrode impedance and the quality of interconnect cable provided by the manufacturer.

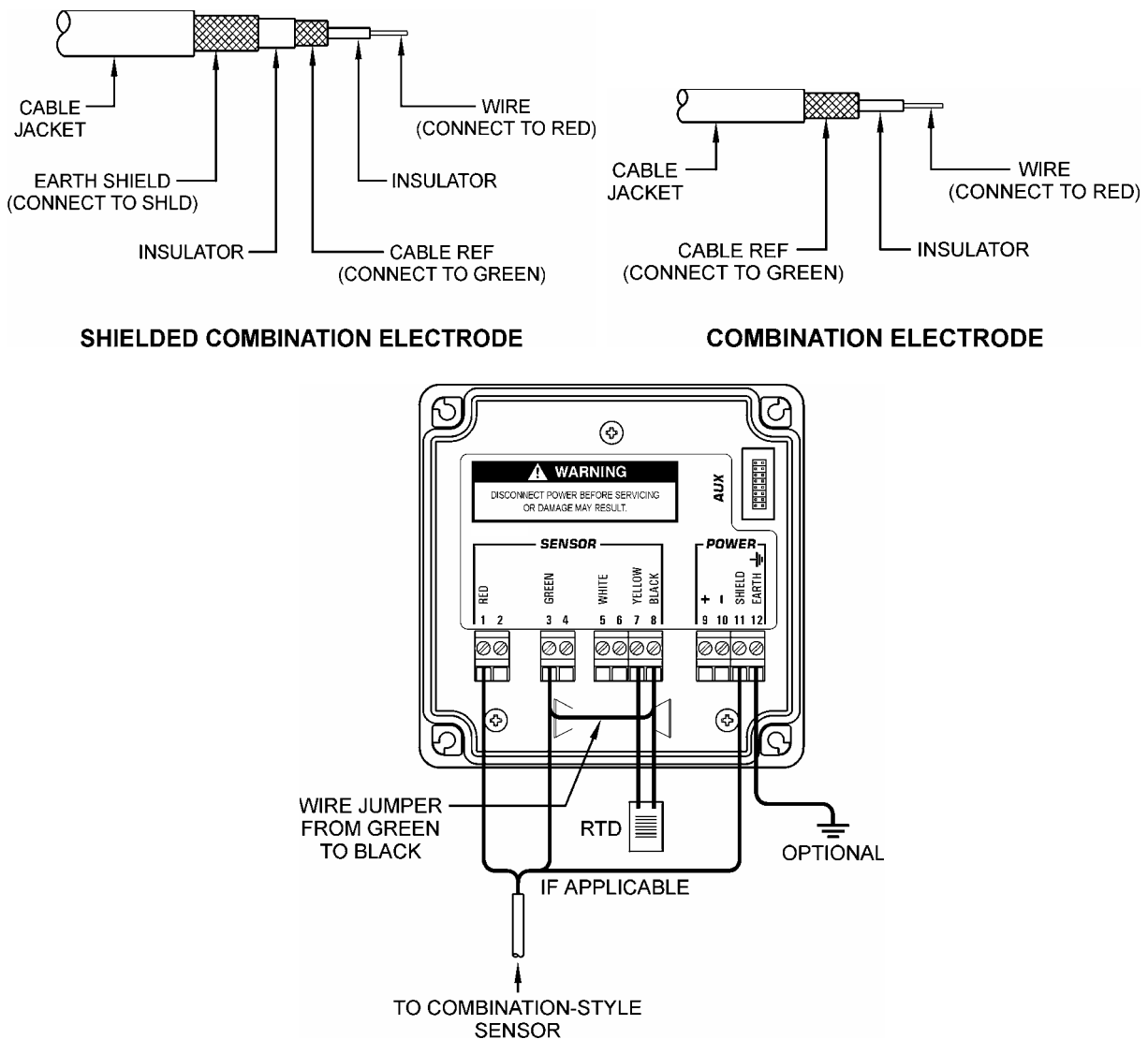


Figure 4-3 Sensor Cable Connections, Combination Electrode



#### 4.4 External Temperature Compensators

The Omega ORE-45P sensor includes an integral Pt1000 RTD. The Omega \*\*TX-45 series instruments also allow user-supplied external Pt1000 or Pt100 elements to be connected to the temperature input, as shown in Figure 4-4. Note that when using the Pt100 connection, sensor cable length will be limited to 40 feet due to the high cable resistance error associated with the lower resistance output of Pt100 RTD elements. In other words, cable resistance represents a higher percentage of error signal when using a lower-resistance RTD.

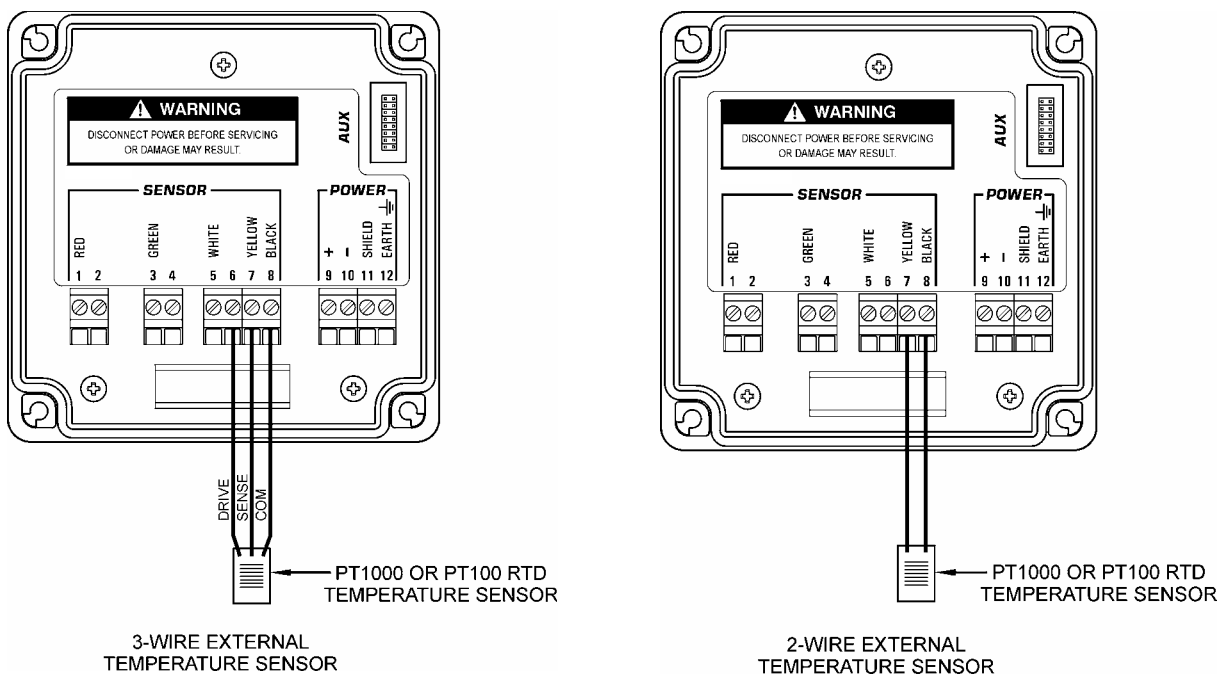


Figure 4-4 External Temperature Compensators

#### 4.5 Long Cable Length Issues

Very long sensor cable runs (> 400 feet) with relatively low-Ohm resistive temperature sensors can suffer from accuracy problems related to additive cable resistance as well as instability of cable resistance over temperature. In such cases, a three or four-wire connection method allows these types of errors to be removed from the measurement. Although the ORTX-45 is configured as a two-wire RTD input for ease of connection, the transmitter may be easily configured as a three-wire element if desired. The three-wire connection allows the instrument to eliminate errors caused by changes in the resistance of very long connection leads.

In addition to cable resistance, sensor cable lengths greater than 400 feet may degrade the electrode diagnostic signals, resulting in false trips. If this occurs, the glass diagnostic may be switched off without affecting the remaining system diagnostics. See Section 5.25 for further details.

#### Cable Resistance

The Pt1000 temperature element in the Omega ORE-45P sensor is a high accuracy, Class A tolerance element. Tolerance of this element is 0.06% at 0°C, or 0.1°C. In the standard connection the RTD is configured as a two-wire element. The sensor cable on the Model ORE-45P sensor has a lead resistance of approximately 0.0277Ω/ft at 68°F. The lead length for the RTD is twice as long as the sensor cable since two leads are attached to the RTD element in the sensor. Therefore, 100 feet of sensor cable represents a possible uncalibrated measurement error of  $200 \times 0.0277\Omega/\text{ft} = 5.54\Omega$ . Since the Pt1000 RTD has a slope of  $0.00385\Omega/\Omega/^\circ\text{C}$ , this calculates to  $5.54\Omega/3.85 = 1.44^\circ\text{C}$ . Therefore, this length of sensor cable can represent a severe error for instruments that do not allow the user to calibrate temperature. Using the standard two-wire connection, the ORTX-45 transmitter allows the user to calibrate out these errors up to approximately 400 feet of sensor cable.

