**Instruction**

MI 611-216
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# 870ITCR
# Intelligent Contacting Conductivity/Resistivity Transmitters

invensys
Foxboro®

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# Introduction

The 870ITCR Intelligent Transmitter converts contacting conductivity or resistivity measurements to a 4 to 20 mA and/or digital output signal depending on the model selected and the configuration implemented.

The analog output only version (Model 870ITCR-A) supports configuration, calibration, and diagnostic troubleshooting locally at the front panel. The transmitter has one 4 to 20 mA dc output which can be software configured (connected) to temperature compensated measurement, uncompensated (absolute) measurement, or temperature.

The digital output version (Model 870ITCR-F) supports configuration, calibration, and diagnostic troubleshooting locally at the front panel, via a PC-based configurator anywhere on the signal leads, or from any I/A Series workstation via an Intelligent Transmitter Fieldbus Module. The digital output version supports either digital only communication or a hybrid 4 to 20 mA dc/digital communication as configured. When operating in either of these modes, the transmitter continuously outputs three digital measurement values: temperature compensated measurement, uncompensated (absolute) measurement, and temperature. In the 4 to 20 mA mode, you may assign the output to any one of the three measurement parameters.

# Quick Start

The purpose of this section is to:

- Help you to wire your transmitter
- Familiarize you with the instrument configuration as received from the factory
- Assist you in verifying that your transmitter is in calibration
- Explain normal operation in Measure mode.

## Wiring

Your 870IT is a 2-wire transmitter. As such, it transmits output over the same two wires through which it receives power. If your transmitter was specified with analog communications (870ITCR-A), you must supply its power source. If it was specified with digital communications (870ITCR-F), power can be provided via the I/A Series Fieldbus Module. Connect this power/output signal to the power terminals and the signals from your measurement sensor to the appropriate terminals near the top of the case as shown in Figure 1.

**WARNING**

Wiring installation must comply with any existing local regulations.

**WARNING**

A safety agency certified energy barrier must be used with this apparatus to meet agency certification requirements. See MI 611-206 (FM/CSA) or MI 611-208 (ATEX) for details.

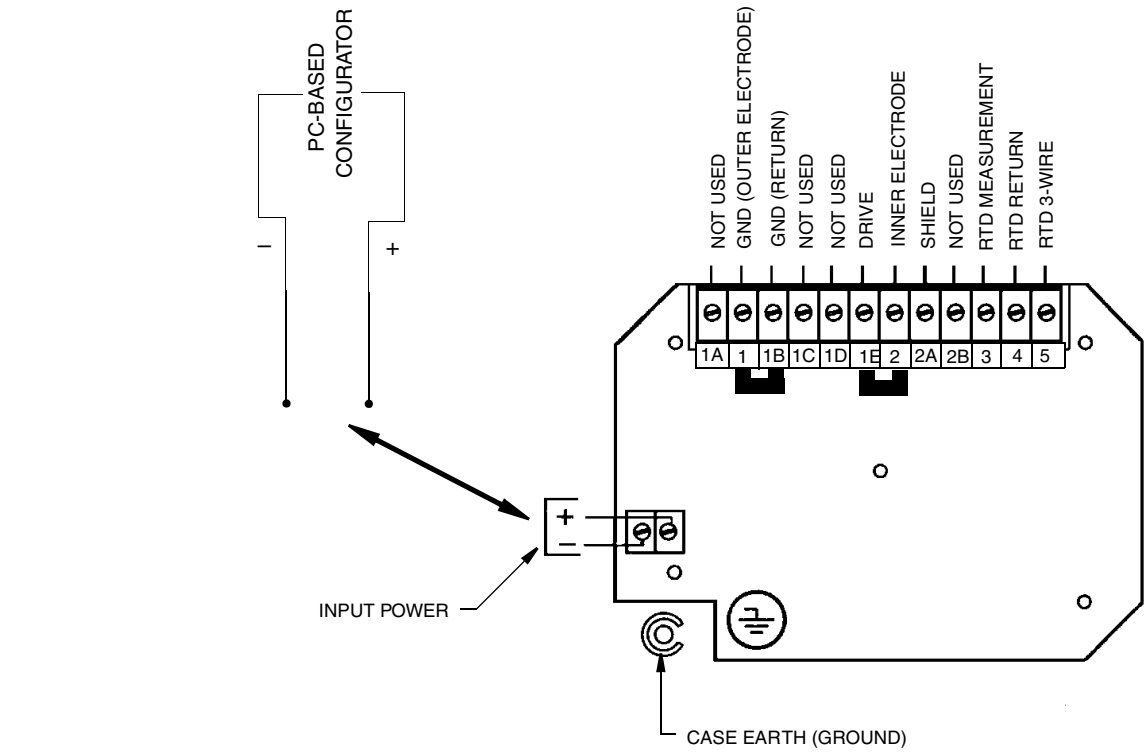



*Figure 1. Wiring for 871CR Sensor*

## Factory Default Passcode

The factory default passcode for both minor and major passcodes is 0800.

## Checking Factory Configuration

Following the structure diagrams in Appendix A and using the arrow keys, you can step through the product structure as configured in the factory. The factory default values are listed in Appendix B. There is space provided to make any notations you wish in the last column of the table that comprises this appendix.

## Basic Operation in Measure Mode

Measure is the normal operating mode of your transmitter. The conductivity or resistivity measurement is shown on the top line of the display. The second line of your display shows the absolute value of the measurement signal (conductivity in S/m, µS/cm, mS/cm, or mS/m and resistivity in kΩ•cm or MΩ•cm), the output in 4 to 20 mA, or the temperature, depending on your configuration. You can view one of the other two selections by using the Up and Down arrow keys. The display will return to the configured selection when the configured **TIMEOUT** time is reached. Configuration error signals and sensor error signals are also shown on your display while in the Measure mode.

## Looking for More Information?

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

For installation information, refer to "Installation" on page 6.

For detailed explanation of the controls and indicators, refer to "Controls and Indicators" on page 9.

For detailed configuration instructions, refer to "Configuration" on page 15.

For detailed calibration instructions, refer to "Calibration" on page 30.

For dimensional information, refer to DP 611-163.

General information on this and other electrochemical products are available on line at **www.foxboro.com** (pull down **Products** menu and select **Echem Analytical**).

If you need additional help, please call 1-866-746-6477 in the U.S.A. or contact your local Invensys Foxboro representative.

# Reference Documents

| Document[(a)] | Title |
|---|---|
| DP 611-163 | Dimensional Print - 870IT Intelligent Transmitters |
| MI 020-495 | PC20 Intelligent Field Device Tool |
| MI 020-501 | PC50 Intelligent Field Device Tool |
| MI 020-504 | PC50 Intelligent Field Device Tool (FoxCom Communication) |
| MI 611-206 | FM and CSA Intrinsic Safety Connection Diagrams and Nonincendive Circuits |
| MI 611-208[(b)] | Electrochemical Products Safety Information (for European installations) |
| PL 611-153 | Parts List - 870IT Style B Intelligent Transmitters |

(a) Documents are available on line at **www.foxboro.com** (pull down **Products** menu and select **Documentation**).

(b) Available in many languages on line at www.foxboro.com/us/eng/products/instrumentation/downloads/ecanalyticalsafety/ecanalyticalsafety.htm.

# Specifications

Sensors:

The 870ITCR Transmitter is used with Foxboro 871CR Series Conductivity/Resistivity Sensors. Contact Invensys Foxboro for limitations and procedures with other electrically compatible sensors.

Maximum Distance Between Sensor and Transmitter: 33 m (100 ft)

Temperature Compensation Inputs:

100 ohm platinum RTD
1000 ohm platinum RTD
100 kilohm thermistor

Ambient Temperature: -25 to +55° C

Relative Humidity: 0 to 95% noncondensing

**Electromagnetic Compatibility (EMC):** The Model 870ITPH Intelligent Transmitter complies with the requirements of the European EMC Directive 89/336/EEC when the sensor cable and I/O cables are enclosed in rigid metal conduit. (See Table 2.)

Power Supply Requirements (for 4 to 20 mA output): 12.5 to 42 V dc (See Figure 2)

Load Limitations (for 4 to 20 mA output): 0 to 1450 ohms (See Figure 2)

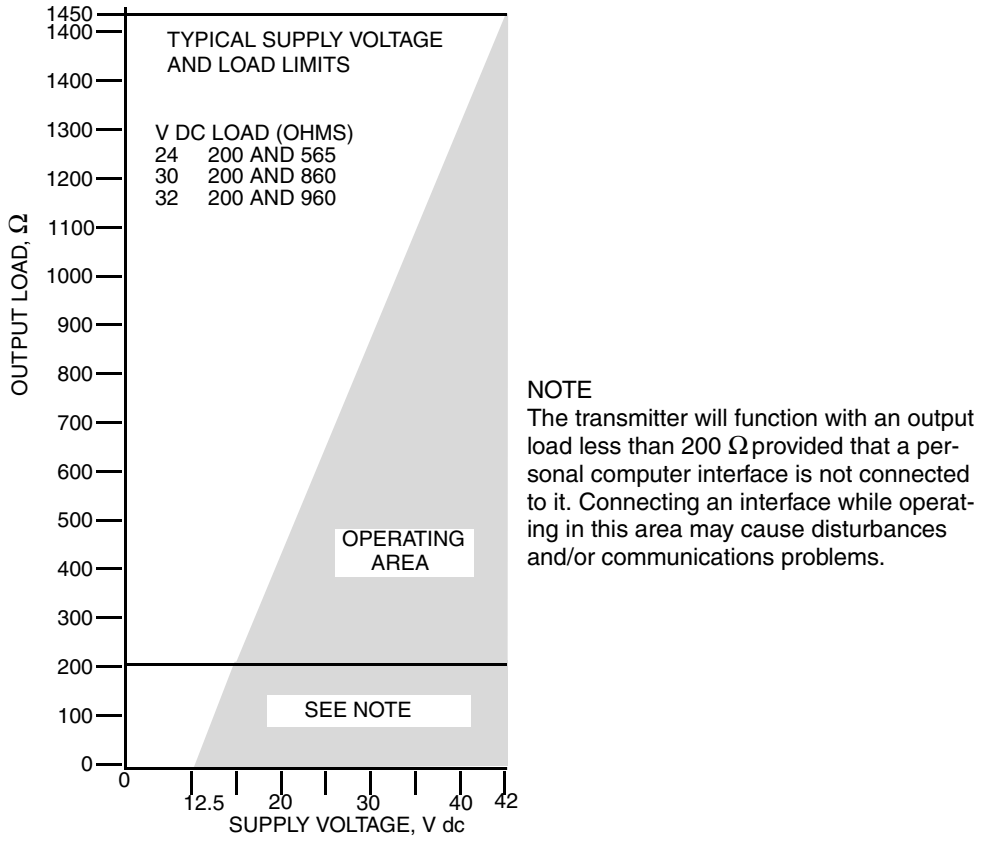



*Figure 2. Supply Power vs. Load*

Product Safety: The 870IT transmitters have been designed to meet electrical safety descriptions listed in Table 1. For detailed information, or status of testing laboratory approvals/certifications, contact Invensys Foxboro.

*Table 1. Product Safety Specifications*

| Testing Laboratory, Types of Protection, and Area Classification | Application Conditions | Electrical Safety Design Code |
|---|---|---|
| **ATEX** intrinsically safe for II 1 G, EEx ia IIC hazardous locations. | Temperature Class T4 - T6 | AAA |
| **ATEX** Type n energy limited for II 3 G EEx nL IIC hazardous locations | Temperature Class T4 - T6 | ANN |
| **CSA** intrinsically safe for Class I, Division 1, Groups A, B, C, and D; Class II, Division 1, Groups E, F, and G; Class III, Division 1 hazardous locations. | Connect per TI 005-105. Temperature Class T4. | CAA |
| **CSA** Class I, Division 2, Groups A, B, C, and D; Class II, Division 2, Groups F and G; Class III, Division 2 hazardous locations. | Temperature Class T4. | CNZ |
| **FM** intrinsically safe for Class I, Division 1, Groups A, B, C, and D; Class II, Division 1, Groups E, F, and G; Class III, Division 1 hazardous locations. | Connect per TI 005-101. Temperature Class T4. | FAA |
| **FM** Class I, Division 2, Groups A, B, C, and D; Class II, Division 2, Groups F and G; Class III, Division 2 hazardous locations. | Temperature Class T4. | FNZ |

# Identification

A data label is fastened to the left side surface of the enclosure. This label provides the model number and other information pertinent to your particular transmitter.

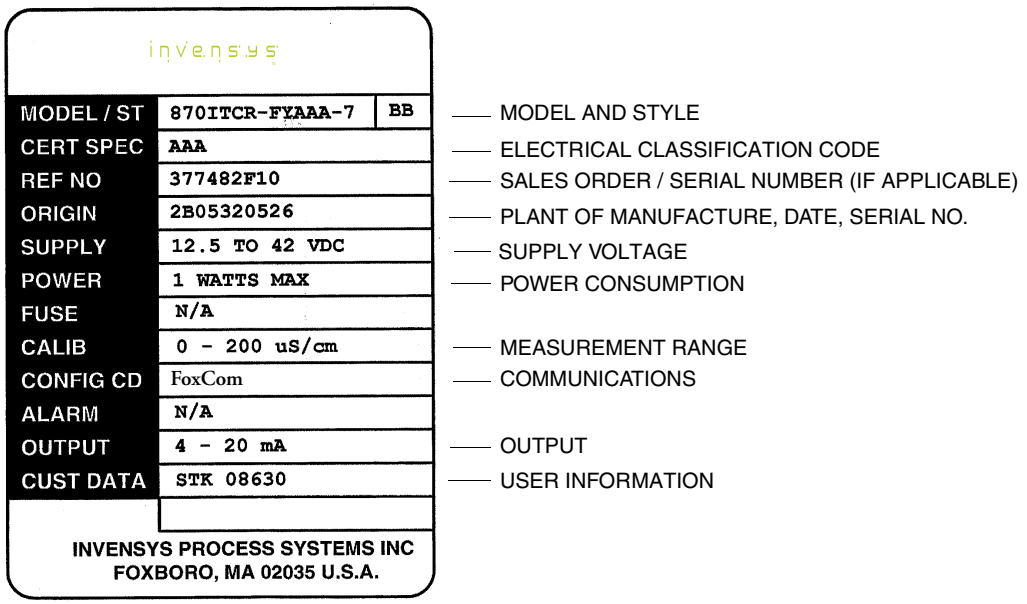



*Figure 3. Data Label*

# Installation

## Unpacking

1. Remove the transmitter from the shipping container and check for visible damage.
2. Save the container until you determine that no shipping damage has occurred.
   a. If no damage is observed, proceed to "Mounting" section below.
   b. If transmitter has been damaged, notify the carrier immediately and request an inspection report. Obtain a signed copy of the report from the carrier and call the Customer Satisfaction Center at 1-866-746-6477 in the U.S.A., or contact your local Invensys Foxboro representative.

## Mounting

### *Panel Mounting*

Panel mounting of the transmitter is shown in Figure 4. For panel cutout size, space requirements, and other dimensional data, see DP 611-163.

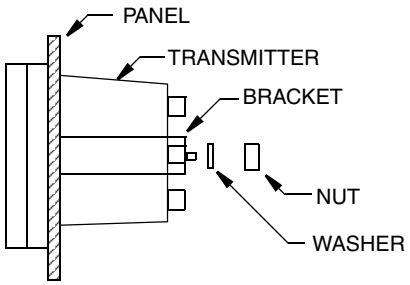



*Figure 4. Panel Mounting*

## Surface Mounting

Surface mounting of the transmitter is shown in Figure 5. Fasten mounting bracket to transmitter using screws, washers, and lockwashers provided. Fasten mounting plate to surface using appropriate hardware. For space requirements and other dimensional data, see DP 611-163.

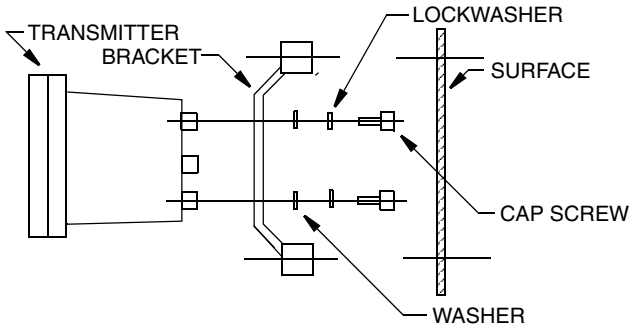



*Figure 5. Surface Mounting*

## Pipe Mounting

Pipe mounting of the transmitter is shown in Figure 6. Securely fasten mounting bracket to a DN50 or 2-in pipe as shown. For space requirements and other dimensional data, see DP 611-163.

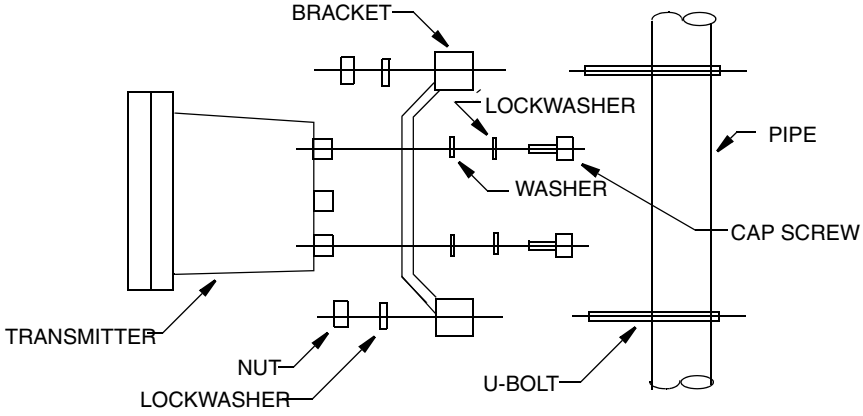



*Figure 6. Pipe Mounting*

# Wiring

Your 870IT is a 2-wire transmitter. As such, it transmits output over the same two wires through which it receives power. If your transmitter was specified with analog communications (870ITCR-A), you must supply its power source. If it was specified with digital communications (870ITCR-F), power can be provided via the Foxboro I/A Series Fieldbus Module. Connect this power/output signal and the signal from your measurement sensor as follows:

1. Open the hinged case door.
2. Remove the plastic shipping caps from the openings on the bottom of the case and replace with proper fittings. You will be running wires through the left and right openings and capping the middle opening.

