

**870ITEC Intelligent
Electrochemical Transmitter**

for Electrodeless Conductivity Measurements

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Introduction

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

The analog only output version (Model 870ITEC-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 870ITEC-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 (870ITEC-A), you must supply its power source. If it was specified with digital communications (870ITEC-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.

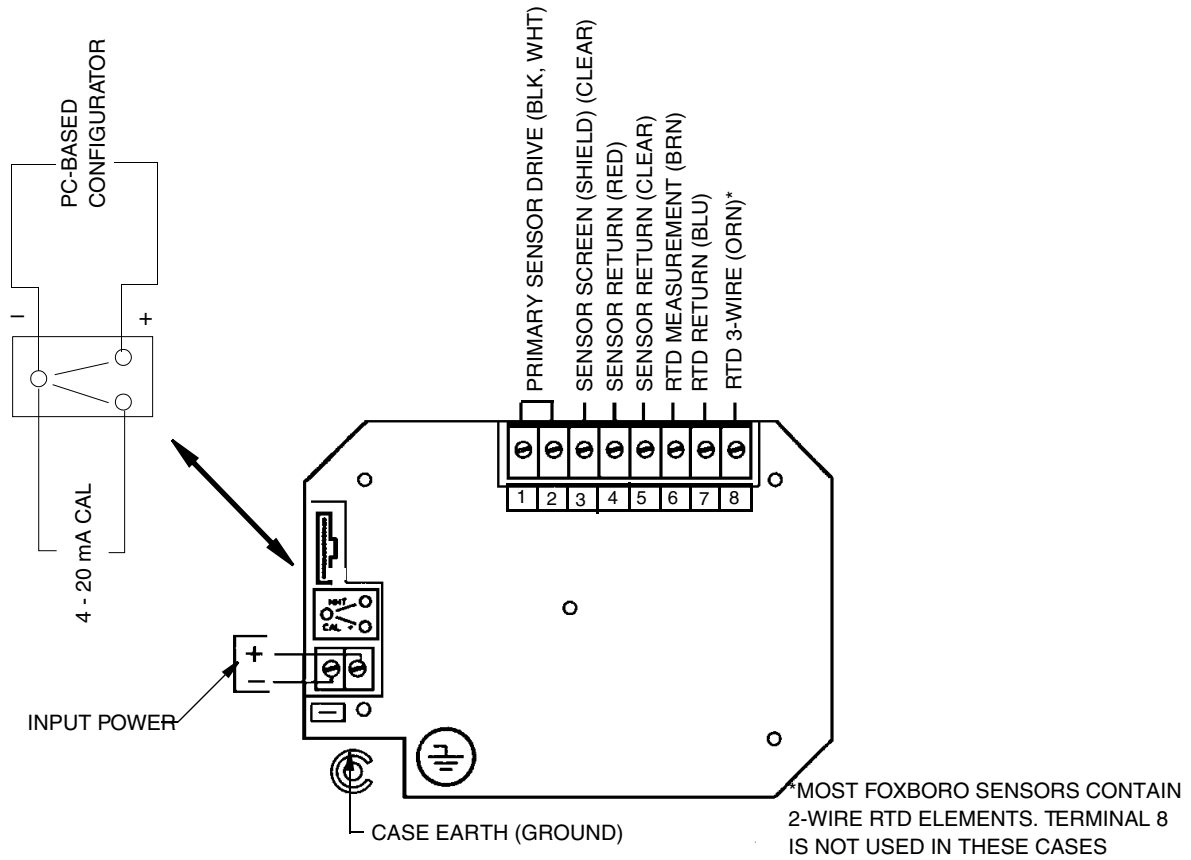


Figure 1. Wiring

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.

Verifying Valid Measurements

Your transmitter was calibrated at the factory. However, after you connect it to your sensor, you need to do a single point calibration (in air if range is zero based) to zero the instrument. To do this use the following procedure:

1. Press the Calibration key and enter the minor Passcode at the prompt.
2. At **CALx SOLUTION** use the Right arrow key to get to **SOLUTION SINGLEPT** and then to **SINGLEPT OFFSET**, and to **IMMERSE IN SOL 1**.
3. Holding the sensor in air, press **ENTER**.

4. Wait for the display **READING XXXXXXXX** to alternate with the message **ENTER TO EDIT** and then press **ENTER** again. Upon the prompt **OFFSET**, enter 0000. Press **ENTER**. When the calibration is complete, the display will read **CAL COMPLETE**.
5. Press the Measure key to go to Measure mode. Place your sensor in a known solution and check the measurement.

Basic Operation in Measure Mode

Measure is the normal operating mode of your transmitter. The electrodeless conductivity measurement is shown on the top line of the display. The second line of your display shows the absolute value of the measurement signal in $\mu\text{S}/\text{cm}$ or mS/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 errors and transmitter and sensor errors are also shown on your display while in the Measurement 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 10.

For detailed configuration instructions, refer to “Configuration” on page 16.

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

For dimensional information, refer to DP 611-163.

General information on this and other electrochemical products are available on line at www.ips.invensys.com (pull down **Products** menu and select **Measurement & Instruments**, then **Documentation**, then **Specs, Instructions, Drawings, Parts**).

If you need additional help, please call 1-866-746-6477 in the U.S.A. or contact your local Invensys Process Systems (IPS) 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)
MI 611-220	Electrodeless Conductivity System Calibration Examples
PL 611-153	Parts List - 870IT Style B Intelligent Transmitters

(a) Documents are available on line at www.ips.invensys.com (pull down **Products** menu and select **Measurement & Instruments**, then **Documentation**, then **Specs, Instructions, Drawings, Parts**).

(b) Available in many languages on line at www.ips.invensys.com (pull down **Products** menu and select **Measurement & Instruments**, then **Downloads**, then **Safety Instructions for Analytical**).

Specifications

Sensors:

The 870ITEC Transmitter can be used with any 871EC Series Electrodeless Conductivity Sensor or 871FT Series Flow-Through Sensor. They can also be used with other electrically compatible sensors by entering the cell factor as part of the configuration procedure.

Maximum Distance Between Sensor and Transmitter: 30.5 m (100 ft)

Temperature Compensation Inputs:

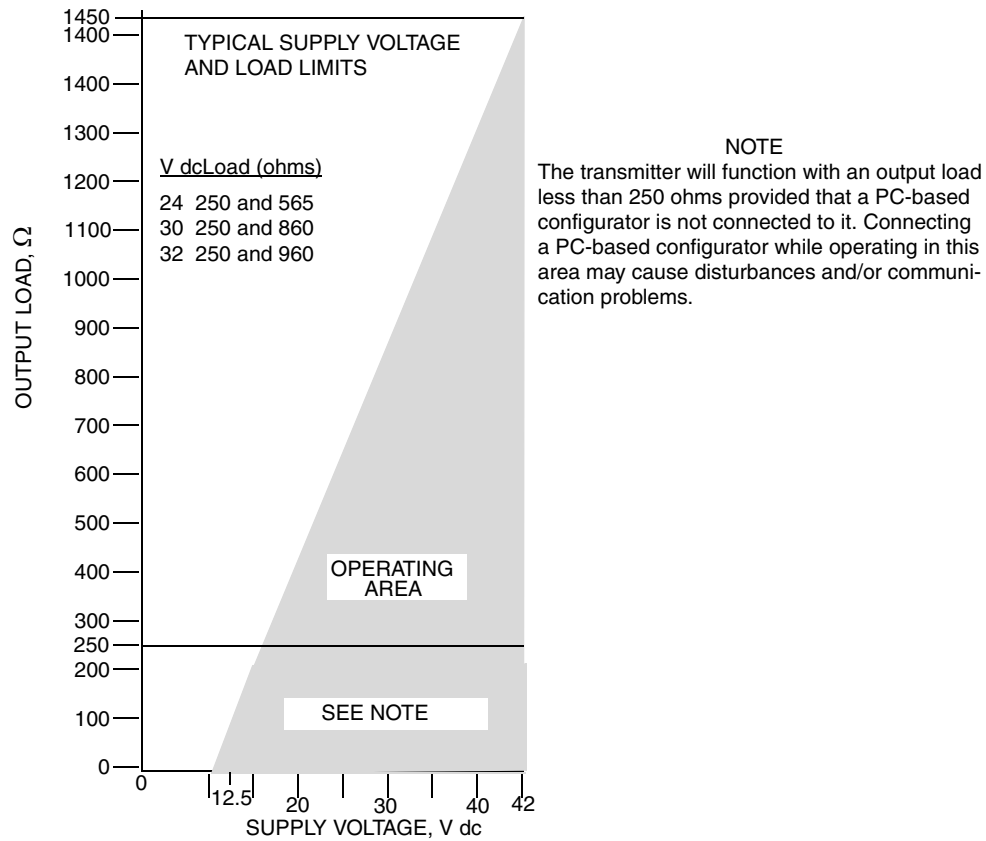
100 ohm platinum RTD
 1000 ohm platinum RTD
 100 kilohm thermistor

Ambient Temperature: -25 to +55°C

Relative Humidity: 0 to 95% noncondensing

Electromagnetic Compatibility (EMC): The Model 870ITEC 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 IPS.

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, II, and III, Groups A, B, C, D, E, F, and G, Division 1 hazardous locations.	Connect per MI 611-206. Temperature Class T4.	CAA
CSA suitable for use in Class I, Groups A, B, C, D, F, and G, Division 2 hazardous locations.	Temperature Class T4.	CNZ
FM intrinsically safe for Class I, II, and III, Groups A, B, C, D, E, F, and G, Division 1 hazardous locations.	Connect per MI 611-206. Temperature Class T4.	FAA

Table 1. Product Safety Specifications

Testing Laboratory, Types of Protection, and Area Classification	Application Conditions	Electrical Safety Design Code
FM nonincendive for Class I, II, and III, Groups A, B, C, D, E, and G, 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.


invensys® FOXBORO®		
MODEL / ST	870ITEC-FWFAA	BB — MODEL AND STYLE
CERT SPEC	AAA	— ELECTRICAL CLASSIFICATION CODE
REF NO	377482F10	— SALES ORDER / SERIAL NUMBER (IF APPLICABLE)
ORIGIN	2B05320526	— PLANT OF MANUFACTURE, DATE, SERIAL NO.
SUPPLY	12.5 TO 42 VDC	— SUPPLY VOLTAGE
POWER	1 WATTS MAX	— POWER CONSUMPTION
FUSE	N/A	
CALIB	0 - 200 uS/cm	— MEASUREMENT RANGE
CONFIG CD	FoxCom	— COMMUNICATIONS
ALARM	N/A	
OUTPUT	4 - 20 mA	— OUTPUT
CUST DATA	STK 08630	— USER INFORMATION
 INVENSYS PROCESS SYSTEMS INC FOXBORO, MA 02035 U.S.A.		

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 the mounting procedure.
 - b. If the 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 IPS Global Client Support Center at 1-866-746-6477 or contact your local IPS 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.

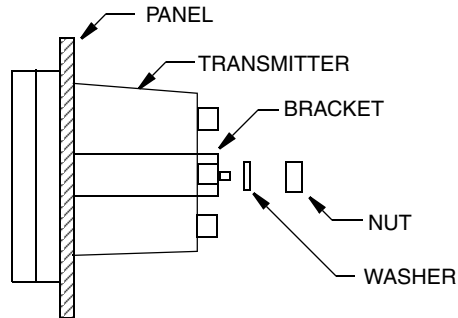


Figure 4. Panel Mounting

Surface Mounting

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

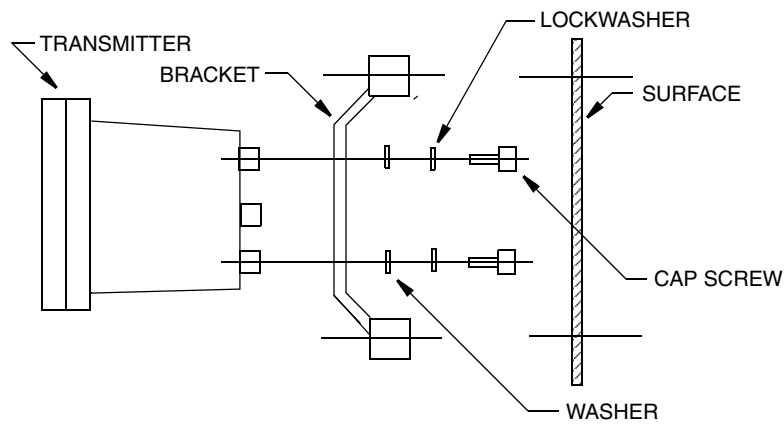


Figure 5. Surface Mounting

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.