**Cable  
Temperature Shift**

In addition to cable length errors, the user must consider the effects of temperature changes on the sensor cable itself. The wire in the ORE-45P sensor is copper, and the temperature coefficient for copper is  $0.00393/^{\circ}\text{C}$ . When mounted indoors, the effects of temperature change over the entire length of cable are negligible. However, long lengths of cable mounted outdoors may undergo appreciable shifts in resistance over temperature, causing large errors. Using the temperature coefficient, 100 feet of cable can result in an error of approximately  $0.3^{\circ}\text{C}$  over a  $50^{\circ}\text{C}$  change from standardization. This type of error cannot be calibrated out. It can only be removed by utilizing the three-wire connection scheme (see below). However, this error is unusual in that the entire cable length must change by the same temperature.

**Three-Wire RTD  
Connection**

For sensor cable distances of 400 feet or more, a three-wire RTD connection will produce the highest accuracy measurement. This connection requires the use of a junction box. To configure the instrument for a three-wire connection, the metal PCB shield over the terminal strips must be carefully removed by first removing the three retaining screws, then gently prying the shield upward and slightly pushing the terminal strips through the opening in the shield. Once the shield has been removed, the user must cut a small white jumper J1 in the lower-right section of the top scaling board. Replace the shield and connect the Model ORE-45P sensor as shown in Figure 4-5. If the two-wire connection is desired at any time after this change has been made, the user must install a wire jumper between terminals 6 and 7 on the transmitter.

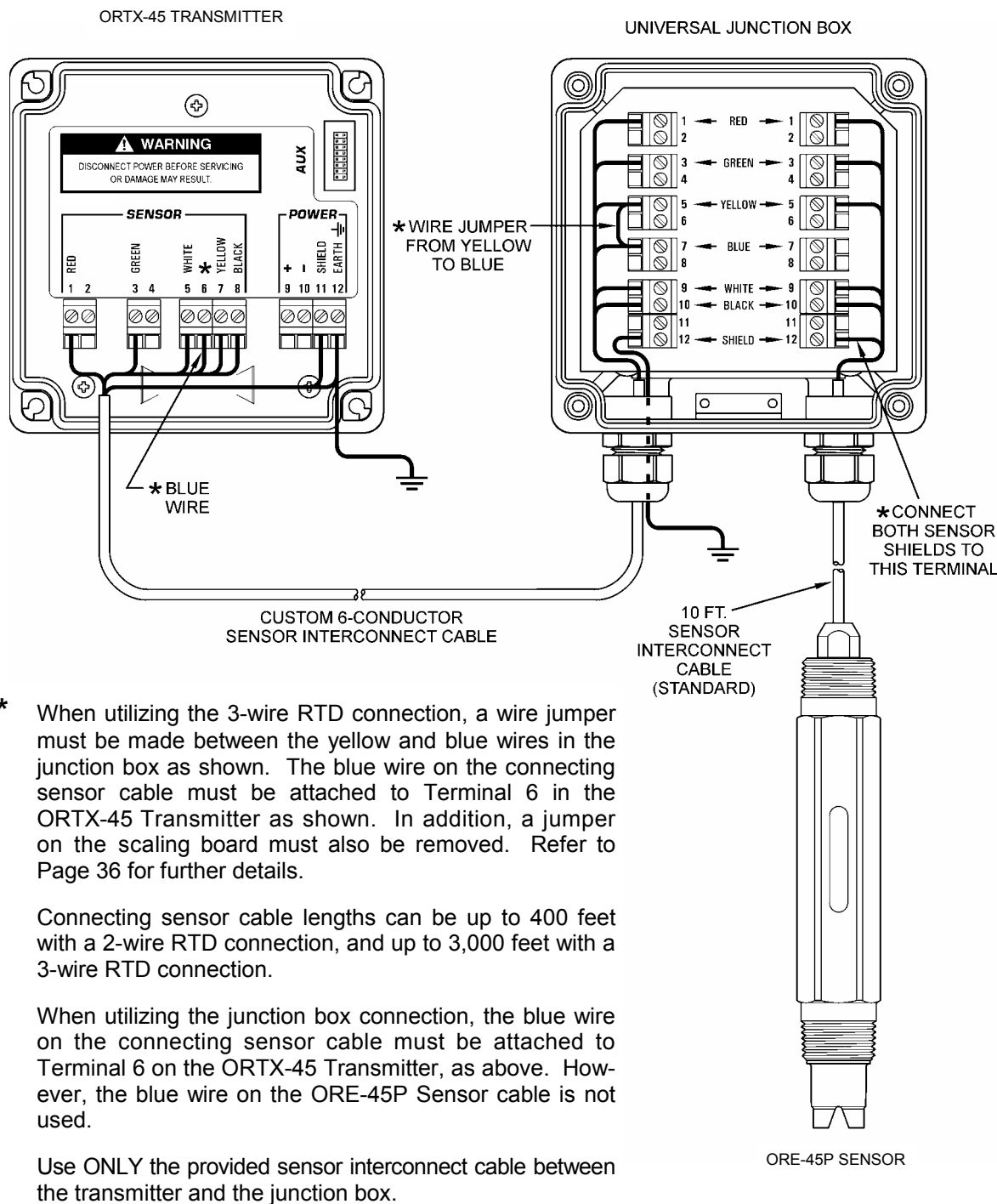
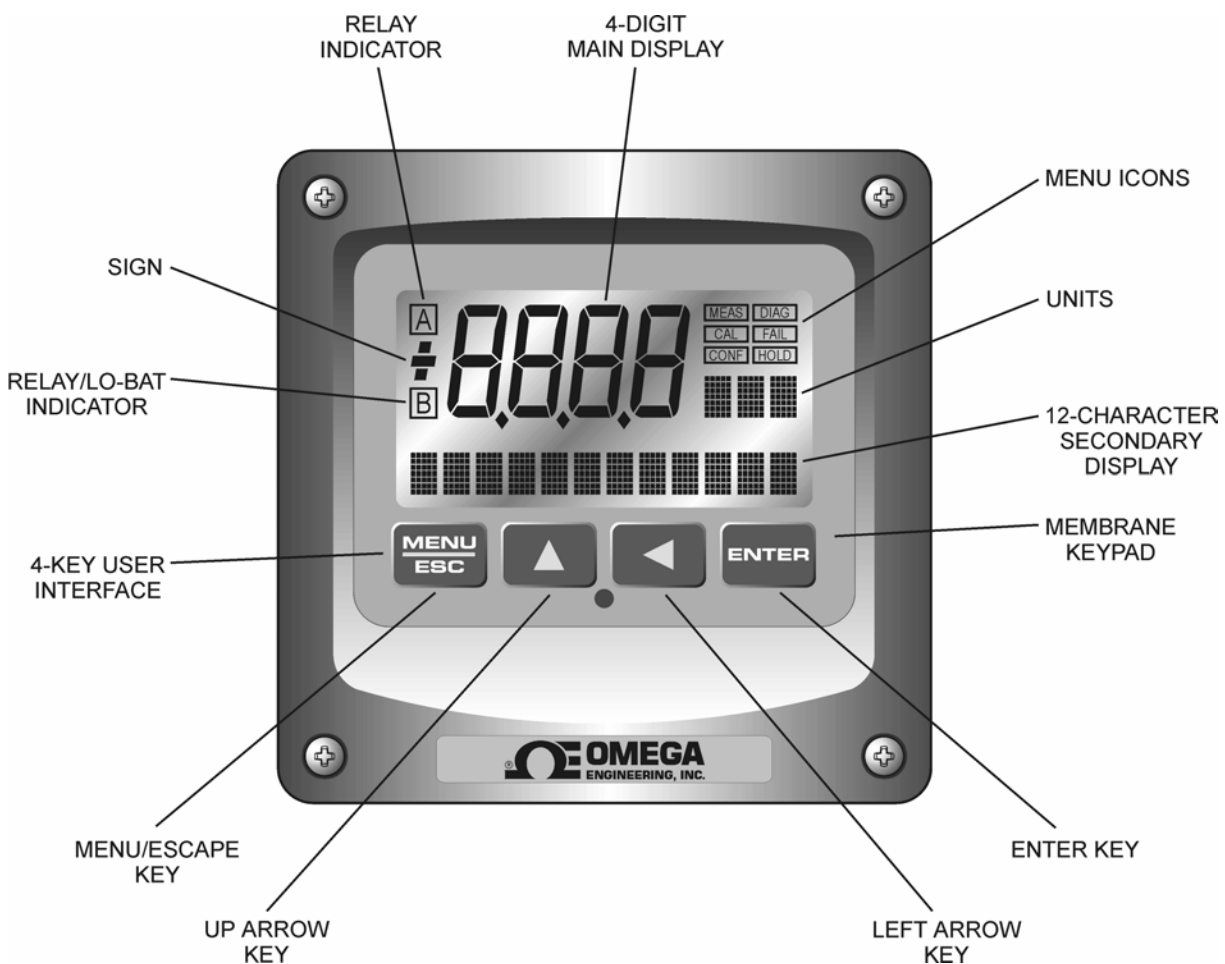


Figure 4-5 Junction Box Connection and Three-Wire RTD Connection

## Part 5 - Operation

### 5.1 User Interface

The user interface for the ORTX-45 instrument consists of a custom display and a membrane keypad. All functions are accessed from this user interface (no internal jumpers, pots, etc.).