**WARNING**

Wiring must comply with any existing local regulations.

**WARNING**

A safety agency certified energy barrier must be used with this apparatus to meet agency certification requirements. See MI 611-206 (FM/CSA) or MI 611-208 (ATEX) for details.

**CAUTION**

1. Failure to adequately seal open ports or secure the cover will jeopardize NEMA 4X, CSA Enclosure 4X, or IEC IP65 and will void instrument warranty.
2. To maintain a rating of NEMA 4X, CSA Enclosure 4X, or IEC IP65, wiring methods, conduit, and fittings appropriate to the ratings must be used. Table 2 identifies recommended parts.

**CAUTION**

To mimimize RFI/EMI effect, use grounded metal conduit on sensor cable and input power leads.

*Table 2. Recommended Conduit and Fittings*

| Material | 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 HV, 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 |

*T&B = Thomas & Betts Corp., 1001 Frontier Road, Bridgewater, NJ 08807

3. Bring the wires from your 2-wire input power in the left opening and connect to the input power terminals shown in Figure 7. Bring the sensor cable in the right opening and connect to the appropriate terminals near the top of the case per Figure 7.
4. If you are **not** wiring a temperature measuring device, short terminals 3, 4, and 5 to minimize noise.

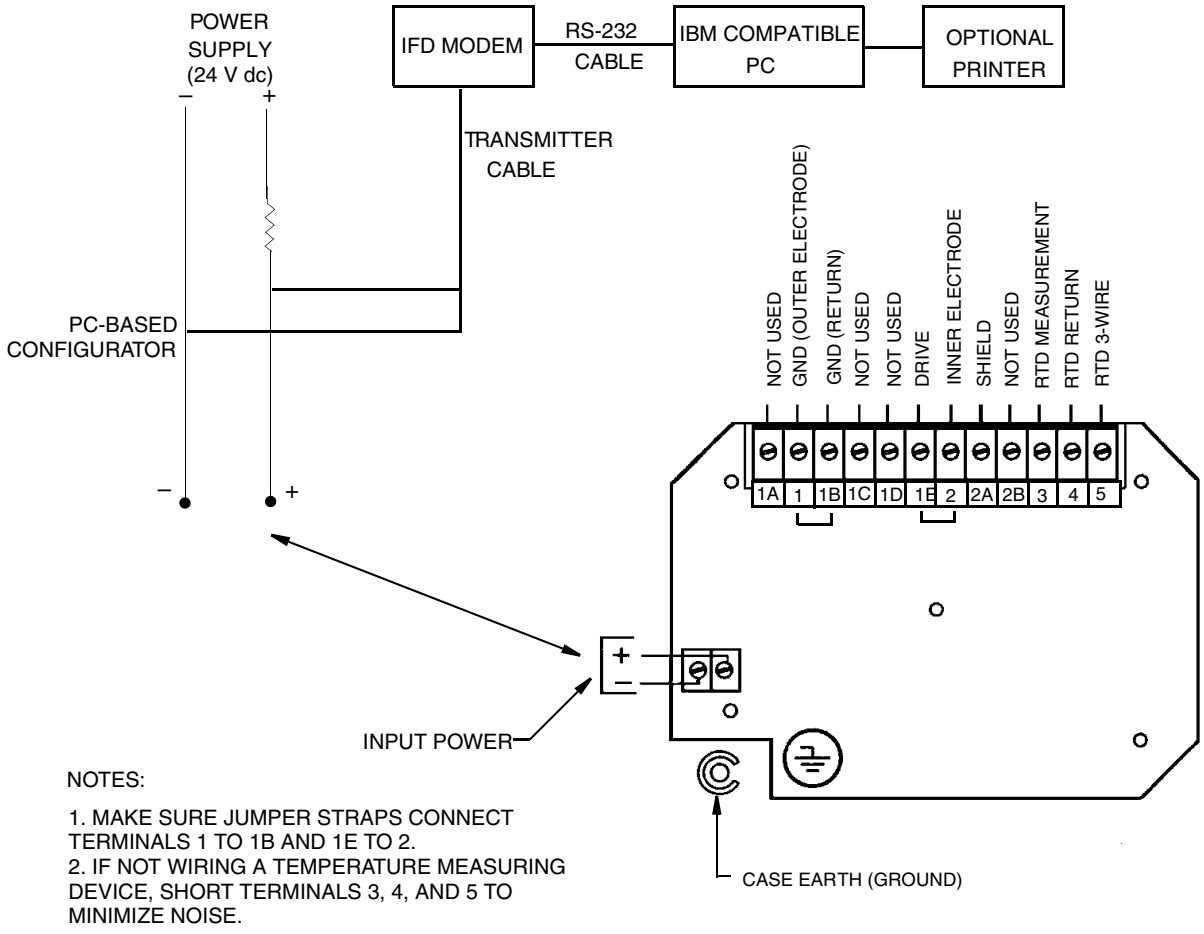



*Figure 7. Wiring for 871CR Sensor*

# Operation

## Controls and Indicators

Operator controls and indicators are located on the front panel. Figure 8 shows the panel arrangement. Table 3 identifies the function of each element.

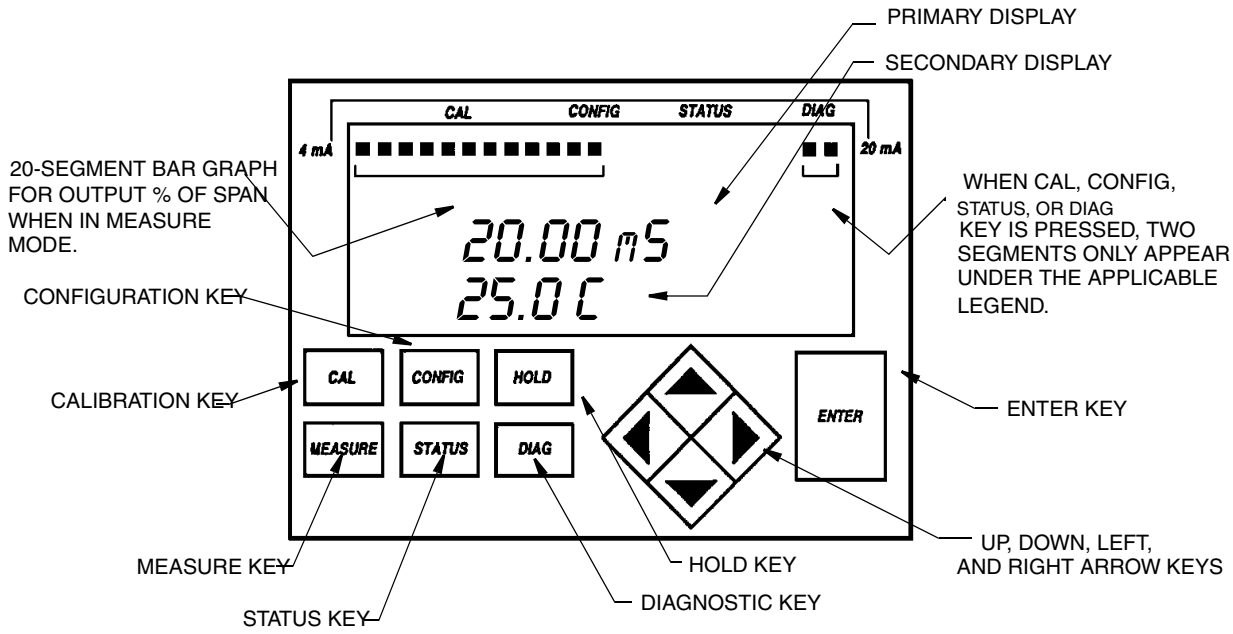



*Figure 8. Indicators and Controls*

*Table 3. Indicators and Controls*

| Control/Indicator | Function |
|---|---|
| Digital Bar Graph | Displays analog output percent-of-range indication. During Configuration, "zips" as an indication of a value being entered. Also indicates mode of operation (**CAL**, **CONFIG**, **STATUS**, or **DIAG**) displayed. |
| Primary Display | Displays measurement and some error messages. |
| Secondary Display | Displays the absolute value of the measurement signal (conductivity in mS/m, S/m, µS/cm, mS/cm and resistivity in kΩ•cm, or MΩ•cm), the output in 4 to 20 mA, or the temperature, and error messages and configuration/calibration prompts. |
| CALibration Key | Places transmitter in Calibration mode. This enables you to calibrate the transmitter with solutions, resistors/capacitors, or factory default calibration data. |
| CONFIGuration Key | Places transmitter in Configuration mode. This enables you to configure the value or status of each parameter required for your application. |
| HOLD Key | Places transmitter in Hold mode. This enables you to hold the output at a determined value while configuring or calibrating the transmitter or performing sensor maintenance. |
| MEASUREment Key | Places transmitter in Measurement (normal operation) mode. |
| STATUS Key | Places transmitter in Status mode. This enables you to view the measurement and system parameters and thus assess the performance of the loop. |

*Table 3. Indicators and Controls (Continued)*

| Control/Indicator | Function |
|---|---|
| DIAGnostics Key | Places transmitter in Diagnostic mode. Pressing the right arrow key after entering this mode enables you to further identify specific errors and possible solutions to an error flagged in Measurement mode. |
| Direction (Arrow) Keys | Moves you through the structure diagram and subsequent menus. They may be used to increment one position at a time, or through a menu or string of values by holding a key in the depressed position. |
| ENTER Key | Enters the menu item or value selected. |

# Error Messages

The 870IT will display one of several messages when a problem occurs. These are summarized below:

**Flashing Display:** Occurs when there are not enough significant digits on the display to display a number. For example, if the **PRIMARY SCALE** was configured as 50.00 and a measurement of 100 was received, the display would flash +99.99.

CAL ERROR: Occurs when a limit condition was exceeded during an attempted calibration. CAL appears on the top line and **ERROR** on the bottom line of the display.

PROBE ER: Occurs in Measure mode only when one of the probe errors (Leakage, ATC Short, or ATC Open) is present and the diagnostic is enabled. For more information, see "Diagnostics" on page 14. The message appears on the bottom line of the display and flashes alternately with the bottom line measurement. The transmitter is still configurable. For probe errors of ATC Short or ATC Open, temperature inputs can be held at the fail-safe value if set. See "Config Temp" on page 25.

CONFIG ER: Occurs in measure mode only when one of the following errors is present: Configuration Required (**CFG REQ**), 4 - 20 mA Range (**4-20 RNG**), Measurement Range (**MEAS RNG**), and Compensation Range (COMP RNG). For more information, see "Diagnostics" on page 14. The message appears on the bottom line of the display and flashes alternately with the bottom line measurement.

ER DATA: Occurs after you change a value and try to enter it with the **ENTER** key. The display flashes ER DATA, then reverts to the beginning of the entry data. The top line does not change from the previous edit prompt. Situations causing this message are:

1. New value is out of range.
2. The slope of a chemical composition curve has changed sign.
3. The first value of a compensation point pair (**TEMPxx** in **TEMPCOMP** or **ABSxx** in **CHEMCOMP**) was entered that was not greater than the last one.

**— NOTE**

Occasionally the display flashes **WAIT** for an extended period of time. The diagnostics may be checking ROM, EEPROM, EPROM, RAM, stack checking, watchdog timer, processor register integrity, and sensor board validation.

## Passcode Access

Two levels of passcode protection are available. The Minor level permits access to Calibration and Output Hold. The Major level permits changing parameters in Configuration as well as Calibration and Hold. Both are 4-digit passcodes. The passcodes may or may not be the same. They are set as part of configuring the instrument.

Upon entering the Configuration, Calibration, or Hold mode by pressing the appropriate key, the display will read **PASSCODE 0000**. Upon entering the proper passcode and then pressing the **ENTER** key, the display will change to the next item in the appropriate structure. The initial factory default value for both Minor and Major passcodes is 0800. If the incorrect passcode is entered when you seek to enter Configuration, the unit will remain locked but the configuration settings can be viewed.

## Viewing and Changing Data

In the Configuration, Calibration, Hold, Diagnostic, and Status modes, you need to move through a structure of parameters (using the arrow keys and **ENTER** key) to view (and in some modes change) the value or status of a particular parameter. Structure diagrams, located in Appendix A, will aid you in doing this.

Note that the Up and Down arrow keys will scroll through a menu in either direction. Also, that the arrow keys may be used to increment one position at a time, or to move continuously through a menu or string of values by holding the key in the depressed position.

The following example will show you how to use the keys in moving through the structure. The example used is that of configuring temperature features. For the example, assume Fahrenheit temperature units, an automatic temperature mode, a fail signal of 77°F, and a 3-wire, 1000 ohm RTD. In following the procedure, refer to Figure 9.

1. Use the Right arrow key to move from **CONFIG TEMP** to **TEMP UNITS** and then to **UNITS CELSIUS**.
2. Use the Down arrow key to move to **UNITS FAHREN** and press the **ENTER** key. This will “enter” your Fahrenheit selection and return the display to **TEMP MODE**. Every temperature entry in the transmitter will now be in Fahrenheit units.
3. Use the Right arrow key to move to **MODE AUTO**. Press the **ENTER** key. This will “enter” your Auto selection and move the display to **FAIL SIG 000.0**. The tenths digit will be flashing.
4. Because you do not need to change the tenths digit, use the Left arrow key to move to the units digit. Use the Up arrow key to change this digit to 7.
5. Use the Left arrow key to move to the tens digit and the Up arrow key to change this digit to 7. You have now achieved your goal of setting the value to 77.0, so press the **ENTER** key. This will enter your value of 77 and move the display to **TEMP TYPE**.
6. Use the Right arrow key to move to **TYPE RTD** and press the **ENTER** key. This will “enter” your selection of RTD and move the display to **RTD 2 WIRE**.
7. Use the Down arrow key to move to **RTD 3 WIRE** and press the **ENTER** key. This will “enter” your selection of 3 Wire and move the display to **3 WIRE 100 OHM**.

8. Use the Down arrow key to move to **1000 OHM** and press the **ENTER** key. This will "enter" your selection of 1000 OHM and move the display back to **CONFIG TEMP**. This completes the example.

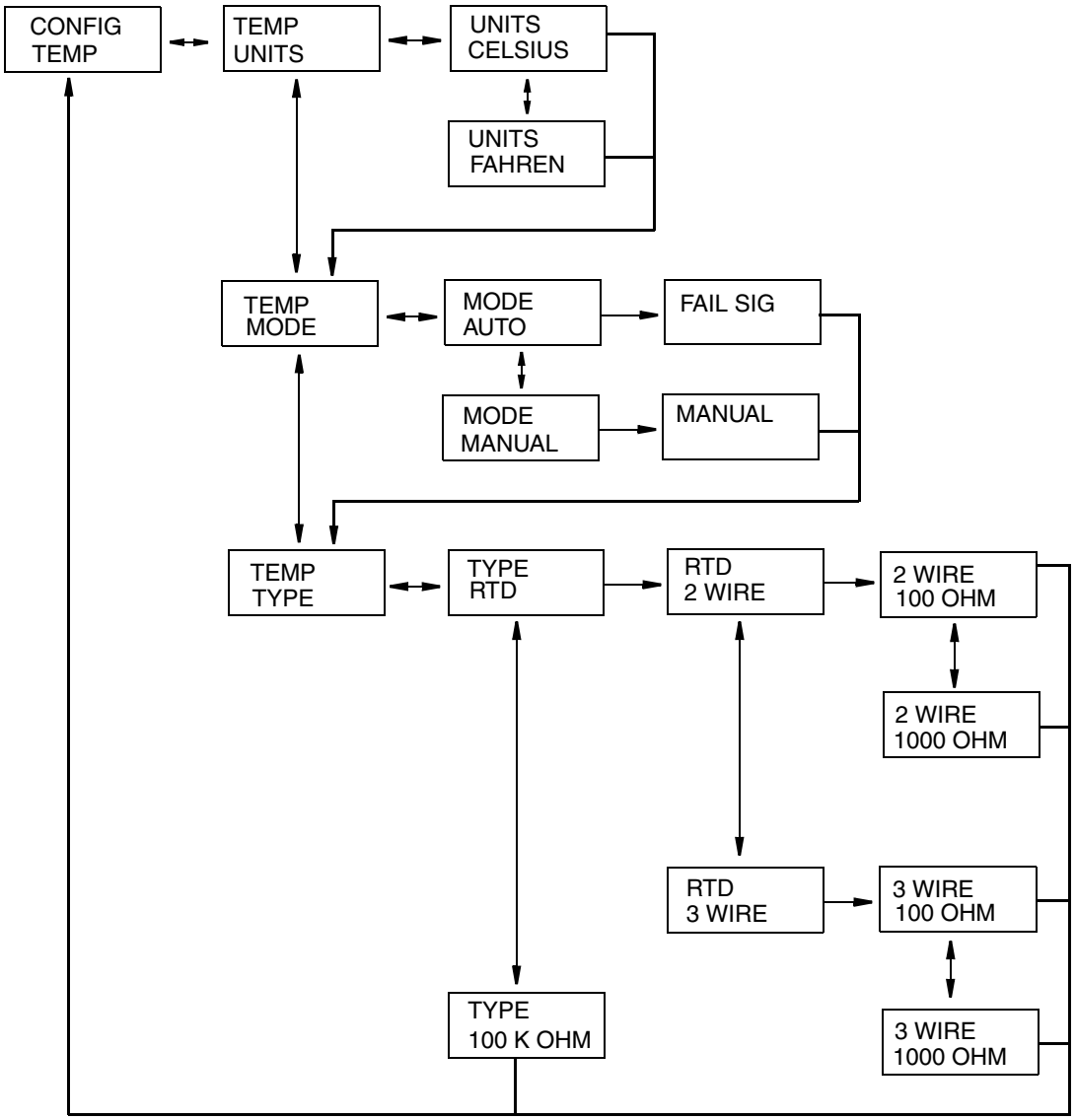



*Figure 9. Example of Structure Diagram*

# Measure

Measure is the normal operating mode of your transmitter. The conductivity/resistivity measurement is shown on the top line of the display. It is in the units specified during configuration. The second line of your display continually displays the absolute conductivity value in mS/m, S/m, µS/cm, mS/cm or absolute resistivity in kΩ•cm, or MΩ•cm, the analog output in 4 to 20 mA, or the temperature, depending on your configuration. You can view one of the other two selections by using the Up and Down arrow keys. The display will return to the configured selection when the **TIMEOUT** time is reached or by pressing the Measure key. Because

the 870ITCR Transmitter can be preconfigured for up to three distinct applications, you can move from one application to another by "calling up" a specific application in Configuration mode and then monitor and control it in the Measurement mode. Sensor (**PROBE ER**) and Configuration (**CONFIG ER**) errors are also shown on your display while in the Measurement mode.

