Instruction

MI 611-191
June 2004

873APH Ace Series Electrochemical Analyzers for pH Measurements

Style A

Invensys®
FOXBORO®

Contents

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1. Introduction

Quick Start

The purpose of this section is to give you the basic steps to quickly begin using your 873APH Electrochemical Analyzer.

- Step 1 - Wiring
- Step 2 - Verify Analyzer Identification
- Step 3 - Verify Valid Measurements

Step 1 - Wiring

⚠ CAUTION

Wiring installation must comply with any existing local regulations.

The 873A Analyzer is supplied in two types – plastic enclosure or metal enclosure. Follow the wiring instructions for the type of enclosure that you have. More wiring information can be found in the sections on "Wiring of Plastic Enclosure (General Purpose Version)" on page 18 and "Wiring of Metal Enclosure (Field-Mounted Version)" on page 20.

Wiring of Plastic Enclosure (General Purpose Version)

1. Remove optional rear cover assembly BS805QK, if present.
2. Connect ALM 1 and ALM 2 alarm wires to TB3 as shown in Figure 1. Failsafe operation requires connections to be made between contacts NC and C. For details see "Wiring of Alarms" on page 22.
3. Connect wires from external circuit to analog output terminals TB3 (M+) and TB3 (M–). Refer to Figure 1.
4. Remove factory-installed jumper assembly from terminal block TB2 and discard.
5. Connect sensor wires to analyzer terminal block TB2 as shown in Figure 1.
6. Connect power wires to terminal block TB1 as shown in Figure 1.
7. Attach optional rear panel cover, if present.

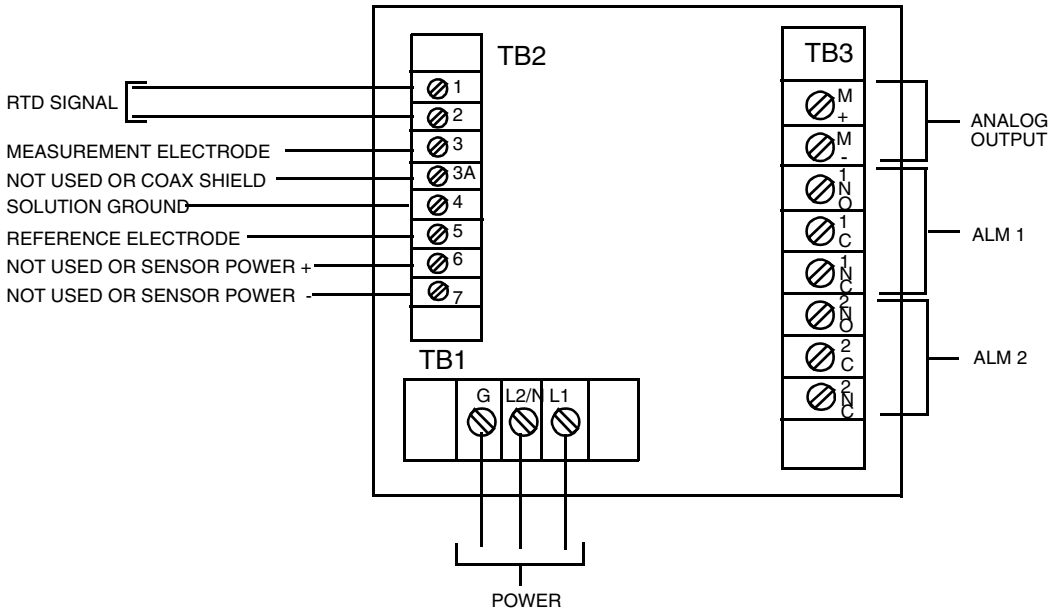


Figure 1. Plastic Enclosure Rear Panel Wiring for Power, Output, and Alarms

Wiring of Metal Enclosure (Field-Mounted Version)

NOTE

1. To maintain enclosure tightness such as NEMA 4X, CSA Enclosure 4X, or IEC Degree of Protection IP-65, wiring methods and fittings appropriate to the rating must be used. Table 2 lists the recommended parts.
2. Alarm wires should run through the same conduit as the analog output wires. Sensor wires and power wires should be run through separate conduits.

1. Remove back cover.

2. Connect ALM 1 and ALM 2 Alarm wires to TB3 as shown in Figure 2. Failsafe operation requires connections to be made between contacts NC and C. For details see "Wiring of Alarms" on page 22.

3. Connect wires from external circuit for analog output to terminal block TB4.

4. Connect sensor wires to analyzer terminal block TB2 as shown in Figure 2.

5. Connect power wires to terminal block TB1, as shown in Figure 2. The earth (ground) connection from the power cord should be connected to the ground stud located in the bottom of the case. This connection is mandatory for safe operation.

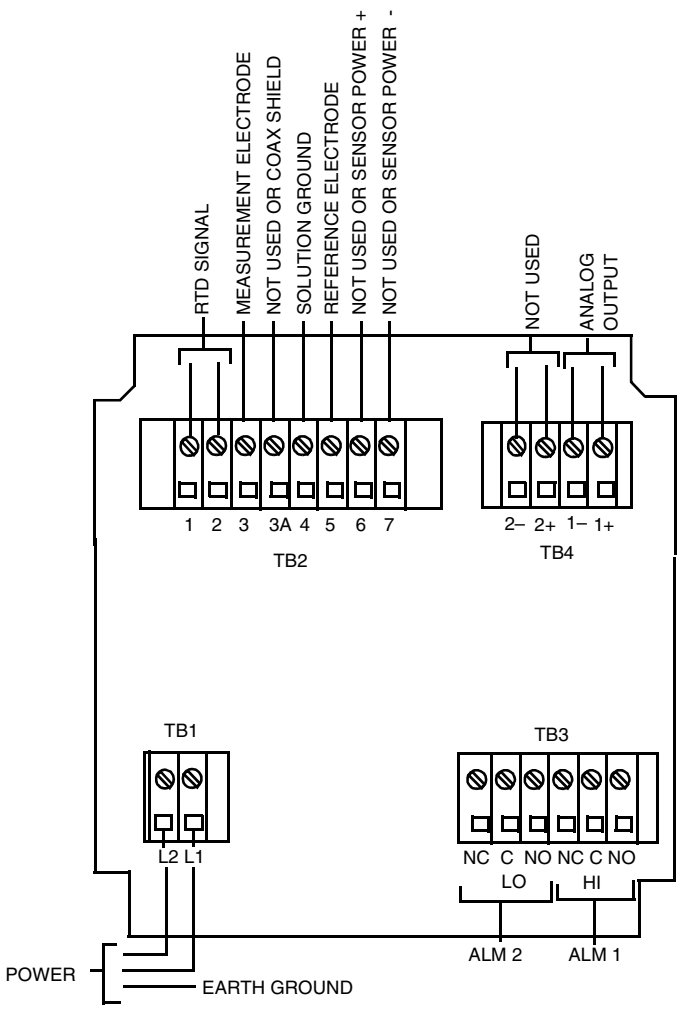


Figure 2. Metal Enclosure Rear Panel Wiring for Power, Output, and Alarms

Step 2 - Verify Analyzer Identification

Verify the information shown on the data label on the side of the instrument. Note especially the range shown beside "**CALIB**." This range should encompass your desired measurement range.

To reconfigure your instrument, refer to Table 4, "User Configuration Setup Entries," on page 29.

Step 3 - Verify Valid Measurements

Your analyzer was calibrated at the factory. Therefore, you should not have to calibrate it. However, it is good practice to adjust your analyzer to your sensor. See "Calibration" on page 33 for more details.

Follow these steps to calibrate:

1. Remove the pH sensor from the process stream. Clean the immersion end and rinse with distilled water.

2. Select buffers near or bracketing process pH. The buffers should be at the same temperature and, for best results, near the process temperature.
3. Immerse the cleaned sensor in the solution with lower known value. Wait until the measurement stabilizes.
4. Press **Shift** and while holding this key, press **Cal Lo**. Remove fingers from both keys. Use **Next** and Δ keys until the display reads the value of the solution. Press **Enter**.
5. Thoroughly rinse the sensor in distilled water and immerse it in the second solution with higher known value. Wait until the measurement stabilizes.
6. Press **Shift** and while holding this key, press **Cal Hi**. Remove fingers from both keys. Use **Next** and Δ until the display reads the value of the second solution. Press **Enter**.
7. Press **Temp** key and note temperature reading. If temperature needs adjustment, refer to "Temperature Correction Procedure" on page 35.

Looking for More Information?

For more detailed information, refer to the following sections of this manual:

For installation information, refer to "Installation" on page 11. For dimensional information, refer to DP 611-163.

For detailed explanation of the controls and indicators, refer to "Operation" on page 23.

For detailed configuration instructions, refer to "Configuration" on page 29.

For detailed calibration instructions, refer to "Calibration" on page 33.

If you need additional help, please call the Electrochemical Service Center at 1-508-549-4730 in the U.S.A. or call your local Invensys Foxboro representative.

General Description

The 873APH Electrochemical Analyzer measures, displays, and transmits the pH of aqueous solutions. Its measurement display may be read in either mV or pH. Solution temperature is also continuously measured and is used for automatic temperature compensation. It may be displayed at any time. The analyzer provides an isolated output signal proportional to the measurement for transmission to an external receiver.

Instrument Features

Described below are some of the features of the 873APH Electrochemical Analyzer:

- Plastic or Metal Enclosure
- Dual Alarms
- Analog Output
- EEPROM Memory
- Hazardous Area Class on Metal Enclosure
- Front Panel Display
- Front Panel Keypad
- Application Flexibility
- Storm Door Option

Enclosures

The plastic enclosure is intended for panel mounting in general purpose locations, and mounts in 1/4 DIN size panel cutout. It meets the enclosure ratings of NEMA 1 and CSA Enclosure 1.

The metal enclosure is intended for field locations and may be either panel, pipe, or surface mounted. It is constructed of cast aluminum coated with a tough epoxy-based paint. The enclosure is watertight, dusttight, and corrosion-resistant, meeting the enclosure rating of NEMA 4X, CSA Enclosure 4X, and IEC Degree of Protection IP-65. The unit fits in a 92 x 92 mm (3.6 x 3.6 in) panel cutout (1/4 DIN size). The metal enclosure provides protection against radio frequency interference (RFI) and electromagnetic interference (EMI).

Dual Alarms

Dual independent, Form C dry alarm contacts, rated 5 A noninductive 125 V ac/30 V dc, are provided. The alarm status is alternately displayed with the measurement on the LED (light-emitting diode) display.

⚠ CAUTION

When the contacts are used at signal levels of less than 20 W, contact function may become unreliable over time due to the formation of an oxide layer on the contacts. See “Alarm Contact Maintenance” on page 41.

No Battery Backup Required

Nonvolatile EEPROM memory is employed to protect all operating parameters and calibration data in the event of power interruptions.

Hazardous Area Classification

The metal field-mounted versions are designed to meet the Factory Mutual and the Canadian Standards Association requirements for Class I, Division 2 hazardous locations. For details see Table 1.