(Display shown with all segments ON)

Figure 5-1 User Interface

### 5.11 Keys

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

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

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

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

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

### 5.12 Display

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

#### Main Parameter

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



**Lower Line**

During normal operation, the lower line of the display indicates user-selected secondary measurements that the system is making. This also includes calibration data from the last calibration sequence and the instrument model number and software version. During configuration, the lower line displays menu items and set-up prompts to the user. Finally, the lower line will display error messages when necessary. For a description of all display messages, refer to Section 7.3.

**Icon Area**

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

**HOLD**

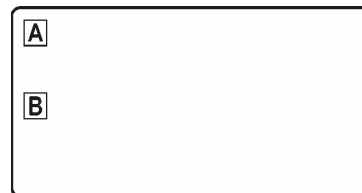
The HOLD icon indicates that the current output of the instrument has been put into output hold. In this case, the output is locked to the last input value measured when the HOLD function was entered. HOLD values are retained even if the unit power is cycled.

**FAIL**

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

**Relay Area A/B**

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

**5.2 Software**

The software of the ORTX-45 is organized in an easy to follow menu-based system. All user settings are organized under four menu sections: Measure, Calibration [**CAL**], Configuration [**CONFIG**], and Diagnostics [**DIAG**].

*Note:* The default Measure Menu is display-only and has no menu icon.

**5.21 Software Navigation**

Within the CAL, CONFIG 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 5-2 for a visual description of the software.



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Each list item allows a change to a stored system variable. List items are designed in one of two forms: simple single variable, or multiple variable sequence. In the single variable format, the user can quickly modify one parameter - for example, changing temperature display units from °F to °C. In the multiple variable sequence, variables are changed as the result of some process. For example, the calibration of ORP generally requires more than one piece of information to be entered. The majority of the menu items in the software consist of the single variable format type.

Any data that may be changed will be flashing. This flashing indicates user entry mode and is initiated by pressing the ENTER key. The UP arrow key will increase a flashing digit from 0 to 9. The LEFT arrow key moves the flashing digit from right to left. Once the change has been completed, pressing ENTER again stores the variable and stops the flashing. Pressing ESC aborts the change and also exits user entry mode.

The starting (default) screen is always the Measure Menu. The UP arrow key is used to select the desired display. From anywhere in this section the user can press the MENU key to select one of the four Menu Sections.

The UP arrow icon next to all list items on the display is a reminder to scroll through the list using the UP arrow key.

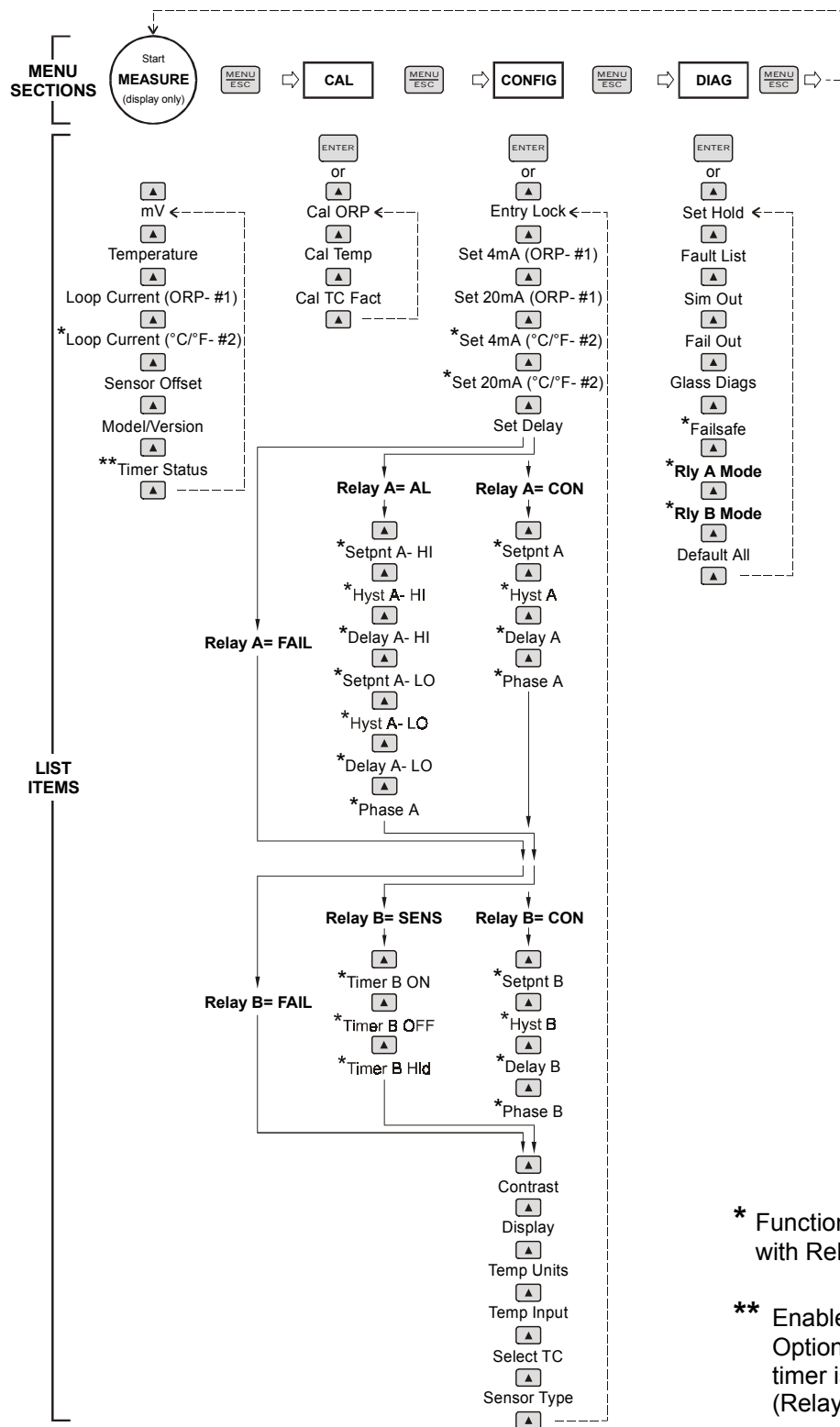


Figure 5-2 Software Map

To select a list item for modification, first select the proper menu with the MENU key. Scroll to the list item with the UP arrow key and then press the ENTER key. This tells the system that the user wishes to perform a change on that item. For single item type screens, once the user presses the ENTER key, part or all of the variable will begin to flash, indicating that the user may modify that variable using the arrow keys. However, if the instrument is locked (see Section 5.24), the instrument will display the message **Locked!** and will not enter user entry mode. The instrument must be unlocked by entering the proper code value to allow authorized changes to user entered values. Once the variable has been reset, pressing the ENTER key again causes the change to be stored and the flashing to stop. The message **Accepted!** will be displayed if the change is within pre-defined variable limits. If the user decides not to modify the value after it has already been partially changed, pressing the ESC key aborts the modification and returns the entry to its original stored

In a menu item which is a multiple variable sequence type, once the ENTER key is pressed there may be several prompts and sequences that are run to complete the modification. The ESC key can always be used to abort the sequence without changing any stored variables.