## Diagnostics

(Refer to "Structure Diagram 13" on page 48.)

The Diagnostics mode enables you to perform checks on your system at any point in time. While you are in the Diagnostic mode, two segments of the bar graph will appear under the legend DIAG at the top of the front panel. To enter the Diagnostics mode, press the **DIAG** key on the front panel. If there are no errors, your display will read **DIAGS OK**. If there was an error flagged as **PROBE ER** or **CONFIG ER** in the Measurement mode, pressing the right arrow key in Diagnostics mode will help you further identify the specific error and corrective action. Possible errors and the recommended corrective actions are listed in Table 4.

**— NOTE**

If an error occurs, even with **OUTPUT FAILSAFE** configured **OFF**, the display still flags the error in Measurement mode if the diagnostic is configured **ENABLE**.

*Table 4. Diagnostic Errors*

| Message | Description | Corrective Action |
|---|---|---|
| Probe Errors | | |
| LEAKAGE | Checks solution leakage into the probe. | Replace sensor. |
| ATCSHORT<br>ATC OPEN | Flags an error if the resistance of the temperature compensator is greater or less than the expected resistance of the device configured. | Replace sensor or run in Manual Temp mode. |
| Configuration Errors | | |
| INVALID | Configuration includes a combination of cell factor, units and scale not supported by the transmitter. | Reconfigure specified application. |
| 4 - 20 RNG | Measurement over or under configured range. | Reconfigure range or correct process error. |
| MEAS RNG | Measurement is over or under the range that can be supported by the transmitter in the present configuration. | Reconfigure scale or correct process error. |
| COMP RNG | Measurement is over or under the temperature or concentration compensation tables. | Reconfigure compensation or correct process error. |

## Status

(Refer to "Structure Diagram 10" on page 45.)

The Status mode enables you to view the measurement and system parameters and thus assess the performance of the loop. You may not edit them in this mode. All measurements (outputs)

continue while in the Status mode. To enter the Status mode, press the **STATUS** key. Move through the menu by using the Up and Down arrow keys. While you are in the Status mode, two segments of the bar graph will appear under the legend **STATUS** at the top of your front panel. The Status menu contains the following parameters:

*Table 5. Status Parameters*

| Parameter | Description |
|---|---|
| APP # | Application number currently running (if number of applications is greater than 1). |
| TEMP | Process Temperature |
| ABSOLUTE | Uncompensated conductivity or resistivity signal from sensor |
| UNITS | Configured conductivity or resistivity unit or percent. |
| mA | Analog Output: Analog output value in mA<br>Digital Output: Output shown on secondary display in mA. |
| ATC RES | Resistance of temperature compensator |
| CAL NAME | Name of last calibrator |
| LAST CAL | Date of last calibration (mm/dd/yy) |
| CAL USED | Type of last calibration (solution, factory default, user instrument, or pure water) |
| TAG NAME | Tag name* |
| LOCATION | Location of measurement* |
| SONUMBER | Sales order number |
| MS CODE | Model code |
| S/W VER | Software version |
| DEV NAME | Device name* |
| DEV TYPE | Device type* |
| TAG NUM | Tag Number |

*Appears only on devices model coded 870ITCR-F

Only eight characters will be shown on your display at a time but you may scroll using the Left and Right arrow keys.

# Configuration

Configuration is the process of establishing functional capability in the transmitter firmware for your application. This section will help you to systematically determine and configure the value or status of each parameter required for your application. Many applications require only changing a few of the default values already entered. While you are in the Configuration mode, two segments of the bar graph will appear under the legend **CONFIG** at the top of your front panel. These segments will flash if you are also in a Hold mode. To enter the Configuration mode, press the **CONFIG** key. At the prompt, enter the four character Major passcode and press **ENTER**.

**NOTE**

The factory set passcode is 0800.

If the passcode is correct, the display will flash **UNLOCKED** and then change to the first item in the configuration structure. You may then edit any of the parameters in the Configuration mode. If the passcode is incorrect, the display will flash **LOCKED** and then change to the first item in the configuration structure. You may view the parameters in this mode but will not have the ability to change them. In the **UNLOCKED** condition, the analog output defaults to 3.8 mA. If you do not want this to happen, turn the Hold feature on first.

**! CAUTION**

Always exit the Configuration mode by pressing the Measure key before power is turned off. This allows proper reinitialization of internal data base security checks.

When configured parameters are entered, the bar graph "zips" (every segment illuminates one at a time in rapid succession) indicating confirmation of the new configuration.

## *Config Appls*

(Refer to "Structure Diagram 1" on page 36.)

**NOTE**

This parameter appears only when the number of applications set in "Config Num Apps" on page 29 is more than 1.

The 870ITCR Transmitter can be preconfigured for up to three distinct applications. Each application can have its own display, temperature compensation curve, chemical concentration curve (if applicable), and output configuration. Each application is assigned an identification number (such as 1, 2, or 3). You must first specify the number of applications you wish to configure in "Config Num Apps" on page 29). If Config Num Apps is set at "1", then the Config Appls parameter is bypassed in the menu structure.

If in using the transmitter, you wish to change from one application to another, you can specify the application number in **CONFIG APPLS**, and the entire application set switches to that preconfigured application.

You can also specify **AUTO** instead of **1**, **2**, or **3**, and the transmitter will switch from one application to another when triggered by measurements above or below established limits. When using **AUTO**, Appl 1 must have the lowest measurement values, Appl 2 the next higher, and Appl 3 the highest. All application must use the same cell constant. Refer to "Config Trigger" on page 29.

## *Config Celconst*

This section of the structure asks you to specify the cell constant. Specify **0.10**, **10.00**, or **OTHER**. If **OTHER**, specify its cell factor. The firmware allows a cell factor entry between 00.00 and 99.99. Contact Invensys Foxboro regarding the use of other sensors on this transmitter.

## Configx Display

**NOTE**

In the next several sections, when the first line prompt in the structure diagrams is suffixed by the letter "x," the "x" is replaced by the application number that is currently being edited. The application number is omitted when **CONFIG NUM APPS** is configured as 1.

(Refer to "Structure Diagram 2" on page 37.)

This section enables configuration of the primary (top) and secondary (bottom) digital displays for local viewing.

Under **DISPLAY PRIMARY** you can specify the **PRIMARY UNITS** as MΩ•cm, kΩ•cm, mS/m, µS/cm, or Custom if the cell constant was configured as 0.1. You can specify the **PRIMARY UNITS** as kΩ•cm, mS/m, S/m, or µS/cm, mS/cm, %, or Custom if the cell constant was configured as 10. If Custom, you can specify the units as % (percent), g/l (grams/liter), ppm (parts per million), oz/gal (ounces per gallon), ppt (parts per thousand), or None.

**NOTE**

If custom units are selected, you must configure both custom temperature and chemical compensation data.

Next, if you selected MΩ•cm, kΩ•cm, mS/m, S/m, or µS/cm, or mS/cm as **PRIMARY UNITS**, you will be asked to specify the **PRIMARY SCALE** as indicated in Table 6.

*Table 6. Primary Scale for Units Other than Custom*

| Units | Cell Constant | Scale* |
|---|---|---|
| MΩ•cm | 0.1 | 2, 5, 10, 15, 20 |
| | OTHER | 2, 5, 10, 15, 20 |
| kΩ•cm | 0.1 | 50, 100, 500, 1000, 2000, 5000 |
| | 10 | 10, 50 |
| | OTHER | 10, 50, 100, 500, 1000, 2000, 5000 |
| mS/m | 0.1 | 0.2, 0.5, 1, 2, 5, 10, 20 |
| | 10 | 50, 100, 200, 500 |
| | OTHER | 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000 |
| S/m | 10 | 0.2, 0.5, 1, 2 |
| | OTHER | 0.1, 0.2, 0.5, 1, 2 |
| µS/cm | 0.1 | 1, 2, 5, 10, 20, 50, 100, 200 |
| | 10 | 200, 500, 1000, 2000, 5000 |
| | OTHER | 1, 2, 5, 10, 20, 50, 100, 200 |
| mS/cm | 10 | 0.2, 0.5, 1, 2, 5, 10, 20 |
| | OTHER | 0.1, 0.2, 0.5, 1, 2, 5, 10, 20 |

* These scales are temperature compensated upper range settings. In absolute Tempcomp, measurement can exceed scale selected by an approximate factor of five. See Table 7 for some exact upper range settings at different temperatures.

**— NOTE**

In Measurement mode, because of space availability, the units µS/cm, mS/m, and mS/cm are displayed locally as µS and mS respectively.

*Table 7. Actual Upper Range Settings as a Function of Temperature*

| Cell Constant | Scale Value | Upper Range Settings as Function of Temperature | | | | | |
|---|---|---|---|---|---|---|---|
| | | 0 - 30°C | 30 - 60°C | 60 - 90°C | 90 - 120°C | 120 - 150°C | 150 - 200°C |
| 0.1 $cm^{-1}$ | µS/cm | | | | | | |
| | 1.000 | 4.717 | 2.670 | 1.885 | 1.504 | 1.244 | 1.000 |
| | 2.000 | 9.434 | 5.340 | 3.770 | 3.007 | 2.489 | 2.000 |
| | 5.000 | 9.999 | 9.999 | 9.424 | 7.518 | 6.222 | 5.000 |
| | 10.00 | 47.17 | 26.69 | 18.84 | 15.03 | 12.44 | 10.00 |
| | 20.00 | 94.34 | 53.39 | 37.69 | 30.07 | 24.88 | 20.00 |
| | 50.00 | 99.99 | 99.99 | 94.24 | 75.17 | 62.22 | 50.00 |
| | 100.0 | 471.7 | 266.9 | 188.5 | 150.3 | 124.4 | 100.0 |
| | 200.0 | 943.4 | 533.9 | 376.9 | 300.7 | 248.9 | 200.0 |
| 10 $cm^{-1}$ | µS/cm | | | | | | |
| | 200.0 | 943.4 | 533.9 | 376.9 | 300.7 | 248.9 | 200.0 |
| | mS/cm | | | | | | |
| | 0.200 | 0.943 | 0.534 | 0.377 | 0.301 | 0.249 | 0.200 |
| | 0.500 | 0.999 | 0.999 | 0.942 | 0.752 | 0.622 | 0.500 |
| | 1.000 | 4.717 | 2.669 | 1.884 | 1.503 | 1.244 | 1.000 |
| | 2.000 | 9.434 | 5.339 | 3.769 | 3.007 | 2.488 | 2.000 |
| | 5.000 | 9.999 | 9.999 | 9.424 | 7.517 | 6.222 | 5.000 |
| | 10.00 | 47.17 | 26.69 | 18.85 | 15.03 | 12.44 | 10.00 |
| | 20.00 | 94.34 | 53.39 | 37.69 | 30.07 | 24.89 | 20.00 |

If you have a 10 $cm^{-1}$ cell factor and selected % (but not CUSTOM %) as PRIMARY UNITS, you will be asked to specify the scale according to the chemical being measured. See Table 8. The most recently programmed chemical will appear on the display. Use the arrow keys to display the desired chemical and press ENTER. The reference temperature is 25°C (77°F).

**— NOTE**

Setting these parameters sets the units, decimal placement, and temperature compensation.

*Table 8. Primary Scale in Percent by Weight*

| Chemical | Scale | mS/cm Equivalent at 25°C |
|---|---|---|
| Phosphoric Acid ($H_3PO_4$) | 0 - 3% | 0 to 200 |
| Acetic Acid ($CH_3OOH$) | 0 - 9% | 0 to 1.556 |

For each of these scale ranges, the value to the right of the "-" is editable (to tenths resolution) in order to close the span to no less than 10% of the full scale shown. The span cannot be increased beyond what is shown. Once a span has been selected, the greatest absolute conductivity for that span will be validated against the selected cell type.

Next, under **DISPLAY SECOND**, you can configure the secondary display to show the absolute value of the absolute measurement in conductivity units, the output in 4 to 20 mA, or the temperature.

## *Configx Chemcomp*

(Refer to "Structure Diagram 5" on page 40.)

This section of the structure asks you to specify the chemical compensation, the relationship between conductivity/resistivity units in kΩ•cm, mS/m, S/m, µS/cm, or mS/cm and Custom units in units of your choice.

**— NOTE**

This parameter will not appear unless your **PRIMARY UNITS** were configured as Custom (%, g/l, ppm, oz/gal, ppt, or None) in "Configx Display" on page 17.

The process specific compensation data must be generated or extracted in advance of entering it into the transmitter. The data should be plotted graphically as well as tabularly to prepare it for entry into your transmitter. See Figure 10.

The prompts first ask you to specify the absolute scale **UNITS** in kΩ•cm, mS/m, S/m, µS/cm, or mS/cm, the absolute scale (**ABSSCALE**) as .9999, 9.999, 99.99, 999.9, or 9999., and the custom scale (**CUSSCALE**) as .9999, 9.999, 99.99, 999.9, or 9999. The absolute scale is in kΩ•cm, mS/m, S/m, µS/cm, or mS/cm as just specified and the custom scale is in the units previously configured in **CONFIG X DISPLAY**. Next, you are asked to specify a number of points (**NUM PTS**) to plot the compensation curve. The number of points can be specified from 2 to 21 and has a default of 2. Lastly, for each of the number of points specified above, specify an absolute value (**ABSxx**) and the value you want it to be (**NEWxx**).

A maximum or minimum difference between successive concentrations is not required. The intervals do not have to be evenly spaced. We suggest 2 or 3 points be used in linear regions and more data points be used in curved regions. See Figure 11.

**— NOTE**

Although the message "Underrange" may flash after data entry, you may continue to enter data without problems.

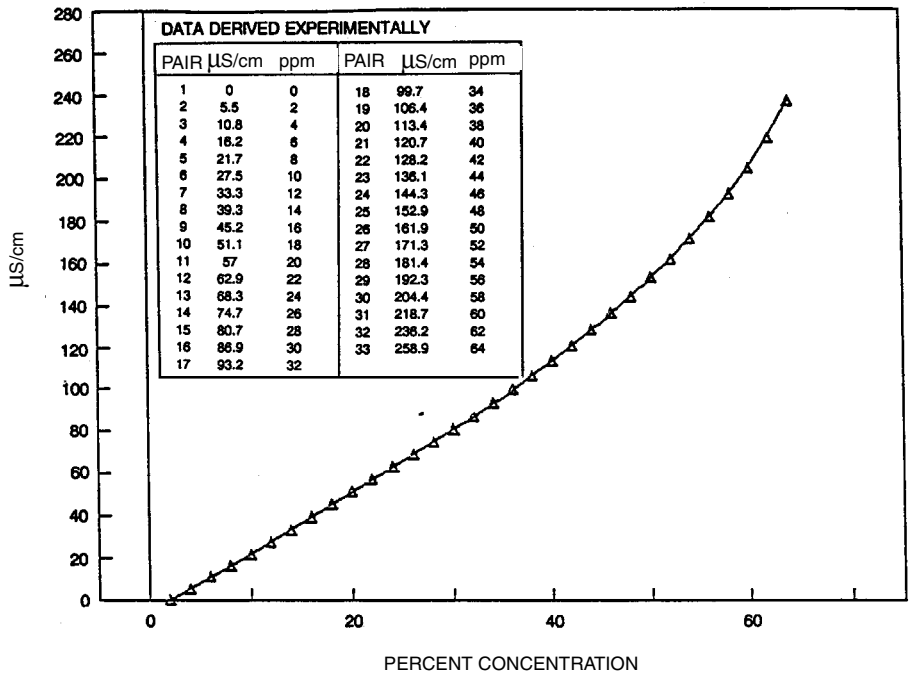



*Figure 10. Reference Conductivity vs. Concentration Data*

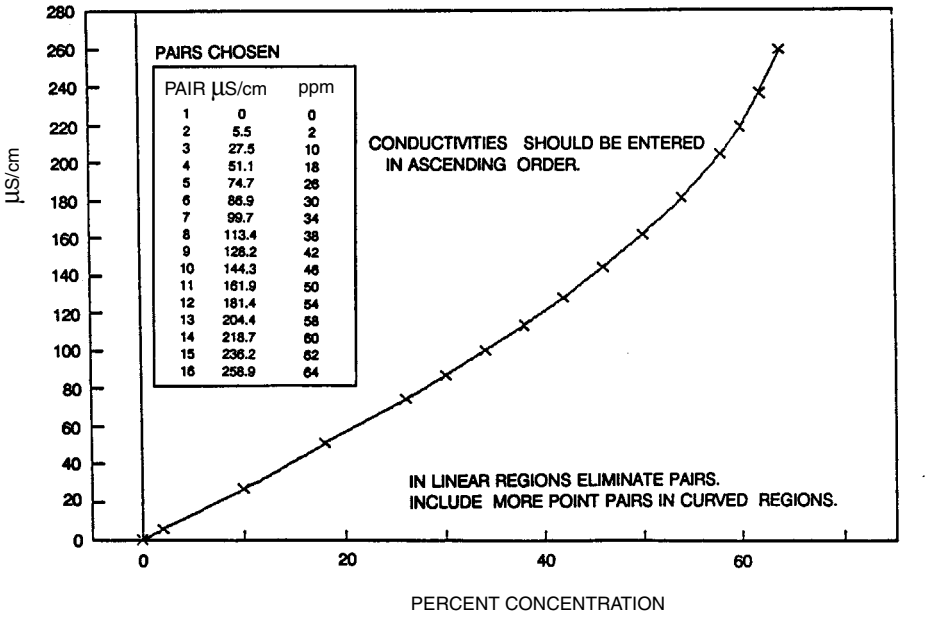



*Figure 11. Configured Conductivity vs. Concentration Data*

In the example used in Figure 12 and Figure 13, the 33 reference points were reduced to 16 configured points. The configuration procedure would have been as follows:

1. Specify your **PRIMARY UNITS** as **CUSTOM** and % in "Configx Display" on page 17.
2. Go to **CONFIG CHEMCOMP** and specify the absolute units. For this example, µS/cm.
3. Specify the scale of your absolute values. For this example, because they are from 0 to 258.9, specify **ABSSCALE** as 999.9.
4. Specify the scale of your custom units. For this example, because they are from 0 to 64 percent concentration and the degree of accuracy is only required in whole units of percent, specify **CUSSCALE** as 9999.
5. Specify the number of points on your curve. For this example, 16.
6. Specify the 16 point pairs.

