Process Control

FOUNDATION Fieldbus™ Device Configuration

Courseware Sample

86002-F0

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Safety and Common Symbols

The following safety and common symbols may be used in this manual and on the equipment:

Symbol	Description
⚠ DANGER	**DANGER** indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.
⚠ WARNING	**WARNING** indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.
⚠ CAUTION	**CAUTION** indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.
CAUTION	**CAUTION** used without the *Caution, risk of danger* sign ⚠, indicates a hazard with a potentially hazardous situation which, if not avoided, may result in property damage.
	Caution, risk of electric shock
	Caution, hot surface
	Caution, risk of danger
	Caution, lifting hazard
	Caution, hand entanglement hazard
	Notice, non-ionizing radiation
	Direct current
	Alternating current
	Both direct and alternating current
	Three-phase alternating current
	Earth (ground) terminal

Safety and Common Symbols

Symbol	Description
	Protective conductor terminal
	Frame or chassis terminal
	Equipotentiality
	On (supply)
	Off (supply)
	Equipment protected throughout by double insulation or reinforced insulation
	In position of a bi-stable push control
	Out position of a bi-stable push control

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Preface

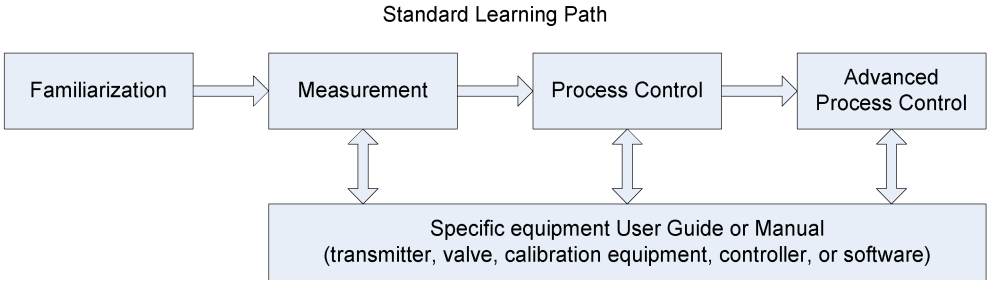
Automated process control offers so many advantages over manual control that the majority of today's industrial processes use it to some extent. Breweries, wastewater treatment plants, mining facilities, and the automotive industry are just a few industries that benefit from automated process control systems.

Maintaining process variables such as pressure, flow, level, temperature, and pH within a desired operating range is of the utmost importance when manufacturing products with a predictable composition and quality.