## 5.22 Default Menu

The default menu for the system is a display-only measurement menu. This menu has no changeable list items and no navigation icon. When left alone, the instrument will automatically return to this menu after approximately 30 minutes. While in the default menu, the UP arrow key allows the user to scroll through the secondary variables on the lower line of the display, including temperature, current output, offset data from the last calibration, model number/software version, and timer status for Relay B (if enabled). Variables displayed on the lower line will not duplicate the main display (i.e., the instrument cannot show mV on both the main and secondary displays).

The timer status screen is only displayed if the probe timer feature is enabled (available with optional Relay Card), by setting Relay B Mode = **SENS** (see Section 5.25). The screen shows the present phase of the timer, as well as how much time is left before the next phase.

*Note:* A timer wash cycle can be manually started by pressing and holding the ENTER key for a few seconds while viewing the timer status screen in the Default Menu. The timer must be in the "OFF" state to allow a manual start ("T" is not flashing on the display). After this forced cycle, the system will return to normal.

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

### 5.23 Calibration Menu [CAL]

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

#### Cal ORP

The ORP calibration menu offers two choices for calibration of ORP: 2-point and 1-point (sample) methods. See Part 6 - Calibration for more details.

#### Cal Temp

The temperature calibration function allows the user to adjust the offset of the temperature response by a small factor of  $\pm 5$  °C. The temperature input is factory calibrated to very high accuracy. However, very long cable lengths and junction boxes may degrade the accuracy of the temperature measurement in some extreme situations. Therefore, this feature is provided only as an adjustment. Modifying the present temperature calibration is not recommended since it can be very difficult to obtain a highly accurate and stable reference solution as a reference. See Part 6 - Calibration for more details.

#### Cal TC Factor

This function is intended to give the user direct control of the temperature calibration offset value without having to perform an entire temp cal procedure. See Part 6 - Calibration for more details.

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**5.24 Configuration Menu**  
**[CONFIG]**

The Configuration Menu contains all of the general user settings:

**Entry Lock**

This function allows the user to lock out unauthorized tampering with instrument settings. All settings may be viewed while the instrument is locked, but they cannot be modified. The Entry Lock feature is a toggle-type setting; that is, entering the correct code will lock the transmitter and entering the correct code again will unlock it. The code is preset at a fixed value. Press ENTER to initiate user entry mode and the first digit will flash. Use arrow keys to modify value. **The ORTX-45 lock/unlock code is 1452.** Press ENTER to toggle lock setting once code is correct. Incorrect codes do not change state of lock condition.

**Set 4 mA**  
**[ORP]**

This function sets the main 4 mA current loop output point for the instrument. When the Relay Option Board is installed, the display will read **Set 4 mA #1**. The value stored for this point may be higher or lower than the value stored for the 20 mA point. The entry value is limited to a value between -1000 and +2000 mV, and the 4 mA and the 20 mA point must be at least 100 mV away from each other. Press ENTER to initiate user entry mode, and the value will flash. Use arrow keys to modify value; range is -1000 to +2000 mV. Press ENTER to store the new value.

**Set 20 mA**  
**[ORP]**

This function sets the 20 mA current loop output point for the instrument. When the Relay Option Board is installed, the display will read **Set 20 mA #1**. The value stored for this point may be higher or lower than the value stored for the 4 mA point. The entry is limited to a value between -1000 and +2000 mV, and the 20 mA point and the 4 mA point must be at least 100 mV away from each other. Press ENTER to initiate user entry mode, and the value will flash. Use arrow keys to modify value; range is -1000 to +2000 mV. Press ENTER to store the new value.

**\*Set 4 mA #2**  
[temp]**ONLY AVAILABLE WITH RELAY OPTION BOARD.**

This function sets the second 4 mA current loop output point for the transmitter. The value stored for this point may be higher or lower than the value stored for the 20 mA point. The entry value is limited to a value between 0 and 110 °C, and the 4 mA and the 20 mA point must be at least 10 °C units away from each other. Press ENTER to initiate user entry mode, and the value will flash. Use arrow keys to modify value; range is 0.0 to 110.0 °C. Press ENTER to store the new value. The optional temperature output is a monitoring type output. It does not include bumpless transfer, simulate, or fail mode features. However, HOLD does affect this output.

**\*Set 20 mA #2**  
[temp]**ONLY AVAILABLE WITH RELAY OPTION BOARD.**

This function sets the second 20 mA current loop output point for the transmitter. The value stored for this point may be higher or lower than the value stored for the 4 mA point. The entry is limited to a value between 0 and 110 °C, and the 20 mA point and the 4 mA point must be at least 10 °C units away from each other. Press ENTER to initiate user entry mode, and the value will flash. Use arrow keys to modify value; range is 0.00 to 110.0 °C. Press ENTER to store the new value. The optional temperature output is a monitoring type output. It does not include bumpless transfer, simulate, or fail mode features. However, HOLD does affect this output.

**Set Delay**

The delay function sets the amount of damping on the instrument. This function allows the user to apply a first order time delay function to the ORP measurements being made. Both the display and the output value are affected by the degree of damping. Functions such as calibration are not affected by this parameter. The calibration routines contain their own filtering and stability monitoring functions to minimize the calibration timing. Press ENTER to initiate user entry mode, and the value will flash. Use the arrow keys to modify value; range is 0.1 to 9.9 minutes. Press ENTER to store the new value.

**\*Setpnt A****ONLY AVAILABLE WITH RELAY OPTION BOARD.**

This function establishes the setpoint, or “trip” point for Relay A. The entry value is limited to a value between –1000 and +2000 mV. Press ENTER to initiate user entry mode, and the value will flash. Use arrow keys to modify value; range is –1000 and +2000 mV. Press ENTER to store the new value.

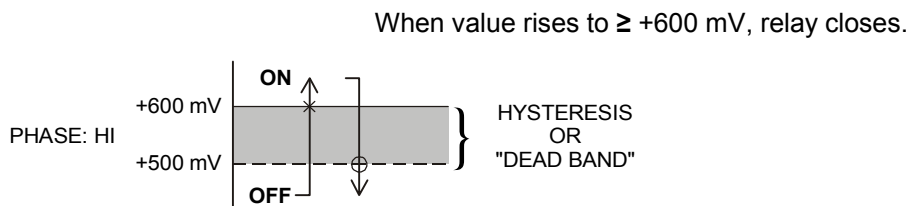
**\*Hyst A****ONLY AVAILABLE WITH RELAY OPTION BOARD.**

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 between the ON/OFF trip points of the relay. Press ENTER to initiate user entry mode, and the value will flash. Use the arrow keys to modify value; range is +5 mV to +2000 mV. Press ENTER to store the new value.

**\*Delay A****ONLY AVAILABLE WITH RELAY OPTION BOARD.**

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

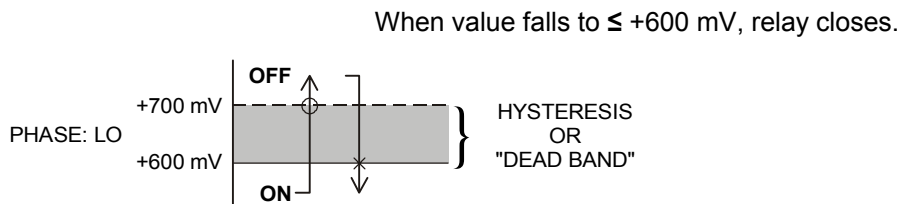
See Figure 5-3 for a visual description of a typical control relay application.



When value falls to  $\leq +500$  mV, relay opens.

#### Settings:

Setpoint: +600 mV  
 Hyst: +100 mV  
 Delay: 000  
 Failsafe: OFF



When value rises to  $\geq +700$  mV, relay opens.

Figure 5-3 Control Relay Example

#### \*Phase A

#### ONLY AVAILABLE WITH RELAY OPTION BOARD.

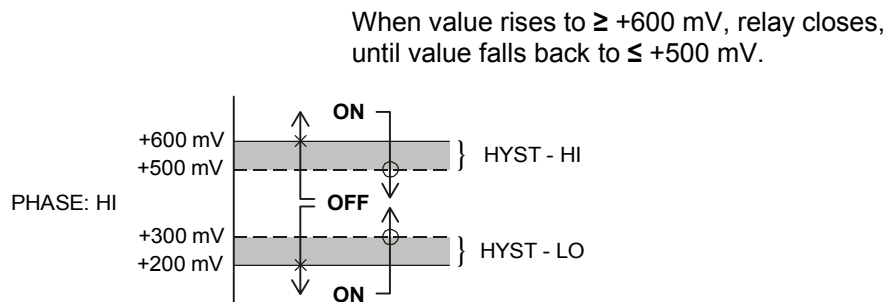
This function establishes the direction of the relay trip. When phase is HI, the relay operates in a direct mode. Therefore, the relay energizes and the LCD indicator illuminates when the mV value **exceeds** the setpoint. When the phase is LO, the relay energizes and the LCD indicator illuminates when the mV drops **below** the setpoint. The failsafe setting does have an impact on this logic. The description here assumes that the failsafe setting is OFF. Press ENTER to initiate user entry mode, and the entire value will flash. Use the UP arrow key to modify the desired value; selections include **HI** for direct operation or **LO** for reverse operation. Press ENTER to store the new value.