Front Panel Display

The instrument's display consists of a four-digit bank of red LEDs with decimal point, and an illuminated legend area to the right of the LEDs (see Figure 3). The 14.2 mm (0.56 in) display height provides visibility at a distance up to 6 m (20 ft) through a smoke-tinted, nonreflective, protective window on the front panel.

The measurement value is the normally displayed data. If other data is displayed due to prior keypad operations, the display automatically defaults to the measurement value about four minutes after the last keypad depression.

If no fault or alarm conditions are detected in the instrument, the measurement value is steadily displayed. If fault or alarm conditions are detected, the display alternates displaying the measurement value and a fault or alarm message at a 1 second rate.

Front Panel Keypad

The front panel keypad consists of eight keys. Certain keys are for fixed functions and other keys are for split functions. The upper function (green legends) of a split function key is actuated by pressing the **Shift** key in conjunction with the split function key. Refer to Figure 3.

Application Flexibility

The 873A Analyzer offers application flexibility through its standard firmware package. The software, run on the internal microprocessor, allows you to define and set operating parameters particular to his application. These parameters fall into two general categories: Alarm Configuration and Output Characterization. These parameters are retained in the EEPROM nonvolatile memory. Following power interruptions, all operating parameters are maintained.

Storm Door Option

This door is attached to the top front surface of the enclosure. It is used to prevent accidental or inadvertent actuation of front panel controls, particularly in field mounting applications. The transparent storm door allows viewing of the display and is hinged for easy access to the front panel controls.

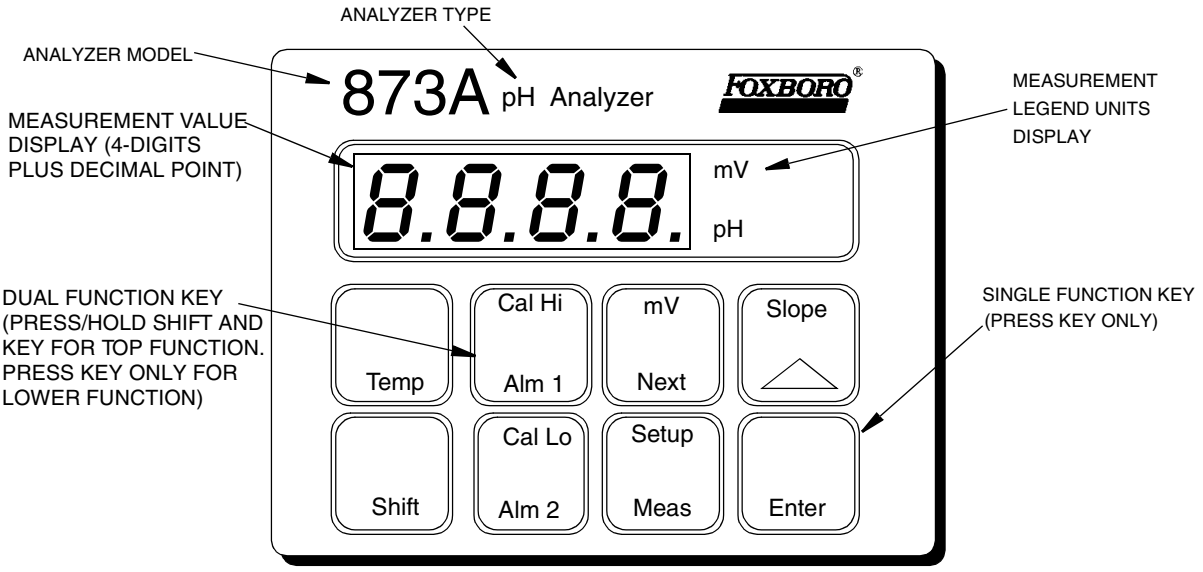


Figure 3. Front Panel Display and Keypad

Analyzer Identification

A data label is fastened to the side surface of the enclosure. This data label provides Model Number and other information pertinent to the particular analyzer purchased. Refer to Figure 4.

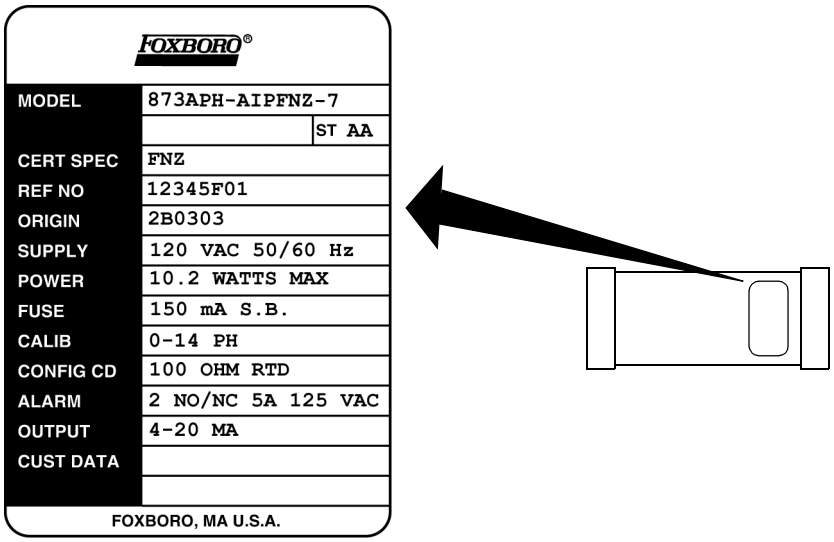


Figure 4. Data Label

Product Safety Specifications

Table 1. Product Safety Specifications

Testing Laboratory, Type of Protection, and Area Classification	Application Conditions	Electrical Safety Design Code
FM for use in general purpose (ordinary) locations.		FGZ
FM nonincendive for use in Class I, Division 2, Groups A, B, C, and D and Class II, Division 2, Groups F and G hazardous locations.	Instruments with metal enclosure (codes W, X, Y, and Z) only. Temperature Class T6.	FNZ
CSA (Canada) for use in general purpose (ordinary) locations.	Supply Voltage 24 V, 100 V, and 120 V ac (codes -A, -E, -J) only.	CGZ
CSA (Canada) suitable for use in Class I, Division 2, Groups A, B, C, and D, hazardous locations.	Instruments with metal enclosure (codes W, X, Y, and Z) only. Supply Voltage 24 V, 100 V, and 120 V ac (codes -A, -E, -J) only.	CNZ

— NOTE

The analyzer has been designed to meet the electrical safety descriptions noted in the table above. For detailed information or status of testing laboratory approvals and certifications, contact your Invensys Foxboro representative.

—⚠ CAUTION

1. When replacing covers on the 873A metal case, use Loctite (Part No. S0106ML) on the threads for the front cover and Lubriplate (Part No. X0114AT) on the threads for the rear cover. Do not mix.
2. Exposure to some chemicals may degrade the sealing properties of Polybutylene Teraethalate and Epoxy Magnacraft 276XAXH-24 used in relays K1 and K3. These materials are sensitive to acetone, MEK, and acids. Periodically inspect relays K1 and K3 for any degradation of properties and replace if degradation is found.

Standard Specifications

Supply Voltages	A 120 V ac B 220 V ac C 240 V ac E 24 V ac J 100 V ac
Supply Frequency	50 or 60, ±3 Hz
Output Signal	I 4 to 20 mA isolated T 0 to 10 V dc isolated E 0 to 20 mA isolated
Ambient Temperature Limits	–25 to +55°C (–13 to +131°F)
Measurement Ranges	–2 to +16 pH
Temperature Measurement Range	–17 to +199°C (0 to 390°F)
Temperature Compensation Range	-5 to +105°C (23 to 221°F)
Relative Humidity Limits	5 to 95%, noncondensing
Accuracy of Analyzer	±0.1% of upper range limit
Dimensions	Plastic Enclosure: 92(H) x 92(W) x 183(L) mm Metal Enclosure: 92(H) x 92(W) x 259(L) mm
Enclosure/Mounting Options	–P Plastic General Purpose/Panel Mount –W Metal Field Mount/Panel Mount –X Metal Field Mount/Surface Mount –Y Metal Field Mount/Pipe Mount –Z Metal Field Mount/Movable Surface Mount
Approximate Mass	
Plastic Enclosure:	0.68 kg (1.5 lb)
Metal Enclosure (with Brackets):	
Panel Mounting	1.54 kg (3.4 lb)
Pipe Mounting	2.31 kg (5.1 lb)
Fixed Surface Mounting	2.22 kg (4.9 lb)
Movable Surface Mounting	3.13 kg (6.9 lb)
Instrument Response	Two seconds maximum. Temperature response is 15 seconds maximum.
Alarms	• Two alarms configurable via keypad • Individual set points continuously adjustable 0 to full scale via keypad

Alarm Contacts	Two independent, nonpowered Form C contacts, rated 5 A noninductive, 125 V ac/30 V dc (minimum current rating 1 A). Inductive loads can be driven with external surge-absorbing devices installed across contact terminations. **CAUTION**: When the contacts are used at signal levels of less than 20 W, contact function may become unreliable over time due to the formation of an oxide layer on the contacts. See "Alarm Contact Maintenance" on page 41.
Alarm Indication	Alarm status alternately displayed with measurement on LED display.
RFI Susceptibility	(When all sensor and power cables are enclosed in a grounded conduit.)
Plastic Enclosure	<0.5 V/m from 27 to 1000 MHz
Metal Enclosure	10 V/m from 27 to 1000 MHz
Electromagnetic Compatibility (EMC)	The Model 873APH Electrochemical Analyzer, 220 V ac or 240 V ac systems with metal enclosure, comply with the requirements of the European EMC Directive 89/336/EEC when the sensor cable, power cable, and I/O cable are enclosed in rigid metal conduit (see Table 2). The plastic case units are intended for mounting in solid metal consoles or cabinets. The plastic case units will comply with the European EMC Directive 89/336/EEC when mounted in a solid metal enclosure and the I/O cables extending outside the enclosure are enclosed in solid metal conduit (see Table 2).

2. Installation

Mounting to a Panel - Plastic Enclosure, 873APH-_ _ P

The plastic enclosure is mounted in a panel as described below (see Figure 5).

1. Size panel opening in accordance with dimensions specified on DP 611-162.
2. Insert spring clips on each side of the analyzer.
3. Insert the analyzer in the panel opening until side spring clips engage on the panel.
4. From the rear of the panel, attach and tighten the top and bottom mounting screws until the analyzer is securely held in place.