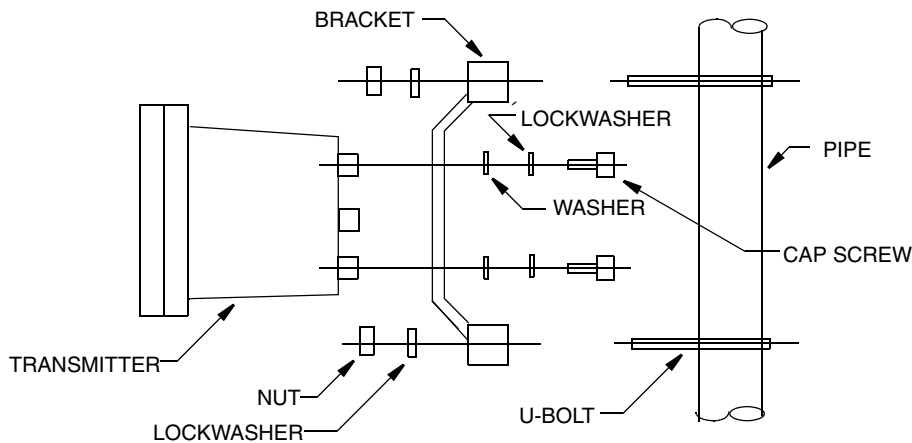


Figure 6. Pipe Mounting

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 (870ITEC-A), you must supply its power source. If it was specified with digital communications (870ITEC-F), power can be provided via the 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

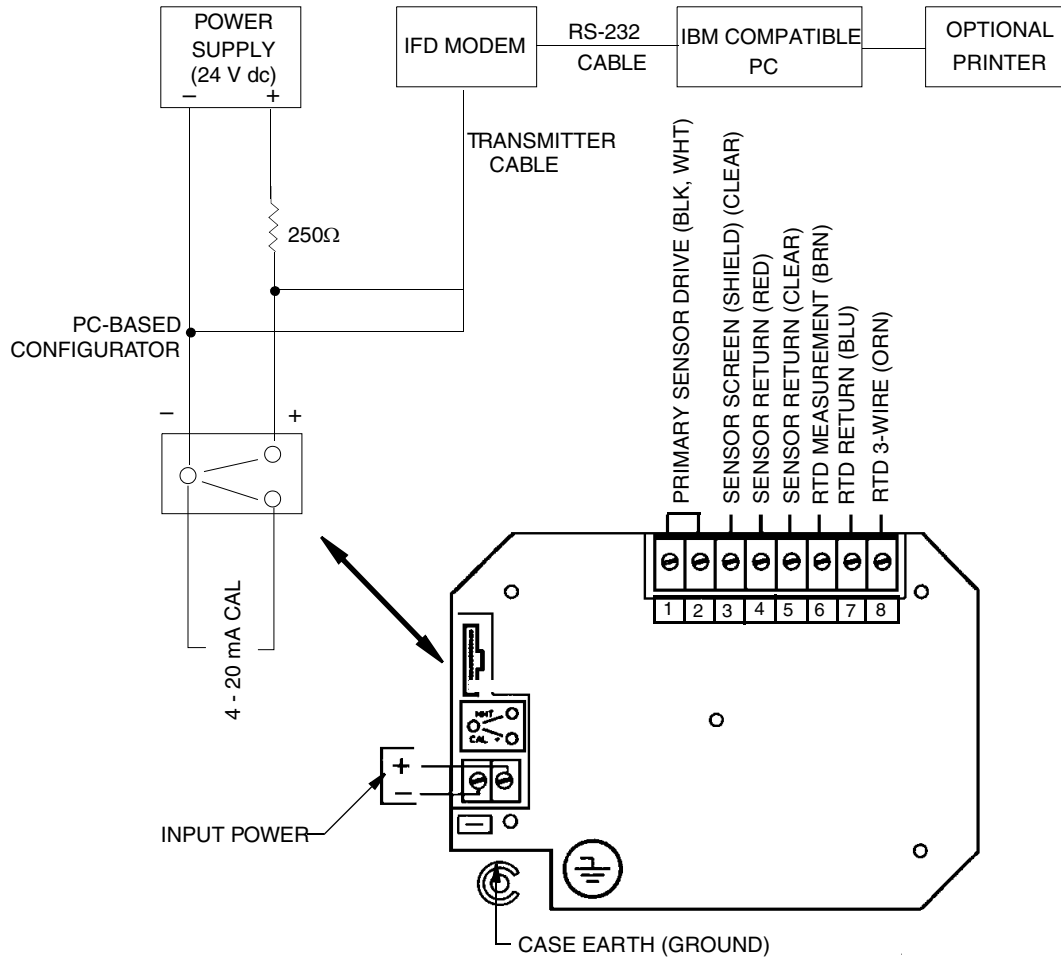
To minimize RFI/EMI effect, use grounded metal conduit on sensor cable and input power leads.

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 6, 7, and 8 to minimize noise.



NOTES:

1. IF NOT WIRING A TEMPERATURE MEASURING DEVICE, SHORT TERMINALS 6, 7, AND 8.
2. TERMINAL 8 IS NOT USED WHEN YOUR SENSOR CONTAINS A 2-WIRE TEMPERATURE ELEMENT.

Figure 7. Wiring

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.

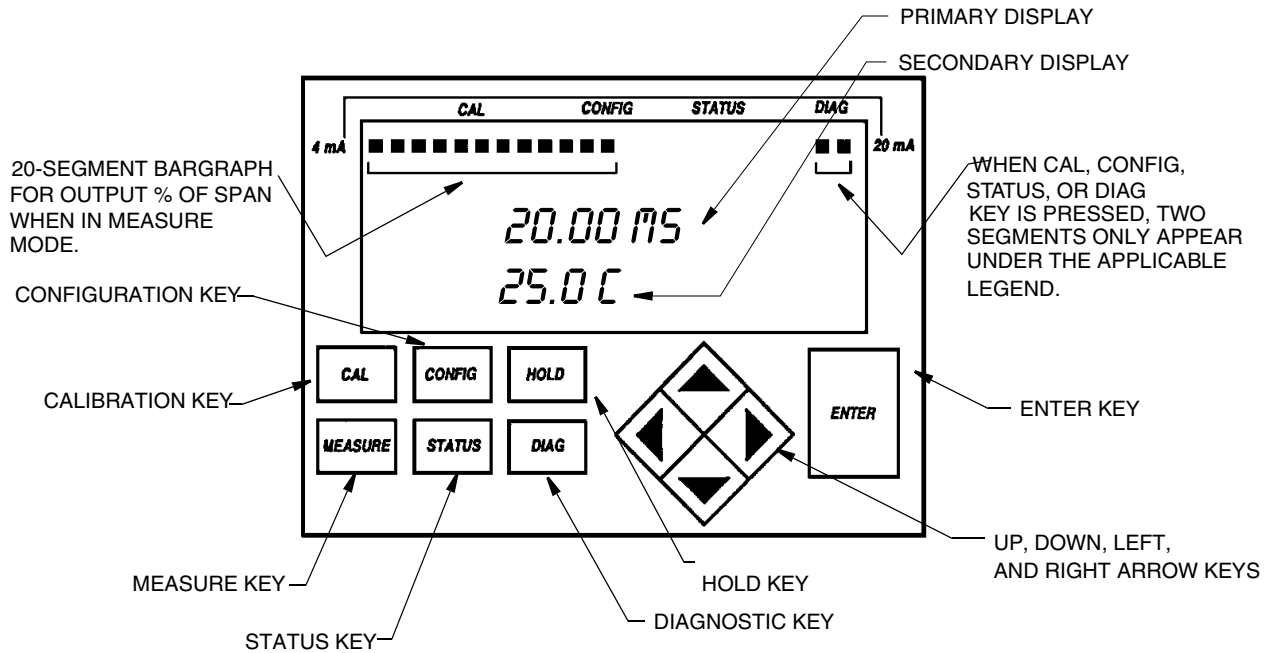


Figure 8. Indicators and Controls

Table 3. Indicators and Controls

Control/Indicator	Function
Digital Bar Graph	Displays percent-of-range indication.
Primary Display	Displays measurement and some error messages.
Secondary Display	Displays the absolute value of the measurement signal in $\mu\text{S}/\text{cm}$ or mS/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 resistors or solutions.
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.
DIAGnostics Key	Places transmitter in Diagnostic mode. This enables you to further identify specific errors and possible solutions to an error flagged in Measurement mode.
Direction (Arrow) Keys	Move 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 Transmitter 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 99.99 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.

XMTR ER: Occurs in Measure mode only to indicate a transmitter problem. The transmitter is still configurable but measurements are held at the fail-safe value if set.

PROBE ER: Occurs in Measure mode only when one of the following probe errors is present: Leakage, ATC Short, and ATC Open. For more information, see “Diagnostics” on page 15. 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, measurements are held at the fail-safe value if set.

CONFIG ER: Occurs in Measure mode only when one of the following errors is present: Calibration Required, 4 - 20 Range, Measurement Range, and Compensation Range. For more information, see “Diagnostics” on page 15. 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 message appears on the bottom line of the display. 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.

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.

Viewing and Changing Data

In the Configuration, Calibration, Hold, and Status modes, you will need to move through a structure of parameters (using the arrow keys and **ENTER** key) to view and/or 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.

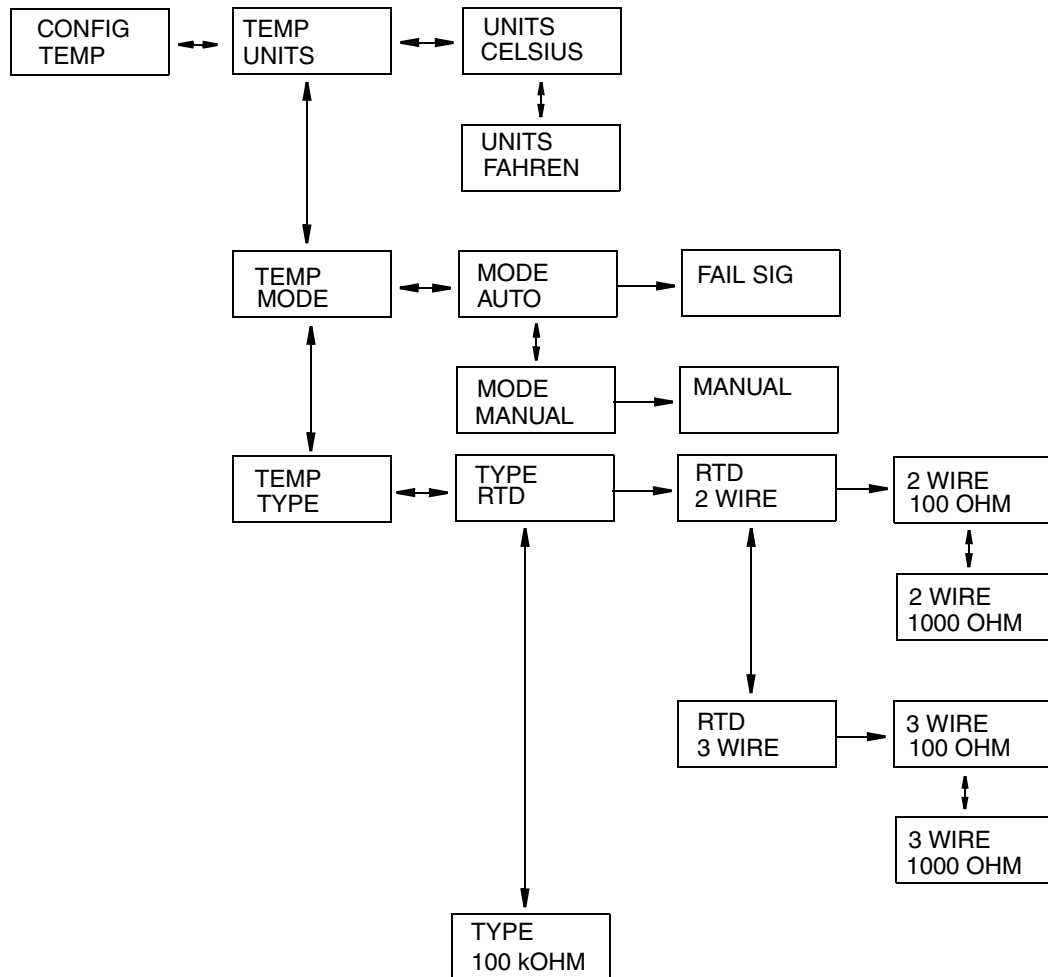


Figure 9. Example of Structure Diagram

Measure

Measure is the normal operating mode of your transmitter. The conductivity measurement is shown on the top line of the display. It is in the units specified during configuration. If the measurement is too small to be displayed at the configured resolution, the display will read **CONFIG ER**. The second line of your display continually displays the absolute conductivity value in $\mu\text{S}/\text{cm}$ or mS/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. Because the 870ITEC 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 monitoring and controlling it in the Measurement mode. Transmitter (**XMTR ER**) and sensor (**PROBE ER**) errors are also shown on your display while in the Measurement mode.

Diagnostics

(Refer to “Structure Diagram 14” on page 55.)

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 **XMTR ER**, **PROBE ER**, or **CONFIG ER** in the Measurement mode, the 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
Transmitter Error		
Probe Errors		
LEAKAGE	Checks solution leakage into the probe.	Replace probe
ATCSHORT 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 temperature compensator
Configuration Errors		
CAL REQ	Calibration required	Calibrate specified application
4 - 20 RNG	Measurement over or under configured range	Reconfigure range or correct process error
MEAS RNG	Measurement over or under configured precision or scale	Reconfigure precision or correct process error
COMP RNG	Measurement over or under compensation range	Reconfigure compensation or correct process error

Status

(Refer to “Structure Diagram 11” on page 52.)

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 NUM	Application number currently running
TEMP	Process Temperature
ABSOLUTE	Uncompensated $\mu\text{S}/\text{cm}$ or mS/cm signal from sensor
mA	Analog Output: Analog output value in mA 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)
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 870ITEC-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 4-character Major passcode and press **ENTER**. 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.

Config Appls

(Refer to “Structure Diagram 1” on page 42.)

— NOTE

This parameter appears only when the number of applications set in “Config Num Apps” on page 31 is more than 1.

The 870ITEC 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 31). If Config Num Apps is set at “1”, then the Config Appls parameter is bypassed in the menu structure.

If 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.

Config Sensor

(Refer to “Structure Diagram 1” on page 42.)

This section of the structure asks you to specify the sensor being used. If the sensor being used is not one of the Foxboro sensors listed, specify **OTHER** and its electrical cell factor (**CELLFACT**). The firmware allows a cell factor entry between 00.00 and 99.99. For Foxboro Flow-Through sensors, such as the 871FT series, specify **OTHER** and enter the electrical cell factor, not the geometric cell factor. Refer to MI 611-202 on 871FT sensors.

— NOTE

A change of sensor requires a calibration.

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 43.)

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 **μS/cm**, **mS/cm**, **%**, or **CUSTOM**. If **CUSTOM**, you can specify the units as **%** (percent), **g/l** (grams/litre), **ppm** (parts per million), **oz/gal** (ounces per gallon), **ppt** (parts per thousand), **S/m** (Siemens per meter), or **NONE**.

If you selected **μS/cm** or **mS/cm** as **PRIMARY UNITS**, you will be asked to specify the **PRIMARY SCALE**. The scale may be selected as indicated in Table 6 or Table 7.

Table 6. Primary Scale in $\mu\text{S}/\text{cm}$

Scale	Limitations
50.00	Sensor LB, UT, OTHER only
100.0	Sensor LB, UT, OTHER only
200.0	Sensor AB, BW, EV, LB, RE, UT, OTHER only
500.0	Sensor AB, BW, EV, LB, RE, UT, OTHER only
1000	No limitations
5000	No limitations

Table 7. Primary Scale in mS/cm

Scale	Limitations
1.000	No limitations
2.000	No limitations
5.000	No limitations
10.00	No limitations
20.00	No limitations
50.00	No limitations
100.0	No limitations
200.0	No limitations
500.0	Sensor LB, UT only are excluded
1000	Sensor LB, UT only are excluded
2000	Sensor AB, BW, EV, LB, RE, UT only are excluded

— NOTE —

In Measurement mode, because of space availability, the units $\mu\text{S}/\text{cm}$ and mS/cm are displayed locally as μS and mS respectively.

