Instruction Manual
IB-106-4081 Rev. 1.2
September, 2002

Model 4081FG

Two-Wire In Situ Oxygen Analyzer (550° to 1600°C) with FOUNDATION Fieldbus Communications

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ESSENTIAL INSTRUCTIONS
READ THIS PAGE BEFORE PROCEEDING!

Rosemount Analytical designs, manufactures and tests its products to meet many national and international standards. Because these instruments are sophisticated technical products, you **MUST properly install, use, and maintain them** to ensure they continue to operate within their normal specifications. The following instructions **MUST be adhered to** and integrated into your safety program when installing, using, and maintaining Rosemount Analytical products. Failure to follow the proper instructions may cause any one of the following situations to occur: Loss of life; personal injury; property damage; damage to this instrument; and warranty invalidation.

- **Read all instructions** prior to installing, operating, and servicing the product.
- If you do not understand any of the instructions, **contact your Rosemount Analytical representative** for clarification.
- **Follow all warnings, cautions, and instructions** marked on and supplied with the product.
- **Inform and educate your personnel in the proper installation, operation, and maintenance of the product**.
- **Install your equipment as specified in the Installation Instructions of the appropriate Instruction Manual and per applicable local and national codes**. Connect all products to the proper electrical and pressure sources.
- To ensure proper performance, **use qualified personnel** to install, operate, update, program, and maintain the product.
- When replacement parts are required, ensure that qualified people use replacement parts specified by Rosemount. Unauthorized parts and procedures can affect the product's performance, place the safe operation of your process at risk, **and VOID YOUR WARRANTY**. Look-alike substitutions may result in fire, electrical hazards, or improper operation.
- **Ensure that all equipment doors are closed and protective covers are in place, except when maintenance is being performed by qualified persons, to prevent electrical shock and personal injury**.

The information contained in this document is subject to change without notice.

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HIGHLIGHTS OF CHANGES

Effective April, 2001 Rev. 1.0

Page	Summary
Throughout	Changed all references of 38 in. (965 mm) probe to 34.625 in. (880 mm).
Page 11-2	Added drawing 1400175.

Effective December, 2001 Rev. 1.1

Page	Summary
Page 1-3	Updated Product Matrix.

Effective September, 2002 Rev. 1.2

Page	Summary
Page 1-8	Updated process temperature limits specification.

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LIST OF ILLUSTRATIONS (CONTINUED)

LIST OF TABLES

PREFACE

The purpose of this manual is to provide information concerning the components, functions, installation and maintenance of this particular NGA 2000 module.

Some sections may describe equipment not used in your configuration. The user should become thoroughly familiar with the operation of this module before operating it. Read this instruction manual completely.

DEFINITIONS

The following definitions apply to WARNINGS, CAUTIONS, and NOTES found throughout this publication.

WARNING

Highlights an operation or maintenance procedure, practice, condition, statement, etc. If not strictly observed, could result in injury, death, or long-term health hazards of personnel.

CAUTION

Highlights an operation or maintenance procedure, practice, condition, statement, etc. If not strictly observed, could result in damage to or destruction of equipment, or loss of effectiveness.

NOTE

Highlights an essential operating procedure, condition, or statement.

⏚ : EARTH (GROUND) TERMINAL

⏚ : PROTECTIVE CONDUCTOR TERMINAL

⚠ : RISK OF ELECTRICAL SHOCK

⚠ : WARNING: REFER TO INSTRUCTION BULLETIN

NOTE TO USERS

The number in the lower right corner of each illustration in this publication is a manual illustration number. It is not a part number, and is not related to the illustration in any technical manner.

IMPORTANT

SAFETY INSTRUCTIONS FOR THE WIRING AND INSTALLATION OF THIS APPARATUS

The following safety instructions apply specifically to all EU member states. They should be strictly adhered to in order to assure compliance with the Low Voltage Directive. Non-EU states should also comply with the following unless superseded by local or National Standards.

1. Adequate earth connections should be made to all earthing points, internal and external, where provided.

2. After installation or troubleshooting, all safety covers and safety grounds must be replaced. The integrity of all earth terminals must be maintained at all times.

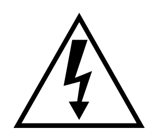
3. Mains supply cords should comply with the requirements of IEC227 or IEC245.

4. All wiring shall be suitable for use in an ambient temperature of greater than 75°C.

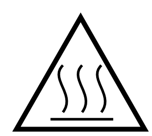
5. All cable glands used should be of such internal dimensions as to provide adequate cable anchorage.

6. To ensure safe operation of this equipment, connection to the mains supply should only be made through a circuit breaker which will disconnect all circuits carrying conductors during a fault situation. The circuit breaker may also include a mechanically operated isolating switch. If not, then another means of disconnecting the equipment from the supply must be provided and clearly marked as such. Circuit breakers or switches must comply with a recognized standard such as IEC947. All wiring must conform with any local standards.

7. Where equipment or covers are marked with the symbol to the right, hazardous voltages are likely to be present beneath. These covers should only be removed when power is removed from the equipment — and then only by trained service personnel.



8. Where equipment or covers are marked with the symbol to the right, there is a danger from hot surfaces beneath. These covers should only be removed by trained service personnel when power is removed from the equipment. Certain surfaces may remain hot to the touch.



9. Where equipment or covers are marked with the symbol to the right, refer to the Operator Manual for instructions.

10. All graphical symbols used in this product are from one or more of the following standards: EN61010-1, IEC417, and ISO3864.

SECTION 1
DESCRIPTION AND SPECIFICATIONS

1-1 COMPONENT CHECKLIST OF TYPICAL SYSTEM (PACKAGE CONTENTS)

A typical Rosemount Two-Wire In Situ Oxygen Analyzer should contain the items shown in Figure 1-1. Record the part number, serial number, and order number for each component of your system in the table located on the first page of this manual. Also, use the product matrix in Table 1-1 to compare your order number against your unit. The first part of the matrix defines the model. The last part defines the various options and features of the analyzer. Ensure the features and options specified by your order number are on or included with the unit.

1-2 SYSTEM OVERVIEW

a. Scope

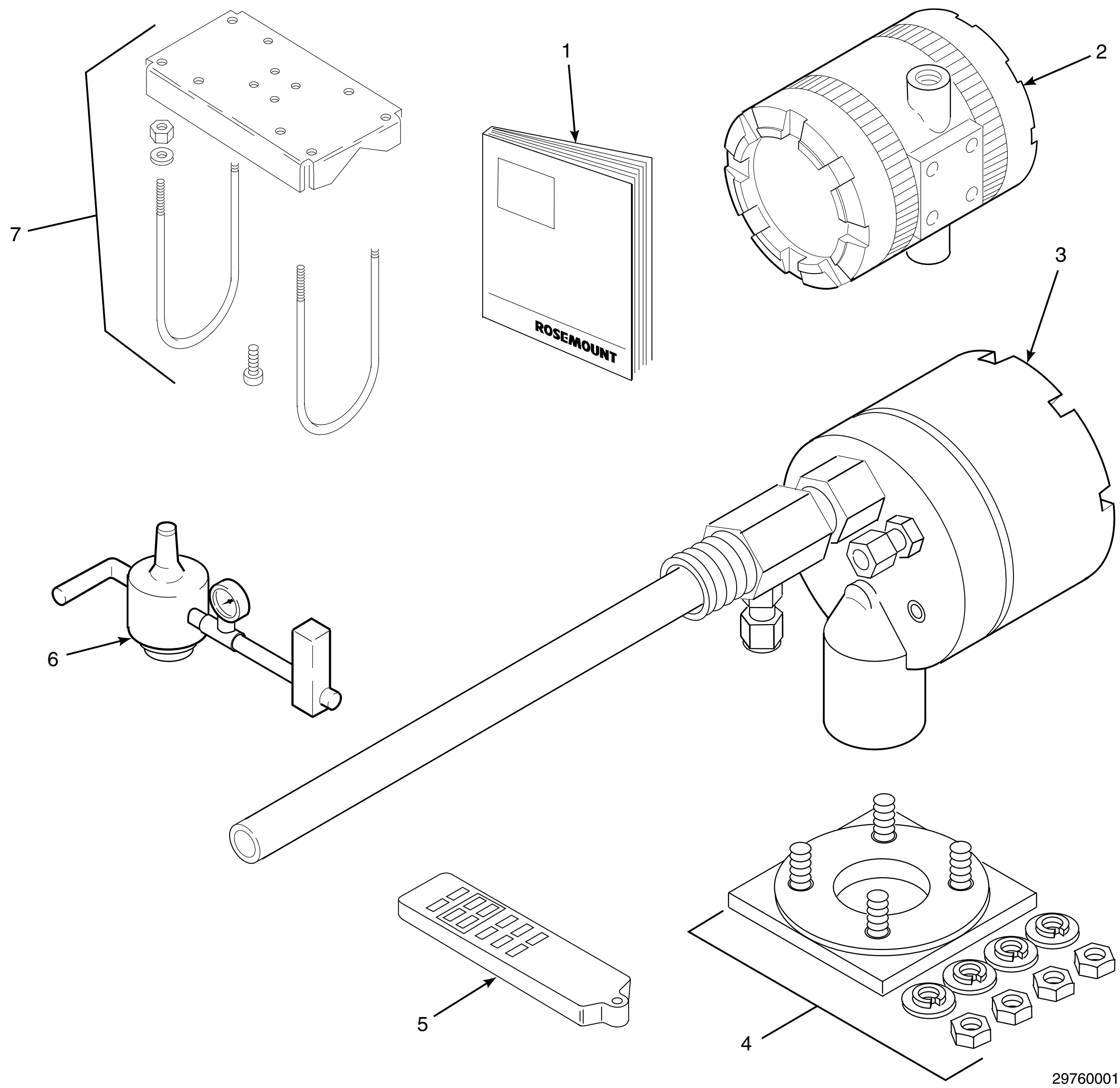
This Instruction Bulletin is designed to supply details needed to install, start up, operate, and maintain the Rosemount Two-Wire In Situ Oxygen Analyzer. The analyzer consists of an oxygen probe and Model 4081 Transmitter. Integral signal conditioning electronics outputs a digital FOUNDATION fieldbus signal representing an O_2 value. An infrared remote control (IRC) allows access to setup, calibration, and diagnostics. This same information, plus additional details, can be accessed via fieldbus digital communications.

b. FOUNDATION Fieldbus Technology

FOUNDATION fieldbus is an all digital, serial, two-way communication system that inter-connects field equipment such as sensors, actuators, and controllers. Fieldbus is a Local Area Network (LAN) for instruments used in both process and manufacturing automation with built-in capacity to distribute the control application across the network. The fieldbus environment is the base level group of digital networks in the hierarchy of planet networks.

The fieldbus retains the desirable features of the 4-20 mA analog system, including a standardized physical interface to the wire, bus powered devices on a single wire, and intrinsic safety options, and enables additional capabilities, such as:

- Increased capabilities due to full digital communications
- Reduced wiring and wire terminations due to multiple devices on one set of wires
- Increased selection of suppliers due to inter-operability
- Reduced loading on control room equipment with the distribution of some control and input/output functions to field devices
- Speed options for process control and manufacturing applications



1. Instruction Bulletin
2. Model 4081 Transmitter
3. Oxygen Probe
4. Adapter Plate with Mounting Hardware and Gasket (Optional)
5. Infrared Remote Control (IRC) (Optional)
6. Reference Air Set (Optional)
7. Pipe Mounting Kit (Optional)

Figure 1-1. Typical System Package

Table 1-1. Product Matrix

4081FG	**Model 4081FG In Situ Oxygen Analyzer with FOUNDATION Fieldbus Communications**
	Model 4081FG Oxygen Analyzer - Instruction Book

Code	Sensing Probe Length
1	20 in. (508 mm) probe, 1/4 in. tube fittings
2	26 in. (660 mm) probe, 1/4 in. tube fittings
3	38 in. (965 mm) probe, 1/4 in. tube fittings

Code	Probe Outer Tube Material - Maximum Operating Temperature
1	Alumina - 2912°F (1600°C) maximum - 1.25 NPT mounting
2	Inconel 600 - 1832°F (1000°C) maximum - 1.25 NPT mounting

Code	Mounting Adapter - Stack Side
0	No adapter plate required uses 1.25 NPT (“0” must also be chosen under “Mounting Adapter” probe side)
1	New flanged installation - Square weld plate with studs (matches “Mounting Adapter” probe side)
2	Model 450 mounting (“4” must also be chosen under “Mounting Adapter” probe side)
3	Competitor's Mount (“5” must also be chosen under “Mounting Adapter” probe side)

Code	Mounting Adapter - Probe Side
0	No adapter plate
1	ANSI 2 in. 150 lb flange to 1.25 NPT adapter (6 in. dia. Flange, 4.75 in. BC with 4 x 0.75 in. dia. holes)
2	DIN to 1.25 NPT adapter (184 mm flange, 145 mm BC with 4 x 18 mm dia. holes)
3	JIS to 1.25 NPT adapter (155 mm flange, 130 mm BC with 4 x 13 mm dia. holes)
4	Model 450 to 1.25 NPT adapter
5	Competitor’s mounting flange

Code	Electronics & Housing - Intrinsically Safe, NEMA 4X, IP65
1	4081 FOUNDATION Fieldbus Electronics - CENELEC EEx ia IIC T5 with Control Suite
2	4081 FOUNDATION Fieldbus Electronics - CSA pending, with Control Suite
3	4081 FOUNDATION Fieldbus Electronics-FM Class I, Div. I, Groups B,C,D with Control Suite
4	4081 FOUNDATION Fieldbus Electronics - CENELEC EEx ia IIC T5 without Control Suite
5	4081 FOUNDATION Fieldbus Electronics - CSA pending, without Control Suite
6	4081 FOUNDATION Fieldbus Electronics-FM Class I, Div. I, Groups B,C,D without Control Suite

Code	Housing Mounting
0	Surface or wall mounting
1	1/2 to 2 in. pipe mounting

Code	Communications
0	No remote control
1	Infrared Remote Control (IRC) (LCD display through cover)

Code	Calibration Accessories
1	No hardware
2	Reference air flowmeters and pressure regulator

Code	Armored Cable Length
00	No cable
11	20 ft (6 m)
12	40 ft (12 m)
13	60 ft (18 m)
14	80 ft (24 m)
15	100 ft (30 m)
16	150 ft (45 m)
17	200 ft (61 m)
18	300 ft (91 m)
19	400 ft (122 m)
20	500 ft (152 m)

4081FG	**2**	**1**	**0**	**0**	**1**	**1**	**1**	**2**	**11**	**Example**

Table 1-2. Accessories

Part No.	Description
1A99135H01	Armored cable, bulk, uncut, no connectors 100' minimum.
1A99135H02	Unarmored cable, bulk, uncut, no connectors 100' minimum.

Order as separate items.

Table 1-3. Mounting Adapter

Type	Description
Plate with studs	Bolt circle diameter, number and arrangement of studs, stud thread, stud height above mounting plate.
Plate without studs	Bolt circle diameter, number and arrangement of holes, thread, depth of stud mounting plate with accessories.

Where possible specify SPS number; otherwise provide details of the existing mounting plate.

c. System Description

The Rosemount Two-Wire In Situ Oxygen Analyzer is designed to measure the net concentration of oxygen in an industrial process; i.e., the oxygen remaining after all fuels have been oxidized. The oxygen probe is permanently positioned within an exhaust duct or stack and performs its task without the use of a sampling system. The Model 4081 Transmitter is mounted remotely and conditions the oxygen probe outputs.

The equipment measures oxygen percentage by reading the voltage developed across an electrochemical cell, which consists of a small yttria-stabilized, zirconia disc. Both sides of the disc are coated with porous metal electrodes. The millivolt output voltage of the cell is given by the following Nernst equation:

$$EMF = KT \log_{10}(P_1/P_2) + C$$

Where:

1. P_2 is the partial pressure of the oxygen in the measured gas on one side of the cell.
2. P_1 is the partial pressure of the oxygen in the reference air on the opposite side of the cell.
3. T is the absolute temperature.
4. C is the cell constant.
5. K is an arithmetic constant.

NOTE

For best results, use clean, dry, instrument air (20.95% oxygen) as the reference air.

NOTE

The probe uses a Type B thermocouple to measure the cell temperature.

When the cell is at 550°C to 1600°C (1022°F to 2912°F) and there are unequal oxygen concentrations across the cell, oxygen ions will travel from the high oxygen partial pressure side to the low oxygen partial pressure side of the cell. The resulting logarithmic output voltage is approximately 50 mV per decade.

The output is proportional to the inverse logarithm of the oxygen concentration. Therefore, the output signal increases as the oxygen concentration of the sample gas decreases. This characteristic enables the Rosemount Two-Wire In Situ Oxygen Analyzer to provide exceptional sensitivity and accuracy at low oxygen concentrations.

Oxygen analyzer equipment measures net oxygen concentration in the presence of all the products of combustion, including water vapor. Therefore, it may be considered an analysis on a “wet” basis. In comparison with older methods, such as the portable apparatus, which provides an analysis on a “dry” gas basis, the “wet” analysis will, in general, indicate a lower percentage of oxygen. The difference will be proportional to the water content of the sampled gas stream.

d. System Configuration

The equipment discussed in this manual consists of two major components: the oxygen probe and the Model 4081 Transmitter.

Oxygen probes are available in three length options, providing in situ penetration appropriate to the size of the stack or duct. The options on length are 20 in. (508 mm), 26 in. (660 mm), or 38 in. (965 mm).

The Model 4081 Transmitter is a two-wire transmitter providing an output proportional to the measured oxygen concentration. A customer-supplied 24 VDC power source is required to provide power to the electronics. The transmitter accepts millivolt signals generated by the probe and produces the outputs to be used by other remotely connected devices. The output is a FOUNDATION fieldbus digital communication signal.

e. System Features

1. The cell output voltage and sensitivity increase as the oxygen concentration decreases.
2. High process temperatures eliminate the need for external cell heating and increase cell accuracy.
3. FOUNDATION fieldbus is standard.
4. Easy probe replacement due to the lightweight, compact probe design.
5. Remote location of the Model 4081 Transmitter removes the electronics from high temperature or corrosive environments.
6. Power is supplied to the electronics through the FOUNDATION fieldbus digital signal line for intrinsic safety (IS) purposes.
7. Infrared remote control (IRC) allows inter-facing without exposing the electronics.
8. An operator can operate and diagnostically troubleshoot the Two-Wire In Situ Oxygen Analyzer in one of two ways:

   (a) Infrared Remote Control. The IRC allows access to fault indication menus on the Model 4081 Transmitter LCD display. Calibration can be performed from the IRC keypad.

   (b) FOUNDATION fieldbus Interface. The transmitter’s output carries a signal containing the oxygen level encoded in digital format. This digital output can also be used to communicate with the oxygen analyzer and access all of the oxygen analyzer status information.

9. Selected Distributed Control Systems - The use of distributed control systems requires input/output (I/O) hardware and AMS Security codes are provided (by infrared remote control) to prevent unintended changes to analyzers adjacent to the one being accessed.
10. A calibration check procedure is provided to determine if the Rosemount Two-Wire In Situ Oxygen Analyzer is correctly measuring the net oxygen concentration in the industrial process.

f. Handling the Analyzer

The probe was specially packaged to prevent breakage due to handling. Do not remove the padding material from the probe until immediately before installation.

CAUTION

It is important that printed circuit boards and integrated circuits are handled only when adequate antistatic precautions have been taken to prevent possible equipment damage.

CAUTION

The oxygen probe is designed for industrial applications. Treat with care to avoid physical damage. The probe contains components made from ceramic, which are susceptible to shock when mishandled. THE WARRANTY DOES NOT COVER DAMAGE FROM MISHANDLING.

g. System Considerations

Prior to installing your Rosemount Two-Wire In Situ Oxygen Analyzer, make sure you have all the components necessary to make the system installation. Ensure all the components are properly integrated to make the system functional.

After verifying that you have all the components, select mounting locations and determine how each component will be placed in terms of available line voltage, ambient temperatures, environmental considerations, convenience, and serviceability Figure 1-2 shows the FOUNDATION Fieldbus communications interface. A typical system installation is illustrated in Figure 1-3.

A source of instrument air is required at the oxygen probe for reference air use. Since the Two-Wire In Situ Oxygen Analyzer is equipped with an in-place calibration feature, provisions should be made for connecting calibration check gas tanks to the oxygen probe during calibration.

If the calibration check gas bottles are to be permanently connected, a check valve is required next to the calibration fittings on the integral electronics.

This check valve is to prevent breathing of calibration check gas line and subsequent flue gas condensation and corrosion. The check valve is in addition to the stop valve in the calibration check gas kit.

NOTE

The electronics of the Model 4081 Transmitter is rated NEMA 4X (IP65) and is capable of operating at temperatures up to 65°C (149°F).

NOTE

Retain the packaging in which the Rosemount Two-Wire In Situ Oxygen Analyzer arrived from the factory in case any components are to be shipped to another site. This packaging has been designed to protect the product.

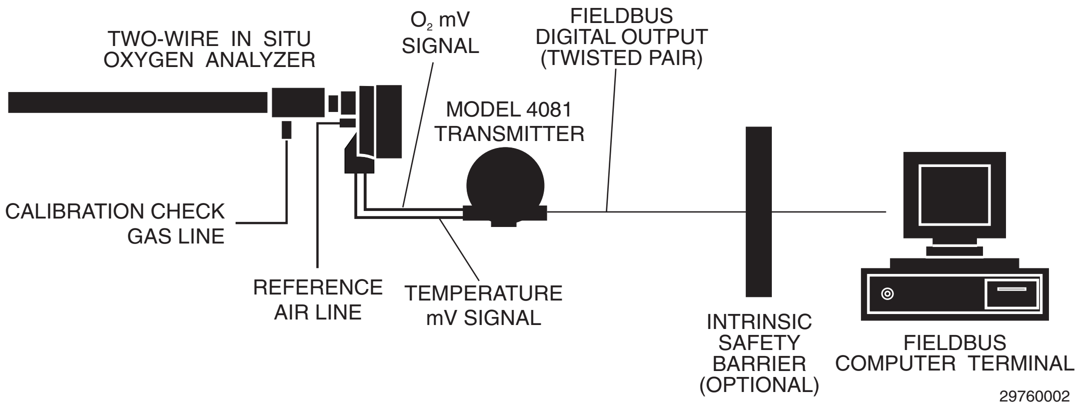


Figure 1-2. Two-Wire In Situ Oxygen Analyzer Fieldbus Connections

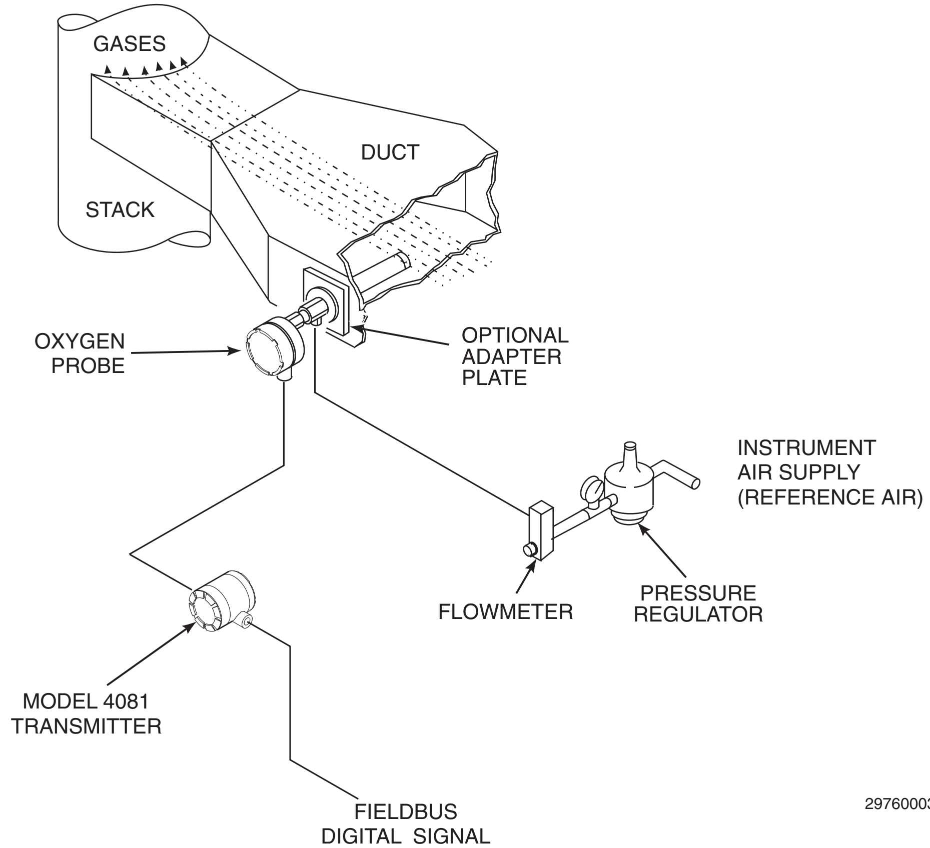


Figure 1-3. Typical System Installation

1-3 SPECIFICATIONS

Net O_2 Range	0 to 25% O_2 Fully Field Selectable via the FOUNDATION Fieldbus Interface
Lowest Limit	0.05% O_2
Highest Limit	25.00% O_2
Accuracy	±1.5% of reading or 0.05% O_2, whichever is greater
System Response to Calibration Check Gas	Initial response in less than 3 seconds T90 in less than 10 seconds

Probe

Lengths	20 in. (508 mm) 26 in. (660 mm) 34.625 in. (880 mm)
Temperature Limits	
Process Temperature Limits	550° to 1400°C (1022° to 2552°F) Operation to 1600°C (2912°F) with reduced cell life.
Ambient	-40° to 149°C (-40° to 300°F) Ambient
Mounting and Mounting Position	Vertical or Horizontal
Materials of Construction - Process Wetted Parts	
Inner Probe	Zirconia
Outer Protection Tube	Alumina [1600°C (2912°F) limit] Inconel 600 [1000°C (1832°F) limit]
Probe Junction Box	Cast aluminum
Speed of Installation/Withdrawal	1 in. (25.4 mm) per minute
Hazardous Area Certification	Intrinsically safe per EN50 014 (1977), clause 1.3[(1)] (pending)
Reference Air Requirement	100 ml per minute (0.2 scfh) of clean, dry instrument air; 1/4 in. tube fittings
Calibration Check Gas Fittings	1/4 in. tube fittings
Cabling	Two twisted pairs, shielded

Electronics

Enclosure	IP65 (NEMA 4X), weatherproof, and corrosion-resistant
Materials of Construction	Low copper aluminum
Ambient Temperature Limits	-20° to 65°C (-4° to 149°F)
Relative Humidity	95% with covers sealed
Inputs (from O_2 Probe)	Two wires - O_2 signal, Two wires - type B thermocouple
Output	FOUNDATION Fieldbus digital signal
Fieldbus Logic Function Blocks	
Two AI Blocks: Execution Rate	75mS
PID Block: Execution Rate	150mS
Fieldbus Segment Power Consumption	30mA max, 30VDC max
Hazardous Area Certification	Cenelec EEx ia IIC T4 or T5(2) (pending) NEC Class I Div.I Group B,C,D (pending)

CE Fisher-Rosemount has satisfied all obligations coming from the European legislation to harmonize the product requirements in Europe.

Power Transient Protection	IEC 801-4
Shipping Weight	10 lbs (4.5 kg)

Infrared Remote Control

Power Requirements	Three AAA batteries
Hazardous Area Certification	Cenelec EEx ia IIC Class I, Div. I, Group A, B, C, D

(1) Thermocouple and O_2 probe cell are both unpowered, developing a millivolt emf, and are considered a “simple apparatus” by certifying agencies.
(2) Dependent on ambient temperature limits.

2

SECTION 2
INSTALLATION

2-1 PRE-INSTALLATION

a. Inspect

Carefully inspect the shipping container for any evidence of damage. If the container is damaged, notify the carrier immediately.

b. Packing List

Confirm all items shown on the packing list are present. Notify Rosemount Analytical immediately if items are missing.

WARNING

Before installing this equipment, read the "Safety instructions for the wiring and installation of this apparatus" at the front of this Instruction Bulletin. Failure to follow the safety instructions could result in serious injury or death.

2-2 MECHANICAL INSTALLATION

CAUTION

Avoid installation locations near steam soot blowers.

a. Locating Oxygen Probe

1. The location of the oxygen probe in the stack or flue is important for maximum accuracy in the oxygen analyzing process. The probe must be positioned so the gas it measures is representative of the process. Best results are normally obtained if the probe is positioned near the center of the duct (40-60% insertion). Longer ducts may require several analyzers since the O_2 can vary due to stratification. A point too near the wall of the duct, or the inside radius of a bend, may not provide a representative sample because of the very low flow conditions. The sensing point should be selected so the process gas temperature falls within a range of 550° to 1600°C (1022° to 2912°F). Figure 2-1 provides mechanical installation references.

2. Check the flue or stack for holes and air leakage. The presence of this condition will substantially affect the accuracy of the oxygen reading. Therefore, either make the necessary repairs or install the probe up-stream of any leakage.

3. Ensure the area is clear of internal and external obstructions that will interfere with installation and maintenance access to the probe. Allow adequate clearance for probe removal (Figure 2-1).

b. Installing Oxygen Probe

CAUTION

The probe was specially packaged to prevent breakage due to handling. Do not remove the padding material from the probe until immediately before installation.

1. Ensure all components are available to install the probe.

NOTE

Leave the probe inner protective cover in place until installation. This is required to protect the ceramic cell during movement.

2. If using an optional adapter plate (Figure 2-2) or an optional mounting flange (Figure 2-3), weld or bolt the component onto the duct. The through hole in the stack or duct wall and refractory material must be 2 in. (50.8 mm) diameter, minimum.