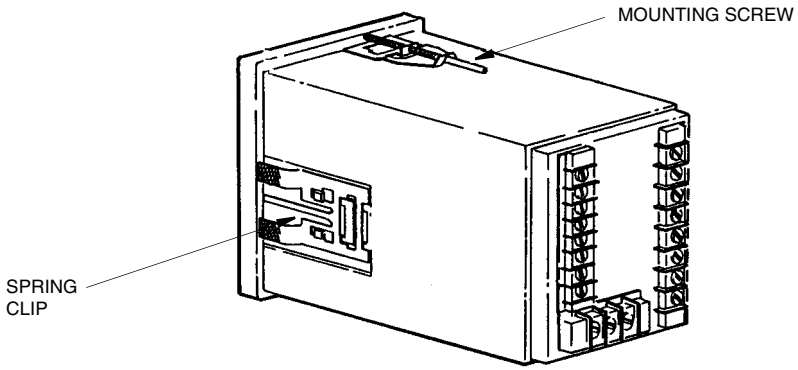


Figure 5. Mounting to a Panel - Plastic Enclosure

Mounting to a Panel - Metal Enclosure, 873APH-_ _ W

The metal enclosure is mounted to a panel as described below:

1. Size panel opening in accordance with dimensions specified on DP 611-162.
2. Insert the analyzer through the panel cutout and temporarily hold in place. The rear bezel will have to be removed to perform this procedure.)
3. From the rear of the panel, slide the plastic clamp onto the enclosure until the two clamp latches snap into two opposing slots on longitudinal edges of the enclosure. See Figure 6.
4. Tighten screws (clockwise) on the clamp latches until the enclosure is secured to panel.
5. Reassemble the rear bezel to the enclosure using four screws.

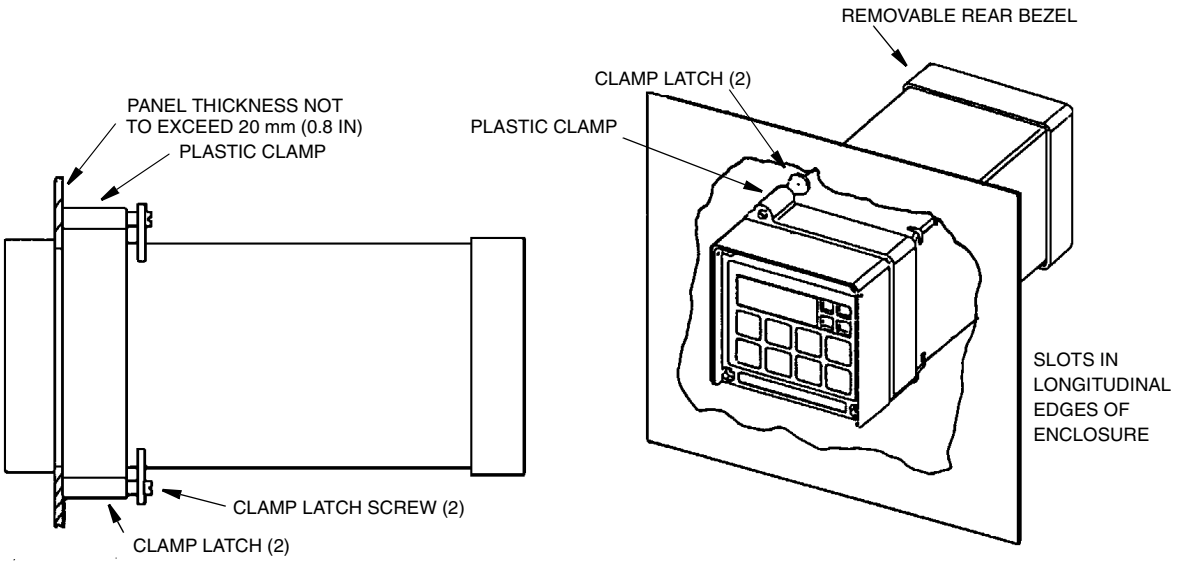


Figure 6. Mounting to a Panel - Metal Enclosure

Mounting to a Pipe - Metal Enclosure, 873APH-_ _ Y

1. Locate a horizontal or vertical DN 50 or 2 inch pipe.
2. Assemble universal mounting as follows:
   a. Place hex bolts (5) through spacer (3) into support bracket (2).
   b. Slide nylon washers (11) over bolts (5).
   c. Slide bolts through pipe mounting bracket (1) and fasten assembly tightly with hardware designated 7, 6, and 13.
   d. Attach pipe mounting bracket (1) to pipe using U-bolts (12) and hardware designated 6 and 13.

3. Slide the analyzer into support bracket (2) and slide strap clamp (4) onto analyzer. Using two screws, nuts, and washers, attach the strap clamp to the support bracket to secure the analyzer.
4. Lift entire assembly of Step 3, and using two U-clamps (12), nuts (13), and washers (6), secure mounting bracket (1) to pipe.

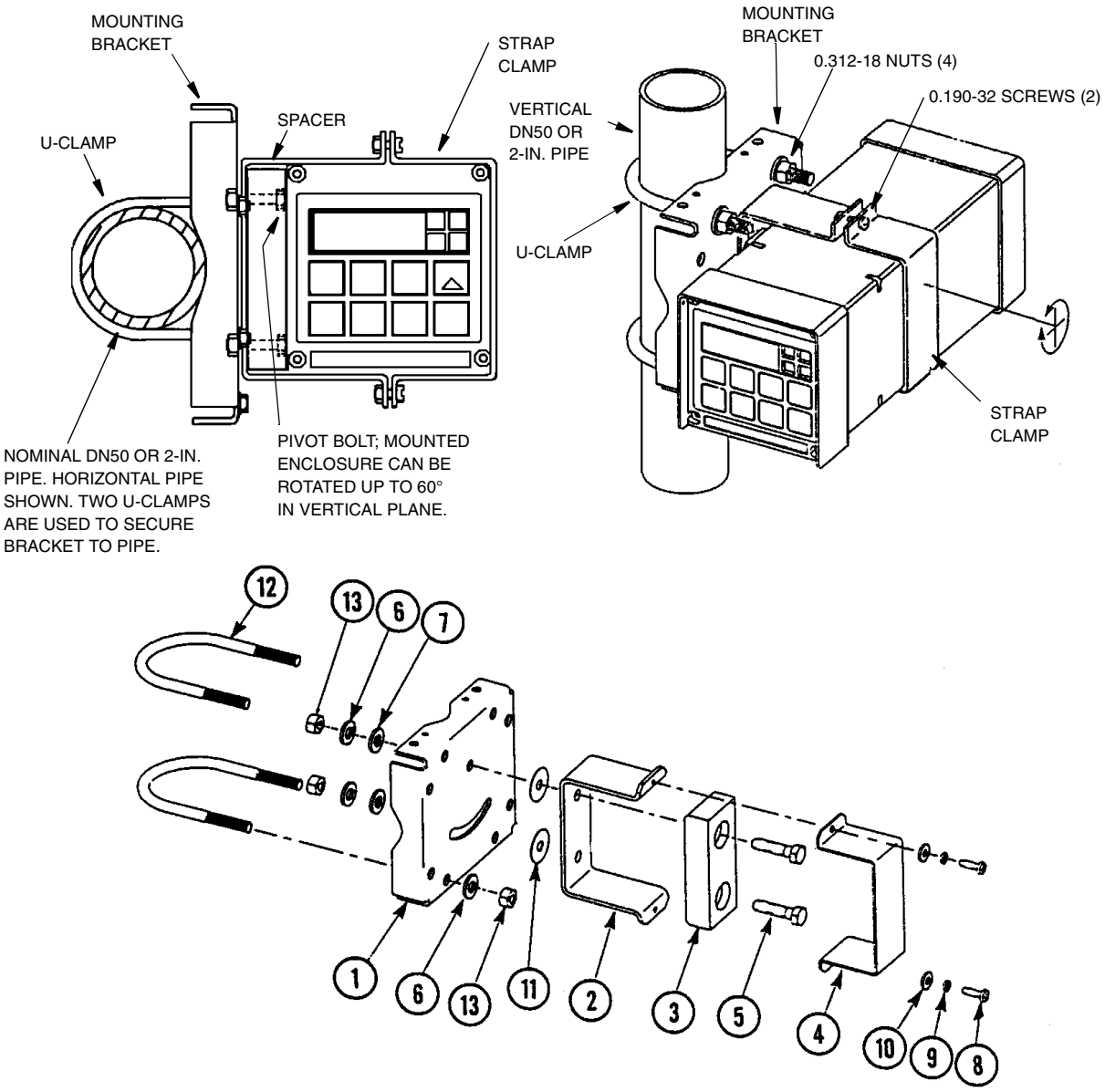


Figure 7. Metal Enclosure - Pipe Mounting

Mounting to a Surface, Fixed Mount - Metal Enclosure, 873APH-_ _ X

1. Locate the mounting surface for the analyzer.
2. Referring to Figure 8, use mounting bracket (1) as a template for drilling four holes into the mounting surface. Notice that holes in the mounting bracket are 8.74 mm (0.344 in) in diameter. Do not attach the mounting bracket to the surface at this time.
3. Assemble universal mounting as follows:
   a. Place hex bolts (5) through spacer (3) into support bracket (2).
   b. Slide nylon washers (11) over bolts (5).
   c. Slide bolts through universal mounting bracket (1) and fasten assembly together with hardware designated 7, 6, and 12.
   d. Attach universal mounting bracket (1) to wall.
4. Slide the analyzer into support bracket (2) and slide strap clamp (4) onto the analyzer. Using two screws, nuts, and washers, attach the strap clamp to the support bracket to secure the analyzer.