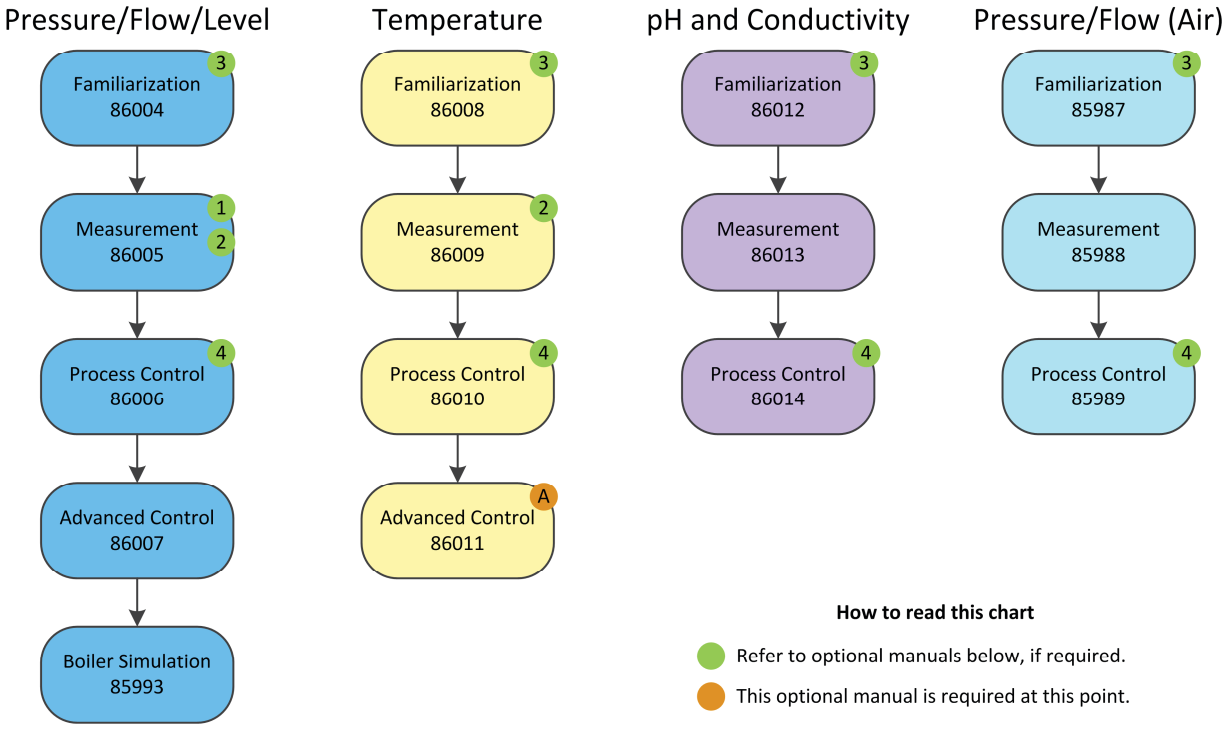
The Instrumentation and Process Control Training System, series 353X, is a state-of-the-art system that faithfully reproduces an industrial environment. Throughout this course, students develop skills in the installation and operation of equipment used in the process control field. The use of modern, industrial-grade equipment is instrumental in teaching theoretical and hands-on knowledge required to work in the process control industry.

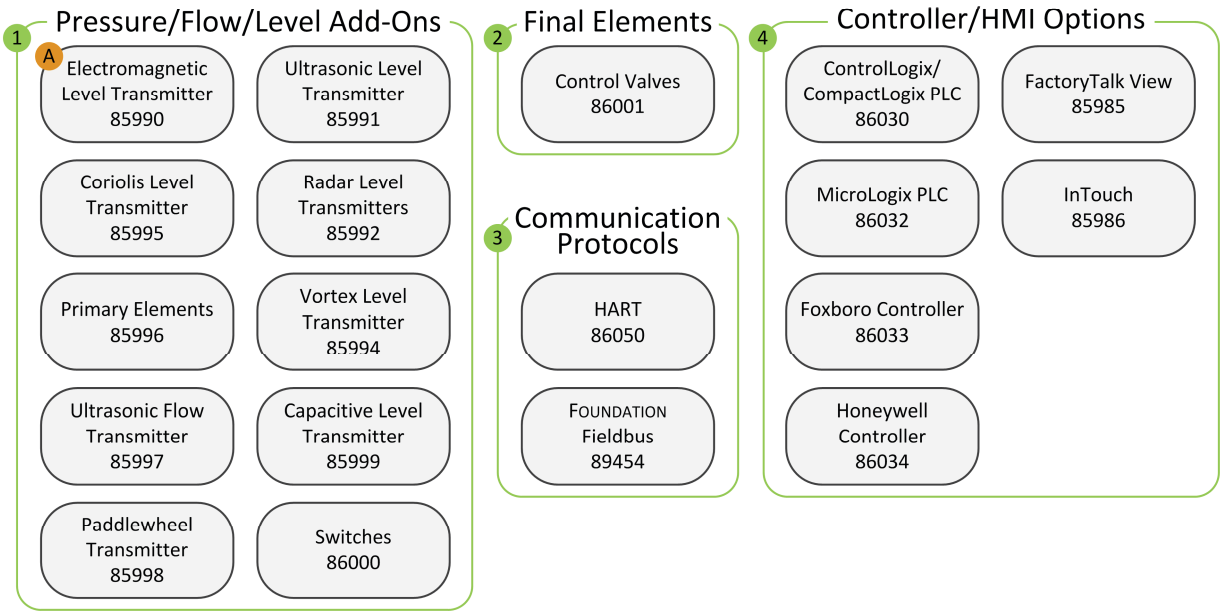
The modularity of the system allows the instructor to select the equipment required to meet the objectives of a specific course. Two mobile workstations, on which all of the equipment is installed, form the basis of the system. Several optional components used in pressure, flow, level, temperature, and pH control loops are available, as well as various valves, calibration equipment, and software. These add-ons can replace basic components having the same functionality, depending on the context. During control exercises, a variety of controllers can be used interchangeably depending on the instructor's preference.