Figure 2-1. Probe Installation Details

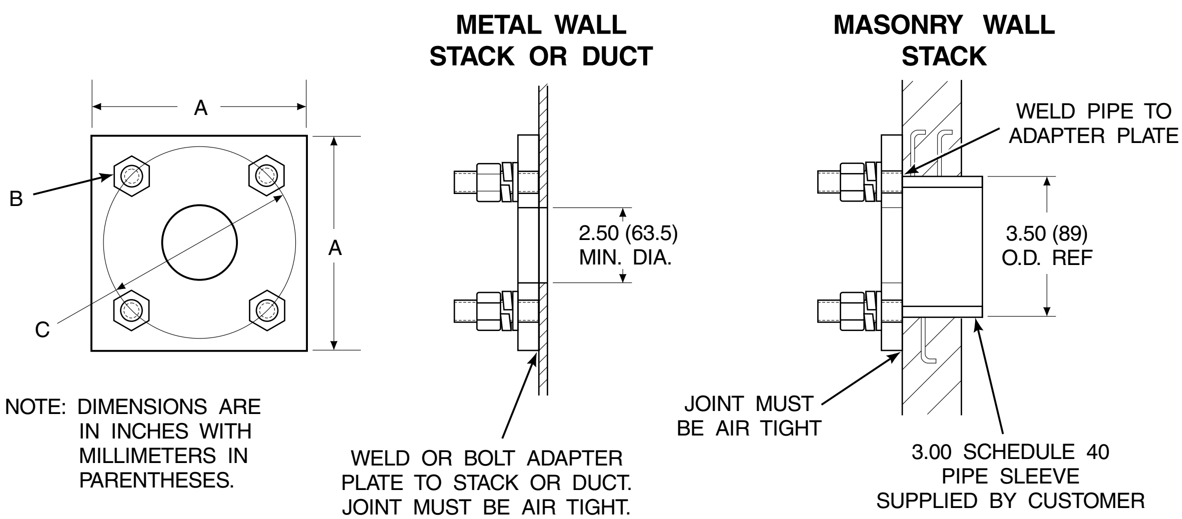


PLATE DIMENSIONS			
DIMENSION	**ANSI 4512C34G01**	**DIN 4512C36G01**	**JIS 4512C35G01**
"A"	6.00 (153)	7.5 (191)	6.50 (165)
"B" THREAD	0.625-11	M-16x2	M-12x1.75
"C" DIA.	4.75 (121)	5.71 (145)	5.12 (130)

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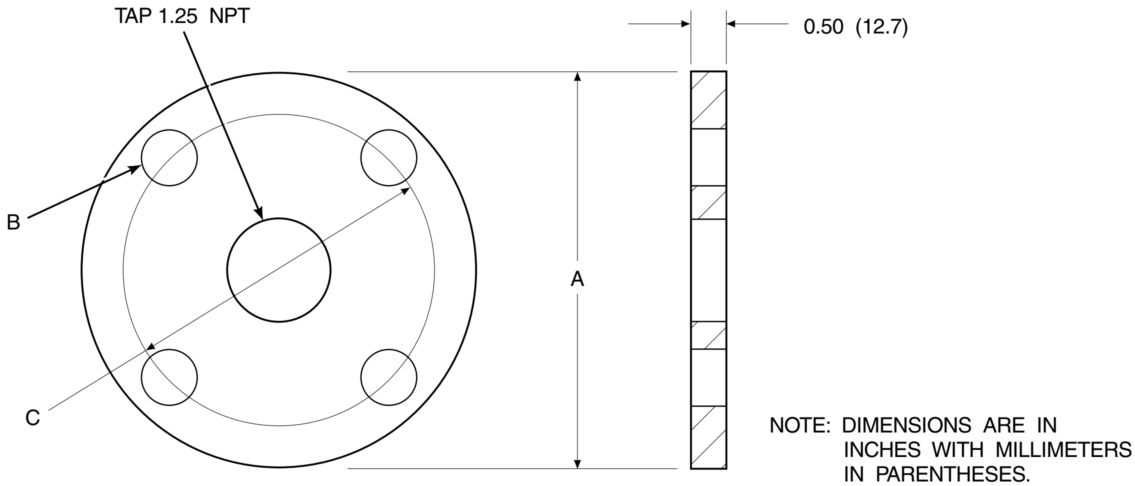
Figure 2-2. Optional Adapter Plate

2



FLANGE DIMENSIONS				
DIMENSION	**ANSI 5R10158H01**	**DIN 5R10158H02**	**JIS 5R10158H03**	**MODEL 450 5R10158H04**
"A" DIA.	6.00 (153)	7.28 (185)	6.10 (155)	9.00 (229)
"B" DIA.	0.75 (20)	0.71 (18)	0.59 (15)	0.50 (13)
"C" DIA.	4.75 (121)	5.71 (145)	5.12 (130)	7.68 (195)

29750003

Figure 2-3. Optional Probe Mounting Flange

3. If the optional adapter plates are not used, a 2 in. NPT, schedule 40, pipe nipple (Figure 2-4) should be welded to the stack or duct wall.

When a 2 in. NPT to 1.25 NPT adapter is threaded to the welded pipe nipple, the adapter provides the pipe threads needed for the probe's process fitting.

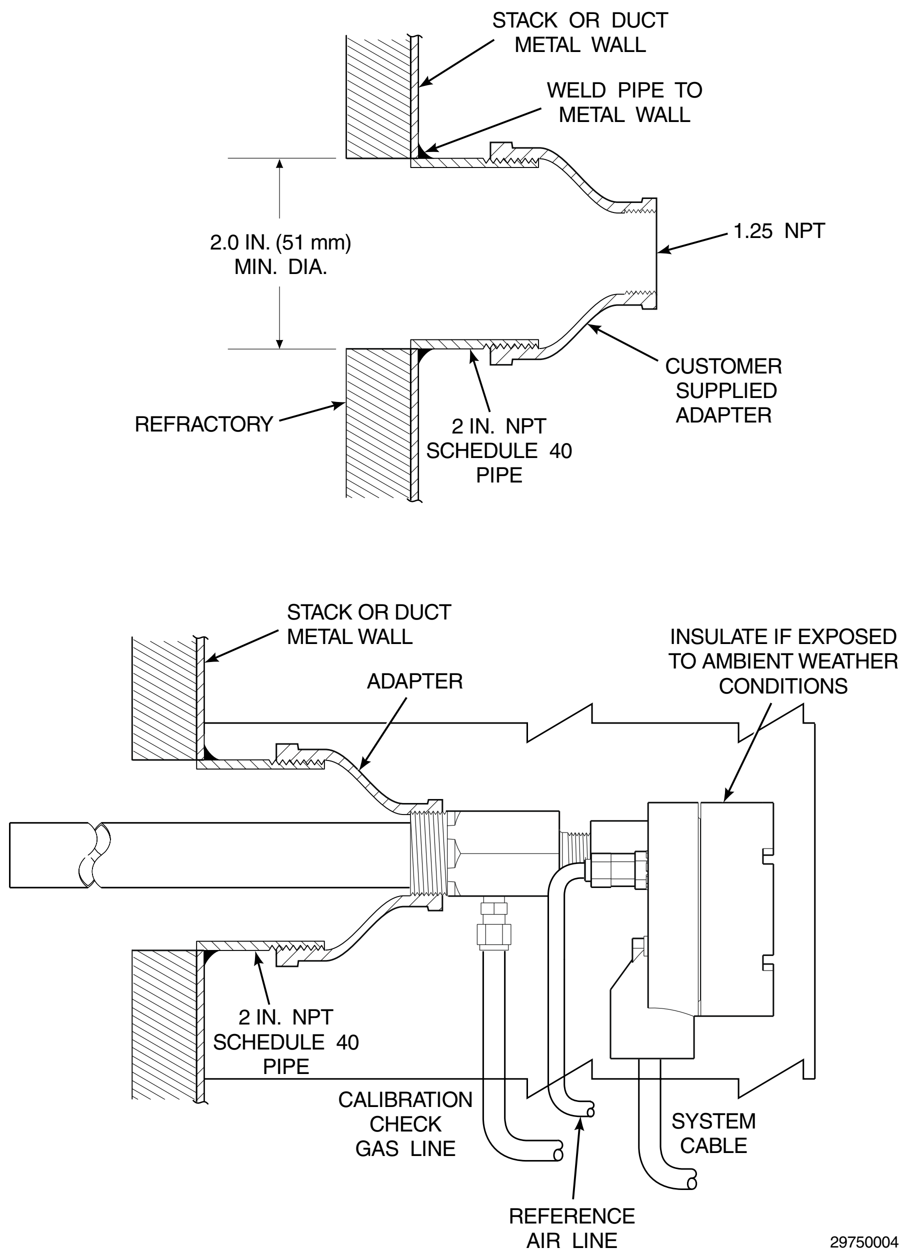


Figure 2-4. Horizontal Probe Installation

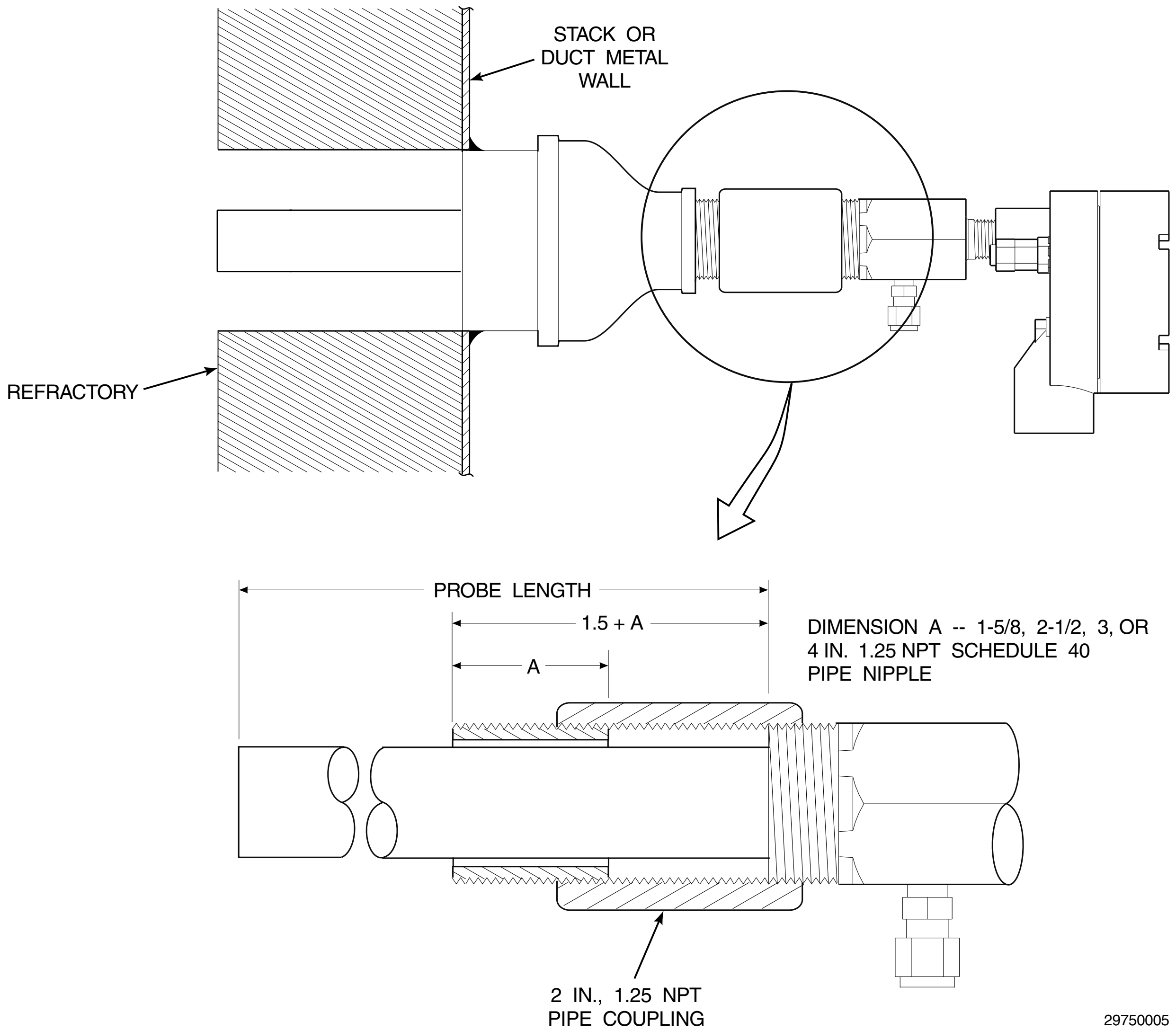


Figure 2-5. Adjusting Probe Insertion Depth

4. Where high particulate or slag is in the flue gas stream, it may be desirable to inset the probe in the refractory as shown in Figure 2-5. Use pipe couplings and nipples to adjust the probe insertion depth.

5. Use rags or other material to seal around the probe during insertion. This prevents hot gases from escaping or cold air from entering the stack or duct.

6. Initially insert the probe to a depth of 3 in. (76.2 mm) or ½ the depth of the stack or duct refractory, whichever is greater.

CAUTION

After initial insertion, do not insert the probe at a rate exceeding 1 in. per minute (25.4 mm per minute) or damage to the probe may result due to thermal shock.

7. After initial insertion, insert the probe at a rate of 1 in. (25.4 mm) per minute until the probe is fully inserted.

8. Install anti-seize compound on the pipe threads and screw the probe into the process flange or adapter.

NOTE

Use anti-seize compound on threads to ease future removal of probe.

The electrical conduit port should be facing down for a horizontal probe installation. See Figure 2-4. In vertical probe installations, orient the probe so the system cable drops vertically from the probe. Ensure the electrical conduit is routed below the level of the terminal block housing. This drip loop minimizes the possibility that moisture will accumulate in the housing.

9. If insulation was removed to access the duct work for probe mounting, make sure the insulation is replaced afterward. See Figure 2-4.

CAUTION

If the ducts will be washed down during outage, MAKE SURE to power down the probes and remove them from the wash area.

c. Locating Model 4081 Transmitter

1. Ensure the Model 4081 Transmitter is easily accessible for maintenance and service and for using the infrared remote control (if applicable).

CAUTION

Do not allow the temperature of the Model 4081 Transmitter to exceed 65°C (149°F) or damage to the unit may result.

2. The ambient temperature of the transmitter housing must not exceed 65°C (149°F). Locate the electronics in an area where temperature extremes, vibration, and electromagnetic and radio frequency interference are minimal.

3. Locate the Model 4081 Transmitter within 150 ft (45.7 m) of the oxygen probe due to wiring and signal considerations.

d. Installing Model 4081 Transmitter

1. Ensure all components are available to install the Model 4081 Transmitter.

2. Choose a method or location to mount the transmitter.

   (a) Flat Surface Mounting. The transmitter may be mounted on a flat surface using the threaded mounting holes located on the bottom of the transmitter housing. Refer to Figure 2-6 for installation references.

   (b) Pipe Mounting. An optional pipe mounting bracket is available for this type of installation. Refer to Figure 2-7 for installation references.

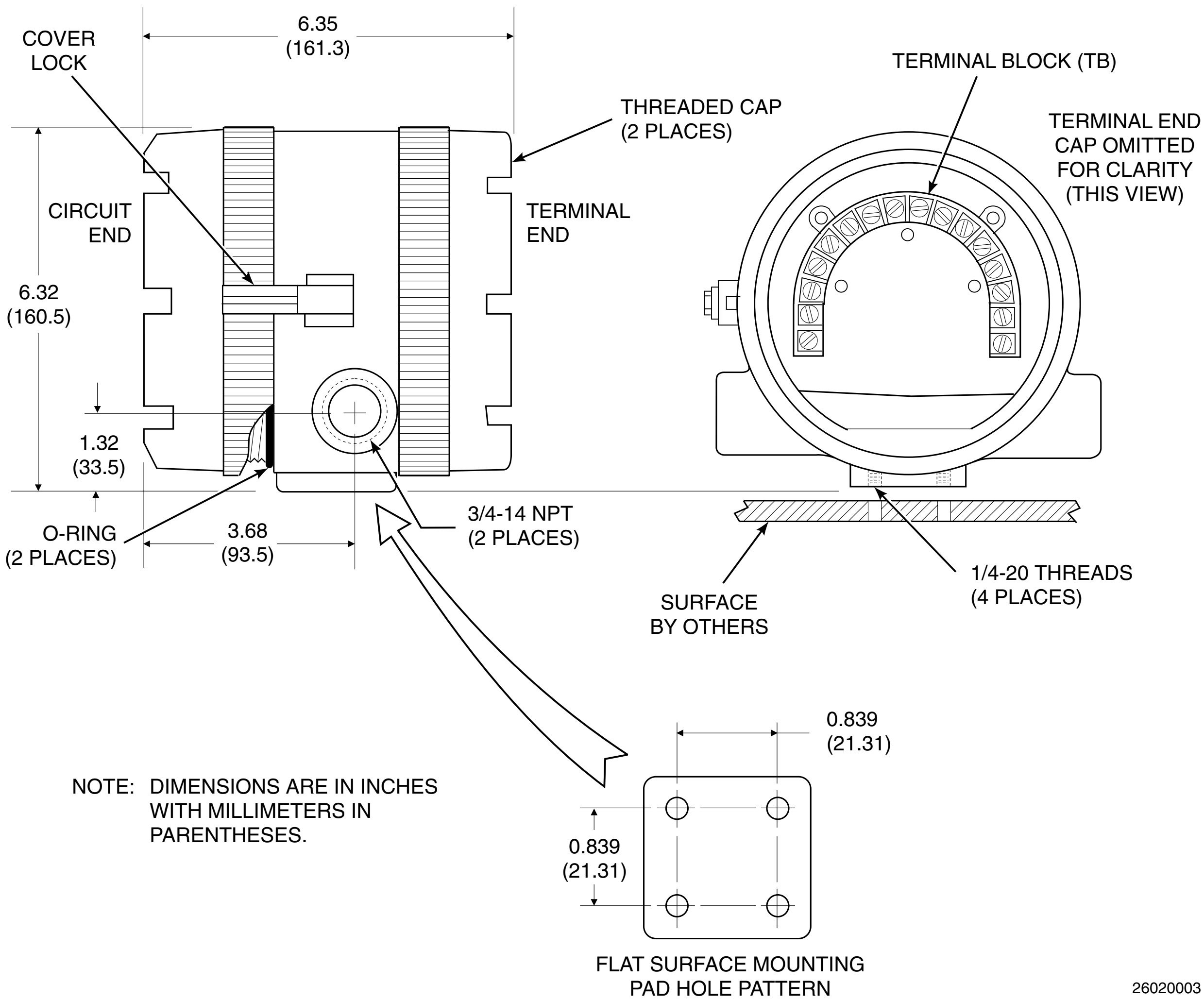


Figure 2-6. Flat Surface Mounting Dimensional Information

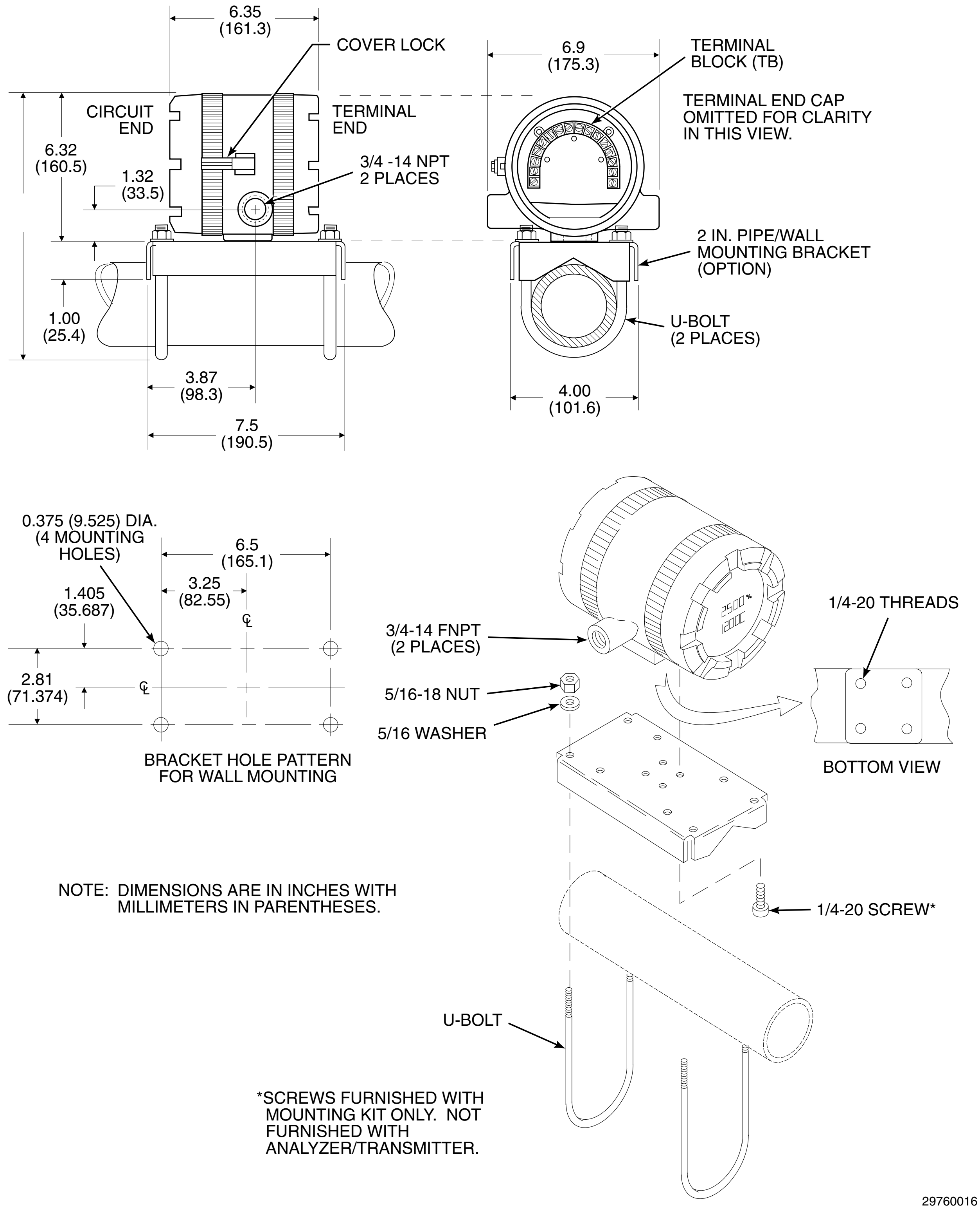


Figure 2-7. Pipe Mounting Dimensional Information

3. For correct viewing orientation, the display may be changed 90 degrees, using the following procedure:

   (a) Refer to Figure 2-8. Loosen the cover lock screw until the cover lock is disengaged from the knurled surface on the threaded circuit end cap.

   (b) Remove the circuit end cap.

   (c) Remove the three screws retaining the display board in place.

   (d) Lift and rotate the display board 90 degrees either way.

   (e) Reposition the display board on the standoffs. Install and tighten all three screws.

   (f) Install the circuit end cap and tighten the cover lock screw to secure the cover lock in place.

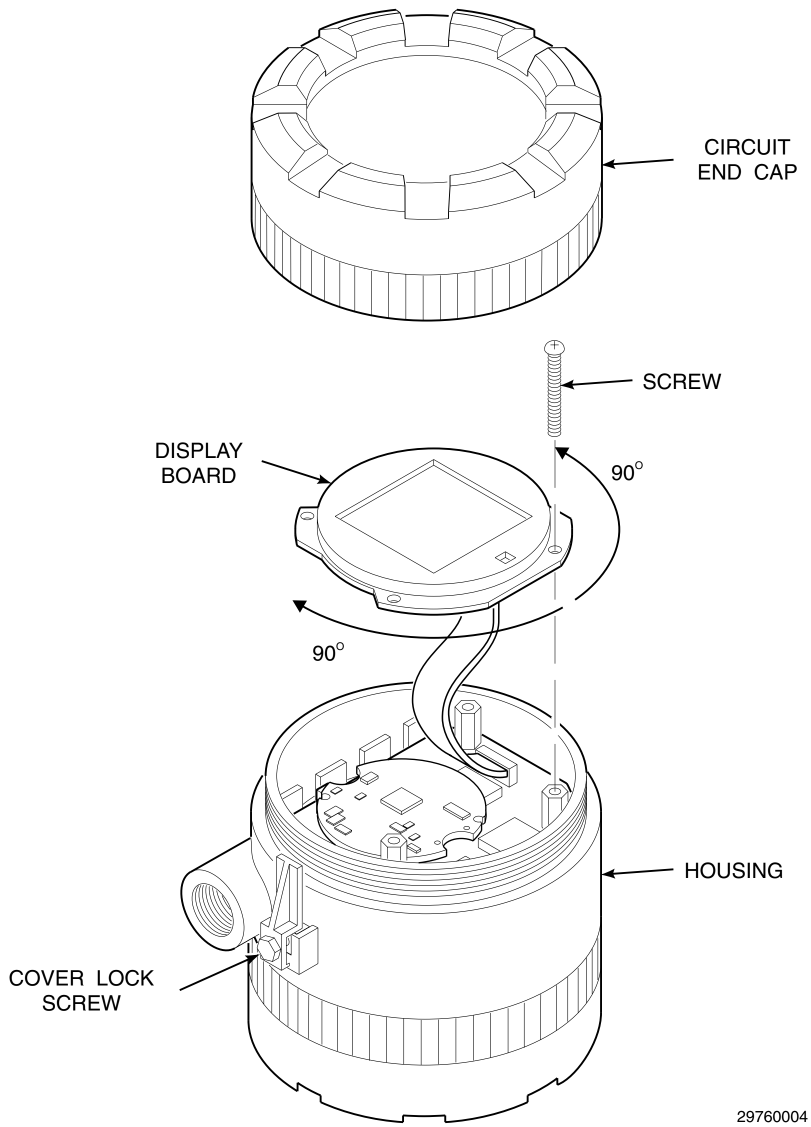


Figure 2-8. Display Positioning Assembly

2-3 ELECTRICAL INSTALLATION

All wiring must conform to local and national codes.

WARNING

Disconnect and lock out power before connecting the unit to the power supply.

WARNING

Install all protective equipment covers and safety ground leads after installation. Failure to install covers and ground leads could result in serious injury or death.

WARNING

To meet the Safety Requirements of IEC 1010 (EC requirement), and ensure safe operation of this equipment, connection to the main electrical power supply must be made through a circuit breaker (min 10 A) which will disconnect all current-carrying conductors during a fault situation. This circuit breaker should also include a mechanically operated isolating switch. If not, then another external means of disconnecting the supply from the equipment should be located close by. Circuit breakers or switches must comply with a recognized standard such as IEC 947.

a. General

The power supply and signal wiring should be shielded. Also, make sure the signal wiring is grounded at the Model 4081 Transmitter end only. Do not ground the signal loop at more than one point. Twisted pairs are recommended. Ground the transmitter housing to an earth ground to prevent unwanted electromagnetic interference (EMI) or radio frequency interference (RFI).

NOTE

For optimum EMI/RFI immunity, shield the FOUNDATION fieldbus signal cable and enclose in an earth grounded metal conduit.

Never run signal or sensor wiring in the same conduit, or open tray, with power cables. Keep signal or sensor wiring at least 12 in. (0.3 m) away from other electrical equipment and 6.5 ft (2 m) from heavy electrical equipment.

It is necessary to prevent moisture from entering the Model 4081 Transmitter housing. The use of weather-tight cable glands is required. If conduit is used, plug and seal connections on the transmitter housing to prevent moisture accumulation in the terminal side of the housing.

CAUTION

Moisture accumulation in the transmitter housing can affect its performance and may void its warranty.

b. Oxygen Probe Signal Connections

1. Two signals represent the O_2 value and the cell temperature. The probe provides these values to the Model 4081 Transmitter for processing and signal conditioning.

2. Wiring connections for the probe are shown in Figure 2-9.

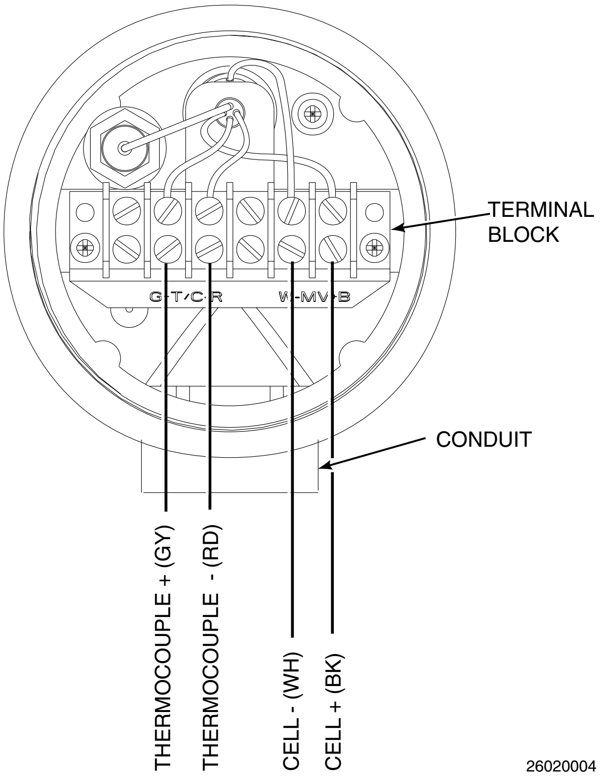


Figure 2-9. Oxygen Probe Terminal Block

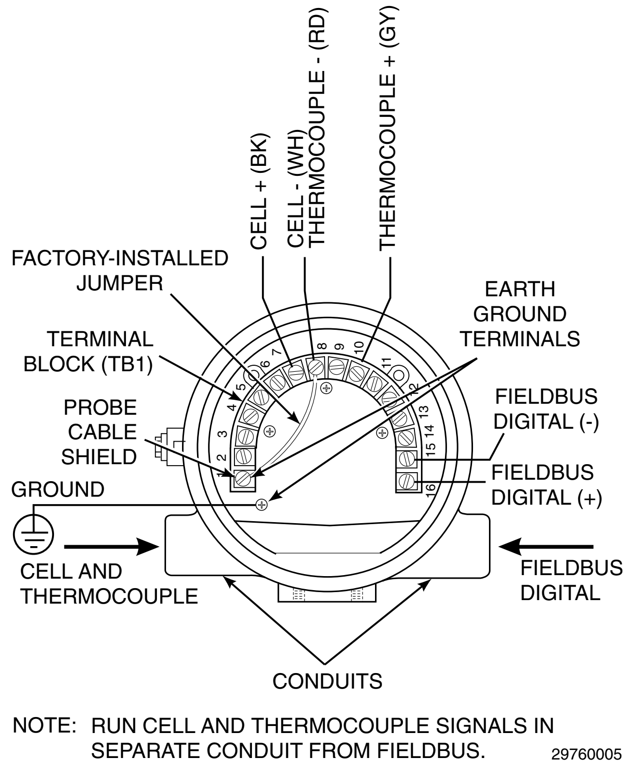


Figure 2-10. Model 4081 Transmitter Terminal Block

c. Model 4081 Transmitter and FOUNDATION Fieldbus Signal Connections

1. Two signals representing the O_2 value and the cell temperature are supplied to the Model 4081 Transmitter from the oxygen probe.