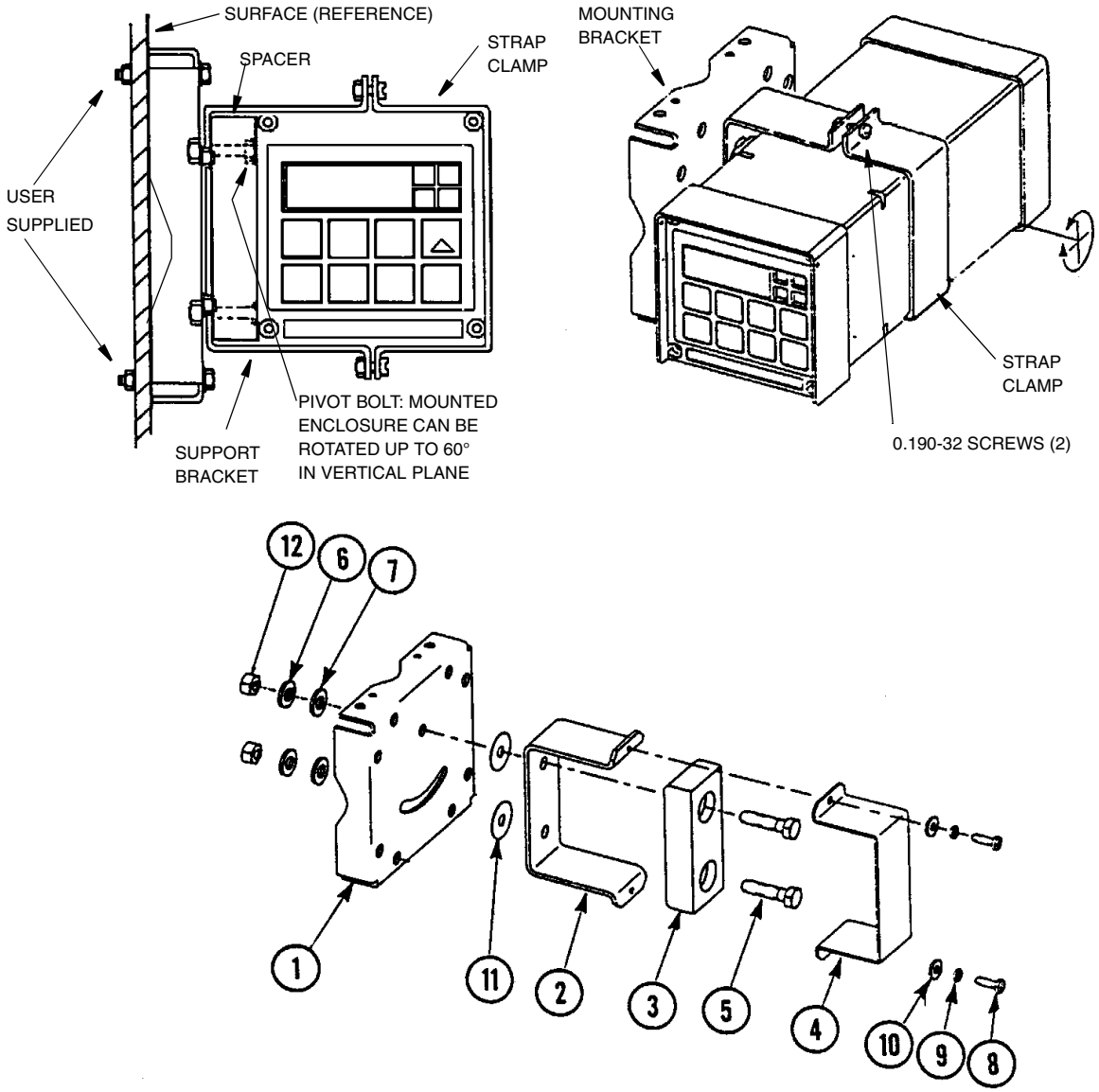


Figure 8. Metal Enclosure - Fixed Mount

Mounting to a Surface, Movable Mount - Metal Enclosure, 873APH-_ _ Z

1. Locate the mounting surface for the analyzer. Also refer to PL 611-016.
2. Referring to Figure 9, use wall bracket (12) as template for drilling four holes into mounting surface. Notice that the holes in the wall bracket are 9.53 mm (0.375 in) in diameter.
3. Attach wall bracket (12) to surface using four bolts, washers, and nuts.
4. Assemble universal mounting as follows:
   a. Place hex bolts (5) through spacer (3) into support bracket (2).
   b. Slide nylon washers (11) over bolts (5).
   c. Slide bolts through universal mounting bracket (1) and fasten assembly finger tight with hardware designated 9, 10, and 16.
5. Slide analyzer into support bracket (2) and slide strap clamp (4) onto the analyzer. Using two screws, nuts, and washers, attach the strap clamp to the support bracket to secure the analyzer.
6. Lift entire assembly of Step 5, align mounting bracket (1) and wall bracket pivot bolt holes, and then insert pivot bolt (13) through wall and mounting brackets into nylon washer (14) and locking nut (15).
7. Rotate bracket and analyzer assembly in horizontal plane to desired position and lock in place using the screw and washer.
8. Tilt the analyzer to the desired angle and lock in place with the hardware fastened finger tight in Step 4c.

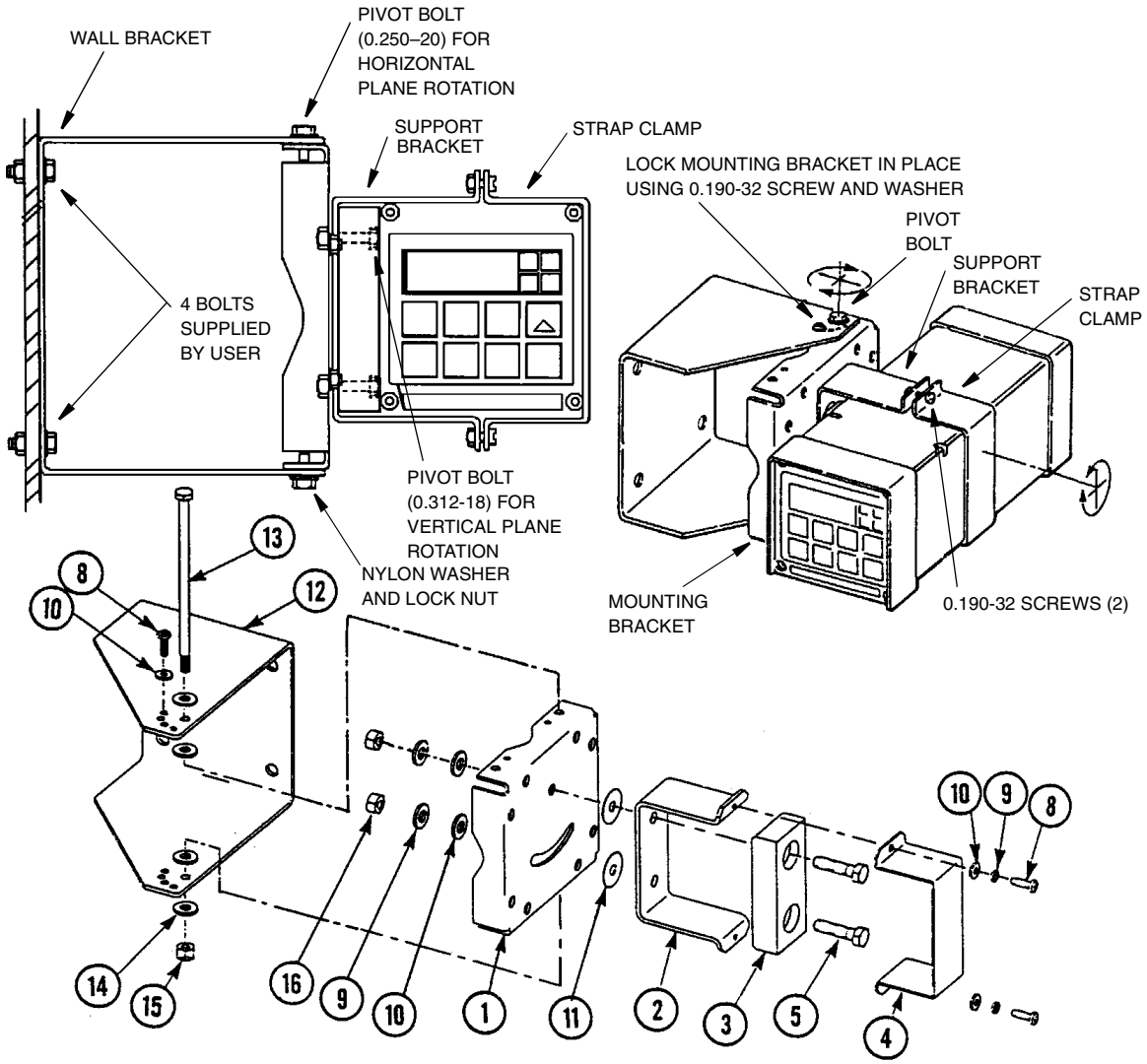


Figure 9. Metal Enclosure - Movable Mount

Wiring of Plastic Enclosure (General Purpose Version)

⚠ CAUTION

Wiring installation must comply with any existing local regulations.

1. Remove optional rear cover assembly BS805QK, if present.
2. Connect ALM 1 and ALM 2 alarm wires to terminal block TB3 as shown in Figure 10. Failsafe operation requires connections to be made between contacts NC and C. Also see "Wiring of Alarms" on page 22.
3. Connect wires from external circuit for analog output to terminals TB3 (M+) and TB3 (M–). Refer to Figure 10.
4. Remove factory-installed jumper assembly from terminal block TB2 and discard.
5. Connect sensor wires to terminal block TB2 as shown in Figure 11.
6. Connect power wires to terminal block TB1 as shown in Figure 10.
7. Attach optional rear panel cover, if present.

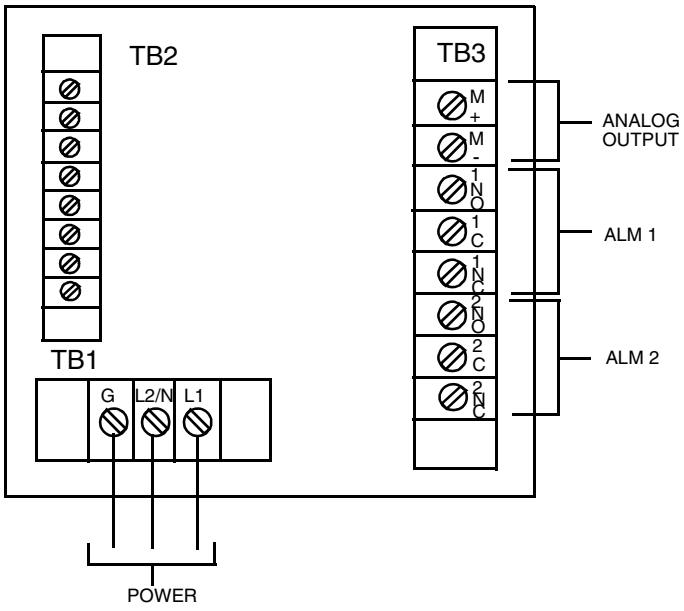
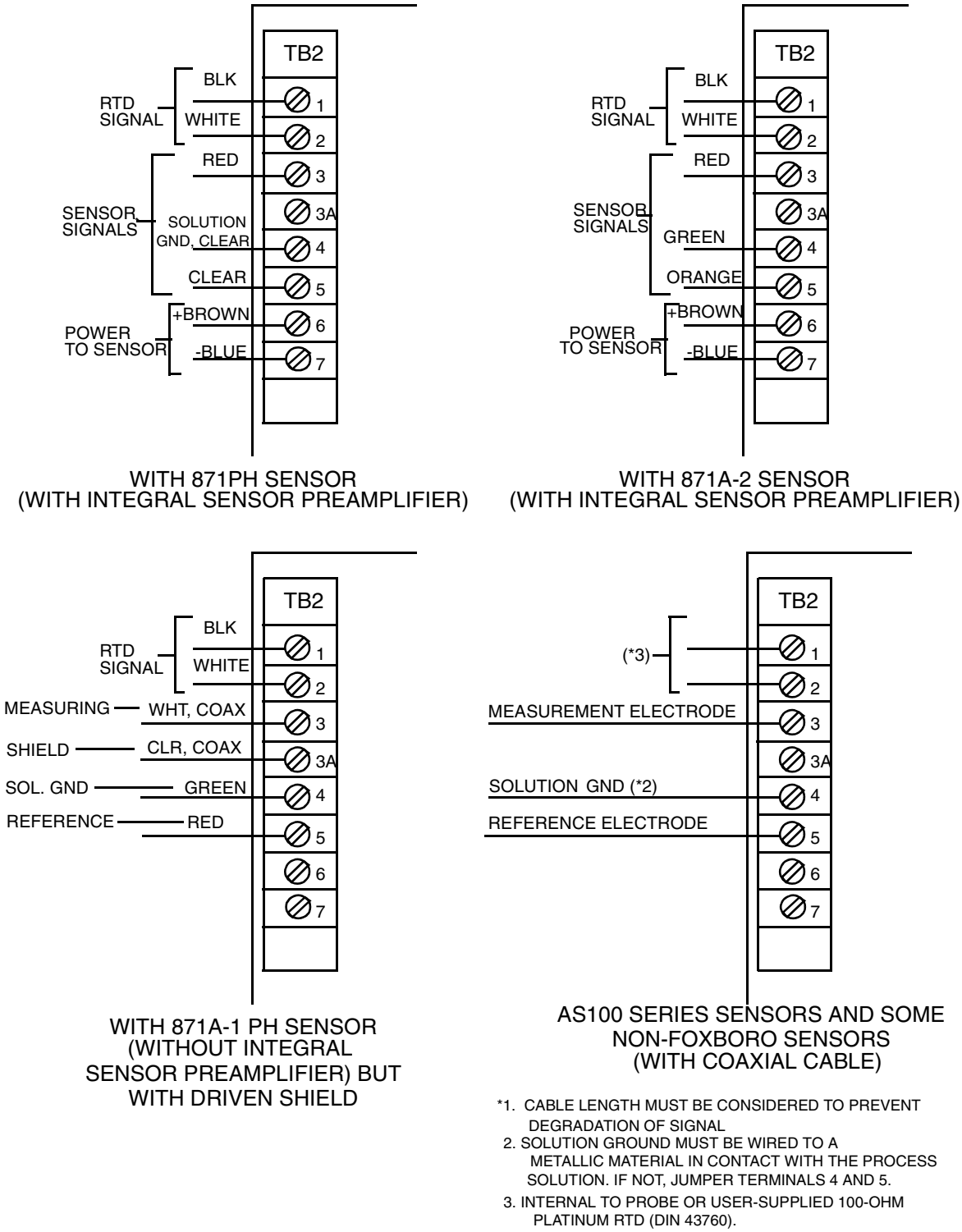