If you 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**. If more than one reference temperature exists for the chemical, the display will show one of the choices, which can be changed to another choice with the arrow and **ENTER** keys. If no choice exists, the reference temperature is 25°C (77°F). When you have completed this configuration, the chemical or reference temperature will appear on the top display and the allowable measurement range in percent by weight on the lower display.

— NOTE —

Setting these parameters sets the units, decimal placement, and temperature compensation. Additionally, internal changes are made within the analyzer which make calibration necessary.

Table 8. Primary Scale in Percent

Chemical	Scale	mS/cm at Various Percent Concentrations													
		1%	5%	10%	15%	18%	20%	25%	35%	42%	93%	96%	99.50%	99.90%	99.99%
Sodium Chloride (NaCl)	0 - 25%	20	80	140	188	212	225	248							
Phosphoric Acid (H ₃ PO ₄)	0 - 35%	10	32	64	92	112	123	153	208						
Hydrochloric Acid (HCl)	0 - 15%	112	430	700	820										
Sulfuric Acid (H ₂ SO ₄)															
50°C Ref	99.5 - 93%										230	205	63	46	42
30°C Ref	99.5 - 93%										158	130	20		
25°C Ref	0 - 25%	50	221	440	595	670	721	790							
OLEUM															
65°C Ref	42- 18%					76	74	64	34	15					
65°C Ref	0 - 10%	39	67	79											
Nitric Acid (HNO ₃)	0 - 10%	63	281	500											
Sodium Hydroxide (NaOH)															
25°C Ref	0 - 15%	60	220	355	410										
50°C Ref	0 - 15%	76	320	530	650										
100°C Ref	0 - 20%	100	495	850	1110	1230	1310								
Potassium Hydroxide (KOH)	0 - 6%	38.5	178	356	495	525									
Potassium Chloride (KCl)	0.5 - 16%	15.7	71.9	143	208										
Acetic Acid (CH ₃ OOH)	0 - 8%	0.64	1.43	1.70	1.82										
Hydrofluoric Acid (HF)															
0°C Ref	99 - 90%										224	39.9	12.6	2.089	
25°C Ref	0 - 30%	11.7	59	120.5	189.5	236	260	325							

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.

See Figure 10 for some sample mS/cm vs. percent concentration curves. Note that the curves are not linear.

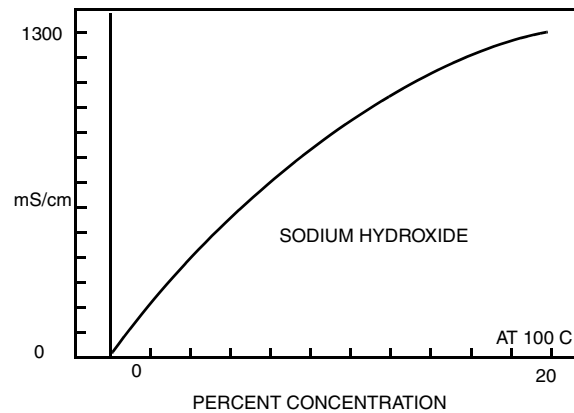
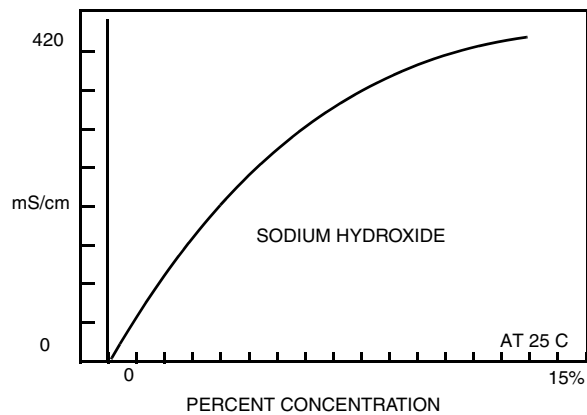
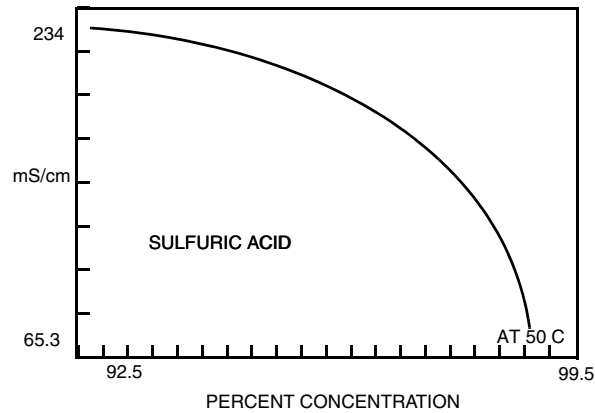


Figure 10. Sample Concentration Curves

Next, under **DISPLAY SECOND**, you can configure the secondary display to show the absolute value of the measurement in $\mu\text{S}/\text{cm}$ or mS/cm , the output in 4 to 20 mA, or the temperature.

Configx Tempcomp

(Refer to “Structure Diagram 4” on page 45.)

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

— NOTE —

This parameter does 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 $\mu\text{S}/\text{cm}$ or mS/cm

If your **PRIMARY UNITS** were configured as $\mu\text{S}/\text{cm}$ or mS/cm , you are first asked to specify **ABSOLUTE**, **LINEAR**, **CUSTOM**, or one of several preprogrammed chemical-specific temperature compensations. **ABSOLUTE** means that there is no temperature compensation applied. If your application is such that one chemical composition dominates, select one of the preprogrammed 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**. If you selected a chemical and more than one reference temperature exists for the chemical, the display will show one of the choices. This choice can be **ENTER**ed or another choice selected with the arrow and **ENTER** keys.

Table 9. Chemical Specific Temperature Compensations

Tempcomp Menu	Valid Temperature Range
Sodium Chloride (NaCl) Dilute (25°C Ref) 0 - 25% (25°C Ref)	0 to 200°C (32 to 392°F) 0 to 200°C (32 to 392°F)
Green Liquor (GRN LIQ) (Na ₂ CO ₃) (85°C Ref)	35 to 96°C (94 to 204°F)
Black Liquor (BLK LIQ) (Na ₂ O) (160°C Ref)	46 to 210°C (115 to 411°F)
Phosphoric Acid (H ₃ PO ₄) (25°C Ref)	4.4 to 93°C (40 to 200°F)
Hydrochloric Acid (HCl) (25°C Ref)	-10 to +122°C (14 to 252°F)
Sulfuric Acid (H ₂ SO ₄) 50°C Ref (99.5 - 93%) 30°C Ref (99.5 - 93%) 25°C Ref (0 - 25%)	-10 to +120°C (14 to 249°F) 10 to 90°C (50 to 194°F) -10 to 120°C (14 to 249°F)
OLEUM 0 - 10% (65°C Ref) 42 - 18% (65°C Ref)	32 to 120°C (89 to 249°F) 32 to 120°C (89 to 249°F)
Nitric Acid (HNO ₃)(25°C Ref)	-10 to +120°C (14 to 249°F)

Table 9. Chemical Specific Temperature Compensations (Continued)

Tempcomp Menu	Valid Temperature Range
Sodium Hydroxide (NaOH) 25°C Ref (0 - 15%) 50°C Ref (0 - 15%) 100°C Ref (0 - 20%)	-0.6 to +121°C (31 to 250°F) 0 to 100°C (32 to 212°F) -11 to +122°C (12 to 252°F)
Potassium Hydroxide (KOH) (20°C Ref)	10 to 40°C (50 to 104°F)
Potassium Chloride (KCl) (20°C Ref)	0 to 25°C (32 to 77°F)
Acetic Acid (CH ₃ COOH) (25°C Ref)	5 to 120°C (40 to 250°F)
Hydrofluoric Acid (HF) 0°C Ref (90 - 99%) 25°C Ref (0 - 30%)	-20 to +208°C (-4 to +406°F) 35 to 95°C (94 to 204°F)

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 11.

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 27. The values (**VALxx**) can be specified from 0 to 2000 mS and have a default of 0.

— **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 need 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.

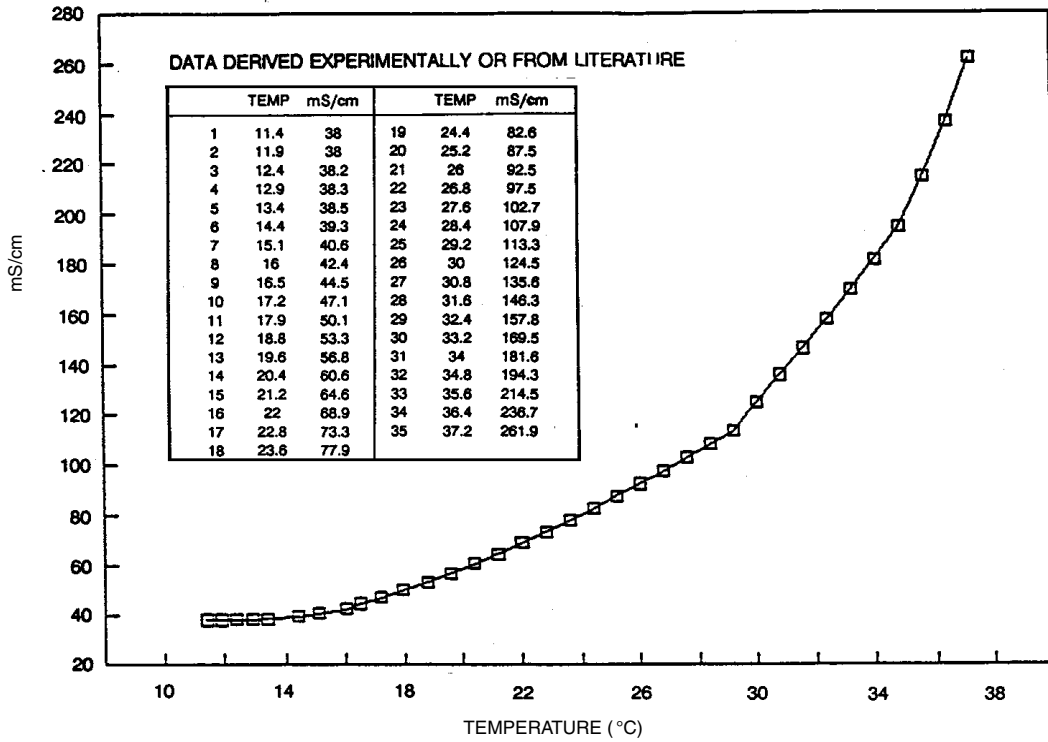


Figure 11. Reference Conductivity vs. Temperature Data

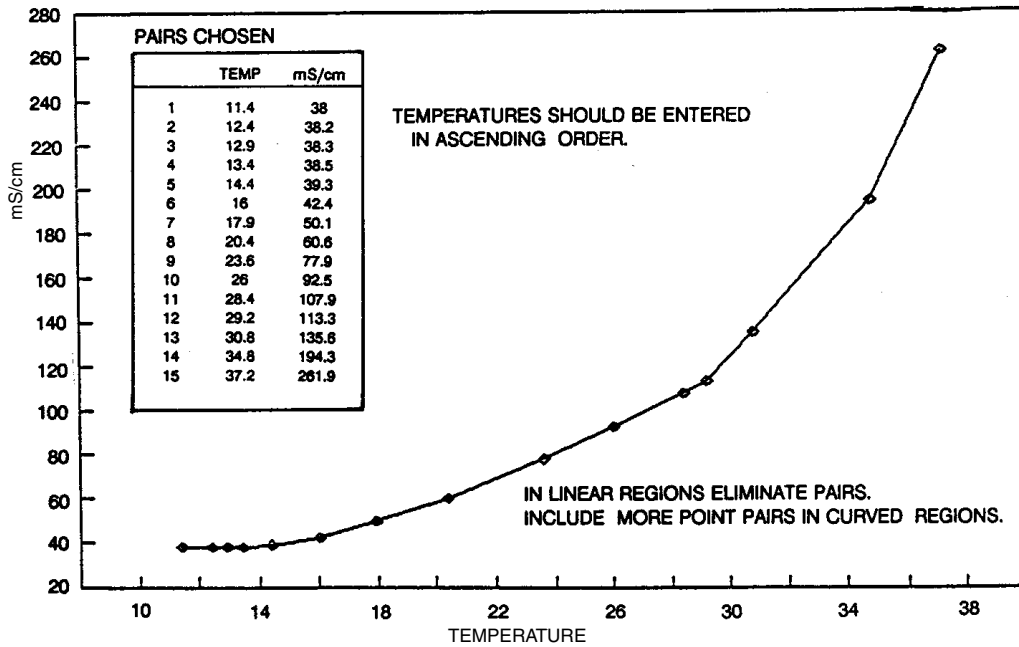


Figure 12. Configured Conductivity vs. Temperature Data

In the example used in Figure 11 and Figure 12, the 35 reference points were reduced to 15 configured points. The configuration procedure was 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 CUSTOM

If your **PRIMARY UNITS** were configured as **CUSTOM** in “Configx Display” on page 17, the prompts will ask you to specify a reference temperature and a number of points to plot a compensation curve as you were in the procedure immediately 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. The temperature units are specified under “Config Temp” on page 27. However, the choice of conductivity units ($\mu\text{S}/\text{cm}$ or mS/cm) was not made previously so it is made here. The values of these units (**VALxx**) can be specified from 0 to 2000 $\mu\text{S}/\text{cm}$ or mS/cm and have a default of 0.

Configx Chemcomp

(Refer to “Structure Diagram 5” on page 46.)

This section of the structure asks you to specify the chemical compensation, the relationship between Absolute units in $\mu\text{S}/\text{cm}$ 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**, **S/m**, 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. We suggest that the data be plotted graphically as well as tabularly to prepare it for entry into your transmitter. See Figure 13.

The prompts first ask you 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. Next, you will be asked to specify the absolute **UNITS** in $\mu\text{S}/\text{cm}$ 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 $\mu\text{S}/\text{cm}$ or mS/cm as just specified and the custom scale is in the units previously configured in **CONFIG X DISPLAY**. Lastly, for each of the number of points specified above, specify an absolute value (**ABSxx**) and the value you want it to be (**NEWxx**). The values can be specified from 0 to 2000 custom units and have a default of 0.