2. Wiring connections for the Model 4081 Transmitter are shown in Figure 2-10.

NOTE

The ground arrangement shown in Figure 2-10 limits the amount of noise introduced into the electronics.

3. Connect wire shields to terminal 1. Connect earth ground as shown.

2-4 PNEUMATIC INSTALLATION

a. General

Reference air is required for O_2 calculation, and calibration check gas is required during a calibration check. Refer to Figure 2-11 for the gas connections on the oxygen probe.

b. Reference Air Package

After the oxygen probe is installed, connect the reference air set. Install the reference air set according to Figure 2-12.

c. Instrument Air (Reference Air)

Instrument air is required for reference. Use 10 psig (68.95 kPa gage) minimum, 225 psig (1551.38 kPa gage) at 0.2 scfh (100 ml/min.); less than 40 parts-per-million total hydrocarbons. Regulator outlet pressure should be set at 5 psi (35 kPa).

d. **Calibration Check Gas**

Two calibration check gas concentrations are used with the Two-Wire In Situ Oxygen Analyzer: Low Gas - 0.4% O_2 and High Gas - 8% O_2, each with the balance in nitrogen. Do not use 100% nitrogen. See Figure 2-11 for the probe connections. Set both calibration check gases at the same flow rate: 5 scfh (2.5 L/min).

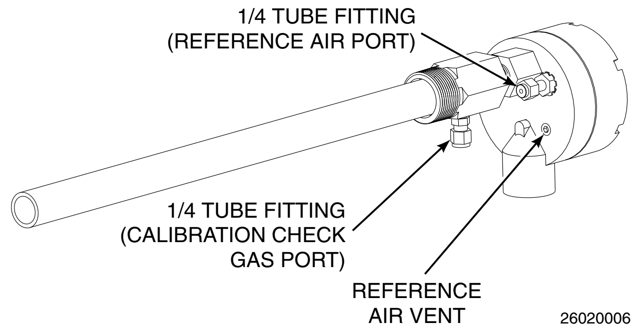
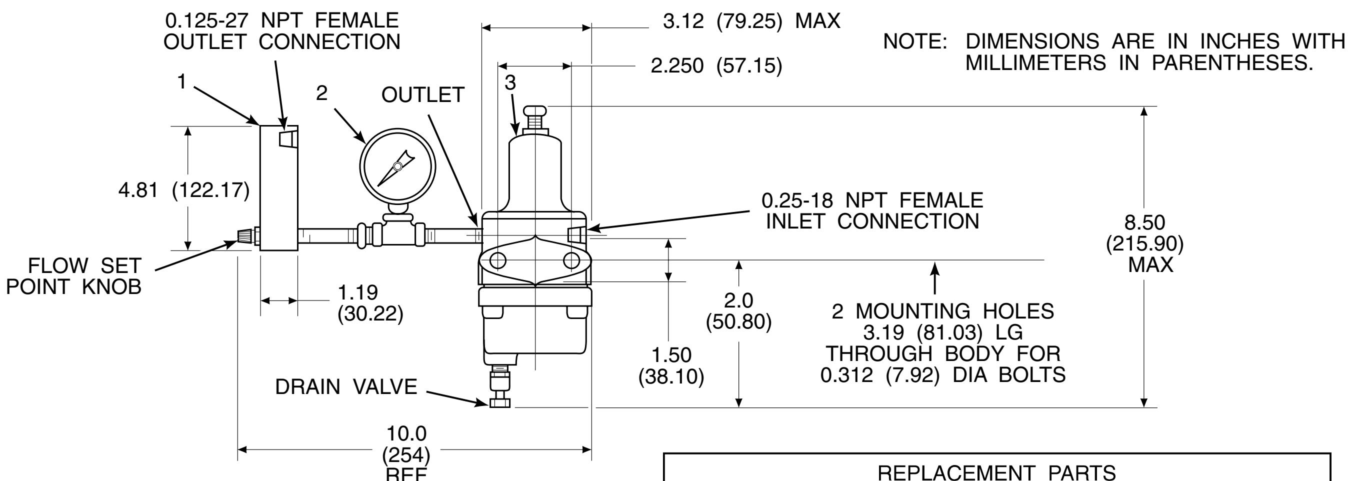
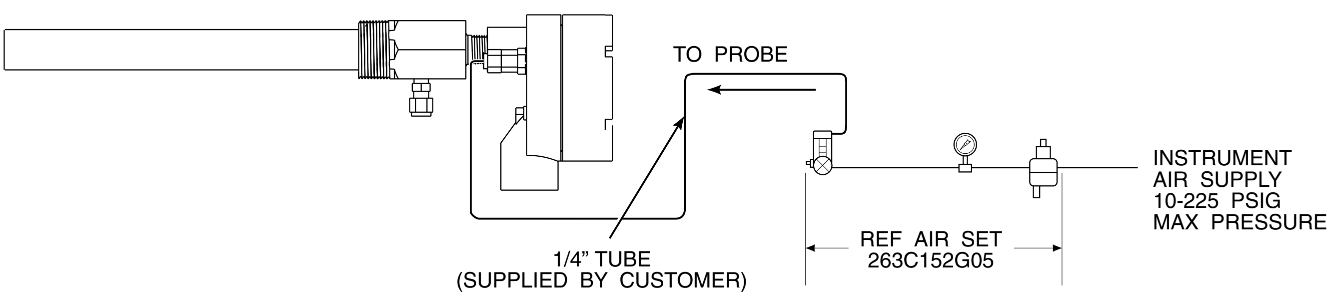


Figure 2-11. Oxygen Probe Gas Connections



REPLACEMENT PARTS			
1	FLOWMETER	0.2-2.0 SCFH	771B635H08
2	2" PRESSURE GAGE	0-15 PSIG	275431-006
3	COMBINATION FILTER-REG.	0-30 PSIG	4505C21G01



SCHEMATIC HOOKUP FOR REFERENCE AIR SUPPLY ON OXYGEN PROBE. 26020034

Figure 2-12. Air Set, Plant Air Connection

SECTION 3
STARTUP

> **WARNING**
>
> **Install all protective equipment covers and safety ground leads before equipment startup. Failure to install covers and ground leads could result in serious injury or death.**

3-1 GENERAL

a. Verify Mechanical Installation

Ensure the Oxygen Analyzer is installed correctly. See paragraph 2-2 for mechanical installation information.

b. Verify Terminal Block Wiring

Ensure the wiring of both the oxygen probe terminal block and Model 4081 Transmitter terminal block is correct. Refer to paragraph 2-3 for electrical installation and wiring information.

3-2 POWER UP

a. General

The Two-Wire In Situ Oxygen Analyzer displays the current oxygen reading on the LCD face of the Model 4081 Transmitter. The O_2 concentration and cell temperature are displayed as shown in Figure 3-1. This and other in-formation may also be accessed using the FOUNDATION Fieldbus.

b. Startup Display

When the probe is first inserted into the stack, some time is required until minimum operating temperatures [550°C (1022°F)] are reached. Some time is also required for the electronics to reach an operating state. Therefore, when the unit is first powered up, a faulted operation display as shown in Figure 3-2 may be displayed by the transmitter until the probe operating temperatures are reached and the electronics are working properly (approximately 5 minutes).

c. Operating Display

After the probe has reached operating temperatures, the Model 4081 Transmitter display should look similar to Figure 3-1. The display will now track the O_2 concentration and cell temperature.

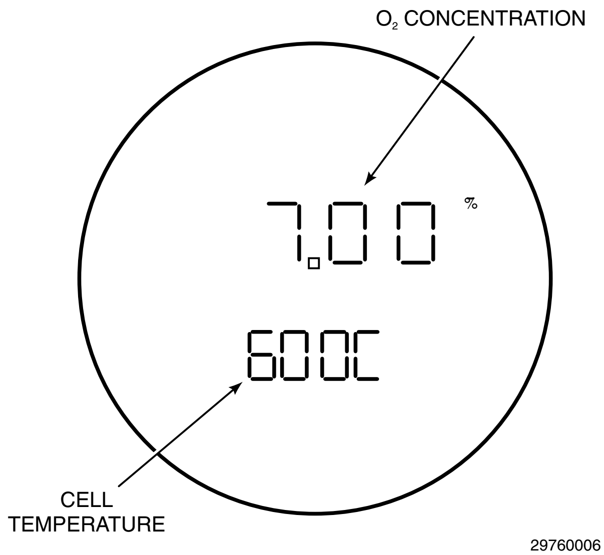


Figure 3-1. Normal Operation Display

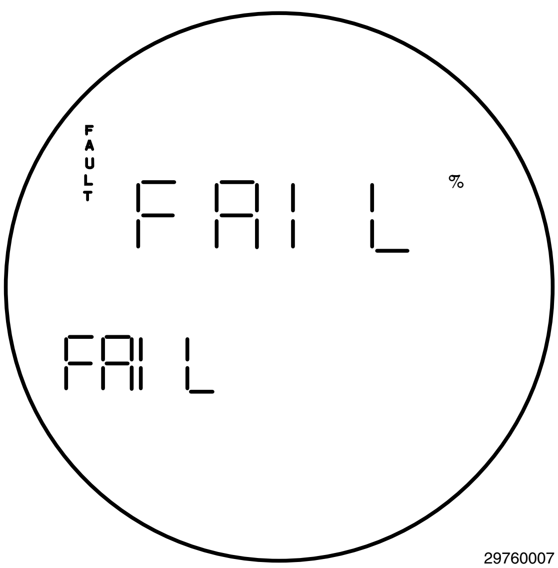


Figure 3-2. Faulted Operation Display

3-3 REESTABLISHING PROPER CALIBRATION CHECK GAS FLOW RATE

The calibration check gas flow must be enough to ensure no combustion flue gases mix with the calibration check gases and only clean, good calibration check gas surrounds the cell without expending excess gas (Figure 3-3). Monitor the O_2 concentration using an IRC or FOUNDATION fieldbus. Set the calibration check gas flow rate as follows:

NOTE

Only set the calibration check gas flow rate at startup. It is not necessary to perform this procedure for each calibration check.

a. Adjust the calibration check gas flow to 5 scfh (2.5 L/min) to ensure the cell is surrounded by calibration check gas. Due to the cooling effect of the gas, the cell temperature will decrease slightly, causing the O_2 concentration to drop. Once the electronics compensates for this effect, the O_2 concentration will stabilize.

b. Next, slowly reduce the calibration check gas flow until the O_2 concentration changes, which indicates that the calibration check and flue gases are mixing. Increase the flow rate until this effect is eliminated.

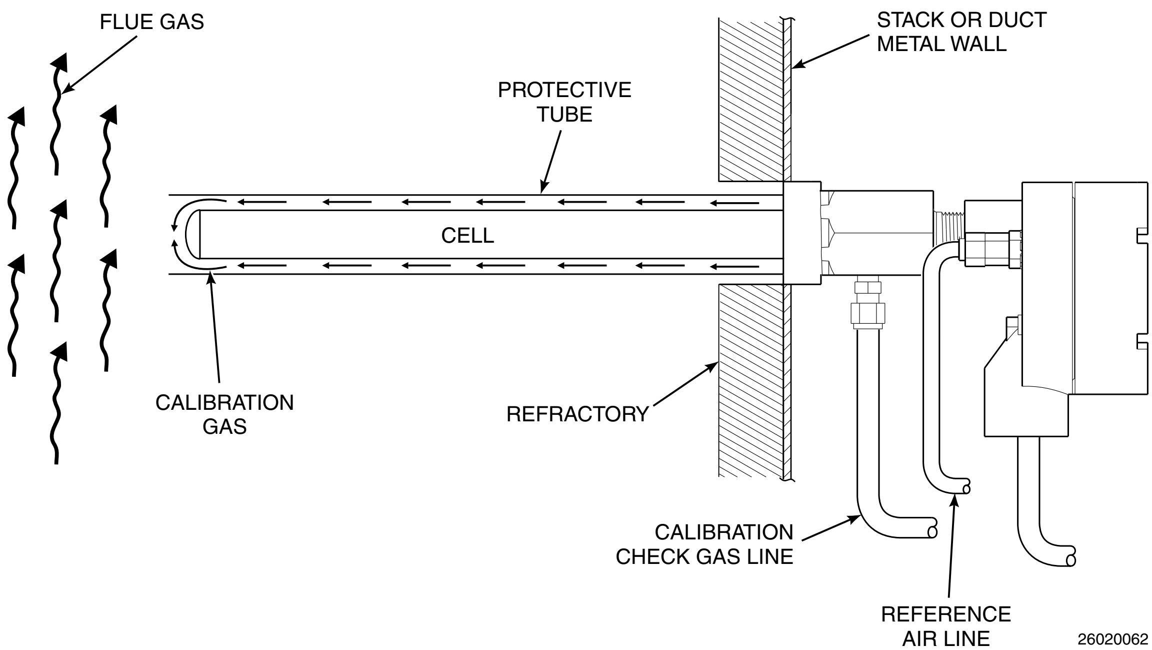


Figure 3-3. Proper Calibration Check Gas Flow Rate

SECTION 4
OPERATION

4-1 GENERAL

a. Overview

This section explains the operator controls and displays of the Two-Wire In Situ Oxygen Analyzer. The use of the Infrared Remote Control (IRC) and the Model 4081 Transmitter Liquid Crystal Display (LCD) are described in detail.

b. Display

The Model 4081 Transmitter LCD displays the O_2 concentration and cell temperature during normal operation (see Figure 4-1). The LCD will also display fault conditions when they occur. To interact with the transmitter, use the IRC and navigate through a series of menus displayed on the LCD.

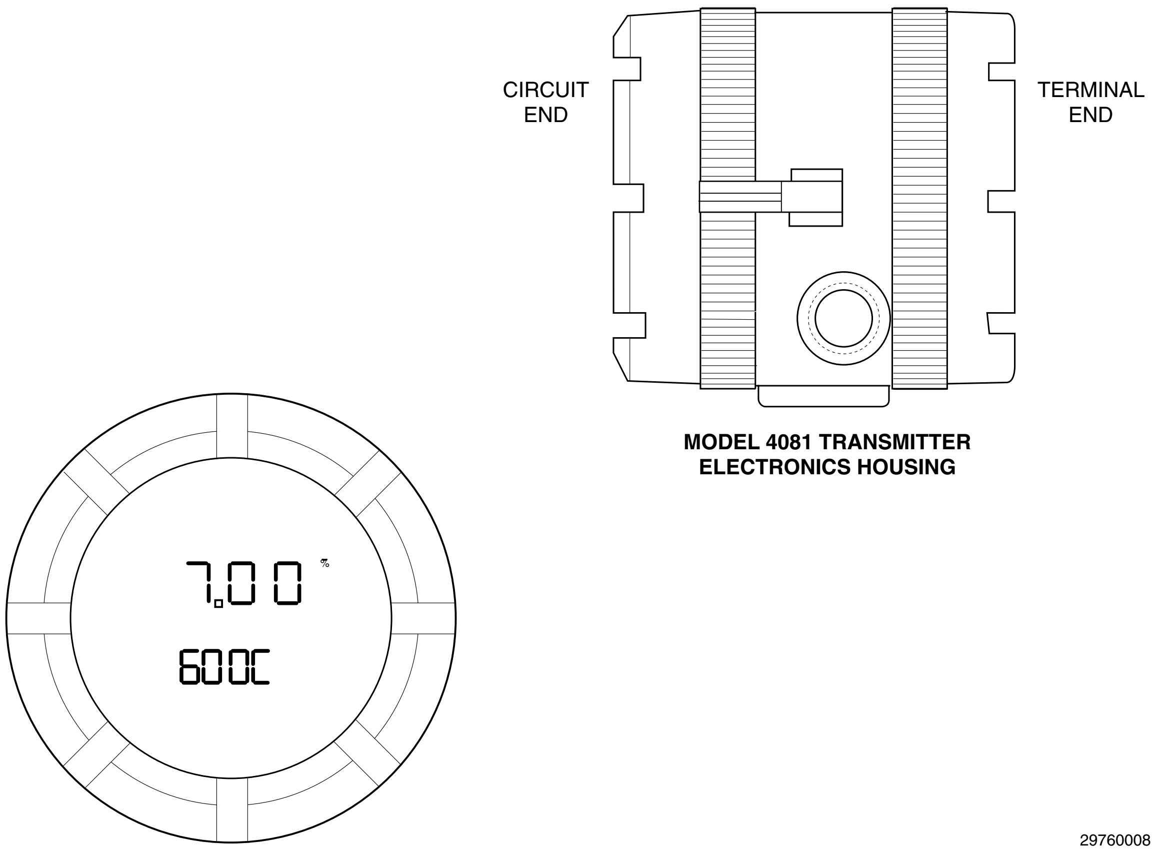


Figure 4-1. Normal Operation Display

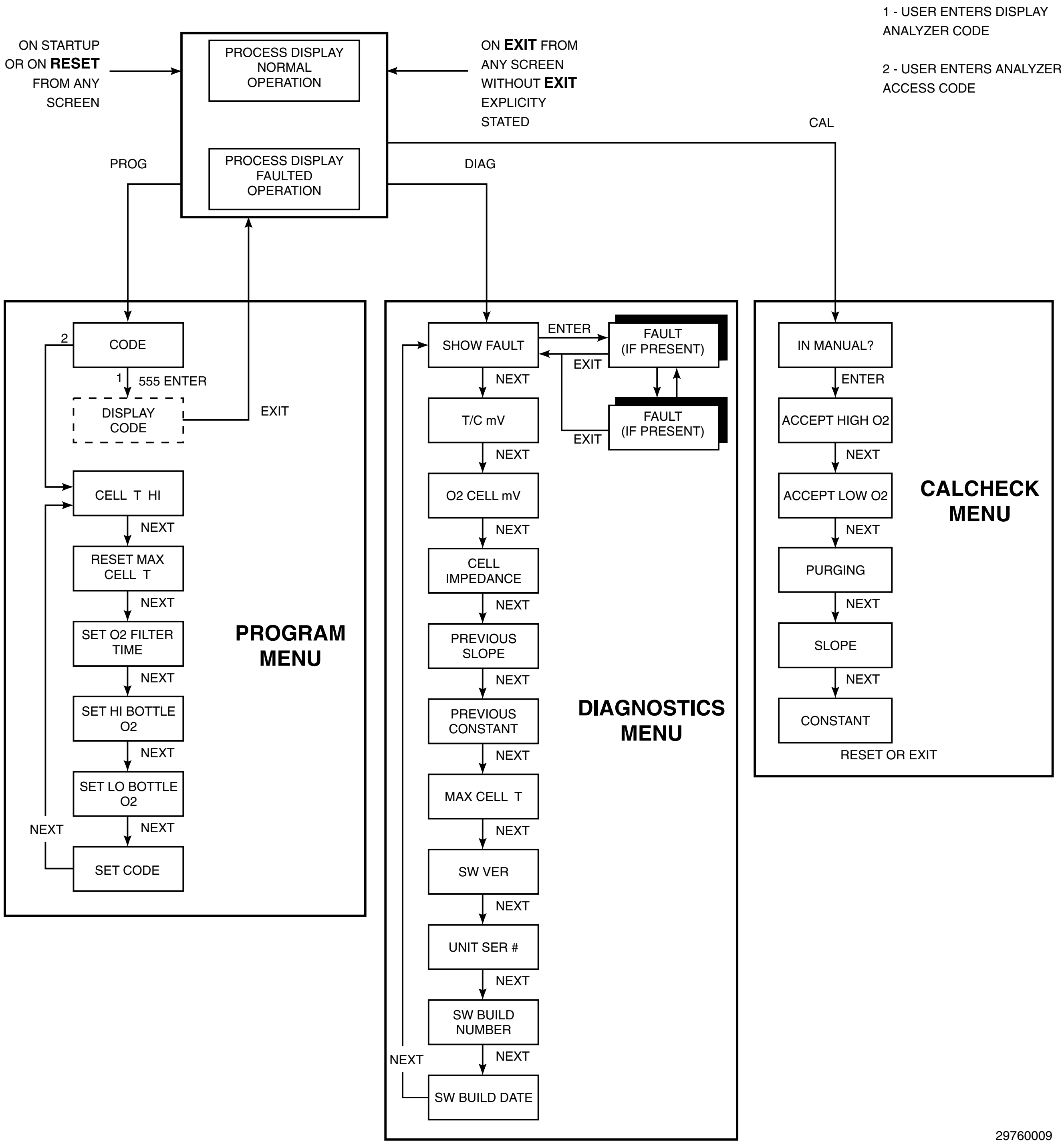


Figure 4-2. Model 4081 Transmitter Menu Tree

c. Menu Tree

The screens that can be displayed are shown in the menu tree of Figure 4-2. These screens are displayed on the LCD and are accessed using the IRC keypad.

d. Navigation

The IRC in Figure 4-3 is used to interact with the Model 4081 Transmitter and navigate through the screens on the LCD.

1. Hold the IRC within 6 ft (1.8 m) of the Model 4081 Transmitter and within 15 degrees from the centerline of the transmitter LCD. The amount of ambient light may also affect IRC performance.

NOTE

The LCD may react slowly to IRC commands. Allow sufficient time between key presses to avoid undesired or repeated commands from accumulating in the command queue.

2. Use the keys on the IRC to navigate through the menu screens. Refer to Figure 4-3. General usage is as follows:

(a) RESET. Returns to the PROCESS DISPLAY screen at the top of the menu tree. Any non-entered number in the exited state will be ignored, and the previous data will be used.

(b) HOLD. Not used.

(c) Left/Right Arrow. Moves left and right among editable digits on the display.

(d) Up/Down Arrow. Increases or decreases the value of the currently selected digit on the display.

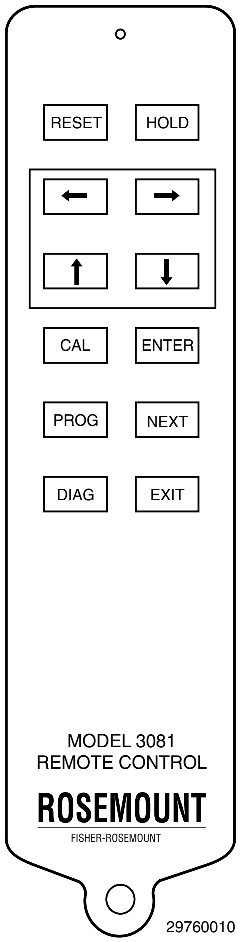


Figure 4-3. Infrared Remote Control (IRC)

(e) CAL. Accesses the CALCHECK MENU branch of the menu tree. Only works from the PROCESS DISPLAY screen.

(f) PROG. Accesses the PROGRAM MENU branch of the menu tree. Only works from the PROCESS DISPLAY screen.

(g) DIAG. Accesses the DIAGNOSTICS MENU branch of the menu tree. Only works from the PROCESS DISPLAY screen.

4

(h) ENTER. Initiates the editing process and causes the most significant digit of the edited item to start flashing. Also processes the entry so the previous value updates to the new value entered using the arrow keys. Failure to press ENTER before exiting a screen will cancel the input value and revert to the previous value.

(i) NEXT. Accesses the next user screen as shown in the menu tree. Any non-entered number in the exited state will be ignored, and the previous data will be used.

(j) EXIT. Exits from sub-branches of the menu tree where an exit option is explicitly shown. Otherwise, returns to the PROCESS DISPLAY screen at the top of the menu tree. Any non-entered number in the exited state will be ignored, and the previous data will be used.

4-2 PROGRAM MENU

The PROGRAM MENU branch of the menu tree allows you to program and edit some process parameters, faults, outputs, and security codes. To access this branch of the menu tree, press the PROG key on the IRC when in the PROCESS DISPLAY screen (Normal or Faulted). You must enter the analyzer code to gain further access to the screens in this branch. Each screen in this branch is accessed sequentially using the NEXT key. Refer to Figure 4-2 during the following menu and screen descriptions.

NOTE

To edit a screen value, press ENTER to access the data field. Use the left and right arrow keys to move among the digits in the data field. Note that the editable position will be flashing. To change the value of a digit, use the up and down arrow keys to increase or decrease the value. When finished editing, press ENTER to accept the value. To go to the next screen in the menu, press NEXT.

a. CODE

Refer to Figure 4-4. After pressing the PROG key, this screen will display. Use this screen to identify a specific analyzer in a process to prevent accessing an adjacent analyzer when using the IRC.

Press ENTER to begin editing. At this point, you can either specify the analyzer by its access code or view its code if it is unknown.

1. To gain further access to the screens in the PROGRAM MENU branch, enter the correct three-digit analyzer access code using the arrow keys and press ENTER. If security is disabled, this screen does not appear and the system displays the FAULT VAL screen.

2. If the analyzer access code is unknown, enter 555 and press ENTER to access the DISPLAY CODE screen. In that screen, you will be able to view the analyzer access code.

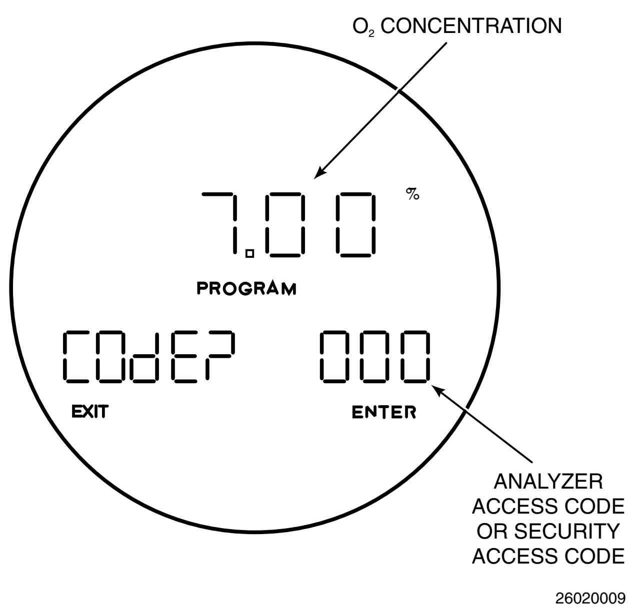


Figure 4-4. CODE

b. DISPLAY CODE

Refer to Figure 4-5. This screen is accessible from the CODE screen by entering 555 and pressing ENTER. The DISPLAY CODE screen identifies the analyzer access code so you can return to the CODE screen and enter the code as described in paragraph 4-2a. To return to the Process Display screen, press EXIT.

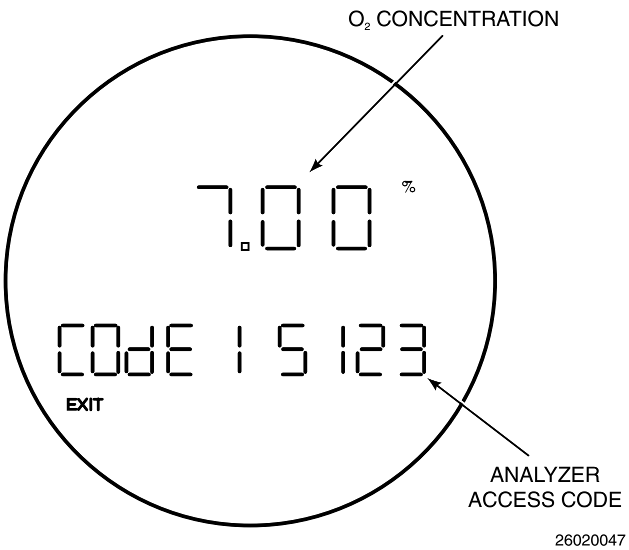


Figure 4-5. DISPLAY CODE

c. CELL T HI

Refer to Figure 4-6. Use this screen to set the value of the upper cell temperature fault condition. This value is the maximum allowed cell temperature before a fault condition is indicated. Press ENTER to begin editing. Use the arrow keys to select and change the value. The value must be between 550° and 1600°C. Press ENTER to accept the value. Pressing NEXT displays the RESET MAX CELL T screen.