**— NOTE**

When entering data, remember to check the ± sign at the left of your display.

**— NOTE**

If chemical compensation curve data is entered such that the slope would change sign, then the message **ER DATA** appears on the bottom line of your display. Press any key to clear the message and continue editing. Editing continues by reverting back to the first point pair entry, with all previously entered values saved. Actual database saving of the compensation table is not performed until the last point pair is entered.

## *Configx Tempcomp*

(Refer to "Structure Diagram 4" on page 39.)

This section of the structure asks you to specify the temperature compensation.

**— NOTE**

This parameter will not appear if your **PRIMARY UNITS** were configured as percent (%) in "Configx Display" on page 17 since the transmitter applies the appropriate compensation automatically.

### Primary Units Configured kΩ•cm, mS/m, S/m, µS/cm, or mS/cm

If your **PRIMARY UNITS** were configured as kΩ•cm, mS/m. S/m, µS/cm, or mS/cm, you are first asked to specify **ABSOLUTE**, **$H_3PO_4$**, **LOW COND**, **$CH_3COOH$**, **USP 23**, **AMMONIA**, **MORPHALN**, **LINEAR**, or **CUSTOM**. Select one of the compensations listed in Table 9. The most recently configured entry will appear on the display. Use the arrow keys to display the desired entry and press **ENTER**.

*Table 9. Temperature Compensations*

| Tempcomp Menu | Additional Information | Valid Temperature Range |
|---|---|---|
| Absolute | No Temp Comp applied | N/A |
| $H_3PO_4$ | Phosphoric Acid (25°C Ref)(0-3%) | 4.4 to 93°C (40 to 200°F) |
| Low Cond<br>Ions + water<br>Ions | <br>Sodium Chloride + water<br>Sodium Chloride (25°C Ref) | All Ranges |
| $CH_3COOH$ | Acetic Acid (25°C Ref) (0-8%) | 5 to 120°C (40 to 250°F) |
| USP23 | $NH_3$/NaCl (25°C Ref) | (0 to 100°C) |
| Ammonia | $NH_3$ (25°C Ref) | (0 to 100°C) |
| Morphaln | Morphaline (25°C Ref) | (0 to 100°C) |
| Linear | | All Ranges |
| Custom | | Varies per situation |

**ABSOLUTE** means that there is no temperature compensation applied. The displayed value can exceed the scale by approximately five times (5X).

**LOW COND** is used for pure water applications. Selecting **IONS** causes the instrument to follow temperature compensation for a sodium chloride salt and causes the conductivity reading to remove the conductivity due to water. Selecting **IONS + $H_2O$** causes the conductivity reading to include that due to both the water and impurities.

If you selected **LINEAR**, specify the slope of the linear compensation curve between 0.5 and 5.0 %/°C. The default value is 2.2. The reference temperature is 25°C.

If you selected **CUSTOM**, the prompts will ask you to specify a reference temperature and a number of points to plot a compensation curve. The process specific compensation data must be generated or extracted in advance of entering it into the transmitter. We suggest that the data be plotted graphically as well as tabularly to prepare it for entry into your transmitter. See Figure 12.

In entering the data, the number of points (**NUM PTS**) can be specified from 2 to 21 points (default value is 2). Each point specifies a conductivity value at a certain temperature. The **TEMPxx** temperature units (Celsius or Fahrenheit) are specified under "Config Temp" on page 25. The values (**VALxx**) can be specified from 0 to five times the scale value chosen.

**— NOTE**

When entering data, remember to check the ± sign at the left of your display.

The data should be input to the transmitter with increasing values of temperature.

**— NOTE**

If temperature compensation curve data is entered such that a temperature value is not greater than the previous one, then the message **ER DATA** flashes on the bottom line of your display. Editing continues by reverting back to the first point pair entry, with all previously entered values saved. Actual database saving of the compensation table is not performed until the last point pair is entered.

A maximum or minimum temperature difference between successive temperatures is not required. The intervals do not have to be evenly spaced. We suggest 2 or 3 points be used in linear regions and more data points be used in curved regions. See Figure 12 and Figure 13.

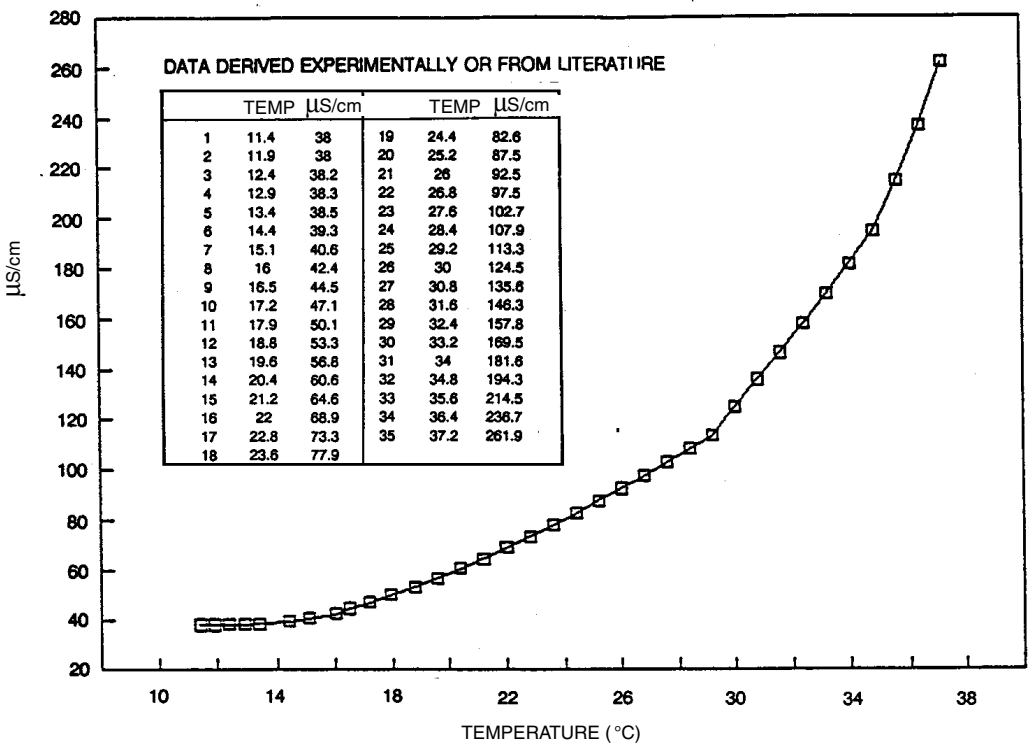



*Figure 12. Reference Conductivity vs. Temperature Data*

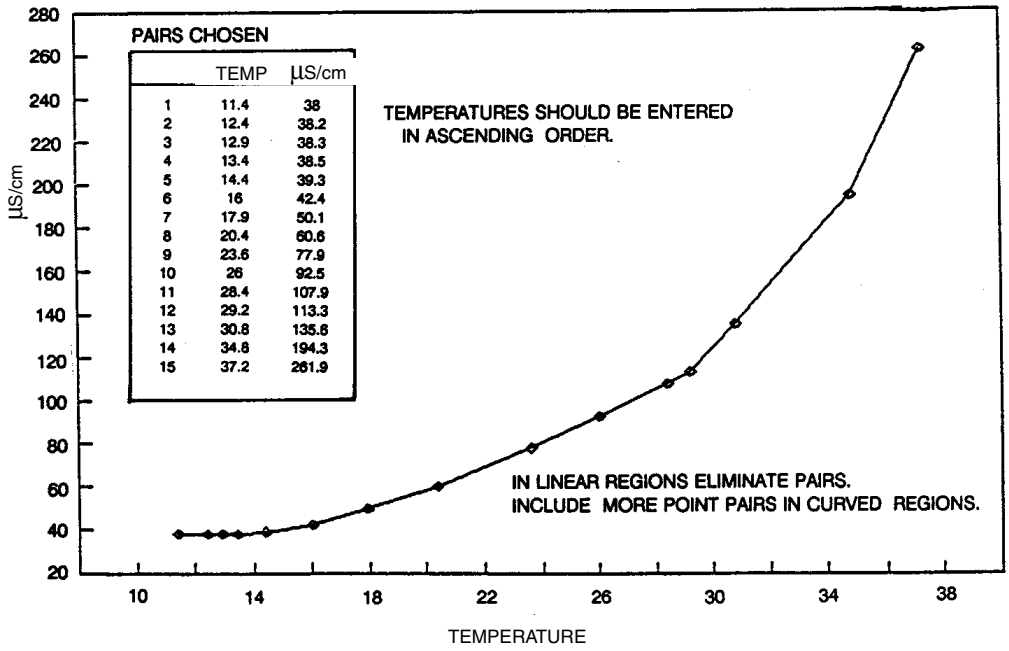



*Figure 13. Configured Conductivity vs. Temperature Data*

In the example used in Figure 12 and Figure 13, the 35 reference points were reduced to 15 configured points. The configuration procedure would have been as follows:

1. Specify the reference temperature. For this example, 25°C.
2. Specify the number of points on your curve. For this example, 15.
3. Specify the 15 point pairs.

#### Primary Units Configured MΩ•cm

If your **PRIMARY UNITS** were configured as MΩ•cm, you are first asked to specify an **ABSOLUTE**, **ULTRAPUR**, **USP 23**, or **CUSTOM** temperature compensation. **ABSOLUTE** means that there is no temperature compensation applied. If you selected **ULTRAPUR**, you must specify the curve as **T.LIGHT** or **M and S** (Marsh & Stokes). For information on these curves, contact Foxboro. If you selected **CUSTOM**, see section immediately above.

#### Primary Units Configured CUSTOM

If your **PRIMARY UNITS** were configured as **CUSTOM** in "Configx Display" on page 17, the prompts ask you to specify a reference temperature. The temperature units (Celsius or Fahrenheit) are specified under "Config Temp" on page 25. However, the choice of conductivity units (kΩ•cm, mS/m, S/m, or µS/cm, or mS/cm) was not made previously so it is made here. Foxboro strongly recommends using the same units selected in **CONFIGx CHEMCOMP**. Next, you are asked to specify a number of points to plot a compensation curve as you were in the procedure above. The number of points (**NUM PTS**) can be specified from 2 to 21 points and has a default value of 2. Each point specifies a value at a certain temperature.

## *Configx Output*

(Refer to "Structure Diagram 5" on page 40.)

This section of the structure first asks you to specify the **MODE**, referring to the communications and measurement output. If your transmitter was specified with analog output only (870ITCR-A), your only choice is to specify **ANALOG**. If your transmitter was specified with I/A Series communications (870ITCR-F), specify **ANALOG** if you want to have a 600 baud digital signal superimposed over an analog 4 to 20 mA signal, or specify **DIGITAL** if you want to have a 4800 baud digital signal only.

If you configured the mode as **DIGITAL**, the 4 to 20 mA output will be fixed at 12 mA.

If you configured the mode as **ANALOG**, you will be asked to configure three parameters:

First, under **OUTPUT ANALOG**, specify the 4 to 20 mA output to represent the uncompensated (**ABSOLUTE**) measurement, the temperature compensated **MEASURE**ment, or the **TEMP**erature.

Next, under **OUTPUT RANGE**, enter the **MIN**imum (4 mA) and **MAX**imum (20 mA) range values for the output just specified. The analog output range can be set up to approximately five times the primary scale chosen. The message **ER DATA** flashes if the setable limit is exceeded.

The units displayed for **MEASURE** are those chosen in **DISPLAY UNITS**. For **ABSOLUTE**, either conductivity or resistivity units are displayed. For **TEMPERATURE**, either °C or °F is displayed depending on what is selected in **CONFIG TEMP**.

**— NOTE**

A change in **OUTPUT ANALOG** causes the **OUTPUT RANGE** to default to 0.0 and thus new **MIN** and **MAX** values must be entered.

Lastly, you can specify a failsafe signal. This signal is triggered for all probe or configuration error conditions enabled. These are enabled singly or as a group in **CONFIG DIAGS** (see page 27). Specify **OFF** under **OUTPUT FAILSAFE** to omit this feature. Specify **ON** to specify a fixed output when in a failed condition. If **ON** is selected, further specify the **DC mA** output between 3.8 and 20.5 mA. The default value is 3.8 mA. If you want to have this signal outputted with ±0.5 mA pulse (as shown below) for greater visibility on a chart recorder or data display, specify **ON** as explained above and then go back and specify **PULSE**.

An example of how to use this feature follows:

Suppose you are using your 4 to 20 mA signal to control a valve that diverts high conductivity water. You also wish to divert the flow if the measurement system is suspect due to a configuration error. To configure your transmitter to do this:

1. Configure your output so that 20 mA is the upper limit of acceptable water before diverting flow.
2. Configure **OUTPUT FAILSAFE** as **ON** and set the **DC mA** value as 20.5.
3. In **CONFIG DIAG**, enable the **4-20 RNG**, **COMP RNG**, and **MEAS RNG** selections and disable the **LEAKAGE**, **ATC OPEN**, and **ATC CLOSED** selections.

**— NOTE**

If an error occurs, even with **OUTPUT FAILSAFE** configured **OFF**, the display still flags the error in Measurement mode if the diagnostic is configured **ENABLE**.

## *Config Temp*

(Refer to “Structure Diagram 5” on page 40.)

This section of the structure asks you to specify the temperature features that will be used for all three applications. First, specify the **TEMP UNITS** as **CELSIUS** or **FAHREN**heit. All references to temperature will appear in the specified units within the transmitter software.

Next, specify the **TEMP MODE** as **AUTO** or **MANUAL**. In the **AUTO** mode, the temperature follows the temperature input RTD or thermistor “ATC” and you can set a temperature default **FAIL SIG**nal value (in case the RTD or thermistor fails) at the temperature at which you expect the process to be operating. In **MANUAL** mode, the temperature can be set at a fixed temperature value and resistance inputs on the temperature terminal are ignored.

Last, specify the **TEMP TYPE** as **RTD** or **100 kOHM** thermistor. If you specify the **TYPE** as **RTD**, specify **2-WIRE** or **3-WIRE** and specify the resistance as **100 OHM** or **1000 OHM**. The 871CR sensor uses a 1000 ohm, 3-wire RTD. Contact Invensys Foxboro for information regarding use of other sensors with this transmitter.

## *Config Damping*

(Refer to "Structure Diagram 5" on page 40.)

This section of the structure asks you to specify the damping response time (90% of step). Choices are 1, 5, 10, 20, 40, and 120 seconds. Damping applies only to measurement data, not to temperature data.

## *Config Instrmnt*

(Refer to "Structure Diagram 6" on page 41.)

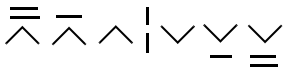
**— NOTE**

This section is not displayed unless the correct passcode was entered for Configuration.

### INSTRMNT mA CAL

This subsection allows you to tune the 4 mA and 20 mA values. The procedure is as follows:

1. Connect a digital current meter in series with the negative power input lead (see Figure 7).
2. With **INSTRMNT mA CAL** displayed, press **ENTER**. The display will change to **mA CAL 4 mA**. Press **ENTER** again.
3. Calibration is performed by having your current meter read 4 mA. Do this by selecting one of the seven icons from the second line of your display by using the Left and Right arrow keys. When you have highlighted the icon you want, press ENTER. The icon meanings (shown below) are (from left to right) large increase, medium increase, small increase, accept and exit, small decrease, medium decrease, large decrease.



4. Repeat Step 3 until your meter reads 4 mA. Then highlight the center icon and press **ENTER**. The display will go to **mA CAL 20 mA**. Press **ENTER**.
5. Repeat the procedure shown in Steps 3 and 4 for 20 mA. The current reading should be 20 mA.

### INSTRMNT STAB IND

When performing a calibration (see "Calibration" on page 30), the transmitter checks for stability in absolute measurement and temperature before accepting a change. This section enables you to configure the **TIME** allowed to attain stability and the amount of fluctuation (**VAR**) allowed during the calibration. The value of **VAR** corresponds to the least significant digit of the measurement in the **PRIMARY SCALE** you configured in "Configx Display" on page 17. Both **TIME** and **VAR** are configured individually in **STAB IND MEAS**urement and **STAB IND TEMP**erature.

First, configure **STAB IND MEAS** as **ON** or **OFF**. If you configure this as **ON**, you need to specify the **TIME** between 5 and 60 seconds (in 5-second increments) and the **VAR**iable between

1 and 9. The default **TIME** is 5 seconds and the default **VAR**iable is 9. A longer time period and a smaller measurement value assures more stability during calibration.

**— NOTE**

In specifying the **VAR**iable, the numbers 1 through 9 refer to the last digit of the primary scale; e.g.,

If scale is 20.00 mS, a **VAR** value of 5 means 0.05 mS

If scale is 100.0 µS, a **VAR** value of 5 means 0.5 µS

Thus, if the scale is 20.00 mS, and the default time and variable are used, the values can change at a rate of 0.09 mS over 5 seconds.

Then repeat the procedure for **STAB IND TEMP**. If you configure this as **ON**, you need to specify the **TIME** between 5 and 60 seconds (in 5-second increments) and the **VAR**iable between 1 and 9 (°C or °F). The default **TIME** is 5 seconds and the default **VAR**iable is 9, thus allowing a temperature change of 0.9°C or °F over a 5-second period.