A maximum or minimum difference between successive concentrations is not required. The intervals do not need 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 14.

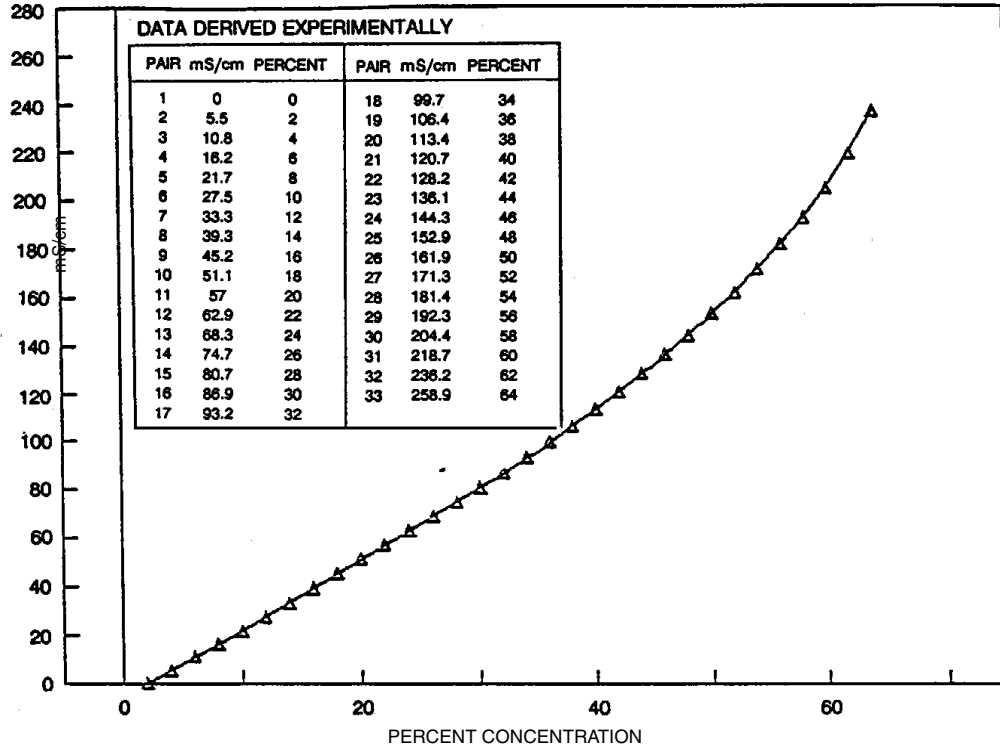


Figure 13. Reference Conductivity vs. Concentration Data

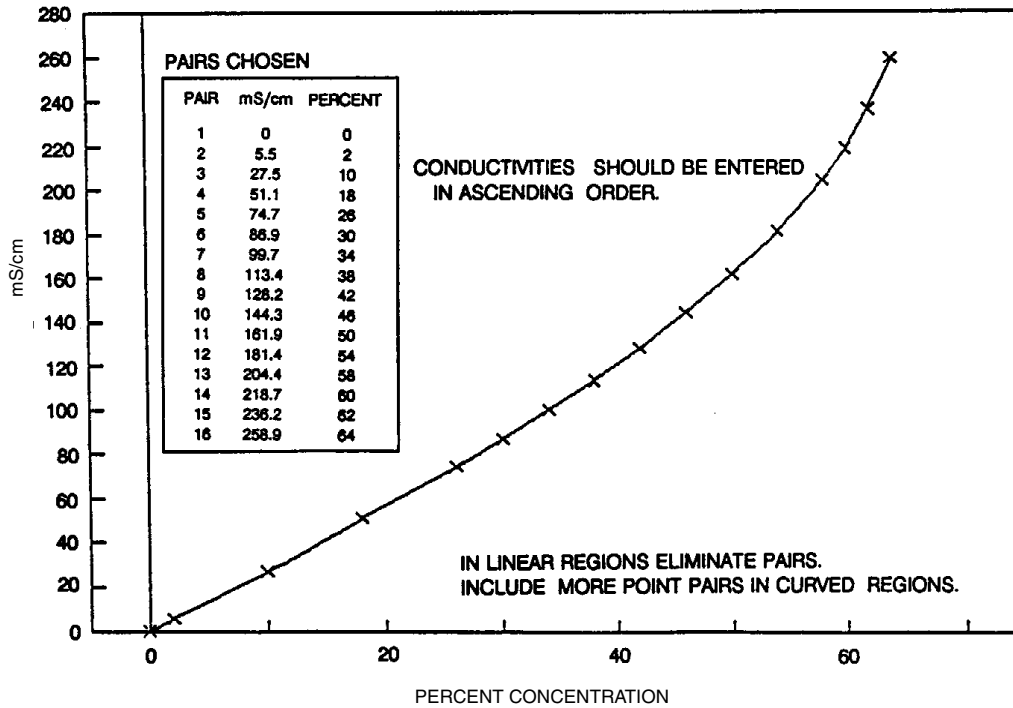


Figure 14. Configured Conductivity vs. Concentration Data

In the example used in Figure 13 and Figure 14, 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 number of points on your curve. For this example, 16.
3. Specify the absolute units. For this example, mS/cm.
4. Specify the scale of your absolute values. For this example, because they are from 0 to 258.9, specify **ABSSCALE** as 999.9.
5. 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.
6. Specify the 16 point pairs.

— **NOTE** —

When entering data, remember to check the \pm 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 Output

(Refer to “Structure Diagram 6” on page 47.)

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 (870ITEC-A), specify **ANALOG**. If your transmitter was specified with I/A Series communications (870ITEC-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 **ANALOG**, you will be asked, under **OUTPUT ANALOG**, to specify the 4 to 20 mA output to represent the uncompensated (**ABSOLUTE**) measurement, the temperature compensated **MEASUREMENT**, or the **TEMPERATURE**.

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

Next, under **OUTPUT RANGE**, enter the **MINIMUM** (4 mA) and **MAXIMUM** (20 mA) range values for the output just specified. Specify in $\mu\text{S/cm}$ or mS/cm for **ABSOLUTE**, in $^{\circ}\text{C}$ or $^{\circ}\text{F}$ for **TEMPERATURE**, or in measurement units (e.g., $\mu\text{S/cm}$, mS/cm , %) for **MEASUREMENT**. To configure the output as reverse acting, enter higher value as **MINIMUM** and the smaller as **MAXIMUM**.

— NOTE

1. The units for temperature °C or °F are specified in the section titled “Config Temp” on page 27.
2. 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 fail-safe signal for sensor diagnostic errors of **ATC SHORT** and **ATC OPEN**. 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**.

**— 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 6” on page 47.)

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 **FAHRENHEIT**. 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 RTD. In Manual mode it is set at a fixed value. At this point you can set a **FAIL SIGNAL** (default) value for the Auto mode (in case the RTD fails) at the temperature at which you expect the process to be operating; or you can set a temperature for the Manual mode.

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**. See Table 10 for standard Foxboro sensors.

Table 10. Foxboro Sensor Data

Sensor	RTD or Thermistor
AB	100 k Ω Thermistor
BW	2 wire, 100 Ω RTD
EV	100 k Ω Thermistor
HP	2 wire, 100 Ω RTD
PP	2 wire, 100 Ω RTD
LB	100 k Ω Thermistor
NL	100 k Ω Thermistor
PN	100 k Ω Thermistor

Table 10. Foxboro Sensor Data (Continued)

Sensor	RTD or Thermistor
PX	100 k Ω Thermistor
RE	100 k Ω Thermistor
SP	100 k Ω Thermistor
PT	100 k Ω Thermistor
TF	100 k Ω Thermistor
UT	2 wire, 100 Ω RTD

Config Damping

(Refer to “Structure Diagram 6” on page 47.)

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 7” on page 48.)

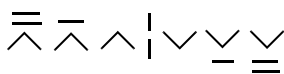
— NOTE —

This section is not displayed unless the correct passcode had been 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 voltmeter to the calibration terminals (see Figure 7 on page 10).
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 voltmeter read 100 mV. 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 100 mV. 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 voltage reading should be 500 mV.

INSTRMNT STAB IND

When performing a calibration (see “Calibration” on page 33), 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 “Config 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 **VARIABLE** between 1 and 9. The default **TIME** is 5 seconds and the default **VARIABLE** is 9. A longer time period and a smaller measurement value assures more stability during calibration.

— NOTE —

In specifying the **VARIABLE**, 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 1000 mS, a **VAR** value of 5 means 5 mS.

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 **VARIABLE** between 1 and 9 (°C or °F). The default **TIME** is 5 seconds and the default **VARIABLE** is 9, thus allowing a temperature change of 0.9°C or °F over a 5-second period.

Config Timeout

(Refer to “Structure Diagram 7” on page 48.)

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 0 and 999 seconds. A value of zero (0) disables the time-out function. The default time is 600 (10 minutes).

Config Passcode

(Refer to “Structure Diagram 7” on page 48.)

— 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.

Config Diags

(Refer to “Structure Diagram 8” on page 49.)

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.

LEAKAGE

This message reports a problem of liquid leakage into the sensor. The message may be enabled, disabled, or cleared.

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.

4 - 20 RNG

This message reports that the measurement tied to the analog output is outside the range configured for the currently running application. The message may be enabled, disabled, or cleared.

MEAS RNG

This message reports that the measurement cannot be displayed accurately in the precision/scale that is configured for the currently running application. The message may be enabled, disabled, or cleared.

COMP RNG

This message reports that the measured temperature or absolute measurement is outside the temperature or chemical compensation curve configured for the currently running application. The message may be enabled, disabled, or cleared.

Config Strings

(Refer to “Structure Diagram 8” on page 49.)

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 11 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 (870ITEC-A).

Table 11. List of Characters

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

Config Num Apps

(Refer to “Structure Diagram 9” on page 50.)

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 17.

Config Trigger

(Refer to “Structure Diagram 9” on page 50.)

If **AUTO** was configured under “Config Appls” on page 17, 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 may overlap, application 1 has the lowest conductivity value, application 2 is next, and application 3 has the highest. See Table 12 for an example of the Trigger function. 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.

Table 12. Example of Trigger Function

	Application 1 RinseWater	Application 2 Product	Application 3 Caustic Cleaner
Example of Process			
Display	0 to 100 $\mu\text{S}/\text{cm}$	0 to 1 mS/cm	0 to 5 oz/gal (0 to 2 mS/cm)
Chemcomp	Not Applicable	Not Applicable	0 to 5 oz/gal (0 to 2 mS/cm)
Tempcomp	NaCl dilute	KCl	Custom Program
Output	20 to 80 $\mu\text{S}/\text{cm}$	0 to 1 mS/cm	0 to 5 oz/gal
Example of Trigger Function			
Trigger	Hi	75 $\mu\text{S}/\text{cm}$	0.9 mS/cm
	Low	- - -	0.05 mS/cm
			- - -
			1 oz/gal (0.6 mS/cm)

In the above example, if the value of Application 1 exceeds 75 $\mu\text{S}/\text{cm}$, the transmitter switches to Application 2; if the value of Application 2 exceeds 0.9 mS/cm , the transmitter switches to Application 3; if the value of Application 2 drops below 0.05 mS/cm it switches to Application 1; if the value of Application 3 drops below 1 oz/gal (0.6 mS/cm), the transmitter switches to Application 2. As the transmitter switches from one application to another, the message SW TO APP X appears on the display.

Hold

(Refer to “Structure Diagram 10” on page 51.)

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 4 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. To enter the Hold mode, press the **HOLD** key. You will be prompted to enter the 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 **MANUALLY** set.

If you selected **MANUAL** and your transmitter was specified with analog communications (870ITEC-A), your display will read **MANUAL ANALOG**. 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.

If you selected **MANUAL** and your transmitter was specified with digital communications (870ITEC-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 **MEASUREMENT** units, **TEMPERATURE**, and **ABSOLUTE** value you want to hold the output at while in the Hold mode.
 - a. The **TEMPERATURE** can be specified between -99.9 and +999.9 (°C or °F). The default value is 0.0.
 - b. The **ABSOLUTE** value can be specified between 0.0 and 2000.0 mS. The default value is 0.0.

If you selected **MANUAL** and your transmitter was specified with digital communications (870ITEC-F), and you had previously selected **DIGITAL** under **CONFIG OUTPUT**, your display will prompt you to specify the **MEASUREMENT** units, **TEMPERATURE**, and **ABSOLUTE** value you want to hold the output at while in the Hold mode.

1. The **TEMPERATURE** can be specified between -99.9 and +999.9 (°C or °F). The default value is 0.0.
2. The **ABSOLUTE** value can be specified between 0.0 and 2000.0 mS. The default value is 0.0.

Calibration

(Refer to “Structure Diagram 12” on page 53.)

Calibration routines in your transmitter were designed for simplicity and the elimination of errors. The procedures are self-prompting. Two routines are available. A bench calibration is accomplished by performing a zero calibration with the sensor suspended in air and calibration of a second point done with the use of a loop resistor, a decade resistance box, a Foxboro calibration plug, or (when used with an 871FT Flow-Through Sensor) a Foxboro calibration cable. A solution calibration enables you to enter or edit 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. However, a single point calibration may only be used if you have previously done a 2-point calibration. A bench calibration is strongly recommended because it is not subject to potential variables such as impurities in a solution or temperature variations. Note that damping does not affect either bench or solution calibration (signal is automatically filtered internally).

— NOTE —

1. Before doing any calibration, check that the temperature on the secondary display in the Measure mode agrees with the actual temperature of the process. If there is a difference, the actual temperature should be entered under **CALX TEMP** in the Calibration mode before beginning your calibration. The temperature may be between -99.9 and +999.9 (°C or °F). Even though the temperature appears on each **CALX TEMP** menu, it is not an application dependent variable and is a constant program among the three applications.
 2. For system calibration examples, see MI 611-220.
-

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 the 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 **CALx SOLUTION**.

Solution Calibration

If you are using a solution calibration, specify **SINGLEPT** or **TWO PT** calibration and if **SINGLEPT**, specify **OFFSET** or **SPAN**. **OFFSET** is used if correcting for a shift in system zero (such as might be present if a sensor becomes magnetized). **SPAN** is used to correct for a shift in system span (such as might be present if a sensor is too close to a pipe or vessel wall).