Figure 10. Plastic Enclosure Rear Panel Wiring for Power, Output, and Alarms



*1. CABLE LENGTH MUST BE CONSIDERED TO PREVENT DEGRADATION OF SIGNAL

2. SOLUTION GROUND MUST BE WIRED TO A METALLIC MATERIAL IN CONTACT WITH THE PROCESS SOLUTION. IF NOT, JUMPER TERMINALS 4 AND 5.

3. INTERNAL TO PROBE OR USER-SUPPLIED 100-OHM PLATINUM RTD (DIN 43760).

Figure 11. Plastic Enclosure Rear Panel Wiring for Sensor

Wiring of Metal Enclosure (Field-Mounted Version)

⚠ CAUTION

Wiring installation must comply with any existing local regulations.

NOTE

1. To maintain enclosure tightness such as NEMA 4X, CSA Enclosure 4X, or IEC Degree of Protection IP-65, wiring methods and fittings appropriate to the rating must be used. Table 2 lists the recommended parts.
2. Alarm wires should run through the same conduit as the analog output wires. Sensor wires and power wires should be run through separate conduits.

1. Remove back cover to access terminal/power board.

2. Connect ALM 1 and ALM 2 alarm wires to TB3 as shown in Figure 12. Failsafe operation requires connections to be made between contacts NC and C. Also see "Wiring of Alarms" on page 22

3. Connect wires from external circuit for analog output to terminal TB4.

4. Connect sensor wires to analyzer terminal block TB2 as shown in Figure 13.

5. Connect power wires to terminal block TB1, as indicated in Figure 12. The earth (ground) connection from the power cord should be connected to the ground stud located in the bottom of the case. This connection is mandatory for safe operation.

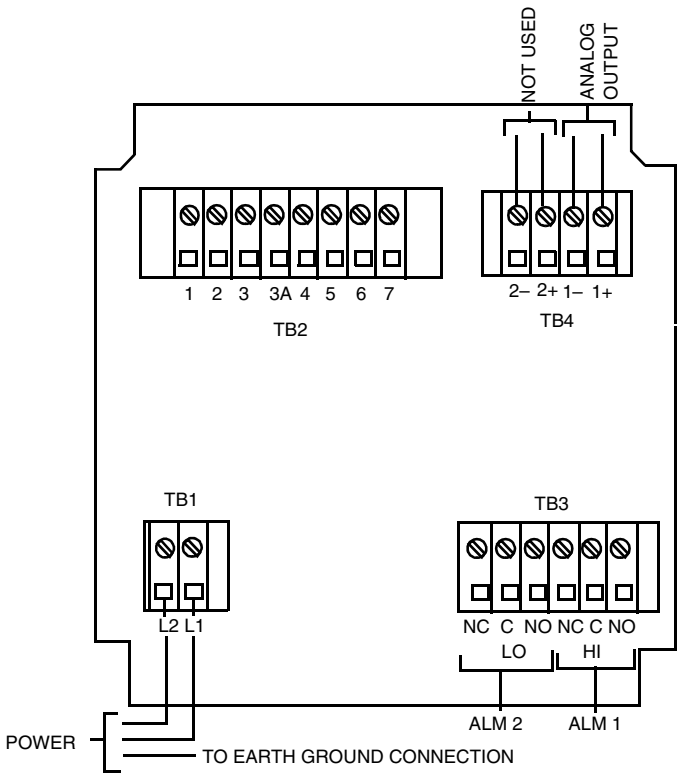
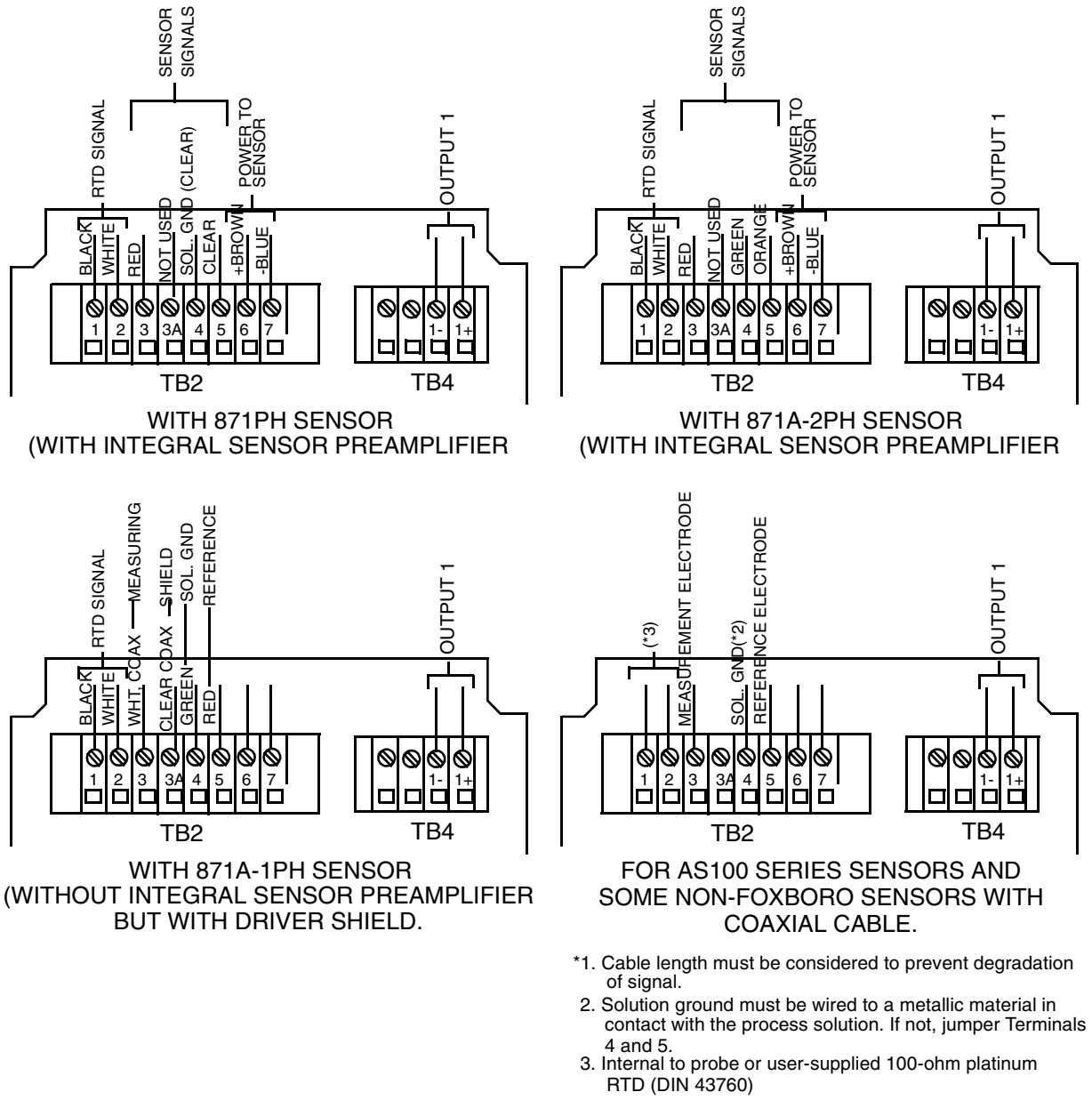


Figure 12. Metal Enclosure Rear Panel Wiring for Power, Output, and Alarms



*1. Cable length must be considered to prevent degradation of signal.
2. Solution ground must be wired to a metallic material in contact with the process solution. If not, jumper Terminals 4 and 5.
3. Internal to probe or user-supplied 100-ohm platinum RTD (DIN 43760)

Figure 13. Metal Enclosure Rear Panel Wiring for Sensor

Table 2. Recommended Conduit and Fitting (Due to Internal Size Restraints)

	Conduit	Fitting
Rigid Metal	1/2-inch Electrical Trade Size	T&B* #370
Semi-rigid Plastic	T&B #LTC 050	T&B #LT 50P or T&B #5362
Semi-rigid Plastic, Metal Core	Anaconda Type HC, 1/2-inch	T&B #LT 50P or T&B #5362
Flexible Plastic	T&B #EFC 050	T&B #LT 50P or T&B #5362

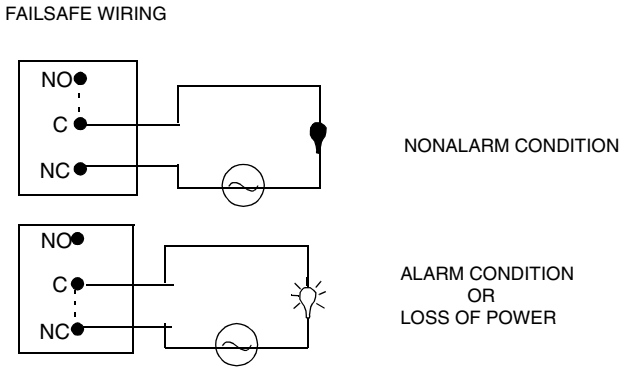
*Thomas & Betts Corp., 1001 Frontier Road, Bridgewater, NJ 08807-0993

Wiring of Alarms

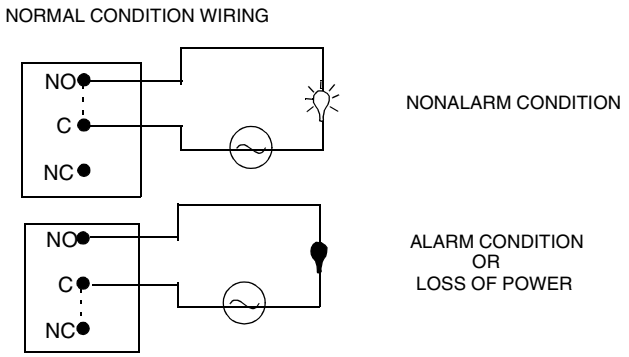
Alarm relays in the 873A Analyzer are "active" relays. This means that the relay is energized when the analyzer is powered and there is no alarm condition.