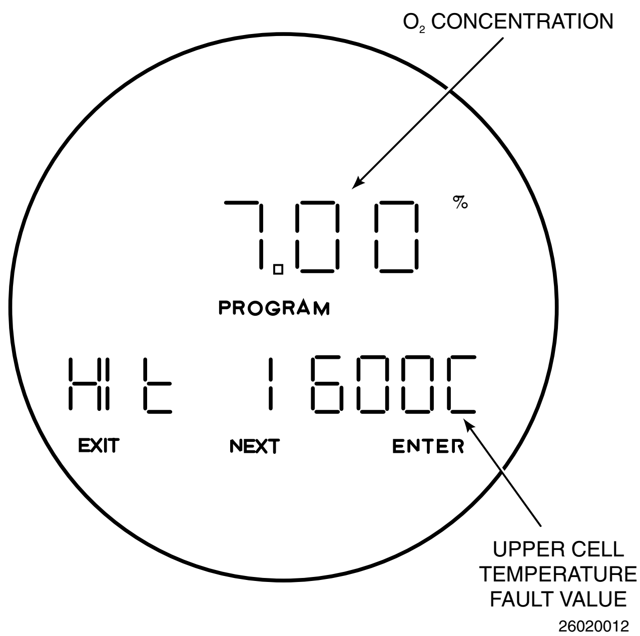


Figure 4-6. CELL T HI

d. RESET MAX CELL T

Refer to Figure 4-7. The transmitter tracks the maximum cell temperature obtained. Use this screen to reset the maximum cell temperature attained value to the current cell temperature. Press ENTER to begin editing. Use the arrow keys to select and change the value (Y/N). Then, press ENTER to accept the value. Pressing NEXT displays the SET O_2 FILTER TIME screen.

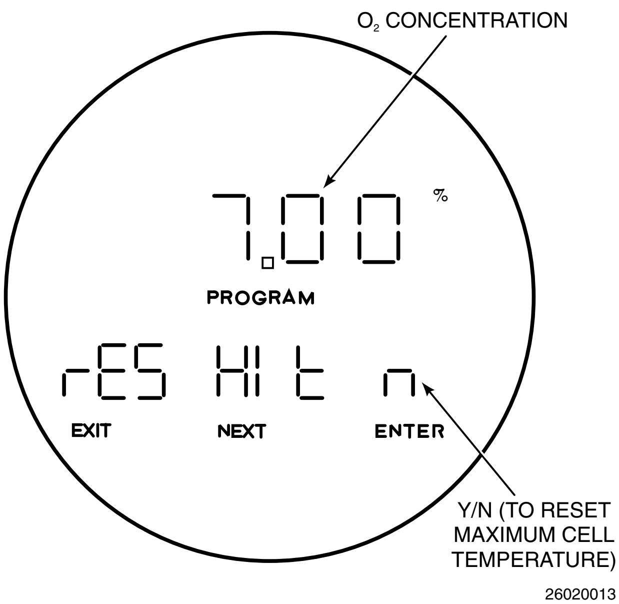


Figure 4-7. RESET MAX CELL T

e. SET O_2 FILTER TIME

Refer to Figure 4-8. In some applications, it is beneficial to dampen the raw O_2 signal coming from the cell. Use this screen to enter the amount of time it will take the O_2 to reach 90% of the new reading. Press ENTER to begin editing. Use the arrow keys to select and change the screen value to the O_2 filter value (in seconds). Enter a value between 0 and 300 seconds and press ENTER to accept the value. Press NEXT to access the SET HI BOTTLE O_2 screen.

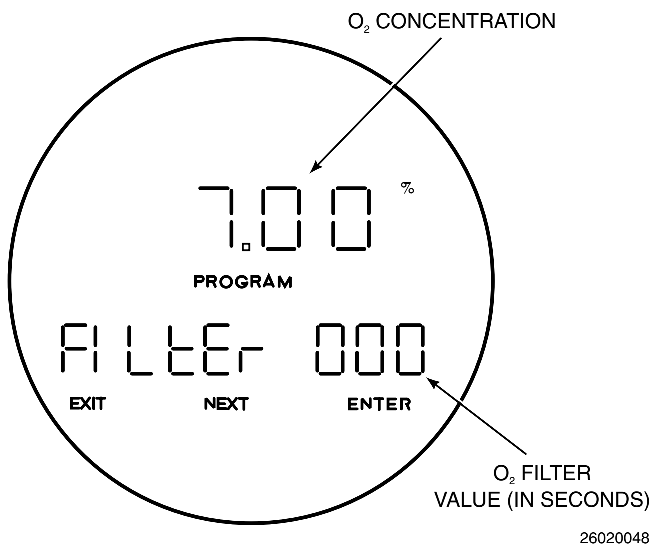


Figure 4-8. SET O_2 FILTER TIME

f. SET HI BOTTLE O_2

Refer to Figure 4-9. Use this screen to identify, within the electronics, the percentage of O_2 used as the high calibration check gas. Press ENTER to begin editing. Use the arrow keys to select and change the screen value to the O_2 percentage of the high calibration check gas. Press ENTER to accept the value. Press NEXT to display the SET LO BOTTLE O_2 screen.

g. SET LO BOTTLE O_2

Refer to Figure 4-10. Use this screen to identify, within the electronics, the percentage of O_2 used as the low calibration check gas. Press ENTER to begin editing. Use the arrow keys to select and change the screen value to the O_2 percentage of the low calibration check gas. Press ENTER to accept the value. Press NEXT to display the SET CODE screen.

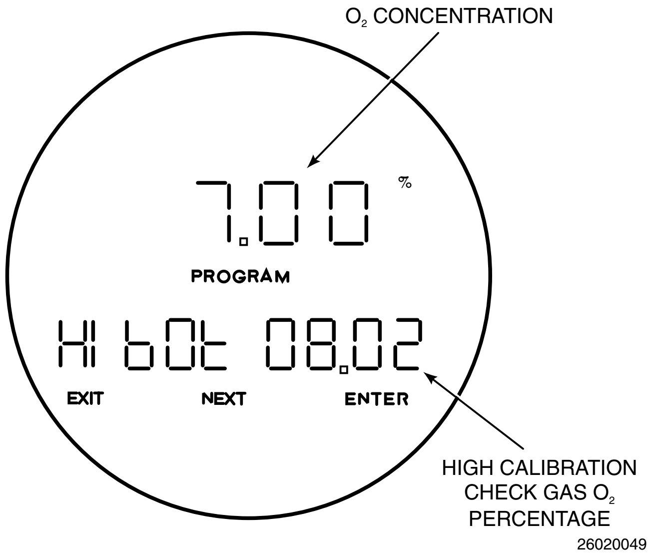


Figure 4-9. SET HI BOTTLE O_2

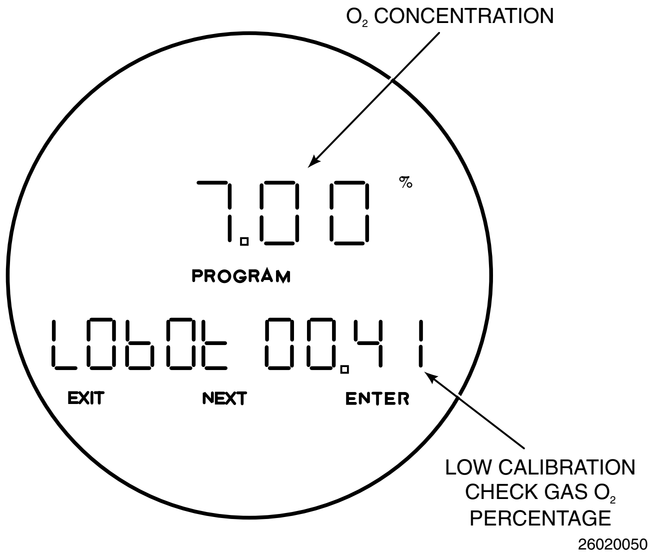


Figure 4-10. SET LO BOTTLE O_2

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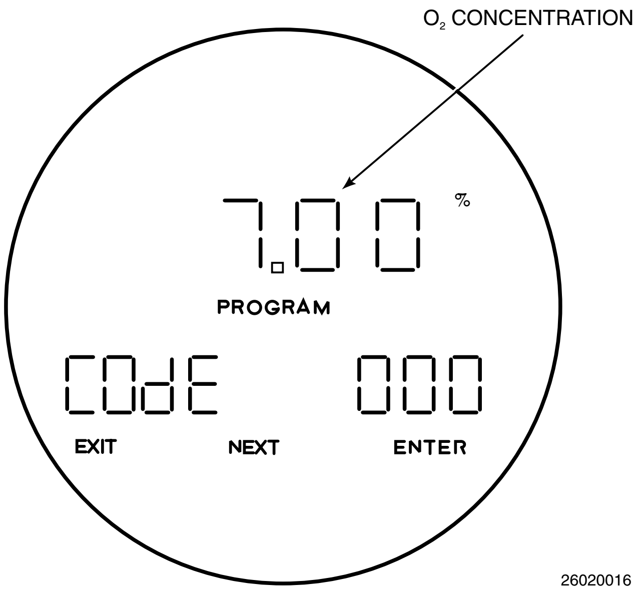


Figure 4-11. SET CODE

h. SET CODE

Refer to Figure 4-11. Use this screen to set the security code for the Model 4081 Transmitter. Press ENTER to begin editing. Use the arrow keys to select and change the value. Select any value between 000 and 999, excluding 000 and 555. Code 000 indicates that no code is set. Code 555 accesses the DISPLAY CODE screen. Press ENTER to accept the value. Pressing NEXT returns to the CELL T HI screen at the beginning of the PROGRAM MENU.

i. Model 4081 Transmitter Parameters

Table 4-1 lists the range and default value of operator-adjustable variables used by the Model 4081 Transmitter. These variables may all be changed from the PROGRAM MENU screens.

Table 4-1. Model 4081 Transmitter Parameters

Parameter	Range	Default
Upper Range Limit	2.0-25.0%	10.0%
Upper Cell Temp. Fault Value	650-1600°C	1600°C
Analyzer Access Code	000-999 (excluding 000 and 555)	000 (no code)

4-3 DIAGNOSTICS MENU

The DIAGNOSTICS MENU branch of the menu tree allows you to examine outputs, current faults, and unit information. None of the items in the DIAGNOSTICS MENU are editable. This branch of the menu tree may be accessed by pressing DIAG on the IRC when in the PROCESS DISPLAY screen (Normal or Faulted). Each screen in this branch is accessed sequentially by pressing NEXT. Refer to Figure 4-2 during the following menu and screen descriptions.

a. SHOW FAULT

Refer to Figure 4-12. After pressing DIAG, this screen displays. Pressing ENTER accesses a screen displaying the current fault (if any). If more than one fault exists, and you are in the fault screen, the display cycles through all existing faults. Information on the fault screens can be found in Section 6, TROUBLESHOOTING. Press EXIT to return from this fault sub-menu and press NEXT to access the T/C mV screen.

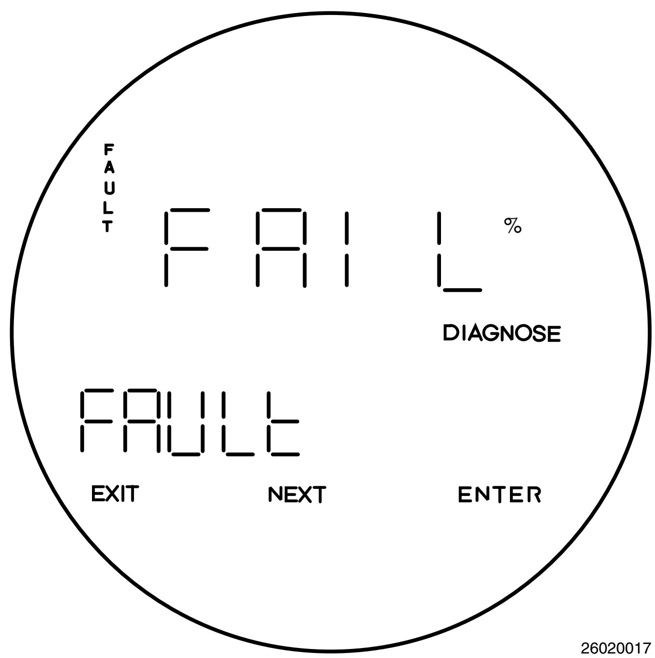


Figure 4-12. SHOW FAULT

b. T/C mV

Refer to Figure 4-13. Use this screen to examine the cell thermocouple mV output. Three decimal places are displayed. Pressing NEXT accesses the O_2 CELL mV screen.

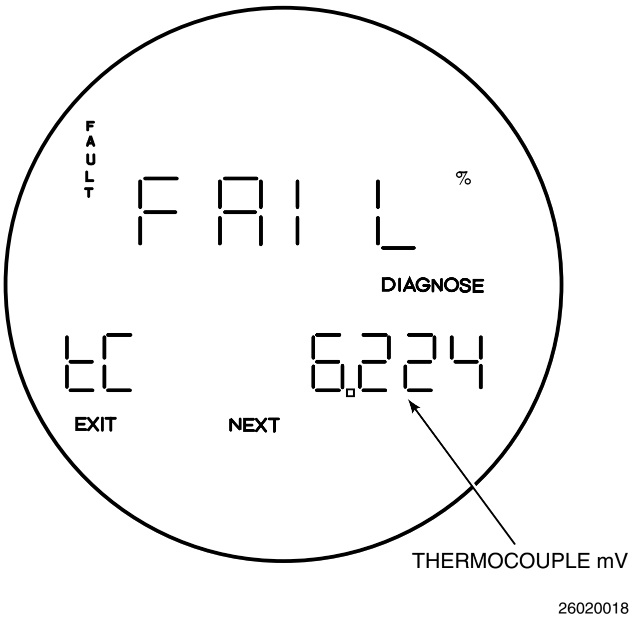


Figure 4-13. T/C mV

c. O_2 CELL mV

Refer to Figure 4-14. Use this screen to examine the O_2 CELL mV output. Pressing NEXT accesses the CELL IMPEDANCE screen.

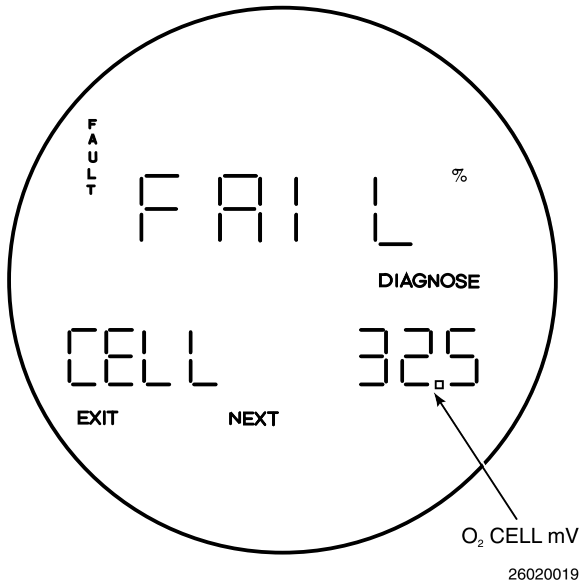


Figure 4-14. O_2 CELL mV

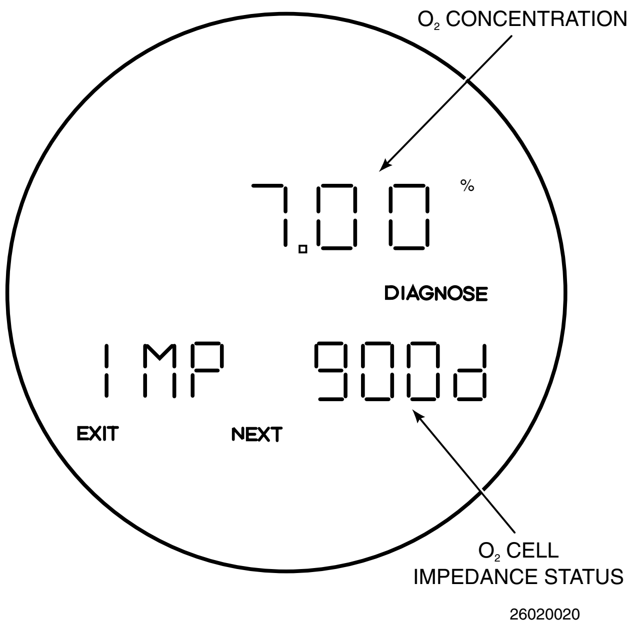


Figure 4-15. CELL IMPEDANCE

d. CELL IMPEDANCE

Refer to Figure 4-15. Use this screen to examine the O_2 CELL IMPEDANCE status. GOOD indicates the cell is operating normally. WARN indicates the cell has degraded but is still operational. HI indicates that the cell has degraded but is still operational; however, failure will occur soon. Pressing NEXT accesses the PREVIOUS SLOPE screen.

NOTE

Temperature influences cell impedance. Wait until the cell is at operating temperature before checking cell impedance. If checked before the cell reaches operating temperature [550°C (1022°F)], this screen displays a fail indication.

e. PREVIOUS SLOPE

Refer to Figure 4-16. Use this screen to examine the slope calculated from the most recent calibration check. The slope is the amount of cell voltage generated for a given O_2 value. For each calibration check, record the slope over the life of the probe. Tracking the slope will indicate if the probe is degrading. Press NEXT to access the PREVIOUS CONSTANT screen.

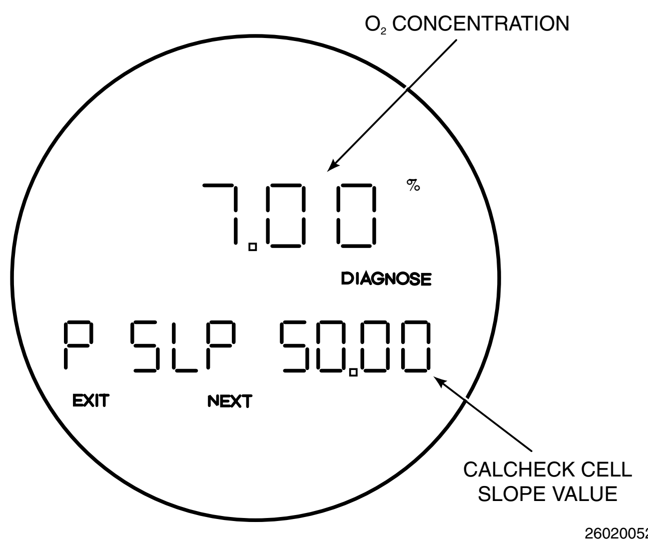


Figure 4-16. PREVIOUS SLOPE

4

f. PREVIOUS CONSTANT

Refer to Figure 4-17. Use this screen to examine the cell zero constant calculated from the most recent calibration check. The constant represents the voltage generated by the cell when no difference exists between the amount of O_2 on the reference and process sides of the cell. Press NEXT to access the MAX CELL T screen.

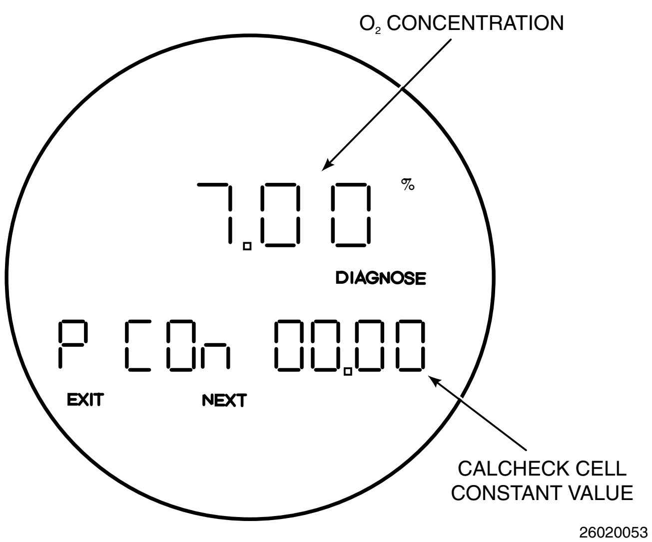


Figure 4-17. PREVIOUS CONSTANT

g. MAX CELL T

Refer to Figure 4-18. Use this screen to examine the maximum temperature attained by the O_2 cell. This value can be reset under the PROGRAM MENU. Pressing NEXT accesses the SW VER screen.

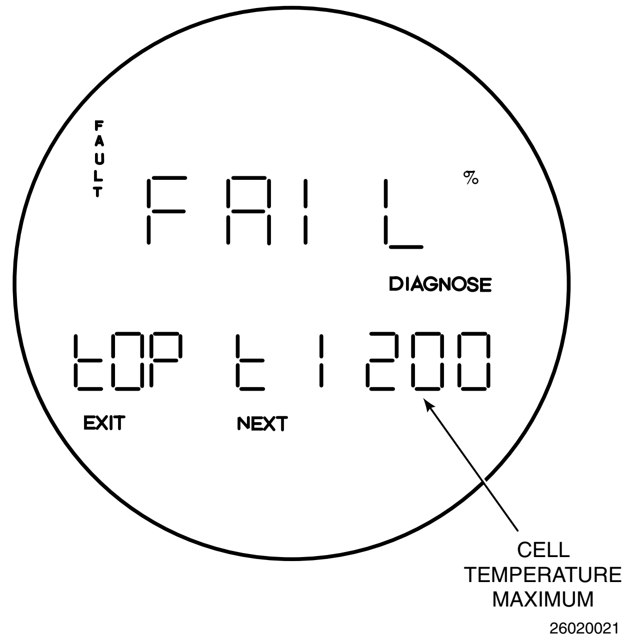


Figure 4-18. MAX CELL T

h. SW VER

Use this screen to see the software version number for the Model 4081 Transmitter. Pressing NEXT accesses the UNIT SER # screen.

i. UNIT SER #

Use this screen to see the unit serial number for the Model 4081 Transmitter. Pressing NEXT accesses the SW BUILD NUMBER screen.

j. SW BUILD NUMBER

Use this screen to see the software build number for the Model 4081 Transmitter. Pressing NEXT accesses the SW BUILD DATE screen.

k. SW BUILD DATE

Use this screen to see the software build date for the Model 4081 Transmitter. Pressing NEXT returns to the beginning of the DIAGNOSTICS MENU branch (the SHOW FAULT screen).

4-4 CALCHECK MENU

The CALCHECK MENU branch of the menu tree (Figure 4-2) allows you to perform a calibration check of the analyzer. Before performing a calibration check, ensure the high calibration check gas and low calibration check gas O_2 percentages are entered into the electronics via the PROGRAM MENU. To set these values, refer to paragraphs 4-2f and 4-2g.

Once these values are set, access the CALCHECK MENU branch by pressing CAL on the IRC when in the PROCESS DISPLAY screen (Normal or Faulted). Each screen in this branch identifies a process step in the calibration check procedure. The first screen in the sequence is the IN MANUAL? screen.

a. IN MANUAL? Refer to Figure 4-19.

> **WARNING**
>
> **Failure to remove the analyzer from automatic control loops prior to performing this procedure may result in a dangerous operating condition.**

If the O_2 output value is used in any automatic process control loops, the loop must be placed in manual before beginning a calibration check.

Once the analyzer is removed from any automatic control loops, press ENTER to edit the screen. Use the arrow keys to select Y (yes) and press ENTER to process the selection and to display the ACCEPT HIGH O_2 screen.

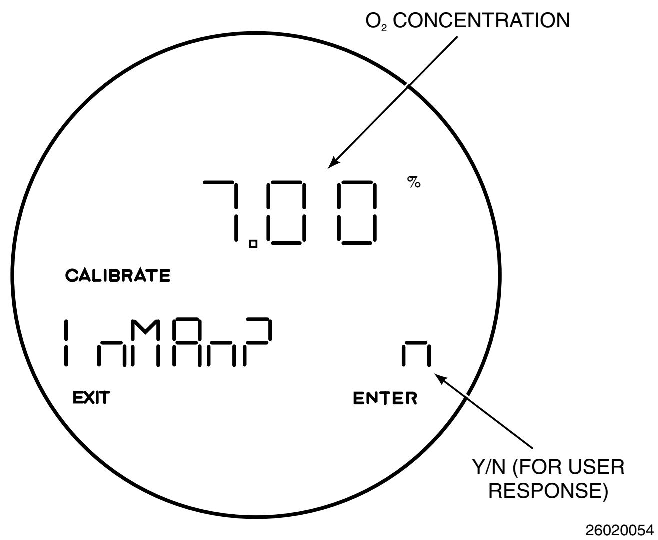


Figure 4-19. IN MANUAL?

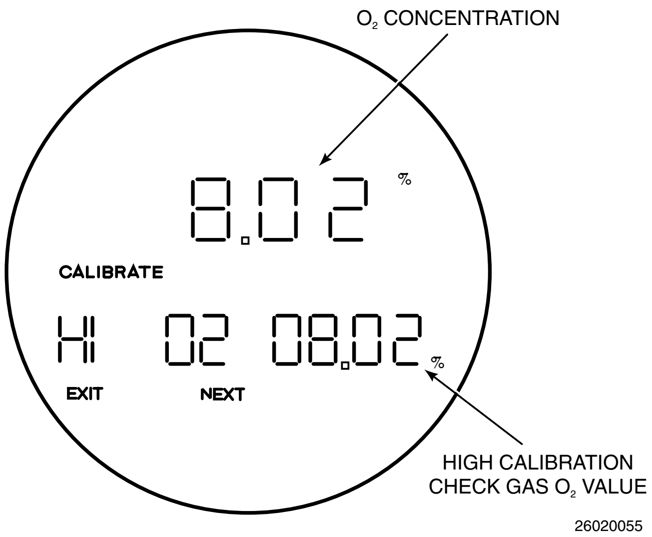


Figure 4-20. ACCEPT HIGH O_2

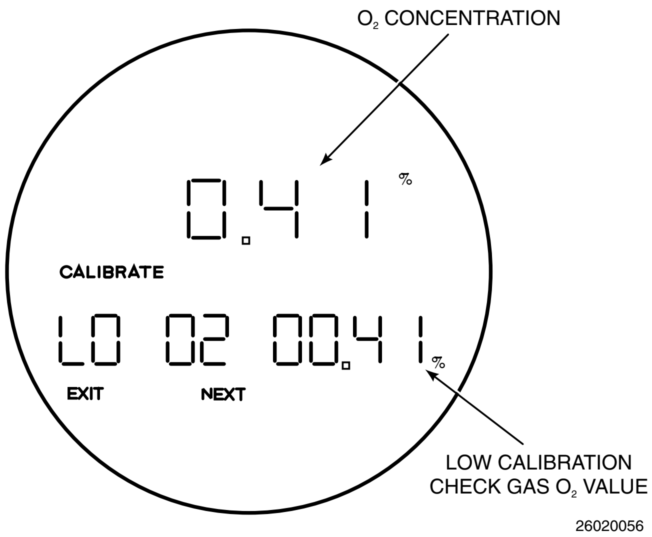


Figure 4-21. ACCEPT LOW O_2

b. **ACCEPT HIGH O_2**

Refer to Figure 4-20. After pressing ENTER to begin the calibration check, the high calibration check gas starts to flow. After waiting approximately three minutes for the displayed O_2 value to settle, press NEXT to accept the high calibration check gas reading and apply the low calibration check gas. The next screen to display is the ACCEPT LOW O_2 screen.

c. **ACCEPT LOW O_2**

Refer to Figure 4-21. Once the low calibration check gas is applied, wait approximately three minutes for the displayed O_2 value to settle. Once the value settles, press NEXT to accept the reading and to display the PURGING screen.

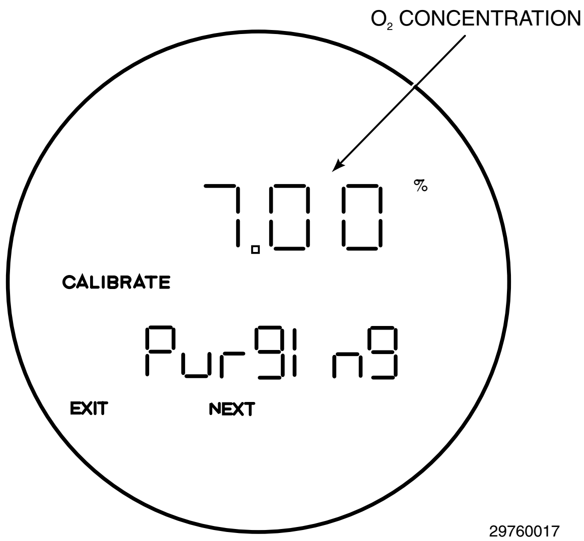


Figure 4-22. PURGING

d. PURGING

The PURGING screen provides an opportunity for the O_2 reading to return to the process gas concentration prior to exiting the calibration procedure. Once the displayed oxygen concentration has returned to the process gas value, press the NEXT button to display the SLOPE screen.

e. SLOPE

Refer to Figure 4-23. Use this screen to examine the slope calculated from current calibration check. The slope is the amount of cell voltage generated for a given O_2 value. After each calibration check, record the slope over the life of the probe. Tracking the slope will indicate if the probe is degrading. Press NEXT to access the CONSTANT screen.

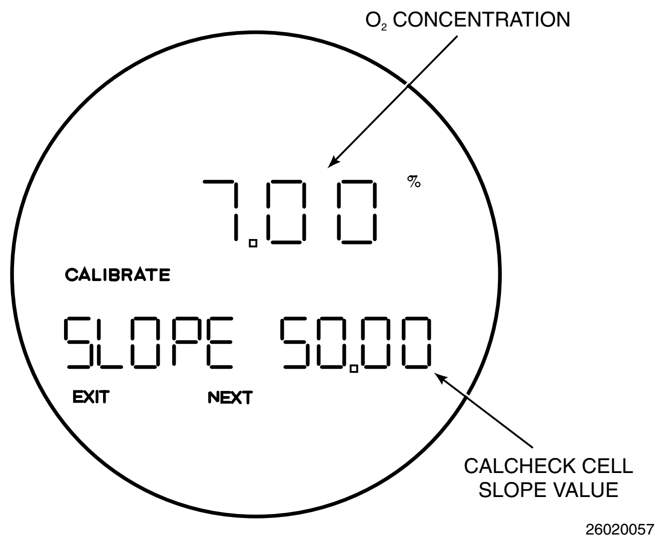


Figure 4-23. SLOPE

f. CONSTANT

Refer to Figure 4-24. Use this screen to examine the cell zero constant calculated from the current calibration check. The constant represents the voltage generated by the cell when no difference exists between the amount of O_2 on the reference and process sides of the cell. Note this value for comparison against future calibration checks. Press RESET or EXIT to return to the PROCESS DISPLAY screen.