We hope that your learning experience with the Instrumentation and Process Control Training System will be the first step toward a successful career in the process control industry.



Manuals of the 353X Series





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We invite readers of this manual to send us their tips, feedback, and suggestions for improving the book.

Please send these to did@de.festo.com.

The authors and Festo Didactic look forward to your comments.

About This Manual

Safety considerations

Safety symbols that may be used in this manual and on the equipment are listed in the Safety Symbols table at the beginning of the manual.

Safety procedures related to the tasks that you will be asked to perform are indicated in each exercise.

Make sure that you are wearing appropriate protective equipment when performing the tasks. You should never perform a task if you have any reason to think that a manipulation could be dangerous for you or your teammates.

Systems of units

Units are expressed using the International System of Units (SI) followed by the units expressed in the U.S. customary system of units (between parentheses).

To the Instructor

You will find in this Instructor Guide all the elements included in the Student Manual together with the answers to all questions, results of measurements, graphs, explanations, suggestions, and, in some cases, instructions to help you guide the students through their learning process. All the information that applies to you is placed between markers and appears in red.

Accuracy of measurements

The numerical results of the hands-on exercises may differ from one student to another. For this reason, the results and answers given in this manual should be considered as a guide. Students who correctly performed the exercises should expect to demonstrate the principles involved and make observations and measurements similar to those given as answers.

Sample Exercise
Extracted from
the Student Manual
and the Instructor Guide

Differential-Pressure Transmitter Configuration

EXERCISE OBJECTIVE

Become familiar with the configuration of a FOUNDATION Fieldbus differential-pressure transmitter.

DISCUSSION OUTLINE

The Discussion of this exercise covers the following points:

- Parameter blocks

DISCUSSION

The DP transmitter is described in the *Familiarization* manual (P/N 85980-E0, 85987-E0, or 86004-E0).

The DTM for the DP transmitter is part of Endress+Hauser's FOUNDATION Fieldbus DTM package provided on the *FieldCare* installation DVD.

Parameter blocks

Figure 2-3 shows the blocks of the differential-pressure DTM, as they appear in *FieldCare* when the device is connected. The DP transmitter has one resource block, five transducer blocks, and an analog input function block. The analog input function block takes its data from the pressure transducer block, processes it, and publishes it over the FF network.