#### INSTRMNT CAL_DEV

The Calibration Deviation subsection allows you to specify the amount of deviation from the factory calibration you can tolerate during your instrument calibration. You may specify 1%, 2%, 5%, 10%, or 20%, or disengage this feature by specifying **OFF**.

## *Config Timeout*

(Refer to “Structure Diagram 6” on page 41.)

This section of the structure asks you to specify the time in which the instrument will bring you back to the on-line/Measurement mode from another on-line mode (Status, Diagnostics, or the view only part of Configuration) when no keyboard input has occurred. In Measure mode, **TIMEOUT** also limits the time to view a secondary display other than that configured in **CONFIG DISPLAY**. The time may be specified between 5 and 999 seconds. The default time is 600 (10 minutes).

## *Config Passcode*

(Refer to “Structure Diagram 6” on page 41.)

**— NOTE**

This parameter is not displayed if the transmitter is “locked” (i.e., the correct passcode was not entered for Configuration).

This section of the structure asks you to specify the Minor and Major Passcode. The Minor passcode limits access to routine maintenance functions including **CALIBRATION** and output **HOLD**. The Major passcode prohibits unauthorized personnel from changing the configuration parameters. Each is a 4-character string between 0000 and 9999. They may or may not be the same. The default passcodes are both 0800. To disable the passcode feature, configure a passcode as 0000. If the Major passcode is 0000, both passcodes are disabled.

## *Config Diags*

(Refer to “Structure Diagram 7” on page 42.)

This section of the structure allows configuring error messages that can appear on your display. You can elect to **ENABLE** all messages, **DISABLE** all messages, or enable or disable each of the following individually: **LEAKAGE**, **ATCSHORT**, **ATC OPEN**, **4 - 20 RNG**, **COMP RNG**, and **MEAS RNG**. Each of these is discussed below. A typical approach is to initially select **ENABLE ALLDIAGS** and to **DISABLE** select messages later when you find out that you do not require them. Further, when you have messages on your display, you may **CLEAR** all of the messages or **CLEAR** specific messages. This feature then disables the reporting of those messages for an hour to allow time for corrective maintenance. Diagnostics that are enabled and triggered can also force a fail-safe analog output signal, if desired. See "Configx Output" on page 24

#### LEAKAGE

This message reports a problem of severe liquid leakage into the sensor which causes an ATC short to a measurement electrode. The message may be enabled, disabled, or cleared. A **PROBE ER** message is displayed if this diagnostic is enabled and this fault occurs.

#### ATCSHORT, ATC OPEN

This message reports a problem if the resistance of the temperature compensator is greater or less than the expected resistance of the device configured. The message for each may be enabled, disabled, or cleared. A **PROBE ER** message is displayed if this diagnostic is enabled and this fault occurs.

#### 4 - 20 RNG

This message reports that the measurement tied to the analog output (measurement, absolute measurement, or temperature) is outside the range configured for the currently running application. The message may be enabled, disabled, or cleared. A **CONFIG ER** message is displayed if this diagnostic is enabled and this fault occurs.

#### COMP RNG

This message reports that the measured temperature or absolute conductivity or resistivity measurement is outside the temperature or chemical compensation curve configured for the currently running application. The message may be enabled, disabled, or cleared. A **CONFIG ER** message is displayed if this diagnostic is enabled and this fault occurs.

#### MEAS RNG

This message reports that the measurement is over or under the measurable range that is configured for the currently running application. The message may be enabled, disabled, or cleared. A **CONFIG ER** message is displayed if this diagnostic is enabled and this fault occurs.

## *Config Strings*

(Refer to "Structure Diagram 8" on page 43.)

This section of the structure asks you to specify the designation of the Tag Number (**TAG NUM**), Tag Name (**TAG NAME**), Location (**LOCATE**), and Device Name (**DEV NAME**). Each can be

made up of characters from Table 10 and can be of up to the following number of characters in length:

| | |
|---|---|
| TAG NUM | 12 |
| TAG NAME | 14 |
| LOCATE | 14 |
| DEV NAME | 6 |

Only eight characters will be shown on your display at a time but the display will scroll as you enter additional characters.

**— NOTE**

Only **TAG NUM** appears if your transmitter was specified with analog output only (870ITCR-A).

*Table 10. List of Characters*

| Characters |
|---|
| 0 through 9 |
| . (period) |
| – (dash) |
| (blank) |
| A through Z |
| _ (underscore) |

## *Config Num Apps*

(Refer to “Structure Diagram 8” on page 43.)

This section of the structure asks you to specify the Number of applications (**NUM APPS**) you wish to preconfigure. It can be 1, 2, or 3. For more information on this subject, see “Config Appls” on page 16.

## *Config Trigger*

(Refer to “Structure Diagram 8” on page 43.)

If **AUTO** was configured under “Config Appls” on page 16, allowing you to switch from one application to another automatically, this section of the structure enables you to specify the parameters under which the switching will occur. Specify the values of these triggers (**APP1 HI**, **APP2 LO**, **APP2 HI**, and **APP3 LO**). These values must be entered in actual values and not in percent. It is assumed that although the ranges of the applications must overlap, application 1 has the lowest conductivity value, application 2 is next, and application 3 has the highest. The switching from one application to another only takes a few seconds. However, once a switch is made, another switch will not be allowed for one minute.

# Hold

(Refer to “Structure Diagram 9” on page 44.)

The Hold mode enables you to hold the output at a determined value, thus allowing you to configure or calibrate the transmitter or perform sensor maintenance without disturbing the control loop. If you do *not* put the transmitter in Hold mode before configuring or calibrating, the output will go to 3.8 mA if you have configured the output as **ANALOG** or be held at the present value if you have configured the output as **DIGITAL**.

While you are in the **HOLD** mode, the bar graph will flash on and off. If you return to the Measure mode without releasing the hold, the message **ON HOLD** will flash on the secondary display.

To enter the Hold mode, press the **HOLD** key. You will be prompted to enter the Major or Minor Passcode. If you enter the incorrect passcode, the transmitter will revert to the Measurement (normal) mode. If you enter the correct passcode, the display will read **HOLD OFF** or **HOLD ON**. If it reads **HOLD OFF**, use the Down arrow key to change it to **HOLD ON**. Then specify whether you want to hold the output at the **PRESENT** value or at another value that you will **MANUAL**ly set.

If you selected **MANUAL** and your transmitter was specified with analog only communications (870ITCR-A), your display will read **MANUAL ANALOG**. Specify the value between 4.00 and 20.00 mA that you want to hold the output at while in the HOLD mode. The default value is 4.00.

If you selected **MANUAL** and your transmitter was specified with both analog and digital communications (870ITCR-F), and you had previously selected **ANALOG** under **CONFIG OUTPUT**, your display will read **MANUAL ANALOG**.

1. Specify the value between 4.00 and 20.00 mA at which you want to hold the output while in the Hold mode. The default value is 4.00.
2. Next, go to **MANUAL DIGITAL** and specify the **MEASURE**ment, **TEMP**erature, and **ABSOLUTE** measurement value at which you want to hold the output while in the Hold mode.
    a. The **MEASURE**ment value can be specified between 0.0 and approximately 4.99 x the scale configured.
    b. The **TEMP**erature can be specified between -99.9 and +999.9 (C or F). The default value is 0.0.
    c. The **ABSOLUTE** measurement value can be specified between 0.0 and approximately 4.99 x the scale configured. The default value is 0.0.

If you selected **MANUAL** and your transmitter was specified with digital communications (870ITCR-F), and you had previously selected **DIGITAL** under **CONFIG OUTPUT**, your display will prompt you to specify the **MEASURE**ment, **TEMP**erature, and **ABSOLUTE** measurement value at which you want to hold the output while in the Hold mode. For allowable values, see a, b, and c above.

# Calibration

(Refer to “Structure Diagram 11” on page 46.)

Calibration routines in your transmitter were designed for simplicity and the elimination of errors. The procedures are self-prompting. Three calibration routines are available for conductivity measurements and two for resistivity measurements. The first, **CALx SOLUTION**,

enables you to enter or edit conductivity value(s) of your solution. A single point offset (to bias the measurement by a constant value), single point span (to correct for cell factor change due to installation), or 2-point solution calibration may be performed. The second routine, **CALx INST**, is accomplished with the use of discrete components or by returning to the stored factory default calibration. The third routine, **CAL PURE H2O**, is only used with pure water. It enables you to enter the specific cell factor and temperature cell factor of your sensor. Note that damping is not active during any of these calibrations (signal is automatically filtered internally).

While you are in the Calibration mode, two segments of the bar graph will appear under the legend **CAL** at the top of your front panel. These segments will flash if you are also in a Hold mode. To enter the Calibration mode, press the **CAL** key. You will be prompted to enter a Passcode. If you enter the incorrect passcode, the transmitter will revert to the Measurement (normal) mode. If you enter the correct passcode, the display will read **CALx SOLUTION** (if conductivity) or **CALx INST** (if resistivity).

**⚠ CAUTION**

Do not use Shorts or Opens to calibrate sensor/transmitter system.

## *Solution Calibration (Conductivity Only)*

If you are using a new (different) sensor, before doing a solution calibration, check that the temperature in Status mode agrees with the actual temperature of your solution. If there is a difference, the actual temperature should be entered before beginning your calibration. To do this, specify **CALx SOLUTION** and then step past **SOLUTION SINGLEPT** and **SOLUTION TWO PT** to get to **SOLUTION TEMP**. The correct solution temperature should be entered between -99.9 and +999.9 (°C or °F).

To begin your calibration, using the down arrow, specify **SINGLEPT** or **TWO PT** calibration. If **SINGLEPT**, further specify **OFFSET** or **SPAN**. **OFFSET** is used if correcting for a shift in system zero. **SPAN** is used to correct for a shift in system span and should be used at the higher end of the measurement range chosen.

Upon the prompt **IMMERSE IN SOLUTION 1**, immerse your sensor into its solution and press **ENTER**. If stability parameters were configured **ON**, the display **READING XXXXXXXX** will flash until stability is achieved and then alternate with the message **ENTER TO EDIT**. Wait for this message and then press **ENTER** again. If stability parameters were configured **OFF**, watch for the measurement to stabilize before proceeding to press **ENTER**. If the reading is not correct, edit it to the correct value under **OFFSET**, **SPAN**, or VALUE n. Press **ENTER**. Wait for a display of **CAL COMPLETE** (for **SINGLEPT**) or **IMMERSE IN SOL 2** (for **TWO PT**). If you are doing a 2-point calibration, place the sensor in the second solution and repeat the procedure. If calibration was not successfully completed, the display will read **CAL ERROR** and return you to the beginning of the procedure.

## *Instrument Calibration (Conductivity and Resistivity)*

If you are using an instrument calibration, specify **CALx INST**. Then you have two choices. You can return to the stored factory default calibration by selecting **FACTORY DEFAULT** and pressing **ENTER**. However, you can alternatively choose to connect your own calibrating discrete components to the transmitter (see Table 11). If so, specify **USER INST** and press **ENTER**.

Upon the prompt **CONNECT RESISTOR**, connect your resistor (Res 1) between terminals 1B and 1E as shown in Figure 14 and press **ENTER**. See Table 11 for resistor values.

**NOTE**

Resistor values must be known within 0.01%.

If stability parameters were configured **ON**, the display **READING XXXXXXXX** will flash until stability is achieved and then alternate with the message **ENTER TO EDIT**. Wait for this message and then press **ENTER** again. If stability parameters were configured **OFF**, watch for the measurement to stabilize before proceeding to press **ENTER**. The actual resistor value should be displayed. If the reading is not correct, edit it to the correct value (to within 0.01%) under **READING XXXXXXXX**. Press **ENTER**. Wait for a display of **CONNECT CAPACITR** or **CONNECT RESISTR2**. Connect your capacitor in parallel with Resistor 1 or Resistor 2 in place of Resistor 1 and repeat the procedure. If calibration was not successfully completed, the display will read **CAL ERROR** and return you to **USER INST**.

*Table 11. Calibration Components*

| Upper Range Value | | | | | | Cell Factor 0.1 | | | Cell Factor 10 | |
|---|---|---|---|---|---|---|---|---|---|---|
| µS/cm | mS/cm | mS/m | S/m | MΩ•cm | kΩ•cm | Res 1 | Res 2 | Cap | Res 1 | Res 2 |
| | | | | 20 | - - - | 1 MΩ | - - - | 300 pF | - - - | - - - |
| | | | | 15 | - - - | 1 MΩ | - - - | 300 pF | - - - | - - - |
| | | | | 10 | - - - | 499 kΩ | - - - | 300 pF | - - - | - - - |
| | | | | 5 | 5000 | 499 kΩ | - - - | 300 pF | - - - | - - - |
| | | | | 2 | 2000 | 100 kΩ | - - - | 300 pF | - - - | - - - |
| | | | | | 1000 | 100 kΩ | - - - | 300 pF | - - - | - - - |
| | | | | | 500 | 50 kΩ | 5 kΩ | - - - | - - - | - - - |
| | | | | | 100 | 10 kΩ | 1 kΩ | - - - | - - - | - - - |
| | | | | | 50 | 5 kΩ | 500 Ω | - - - | 100 kΩ | 10 kΩ |
| | | | | | 10 | - - - | - - - | - - - | 50 kΩ | 5 kΩ |
| 1 | - - - | - - - | - - - | - - - | - - - | 100 kΩ | - - - | 300 pF | - - - | - - - |
| 2 | - - - | 0.2 | - - - | - - - | - - - | 50 kΩ | - - - | 300 pF | - - - | - - - |
| 5 | - - - | 0.5 | - - - | - - - | - - - | 10 kΩ | - - - | 300 pF | - - - | - - - |
| 10 | - - - | 1 | - - - | - - - | - - - | 100 kΩ | 10 kΩ | - - - | - - - | - - - |
| 20 | - - - | 2 | - - - | - - - | - - - | 50 kΩ | 5 kΩ | - - - | - - - | - - - |
| 50 | - - - | 5 | - - - | - - - | - - - | 10 kΩ | 1 kΩ | - - - | - - - | - - - |
| 100 | 0.1 | 10 | - - - | - - - | - - - | 10 kΩ | 1 kΩ | - - - | - - - | - - - |
| 200 | 0.2 | 20 | - - - | - - - | - - - | 5 kΩ | 500 Ω | - - - | 499 kΩ | 50 kΩ |
| 500 | 0.5 | 50 | - - - | - - - | - - - | - - - | ––– | - - - | 100 kΩ | 10 kΩ |
| 1000 | 1 | 100 | 0.1 | - - - | - - - | - - - | - - - | - - - | 100 kΩ | 10 kΩ |
| 2000 | 2 | 200 | 0.2 | - - - | - - - | - - - | - - - | - - - | 50 kΩ | 5 kΩ |
| 5000 | 5 | 500 | 0.5 | - - - | - - - | - - - | - - - | - - - | 10 kΩ | 1 kΩ |
| - - - | 10 | 1000 | 1 | - - - | - - - | - - - | - - - | - - - | 10 kΩ | 1 kΩ |
| - - - | 20 | 2000 | 2 | - - - | - - - | - - - | - - - | - - - | 5 kΩ | 500 Ω |

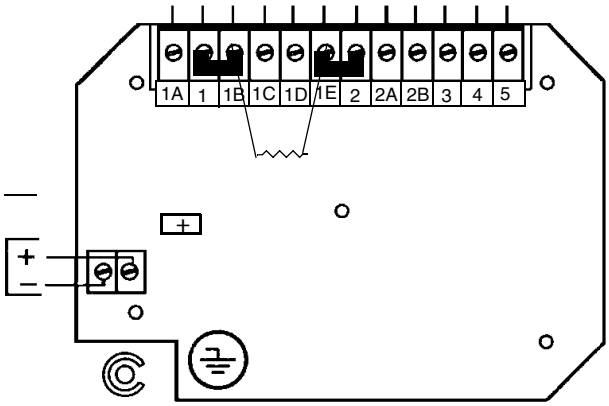



*Figure 14. Component Connections*

### *Pure Water Calibration*

If you are measuring purity of water by checking the conductivity in µS/cm or resistivity in MΩ•cm with an 871CR-A or 871CR-B sensor, you can use this calibration by selecting **CAL PURE H2O**. The display reads **tCF.** Change the tCF shown to the temperature cell factor (tCF) found on your sensor and press **ENTER** again. The display reads **CF**. Change the CF shown to the cell factor (CF) found on your sensor and press **ENTER** again. The calibration is complete.

## Recording Your Calibration

Next, optionally follow the prompts to enter the calibration date and name of the calibrator. The date should be in the form mm/dd/yy. The name of the calibrator can contain up to six characters.

# Maintenance

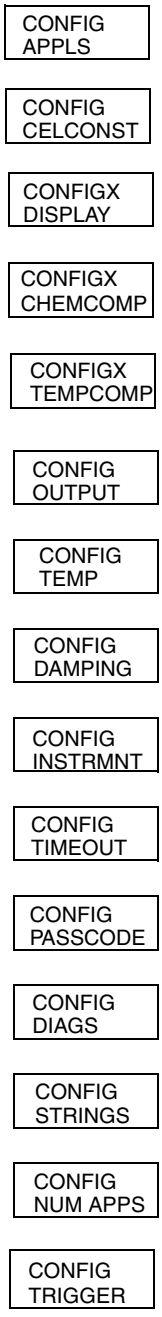
**WARNING**

This product contains components that have critical safety characteristics. **Do not** substitute components. Replace components only with identical, factory-supplied components. Component substitution may impair the electrical safety of this equipment and its suitability for use in hazardous locations.

The maintenance of the 870IT Transmitter is limited to replacement of the keypad and a matched kit of two printed wiring assemblies (core PWA and sensor PWA). See PL 611-156 for part numbers. Attempts to repair printed wiring assemblies could result in damage and voiding of the warranty. The recommended repair procedure is replacement of the PWAs or return of the PWAs to the factory for repair.