You can wire an external device (e.g., light bulb) to the analyzer in either of two ways. Each alarm relay provides a contact closure which can be used as a switch to turn an externally powered device on or off.

- Between NC and C so that the external device is activated when there is an alarm condition or a loss of power to the analyzer. This is referred to as "failsafe."



- Between NO and C so that the external device is activated in the normal condition (i.e., instrument is powered and no alarm condition exists.



⚠ CAUTION

When the contacts are used at signal levels of less than 20 W, contact function may become unreliable over time due to the formation of an oxide layer on the contacts. See "Alarm Contact Maintenance" on page 41.

3. Operation

Overview

The 873A functions in two main modes, OPERATE and CONFIGURE.

As soon as the 873A Analyzer is powered, it is in the OPERATE mode. The instrument first conducts a self diagnostic, then automatically displays the measurement and outputs a proportional analog signal. Any error or alarm condition is alternately displayed with the measurement on the LED display. If two or more errors/alarms exist simultaneously, the analyzer will flash only the one with the highest priority. If the highest priority error/alarm is cleared and a lower priority error/alarm still remains, the analyzer will then flash the highest priority of those remaining.

Also, while in the OPERATE Mode, you may view the process temperature and all the parameter settings configured in the Configuration Setup Entries.

All 873A Analyzers are shipped configured, either with factory default settings or user defined parameters, as specified. In the CONFIGURE Mode, you may change any of the parameters previously entered.

Utilizing either mode requires understanding the functions of both the display and keypad.

Display

The display, Figure 14, is presented in two parts, a measurement/settings display and backlit engineering units. To read anything other than the measurement or to make a configuration or calibration change requires keypad manipulations.

Keypad

The keypad, shown in Figure 14, consists of eight keys, five of which are dual function. The white lettered keys represent normal functions and the green lettered keys represent alternate functions. To operate a white lettered function key, just press the key. To operate a green lettered function key, press/hold the **Shift** key and then press the function key. The notation used to describe this operation is **Shift +** (key). All key functions are described in Table 3.

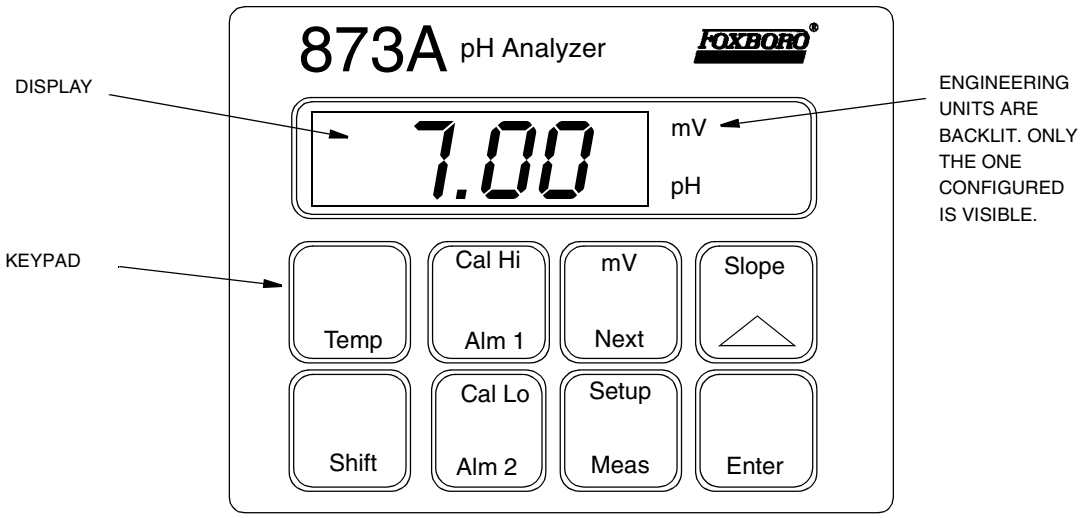


Figure 14. Model 873APH Keypad and Display

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Table 3. Keypad Functions

Key	Function
Shift	**Shift:** Press and hold this key to actuate the green dual-function keys.
Slope △	**Slope:** Press/hold SHIFT and press this key to display the Nernst slope (mV/pH) corrected to 25 °C; determined from the last 2-point calibration entered into the analyzer. **Increment** (Δ)**:** Press this key to increase the display count. Each press increases the value by one. Press and hold to increase the count at a rate of approximately one per second. When 9 is reached, display goes to 0.
Temp	**Temp:** Press this key to display the process temperature. This may be the actual temperature or a manually set value as configured. The temperature is displayed as with one decimal point which alternates with °C or °F as chosen.
Enter	**Enter:** Press this key to display the value or code of a setup entry. You can also use this key to select a parameter or code by entering the value or code into memory.
mV Next	**mV:** Press/hold **Shift** and press this key to display absolute mV value. **Next:** Press this key to select one of the four display digits similar to a cursor except that it causes the digit to flicker. Also used to select the next entry choice of the setup function.
Setup Meas	**Setup:** Press/hold **Shift** and press this key to access the configuration entry function. **Meas:** Press this key at any time to return to Measure mode from other modes.
Cal Lo Alm 2	**Cal Lo:** Press/hold **Shift** and press this key to access the lower calibration function of the analyzer. (Shifts y-intercept or offset voltage). **Alm 2:** Press this key to display and/or change the set point of Alarm 2.
Cal Hi Alm 1	**Cal Hi:** Press/hold **Shift** and press this key to access the upper calibration function of the analyzer. (Changes slope or gain of analyzer). **Alm 1:** Press this key to display and/or change the set point of Alarm 1.

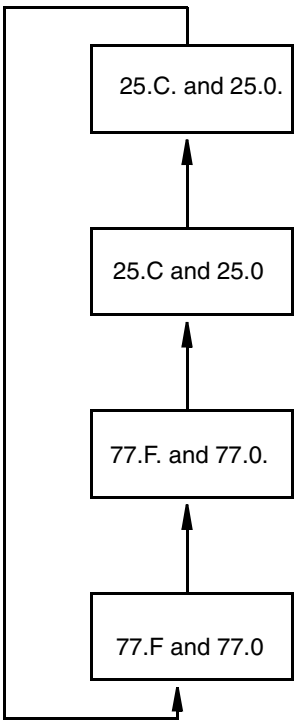
NOTE

1. Pressing **Next** and Δ simultaneously allows you to step backward through the Setup program or digit place movement. Note, however, that you cannot reverse number count by this procedure.
2. Pressing and holding **Shift** and **Enter** simultaneously overrides the wait between Setup entries

To View Process Temperature

To view the process temperature from the measurement mode, press the **Temp** key. The display changes from the measurement to the process temperature or manually adjusted temperature. The display is a rounded whole number with the temperature units (C or F) alternating with tenths of degrees and no units.

The **Temp** key, used in conjunction with the increment (Δ) key, allows the temperature to be changed from °C to °F or vice versa, as well as allowing the use of manual temperature compensation at a given temperature (decimal shown after temperature). When **Temp** is pressed, the process temperature is displayed on the readout. Pressing Δ causes the display to sequence from the displayed value through the following sequence:



When the decimal point after the C or F is present, the process will be temperature compensated *manually* at the temperature displayed. If another manual compensation temperature is desired, use **Next** and Δ to change the display to the desired temperature; then press **Enter**. The process will then be compensated to the new displayed temperature. To return to automatic compensation, sequence the display to remove the decimal point after C or F. Automatic temperature compensation cannot be adjusted by this procedure. See “Temperature Correction Procedure” on page 35 for adjusting temperature in the automatic mode.

— NOTE

To make a minus sign appear on the display, make sure that a number other than zero is present on the display and change the first digit of the number to a minus sign.
For example, to make the display read -20°C, first display 020°C, and then change the first digit to a minus sign.

To View Setup Entries

Setup Entries may be viewed at any time. To view any of the Setup Entries, do the following:

1. Press **Shift + Setup**.
2. If necessary, press **Next** until the desired parameter to be viewed is displayed.
3. Press **Enter**.

When viewing the Setup Entries, you may page through the parameters as rapidly as you wish (**Shift** + **Setup** and then **Next** one or more times). However, once **Enter** is pressed (**Enter** must be pressed to read a parameter value), you must wait (value is displayed for approximately four minutes) for the parameter symbol to reappear.

— NOTE

Pressing **Shift + Enter** overrides this wait.

The parameter symbols appear for about four minutes also. If another key is not pressed in this period, the display defaults to the measurement.

To make changes to any Configuration Setup parameter, refer to “Configuration” on page 29.

4. Configuration

User Configuration Setup Entries

This instrument is shipped with either factory default settings or user defined settings, as specified per sales order. Table 4 (User Configuration Setup Entries) lists all the parameters that can be changed. It lists the displayed symbol, a description of the display, the factory default values and a space to write user settings.

Table 4. User Configuration Setup Entries

Displayed Symbol	Parameters and Values Accessed	Factory Default	User Settings
AL_1	Alarm 1 Off/Hi/Lo Active	1oFF	
AL_2	Alarm 2 Off/Hi/Lo Active	2oFF	
Aohi	Analog Output High (100%)	14.00	
Aolo	Analog Output Low (0%)	00.00	
tCF	Temperature Cell Factor	25.00	
LAdJ	Analog Out Electronics Lower Calibration	- - -	
HAdJ	Analog Out Electronics Upper Calibration	- - -	

To change any of the User Configuration Setup parameters, use the following procedure:

1. Press **Shift + Setup**.
2. If necessary, press **Next** until the desired parameter to be changed is displayed.
3. Press **Enter**.
4. Use **Next** and Δ until the desired code or value is displayed.
5. Press **Enter**.
6. Press **Meas** to return to the measure mode.

Alarms

General Information About Alarms

Dual Independent, Form C dry alarm contacts, rated at 5A noninductive, 125 V ac/30 V dc are provided. Each of the two alarms is configured as off or as a high or low alarm. A *low alarm* relay will trip on decreasing measurement. A *high alarm* relay will trip on increasing measurement. Therefore, combinations of high, low, high/low, low/low, and high/high alarms are possible. The alarm deadband is always set at 1% of the full scale measurement value.

⚠ CAUTION

When the contacts are used at signal levels of less than 20 W, contact function may become unreliable over time due to the formation of an oxide layer on the contacts. See "Alarm Contact Maintenance" on page 41.

Correct wiring of the contacts is necessary for failsafe operation. See "Wiring of Alarms" on page 22 for wiring information.

Alarm conditions (AL 1, AL 2, or A1A2) are alternately displayed with the measurement on the LED display.