**\*Setpnt A-HI****ONLY AVAILABLE WITH RELAY OPTION BOARD.****\*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** (see Section 5.25), then the following settings will appear in the Config Menu list automatically. In this mode, two setpoints can be selected on the same relay, to create an alarm band. Phase HI selection causes the relay to energize outside of the band, and Phase LO causes the relay to energize inside of the band. This feature enables one relay to be used as a control relay while the other is used as a HI-LO Alarm relay at the same time.

See Figure 5-4 for a visual description of a typical alarm relay application.

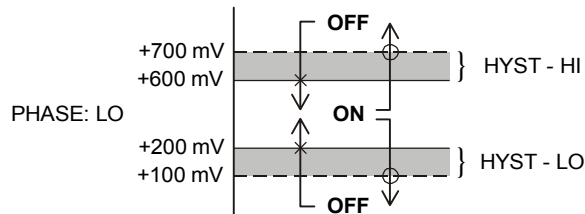
**Settings:**

Setpoint A-HI: +600 mV  
Hyst A-HI: +100 mV  
Delay A-HI: 000

When value falls to  $\leq +200$  mV, relay closes, until value rises back to  $\geq +300$  mV.

Setpoint A-LO: +200 mV  
Hyst A-LO: +100 mV  
Delay A-LO: 000

When value falls to  $\leq +600$  mV, relay closes, until value rises back to  $\geq +700$  mV.



When value rises to  $\geq +200$  mV, relay closes, until value falls back to  $\leq +100$  mV.

Figure 5-4 Alarm Relay Example

---

**\*Setpnt B**                      **ONLY AVAILABLE WITH RELAY OPTION BOARD.**

**\*Hyst B**                        If Relay B Mode is set to **CON** (see Section 5.25), then

**\*Delay B**                      Relay B will function identically to Relay A. Relay B settings

**\*Phase B**                      will appear in the CONFIG menu list automatically.

**\*Timer B ON**                      **ONLY AVAILABLE WITH RELAY OPTION BOARD.**

**\*Timer B OFF**                    If Relay B Mode is set to **SENS** (see Section 5.25), these

**\*Timer B HOLD**                  timer settings will appear in the menu list automatically.

Relay B will toggle ON and OFF based on the time settings entered by the user. The timer ON setting controls the amount of time that Relay B is engaged (N.O. contact closed), and the timer OFF setting controls the amount of time that Relay B is released (N.O. contact open).

The timer HOLD setting allows an output hold time to be entered into the ON/OFF cleaning cycle. This hold time allows the outputs to stabilize back to normal readings before the outputs are changed. Using this feature allows the unit output to appear undisturbed by the cleaning action of the hardware.

Example: If the timer-ON setting is 5 minutes, the timer-OFF setting is 1 hour, and the timer-HOLD setting is 2 minutes, the following sequence will occur: At the instant the timer is enabled, or data for ON/OFF/HOLD is modified, the "OFF" time period begins. Once the 1-hour OFF period ends, the outputs will be put in HOLD and relay B will engage for 5 minutes (ON time). After the 5 minutes have expired, relay B will be released but the hold will stay locked in for an additional 2 minutes (HOLD time), retaining the original output signals. Then, the entire cycle will repeat - the output hold will be released and relay B will stay off for 1 hour, etc.

Since most cleaning cycles will typically occur daily or weekly, it is most likely that the OFF time will be set to a number like 24 hours or perhaps as much as 168 hours (approximately 1 week). If the HOLD timer function is set to 0, the output hold function is released immediately as relay B is released.

*Note:* The sensor wash timer is not based on a “real-time” clock circuit. Therefore, the time accuracy is only within approximately 10 minutes per day.

If the B mode selection is changed from **SENS** to **FAIL** or **CON** while the probe washer is in mid-cycle (and the HOLD is enabled), the HOLD must be turned off manually to return all of the outputs to normal operation. A flashing “T” will be seen on the lower line of the display next to temperature while the probe cleaner function is operating.

The entry value for each timer setting has a maximum value of 10 minutes/999 hours/999 minutes for the ON/OFF/HOLD functions, respectively. Press ENTER to initiate user entry mode, and the entire value will flash. Use arrow keys to modify the desired value. Press ENTER to store the new value.

*Note:* A timer wash cycle can be manually started by pressing and holding the ENTER key for a few seconds while viewing the timer status screen in the Default Menu. The timer must be in the “OFF” state to allow a manual start (“T” is not flashing on the display). After this forced cycle, the system will return to normal.

## Contrast

This function sets the contrast level for the display. The custom display is designed with a wide temperature range, Super-Twist Nematic (STN) fluid to provide the highest possible contrast ratio and widest viewing angle under all conditions. Contrast control of this type of display is generally not necessary, so contrast control is provided as a means for possible adjustment due to aging at extreme ranges. In addition, the display has an automatic temperature compensation network. Press ENTER to initiate user entry mode, and the value will flash. The contrast value is not updated until the new value is entered. Use arrow keys to modify the value; range is 0 to 9 (0 being lightest). Press ENTER to store the new value.

---

<b>Display</b>	This function allows the user to change the measurement in the primary display area. The user may select between sensor millivolts, sensor temperature, or output current. Using this function, the user may choose to put temperature in the main display area and mV on the secondary, lower line of the display. Press ENTER to initiate user entry mode, and the entire value will flash. Use the UP arrow key to modify the desired display value. Press ENTER to store the new value.
<b>Temp Units</b>	This function sets the display units for temperature. Press ENTER to initiate user entry, and the entire value will flash. Use the UP arrow key to modify the display value. The choices are °F and °C. Press ENTER to store the new value.
<b>Temp Input</b>	This function allows the user to manually lock the temperature at a fixed value of 25 °C. Once locked at 25 °C, a small <b>m</b> appears next to the temperature value on the lower line of the display to indicate to the user that the system is in manual lock mode. All temperature compensation is defeated when in manual lock mode. Press ENTER to initiate user entry, and the entire value will flash. Use the UP arrow key to modify the value; selections are <b>SENS</b> for sensor input or <b>F25</b> for fixed at 25 °C. Press ENTER to store the new value.
<b>Select TC</b>	This function allows the user to select either a Pt1000 or Pt100 platinum RTD temperature element. The Pt1000 element is the standard element in all high performance Omega **E-45P sensors; it is the recommended temperature sensing element for all measurements. The Pt100 selection is provided as an alternative for use with existing combination-style sensors. Press ENTER to initiate user entry mode, and the entire value will flash. Use the UP arrow key to modify the desired value. Press ENTER to store the new value.
<b>Sensor Type</b>	This function sets the sensor input type. This selection is critical for control of the internal diagnostics and compensation factors. Press ENTER to initiate user entry mode, and the entire value will flash. Use the UP arrow key to modify the desired value. Selections are <b>1</b> for Quantum sensor, and <b>2</b> for combination electrode. Press ENTER to store the new value.

---

**5.25 Diagnostics  
Menu [DIAG]**

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

**Set Hold**

The Set Hold function locks the current loop output values on the present process value. This function can be used prior to calibration, or when removing the sensor from the process, to hold the output in a known state. Once HOLD is released, the outputs return to their normal state of following the process input. The transfer out of HOLD is bumpless on the main output #1 (ORP) - that is, the transfer occurs in a smooth manner rather than as an abrupt change. An icon on the display indicates the HOLD state, and the HOLD state is retained even if power is cycled. Press ENTER to initiate user entry mode, and entire value will flash. Use the UP arrow key to modify the desired value, selections are **ON** for engaging the HOLD function, and **OFF** to disengage the function. Press ENTER to store the new value.

**Note:** When the Relay Option Board is installed, the Set Hold function holds BOTH current levels, as well as ALL relay settings. When the Set Hold function is released, the transfer is bumpless only on the ORP output (current loop #1).

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

**Fault List**

The Fault List screen is a read-only screen that allows the user to display the cause of the highest priority failure. The screen indicates the number of faults present in the system and a message detailing the highest priority fault present. Note that some faults can result in multiple displayed failures due to the high number of internal tests occurring. As faults are corrected, they are immediately cleared.