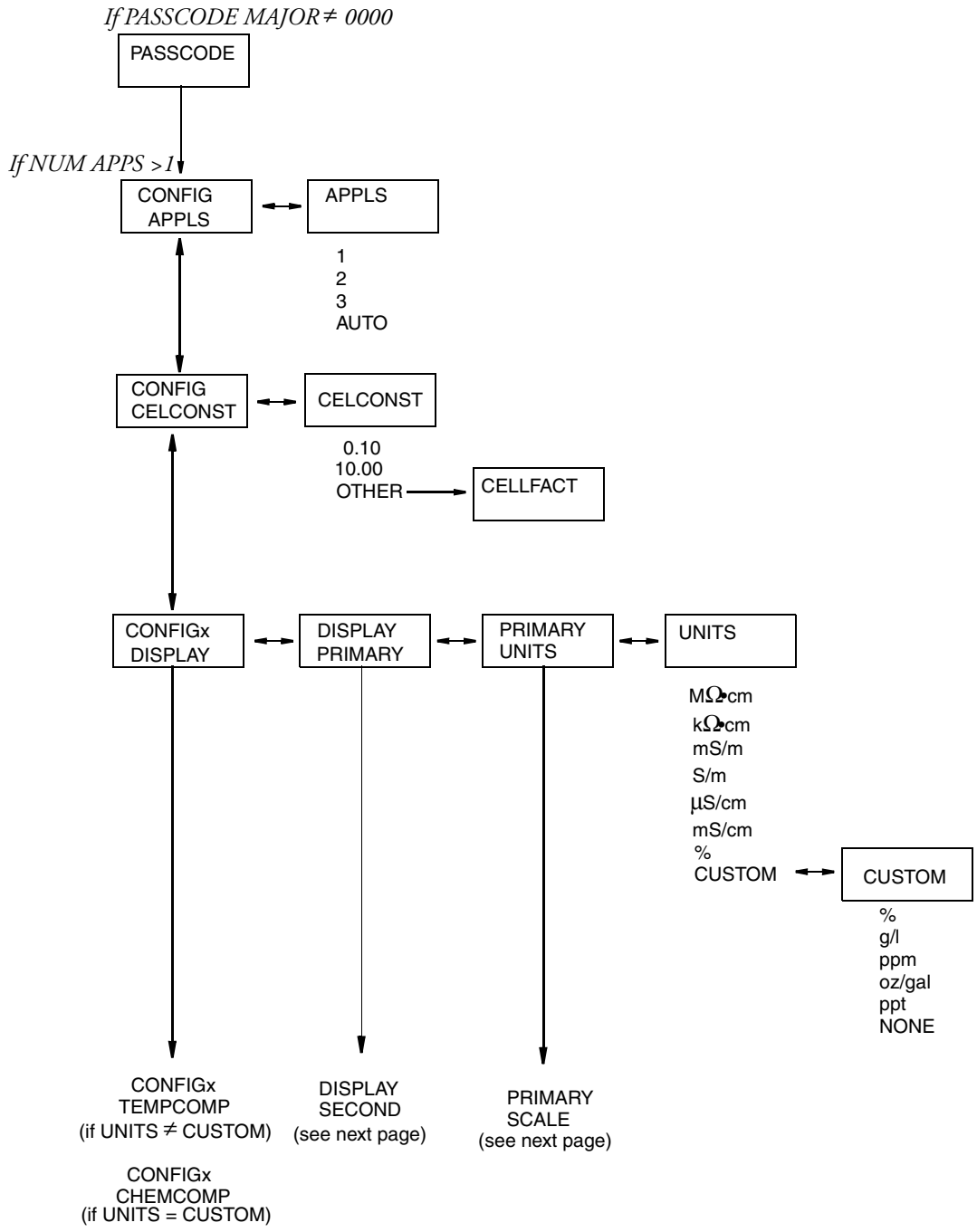
# *Appendix A. Structure Diagrams*

## Top Level Structure Diagram



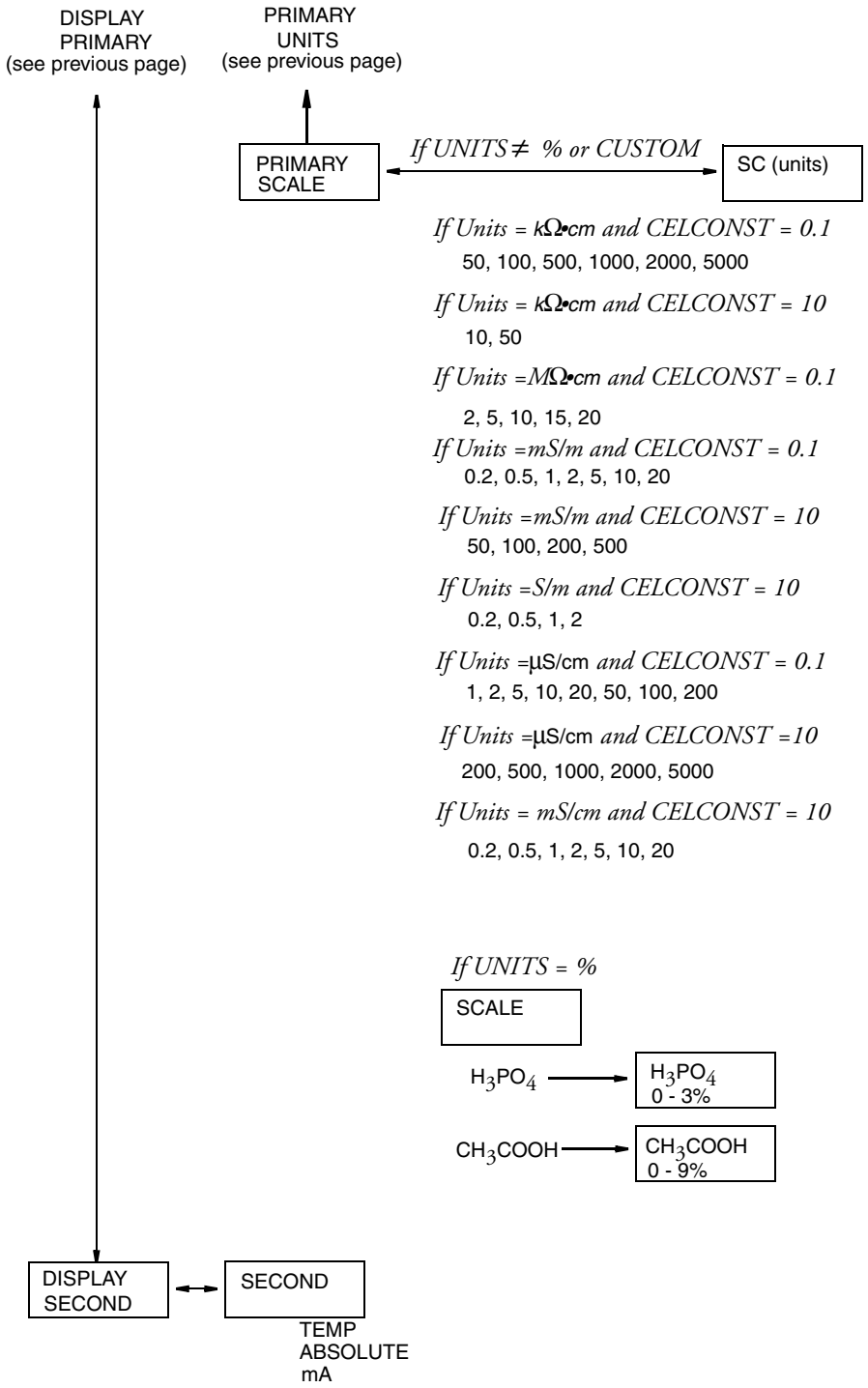
Structure Diagram 1

CONFIGURATION

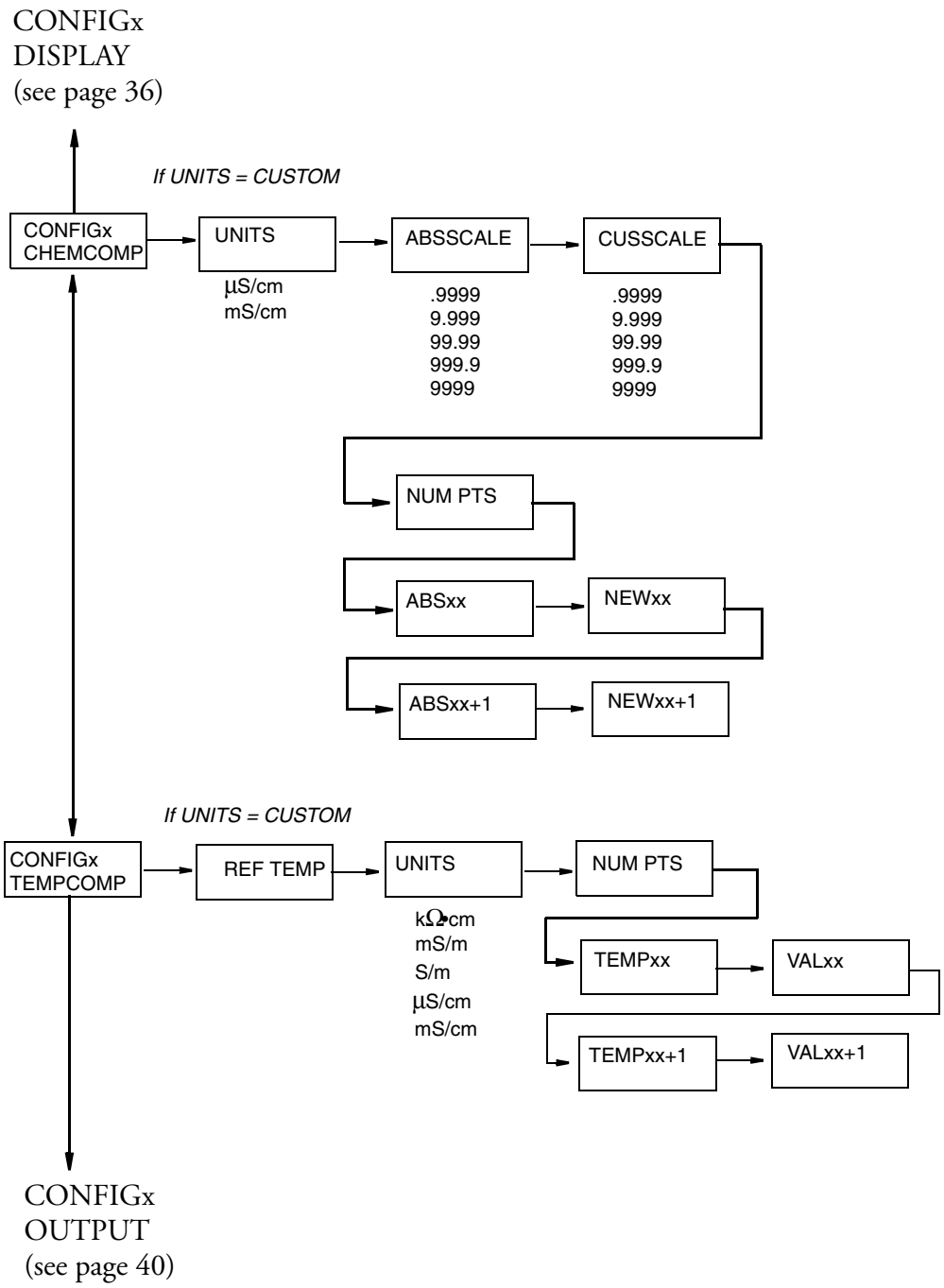



(see page 38 or page 39)

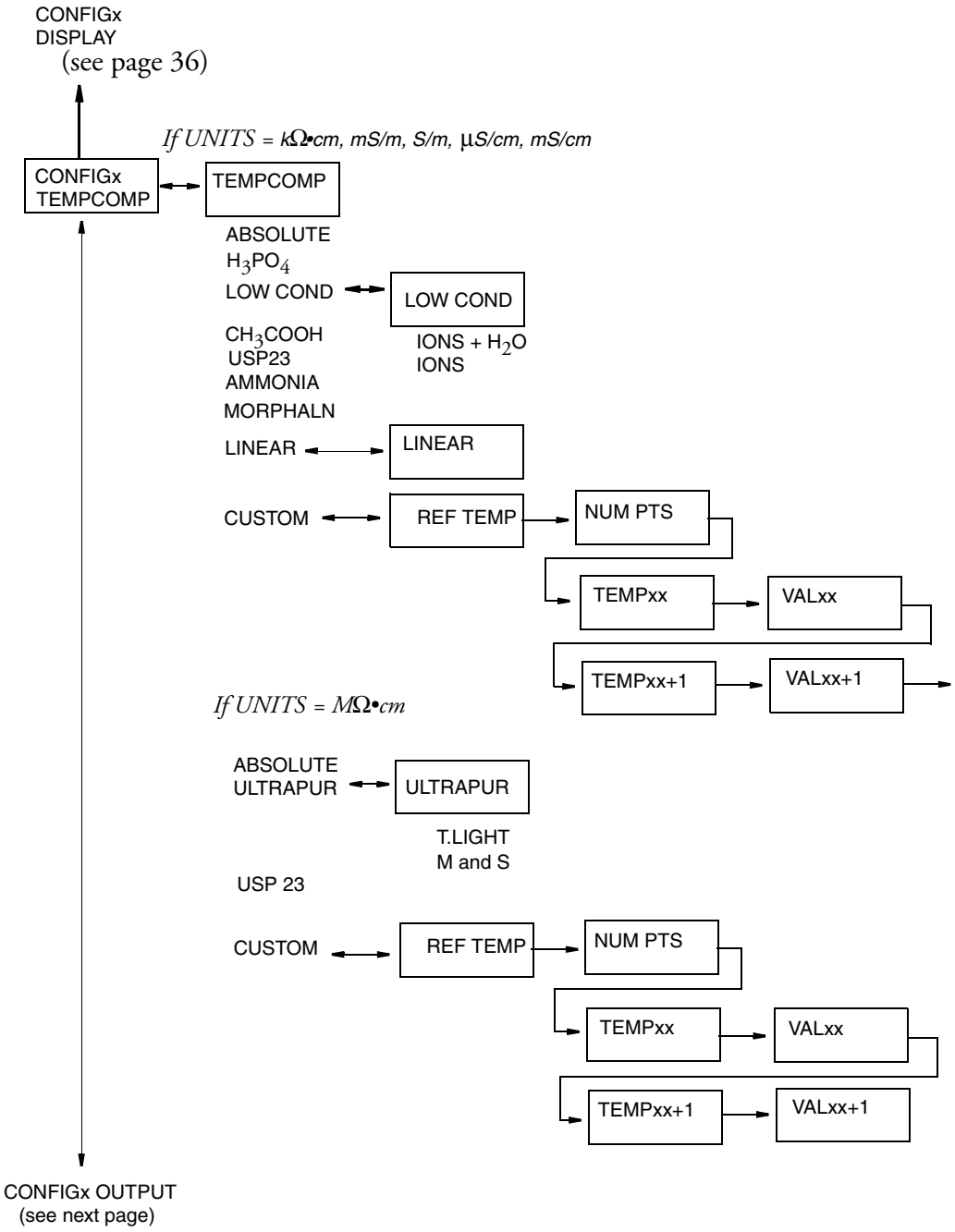
Structure Diagram 2
CONFIGURATION (cont.)



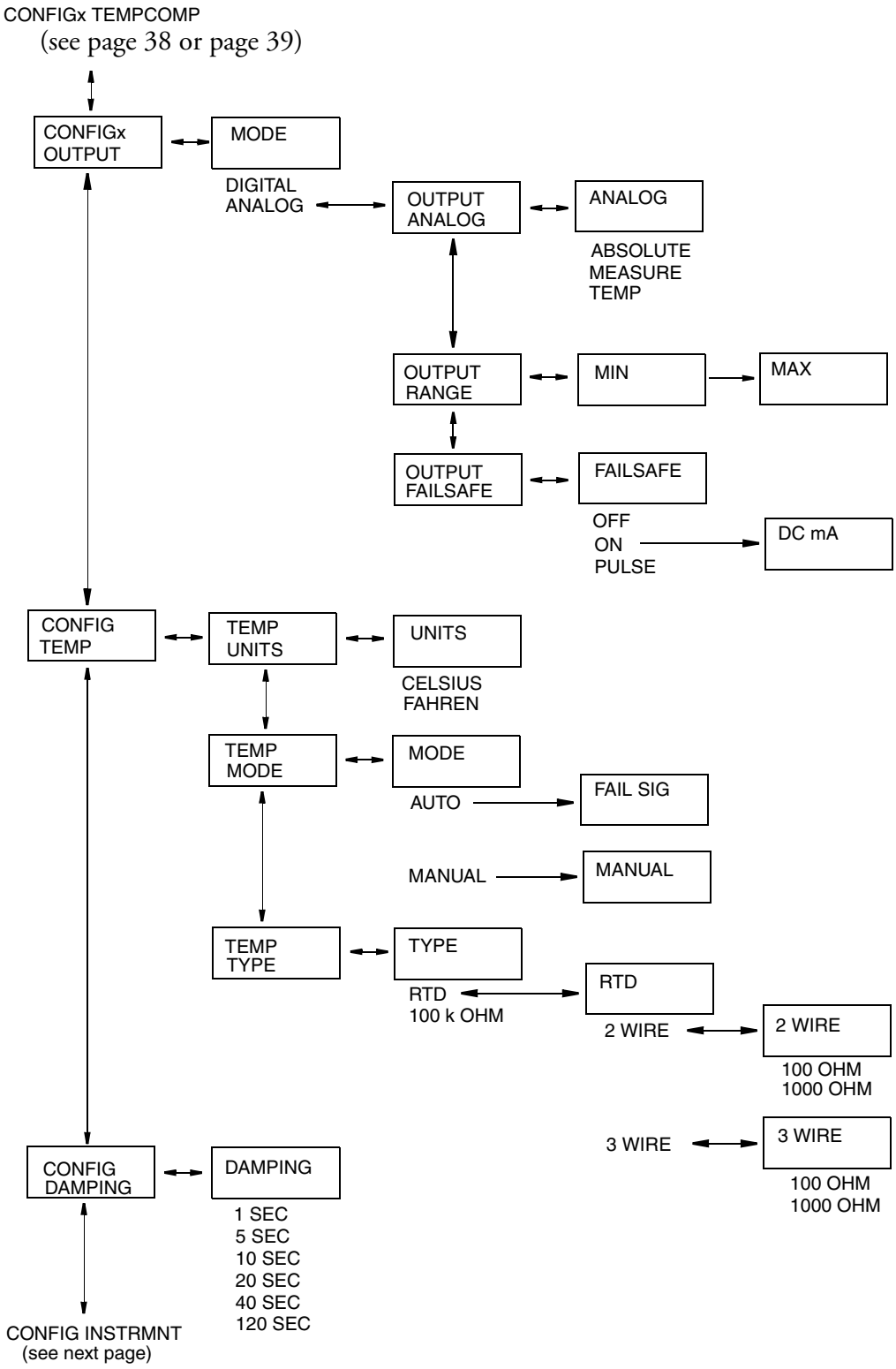
Structure Diagram 3
CONFIGURATION (cont.)