NOTE

Upon powering the instrument: Alarm operation is delayed for a time period proportional to the 10 second factory set damping time. Alarms will remain "OFF" until the measurement has stabilized.

Alarm Configuration

You can configure each alarm to be a high alarm, a low alarm or in the off state.

To configure Alarm 1:

1. Press **Shift + Setup**.
2. If necessary, press **Next** until "AL_1" appears on the display.
3. Press **Enter.**
4. Press **Next** until desired alarm state is displayed.

AL_1 states	1oFF	1_Hi	1_Lo

5. Press **Enter** to set state. The configured state appears on the display (e.g., 1_Lo).
6. Press **Meas** to return to measure or **Shift + Enter** to return setup menu item "AL_1".

To configure Alarm 2:

1. Press **Shift + Setup**.
2. If necessary, press **Next** until "AL_2" appears on the display.
3. Press **Enter.**
4. Press **Next** until desired alarm state is displayed.

AL_2 states	2oFF	2_Hi	2_Lo

5. Press **Enter** to set state. The configured state appears on the display (e.g., 2_Hi).
6. Press **Meas** to return to measure mode or **Shift + Enter** to return setup menu item "AL_2".

Setting Alarm Level(s)

This procedure is relevant only when the alarms were configured as Low or High Alarms as explained in the previous section. When the alarms are configured as Off, alarm level settings have no relevance.

To set the level of Alarm 1:

1. Press **Alm 1**.
2. Use the **Next** key to select each digit and the Δ key to change the value of the digit selected.
3. Press **Enter**.

To set the level of Alarm 2:

1. Press **Alm 2**.
2. Use the **Next** key to select each digit and the Δ key to change the value of the digit selected.
3. Press **Enter**.

Press **Meas** to return to measure mode.

Outputs

Scaling the Analog Outputs

The maximum span that should be set on the analyzer is 16.00. The minimum span that is recommended is 1.60. Although it is physically possible to set the analyzer for a smaller span, a loss of accuracy is possible. The analog output could develop steps instead of following the measurement in a continuum.

Analog Output 100% Value (Aohi)

This 4-digit code may be set to any value between -9.99 and 16.00 pH. The value set by this code will correspond to 100% of the analog output, i.e., 20 mA or 10 volts, depending upon output configuration. This value may be lower than the Analog Output 0% Value (Aolo), if desired.

Example: You wish to have 20 mA correspond to 4.00 pH.

1. Press **Shift + Setup**.
2. If necessary, press **Next** until “Aohi” appears on the display.
3. Press **Enter.**
4. Use the **Next** key to select each digit and the Δ key to change the value of the digit selected until the value 4.00 pH is displayed.
5. Press **Enter.**
6. Press **Meas** to return to measure or **Shift + Enter** to return setup menu item “Aohi”.

Analog Output 0% Value (Aolo)

This 4-digit code may be set to any value between -9.99 and 16.00 pH. The value set by this code will correspond to 0% of the analog output, i.e., 0 mA, 4 mA, or 0 volts, depending upon output configuration. This value may be higher than the Analog Output 100% Value (Aohi), if desired.

Example: You wish to have 4 mA correspond to 10.00 pH.

1. Press **Shift** + **Setup**.
2. If necessary, press **Next** until "Aolo" appears on the display.
3. Press **Enter.**
4. Use the **Next** key to select each digit and the Δ key to change the value of the digit selected until the value 10.00 pH is displayed.
5. Press **Enter.**
6. Press **Meas** to return to measure or **Shift + Enter** to return setup menu item "Aolo".

Analog Output Calibration (LAdJ, HAdJ)

This procedure is used to calibrate the Analog output. This has been done at the factory and should not require recalibration unless the type of output has been changed. An ammeter or voltmeter is required.

1. Connect an ammeter/voltmeter to the analog output terminals. See "Wiring of Plastic Enclosure (General Purpose Version)" on page 18 and "Wiring of Metal Enclosure (Field-Mounted Version)" on page 20.
2. Press **Shift + Setup**.
3. If necessary, press **Next** until "LAdJ" or "HAdJ" appears on the display.
4. Press **Enter**, the display will show "Linc".
5. Press **Next** to select the desired adjustment value:
   - Linc - Large increment ~ +0.3 mA or ~ +0.15 V
   - inc - increment ~ +0.025 mA or ~ +0.01 V
   - Sinc - Small increment smallest possible + adjustment 1/20 the size of "inc"
   - LdEc - Large decrement ~ -0.3 mA or ~ -0.15 V
   - dEc - decrement ~ -0.025 mA or ~ -0.01 V
   - SdEc - Small decrement smallest possible - adjustment 1/20 the size of "dEc"
6. Press **Enter** to change analog output and observe the new reading on your meter.
7. Repeat steps 5 and 6 until desired meter value is observed.
8. Press **Meas** to return to measure or **Shift + Enter** to return setup menu item "LAdJ" or "HAdJ".

5. Calibration

General Information

Three commonly used techniques will be discussed in this chapter.

1. **One Buffer Calibration** is a single point standardization using one buffer, preferably near the process pH. This is often suitable for routine measurements.
2. **Two Buffer Calibration** is a two point standardization. For best possible system accuracy, the buffers should bracket the process control point. This is also the best way to determine how the sensor is performing.
3. **Grab Sample Calibration** uses the process medium. Grab sample calibration offers you the advantage of keeping the sensor installed in the process during the standardization.

In addition, a temperature correction procedure can be implemented to correct temperature measurements that may differ from actual values, such as when sensor cable length exceeds 15.24 m (50 feet). This procedure should be done prior to sensor standardization in buffers.

In all cases, these general guidelines should be observed:

- Sensors should be thoroughly cleaned before standardization.
- Fresh standards should be used.
- Sufficient time for sensor and thermo-compensator thermal equilibrium must be allowed. The temperature should display the correct temperature of the buffer.
- The correct pH value of the buffer should be used during the standardization. pH buffers have different values at different temperatures.
- Sufficient time for chemical equilibrium must be allowed.
- pH sensors must be properly grounded in pH buffers during the standardization. The black threads of the Model 871A sensors must be immersed in the buffer also.

One Buffer Calibration

1. Remove the pH sensor from the process stream. Clean the immersion end and rinse with distilled water.
2. Select buffer near process pH. The buffer should be at the same temperature and, for best results, near the process temperature.
3. Immerse the cleaned sensor in the buffer solution with known pH. Wait until the measurement reading stabilizes.
4. Press **Shift + Cal Lo**.
5. Use the **Next** key to select each digit and the Δ key to change the value of the digit selected until the display reads the pH of the buffer at the temperature of measurement.

6. Press **Enter**.
7. Press **Meas** to return to measure mode.

Two Buffer Calibration

This procedure must be done in order, **Cal Lo** must be performed before **Cal Hi** for proper calibration.

1. Remove the pH sensor from the process stream. Clean the immersion end and rinse with distilled water.
2. Select buffers near or bracketing process pH. The buffers should be at the same temperature and, for best results, near the process temperature.
3. Immerse the cleaned sensor in the buffer solution with lower known pH. Wait until the measurement reading stabilizes.
4. Press **Shift + Cal Lo**.
5. Use the **Next** key to select each digit and the Δ key to change the value of the digit selected until the display reads the pH of the buffer at the temperature of measurement.
6. Press **Enter**.
7. Press **Meas** to return to measure mode.
8. Thoroughly rinse the sensor in distilled water and immerse it into the second buffer with higher known pH value. Wait until the measurement reading stabilizes.
9. Press **Shift + Cal Hi**.
10. Use the **Next** key to select each digit and the Δ key to change the value of the digit selected until the display reads the pH of the second buffer at the temperature of measurement.
11. Press **Enter**.
12. Press **Meas** to return to measure mode.

Grab Sample Standardization

1. Note the present pH reading while extracting a sample from the process stream.
2. Determine the pH of the sample using laboratory techniques suitable for the precision that is required. The laboratory measurement should include precise standardization and temperature compensation of the laboratory sensor, protection of the sample from atmosphere and temperature change.
3. Determine the difference between the laboratory pH and the process reading taken when the sample was removed.
4. Press **Shift + Cal Lo**.
5. Use the **Next** key to select each digit and the Δ key to change the value of the digit selected until the display reads the corrected pH of the process.

6. Press **Enter**.
7. Press **Meas** to return to measure mode.
8. Repeat Steps 1 through 3 to verify the standardization.

Temperature Correction Procedure

An accurate temperature signal is required for proper temperature compensation, especially when measuring over a large temperature gradient. The temperature cell factor (tCF) is used to offset a deviation from the ideal due to cable resistance. The following procedures are recommended for installations that utilize a cable longer than 15.24 m (50 feet). A 100 Ω RTD circuit is used for automatic temperature compensation on the 873A Analyzer. Use this procedure before buffer of grab sample calibrations.

Determining Temperature Cell Factor (tCF)

1. Place the pH sensor and an accurate Celsius thermometer (with 0.10°C resolution) into a container of liquid. Allow the system to reach thermal equilibrium.
2. Press **Temp**. Then using the Δ key, put the analyzer into Automatic Temperature Compensation with a Celsius readout (no decimal point after the C). See "To View Process Temperature" on page 26. Press **Enter**. The current temperature is displayed as a whole number with the unit C alternating with the value expressed to the tenths place.
3. The value read by the 873A must now be viewed to the hundredths place. To do this, press **Temp** and then press **Next** five times. Because only three digits plus the decimal may be viewed on the display, the first digit will not be visible (e.g., 25.20 will be displayed as 5.20).
4. Determine the temperature difference of the two devices by subtracting the 873A reading from the thermometer reading; e.g., the thermometer reads 24.70°C and the 873A says (2)5.20°C; the difference is 24.70°C – 25.20°C = –0.50°C.
5. Add this value to 25.00°C (e.g., 25.00°C + (–0.50°C) = 24.50°C. This is your temperature cell factor. Now that you've determined the tCf, enter it as described in the next section.

Entering a tCF Value

1. Press **Shift** + **Setup**.
2. Press **Next** until "tCF" appears on the display.
3. Press **Enter.**
4. Use the **Next** key to select each digit and the Δ key to change the value of the digit selected until the desired value is displayed.
5. Press **Enter**.
6. Recheck any differences that exist between the thermometer and temperature displayed on the 873A, using the technique described in the previous section.

6. Diagnostics

Troubleshooting

Using the 873APH Analyzer to Troubleshoot a Sensor Problem

The best test of a sensor is to hook it up to an analyzer and to calibrate it in pH buffers. If the sensor calibrates, one can be sure it is fully functional. On the 873A, error flags help in the diagnosis of problems that may occur. Make sure the buffers are fresh and not contaminated, and that the sensor has time to reach thermal and chemical equilibrium with the buffers. You must do a one buffer calibration first.

Error Code	**Action**
Er 1:	Verify that the factory-installed jumper assembly has been removed from TB2 in the plastic general purpose version. Power down the analyzer and then reapply power. Certain temperature sensor errors will cause Er 1. Power down. Disconnect sensor. Reapply power. If Er 1 persists, seek factory repair. If Er 1 changes to t Er, the problem is in the sensor. Replace the sensor.
t Er:	This code indicates an open or shorted temperature input. Replace the sensor.