Faults are not stored; therefore, they are immediately removed if power is cycled. If the problem causing the faults still exists, however, faults will be displayed again after power is re-applied and a period of time elapses during which the diagnostic system re-detects them. The exception to this rule is the calibration failure. When a calibration fails, no corrupt data is stored. Therefore, the system continues to function normally on the data that was present before the calibration was attempted. If power to the instrument is cycled, the failure for calibration will be cleared until calibration is attempted again. If the problem still exists, the calibration failure will re-occur. Press ENTER to initiate view of the highest priority failure. The display will automatically return to normal after a few seconds.

**Sim Out (ORP)**

The Sim Out function allows the user to simulate the main current loop output [ORP] of the instrument once it has been configured. The user enters a loop current value directly onto the screen, from 4.00 mA to 20.00 mA, and the output responds as if it were actually receiving the signal from the sensor. This allows the user to check the function of attached monitoring equipment during set-up or troubleshooting. Escaping this screen returns the unit to normal operation. Press ENTER to initiate the user entry mode, and the right-most digit of the value will flash. Use arrow keys to modify desired value. The starting display value will be the last read value of the input. The output will be under control of the SIM screen until the ESC key is pressed.

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

**Fail Out**

This function sets the condition of the main current loop output [ORP] under a FAIL condition. The output may be forced to 4 mA, 20 mA, or the feature may be disabled. As an example of the use of this feature, the user may set up a usable mV output range from -1000 to +2000 mV across an output span of 5 mA to 19 mA. With the Fail Out setting of 4 mA, any alarm condition will cause the current loop output to drop outside the normal operating range, indicating a system failure that requires attention. In this way, a failure can be distinguished from normal operating levels. Press ENTER to initiate user entry mode, and the entire value will flash. Use the UP arrow key to modify desired value; selections are **4mA**, **20mA**, or **OFF**. Press ENTER to store the new value.

**Glass Diags**

This function allows the user to shut off the glass breakage/leak diagnostics. It does not affect the state of the remaining system diagnostics. This capability is provided to eliminate nuisance trips in electrically noisy applications, such as some plating operations. If ON, Relay B is automatically configured as a fail alarm relay. The relay trips on any fail condition. Therefore, the normal settings for control Relay B will disappear from the CONFIG menu since they cannot be used.

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

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

**\*Failsafe****ONLY AVAILABLE WITH RELAY OPTION BOARD.**

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

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

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

**\*Rly A Mode****ONLY AVAILABLE WITH RELAY OPTION BOARD.**

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** for control mode, **FAIL** for fail alarm mode, and **AL** for HI-LO alarm.

The **CON** setting enables normal control operation for Relay A, with settings for setpoint, hysteresis, phasing, and delay appearing in the CONFIG menu automatically.

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



The **AL** setting allows two setpoints to be selected for the same relay, producing a HI-LO alarm band. In this mode, Relay A will trip inside or outside of the band, depending upon the Phase selected. See Figure 5-4 for further details.

### \*Rly B Mode

#### ONLY AVAILABLE WITH RELAY OPTION BOARD.

Relay B can be used in a number of ways: as a setpoint control, as a fail alarm, or as a timer. Relay B can be used with accessory probe washers or other attached equipment that requires a periodic contact enclosure. The three settings for Relay B Mode are **CON** for control mode, **FAIL** for fail alarm mode, and **SENS** for timer.

The **CON** setting enables normal control operation for Relay B. Relay B then operates identically to Relay A, with settings for setpoint, hysteresis, phasing, and delay appearing in the CONFIG menu automatically. Using this mode allows the User to utilize two individual control relays for process control, high/low alarm applications, etc.

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

The **SENS** setting enables the sensor timer mode for Relay B. Relay B then operates on a cyclic ON/OFF timer, with individual settings for ON-time and OFF-time as well as Timer HOLD appearing in the CONFIG menu automatically. Using this mode allows the User to implement a periodic, automated cleaning system for the sensor.

### Default All

The Default All function allows the user to return the instrument back to factory default data for all user settings. It is intended to be used as a last resort troubleshooting procedure. All user settings are returned to the original factory values. Hidden factory calibration data remains unchanged. Press ENTER to initiate user entry mode and the value **NO** will flash. Use the UP arrow key to modify value to **YES** and press ENTER to reload defaults.

## Part 6 - Calibration

### 6.1 Overview and Methods

The instrument must be calibrated periodically to maintain a high degree of measurement accuracy. Frequency of calibration must be determined by the application. High temperature applications or applications involving other extreme operating conditions may require more frequent calibration than those that operate at more ambient level temperatures. It is important for the user to establish a periodic cleaning and calibration schedule for sensor maintenance to maintain high system accuracy.

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

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

4 pH			7 pH		
20 °C	25 °C	30 °C	20 °C	25 °C	30 °C
+268 mV	+263 mV	+258 mV	+92 mV	+86 mV	+79 mV

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

**6.11 Sensor Slope**

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

**6.12 Sensor Offset**

Sensor offset is a number that indicates sensor output (expressed in mV) in a theoretical 0 mV solution at 25 °C. Ideally, the sensor will output 0 mV under these conditions. A sensor offset reading of +10 mV indicates that the sensor will output +10 mV when placed into a theoretically perfect 0 mV solution at 25 °C. In other words, sensor offset shifts the entire response curve up or down. Changes in sensor offset are generally produced by a small voltage drop at the sensor reference junction. Large offsets are most typically the result of foulants on the reference junction, an aged reference junction, or a weak reference fill solution. The instrument does not allow calibrations on a sensor with an offset greater than approximately +200 mV or less than -200 mV. Since sensor offset is considered an absolute value from the ideal 0 mV value, readings outside the range of -200 to +200 mV are considered "high offset" errors during calibration. Sensor offset information from the most recent calibration can be viewed at any time in the Default Menu (see Section 5.22).

---

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

**6.13 2-Point Calibration Explained**

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

**6.14 1-Point Calibration Explained**

The 1-point calibration method is generally known as the "grab sample" calibration method. In the 1-point calibration method, the sensor may be removed from the application and placed into one mV solution. It may also be left in the measurement process and calibrated by reference. 1-point calibration adjusts only the sensor offset. It is the recommended method for frequent ORP calibrations.

## 6.2 Performing a 2-Point Calibration

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

### Procedure

1. Remove sensor from application. Rinse and clean if necessary.
2. Allow sensor to temperature equilibrate with the solution as best as possible. With the sensor coming from an application solution that differs greatly in temperature from the calibration solution, the user may have to wait as much as 20 minutes for this to occur.
3. Scroll to the CAL menu section using the MENU key and press ENTER or the UP arrow key. **Cal ORP** will then be displayed.
4. Press the ENTER key. The screen will display a flashing **1** for 1-point or a **2** for 2-point calibration. Using the UP arrow key, set for a 2-point calibration and press ENTER.



5. The display will prompt the user to place the sensor in the first mV solution and press ENTER. If the sensor has been placed into this solution already, once the temperature has stabilized, press ENTER to continue.
6. The present mV value will be displayed and the secondary line of the display will flash **Wait** for approximately 10-15 seconds.

7. The screen will display the measured mV value. If the user chooses to change this value, the arrow keys can be used to modify the value. Any value between –1000 mV and +2000 mV can be entered. After adjusting this value, or to accept the automatic value, press ENTER.
8. The system now begins acquiring data for the calibration value of this reference point. As data is gathered, the units for mV and temperature may begin to flash. Flashing units indicate that this parameter is unstable. The data point acquisition will stop only when the data remains stable for a pre-determined amount of time. This can be overridden by pressing ENTER. If the data remains unstable for 10 minutes, the calibration will fail and the message **Cal Unstable** will be displayed.
9. Once the first calibration value has been established, the screen will prompt the user to move the sensor to the second mV solution. Rinse sensor with water and move the sensor into the second solution. Allow temperature to stabilize, then press ENTER.
10. The present mV value will be displayed and the secondary line of the display will flash **Wait** for approximately 10-15 seconds.
11. The screen will display the presently measured mV value to be used for calibration. If the user chooses to change this value, the arrow keys can be used to modify the value. Any value between –1000 mV and +2000 mV can be entered. The second mV solution must be at least 100 mV away from the first. After adjusting this value, press ENTER.
12. The system now begins acquiring data for the calibration value of this reference point. As data is gathered, the units for mV and/or temperature may again flash, indicating unstable parameters.
13. If accepted, the screen will display the message **PASS** with the new slope and offset readings, then it will return to the main measurement display. If the calibration fails, a message indicating the cause of the failure will be displayed and the FAIL icon will be turned on.