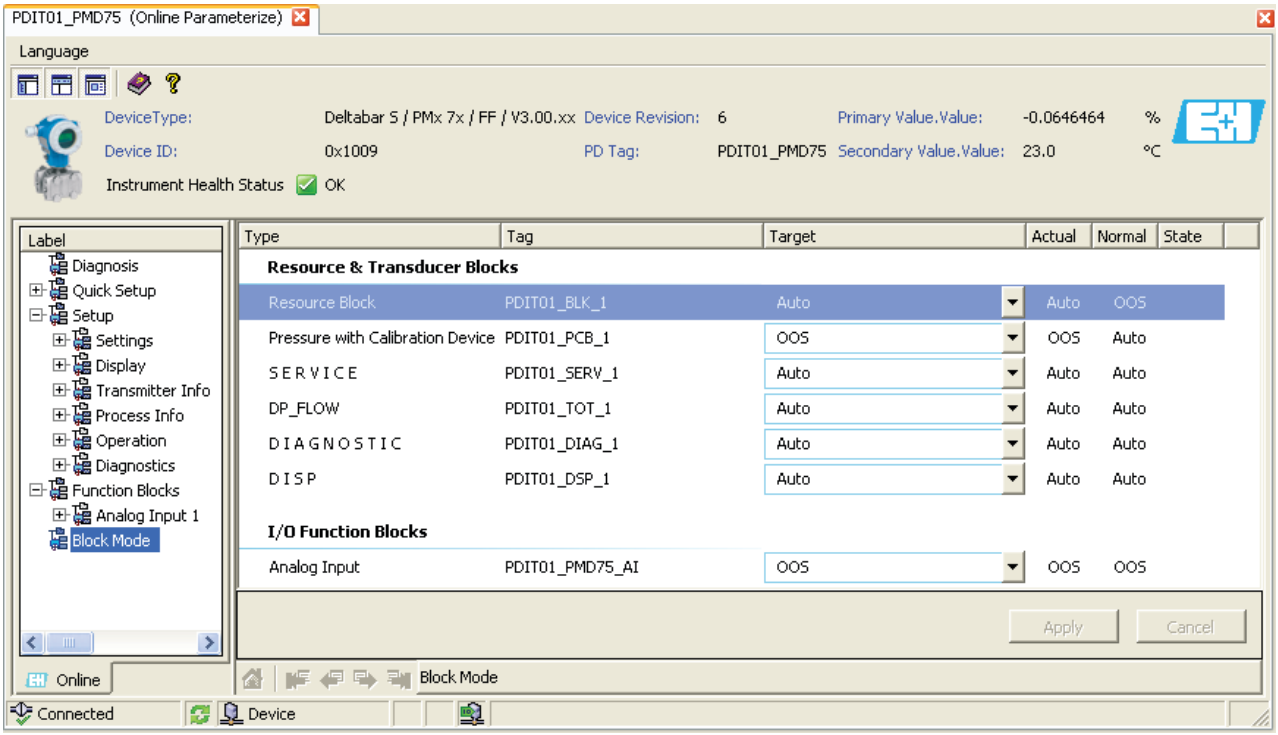

Figure 2-3. Parameter blocks in *FieldCare*.

The Procedure is divided into the following sections:

- Setup and connections
- Communication with *FieldCare*
- Unlocking the device
- Setting the language
- Resetting to factory settings
- Commissioning
- Testing the transmitter

PROCEDURE

Setup and connections

1. Secure the differential-pressure transmitter valve on a mounting pipe.

Table 2-1. Material needed.

Name	Model
DP Transmitter (FOUNDATION Fieldbus)	46920-A or 46921-A
Electrical Unit	46970
Pneumatic Unit	46971
FOUNDATION Fieldbus Terminator	46978
FOUNDATION Fieldbus Bridge	46979
FOUNDATION Fieldbus Software Configurator	46982-A or -B
Accessories	46993

2. Connect the DP transmitter to the FF Bridge's H1-1 connectors and set up the FOUNDATION Fieldbus HSE and H1 networks as shown in Figure 2-4.

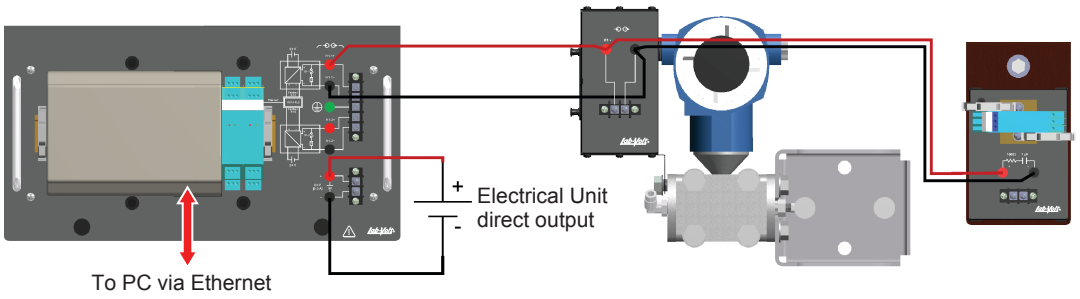

Figure 2-4. FOUNDATION Fieldbus connections.

3. Turn on the power supply to energize the Electrical Unit, the FF Bridge, and the DP transmitter.

Communication with *FieldCare*

4. Launch *FieldCare* on your computer and start the macro for scanning the FF network with the bridge (Figure 2-5).

Refer to Appendix B (Step 28) for instructions on how to set up the FF bridge macro.