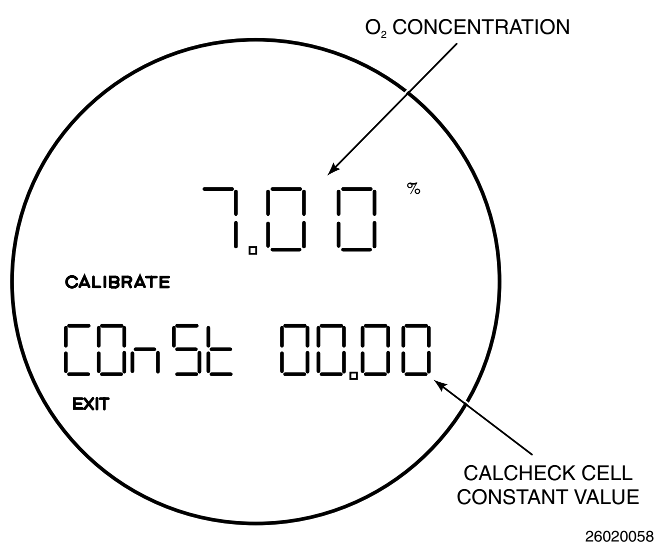


Figure 4-24. CONSTANT

4-5 SIMULATE SWITCH

The Model 4081FG is equipped with a simulate function. Located on the fieldbus board is a switch that controls the simulate enable status of the analyzer. Refer to Figure 4-25. To allow the analyzer to be placed in simulation mode, place the switch in the ON position.

This must be done while the instrument is powered on. The simulate function will not actuate unless it sees the transition from OFF to ON. To remove the device from the simulate mode, place the switch in the OFF position, or cycle power to the analyzer. Note that this switch does not actually place the analyzer in the simulate mode, it only allows the simulate mode to be enabled via fieldbus.

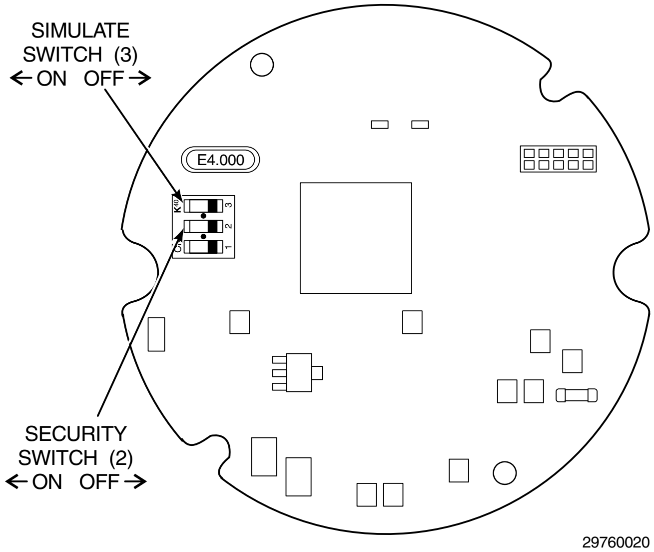


Figure 4-25. Simulate and Security Switch Positions

4-6 SECURITY SWITCH

The Model 4081FG contains a security function which prevents parameter from being changed via fieldbus. Refer to Figure 4-25. To enable the security feature, set the security switch located on the fieldbus board to ON, then enable security in the resource block.

1. Housing
2. O-ring
3. Lockwasher
4. Screw
5. Terminal End Cap
6. Terminal Block
7. Ground Screw
8. Washer
9. O-ring
10. PC Board Stack (CPU, Analog, and FOUNDATION Fieldbus Boards)
11. Display Board
12. Screw
13. Circuit End Cap
14. Screw
15. Cover Lock

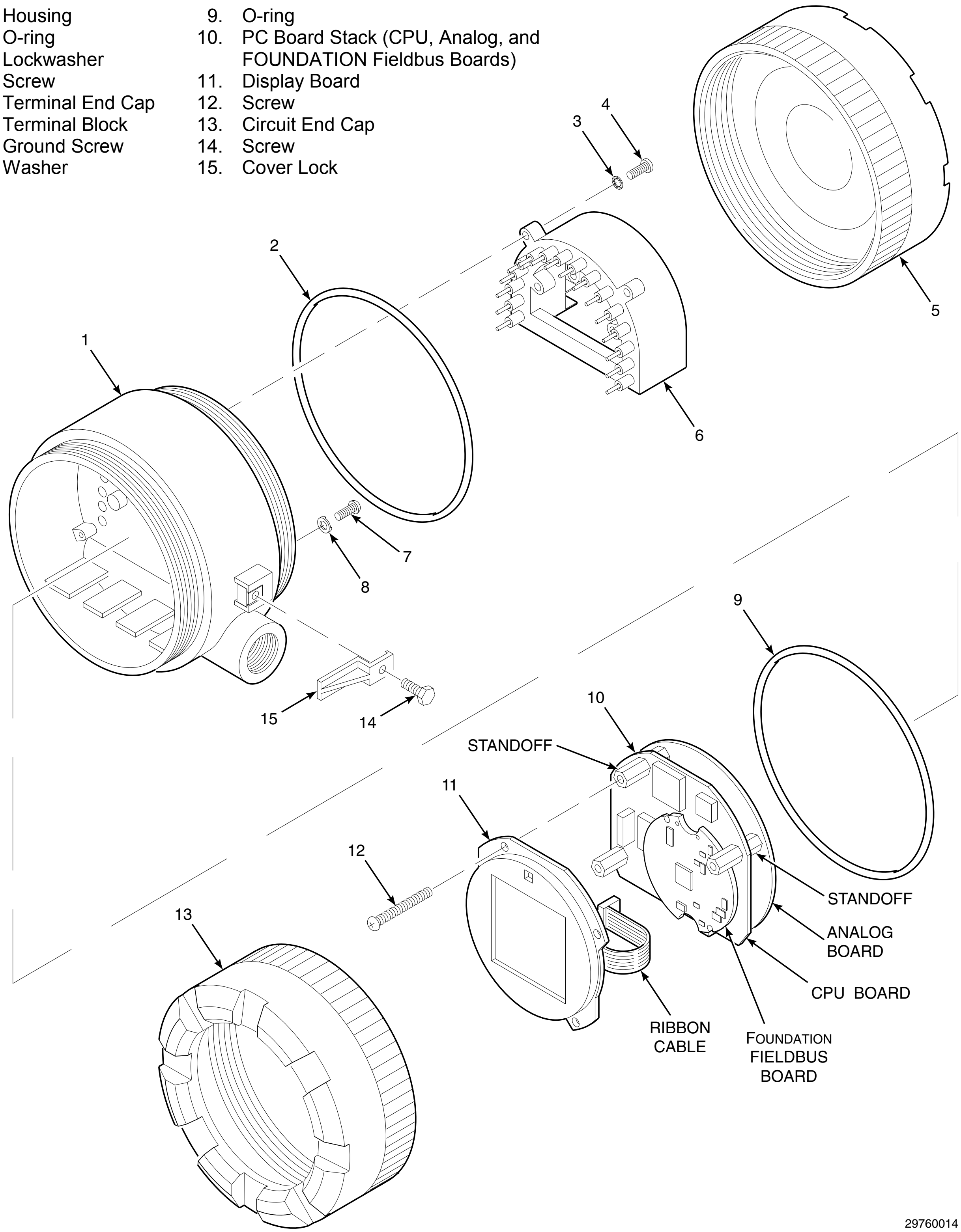


Figure 5-1. Two-Wire In Situ Oxygen Analyzer Exploded View

SECTION 5
MAINTENANCE AND SERVICE

WARNING

Install all protective equipment covers and safety ground leads after equipment repair or service. Failure to install covers and ground leads could result in serious injury or death.

WARNING

Disconnect and lock out power before working on any electrical components.

5-1 MODEL 4081 ELECTRONICS REPLACEMENT

Before replacing any electronic components, verify that the power to the Model 4081 Transmitter is removed. Refer to Table 8-1 for replacement part numbers.

a. Display Board Replacement

Use the following procedure to replace display board (11, Figure 5-1).

1. Loosen screw (14) until cover lock (15) disengages from the knurled surface of circuit end cap (13).
2. Remove circuit end cap (13).
3. Remove three screws (12) retaining the electronics in place.
4. Lift display board (11) and disconnect the ribbon cable connector between the display board and the CPU board of PC board stack (10).
5. Using a replacement display board, connect the ribbon cable connector between the display board and the CPU board of PC board stack (10). Ensure the cable connector is fully seated.
6. Reposition display board (11) on the standoffs. Rotate the display board 90 degrees either way as desired.
7. Install and tighten all three screws (12).
8. Install circuit end cap (13).
9. Tighten cover lock screw (14) until cover lock (15) engages knurled surface of circuit end cap (13).

b. PC Board Stack Replacement

PC board stack (10, Figure 5-1) is composed of the CPU board and the analog board. Use the following procedure to replace these boards as a set.

1. Loosen cover lock screw (14) until cover lock (15) disengages from the knurled surface of circuit end cap (13).
2. Remove circuit end cap (13). Remove three screws (12).
3. Lift display board (11) and disconnect the ribbon cable connector between the display board and the CPU board of PC board stack (10).
4. Lift the CPU board from housing (1) by the standoffs.
5. Remove two screws (4) and lockwashers (3). Lift terminal block (6) until the analog board is unplugged from the terminal board.
6. Reinstall terminal block (6), lockwashers (3), and screws (4).
7. Lift the analog board from housing (1) by the standoffs.

8. Install replacement PC board stack (10) into housing (1). Carefully seat the analog board onto housing pins. Press firmly on the CPU board standoffs to ensure good contact.

9. Connect the ribbon cable connector between display board (11) and the CPU board of PC board stack (10). Ensure the cable connector is fully seated.

10. Reposition display board (11) on the standoffs. Rotate the display board 90 degrees either way as desired.

11. Install and tighten all three screws (12) and circuit end cap (13).

12. Tighten cover lock screw (14) until cover lock (15) engages knurled surface of circuit end cap (13).

WARNING

Use heat resistant gloves and clothing when removing the probe. The probe can be as hot as 1600°C (2912°F). This can cause severe burns.

5-2 OXYGEN PROBE REPLACEMENT

The oxygen probe is designed with ceramic materials to provide maximum life at elevated temperatures and is not rebuildable. The condition of the sensing cell can be determined periodically by two methods:

- Note the cell impedance at the electronics. When the impedance displays a warning indication (WARN), increase the frequency of impedance readings. A cell with a sustained high impedance indication (HI) indicates a probe that is beyond its useful life.
- Conduct a calibration check. Follow the prompts provided by the electronics through the process of flowing two calibration check gases of known values. Record the generated slope and constant values.

Probe replacement may be conducted online as long as the process in which the probe is mounted is operating at a negative, or slightly positive, pressure. Refer to Section 6, TROUBLESHOOTING, for more information.

WARNING

Do not install or remove probes from a process where pressures are more than a few inches of H_2O positive pressure. Hot gases may escape from the stack and cause severe personal injury.

CAUTION

Do not insert or withdraw a probe into or out of a hot process faster than 1 in. (25.4 mm) per minute or instrument damage from thermal shock may occur.

Also, ash, slag, or other materials can build up on the probe body in some applications. If this buildup is causing difficulty when withdrawing the probe, DO NOT FORCE. Rotate the probe back and forth to attempt to loosen the material on the probe body. Or, wait until the process cools down and access the buildup from inside the furnace.

Refer to Table 8-1 for replacement probe part numbers. Before replacing the probe, verify that the reference air and calibration check gas lines are turned off and disconnected from the probe.

a. Remove the end cap of the probe to expose the terminal block.

b. Refer to Figure 5-2. Disconnect the four wires (two oxygen signal wires and two thermocouple wires) from the terminal block.

c. Disconnect the reference air and the calibration check gas lines.

d. Unscrew the probe from the stack and remove.

e. Using a replacement probe, refer to paragraph 2-2c for mechanical installation instructions.

f. Refer to paragraph 2-3b for electrical installation instructions.

g. Refer to paragraph 2-4 for reference air and calibration check gas installation instructions.

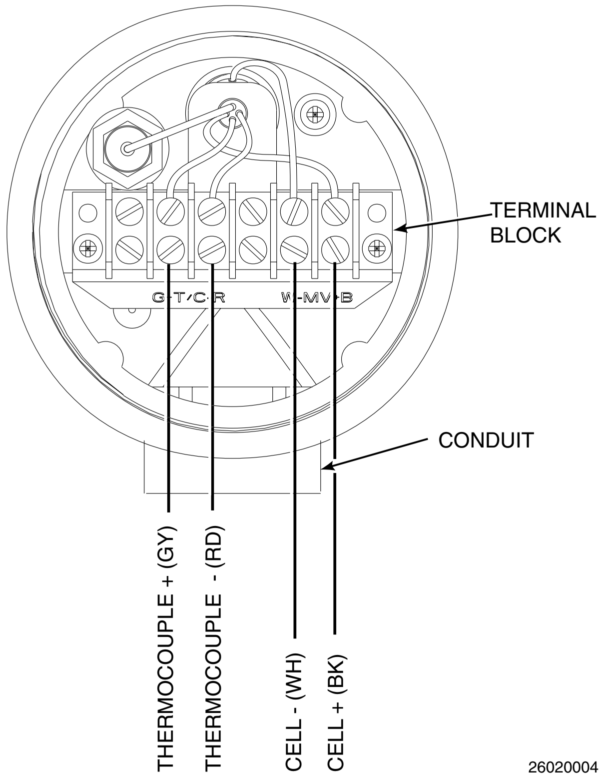


Figure 5-2. Oxygen Probe Terminal Block

5

SECTION 6
TROUBLESHOOTING

> **WARNING**
>
> **Install all protective equipment covers and safety ground leads after troubleshooting. Failure to install covers and ground leads could result in serious injury or death.**

6-1 GENERAL

This troubleshooting section describes how to identify and isolate faults that may develop in the Two-Wire In Situ Oxygen Analyzer.

6-2 PROBE LIFE

The zirconium oxide technology for measuring oxygen is very stable and should provide accurate service for several years.

Life of the probe is negatively impacted by:

- Continued operation at elevated temperatures above 1300°C (2372°F).
- Operation in processes that contain high levels of sulfur, SO_2, or other acidic compounds.

Operating conditions with simultaneously high levels of SO_2 and low levels of O_2 are particularly damaging.

The health and accuracy of a given cell is closely related to the resistance, or impedance, of the cell. Figure 6-1 illustrates that the amount of output from a cell for a given O_2 value (represented as slope) will remain very stable to the point where cell impedance increases to approximately 100 ohms.

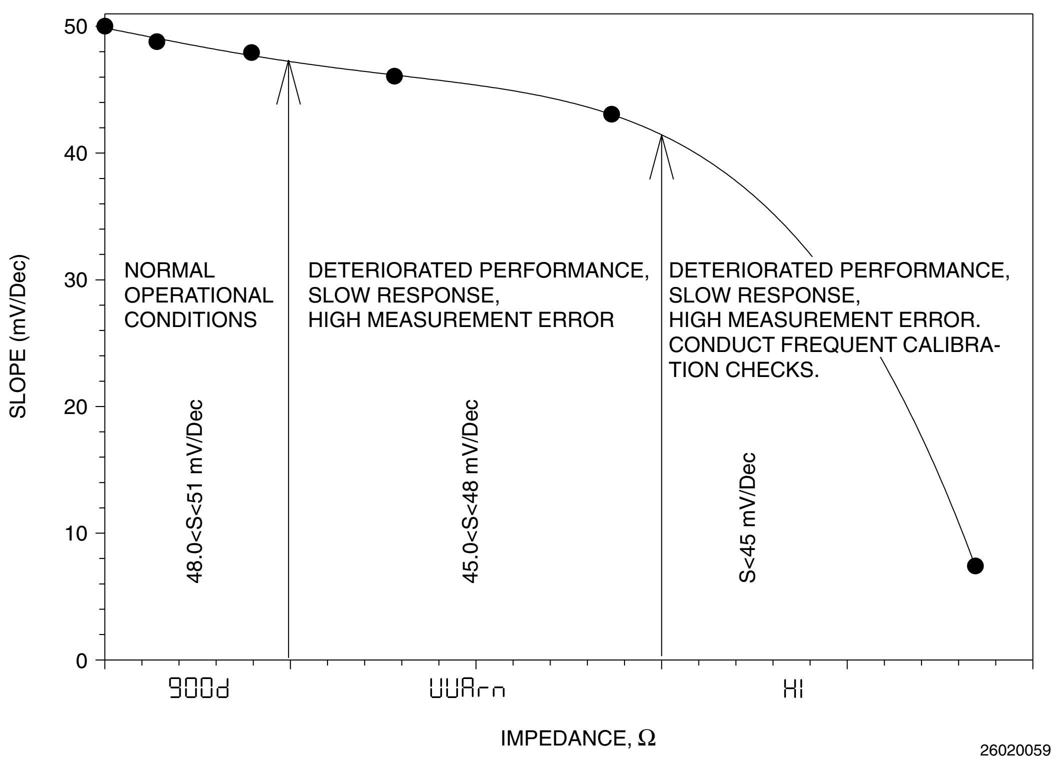


Figure 6-1. Slope vs. Impedance

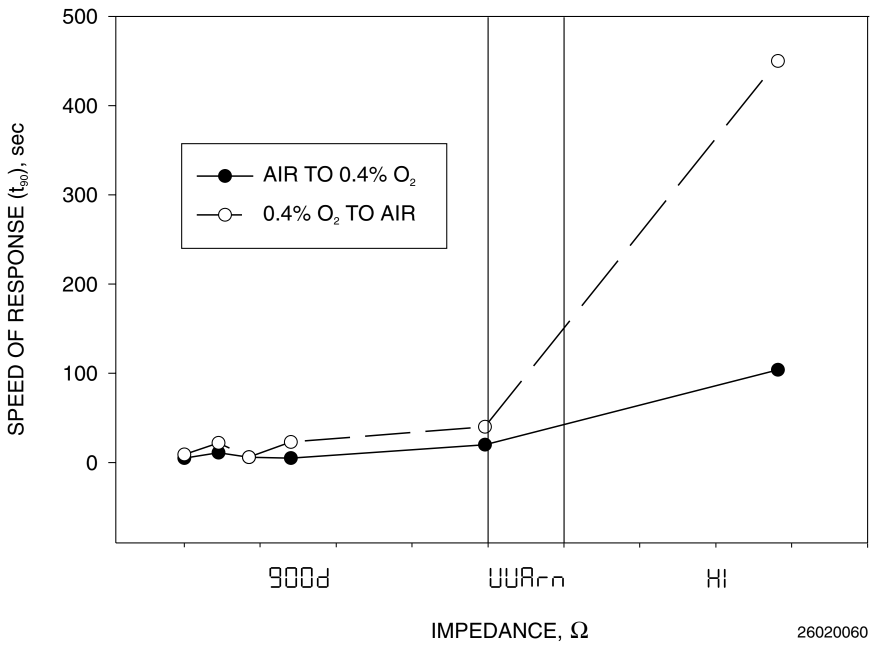


Figure 6-2. Speed of Response

Frequently conduct calibration checks to look for the following conditions:

- Continued degradation of cell slope.
- Sluggish response. (Note how long it takes the cell to respond to the application of calibration check gases.) See Figure 6-2.

The slope will be valid only for the process temperature at which the calibration check gases are flowed, so no adjustments to the electronics are made as a result of a calibration check.

Note that cells exposed to temperatures above 1300°C (2372°F) may lose the ability to measure accurately and respond quickly when returned to the lowest end of the operating temperature range [550°C (1022°F)].

6-3 FAULT INDICATIONS

The fault conditions for the Two-Wire In Situ Oxygen Analyzer will be indicated by the faulted operation display as shown in Figure 6-3. This screen displays when a fault that invalidates the O_2 reading is present. When the error is corrected, the screen will return to a normal operation display unless another error exists.

Figure 6-3. Faulted Operation Display

6-4 IDENTIFYING AND CORRECTING FAULT INDICATIONS

A fault in the operation of the Two-Wire In Situ Oxygen Analyzer is indicated by the faulted operation display. If no faults exist, the display will indicate NONE. Information on the current fault is found under the DIAGNOSTICS MENU as detailed in Section 4, OPERATION.

The following paragraphs describe the faults, possible causes, and corrective actions. Refer to Figure 6-4 as needed for test points and wiring information.

NOTE

Allow adequate time for the oxygen probe to reach its operating temperature [approximately 500°C (932°F)] before investigating a fault. The SHOW FAULTS screen of the DIAGNOSTICS menu will indicate a fault until the unit reaches operating temperature.

NOTE

The probe uses a Type B thermocouple to measure the cell temperature. A Type B thermocouple output table may be useful for troubleshooting.

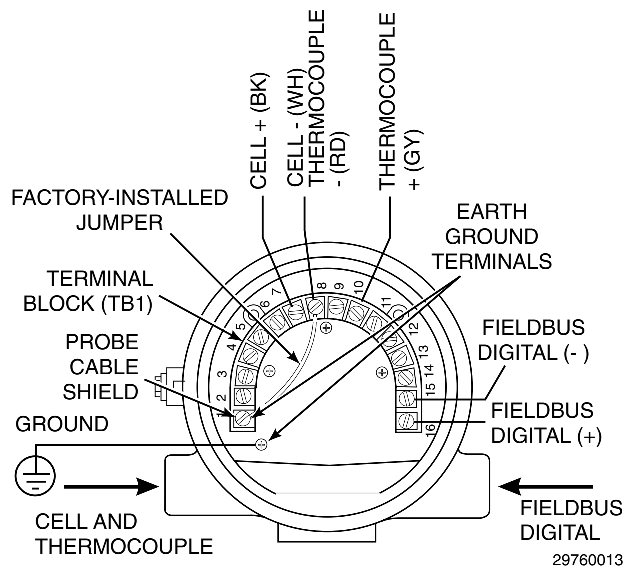


Figure 6-4. Model 4081 Transmitter Terminal Block

6

26020024

Figure 6-5. Fault 1, Open Thermocouple

a. Fault 1, Open Thermocouple

The thermocouple connection is open. The fault displays as shown in Figure 6-5.

1. Refer to Figure 6-4 and check the thermocouple wiring connections at terminals 8 and 10. Ensure the wires are properly connected.

2. Remove power. Disconnect the thermocouple wires (gray and red) from terminals 10 and 8. Measure the continuity across the gray and red thermocouple leads. The measurement should read approximately 1-2 ohms. Larger values indicate the thermocouple is open.

3. If the thermocouple is open, replace the oxygen probe per paragraph 5-2.

26020025

Figure 6-6. Fault 2, Reversed Thermocouple

b. Fault 2, Reversed Thermocouple Active

The thermocouple connections are reversed. The fault displays as shown in Figure 6-6.

1. Allow adequate time for the oxygen probe to reach operating temperatures. Probe temperatures below approximately 500°C (932°F) may result in this fault.

2. Refer to Figure 6-4. Check the gray (to terminal 10) and red (to terminal 8) wires for the proper placement.

3. Using a multimeter, measure between terminals 8(-) and 10(+). If the reading is negative, the thermocouple wiring is re-versed. Rewire as necessary.

4. If the wiring is correct and the probe is at operating temperature, then the transmitter electronics are bad. Replace the PC board stack assembly per paragraph 5-1.

Figure 6-7. Fault 3, Shorted Thermocouple

c. Fault 3, Shorted Thermocouple

The thermocouple connections are shorted. The fault displays as shown in Figure 6-7.

1. Allow adequate time for the oxygen probe to reach operating temperatures. Probe temperatures below approximately 500°C (932°F) may result in this fault.

2. Refer to Figure 6-4. Using a multimeter, measure between terminals 8(-) and 10(+).

3. If the multimeter reading, in voltage mode, is between -0.5 and +0.5 mV, the thermocouple is shorted.

4. If the thermocouple is shorted, replace the oxygen probe per paragraph 5-2.

5. If the thermocouple is not shorted, then replace the PC board stack assembly per paragraph 5-1.

Figure 6-8. Fault 4, High Probe Temperature

d. Fault 4, High Probe Temperature

The probe's temperature has exceeded the maximum cell temperature setpoint. The fault displays as shown in Figure 6-8.

1. If the probe temperature exceeds the maximum cell temperature setpoint, the FOUNDATION fieldbus signal will indicate a questionable O_2 level.

2. Verify that the upper cell temperature setpoint is configured as desired under the PROGRAM MENU (see Section 4, OPERATION).

Figure 6-9. Fault 5, O_2 Cell Open

Figure 6-10. Fault 6, Cell Impedance Too High

e. Fault 5, O_2 Cell Open

The O_2 cell connection is open. The fault displays as shown in Figure 6-9.

1. Allow adequate time for the oxygen probe to reach operating temperatures. Probe temperatures below approximately 500°C (932°F) may result in this fault.

2. Refer to Figure 6-4 and check the O_2 cell wiring connections at terminals 7 and 8. Ensure the wires are properly connected.

NOTE

Check the cell output voltage at the probe terminals -- not at the electronics.

3. Apply low calibration check gas (0.4% O_2). Measure the cell output from the O_2 cell wires at the probe terminal block. The cell output should be 100 ±20 mV. If no voltage can be measured, the cell is open.

4. If the O_2 cell is open, replace the oxygen probe per paragraph 5-2.

f. Fault 6, Cell Impedance Too High

The O_2 cell impedance has exceeded 100 ohms. The fault displays as shown in Figure 6-10.

1. This fault is usually indicated in conjunction with Fault 5, Cell Open. Correcting Fault 5 should correct Fault 6.

2. If Fault 6 appears independently, the cell has degraded beyond specification.

3. If the O_2 cell has become too old, replace the oxygen probe per paragraph 5-2.

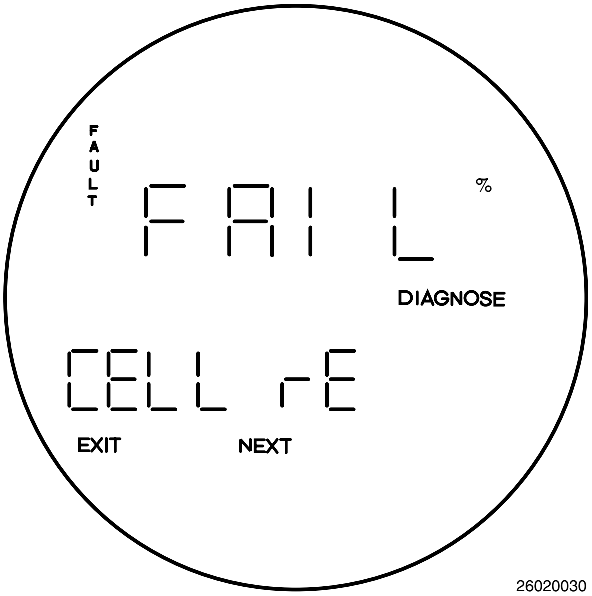


Figure 6-11. Fault 7, Reversed O_2 Cell

g. Fault 7, Reversed O_2 Cell

The O_2 cell connections are reversed. The fault displays as shown in Figure 6-11.

1. Refer to Figure 6-4. Check the black (to terminal 7) and white (to terminal 8) wires for the proper placement. Rewire if necessary.

2. Apply the low calibration check gas (0.4% O_2).

3. Using a multimeter, measure between terminals 7(+) and 8(-). If the cell output reading is negative, the O_2 cell wiring is reversed.

4. If the wiring is correct, check if the multimeter reading is the same as the reading shown on the O_2 CELL mV diagnostics screen (see Section 4, OPERATION).

5. If the reading is different, the transmitter electronics are faulty. Replace the PC board stack assembly per paragraph 5-1.

SECTION 7
RETURN OF MATERIAL

7-1 If factory repair of defective equipment is required, proceed as follows:

a. Secure a return authorization number from a Rosemount Analytical Sales Office or representative before returning the equipment. Equipment must be returned with complete identification in accordance with Rosemount instructions or it will not be accepted.

In no event will Rosemount be responsible for equipment returned without proper authorization and identification.

b. Carefully pack defective unit in a sturdy box with sufficient shock absorbing material to ensure that no additional damage will occur during shipping.

c. In a cover letter, describe completely:

1. The symptoms from which it was determined that the equipment is faulty.
2. The environment in which the equipment has been operating (housing, weather, vibration, dust, etc.).
3. Site from which equipment was removed.
4. Whether warranty or nonwarranty service is requested.
5. Complete shipping instructions for return of equipment.
6. Reference the return authorization number.

d. Enclose a cover letter and purchase order and ship the defective equipment according to instructions provided in Rosemount Return Authorization, prepaid, to:

Rosemount Analytical Inc.
RMR Department
1201 N. Main Street
Orrville, Ohio 44667

If warranty service is requested, the defective unit will be carefully inspected and tested at the factory. If failure was due to conditions listed in the standard Rosemount warranty, the defective unit will be repaired or replaced at Rosemount's option, and an operating unit will be returned to the customer in accordance with shipping instructions furnished in the cover letter.

For equipment no longer under warranty, the equipment will be repaired at the factory and returned as directed by the purchase order and shipping instructions.