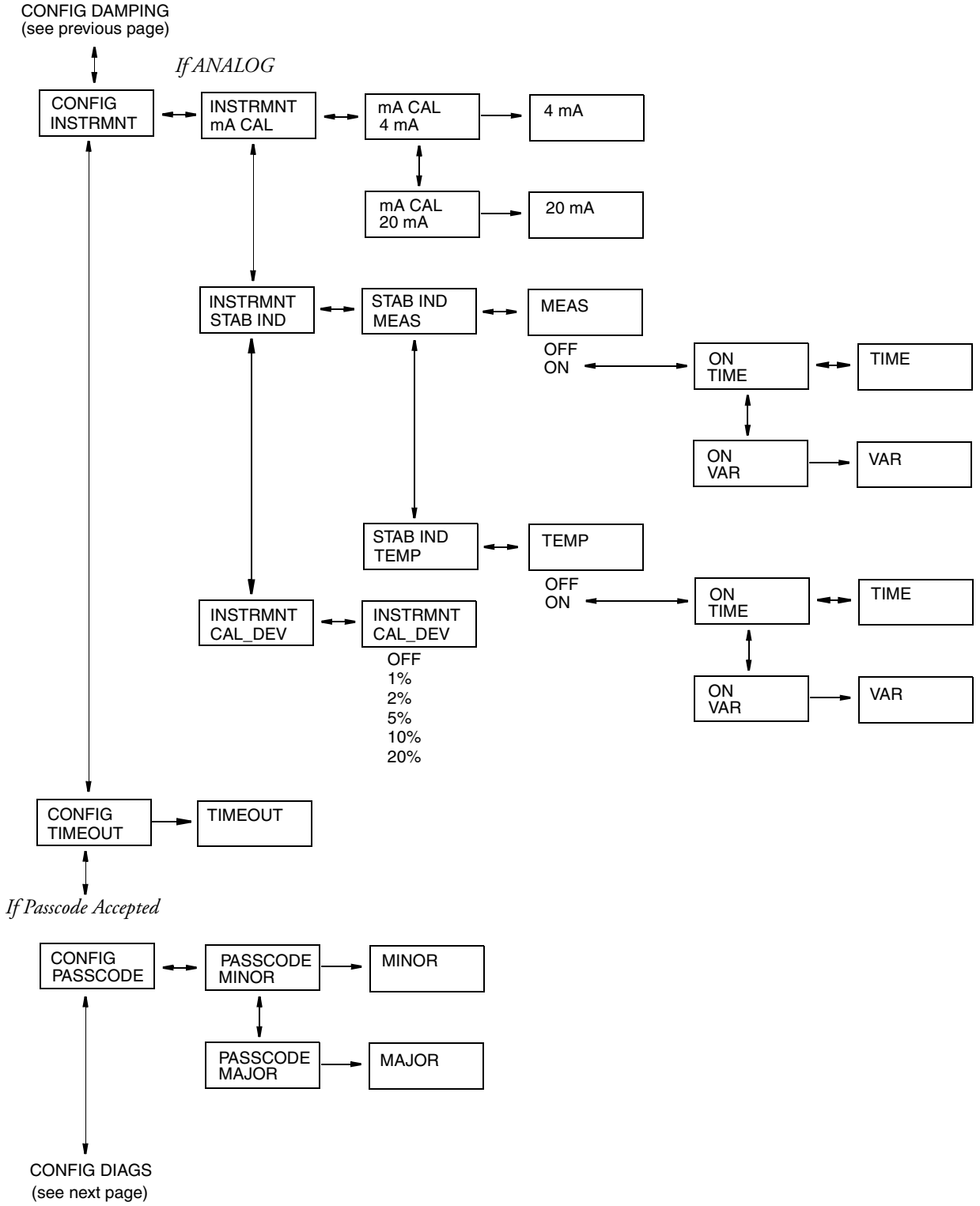
## Structure Diagram 4
## CONFIGURATION (cont.)



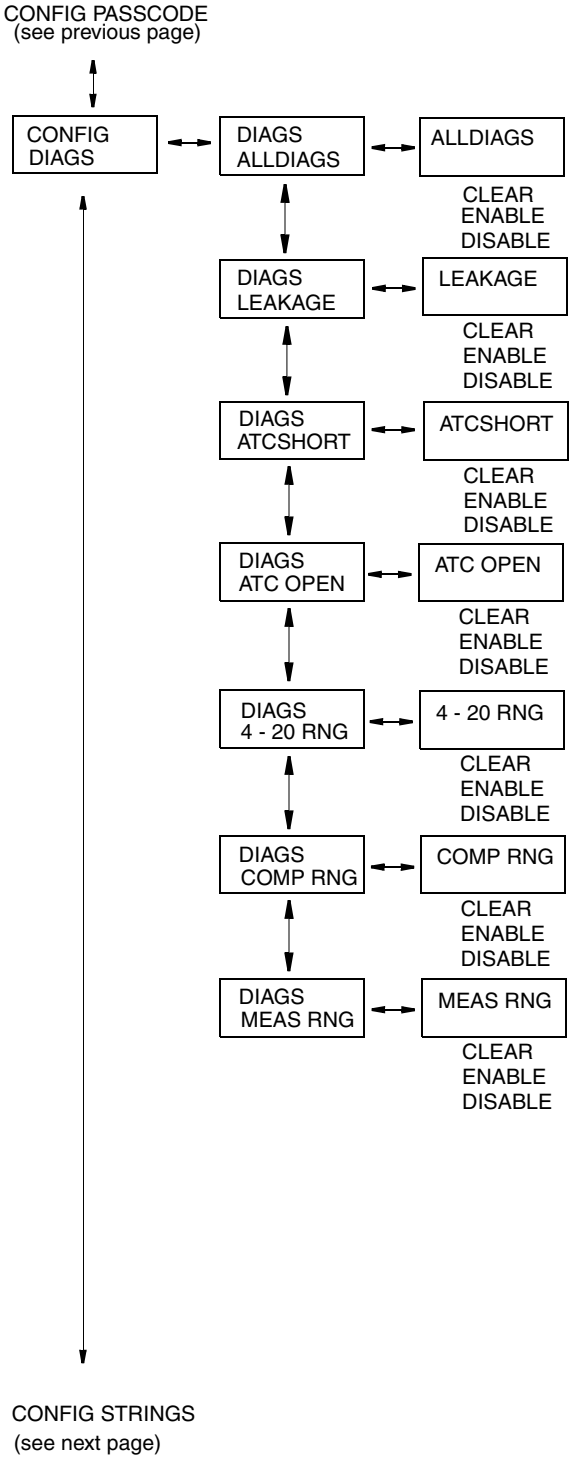
Structure Diagram 5
CONFIGURATION (cont.)



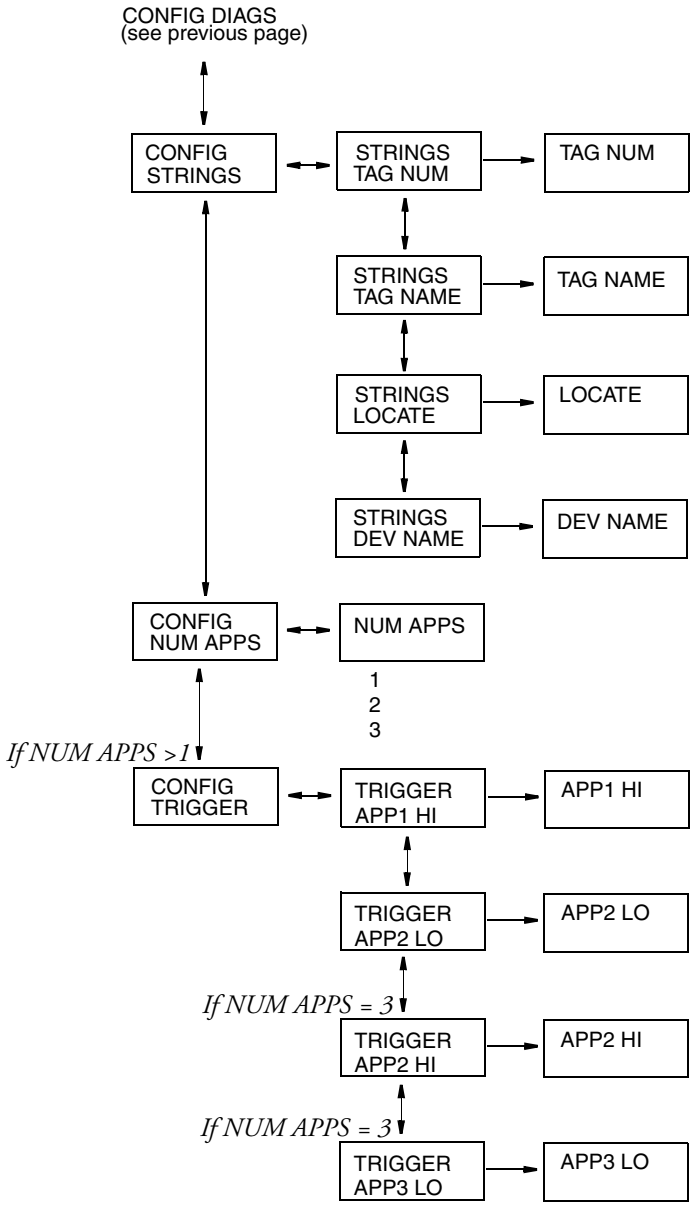
## Structure Diagram 6
## CONFIGURATION (cont.)



## Structure Diagram 7
## CONFIGURATION (cont.)

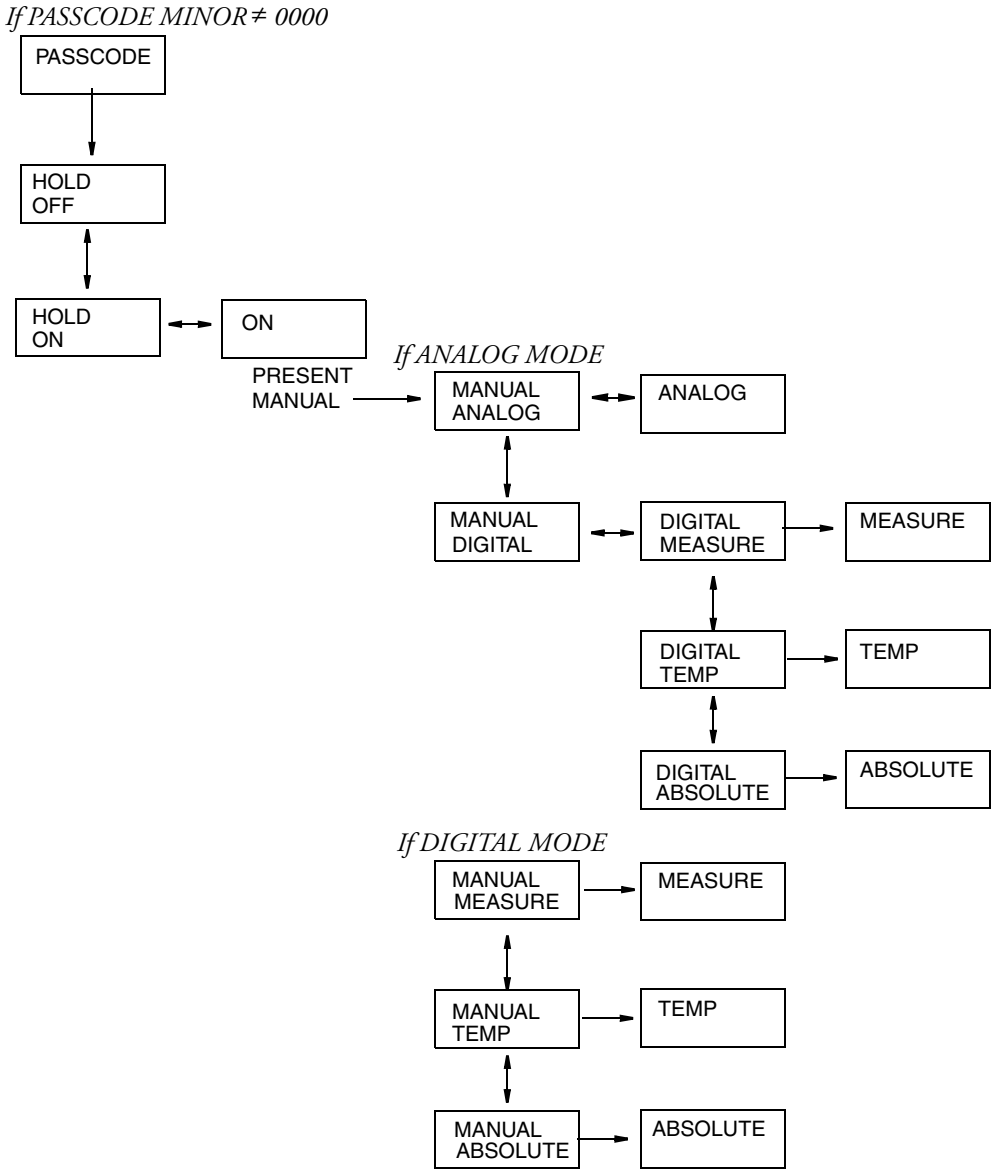


Structure Diagram 8
CONFIGURATION (cont.)