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.

Bench Calibration

If you are using bench calibration:

1. Move to **SUSPEND IN AIR** and suspend the dry sensor in air.

— **NOTE** —

For a nonzero based range (for example, high percent range H_2SO_4), connect a loop resistance through the sensor. The resistance is calculated in a similar manner to that of the full scale resistance explained in Step 3.

2. Move to **ZERO** and enter the zero value. The **ZERO** data will flash while stability is achieved (see note below). Press **ENTER**. The display will indicate **CONNECT LOOP RES**. If a calibration error occurs, the display reads **CAL ERROR** and returns you to the beginning of the procedure.

— **NOTE** —

Flashing continues until measurement is stable as determined by configured stability parameters. If stability parameters are disabled, watch for the measurement to stabilize before proceeding.

3. Calculate the full scale value input resistance required. The geometric cell factor is required for this calculation. Geometric cell factors for various Foxboro invasive sensors are listed in Table 13.

The resistance required to calibrate your system at full scale value is dependent upon:

- ◆ If you are using a user-supplied calibration wire (with an 871FT or 871EC sensor)

- ◆ When your 871FT sensor was manufactured if you are using a Foxboro calibration cable
- ◆ When your 871FT sensor was manufactured if your 871FT sensor has a patch cord cable connection.

The date of manufacture is determined from the last four digits of the Origin Date Code found on the sensor data plate. A code of 2B0149 means the sensor was manufactured in week 49 of 2001,

Use the following formula to calculate full scale loop resistance if using a Foxboro supplied calibration cable **and** your 871FT sensor has an Origin Date code of 2B9710 or later.

$$(Cf_{(geom)} \cdot 1000 \cdot 25) / (FS \text{ in mS/cm}) = \text{Loop R in ohms}$$

where

$Cf_{(geom)}$ = geometric cell factor for the sensor being calibrated, found in Table 13.

FS = Full Scale conductivity value expressed in mS/cm

R = Resistance value, in ohms, to set on the decade resistance box.

Use the following formula to calculate full scale loop resistance:

- ◆ If using a user-supplied calibration wire looped through an 871FT or 871EC sensor
- ◆ If using a Foxboro calibration cable **and** your 871FT sensor has an Origin Date Code earlier than 2B9710
- ◆ If using an 871FT sensor with a patch cord cable connection and your sensor has an Origin Date Code after 2B04xx.

$$(Cf_{(geom)} \cdot 1000) / (FS \text{ in mS/cm}) = \text{Loop R in ohms}$$

where

$Cf_{(geom)}$ = geometric cell factor for the sensor being calibrated, found in Table 13.

FS = Full Scale conductivity value expressed in mS/cm

R = Resistance value, in ohms, to set on the decade resistance box.

Table 13. Cell Factors

871EC Sensor		871FT English Flow-Thru Sensor		Other Sensors	
Sensor Type	Geometric Cell Factor	Sensor Type	Geometric Cell Factor	Sensor Type	Geometric Cell Factor
-AB	0.588	-1C	11.60	EP307B	2.49
-BW	0.873	-2C	11.60	EP307G	2.49
-EV	0.45	-1D	4.14	EP436E	2.185
-HP	2.15	-2D	4.14		
-LB	0.873	-1E	2.67		
-NL	2.35	-2E	2.67		
-PN	2.45	-1F	1.11		
-PX	2.45	-2F	1.11		
-RE	0.873	-1G	0.62		
-SP	2.15	-2G	0.62		
-TF	2.31	-1H	0.38		
-UT	0.873	-2H	0.38		
-PP	2.185	-1J	0.21		
-PT	2.185	-2J	0.21		
		-3C	3.02		
		-4C	3.02		
		-3E	1.06		
		-4E	1.06		
		-3F	0.49		
		-4F	0.49		
		-3G	0.49		
		-4G	0.49		
		-3H	0.25		
		-4H	0.25		
		-3J	0.15		
		-4J	0.15		

Example:

Calibrate an 871FT-1F English Sanitary Flow-Thru Sensor with Full Scale Conductivity = 500 $\mu\text{S}/\text{cm}$ using a Foxboro calibration cable.

From Table 13, $Cf_{(\text{geom})} = 1.11 \text{ cm}^{-1}$.

$R = (1.11 \cdot 1000 \cdot 1) / (0.5) = 2220 \text{ ohms}$ for a sensor with a pre-2B9710 Origin Code.

$R = (1.11 \cdot 1000 \cdot 25) / (0.5) = 55,500 \text{ ohms}$ for a sensor with an Origin Code of 2B9710 or later.

The resistance values calculated in the preceding formulas and example assume a single loop or turn through the sensor as shown in Figure 15. When very small resistances (less than 10 ohms) are required, and are not available using equipment at

hand, you can loop the decade box wire several times through the sensor and then multiply R_C by the square of the number of loops used.

$$R_L = n^2 R_C$$

where:

R_C = Resistance required from calculation

n = Number of loops through sensor donut

R_L = Resistance to use through loop.

Example:

Calibrate an 871FT-3G English Industrial Flow-Thru Sensor with a full scale conductivity = 500 mS/cm.

From Table 13, $Cf_{(geom)} = 0.49 \text{ cm}^{-1}$.

$R = (0.49 \cdot 1000 \cdot 1) / (500) = 0.98 \text{ ohms}$ for a sensor with a pre-2B9710 Origin Code.

$R = (0.49 \cdot 1000 \cdot 25) / (500) = 24.5 \text{ ohms}$ for a sensor with an Origin Code of 2B9710 or later.

The resistance calculated in the first formula (0.98Ω) is less than 10 ohms. Therefore, use 10 turns of wire. Assure you are using a full 10 turns. With 10 turns of wire, multiply the resistance value by 10^2 or 100 and use a resistance of 98 ohms to calibrate the full scale value to 500 mS/cm.

- At the **CONNECT LOOP RES** prompt, connect the loop resistance through the sensor as shown in Figure 15.

— NOTE —

For optimum performance, use discrete metal film resistors and a single turn of 16 AWG or larger wire.

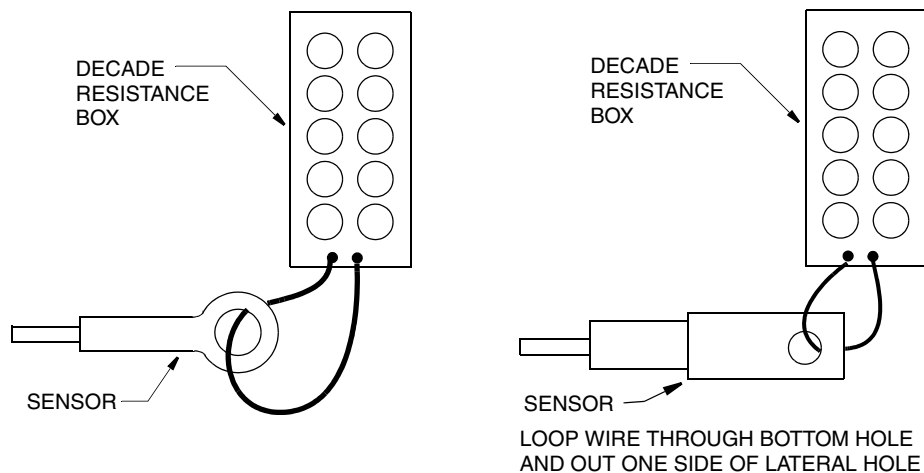


Figure 15. Connection of Loop Resistance

- Press the **ENTER** key. The display will read **VALUE** and a value. When stability is achieved, edit the displayed value as required. Press **ENTER**. When the calibration is

complete, the display will indicate **CAL COMPLETE**. If a calibration error occurs, the display reads **CAL ERROR** and returns you to the beginning of the procedure.

Documentation of Calibration Procedure

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.

Troubleshooting

If your conductivity reading is not what you expect, your RTD may be bad. To check this, compare the resistance across transmitter Terminals 6 and 7 with the appropriate value in Table 14.

Table 14. Temperature vs. RTD Resistance

Temperature		100 Ohm RTD	100 Ohm RTD (MIL SPEC)	1000 Ohm RTD
°C	°F	Ohms	Ohms	Ohms
-5	+20	98.04	98.01	980.4
0	32	100.00	100.00	1000.0
10	50	103.90	103.98	1039.0
20	68	107.79	107.94	1077.9
25	75	109.73	109.92	1097.3
30	86	111.67	111.89	1116.7
40	104	115.54	115.83	1155.4
50	122	119.40	119.77	1194.0
60	140	123.24	123.69	1232.4
70	158	127.07	127.60	1270.7
80	176	130.89	131.49	1308.9
90	194	134.70	135.37	1347.0
100	212	138.50	139.24	1385.0
105	225	140.39	141.17	1403.9
110	230	142.28	143.10	1422.8
120	248	146.06	146.95	1460.6
130	266	149.82	150.79	1498.2
140	284	153.58	154.61	1535.8
150	302	157.32	158.42	1573.2
160	320	161.04	162.22	1610.4
170	338	164.76	166.01	1674.6
180	356	168.47	169.79	1684.7

Table 14. Temperature vs. RTD Resistance (Continued)

Temperature		100 Ohm RTD	100 Ohm RTD (MIL SPEC)	1000 Ohm RTD
°C	°F	Ohms	Ohms	Ohms
190	374	172.16	173.42	1721.6
200	392	175.84	177.23	1758.4
210	410	179.51	181.05	1795.1

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, the core printed wiring assembly (PWA), and the sensor PWA. See Parts List 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 PWA or return of the PWA to the factory for repair.