### 6.3 Performing a 1-Point Calibration

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

#### Procedure

1. Determine whether the calibration will be done on-line or with the sensor removed and placed into a mV solution. If the sensor is removed from the application, rinse and clean if necessary.
2. If the sensor has been removed and placed into a mV solution, allow sensor to temperature equilibrate with the solution as much as possible. With the sensor coming from an application which differs greatly in temperature, the user may have to wait as much as 20 minutes. If the sensor is on-line, the user may want to set the output HOLD feature prior to calibration to lock out any output fluctuations.
3. Scroll to the CAL menu section using the MENU key and press ENTER or the UP arrow key. **Cal ORP** will then be displayed.
4. Press the ENTER key. The screen will display a flashing 1 for 1-point or a 2 for 2-point calibration. Using the UP arrow key, set for a 1-point calibration and press ENTER.



5. The system now begins acquiring data for the calibration value. As data is gathered, the units for mV and temperature may flash. Flashing units indicate that this parameter is unstable. The calibration data point acquisition will stop only when the data remains stable for a pre-determined amount of time. This can be overridden by pressing ENTER. If the data remains unstable for 10 minutes, the calibration will fail and the message **Cal Unstable** will be displayed.
6. The screen will display the last measured mV value and a message will be displayed prompting the user for the lab value. The user must then modify the screen value with the arrow keys and press ENTER. The system then performs the proper checks.
7. If accepted, the screen will display the message **PASS** with the new offset reading, then it will return to the main measurement display. If the calibration fails, a message indicating the cause of the failure will be displayed and the FAIL icon will be turned on.



## 6.4 Temperature Calibration

The temperature input is factory calibrated for the highest accuracy. Temperature calibration is not recommended; however, it is provided for applications in which very long cable lengths are needed. See Section 4.5 for details on long sensor cable lengths.

The temperature calibration sequence is essentially a 1-point offset calibration that allows adjustments of approximately  $\pm 5^{\circ}\text{C}$ .

The sensor temperature may be calibrated on line, or the sensor can be removed from the process and placed into a known solution temperature reference. In any case, it is critical that the sensor be allowed to reach temperature equilibrium with the solution in order to provide the highest accuracy. When moving the sensor between widely different temperature conditions, it may be necessary to allow the sensor to stabilize as much as one hour before the calibration sequence is initiated. If the sensor is on-line, the user may want to set the output HOLD (see Page 54) feature prior to calibration to lock out any output fluctuations.

### Procedure

1. Scroll to the CAL menu section using the MENU key and press ENTER or the UP arrow key.
2. Press the UP arrow key until **Cal Temp** is displayed.
3. Press the ENTER key. The message **Place sensor in ref then press ENTER** will be displayed. Move the sensor into the calibration reference (if it hasn't been moved already) and wait for temperature equilibrium to be achieved. Press ENTER to begin the calibration sequence.
4. The message **Adjust temp value then press ENTER** will be displayed, and the right-most digit will begin to flash, indicating that the value can be modified. Using the UP and LEFT arrow keys, modify the value to the known ref solution temperature. Adjustments up to  $\pm 5^{\circ}\text{C}$  from the factory calibrated temperature are allowed. Press ENTER.

5. The calibration data gathering process will begin. The message **Wait** will flash as data is accumulated and analyzed. The °C or °F symbol may flash periodically if the reading is too unstable.
6. Once completed, the display will indicate **PASS** or **FAIL**. If the unit fails, the temperature adjustment may be out of range, the sensor may not have achieved complete temperature equilibrium, or there may be a problem with the temperature element. In the event of calibration failure, it is recommended to attempt the calibration again immediately.

## 6.5 TC Factor Calibration

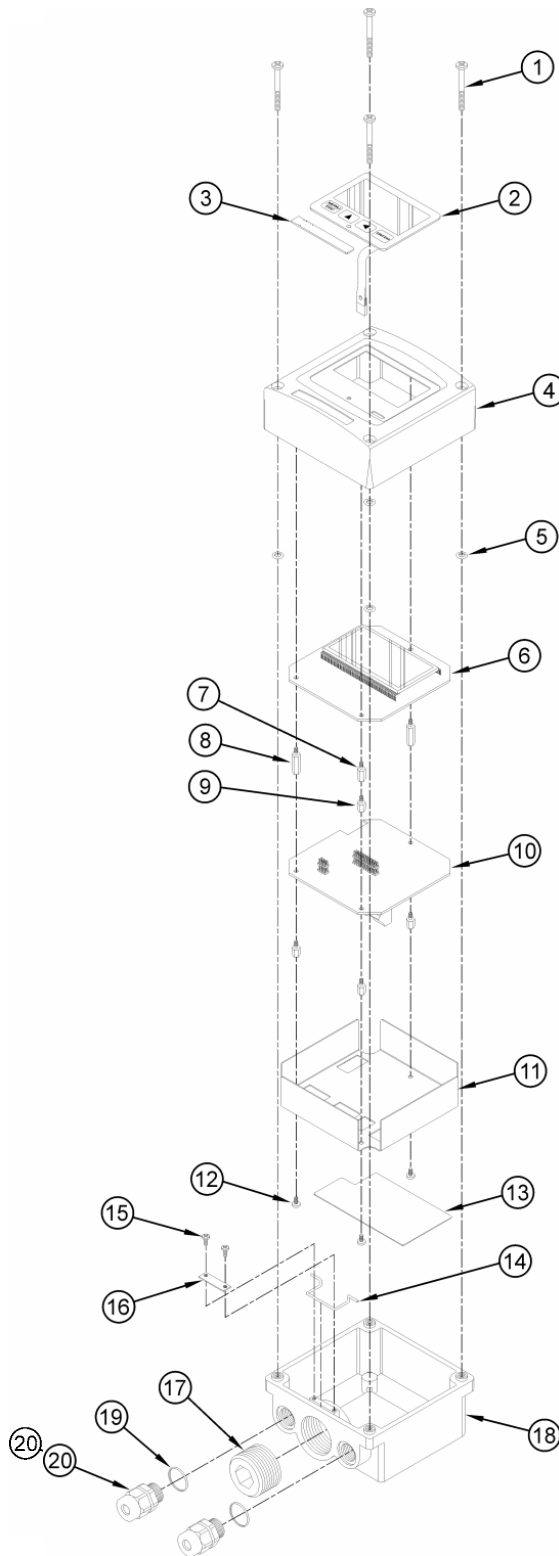
This function is intended to give the user direct control of the temperature calibration offset value without having to proceed through the temperature calibration procedure. Sensor TC offset is a number that indicates the sensor RTD output at 0 °C. Ideally, the sensor temperature output will be 0 °C (1000 Ohms) under these conditions. Sensor offset is primarily the result of sensor RTD tolerance and connecting cable resistance. Large offsets are typically the result of large sensor cable lengths. A sensor offset reading of +1 °C indicates that the sensor will output an uncalibrated reading of +1 °C when placed in a perfect 0 °C temperature bath. In other words, the offset shifts the entire sensor response curve up or down. Since the slope of an RTD is fixed and highly repeatable, the slope is not adjusted in this calibration.

Omega \*\*E45P sensors are labeled with a specific TC factor. Entering this factor directly allows the user to quickly calibrate the transmitter for the sensor being used without performing a time consuming full temperature calibration. However, if the sensor cable length is modified or a new sensor is used, a new TC factor must be entered or the user must perform a full temperature calibration. The default value for the TC factor is 7.50. Increasing this value increases the temperature reading and decreasing the value decreases the temperature reading. A change of approximately +0.1 is equivalent to +0.1 °C. This function is directly related to the full temperature calibration function in that a new offset number is produced if a full temperature calibration has already been performed. If the TC factor is modified, it overrides any previous full temperature calibration data.

**Procedure**

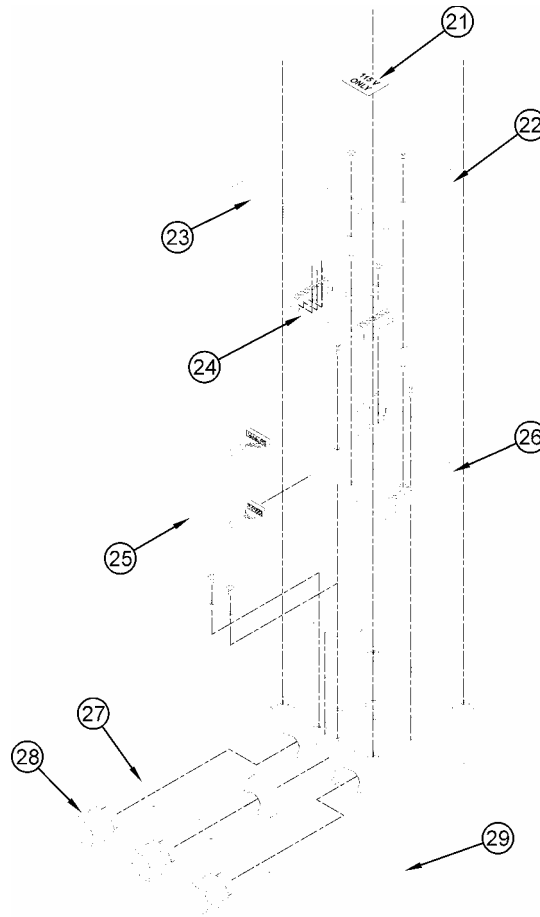
Press ENTER to initiate user entry mode and the first digit will flash. Use arrow keys to modify value; range is 00.00 to 15.00. Press ENTER to save the new value.