SECTION 8
REPLACEMENT PARTS

Table 8-1. Replacement Parts List

Figure and Index No.	Part Number	Description
1-1, 2	1A99372H01	Model 4081 Transmitter CENELEC
1-1, 2	1A99372H02	Model 4081 Transmitter CSA
1-1, 2	1A99372H03	Model 4081 Transmitter FM
1-1, 3	5R10092G01	20” Replacement Oxygen Probe, with Alumina Outer Protection Tube
1-1, 3	5R10092G02	26” Replacement Oxygen Probe, with Alumina Outer Protection Tube
1-1, 3	5R10092G03	38” Replacement Oxygen Probe, with Alumina Outer Protection Tube
1-1, 3	5R10092G09	20” Replacement Oxygen Probe, with Inconel 600 Outer Protection Tube
1-1, 3	5R10092G010	26” Replacement Oxygen Probe, with Inconel 600 Outer Protection Tube
1-1, 3	5R10092G011	34.625” Replacement Oxygen Probe, with Inconel 600 Outer Protection Tube
6-1, 10	23811-03	PC Board Stack Assembly (CPU and Analog Boards) - FOUNDATION Fieldbus
6-1, 11	23652-01	Display Board
6-1, 6	23581-00	Terminal Block
6-1, 13	23593-01	Circuit End Cap (with Glass)

SECTION 9
APPENDICES

APPENDIX A. 4081FG TRANSDUCER BLOCK PARAMETER DESCRIPTION

APPENDIX B. ANALOG INPUT FUNCTION BLOCK

APPENDIX C. PID FUNCTION BLOCK

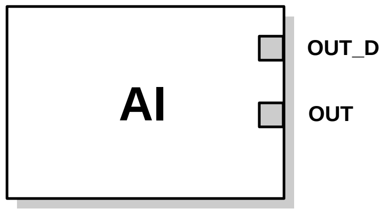
APPENDIX A
4081FG TRANSDUCER BLOCK PARAMETER DESCRIPTIONS

Parameter Mnemonic	Valid Range	Initial Value	Units	Description	Index Number
ALERT_KEY				See FF-891 section 5-3.	4
BLOCK_ALM				See FF-891 section 5-3.	8
BLOCK_ERR				See FF-891 section 5-3.	6
BUILD_DATE		0	N/A	This is the date that the 4081FG software was built.	43
BUILD_NUMBER	0-65445	27		The build number of the 4081FG software.	42
CAL_CONSTANT	±20.0		mV	This parameter represents the constant (offset) value calculated in the calibration check procedure.	21
CAL_MINIMUM_ SPAN				See FF-903 section 3-3. In the 4081FG, a calibration is used for checking the analyzer only. The calculation of the Primary Value is not effected.	18
CAL_POINT_HI	0.0-25.0		$\%O_2$	See FF-903 section 3-3. In the 4081FG, a calibration is used for checking the analyzer only. The calculation of the Primary Value is not effected.	16
CAL_POINT_LO	0.0-25.0		$\%O_2$	See FF-903 section 3-3. In the 4081FG, a calibration is used for checking the analyzer only. The calculation of the Primary Value is not effected.	17
CAL_SLOPE	34.5-57.5		mV/Decade	This parameter represents the slope value calculated during a calibration check procedure.	20
CAL_STATE	See Table 1	0	Enumerated	This parameter represents the present state the calibration check cycle is in. Refer to table 1 for the definition of states.	22
CAL_STEP	0: No effect 1: Go to next step 2: Abort procedure	0	Enumerated	This parameter is used to step the transmitter through a sensor calibration check. Setting this parameter to 1 requests the transmitter to move to the next cycle state of the calibration check procedure. The transmitter will set this parameter value back to 0 when it has completed processing the step request. Setting this parameter to a value of 2 will cause the present calibration to be aborted.	23
CAL_UNIT	See FF-903 section 4.10 Units Codes	1342 (%)	Enumerated	See FF-903 section 3-3. In the 4081FG, a calibration is used for checking the analyzer only. The calculation of the Primary Value is not effected.	19
COLLECTION_ DIRECTORY				See FF-891 section 5-3.	12
DETAILED_STATUS	See Table 4	0	Enumerated	This is a bit-enumerated value used to communicate the status of the 4081FG (This is similar in nature to the command 48 status bits in HART). See Table 5.	40
MODE_BLK				See FF-891 section 5-3.	5

Parameter Mnemonic	Valid Range	Initial Value	Units	Description	Index Number
PRIMARY_VALUE				See FF-903 section 3-3. In the 4081FG, this is the present $\%O_2$ reading and should reflect any test gas being applied.	14
PRIMARY_VALUE_ RANGE				See FF-903 section 3-3. In the 4081FG, this range is 0-40% and the number of displayable units is 2.	15
PRIMARY_VALUE_ TYPE	See section 4.1 in FF-903	65535 (other)	Enumerated	See FF-903 section 3-3 and 4-1. In the 4081FG, this parameter is fixed at a value of 1001(°C).	13
SECONDARY_VALUE				See FF-903 section 3-3. In the 4081FG, this is the temperature of the O_2 sensor. The value of the calculated O_2 value is dependent on this temperature along with the sensor raw mV value.	38
SECONDARY_ VALUE_UNIT	See section 4.1 in FF-903	01001 (°C)	Enumerated	See FF-903 section 3-3 and 4.10. In the 4081FG, this parameter is fixed at a value of 1001 (°C).	39
SENSOR_CAL_DATE				See FF-903 section 3-3.	30
SENSOR_CAL_LOC				See FF-903 section 3-3.	29
SENSOR_CAL_ METHOD				See FF-903 sections 3-3 and 4-5.	28
SENSOR_CAL_WHO				See FF-903 section 3-3.	31
SENSOR_FILTER_ VALUE	0-300	0	Sec	This is the filter value of the sensor. Valid range is 0-300 sec.	32
SENSOR_ IMPEDANCE	See Table		Enumerated	This is the status of the sensor impedance based on the last impedance measurement.	24
SENSOR_RANGE				See FF-903 section 3-3. In the 4081FG, this is the O_2 sensor 0-25%.	26
SENSOR_RAW_ MV_VALUE	±INF		mV	This is the raw signal from the O_2 sensor.	33
SENSOR_RAW_ TC_MV_VALUE	±INF		mV	This is the raw signal from the O_2 sensor ther-mocouple.	34
SENSOR_SN	0-4000000	0		See FF-903 section 3-3.	27
SENSOR_TEMP_ HIGH_ALARM	0-1600	1600	°C	This is the temperature of the sensor where the temperature too high alarm is set in detailed status.	37
SENSOR_TEMP_ MAXIMUM	-32k-32k		°C	The maximum temperature the sensor has been exposed to.	35
SENSOR_TEMP_ MAXIMUM_RESET	0 = Do Not Re-set 1 = Reset High	0		Reset Maximum Cell Temp to current temp.	36
SENSOR_TYPE	See FF-903 section 4.2 Transducer Types	65535 (ZrO2)	Enumerated	See FF-903 section 3-3 and 4-3.	25
ST_REV				See FF-891 section 5-3.	1

Parameter Mnemonic	Valid Range	Initial Value	Units	Description	Index Number
STATS_ATTEMPTS	0-16777215	0		Total number of messages sent to the transducer a/d board.	44
STATS_FAILURES	0-16777215	0		Total number of failed a/d board message attempts.	45
STATS_TIMEOUTS	0-16777215	0		Total number of timed out a/d board message attempts.	46
STRATEGY				See FF-891 section 5-3.	3
TAG_DESC				See FF-891 section 5-3.	2
TRANSDUCER_ DIRECTORY				See FF-903 section 3-3.	9
TRANSDUCER_TYPE				See FF-903 section 3-3.	10
UPDATE_EVT				See FF-891 section 5-3.	7
VERSION			N/A	This is the version of the 4081FG software.	41
XD_ERROR				See Table 5 and FF-903 section 3-3.	11

Appendix B Analog Input (AI) Function Block



OUT = The block output value and status
OUT_D = Discrete output that signals a selected alarm condition

The Analog Input (AI) function block processes field device measurements and makes them available to other function blocks. The output value from the AI block is in engineering units and contains a status indicating the quality of the measurement. The measuring device may have several measurements or derived values available in different channels. Use the channel number to define the variable that the AI block processes.

The AI block supports alarming, signal scaling, signal filtering, signal status calculation, mode control, and simulation. In Automatic mode, the block's output parameter (OUT) reflects the process variable (PV) value and status. In Manual mode, OUT may be set manually. The Manual mode is reflected on the output status. A discrete output (OUT_D) is provided to indicate whether a selected alarm condition is active. Alarm detection is based on the OUT value and user specified alarm limits. Figure B-1 on page B-4 illustrates the internal components of the AI function block, and Table B-1 lists the AI block parameters and their units of measure, descriptions, and index numbers.

TABLE B-1. Definitions of Analog Input Function Block System Parameters.

Parameter	Index Number	Units	Description
ACK_OPTION	23	None	Used to set auto acknowledgment of alarms.
ALARM_HYS	24	Percent	The amount the alarm value must return within the alarm limit before the associated active alarm condition clears.
ALARM_SEL	38	None	Used to select the process alarm conditions that will cause the OUT_D parameter to be set.
ALARM_SUM	22	None	The summary alarm is used for all process alarms in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status parameter. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
ALERT_KEY	04	None	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.

Parameter	Index Number	Units	Description
BLOCK_ALM	21	None	The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status parameter. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
BLOCK_ERR	06	None	This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string, so that multiple errors may be shown.
CHANNEL	15	None	The CHANNEL value is used to select the measurement value. Refer to the appropriate device manual for information about the specific channels available in each device. You must configure the CHANNEL parameter before you can configure the XD_SCALE parameter.
FIELD_VAL	19	Percent	The value and status from the transducer block or from the simulated input when simulation is enabled.
GRANT_DENY	12	None	Options for controlling access of host computers and local control panels to operating, tuning, and alarm parameters of the block. Not used by device.
HI_ALM	34	None	The HI alarm data, which includes a value of the alarm, a timestamp of occurrence and the state of the alarm.
HI_HI_ALM	33	None	The HI HI alarm data, which includes a value of the alarm, a timestamp of occurrence and the state of the alarm.
HI_HI_LIM	26	EU of PV_SCALE	The setting for the alarm limit used to detect the HI HI alarm condition.
HI_HI_PRI	25	None	The priority of the HI HI alarm.
HI_LIM	28	EU of PV_SCALE	The setting for the alarm limit used to detect the HI alarm condition.
HI_PRI	27	None	The priority of the HI alarm.
IO_OPTS	13	None	Allows the selection of input/output options used to alter the PV. Low cutoff enabled is the only selectable option.
L_TYPE	16	None	Linearization type. Determines whether the field value is used directly (Direct), is converted linearly (Indirect), or is converted with the square root (Indirect Square Root).
LO_ALM	35	None	The LO alarm data, which includes a value of the alarm, a timestamp of occurrence and the state of the alarm.
LO_LIM	30	EU of PV_SCALE	The setting for the alarm limit used to detect the LO alarm condition.
LO_LO_ALM	36	None	The LO LO alarm data, which includes a value of the alarm, a timestamp of occurrence and the state of the alarm.
LO_LO_LIM	32	EU of PV_SCALE	The setting for the alarm limit used to detect the LO LO alarm condition.
LO_LO_PRI	31	None	The priority of the LO LO alarm.
LO_PRI	29	None	The priority of the LO alarm.
LOW_CUT	17	%	If percentage value of transducer input fails below this, PV = 0.
MODE_BLK	05	None	The actual, target, permitted, and normal modes of the block. Target: The mode to “go to” Actual: The mode the “block is currently in” Permitted: Allowed modes that target may take on Normal: Most common mode for target
OUT	08	EU of OUT_SCALE	The block output value and status.
OUT_D	37	None	Discrete output to indicate a selected alarm condition.
OUT_SCALE	11	None	The high and low scale values, engineering units code, and number of digits to the right of the decimal point associated with OUT.
PV	07	EU of XD_SCALE	The process variable used in block execution.

Parameter	Index Number	Units	Description
PV_FTIME	18	Seconds	The time constant of the first-order PV filter. It is the time required for a 63% change in the IN value.
SIMULATE	09	None	A group of data that contains the current transducer value and status, the simulated transducer value and status, and the enable/disable bit.
STRATEGY	03	None	The strategy field can be used to identify grouping of blocks. This data is not checked or processed by the block.
ST_REV	01	None	The revision level of the static data associated with the function block. The revision value will be incremented each time a static parameter value in the block is changed.
TAG_DESC	02	None	The user description of the intended application of the block.
UPDATE_EVT	20	None	This alert is generated by any change to the static data.
VAR_INDEX	39	% of OUT Range	The average absolute error between the PV and its previous mean value over that evaluation time defined by VAR_SCAN.
VAR_SCAN	40	Seconds	The time over which the VAR_INDEX is evaluated.
XD_SCALE	10	None	The high and low scale values, engineering units code, and number of digits to the right of the decimal point associated with the channel input value. The XD_SCALE units code must match the units code of the measurement channel in the transducer block. If the units do not match, the block will not transition to MAN or AUTO

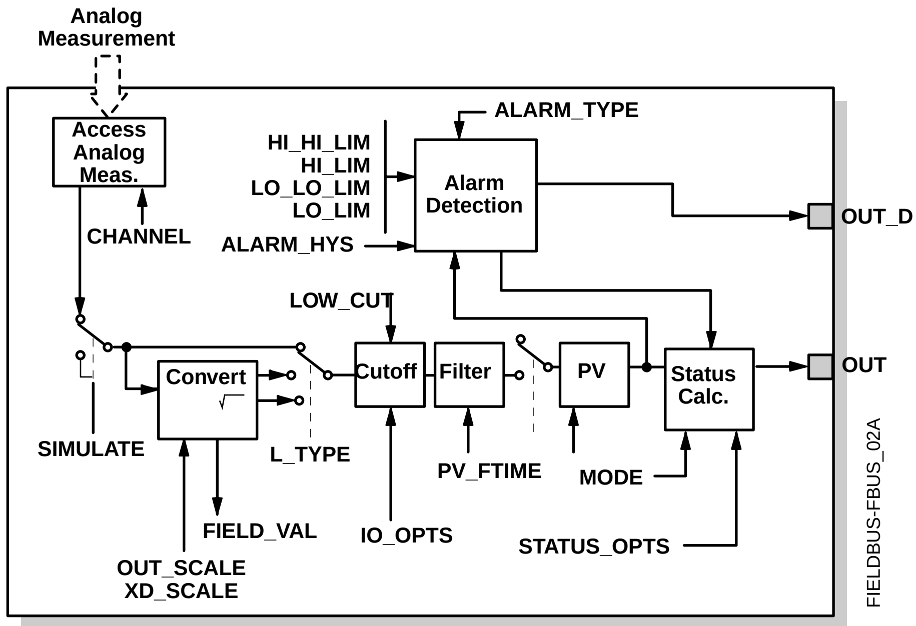
Simulation

To support testing, you can either change the mode of the block to manual and adjust the output value, or you can enable simulation through the configuration tool and manually enter a value for the measurement value and its status. In both cases, you must first set the ENABLE jumper on the field device.

NOTE
All fieldbus instruments have a simulation jumper. As a safety measure, the jumper has to be reset every time there is a power interruption. This measure is to prevent devices that went through simulation in the staging process from being installed with simulation enabled.

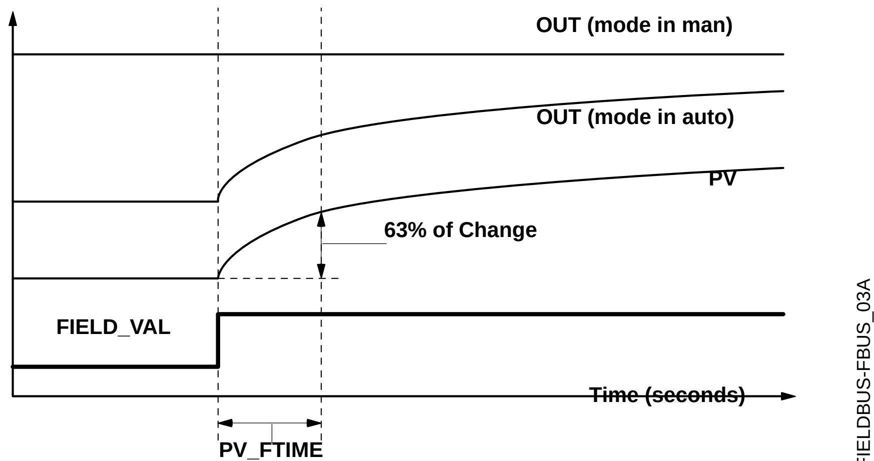
With simulation enabled, the actual measurement value has no impact on the OUT value or the status.

FIGURE B-1. Analog Input Function Block Schematic.



NOTES:
OUT = block output value and status.
OUT_D = discrete output that signals a selected alarm condition.

FIGURE B-2. Analog Input Function Block Timing Diagram.



Filtering

The filtering feature changes the response time of the device to smooth variations in output readings caused by rapid changes in input. You can adjust the filter time constant (in seconds) using the PV_FTIME parameter. Set the filter time constant to zero to disable the filter feature.

B

Signal Conversion

You can set the signal conversion type with the Linearization Type (L_TYPE) parameter. You can view the converted signal (in percent of XD_SCALE) through the FIELD_VAL parameter.

$$\text{FIELD\_VAL} = \frac{100 \times (\text{Channel Value} - \text{EU*@0\%})}{(\text{EU*@100\%} - \text{EU*@0\%})}$$

*** XD_SCALE values**

You can choose from direct, indirect, or indirect square root signal conversion with the L_TYPE parameter.

Direct

Direct signal conversion allows the signal to pass through the accessed channel input value (or the simulated value when simulation is enabled).

$$\text{PV} = \text{Channel Value}$$

Indirect

Indirect signal conversion converts the signal linearly to the accessed channel input value (or the simulated value when simulation is enabled) from its specified range (XD_SCALE) to the range and units of the PV and OUT parameters (OUT_SCALE).

$$\text{PV} = \left(\frac{\text{FIELD\_VAL}}{100}\right) \times (\text{EU**@100\%} - \text{EU**@0\%}) + \text{EU**@0\%}$$

**** OUT_SCALE values**

Indirect Square Root

Indirect Square Root signal conversion takes the square root of the value computed with the indirect signal conversion and scales it to the range and units of the PV and OUT parameters.

$$\text{PV} = \sqrt{\left(\frac{\text{FIELD\_VAL}}{100}\right)} \times (\text{EU**@100\%} - \text{EU**@0\%}) + \text{EU**@0\%}$$

**** OUT_SCALE values**

When the converted input value is below the limit specified by the LOW_CUT parameter, and the Low Cutoff I/O option (IO_OPTS) is enabled (True), a value of zero is used for the converted value (PV). This option is useful to eliminate false readings when the differential pressure measurement is close to zero, and it may also be useful with zero-based measurement devices such as flowmeters.

NOTE
Low Cutoff is the only I/O option supported by the AI block. You can set the I/O option in **Manual** or **Out of Service** mode only.

Block Errors

Table B-2 lists conditions reported in the BLOCK_ERR parameter. Conditions in *italics* are inactive for the AI block and are given here only for your reference.

TABLE B-2. BLOCK_ERR Conditions.

Condition Number	Condition Name and Description
0	*Other*
1	**Block Configuration Error:** the selected channel carries a measurement that is incompatible with the engineering units selected in XD_SCALE, the L_TYPE parameter is not configured, or CHANNEL = zero.
2	*Link Configuration Error*
3	**Simulate Active:** Simulation is enabled and the block is using a simulated value in its execution.
4	*Local Override*
5	*Device Fault State Set*
6	*Device Needs Maintenance Soon*
7	**Input Failure/Process Variable has Bad Status:** The hardware is bad, or a bad status is being simulated.
8	**Output Failure:** The output is bad based primarily upon a bad input.
9	*Memory Failure*
10	*Lost Static Data*
11	*Lost NV Data*
12	*Readback Check Failed*
13	*Device Needs Maintenance Now*
14	*Power Up*
15	**Out of Service:** The actual mode is out of service.

Modes

The AI Function Block supports three modes of operation as defined by the MODE_BLK parameter:

- **Manual (Man)** The block output (OUT) may be set manually
- **Automatic (Auto)** OUT reflects the analog input measurement or the simulated value when simulation is enabled.
- **Out of Service (O/S)** The block is not processed. FIELD_VAL and PV are not updated and the OUT status is set to Bad: Out of Service. The BLOCK_ERR parameter shows Out of Service. In this mode, you can make changes to all configurable parameters. The target mode of a block may be restricted to one or more of the supported modes.

Alarm Detection

A block alarm will be generated whenever the BLOCK_ERR has an error bit set. The types of block error for the AI block are defined above.

Process Alarm detection is based on the OUT value. You can configure the alarm limits of the following standard alarms:

- High (HI_LIM)
- High high (HI_HI_LIM)
- Low (LO_LIM)
- Low low (LO_LO_LIM)

In order to avoid alarm chattering when the variable is oscillating around the alarm limit, an alarm hysteresis in percent of the PV span can be set using the ALARM_HYS parameter. The priority of each alarm is set in the following parameters:

- HI_PRI
- HI_HI_PRI
- LO_PRI
- LO_LO_PRI

Alarms are grouped into five levels of priority:

Priority Number	Priority Description
0	The priority of an alarm condition changes to) after the condition that caused the alarm is corrected.
1	An alarm condition with a priority of 1 is recognized by the system, but is not reported to the operator.
2	An alarm condition with a priority of 2 is reported to the operator, but does not require operator attention (such as diagnostics and system alerts).
3-7	Alarm conditions of priority 3 to 7 are advisory alarms of increasing priority.
8-15	Alarm conditions of priority 8 to 15 are critical alarms of increasing priority.

Status Handling

Normally, the status of the PV reflects the status of the measurement value, the operating condition of the I/O card, and any active alarm condition. In Auto mode, OUT reflects the value and status quality of the PV. In Man mode, the OUT status constant limit is set to indicate that the value is a constant and the OUT status is *Good*.

The **Uncertain -** EU range violation status is always set, and the PV status is set high- or low-limited if the sensor limits for conversion are exceeded.

In the STATUS_OPTS parameter, you can select from the following options to control the status handling:

BAD if Limited – sets the OUT status quality to *Bad* when the value is higher or lower than the sensor limits.

Uncertain if Limited – sets the OUT status quality to *Uncertain* when the value is higher or lower than the sensor limits.

Uncertain if in Manual mode – The status of the Output is set to *Uncertain* when the mode is set to Manual

NOTES

1. The instrument must be in **Manual** or **Out of Service** mode to set the status option.
2. The AI block only supports the **BAD if Limited** option. Unsupported options are not grayed out; they appear on the screen in the same manner as supported options.

Advanced Features

The AI function block provided with Fisher-Rosemount fieldbus devices provides added capability through the addition of the following parameters:

ALARM_TYPE – Allows one or more of the process alarm conditions detected by the AI function block to be used in setting its OUT_D parameter.

OUT_D – Discrete output of the AI function block based on the detection of process alarm condition(s). This parameter may be linked to other function blocks that require a discrete input based on the detected alarm condition.

VAR_SCAN – Time period in seconds over which the variability index (VAR_INDEX) is computed.

VAR_INDEX – Process variability index measured as the integral of average absolute error between PV and its mean value over the previous evaluation period. This index is calculated as a percent of OUT span and is updated at the end of the time period defined by VAR_SCAN.

Application Information

The configuration of the AI function block and its associated output channels depends on the specific application. A typical configuration for the AI block involves the following parameters:

CHANNEL If the device supports more than one measurement, verify that the selected channel contains the appropriate measurement or derived value.

L_TYPE Select **Direct** when the measurement is already in the engineering units that you want for the block output.

Select **Indirect** when you want to convert the measured variable into another, for example, pressure into level or flow into energy.

Select **Indirect Square Root** when the block I/O parameter value represents a flow measurement made using differential pressure, and when square root extraction is not performed by the transducer.

SCALING **XD_SCALE** provides the range and units of the measurement and **OUT_SCALE** provides the range and engineering units of the output.

Application Example: Temperature Transmitter

Situation

A temperature transmitter with a range of –200 to 450 ˚C.

Solution

Table B-3 lists the appropriate configuration settings, and Figure B-3 illustrates the correct function block configuration.

TABLE B-3. Analog Input Function Block Configuration for a Typical Temperature Transmitter.

Parameter	Configured Values
L_TYPE	Direct
XD_SCALE	Not Used
OUT_SCALE	Not Used

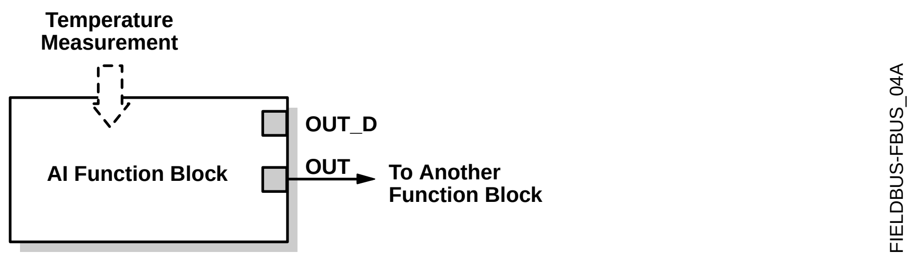


FIGURE B-3. Analog Input Function Block Diagram for a Typical Temperature Transmitter.

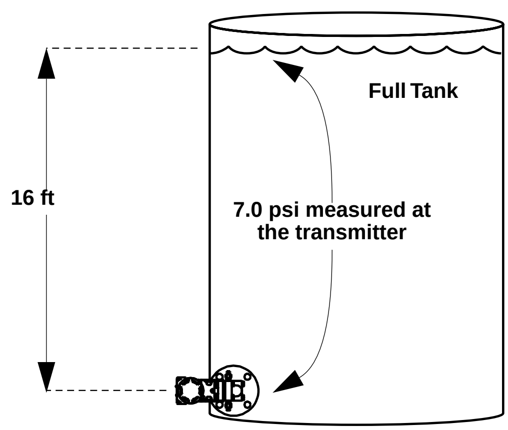
B

Application Example: Pressure Transmitter used to Measure Level in an Open Tank

Situation #1

The level of an open tank is to be measured using a pressure tap at the bottom of the tank. The level measurement will be used to control the level of liquid in the tank. The maximum level at the tank is 16 ft. The liquid in the tank has a density that makes the level correspond to a pressure of 7.0 psi at the pressure tap (see Figure B-4).

FIGURE B-4. Situation #1 Diagram.



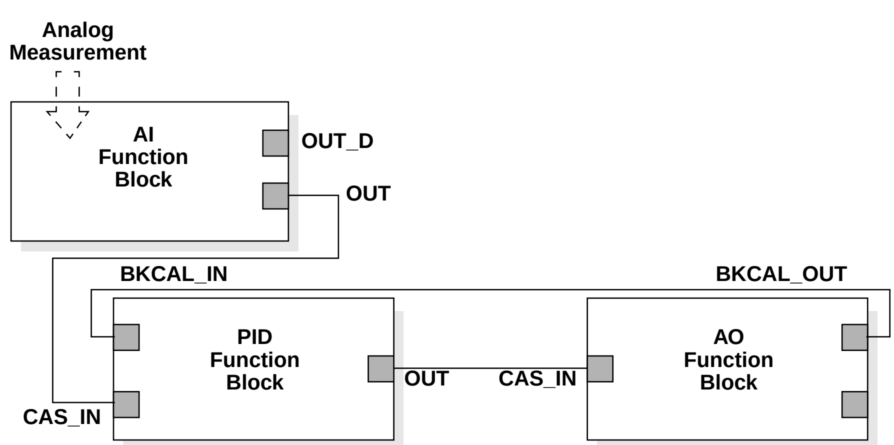
Solution to Situation #1

Table B-4 lists the appropriate configuration settings, and Figure B-5 illustrates the correct function block configuration.

TABLE B-4. Analog Input Function Block Configuration for a Pressure Transmitter used in Level Measurement (situation #1).

Parameter	Configured Values
L_TYPE	Indirect
XD_SCALE	0 to 7 psi
OUT_SCALE	0 to 16 ft

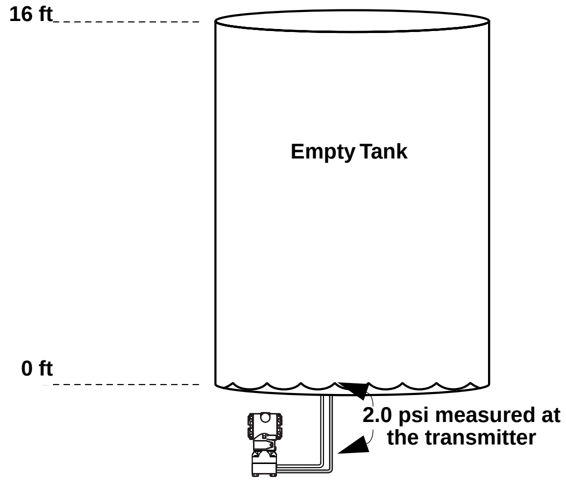
FIGURE B-5. Function Block Diagram for a Pressure Transmitter used in Level Measurement.



Situation #2

The transmitter in situation #1 is installed below the tank in a position where the liquid column in the impulse line, when the tank is empty, is equivalent to 2.0 psi (see Figure B-6).

FIGURE B-6. Situation #2 Diagram.



Solution

Table B-5 lists the appropriate configuration settings.

TABLE B-5. Analog Input Function Block Configuration for a Pressure Transmitter used in Level Measurement (Situation #2).

Parameter	Configured Values
L_TYPE	Indirect
XD_SCALE	2 to 9 psi
OUT_SCALE	0 to 16 ft

Application Example: Differential Pressure Transmitter to Measure Flow

Situation

The liquid flow in a line is to be measured using the differential pressure across an orifice plate in the line, and the flow measurement will be used in a flow control loop. Based on the orifice specification sheet, the differential pressure transmitter was calibrated for 0 to 20 inH_20 for a flow of 0 to 800 gal/min, and the transducer was not configured to take the square root of the differential pressure.

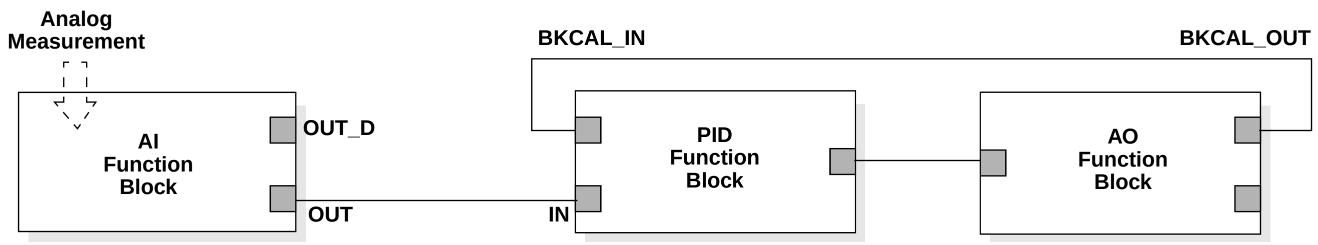
Solution

Table B-6 lists the appropriate configuration settings, and Figure B-7 illustrates the correct function block configuration.