Appendix A. Structure Diagrams

Top Level Structure Diagram

CONFIG
APPLS

CONFIG
SENSOR

CONFIGX
DISPLAY

CONFIGX
TEMPCOMP

CONFIGX
CHEMCOMP

CONFIG
OUTPUT

CONFIG
TEMP

CONFIG
DAMPING

CONFIG
INSTRMNT

CONFIG
TIMEOUT

CONFIG
PASSCODE

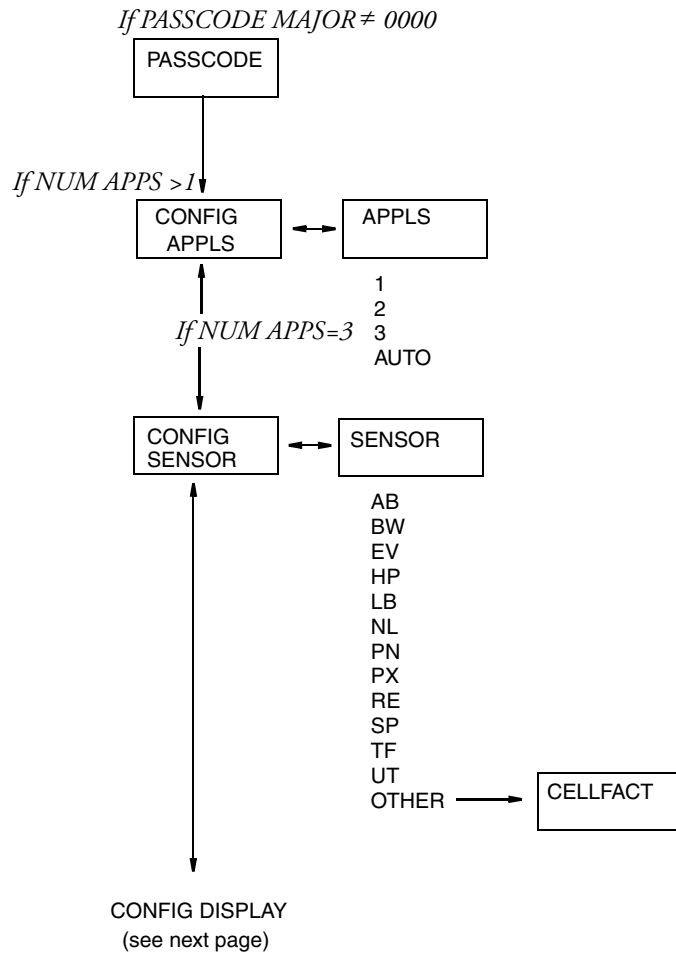
CONFIG
DIAGS

CONFIG
STRINGS

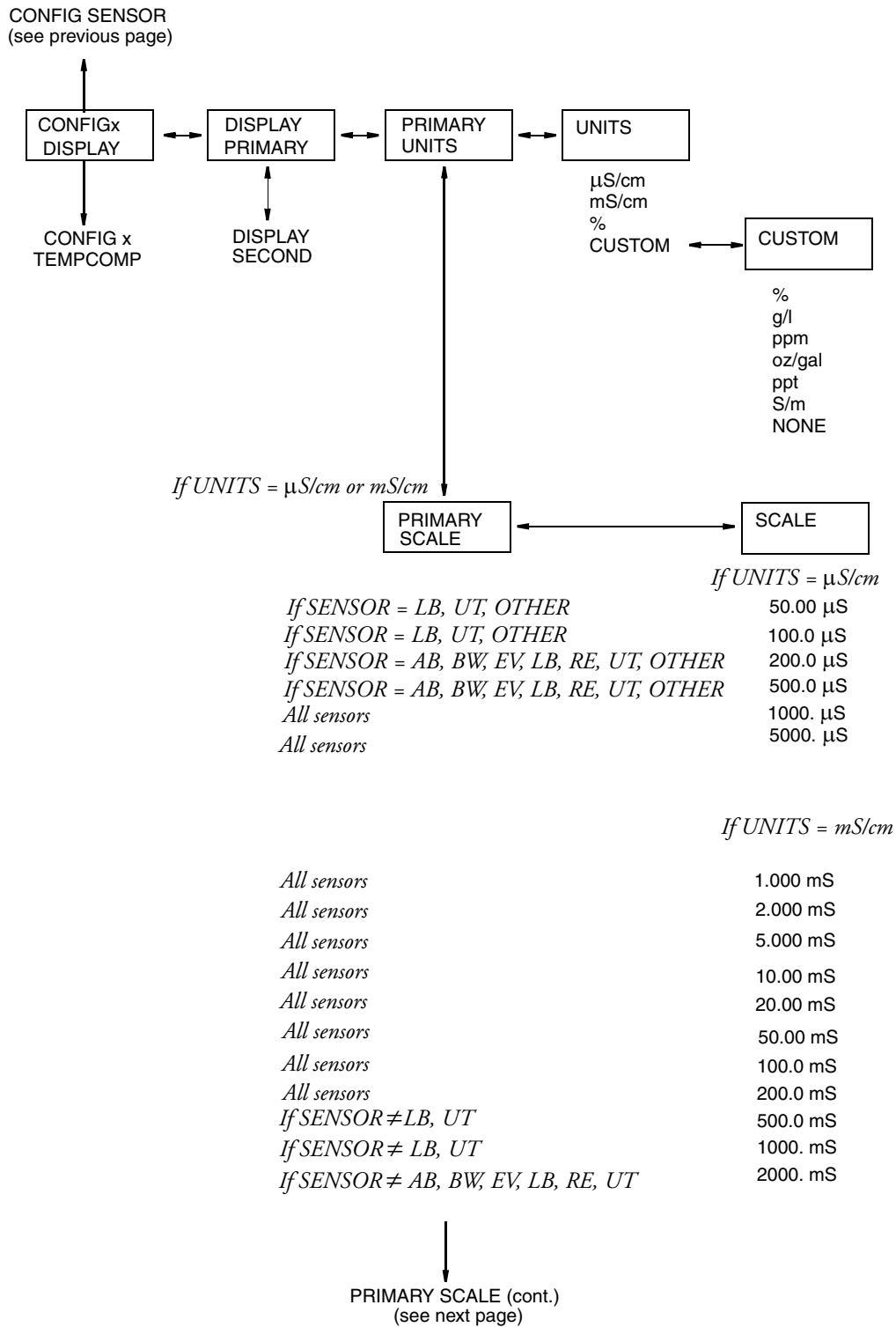
CONFIG
NUM APPS

CONFIG
TRIGGER

Structure Diagram 1 CONFIGURATION

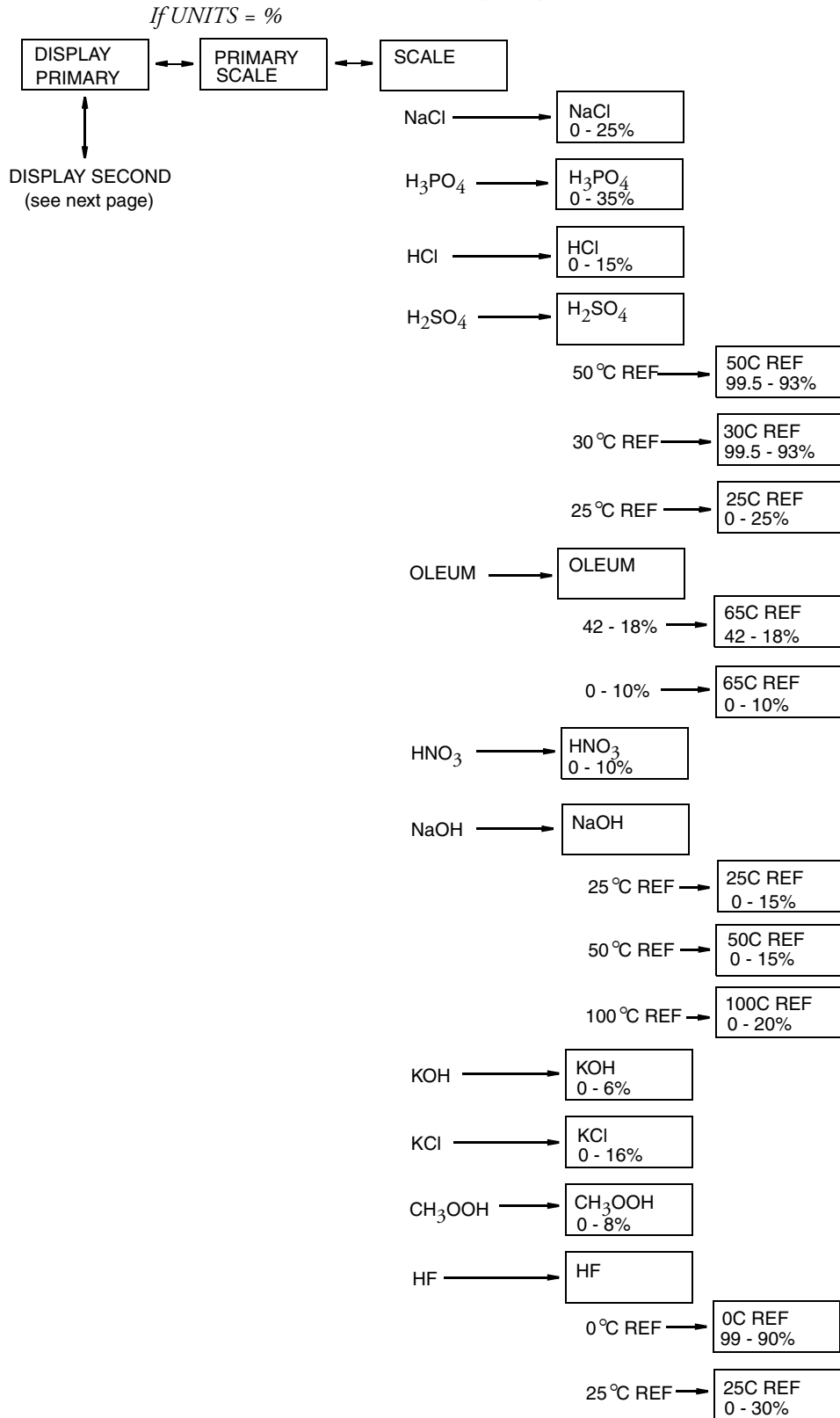


Structure Diagram 2 CONFIGURATION (cont.)

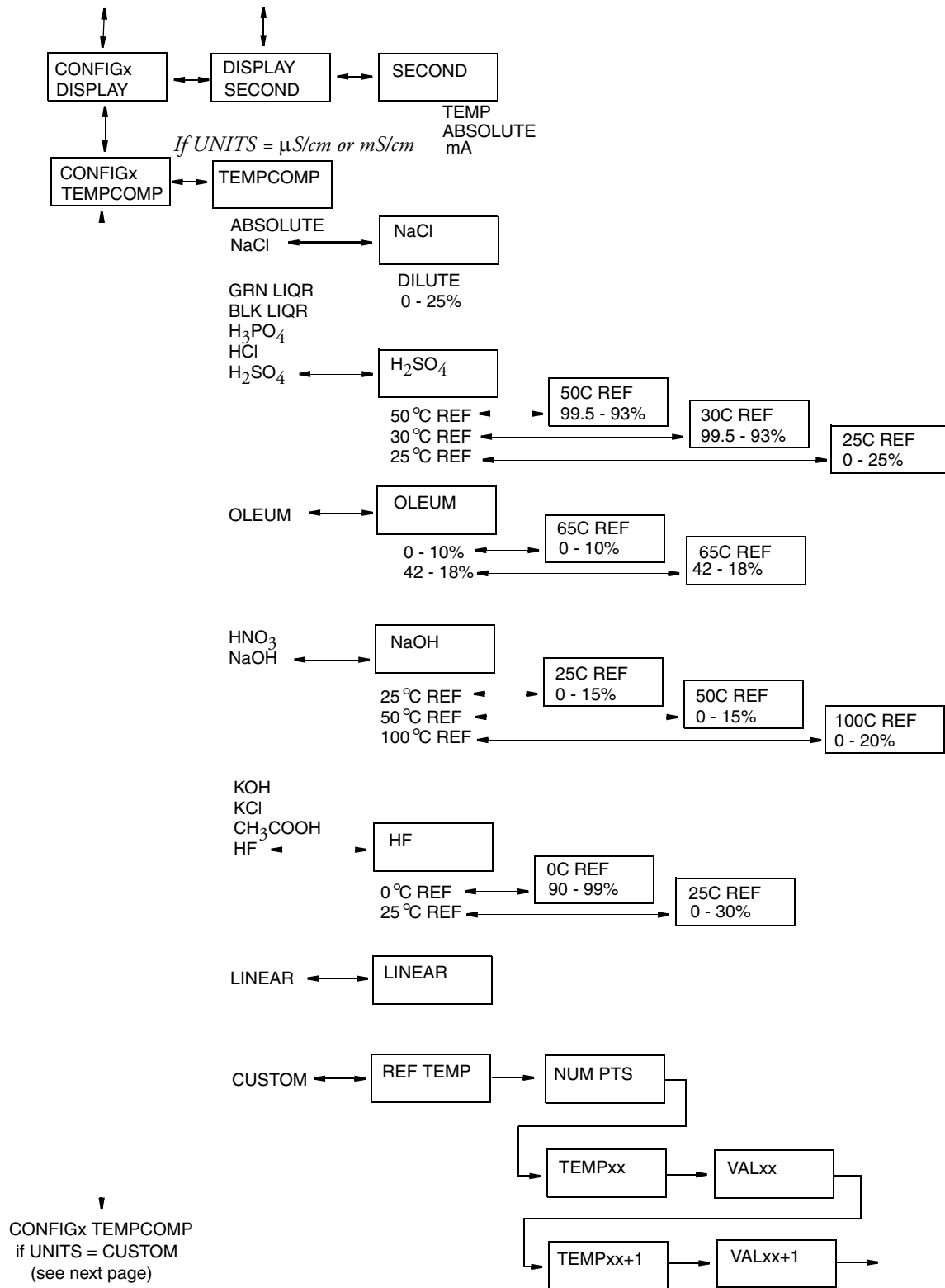


Structure Diagram 3

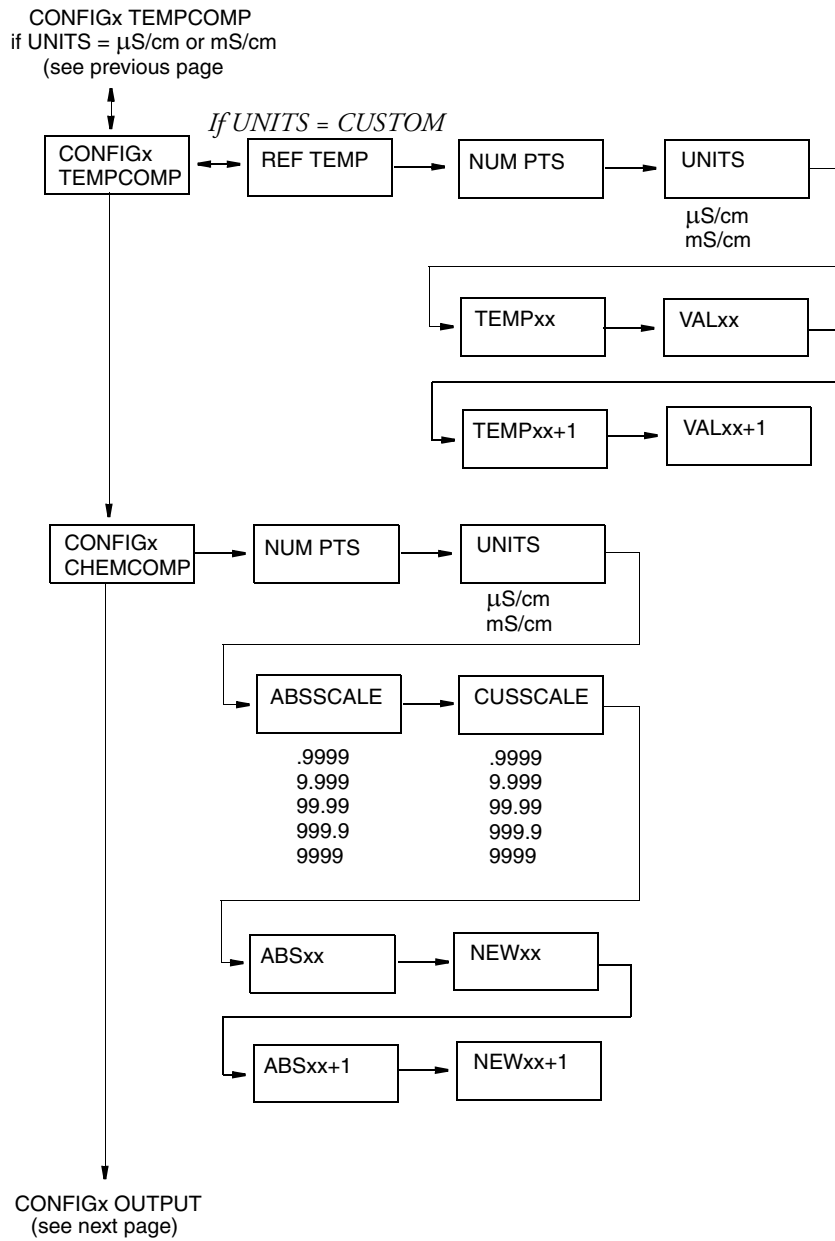
CONFIGURATION (cont.)