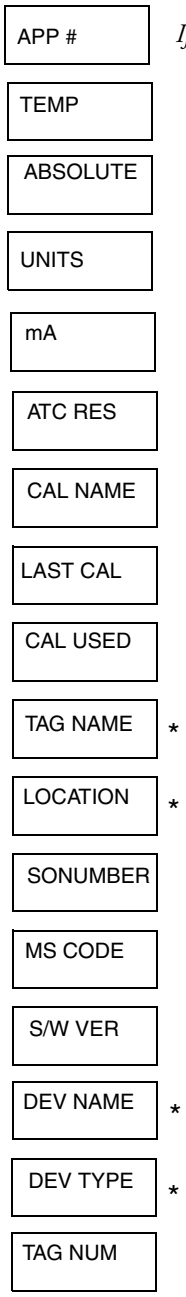


Structure Diagram 9

HOLD



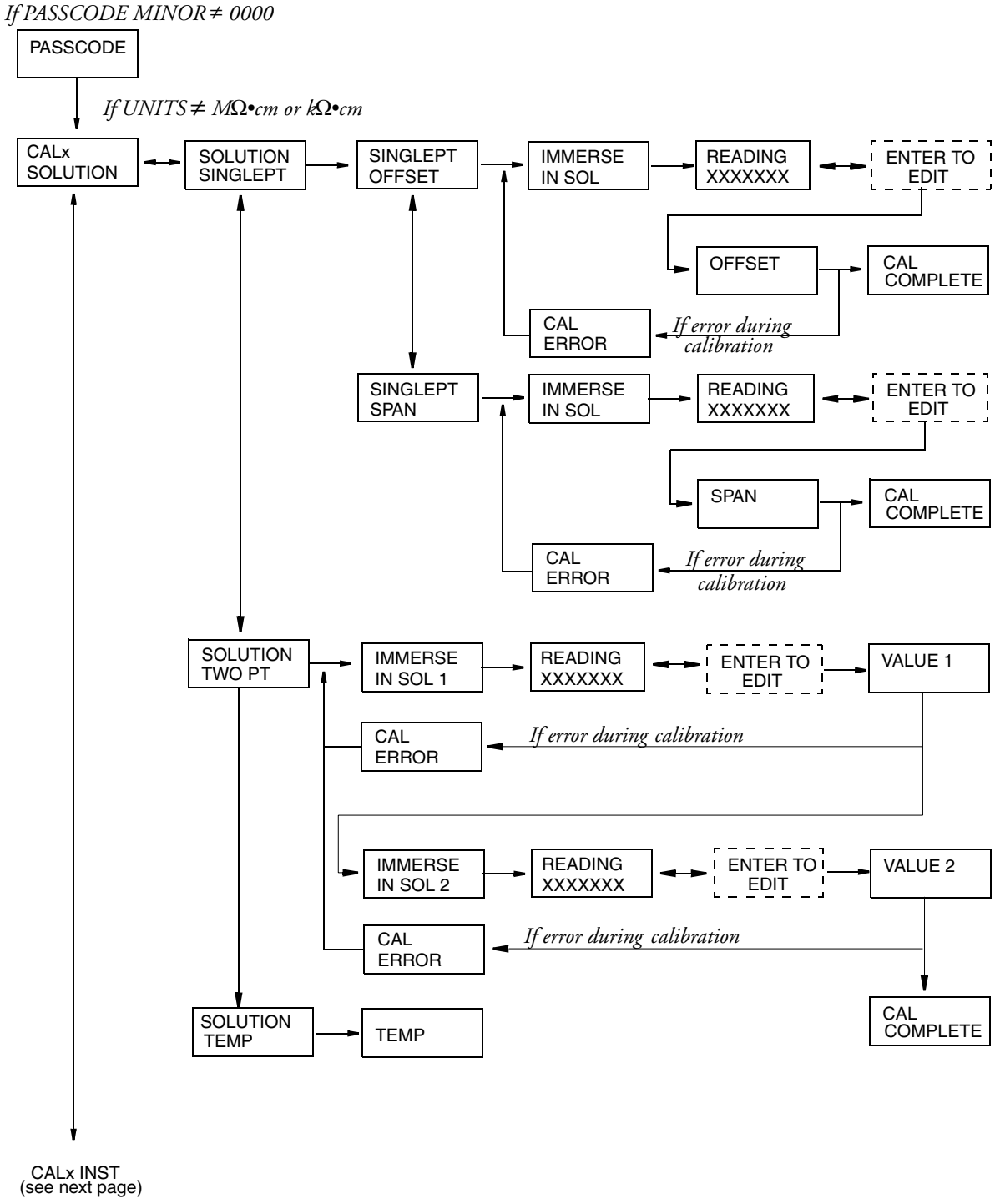
## Structure Diagram 10
## STATUS



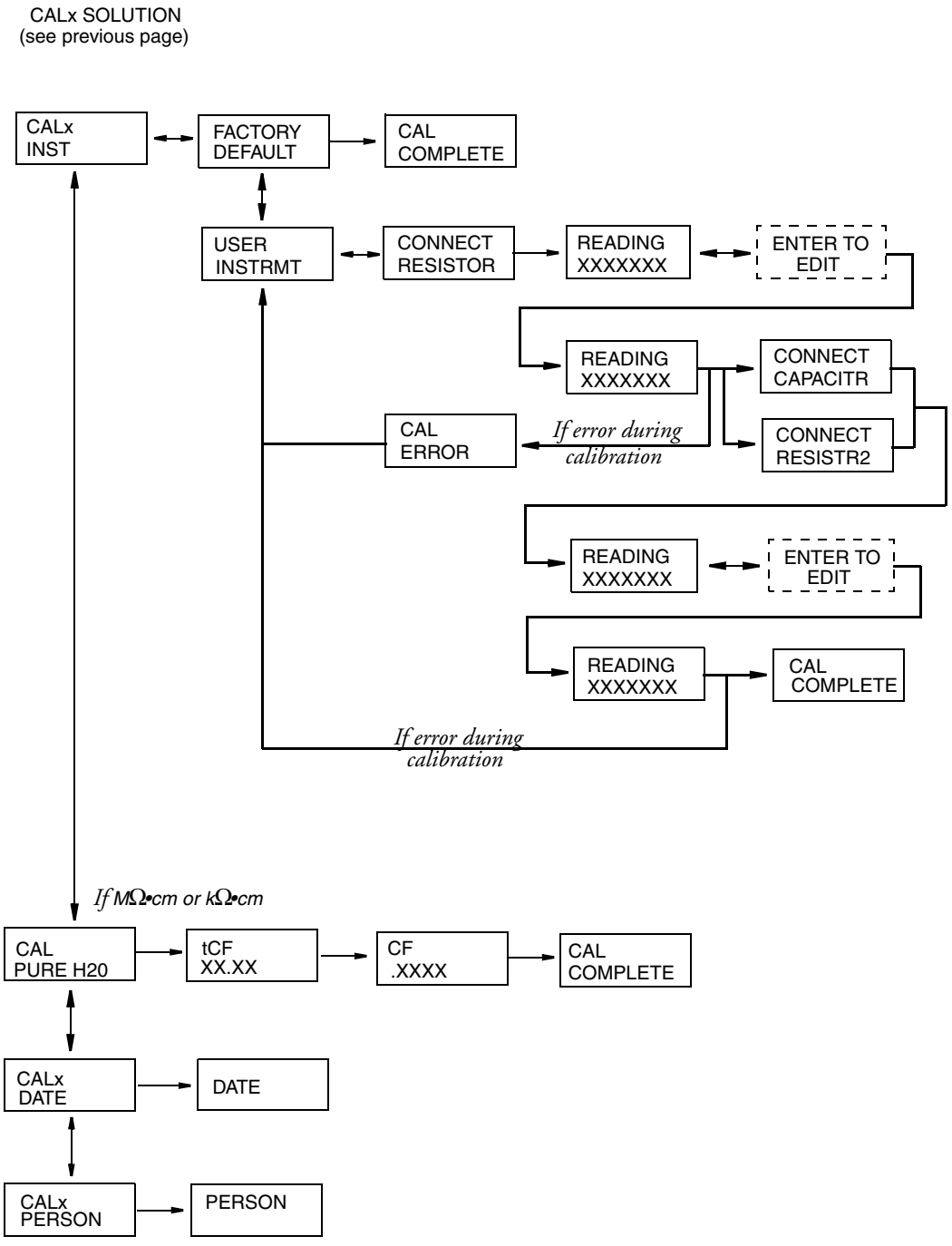

*ONLY ON 870ITCR-F

Structure Diagram 11

CALIBRATION

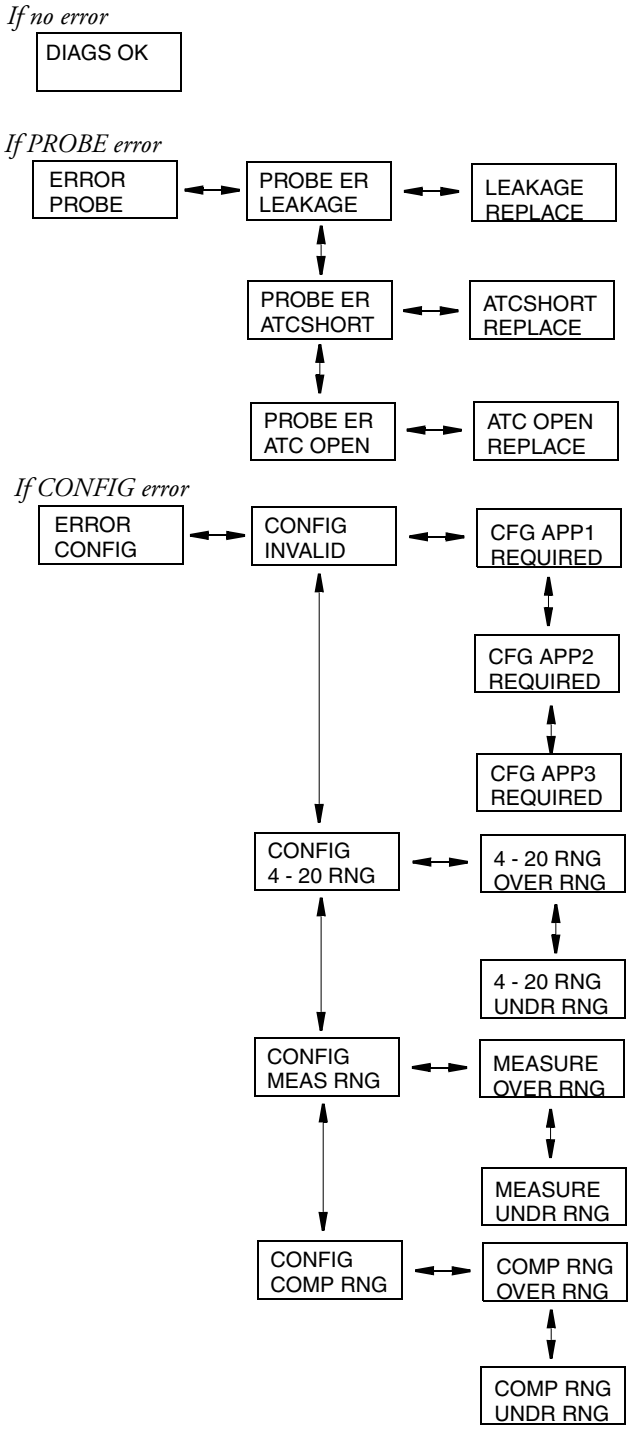


Structure Diagram 12
CALIBRATION (cont.)



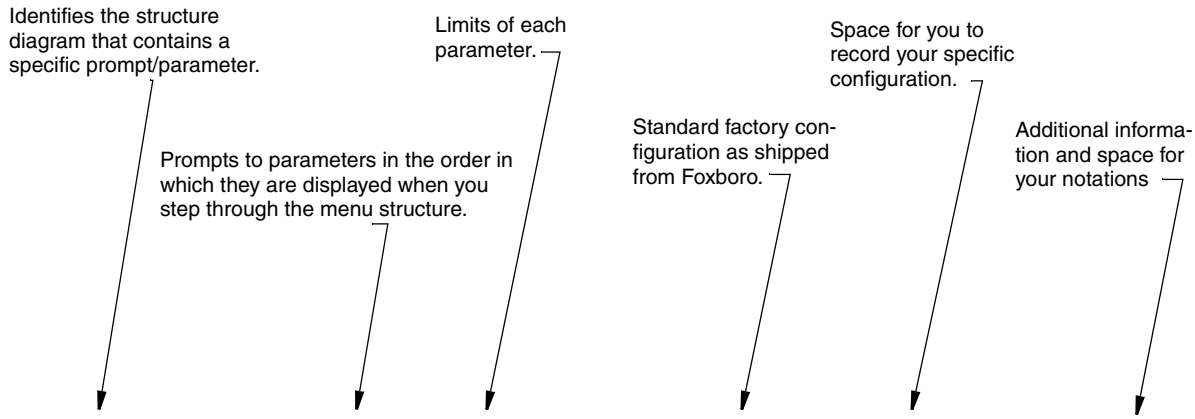
Structure Diagram 13

DIAGNOSTICS



# Appendix B. Configuration Table

This appendix contains information that will help you configure your transmitter. The information is presented in the form of a table containing each prompt/parameter, its limits, and its factory default value. It also provides space for you to record your specific configuration and notations.




| Structure Diagram | Prompt/Parameter | Parameter Limits | Factory Configuration | User Configuration | Remarks and Notes |
|---|---|---|---|---|---|
| 1 | PASSCODE | 0001 AND 9999 | 0800 | | If PASSCODE MAJOR ≠ 0000 |
| | CONFIG APPLS | - - - | | | If NUM APPS >1 |
| | APPLS | 1, 2, 3, AUTO | 1 | | |
| | CELCONST | 0.10, 10.00, OTHER | 0.10 | | |
| | CELLFACT | 0.00 and 99.99 | | | If OTHER |
| | CONFIGx DISPLAY | - - - | | | |
| | DISPLAY PRIMARY | - - - | | | |
| | PRIMARY UNITS | - - - | | | |
| | UNITS | mS/m, S/m, µS/cm, mS/cm, %, kΩcm, MΩcm, CUSTOM | µS/cm | | |
| | CUSTOM | %, g/l, ppm, oz/gal, ppt, NONE | | | If CUSTOM |

| Structure Diagram | Prompt/Parameter | Parameter Limits | Factory Configuration | User Configuration | Remarks and Notes |
|---|---|---|---|---|---|
| 2 | PRIMARY SCALE | - - - | | | If mS/m, S/m, µS/cm, mS/cm, kΩ•cm, MΩ•cm |
| | SC (units) (If not % or CUSTOM) | Depends on sensor, cell constant, and units | 50.00 mS/cm | | |
| | SCALE (if %) | Per chemical | | | |
| | DISPLAY SECOND | - - - | | | |
| | SECOND | TEMP, ABSOLUTE, mA | TEMP | | |
| 3 | CONFIG CHEMCOMP | | | | If UNITS = CUSTOM |
| | UNITS | mS/cm, µS/cm | | | |
| | ABSCALE | .9999, 9.999, 99.99, 999.9, 9999 | | | |
| | CUSSCALE | .9999, 9.999, 99.99, 999.9, 9999 | | | |
| | NUM PTS | 02 and 21 | | | |
| | ABSxx | 0 and 2000 | | | mS/cm, µS/cm |
| | NEWxx | 0 and 2000 | | | Custom units |
| | CONFIGx TEMPCOMP | - - - | | | If UNITS ≠ % |
| | (If UNITS = CUSTOM) | | | | |
| | REF TEMP | -99.9 and 999.9 | | | °C or °F |
| | NUM PTS | 02 and 21 | | | |
| | UNITS | µS/cm, mS/cm, mS/m, S/m, or kΩ•cm | | | |
| | tTEMPxx | -99.9 and 999.9 | | | °C or °F |
| | VALxx | | | | |

| Structure Diagram | Prompt/Parameter | Parameter Limits | Factory Configuration | User Configuration | Remarks and Notes |
|---|---|---|---|---|---|
| 4 | (If UNITS = µS/cm, mS/cm, mS/m, S/m,or kΩ•cm) | | | | |
| | TEMPCOMP | - - - | | | |
| | ABSOLUTE | | | | |
| | LOW COND | IONS + $H_2O$ or IONS | IONS + $H_2O$ | | |
| | LINEAR | 0.5 and 5.0 | | | |
| | (Chemical) | Per Chemical | | | |
| | (CUSTOM) | - - - | | | |
| | REF TEMP | -99.9 and 999.9 | 0.0 | | °C or °F |
| | NUM PTS | 02 and 21 | 02 | | |
| | TEMPxx | -99.9 and 999.9 | 0.0 | | °C or °F |
| | VALxx | | | | |
| | (If UNITS = MΩ•cm) | | | | |
| | ABSOLUTE | | | | |
| | ULTRAPUR | T. LIGHT or M and S | | | |
| | USP 23 | | | | |
| | CUSTOM | | | | |
| | REF TEMP | -99.9 and 999.9 | 0.0 | | °C or °F |
| | NUM PTS | 02 and 21 | 02 | | |
| | TEMPxx | -99.9 and 999.9 | 0.0 | | °C or °F |
| | VALxx | 0 and ???? | ???? | | |

| Structure Diagram | Prompt/Parameter | Parameter Limits | Factory Configuration | User Configuration | Remarks and Notes |
|---|---|---|---|---|---|
| 5 | CONFIGx OUTPUT | - - - | | | |
| | MODE | ANALOG, DIGITAL | ANALOG | | |
| | OUTPUT ANALOG | - - - | | | If ANALOG |
| | ANALOG | ABSOLUTE, MEASURE, TEMP | MEASURE | | |
| | OUTPUT RANGE | - - - | | | |
| | MIN | Depends on Analog Output | 0 µS/cm | | |
| | MAX | | 10 µS/cm | | |
| | OUTPUT FAILSAFE | - - - | | | |
| | FAILSAFE | OFF, ON, PULSE | OFF | | |
| | DC mA | 3.8 and 20.5 mA | 3.8 | | If FAILSAFE = ON |
| | CONFIG TEMP | - - - | | | |
| | TEMP UNITS | - - - | | | |
| | UNITS | CELSIUS, FAHREN | CELSIUS | | |
| | TEMP MODE | - - - | | | |
| | MODE | AUTO, MANUAL | AUTO | | |
| | FAIL SIG | -99.9 and +999.9 | | | If AUTO |
| | MANUAL | -99.9 and +999.9 | | | If MANUAL |
| | TEMP TYPE | - -- | | | |
| | TYPE | RTD, 100 kOHM | RTD | | |
| | RTD | 2 WIRE, 3 WIRE | 3 WIRE | | If RTD |
| | 2 WIRE | 100 OHM, 1000 OHM | | | If 2 WIRE |
| | 3 WIRE | 100 OHM, 1000 OHM | 1000 Ω | | If 3 WIRE |
| | CONFIG DAMPING | - - - | | | |
| | DAMPING | 1, 5, 10, 20, 40, or 120 | 5 | | SECond |

| Structure Diagram | Prompt/Parameter | Parameter Limits | Factory Configuration | User Configuration | Remarks and Notes |
|---|---|---|---|---|---|
| 6 | CONFIG INSTRMNT | - - - | | | |
| | INSTRMNT mA CAL | - - - | | | |
| | mA CAL 4 mA | | | | |
| | 4 mA | | | | |
| | mA CAL 20 mA | | | | |
| | 20 mA | | | | |
| | INSTRMNT STAB IND | - - - | | | |
| | STAB IND MEAS | - - - | | | |
| | MEAS | ON, OFF | OFF | | |
| | ON TIME | | | | |
| | TIME | 5 - 60 | | | Increments of 5 s |
| | ON VAR | | | | |
| | VAR | 1 AND 9 | | | |
| | STAB IND TEMP | - - - | | | |
| | TEMP | ON, OFF | OFF | | |
| | ON TIME | | | | |
| | TIME | 5 - 60 | | | Increments of 5 s |
| | ON VAR | | | | |
| | VAR | 1 AND 9 | | | |
| | INSTRMNT CAL_DEV | | | | |
| | INSTRMNT CAL_DEV | OFF, 1%, 2%, 5%, 10%, or 20% | | | |
| | CONFIG TIMEOUT | - - - | | | |
| | TIMEOUT | 0 and 999 | 600 | | Seconds |
| | CONFIG PASSCODE | - - - | | | |
| | PASSCODE MINOR | - - - | | | |
| | MINOR | 0 AND 9999 | 0800 | | |
| | PASSCODE MAJOR | - - - | | | |
| | MAJOR | 0 AND 9999 | 0800 | | |

| Structure Diagram | Prompt/Parameter | Parameter Limits | Factory Configuration | User Configuration | Remarks and Notes |
|---|---|---|---|---|---|
| 7 | CONFIG DIAGS | - - - | | | |
| | ALLDIAGS | CLEAR, ENABLE, DISABLE | DISABLE | | |
| | LEAKAGE | CLEAR, ENABLE, DISABLE | | | |
| | ATCSHORT | CLEAR, ENABLE, DISABLE | | | |
| | ATC OPEN | CLEAR, ENABLE, DISABLE | | | |
| | 4 - 20 RNG | CLEAR, ENABLE, DISABLE, LIMIT | | | |
| | COMP RNG | CLEAR, ENABLE, DISABLE | | | |
| | MEAS RNG | CLEAR, ENABLE, DISABLE | | | |

| Structure Diagram | Prompt/Parameter | Parameter Limits | Factory Configuration | User Configuration | Remarks and Notes |
|---|---|---|---|---|---|
| 8 | CONFIG STRINGS | - - - | | | |
| | STRINGS TAG NUM | - - - | | | |
| | TAG NUM | | | | |
| | STRINGS TAG NAME | - - - | | | |
| | TAG NAME | | | | |
| | STRINGS LOCATE | - - - | | | |
| | LOCATE | | | | |
| | STRINGS DEV NAME | - - - | | | |
| | DEV NAME | | | | |
| | CONFIG NUM APPS | - - - | | | |
| | NUM APPS | 1, 2, 3 | 1 | | |
| | CONFIG TRIGGER | - - - | | | |
| | TRIGGER APP1 HI | - - - | | | |
| | APP1 HI | | | | |
| | TRIGGER APP2 LO | - - - | | | |
| | APP2 LO | | | | |
| | TRIGGER APP2 HI | - - - | | | |
| | APP2 HI | | | | |
| | TRIGGER APP3 LO | - - - | | | |
| | APP3 LO | | | | |

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