TABLE B-6. Analog Input Function Block Configuration for a Differential Pressure Transmitter.

Parameter	Configured Values
L_TYPE	Indirect Square Root
XD_SCALE	0 to 20 in.
OUT_SCALE	0 to 800 gal/min.

FIGURE B-7. Function Block Diagram for a Differential Pressure Transmitter Used in a Flow Measurement.



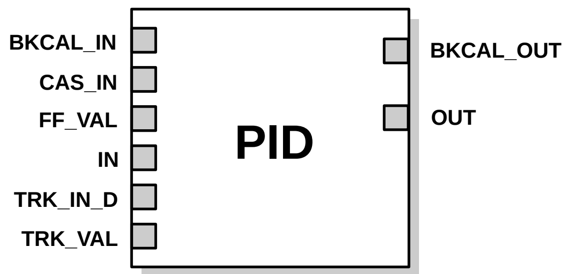
Troubleshooting

Refer to Table B-7 to troubleshoot any problems that you encounter.

TABLE B-7. Troubleshooting.

Symptom	Possible Causes	Corrective Action
Mode will not leave OOS	1. Target mode not set.	1. Set target mode to something other than OOS.
	2. Configuration error	2. BLOCK_ERR will show the configuration error bit set. The following are parameters that must be set before the block is allowed out of OOS: a. CHANNEL must be set to a valid value and cannot be left at initial value of 0. b. XD_SCALE.UNITS_INDX must match the units in the transducer block channel value. c. L_TYPE must be set to Direct, Indirect, or Indirect Square Root and cannot be left at initial value of 0.
	3. Resource block	3. The actual mode of the Resource block is OOS. See Resource Block Diagnostics for corrective action.
	4. Schedule	4. Block is not scheduled and therefore cannot execute to go to Target Mode. Schedule the block to execute.
Process and/or block alarms will not work.	1. Features	1. FEATURES_SEL does not have Alerts enabled. Enable the Alerts bit.
	2. Notification	2. LIM_NOTIFY is not high enough. Set equal to MAX_NOTIFY.
	3. Status Options	3. STATUS_OPTS has Propagate Fault Forward bit set. This should be cleared to cause an alarm to occur.
Value of output does not make sense	1. Linearization Type	1. L_TYPE must be set to Direct, Indirect, or Indirect Square Root and cannot be left at initial value of 0.
	2. Scaling	2. Scaling parameters are set incorrectly: a. XD_SCALE.EU0 and EU100 should match that of the transducer block channel value. b. OUT_SCALE.EU0 and EU100 are not set properly.
Cannot set HI_LIMIT, HI_HI_LIMIT, LO_LIMIT, or LO_LO_LIMIT Values	1. Scaling	1. Limit values are outside the OUT_SCALE.EU0 and OUT_SCALE.EU100 values. Change OUT_SCALE or set values within range.

PID Function Block



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BKCAL_IN = **The analog input value and status from another block's BKCAL_OUT output that is used for backward output tracking for bumpless transfer and to pass limit status.**

CAS_IN = **The remote setpoint value from another function block.**

FF_VAL = **The feedforward control input value and status.**

IN = **The connection for the process variable from another function block.**

TRK_IN_D = **Initiates the external tracking function.**

TRK_VAL = **The value after scaling applied to OUT in Local Override mode.**

BKCAL_OUT = **The value and status required by the BKCAL_IN input of another function block to prevent reset windup and to provide bumpless transfer to closed loop control.**

OUT = **The block output and status.**

The PID function block combines all of the necessary logic to perform proportional/integral/derivative (PID) control. The block supports mode control, signal scaling and limiting, feedforward control, override tracking, alarm limit detection, and signal status propagation.

The block supports two forms of the PID equation: Standard and Series. You can choose the appropriate equation using the FORM parameter. The Standard ISA PID equation is the default selection.

$$\text{Standard Out} = \text{GAIN} \times \text{e} \times \left(1 + \frac{1}{\tau_r s + 1} + \frac{\tau_d s}{\alpha \times \tau_d s + 1}\right) + F$$

$$\text{Series Out} = \text{GAIN} \times \text{e} \times \left[\left(1 + \frac{1}{\tau_r s}\right) + \left(\frac{\tau_d s + 1}{\alpha \times \tau_d s + 1}\right)\right] + F$$

Where

GAIN: proportional gain value
τ_r: integral action time constant (RESET parameter) in seconds
s: laplace operator
τ_d: derivative action time constant (RATE parameter)
α: fixed smoothing factor of 0.1 applied to RATE
F: feedforward control contribution from the feedforward input (FF_VAL parameter)
e: error between setpoint and process variable

To further customize the block for use in your application, you can configure filtering, feedforward inputs, tracking inputs, setpoint and output limiting, PID equation structures, and block output action. Table C-1 lists the PID block parameters and their descriptions, units of measure, and index numbers, and Figure C-1 on page C-5 illustrates the internal components of the PID function block.

TABLE C-1. PID Function Block System Parameters.

Parameter	Index Number	Units	Description
ACK_OPTION	46	None	Used to set auto acknowledgment of alarms.
ALARM_HYS	47	Percent	The amount the alarm value must return to within the alarm limit before the associated active alarm condition clears.
ALARM_SUM	45	None	The summary alarm is used for all process alarms in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status parameter. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
ALERT_KEY	04	None	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
ALG_TYPE	74	None	Selects filtering algorithm as Backward or Bilinear.
BAL_TIME	25	Seconds	The specified time for the internal working value of bias to return to the operator set bias. Also used to specify the time constant at which the integral term will move to obtain balance when the output is limited and the mode is AUTO, CAS, or RCAS.
BIAS	66	EU of OUT_SCALE	The bias value used to calculate output for a PD type controller.
BKCAL_HYS	30	Percent	The amount the output value must change away from the its output limit before limit status is turned off.
BKCAL_IN	27	EU of OUT_SCALE	The analog input value and status from another block's BKCAL_OUT output that is used for backward output tracking for bumpless transfer and to pass limit status.
BKCAL_OUT	31	EU of PV_SCALE	The value and status required by the BKCAL_IN input of another block to prevent reset windup and to provide bumpless transfer of closed loop control.
BLOCK_ALM	44	None	The block alarm is used for all configuration, hardware, connection failure, or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the active status in the status parameter. As soon as the Unreported status is cleared by the alert reporting task, and other block alert may be reported without clearing the Active status, if the subcode has changed.
BLOCK_ERR	06	None	This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string so that multiple errors may be shown.
BYPASS	17	None	Used to override the calculation of the block. When enabled, the SP is sent directly to the output.
CAS_IN	18	EU of PV_SCALE	The remote setpoint value from another block.
CONTROL_OPTS	13	None	Allows you to specify control strategy options. The supported control options for the PID block are Track enable, Track in Manual, SP-PV Track in Man, SP-PV Track in LO or IMAN, Use PV for BKCAL OUT, and Direct Acting
DV_HI_ALM	64	None	The DV HI alarm data, which includes a value of the alarm, a timestamp of occurrence, and the state of the alarm.
DV_HI_LIM	57	EU of PV_SCALE	The setting for the alarm limit used to detect the deviation high alarm condition.
DV_HI_PRI	56	None	The priority of the deviation high alarm.

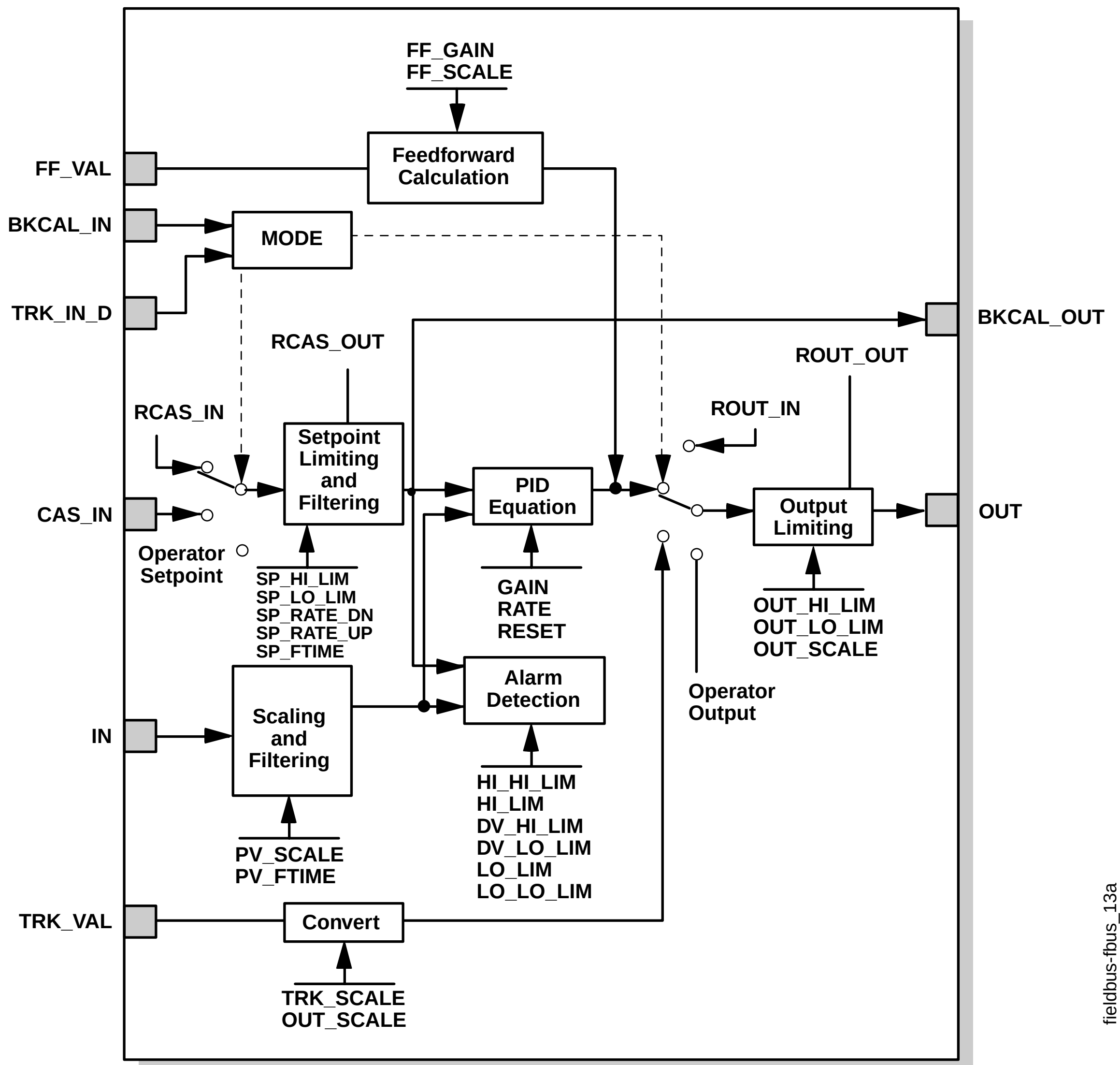
Parameter	Index Number	Units	Description
DV_LO_ALM	65	None	The DV LO alarm data, which includes a value of the alarm, a timestamp of occurrence, and the state of the alarm.
DV_LO_LIM	59	EU of PV_SCALE	The setting for the alarm limit use to detect the deviation low alarm condition.
DV_LO_PRI	58	None	The priority of the deviation low alarm.
ERROR	67	EU of PV_SCALE	The error (SP-PV) used to determine the control action.
FF_ENABLE	70	None	Enables the use of feedforward calculations
FF_GAIN	42	None	The feedforward gain value. FF_VAL is multiplied by FF_GAIN before it is added to the calculated control output.
FF_SCALE	41	None	The high and low scale values, engineering units code, and number of digits to the right of the decimal point associated with the feedforward value (FF_VAL).
FF_VAL	40	EU of FF_SCALE	The feedforward control input value and status.
GAIN	23	None	The proportional gain value. This value cannot = 0.
GRANT_DENY	12	None	Options for controlling access of host computers and local control panels to operating, tuning, and alarm parameters of the block. Not used by the device.
HI_ALM	61	None	The HI alarm data, which includes a value of the alarm, a timestamp of occurrence, and the state of the alarm.
HI_HI_ALM	60	None	The HI HI alarm data, which includes a value of the alarm, a timestamp of occurrence, and the state of the alarm.
HI_HI-LIM	49	EU of PV_SCALE	The setting for the alarm limit used to detect the HI HI alarm condition.
HI_HI_PRI	48	None	The priority of the HI HI Alarm.
HI_LIM	51	EU of PV_SCALE	The setting for the alarm limit used to detect the HI alarm condition.
HI_PRI	50	None	The priority of the HI alarm.
IN	15	EU of PV_SCALE	The connection for the PV input from another block.
LO_ALM	62	None	The LO alarm data, which includes a value of the alarm, a timestamp of occurrence, and the state of the alarm.
LO_LIM	53	EU of PV_SCALE	The setting for the alarm limit used to detect the LO alarm condition.
LO_LO_ALM	63	None	The LO LO alarm data, which includes a value of the alarm, a timestamp of occurrence, and the state of the alarm.
LO_LO_LIM	55	EU of PV_SCALE	The setting for the alarm limit used to detect the LO LO alarm condition.
LO_LO_PRI	54	None	The priority of the LO LO alarm.
LO_PRI	52	None	The priority of the LO alarm.
MATH_FORM	73	None	Selects equation form (series or standard).
MODE_BLK	05	None	The actual, target, permitted, and normal modes of the block. Target: The mode to “go to” Actual: The mode the “block is currently in” Permitted: Allowed modes that target may take on Normal: Most common mode for target
OUT	09	EU of OUT SCALE	The block input value and status.
OUT_HI_LIM	28	EU of OUT_SCALE	The maximum output value allowed.

C

Parameter	Index Number	Units	Description
OUT-LO_LIM	29	EU of OUT_SCALE	The minimum output value allowed
OUT_SCALE	11	None	The high and low scale values, engineering units code, and number of digits to the right of the decimal point associated with OUT.
PV	07	EU of PV_SCALE	The process variable used in block execution.
PV_FTIME	16	Seconds	The time constant of the first-order PV filter. It is the time required for a 63 percent change in the IN value.
PV_SCALE	10	None	The high and low scale values, engineering units code, and number of digits to the right of the decimal point associated with PV.
RATE	26	Seconds	The derivative action time constant.
RCAS_IN	32	EU of PV_SCALE	Target setpoint and status that is provided by a supervisory host. Used when mode is RCAS.
RCAS_OUT	35	EU of PV_SCALE	Block setpoint and status after ramping, filtering, and limiting that is provided to a supervisory host for back calculation to allow action to be taken under limiting conditions or mode change. Used when mode is RCAS.
RESET	24	Seconds per repeat	The integral action time constant.
ROUT_IN	33	EU of OUT_SCALE	Target output and status that is provided by a supervisory host. Used when mode is ROUT.
ROUT_OUT	36	EU of OUT_SCALE	Block output that is provided to a supervisory host for a back calculation to allow action to be taken under limiting conditions or mode change. Used when mode is RCAS.
SHED_OPT	34	None	Defines action to be taken on remote control device timeout.
SP	08	EU of PV_SCALE	The target block setpoint value. It is the result of setpoint limiting and setpoint rate of change limiting.
SP_FTIME	69	Seconds	The time constant of the first-order SP filter. It is the time required for a 63 percent change in the IN value.
SP_HI_LIM	21	EU of PV_SCALE	The highest SP value allowed.
SP_LO_LIM	22	EU of PV_SCALE	The lowest SP value allowed.
SP_RATE_DN	19	EU of PV_SCALE per second	Ramp rate for downward SP changes. When the ramp rate is set to zero, the SP is used immediately.
SP-RATE_UP	20	EU of PV_SCALE per second	Ramp rate for upward SP changes. When the ramp rate is set to zero, the SP is used immediately.
SP_WORK	68	EU of PV_SCALE	The working setpoint of the block after limiting and filtering is applied.
STATUS_OPTS	14	None	Allows you to select options for status handling and processing. The supported status option for the PID block is Target to Manual if Bad IN.
STRATEGY	03	None	The strategy field can be used to identify grouping of blocks. This data is not checked or processed by the block.
ST_REV	01	None	The revision level of the static data associated with the function block. The revision value will be incremented each time a static parameter value in the block is changed.
STRUCTURE. CONFIG	75	None	Defines PID equation structure to apply controller action.
TAG_DESC	02	None	The user description of the intended application of the block.
TRK_IN_D	38	None	Discrete input that initiates external tracking.

Parameter	Index Number	Units	Description
TRK_SCALE	37	None	The high and low scale values, engineering units code, and number of digits to the right of the decimal point associated with the external tracking value (TRK_VAL).
TRK_VAL	39	EU of TRK SCALE	The value (after scaling from TRK_SCALE to OUT_SCALE) applied to OUT in LO mode.
UBETA	72	Percent	Used to set disturbance rejection vs. tracking response action for a 2.0 degree of freedom PID.
UGAMMA	71	Percent	Used to set disturbance rejection vs. tracking response action for a 2.0 degree of freedom PID.
UPDATE_EVT	43	None	This alert is generated by any changes to the static data.

FIGURE C-1. PID Function Block Schematic.



Setpoint Selection and Limiting

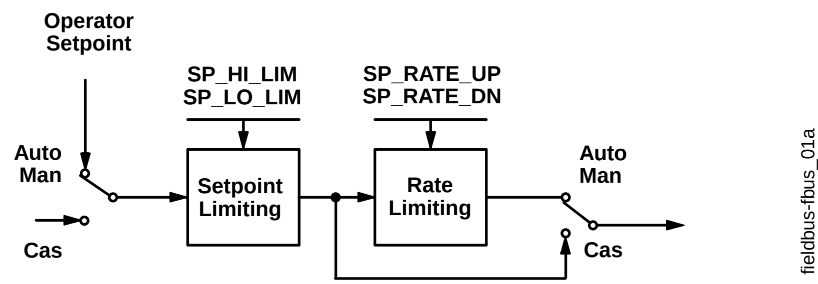
The setpoint of the PID block is determined by the mode. You can configure the SP_HI_LIM and SP_LO_LIM parameters to limit the setpoint. In **Cascade** or **RemoteCascade** mode, the setpoint is adjusted by another function block or by a host computer, and the output is computed based on the setpoint.

In **Automatic** mode, the setpoint is entered manually by the operator, and the output is computed based on the setpoint. In Auto mode, you can also adjust the setpoint limit and the setpoint rate of change using the SP_RATE_UP and SP_RATE_DN parameters.

In **Manual** mode the output is entered manually by the operator, and is independent of the setpoint. In **RemoteOutput** mode, the output is entered by a host computer, and is independent of the setpoint.

Figure C-2 illustrates the method for setpoint selection.

FIGURE C-2. PID Function Block Setpoint Selection.



Filtering

The filtering feature changes the response time of the device to smooth variations in output readings caused by rapid changes in input. You can configure the filtering feature with the FILTER_TYPE parameter, and you can adjust the filter time constant (in seconds) using the PV_FTIME or SP_FTIME parameters. Set the filter time constant to zero to disable the filter feature.

Feedforward Calculation

The feedforward value (FF_VAL) is scaled (FF_SCALE) to a common range for compatibility with the output scale (OUT_SCALE). A gain value (FF_GAIN) is applied to achieve the total feedforward contribution.

Tracking

You enable the use of output tracking through the control options. You can set control options in Manual or Out of Service mode only.

The **Track Enable** control option must be set to *True* for the track function to operate. When the Track in Manual control option is set to *True*, tracking can be activated and maintained only when the block is in **Manual** mode. When **Track in Manual** is *False*, the operator can override the tracking function when the block is in **Manual** mode. Activating the track function causes the block's actual mode to revert to **Local Override**.

The TRK_VAL parameter specifies the value to be converted and tracked into the output when the track function is operating. The TRK_SCALE parameter specifies the range of TRK_VAL.

When the TRK_IN_D parameter is *True* and the **Track Enable** control option is *True*, the TRK_VAL input is converted to the appropriate value and output in units of OUT_SCALE.

Output Selection and Limiting

Output selection is determined by the mode and the setpoint. In **Automatic**, **Cascade**, or **RemoteCascade** mode, the output is computed by the PID control equation. In **Manual** and **RemoteOutput** mode, the output may be entered manually (see also **Setpoint Selection and Limiting** on page C-6). You can limit the output by configuring the OUT_HI_LIM and OUT_LO_LIM parameters.

Bumpless Transfer and Setpoint Tracking

You can configure the method for tracking the setpoint by configuring the following control options (CONTROL_OPTS):

SP-PV Track in Man — Permits the SP to track the PV when the target mode of the block is Man.

SP-PV Track in LO or IMan — Permits the SP to track the PV when the actual mode of the block is Local Override (LO) or Initialization Manual (IMan).

When one of these options is set, the SP value is set to the PV value while in the specified mode.

You can select the value that a master controller uses for tracking by configuring the **Use PV for BKCAL_OUT** control option. The BKCAL_OUT value tracks the PV value. BKCAL_IN on a master controller connected to BKCAL_OUT on the PID block in an open cascade strategy forces its OUT to match BKCAL_IN, thus tracking the PV from the slave PID block into its cascade input connection (CAS_IN). If the **Use PV for BKCAL_OUT** option is not selected, the working setpoint (SP_WRK) is used for BKCAL_OUT.

You can set control options in **Manual** or **Out of Service** mode only. When the mode is set to **Auto**, the SP will remain at the last value (it will no longer follow the PV.

PID Equation Structures

Configure the STRUCTURE parameter to select the PID equation structure. You can select one of the following choices:

- PI Action on Error, D Action on PV
- PID Action on Error
- I Action on Error, PD Action on PV

Set RESET to zero to configure the PID block to perform integral only control regardless of the STRUCTURE parameter selection. When RESET equals zero, the equation reduces to an integrator equation with a gain value applied to the error:

$$\frac{\mathrm{GAIN} \times e(s)}{s}$$

Where

GAIN: proportional gain value
e: error
s: laplace operator

Reverse and Direct Action

To configure the block output action, enable the **Direct Acting** control option. This option defines the relationship between a change in PV and the corresponding change in output. With **Direct Acting** enabled (True), an increase in PV results in an increase in the output.

You can set control options in **Manual** or **Out of Service** mode only.

NOTE
Track Enable, **Track in Manual**, **SP-PV Track in Man**, **SP-PV Track in LO or IMan**, **Use PV for BKCAL_OUT**, and **Direct Acting** are the only control options supported by the PID function block. Unsupported options are not grayed out; they appear on the screen in the same manner as supported options.

Reset Limiting

The PID function block provides a modified version of feedback reset limiting that prevents windup when output or input limits are encountered, and provides the proper behavior in selector applications.

Block Errors

Table C-2 lists conditions reported in the BLOCK_ERR parameter. Conditions in *italics* are inactive for the PID block and are given here only for your reference.

TABLE C-2. BLOCK_ERR Conditions

Condition Number	Condition Name and Description
0	*Other*
1	**Block Configuration Error:** The BY_PASS parameter is not configured and is set to 0, the SP_HI_LIM is less than the SP_LO_LIM, or the OUT_HI_LIM is less than the OUT_LO_LIM.
2	*Link Configuration Error*
3	*Simulate Active*
4	**Local Override**: The actual mode is LO.
5	*Device Fault State Set*
6	*Device Needs Maintenance Soon*
7	**Input Failure/Process Variable has Bad Status:** The parameter linked to IN is indicating a Bad status.
8	*Output Failure*
9	*Memory Failure*
10	*Lost Static Data*
11	*Lost NV Data*
12	*Readback Check Failed*
13	*Device Needs Maintenance Now*
14	*Power Up*
15	**Out of Service:** The actual mode is out of service.

Modes

The PID function block supports the following modes:

Manual (Man)—The block output (OUT) may be set manually.

Automatic (Auto)—The SP may be set manually and the block algorithm calculates OUT.

Cascade (Cas)—The SP is calculated in another block and is provided to the PID block through the CAS_IN connection.

RemoteCascade (RCas)—The SP is provided by a host computer that writes to the RCAS_IN parameter.

RemoteOutput (Rout)—The OUT is provided by a host computer that writes to the ROUT_IN parameter.

Local Override (LO)—The track function is active. OUT is set by TRK_VAL. The BLOCK_ERR parameter shows Local override.

Initialization Manual (IMan)—The output path is not complete (for example, the cascade-to-slave path might not be open). In IMan mode, OUT tracks BKCAL_IN.

Out of Service (O/S)—The block is not processed. The OUT status is set to *Bad: Out of Service*. The BLOCK_ERR parameter shows Out of service.

You can configure the Man, Auto, Cas, and O/S modes as permitted modes for operator entry.

Alarm Detection

A block alarm will be generated whenever the BLOCK_ERR has an error bit set. The types of block error for the AI block are defined above.

Process alarm detection is based on the PV value. You can configure the alarm limits of the following standard alarms:

- High (HI_LIM)
- High high (HI_HI_LIM)
- Low (LO_LIM)
- Low low (LO_LO_LIM)

Additional process alarm detection is based on the difference between SP and PV values and can be configured via the following parameters:

- Deviation high (DV_HI_LIM)
- Deviation low (DV_LO_LIM)

In order to avoid alarm chattering when the variable is oscillating around the alarm limit, an alarm hysteresis in percent of the PV span can be set using the ALARM_HYS parameter. The priority of each alarm is set in the following parameters:

- HI_PRI
- HI_HI_PRI
- LO_PRI
- LO_LO_PRI
- DV_HI_PRI
- DV_LO_PRI

Alarms are grouped into five levels of priority:

Priority Number	Priority Description
0	The priority of an alarm condition changes to) after the condition that caused the alarm is corrected.
1	An alarm condition with a priority of 1 is recognized by the system, but is not reported to the operator.
2	An alarm condition with a priority of 2 is reported to the operator, but does not require operator attention (such as diagnostics and system alerts).
3-7	Alarm conditions of priority 3 to 7 are advisory alarms of increasing priority.
8-15	Alarm conditions of priority 8 to 15 are critical alarms of increasing priority.

Status Handling

If the input status on the PID block is *Bad*, the mode of the block reverts to **Manual**. In addition, you can select the **Target to Manual if Bad IN** status option to direct the target mode to revert to manual. You can set the status option in **Manual** or **Out of Service** mode only.

NOTE
Target to Manual if Bad IN is the only status option supported by the PID function block. Unsupported options are not grayed out; they appear on the screen in the same manner as supported options.

Application Information

The PID function block is a powerful, flexible control algorithm that is designed to work in a variety of control strategies. The PID block is configured differently for different applications. The following examples describe the use of the PID block for closed-loop control (basic PID loop), feedforward control, cascade control with master and slave, and complex cascade control with override.

Closed Loop Control

To implement basic closed loop control, compute the error difference between the process variable (PV) and setpoint (SP) values and calculate a control output signal using a PID (Proportional Integral Derivative) function block.

The proportional control function responds immediately and directly to a change in the PV or SP. The proportional term **GAIN** applies a change in the loop output based on the current magnitude of the error multiplied by a gain value.

The integral control function reduces the process error by moving the output in the appropriate direction. The integral term **RESET** applies a correction based on the magnitude and duration of the error. Set the RESET parameter to zero for integral-only control. To reduce reset action, configure the RESET parameter to be a large value.

The derivative term **RATE** applies a correction based on the anticipated change in error. Derivative control is typically used in temperature control where large measurement lags exist.

The MODE parameter is a switch that indicates the target and actual mode of operation. Mode selection has a large impact on the operation of the PID block:

- **Manual** mode allows the operator to set the value of the loop output signal directly.
- **Automatic** mode allows the operator to select a setpoint for automatic correction of error using the **GAIN**, **RESET**, and **RATE** tuning values.
- **Cascade** and **Remote Cascade** modes use a setpoint from another block in a cascaded configuration.
- **Remote Out** mode is similar to **Manual** mode except that the block output is supplied by an external program rather than by the operator.
- **Initialization Manual** is a non-target mode used with cascade configurations while transitioning from manual operation to automatic operation.
- **Local Override** is a non-target mode that instructs the block to revert to Local Override when the tracking or fail-safe control options are activated.
- **Out of Service** mode disables the block for maintenance.

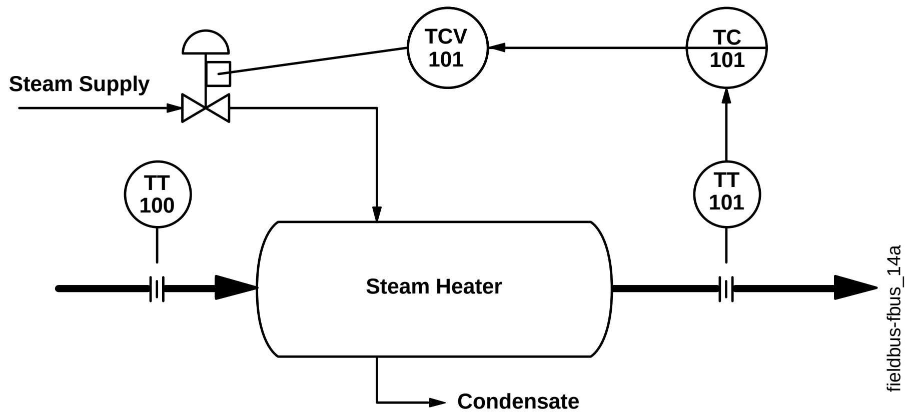
Abrupt changes in the quality of the input signal can result in unexpected loop behavior. To prevent the output from changing abruptly and upsetting the process, select the **SP-PV Track in Man** I/O option. This option automatically sets the loop to **Manual** if a *Bad* input status is detected. While in manual mode, the operator can manage control manually until a *Good* input status is reestablished.