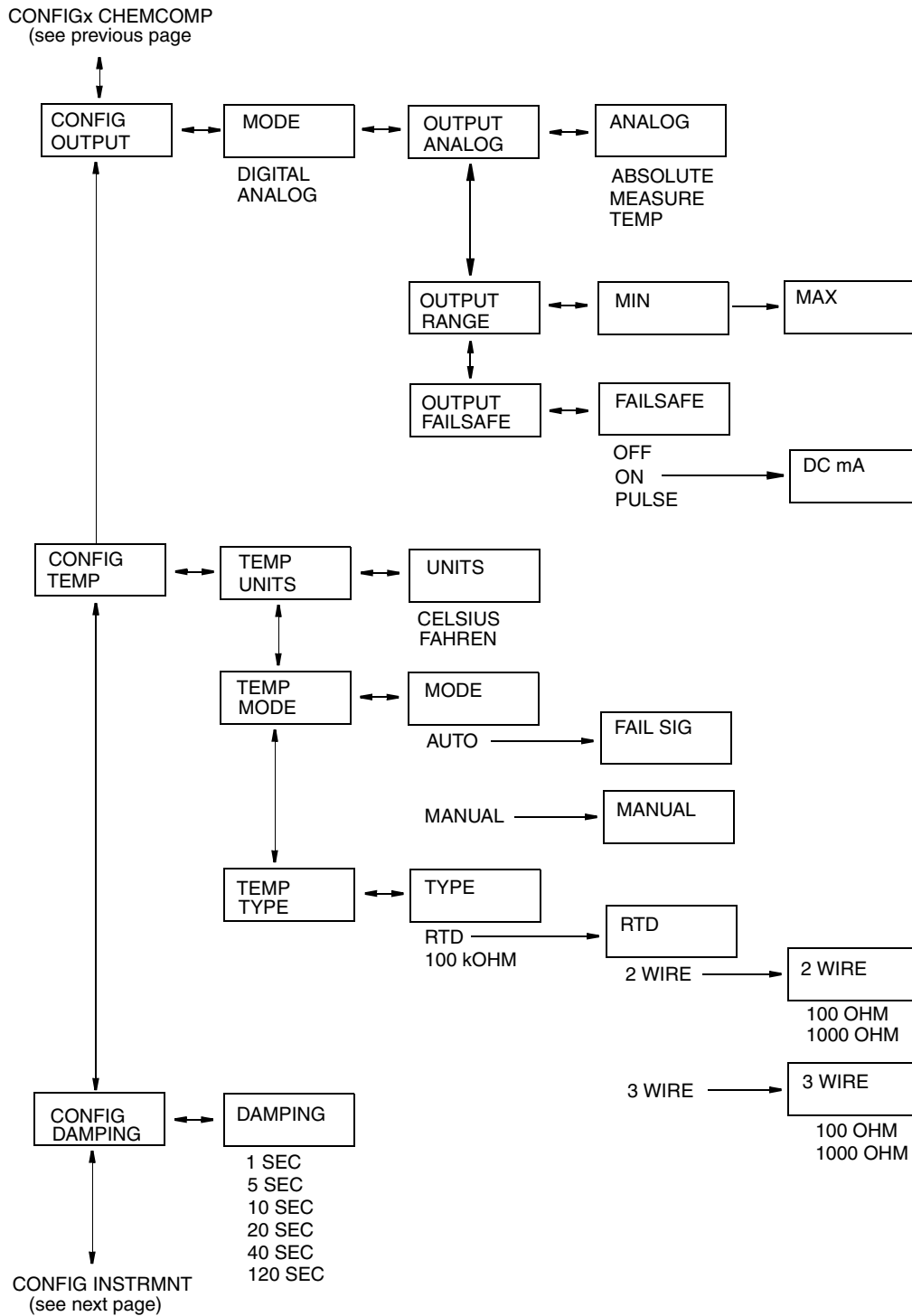
Structure Diagram 4
CONFIGURATION (cont.)



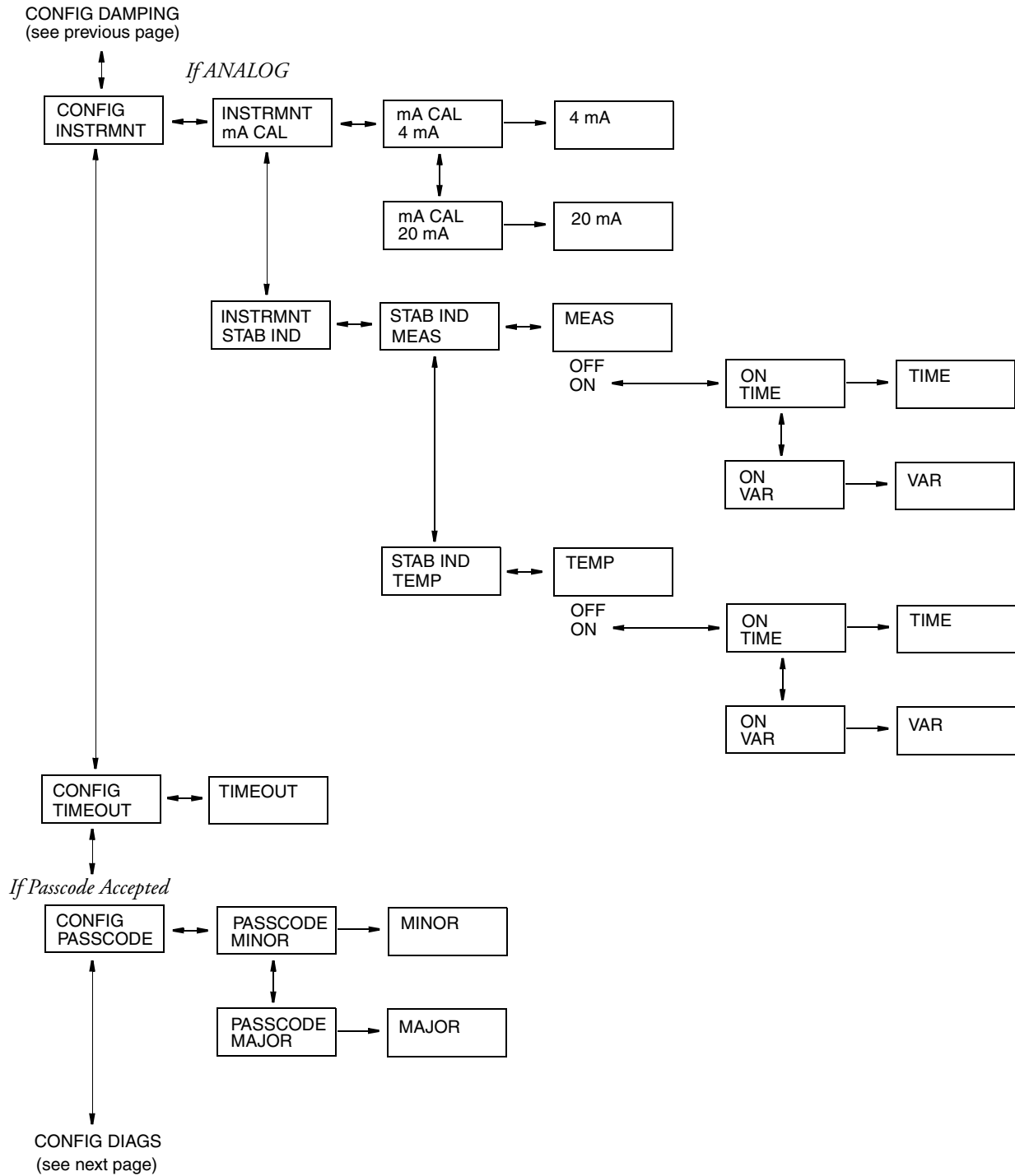
Structure Diagram 5 CONFIGURATION (cont.)



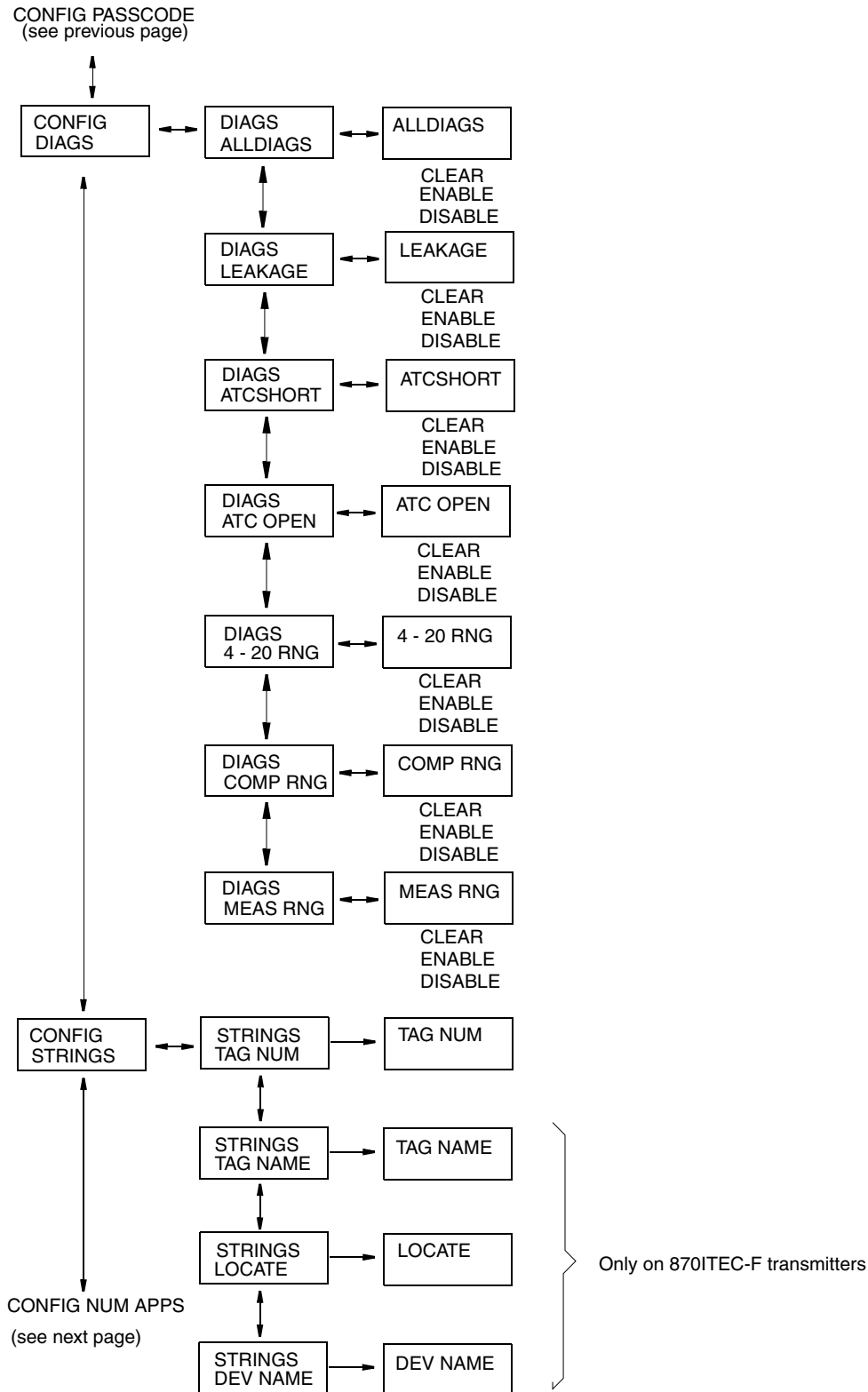
Structure Diagram 6 CONFIGURATION (cont.)



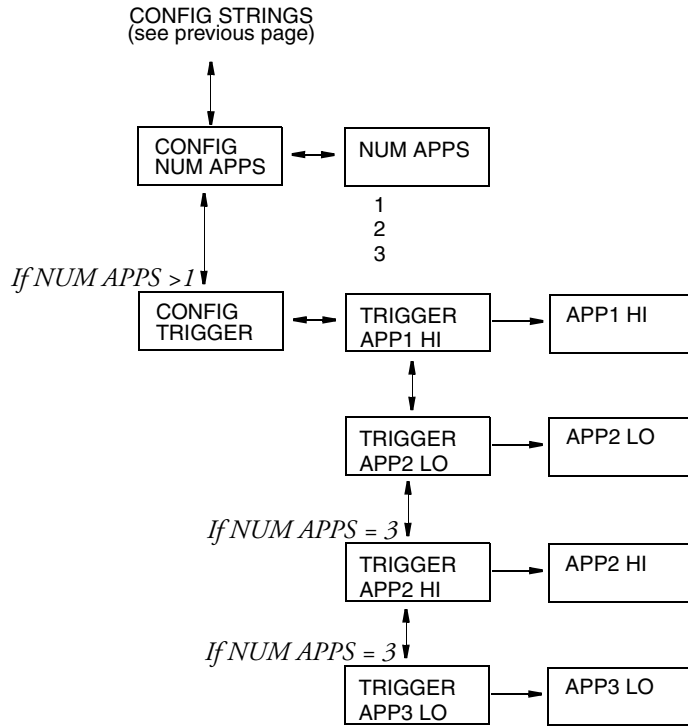
Structure Diagram 7 CONFIGURATION (cont.)



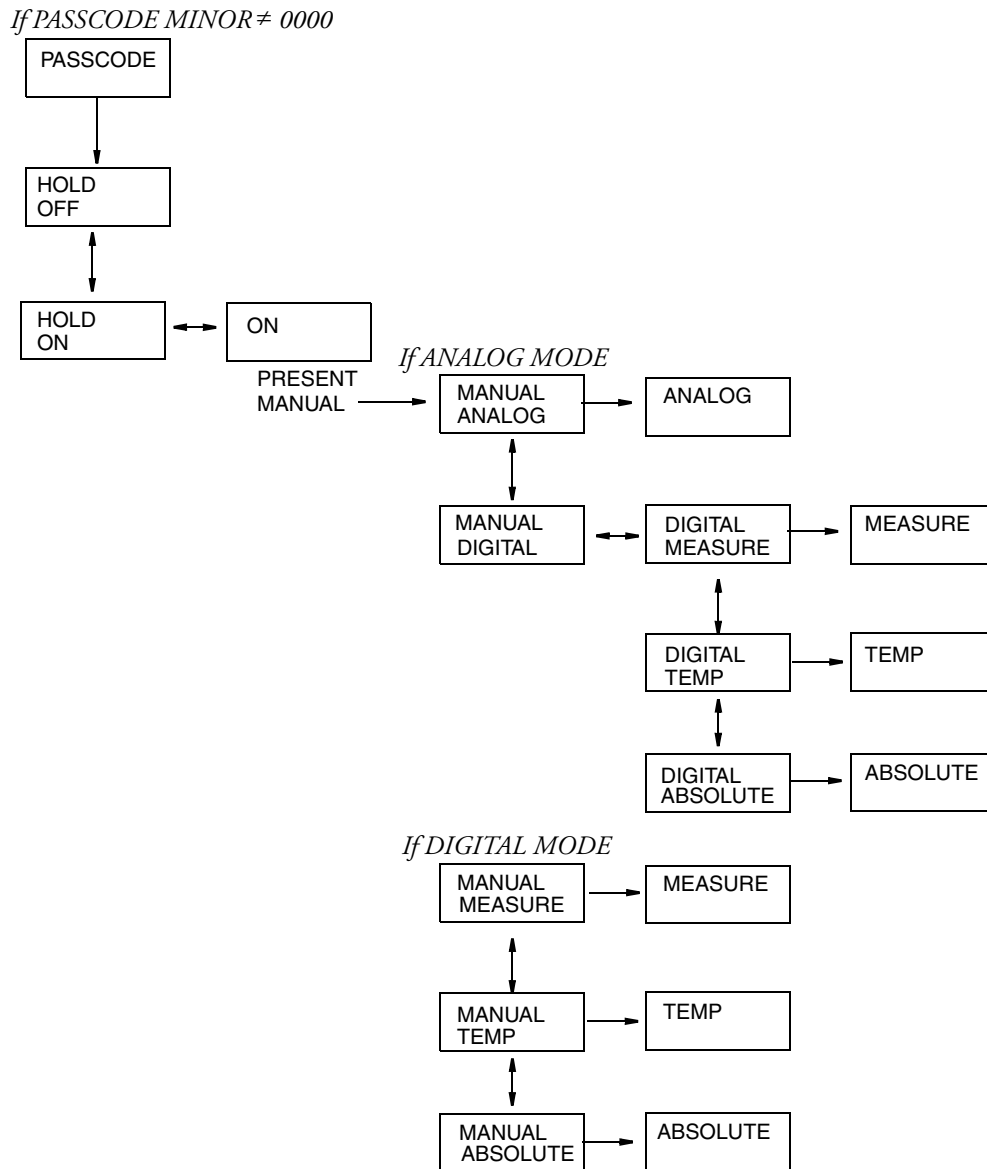
Structure Diagram 8 CONFIGURATION (cont.)