## Part 7 - Service and Maintenance



<u>No.</u>	<u>Description</u>	<u>Qty.</u>
1.	Case Screw	4
2.	Display	1
3.	Label	1
4.	Case Front	1
5.	Retaining Washer	4
6.	Micro Board	1
7.	Board Spacer, Med.	1
8.	Board Spacer, Long	2
9.	Board Spacer, Short	4
10.	Scaling Board	1
11.	Shield	1
12.	Shield Screw	3
13.	Wiring Label	1
14.	Hinge Pin	1
15.	Hinge Screw	2
16.	Hinge Retainer	1
17.	Plug, 1" NPT	1
18.	Case Back	1
19.	O-Ring, -015	2
20.	Cordgrip, PG-9	2

Figure 5-1 ORTX-45 Assembly Diagram (loop-powered configuration)



<u>No.</u>	<u>Description</u>	<u>Qty.</u>
21.	Voltage Label	1
22.	Power Supply Cover	1
23.	Power Supply Wire	3
24.	Relay Option Card	1
25.	Connector Cable	1
26.	Power Supply Card	1
27.	O-Ring, -017	3
28.	Cordgrip, PG-11	3
29.	Serial Number Label	1

Figure 7-2 ORTX-45 Assembly Diagram (rear enclosure, optional configurations)

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**7.1 System Checks**

1. If the FAIL icon is flashing on the display, check the Fault List to determine the cause of the failure. To access the Fault List, press the MENU/ESC key until the DIAG menu appears. Then press the UP arrow key until the Fault List appears. Press the ENTER key to access the Fault List, and the highest priority fault message will be displayed. For a list of all messages and possible causes/solutions, refer to Section 7.3.
2. In **ALL** environments, connect an earth ground jumper to earth terminal connection on transmitter.
3. Perform a two-point calibration with two fresh buffers prior to sensor installation.
4. Check sensor cable color to terminal strip markings.
5. For highly unstable behavior, remove sensor from the process and measure the process solution in a plastic beaker. If the reading now stabilizes, place wire in beaker solution and actual process solution to determine if a ground loop exists.
6. Verify that the black rubber shipping boot has been removed from the end of the sensor prior to submersion. If the sensor has been left to dry out, allow sensor to be submerged in buffer or water to re-hydrate for at least 4 hours. The saltbridge may need replacement if the sensor has dried out for too long.
7. If the instrument 4-20 mA output is connected into other control systems, disconnect output loop from system load and run through a handheld DMM to monitor current. Verify that the system operates correctly in this mode first.

---

**7.2 Instrument Checks**

1. Remove sensor completely and connect 1100 Ohms from the yellow to black sensor input leads. Make sure the unit is configured for a Pt1000 thermal element and that the temperature is not in manual locked mode. Also, connect a wire jumper from the red cable lead input to the green cable lead input. The temperature reading should be approximately 25 °C, and the ORP reading should be between -100 mV and +100 mV.
2. With a DMM, measure the DC voltage from the white sensor lead connection to the black sensor lead connection. With the positive DMM lead on the white wire, the meter should read between -4.5 and -5.5 VDC.
3. For the line powered version, verify the proper line voltage power. With power disconnected, verify continuity across the line fuse.
4. For the DC transmitter variation, verify that power supply has required voltage based on size of resistance in current loop. Large resistive loads can reduce available power for transmitter.

See sensor manual for specific sensor tests to be performed.

### 5.3 Display Messages

The \*\*TX-45 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 (see Section 5.25).

The following messages will appear as prompts:

MESSAGE	DESCRIPTION	POSSIBLE CORRECTION
<b>Max is 200</b>	Entry failed, maximum value allowed is 200.	Reduce value to $\leq 200$
<b>Min is 200</b>	Entry failed, minimum value allowed is 200.	Increase value to $\geq 200$
<b>Cal Unstable</b>	Calibration problem, temperature and/or input data too unstable to calibrate.	Clean sensor, get fresh cal solutions, allow temperature and ORP readings to fully stabilize, do not handle sensor or cable during calibration.
<b>Slope HIGH</b>	Sensor slope from calibration is greater than 140%.	Get fresh cal solutions, allow temperature and ORP readings to fully stabilize, check for correct buffer values.
<b>Slope LOW</b>	Sensor slope from calibration is less than 60%.	Clean sensor, get fresh cal solutions, allow temperature and ORP readings to fully stabilize, check for correct buffer values.
<b>Offset HIGH</b>	Sensor offset from calibration is less than $-200$ mV or greater than $+200$ mV	Clean or replace saltbridge, replace reference cell solution, clean sensor, get fresh cal solutions, allow temperature and ORP readings to fully stabilize, check for correct buffer values.
<b>Out of Range</b>	Input value is outside selected range of the specific list item being configured.	Check manual for limits of the function to be configured.
<b>Locked!</b>	Transmitter security setting is locked.	Enter security code to allow modifications to settings. See last page of manual.
<b>Unlocked!</b>	Transmitter security has just been unlocked.	Displayed just after security code has been entered.
<b>TC-F25 lock!</b>	The TC selection is in F25 mode, locked at $25^{\circ}\text{C}$	Calibration and TC adjustment cannot be performed while the TC is in F25 mode. To allow access to TC calibrations, change TC mode from F25 (fixed 25) to SENS (sensor).



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

MESSAGE	DESCRIPTION	POSSIBLE CORRECTION
<b>Sensor High</b>	The raw signal from the sensor is too high.	Check wiring connections to sensor.
<b>Sensor Low</b>	The raw signal from the sensor is too low.	Check wiring connections to sensor.
<b>ORP too High</b>	The mV reading is > +2000 mV.	The ORP reading is over operating limits.
<b>ORP too Low</b>	The mV reading is < -1000 mV.	The ORP reading is under operating limits.
<b>Temp High</b>	The temperature reading is > 110 °C.	The temperature reading is over operating limits. Check wiring and expected temp level. Perform RTD test as described in sensor manual. Recalibrate sensor temperature element if necessary.
<b>Temp Low</b>	The temperature reading is < -10 °C	The temperature reading is under operating limits. Check wiring and expected temp level. Perform RTD test as described in sensor manual. Recalibrate sensor temperature element if necessary.
<b>TC Error</b>	TC may be open or shorted.	Check sensor wiring and perform RTD test as described in sensor manual.
<b>Meas Break</b>	Leakage detected on measuring electrode of sensor.	Measuring electrode may be cracked or broken. Electrical noise may falsely trip this diagnostic. Turn off glass diagnostic feature and see if sensor operates correctly. If it does not, sensor must be replaced.
<b>Ref Break</b>	Leakage detected on reference electrode of sensor.	Reference glass electrode may be cracked or broken. Electrical noise may falsely trip this diagnostic. Turn off glass diagnostic feature and see if sensor operates correctly. If it does not, sensor must be replaced.

Fault List display messages (continued):

MESSAGE	DESCRIPTION	POSSIBLE CORRECTION
<b>ORP Cal Fail</b>	Failure of ORP calibration.	Clean sensor, get fresh cal solutions, regenerate sensor (if necessary) and redo calibration. If still failure, sensor slope may be less than 65% or offset may be out of range. Perform sensor tests as described in sensor manual. Replace sensor if still failure.
<b>TC Cal Fail</b>	Failure of temperature calibration.	Clean sensor, check cal solution temperature and repeat sensor temp calibration. TC calibration function only allows adjustments of +/- 6 °C. If still failure, perform sensor tests as described in sensor manual. Replace sensor if still failure. Note that TC offset may also be adjusted using the Cal TC Factor function (See Section 6.5) which involves no calibration reference solutions.
<b>Eeprom Fail</b>	Internal nonvolatile memory failure	System failure, consult factory.
<b>Checksum Fail</b>	Internal software storage error.	System failure, consult factory.
<b>Display Fail</b>	Internal display driver fail.	System failure, consult factory.
<b>mV Cal Fail</b>	Failure of factory temperature calibration.	Consult factory.