Application Example: Basic PID Block for Steam Heater Control

Situation

A PID block is used with an AI block and an AO block to control the flow steam used to heat a process fluid in a heat exchanger. Figure C-3 illustrates the process instrumentation diagram.

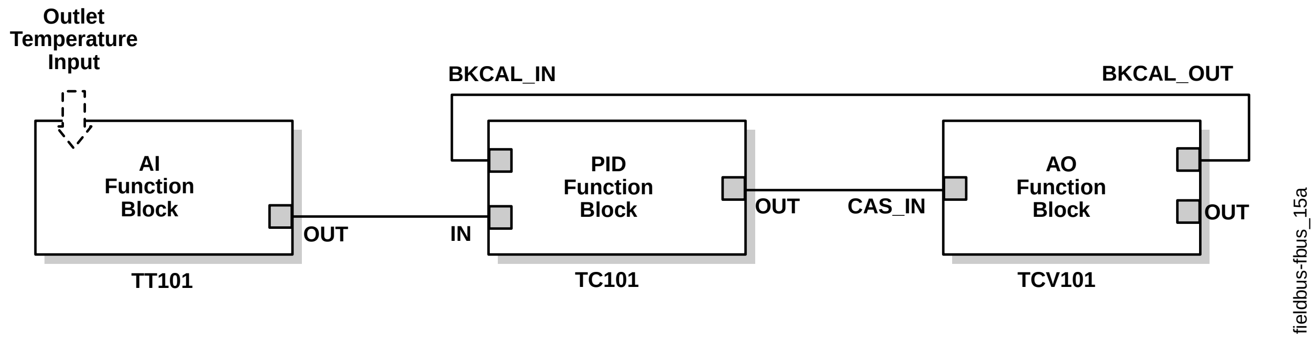
FIGURE C-3. PID Function Block Steam Heater Control Example.



Solution

The PID loop uses TT101 as an input and provides a signal to the analog output TCV101. The BKCAL_OUT of the AO block and the BKCAL_IN of the PID block communicate the status and quality of information being passed between the blocks. The status indication shows that communications is functioning and the I/O is working properly. Figure C-4 illustrates the correct function block configuration.

FIGURE C-4. PID Function Block Diagram for Steam Heater Control Example.



Application Example: Feedforward Control

Situation

In the previous example, control problems can arise because of a time delay caused by thermal inertia between the two flow streams (TT100 and TT101). Variations in the inlet temperature (TT100) take an excessive amount of time to be sensed in the outlet (TT101). This delay causes the product to be out of the desired temperature range.

Solution

Feedforward control is added to improve the response time of the basic PID control. The temperature of the inlet process fluid (TT100) is input to an AI function block and is connected to the FF_VAL connector on the PID block. Feedforward control is then enabled (FF_ENABLE), the feedforward value is scaled (FF_SCALE), and a gain (FF_GAIN) is determined. Figure C-5 illustrates the process instrumentation diagram, and Figure C-6 illustrates the correct function block configuration.

FIGURE C-5. PID Function Block Feedforward Control Example.

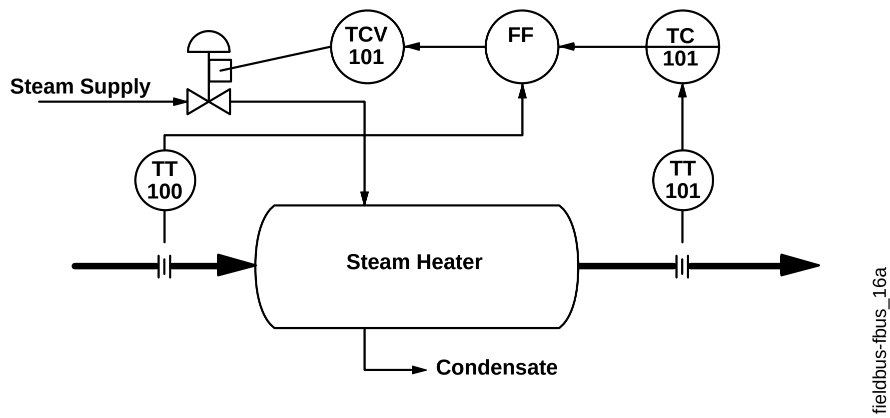
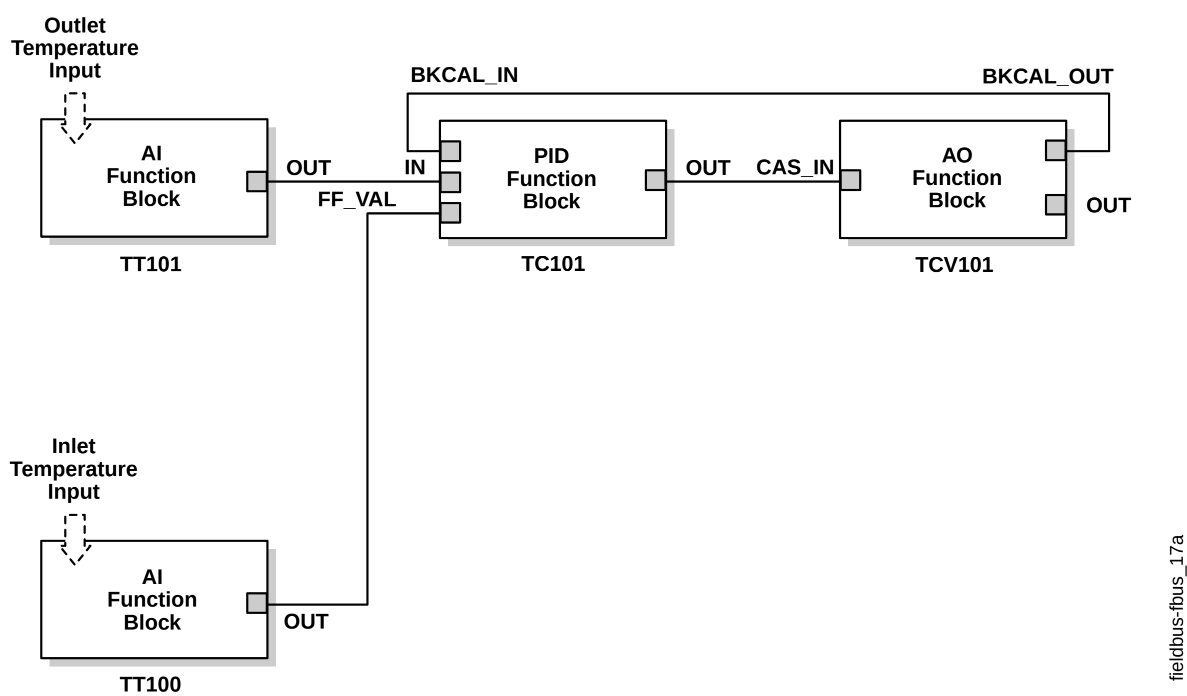


FIGURE C-6. Function Block Diagram for Feedforward Control.

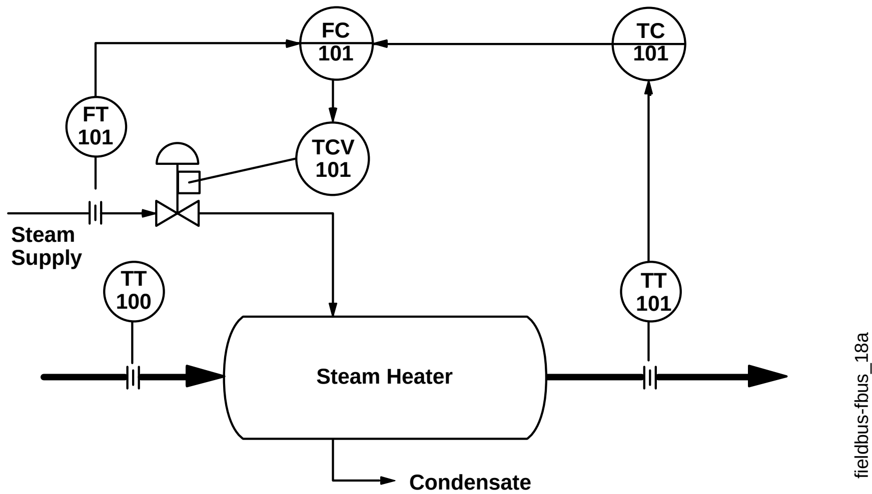


Application Example: Cascade Control with Master and Slave Loops

Situation

A slave loop is added to a basic PID control configuration to measure and control steam flow to the steam heater. Variations in the steam pressure cause the temperature in the heat exchanger to change. The temperature variation will later be sensed by TT101. The temperature controller will modify the valve position to compensate for the steam pressure change. The process is slow and causes variations in the product temperature. Figure C-7 illustrates the process instrumentation diagram.

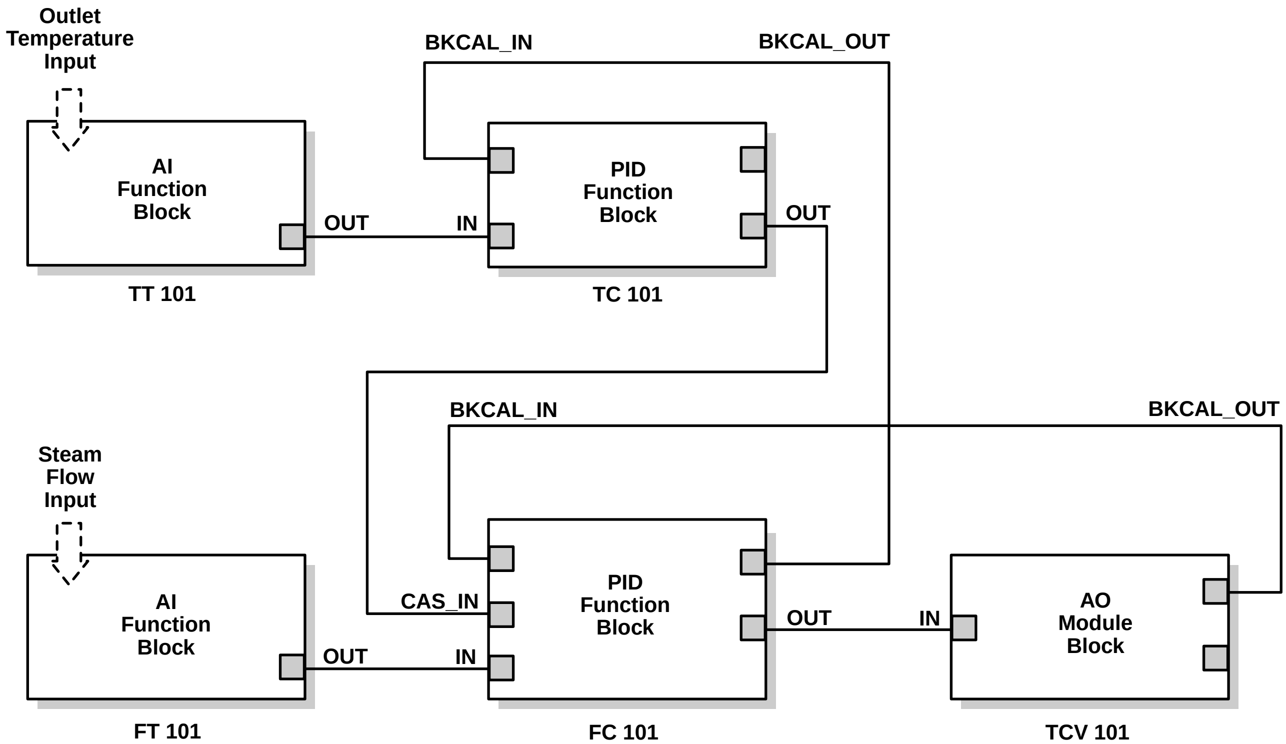
FIGURE C-7. PID Function Block Cascade Control Example.



Solution

If the flow is controlled, steam pressure variations will be compensated before they significantly affect the heat exchanger temperature. The output from the master temperature loop is used as the setpoint for the slave steam flow loop. The BKCAL_IN and BKCAL_OUT connections on the PID blocks are used to prevent controller windup on the master loop when the slave loop is in Manual or Automatic mode, or it has reached an output constraint. Figure C-8 illustrates the correct function block configuration.

FIGURE C-8. PID Function Block Diagram for Cascade Control Example.



Application Example: Cascade Control with Override

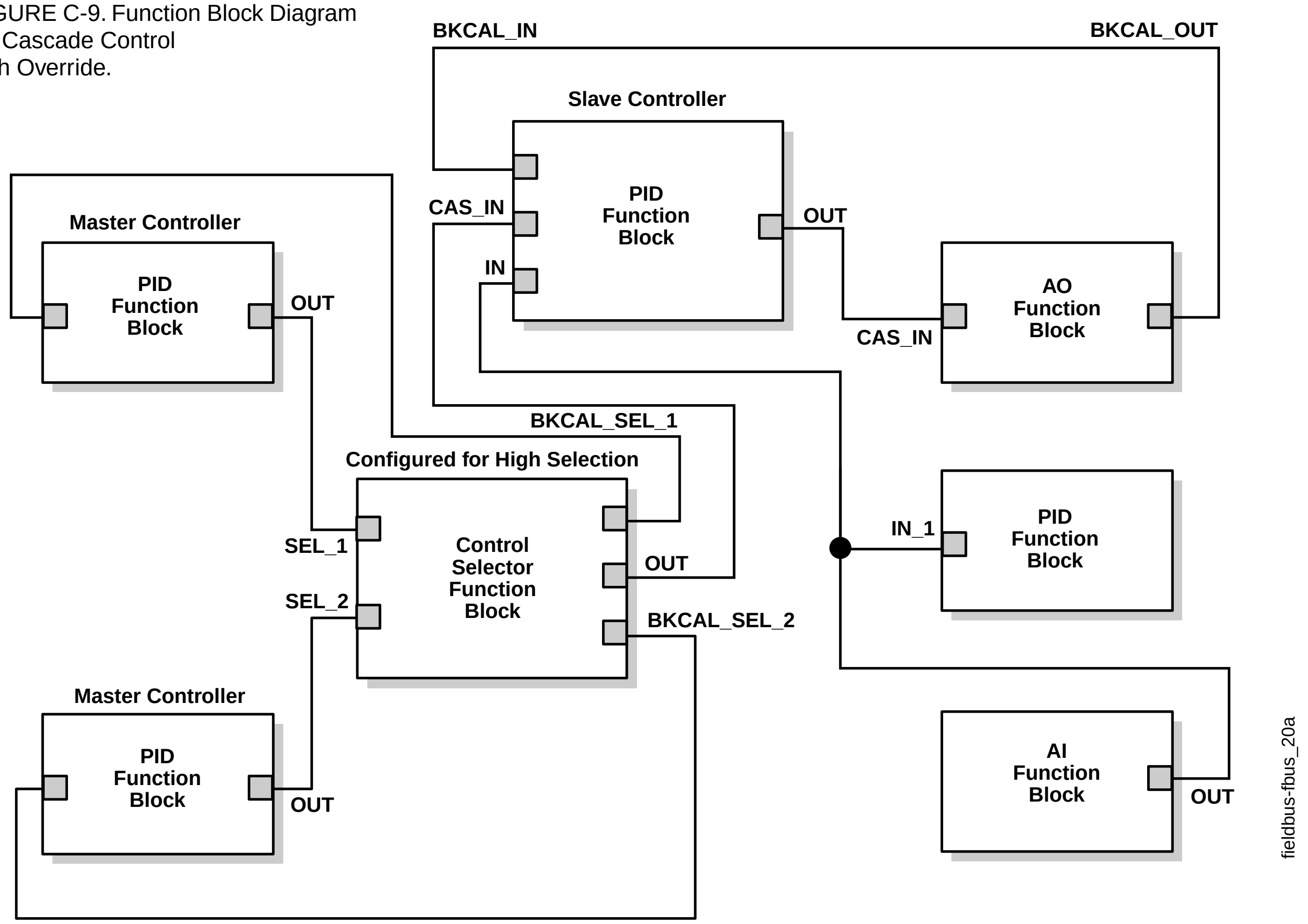
You can use the PID function block with other function blocks for complex control strategies. Figure C-9 illustrates the function block diagram for cascade control with override.

When configured for cascade control with override, if one of the PID function blocks connected to the selector inputs is deselected, that PID block filters the integral value to the selected value (the value at its BKCAL_IN). The selected PID block behaves normally and the deselected controller never winds up. At steady state, the deselected PID block offsets its OUT value from the selected value by the proportional term. When the selected block becomes output-limited, it prevents the integral term from winding further into the limited region.

When the cascade between the slave PID block and the Control Selector block is open, the open cascade status is passed to the Control Selector block and through to the PID blocks supplying input to it. The Control Selector block and the upstream (master) PID blocks have an actual mode of **IMan**.

If the instrument connected to the AI block fails, you can place the AI block in **Manual** mode and set the output to some nominal value for use in the Integrator function block. In this case, IN at the slave PID block is constant and prevents the integral term from increasing or decreasing.

FIGURE C-9. Function Block Diagram for Cascade Control with Override.



C

Troubleshooting

Refer to Table C-3 to troubleshoot any problems that you encounter.

TABLE C-3. Troubleshooting.

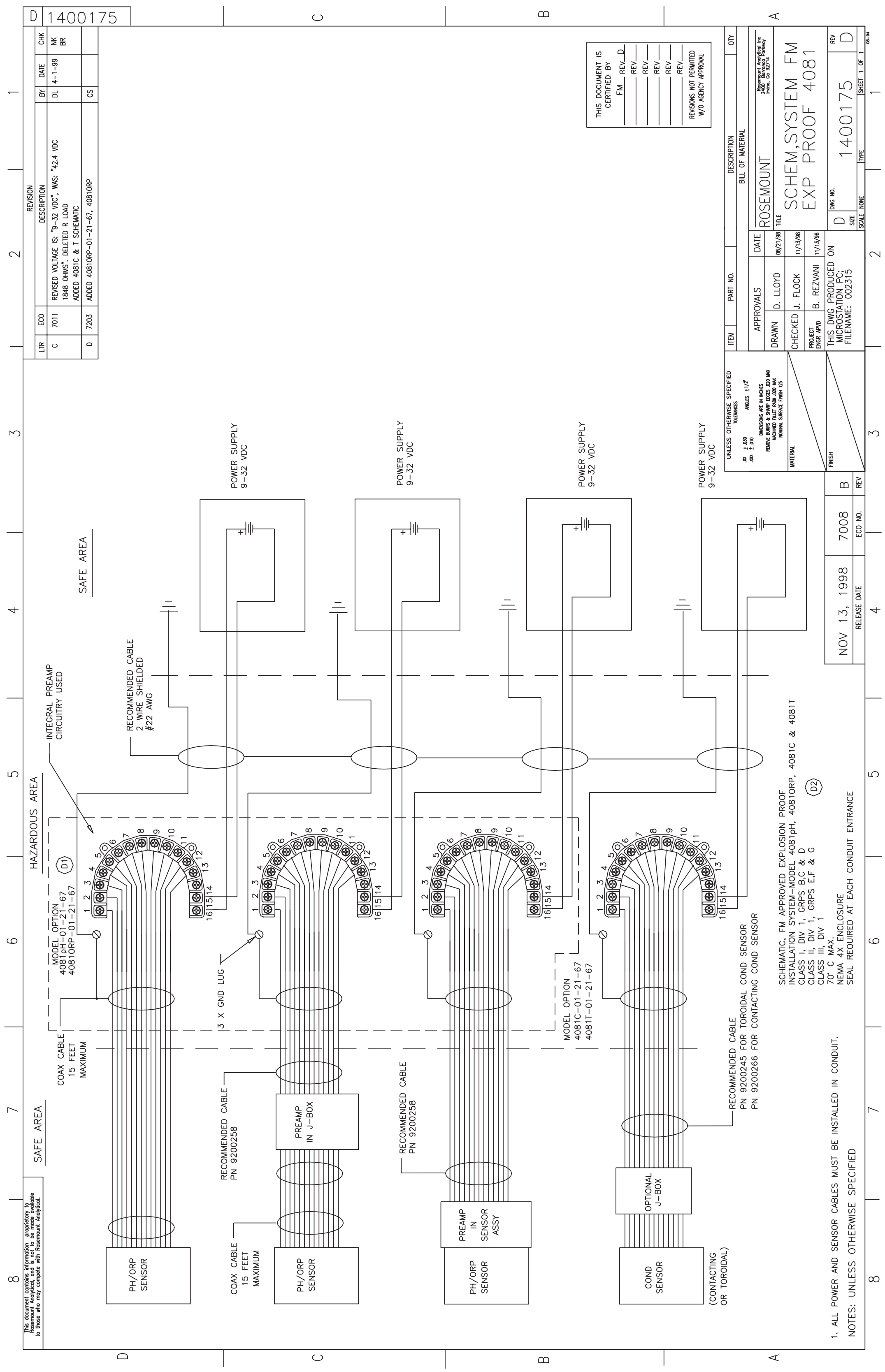
Symptom	Possible Causes	Corrective Action
Mode will not leave OOS	1. Target mode not set.	1. Set target mode to something other than OOS.
	2. Configuration error	2. BLOCK_ERR will show the configuration error bit set. The following are parameters that must be set before the block is allowed out of OOS: a. BYPASS must be off or on and cannot be left at initial value of 0. b. OUT_HI_LIM must be less than or equal to OUT_LO_LIM. c. SP_HI_LIM must be less than or equal to SP_LO_LIM.
	3. Resource block	3. The actual mode of the Resource block is OOS. See Resource Block Diagnostics for corrective action.
	4. Schedule	4. Block is not scheduled and therefore cannot execute to go to Target Mode. Schedule the block to execute.
Mode will not leave IMAN	1. Back Calculation	1. BKCAL_IN a. The link is not configured (the status would show “Not Connected”). Configure the BKCAL_IN link to the downstream block. b. The downstream block is sending back a Quality of “Bad” or a Status of “Not Invited”. See the appropriate downstream block diagnostics for corrective action.
Mode will not change to AUTO	1. Target mode not set.	1. Set target mode to something other than OOS.
	2. Input	2. IN a. The link is not configured (the status would show “Not Connected”). Configure the IN link to the block. b. The upstream block is sending back a Quality of “Bad” or a Status of “Not Invited”. See the appropriate upstream block diagnostics for corrective action.
Mode will not change to CAS	1. Target mode not set.	1. Set target mode to something other than OOS.
	2. Cascade input	2. CAS_IN a. The link is not configured (the status would show “Not Connected”). Configure the CAS_IN link to the block. b. The upstream block is sending back a Quality of “Bad” or a Status of “Not Invited”. See the appropriate up stream block diagnostics for corrective action.
Mode sheds from RCAS to AUTO	1. Remote Cascade Value	1. Host system is not writing RCAS_IN with a quality and status of “good cascade” within shed time (see 2 below).
	2. Shed Timer	2. The mode shed timer, SHED_RCAS in the resource block is set too low. Increase the value.

Symptom	Possible Causes	Corrective Action
Mode sheds from ROUT to MAN	1. Remote output value	1. Host system is not writing ROUT_IN with a quality and status of “good cascade” within shed time (see 2 below).
	2. Shed timer	2. The mode shed timer, SHED_RCAS, in the resource block is set too low. Increase the value.
Process and/or block alarms will not work.	1. Features	1. FEATURES_SEL does not have Alerts enabled. Enable the Alerts bit.
	2. Notification	2. LIM_NOTIFY is not high enough. Set equal to MAX_NOTIFY.
	3. Status Options	3. STATUS_OPTS has Propagate Fault Forward bit set. This should be cleared to cause an alarm to occur.

SECTION 10
INDEX

This index is an alphabetized listing of parts, terms, and procedures having to do with the Hazardous Area Oxygen/Combustibles Transmitter. Every item listed in this index refers to a location in the manual by one or more page numbers.

SECTION 11
DRAWINGS AND SCHEMATICS


D 1400175
REVISION
LTR ECO DESCRIPTION BY DATE CHK
C 7011 REVISED VOLTAGE IS: "9-32 VDC", WAS: "42.4 VDC 1848 OHMS", DELETED R LOAD DL 4-1-99 NK
ADDED 4081C & T SCHEMATIC BR
D 7203 ADDED 4081ORP-01-21-67, 4081ORP CS
THIS DOCUMENT IS CERTIFIED BY FM REV D
REVISIONS NOT PERMITTED W/O AGENCY APPROVAL
POWER SUPPLY 9-32 VDC
SAFE AREA
HAZARDOUS AREA
INTEGRAL PREAMP CIRCUITRY USED
RECOMMENDED CABLE 2 WIRE SHIELDED #22 AWG
MODEL OPTION 4081pH-01-21-67 4081ORP-01-21-67
MODEL OPTION 4081C-01-21-67 4081T-01-21-67
3 X GND LUG
COAX CABLE 15 FEET MAXIMUM
RECOMMENDED CABLE PN 9200258
PREAMP IN J-BOX
PREAMP IN SENSOR ASSY
OPTIONAL J-BOX
PH/ORP SENSOR
COND SENSOR
(CONTACTING OR TOROIDAL)
RECOMMENDED CABLE PN 9200245 FOR TOROIDAL COND SENSOR PN 9200266 FOR CONTACTING COND SENSOR
SCHEMATIC, FM APPROVED EXPLOSION PROOF INSTALLATION SYSTEM-MODEL 4081pH, 4081ORP, 4081C & 4081T
CLASS I, DIV 1, GRPS B,C & D
CLASS II, DIV 1, GRPS E,F & G
CLASS III, DIV 1
70° C MAX.
NEMA 4X ENCLOSURE
SEAL REQUIRED AT EACH CONDUIT ENTRANCE
1. ALL POWER AND SENSOR CABLES MUST BE INSTALLED IN CONDUIT.
NOTES: UNLESS OTHERWISE SPECIFIED
NOV 13, 1998 RELEASE DATE
7008 ECO NO.
B REV
ROSEMOUNT
SCHEM,SYSTEM FM EXP PROOF 4081
DRAWN D. LLOYD
CHECKED J. FLOCK
PROJECT ENGR APVD B. REZVANI
THIS DWG PRODUCED ON MICROSTATION PC; FILENAME: 002315
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SCALE NONE SHEET 1 OF 1

WARRANTY

Goods and part(s) (excluding consumables) manufactured by Seller are warranted to be free from defects in workmanship and material under normal use and service for a period of twelve (12) months from the date of shipment by Seller. Consumables, glass electrodes, membranes, liquid junctions, electrolyte, o-rings, etc., are warranted to be free from defects in workmanship and material under normal use and service for a period of ninety (90) days from date of shipment by Seller. Goods, part(s) and consumables proven by Seller to be defective in workmanship and/or material shall be replaced or repaired, free of charge, F.O.B. Seller's factory provided that the goods, part(s) or consumables are returned to Seller's designated factory, transportation charges prepaid, within the twelve (12) month period of warranty in the case of goods and part(s), and in the case of consumables, within the ninety (90) day period of warranty. This warranty shall be in effect for replacement or repaired goods, part(s) and the remaining portion of the ninety (90) day warranty in the case of consumables. A defect in goods, part(s) and consumables of the commercial unit shall not operate to condemn such commercial unit when such goods, part(s) and consumables are capable of being renewed, repaired or replaced.

The Seller shall not be liable to the Buyer, or to any other person, for the loss or damage directly or indirectly, arising from the use of the equipment or goods, from breach of any warranty, or from any other cause. All other warranties, expressed or implied are hereby excluded.

IN CONSIDERATION OF THE HEREIN STATED PURCHASE PRICE OF THE GOODS, SELLER GRANTS ONLY THE ABOVE STATED EXPRESS WARRANTY. NO OTHER WARRANTIES ARE GRANTED INCLUDING, BUT NOT LIMITED TO, EXPRESS AND IMPLIED WARRANTIES OR MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

Limitations of Remedy. SELLER SHALL NOT BE LIABLE FOR DAMAGES CAUSED BY DELAY IN PERFORMANCE. THE SOLE AND EXCLUSIVE REMEDY FOR BREACH OF WARRANTY SHALL BE LIMITED TO REPAIR OR REPLACEMENT UNDER THE STANDARD WARRANTY CLAUSE. IN NO CASE, REGARDLESS OF THE FORM OF THE CAUSE OF ACTION, SHALL SELLER'S LIABILITY EXCEED THE PRICE TO BUYER OF THE SPECIFIC GOODS MANUFACTURED BY SELLER GIVING RISE TO THE CAUSE OF ACTION. BUYER AGREES THAT IN NO EVENT SHALL SELLER'S LIABILITY EXTEND TO INCLUDE INCIDENTAL OR CONSEQUENTIAL DAMAGES. CONSEQUENTIAL DAMAGES SHALL INCLUDE, BUT ARE NOT LIMITED TO, LOSS OF ANTICIPATED PROFITS, LOSS OF USE, LOSS OF REVENUE, COST OF CAPITAL AND DAMAGE OR LOSS OF OTHER PROPERTY OR EQUIPMENT. IN NO EVENT SHALL SELLER BE OBLIGATED TO INDEMNIFY BUYER IN ANY MANNER NOR SHALL SELLER BE LIABLE FOR PROPERTY DAMAGE AND/OR THIRD PARTY CLAIMS COVERED BY UMBRELLA INSURANCE AND/OR INDEMNITY COVERAGE PROVIDED TO BUYER, ITS ASSIGNS, AND EACH SUCCESSOR INTEREST TO THE GOODS PROVIDED HEREUNDER.

Force Majeure. Seller shall not be liable for failure to perform due to labor strikes or acts beyond Seller's direct control.

Instruction Manual
IB-106-4081 Rev. 1.2
September, 2002

Model 4081FG

Two-Wire In Situ Oxygen Analyzer

Part no. ______________________
Serial no.______________________
Order no.______________________

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