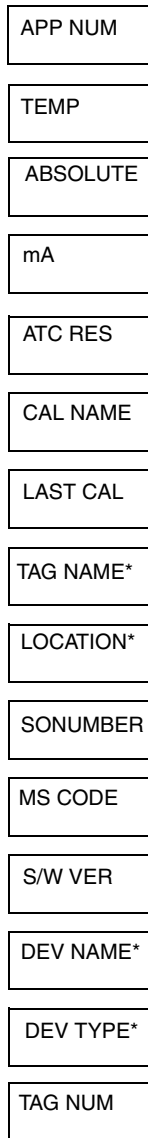
Structure Diagram 9 CONFIGURATION (cont.)



Structure Diagram 10 HOLD



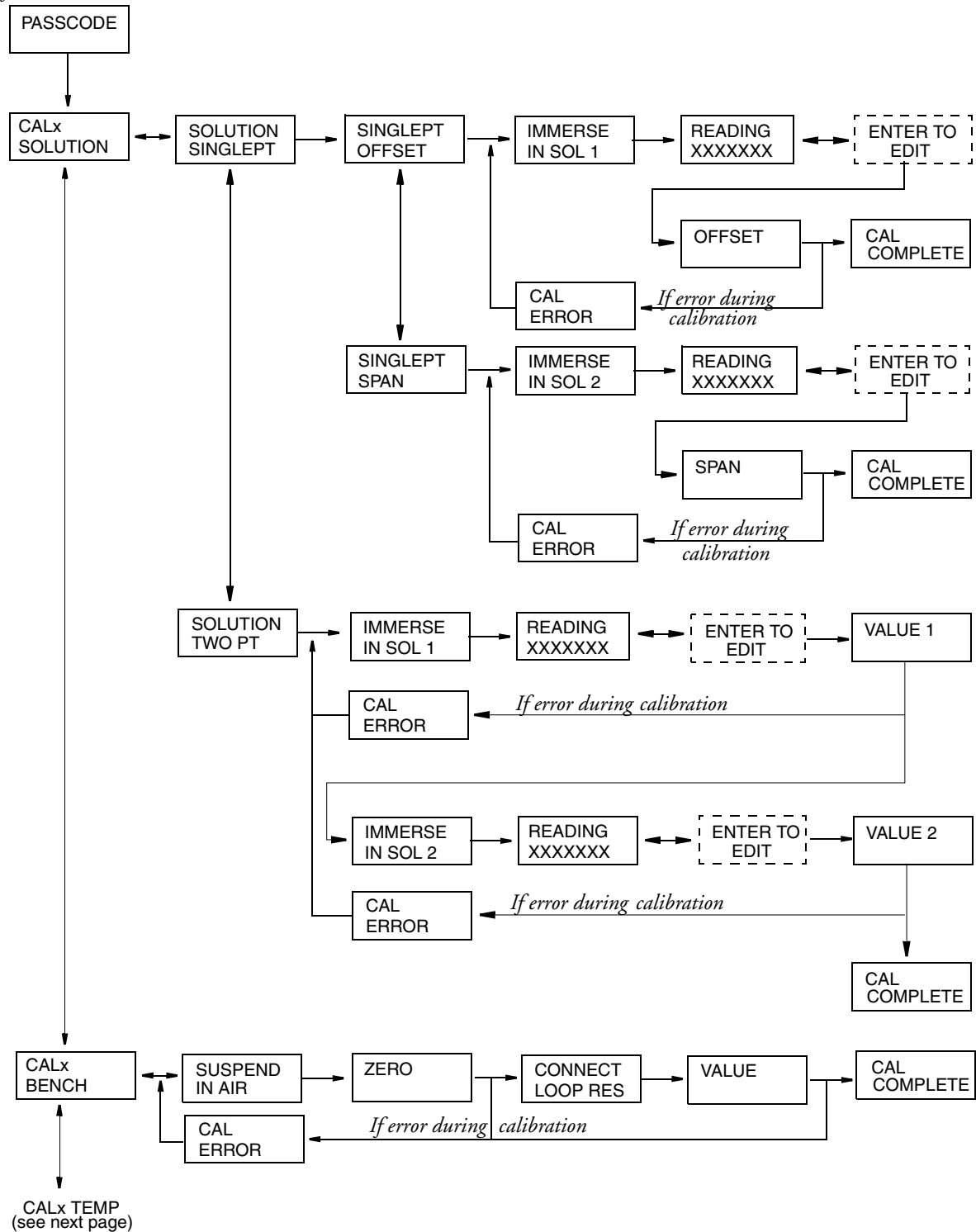
Structure Diagram 11 STATUS



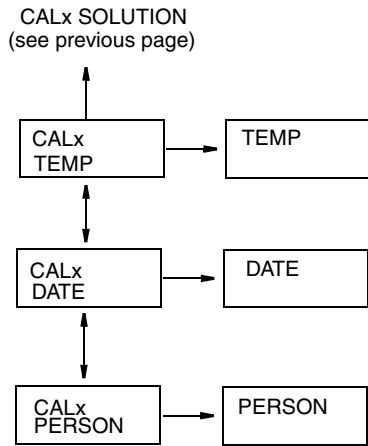
*Only on 870ITEC-F Transmitters

Structure Diagram 12 CALIBRATION

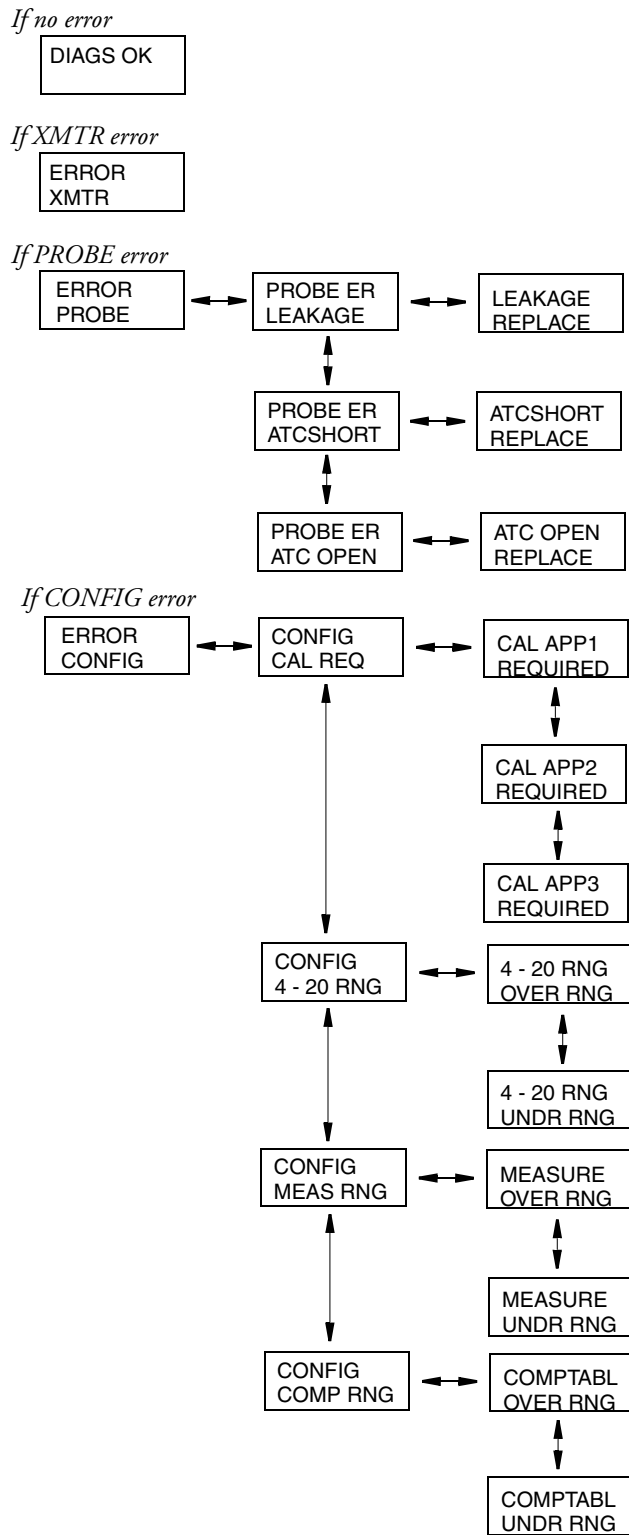
If PASSCODE MINOR ≠ 0000



Structure Diagram 13 CALIBRATION (cont.)



Structure Diagram 14 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.

Identifies the structure diagram that contains a specific prompt/parameter.

Limits of each parameter.

Space for you to record your specific configuration.

Prompts to parameters in the order in which they are displayed when you step through the menu structure.

Standard factory configuration as shipped from Foxboro.

Additional information and space for your notations

Structure Diagram	Prompt/Parameter	Parameter Limits	Factory Configuration	User Configuration	Remarks and Notes	
1	PASSCODE	0001 AND 9999	0800		If PASSCODE MAJOR \neq 0000	
	CONFIG APPLS	- - -			If NUM APPS >1	
	APPLS	1, 2, 3, AUTO	1			
	CONFIG SENSOR	- - -				
	SENSOR	AB, BW, EV, HP, LB, NL, PN, PX, RE, SP, TF, UT, OTHER	SP			
	CELLFACT	0.00 and 99.99				If OTHER
2	CONFIG _x DISPLAY	- - -				
	DISPLAY PRIMARY	- - -				
	PRIMARY UNITS	- - -				
	UNITS	μ S/cm, mS/cm, %, CUSTOM	mS/cm			
	CUSTOM	%, g/l, ppm, oz/gal, ppt, S/m, NONE				If CUSTOM
	PRIMARY SCALE	- - -				If μ S/cm, mS/cm, %
	SCALE	Depends on sensor	50.00 mS/cm			

Structure Diagram	Prompt/Parameter	Parameter Limits	Factory Configuration	User Configuration	Remarks and Notes
2	(if $\mu\text{S}/\text{cm}$)	50.00, 100.0, 200.0, 500.0, 1000, 5000			Dependent on sensor
	(if mS/cm)	1.000, 2.000, 5.000, 10.00, 20.00, 50.00, 100.0, 200.0, 500.0, 1000, 2000			Dependent on sensor
3	(if %)	Per chemical			See “Structure Diagram 1” on page 42
4	DISPLAY SECOND	- - -			
	SECOND	TEMP, ABSOLUTE, mA	TEMP		
	CONFIGx TEMPCOMP				If UNITS \neq %
	(If UNITS = $\mu\text{S}/\text{cm}$ or mS/cm)				
	TEMPCOMP	ABSOLUTE, LINEAR, CUSTOM, Per chemical	NaCl, dilute		If UNITS = $\mu\text{S}/\text{cm}$ or mS/cm
	LINEAR	0.5 and 5.0			If LINEAR
	(Chemical Symbol)	Per Chemical			See “Structure Diagram 1” on page 42.
	(CUSTOM)	- - -			If CUSTOM
	REF TEMP	-99.9 and 999.9	0.0		$^{\circ}\text{C}$ or $^{\circ}\text{F}$
	NUM PTS	02 and 21	02		
	TEMP _{xx}	-99.9 and 999.9	0.0		$^{\circ}\text{C}$ or $^{\circ}\text{F}$
	VAL _{xx}	0 and 2000	0.00		If $\mu\text{S}/\text{cm}$, mS/cm
5	(if UNITS = CUSTOM)				
	REF TEMP	-99.9 and 999.9			$^{\circ}\text{C}$ or $^{\circ}\text{F}$
	NUM PTS	02 and 21			
	UNITS	$\mu\text{S}/\text{cm}$, mS/cm			
	TEMP _{xx}	-99.9 and 999.9			$^{\circ}\text{C}$ or $^{\circ}\text{F}$
	VAL _{xx}	0 AND 2000 ppm			
	CONFIG CHEMCOMP	- - -			
	CHEMCOMP	- - -			If UNITS = CUSTOM
	NUM PTS	02 and 21	2		
	ABSSCALE	.9999, 9.999, 99.99, 999.9, 9999			
	CUSSCALE	.9999, 9.999, 99.99, 999.9, 9999			
	ABS _{xx}	0 and 2000			$\mu\text{S}/\text{cm}$, mS/cm
	NEW _{xx}	0 and 2000			Custom units

Structure Diagram	Prompt/Parameter	Parameter Limits	Factory Configuration	User Configuration	Remarks and Notes
6	CONFIG _x OUTPUT	---			
	MODE	ANALOG, DIGITAL	ANALOG		
	OUTPUT ANALOG	---			If ANALOG
	ANALOG	ABSOLUTE, MEASURE, TEMP	MEASURE		
	OUTPUT RANGE	---			
	MIN	Depends on Analog Output	0 mS/cm		
	MAX		50 mS/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
6	MANUAL	-99.9 and +999.9			If MANUAL
	TEMP TYPE	--			
	TYPE	RTD, 100 KOHM	100 k Ω		
	RTD	2 WIRE, 3 WIRE			If RTD
	2 WIRE	100 OHM, 1000 OHM			If 2 WIRE
	3 WIRE	100 OHM, 1000 OHM			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
7	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			
	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	
8	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				
	CONFIG STRINGS	---				
	STRINGS TAG NUM	---				
	TAG NUM					
	STRINGS TAG NAME	---				
	TAG NAME					
	STRINGS LOCATE	---				
	LOCATE					
	8	STRINGS DEV NAME	---			
		DEV NAME				
9	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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