— NOTE

For the short term, if the process measurement does not change temperature, is close to 7 pH, or has very wide accuracy specifications, manual temperature operation may be used

HCAL:	During 2-point calibration with *fresh non-contaminated* buffers, a sensor will cause HCAL to occur because it is not generating a large enough voltage difference between the buffers for the temperature the analyzer thinks the sensor sees. If the sensor is sufficiently conditioned, and relatively stable in each solution, more conditioning time may improve the response. Soak your electrode in dilute KCl solution without silver chloride. Verify temperature and adjust tCF if necessary. A new sensor installation may experience this problem also. The sensor recovery may be hastened by immersing the sensor in a warmed KCl solution, then allowing it to cool to room temperature while immersed in this solution. If the sensor reads the same value in every buffer, a short due to breakage is suspected. Replacement of the pH module should correct the problem. The 873APH Analyzer will accept a 2-buffer calibration as long as the SLOPE (mV/pH) exceeds ~50 mV. The slope value is accessed by pressing

Shift + **Slope**. The slope is always displayed at a temperature of 25.0°C, no matter what temperature the calibration occurred at. If the slope falls below 50.3, the calibration will still be accepted into the unit, but HCAL will flash intermittently with the sample value.
Invensys Foxboro recommends sensor servicing on all sensors whose slope is below 53.3 mV/pH (90% efficiency). See Item 2 in "Additional Troubleshooting" on page 38.
Verify the temperature in the automatic temperature mode. See "To View Process Temperature" on page 26.
Use the correct buffer values at the temperature of measurement.

Additional Troubleshooting

1. Sensor Does Not Appear To Be Functioning.

For sensors with a preamplifier: Leave all sensor leads connected to the analyzer. Leave power on the 873A. Connect a volt meter to terminals 4 and 6 of TB2; +6 V should be measured. Then connect the meter to terminals 4 and 7; –6 V should be measured. If either reading is not correct, disconnect the sensor and repeat this procedure. If it can now be measured, a problem existed with the sensor. If the voltage is still not present, an analyzer problem exists. If both the sensor and analyzer pass this test, continue to Item 2, Low Slope.

2. Low Slope.

Leave all sensor leads connected to the powered analyzer. Clean the "business end" of the sensor off and place into a beaker of 7 pH buffer. Use the **mV** key to display the measured absolute voltage generated by your sensing and reference electrodes. The value should be 0 V ±20 mV. The reading should change approximately 59 mV per pH unit, when the sensor is cleaned and placed into a second buffer (25°C). In a 10 pH buffer, the mV reading should be less than the 7 pH buffer reading by approximately 174 mV (177.3 theoretically). In a 4 pH buffer, the mV value should be greater than the mV value in 7 pH buffer by 174 mV. If the sensor passes this test and there is still a problem with the measurement, an analyzer problem may exist. Verify that the sensor temperature is in automatic mode and reading correctly. See Figure 15.

— NOTE

HINT: It is a good idea to keep records of your calibrations. Recording the mV values and Slope can help you establish maintenance and replacement information on your sensors.

3. Erratic.

On 871PH sensor only: Measure between wire #4 (clear) and the knurled screw on the immersion end of the sensor with a resistance measuring device. The resistance should be 0 (shorted) or very small. If not, you have a grounding problem with your sensor.

For an 871A sensor, make sure grounding threads are in contact with the solution. Ptfe (e.g., teflon) tape around these threads may prevent a ground to be made.

Troubleshooting a ground loop or grounding problem may also be done in a beaker of buffer. Immerse a sensor in buffer (not at pH 7) and note the pH. Attach a wire to a piece of metal (paper clip will do) and to an earth ground (metal pipe, outlet ground). Now place the metal piece into the beaker and watch the pH of the analyzer. It should not change. A change in pH during this procedure indicates a problem exists.

5. Slow.

If the sensor is very slow in responding, a blockage may have occurred on the reference junction. Soak sensor in a container of warmed KCI solution until completely cooled. This procedure will dissolve dried salts, or replace dehydrated reference solution.

Trapped air bubbles can also cause problems by increasing resistance in this circuit. A firm shakedown, like is done to a clinical thermometer, and soaking sensor can often help.

Slow response can also indicate a coated or dehydrated pH glass. Cleaning or cleaning and soaking may help correct this phenomenon. pH electrode replacement may be indicated. Also see HCAL troubleshooting earlier in this section.

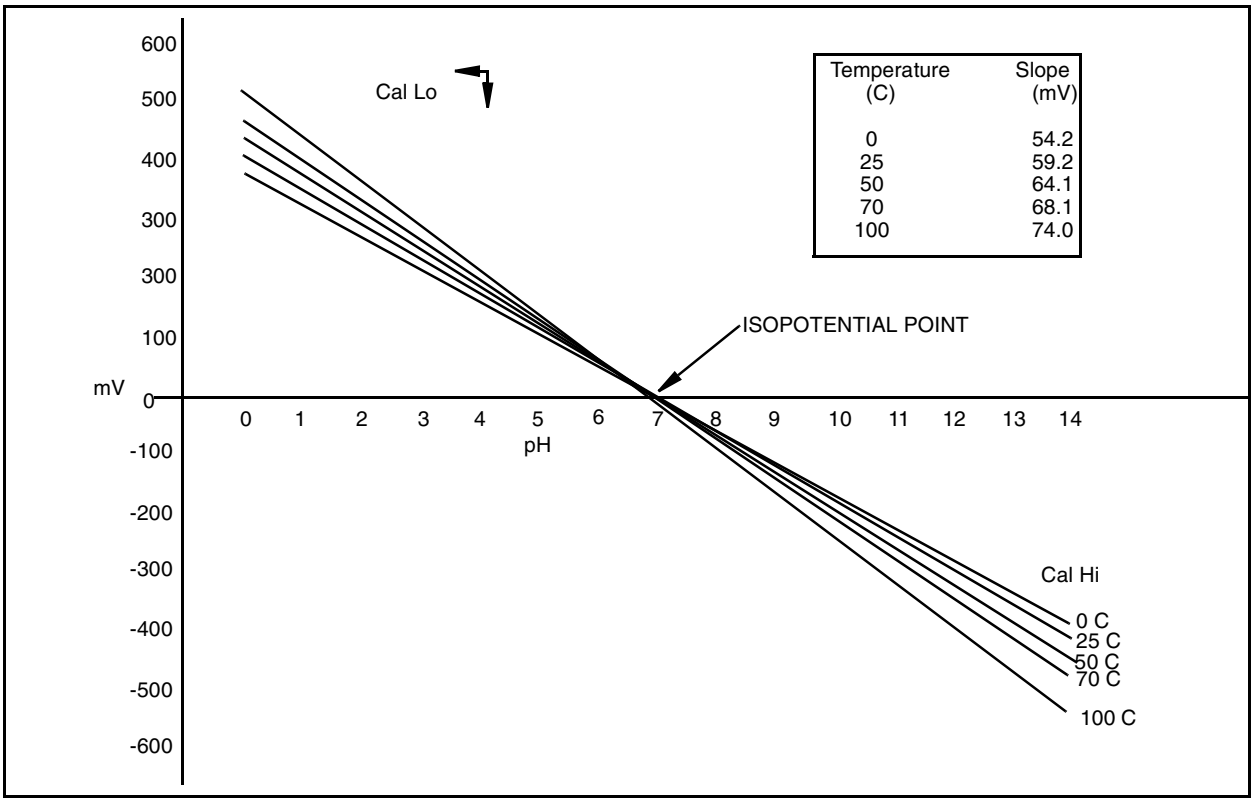


Figure 15. Relationship between pH and mV at Different Temperatures for a Standard Glass pH Sensor and Ag/AgCl Reference Electrode.

Error Codes

When the analyzer is operating normally, the measurement value is displayed constantly. If error or alarm conditions exist, the display alternates between the measurement value and the error/alarm message at a one second rate. The alternate (error/alarm) messages are shown in Table 5.

Table 5. Error/Alarm Messages

Alternate Display	Condition	Priority	Action Required to Clear Message
Er 1	Instrument Fault, RAM/ROM, software watchdog timer.	1 (Highest)	Power down unit.
Err	Incorrect code or parameter entered.	2	Check code and reenter.
t Er	Temperature out of range	3	1. Replace sensor. 2. Place temperature in manual mode (e.g.,25.C.).
LCAL	Low Calibration Required.	4	Use one buffer calibration procedure to recalibrate analyzer.
HCAL	High Calibration Required.	4	Use two buffer calibration procedure to recalibrate analyzer.
A1A2	Both alarm relays activated	5	1. Measurement returns to within alarm bounds. 2. Turn off Alarm 1 and Alarm 2.
Al 1	Alarm 1 relay activated	6	1. Measurement returns to within alarm bounds. 2. Turn off Alarm 1.
Al 2	Alarm 2 relay activated	6	1. Measurement returns to within alarm bounds. 2. Turn off Alarm 2.

NOTE: If two or more errors exist simultaneously, the analyzer will flash only the error with the highest priority. If the highest priority error is cleared and a lower priority error still remains, the analyzer will then flash the highest priority error of the remaining error

7. Alarm Contact Maintenance

The alarm relay contacts are selected to switch loads equal to or greater than 20 watts. The minimum contact current is 1 ampere. The silver alloy contacts rely on the very slight arc generated during switching to eliminate oxide layers that form on the contacts. When the contacts are used at low (signal) levels, contact function may become unreliable over time due to the formation of an oxide layer on the contacts.

When contacts must be used at low levels, attention must be paid to contact condition. The maximum contact resistance for new relays is 100 milliohms. Values above this level or unstable values indicate deterioration of the contact surface as noted above and may result in unreliable alarm function.

The contact surfaces can be restored as follows:

1. Disconnect the alarm wiring from the analyzer.
2. Connect a load of 20 W or more as shown in Figure 16 so that both NO and NC contacts are exercised.
3. Use the analyzer to switch the alarm relay several times.
4. Disconnect the load installed in Step 2 and reconnect the wiring removed in Step 1.
5. Check to ensure that the alarms are functioning properly.

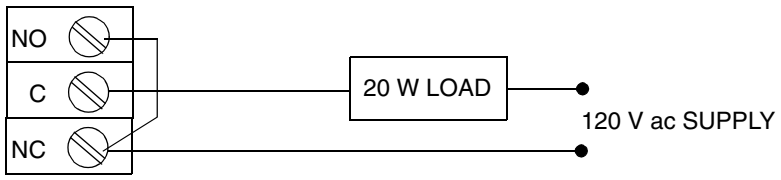


Figure 16. Alarm Contact Reconditioning Circuit

8. Warranty

For sales information or to place an order, contact your local Invensys Foxboro distributor or local Invensys Foxboro sales office.

For Warranty Information 1-800-746-6477

For Electrochemistry Analyzer Repair/Troubleshooting Information 508-549-2168

For Electrochemistry Technical Assistance and Application Support..... 508-549-4730

Or by FAX 508-549-4734

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