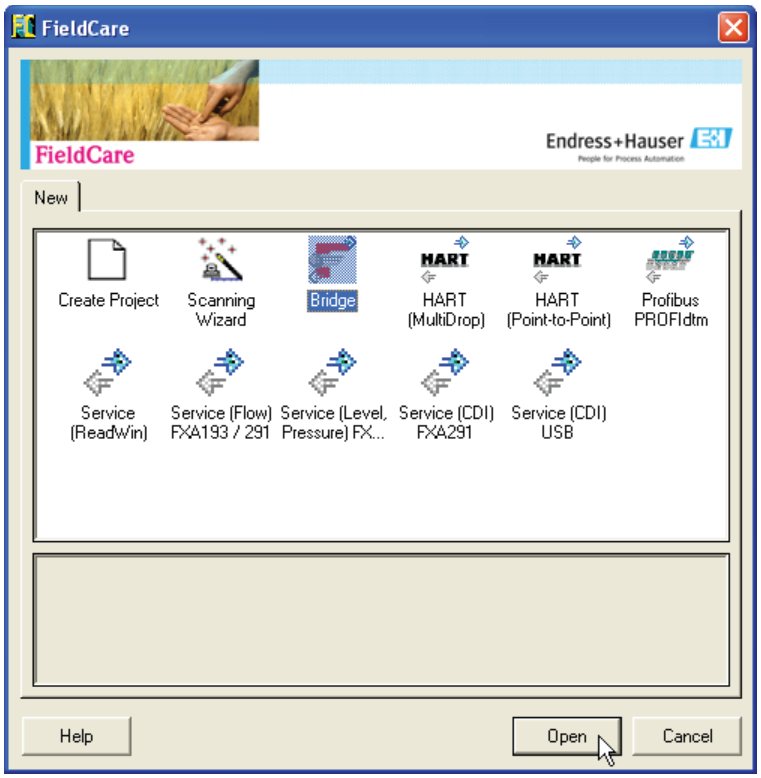

Figure 2-5. Selecting the FF Bridge macro.

5. *FieldCare* should detect one device (the DP transmitter) as shown in Figure 2-6.

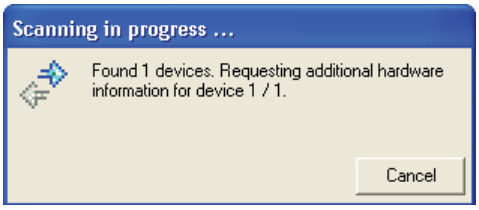

Figure 2-6. Found new device.

6. After the device has been detected, *FieldCare* should automatically connect to the device, as indicated by the ◆▶ sign beside the valve in the Network view (Figure 2-7). Alternately, you can connect to the device via *Device Operation* ► *Connect*.

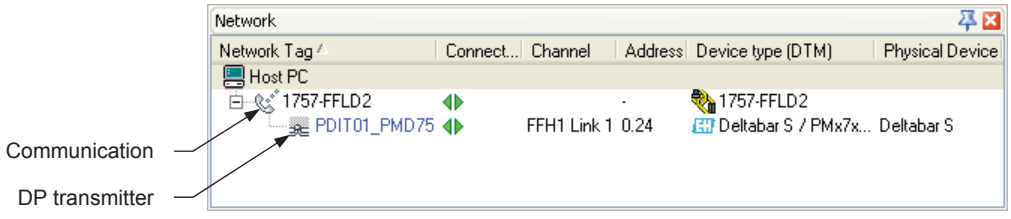

Figure 2-7. Network view.

The Offline Parameterize window allows you to write multiple parameters all at once.

7. If the Online Parameterize window does not open right away, right-click on the device name in the Network view and select the *Online Parameterize* command to open the DTM pertaining to the DP Transmitter (Figure 2-8). Note the presence of the parameters tree at the left of the screen. Clicking the plus (+) and minus (-) signs opens and closes the different menus.

The menus are not necessarily organized in terms of Resource, Transducer, or Function blocks within FieldCare.

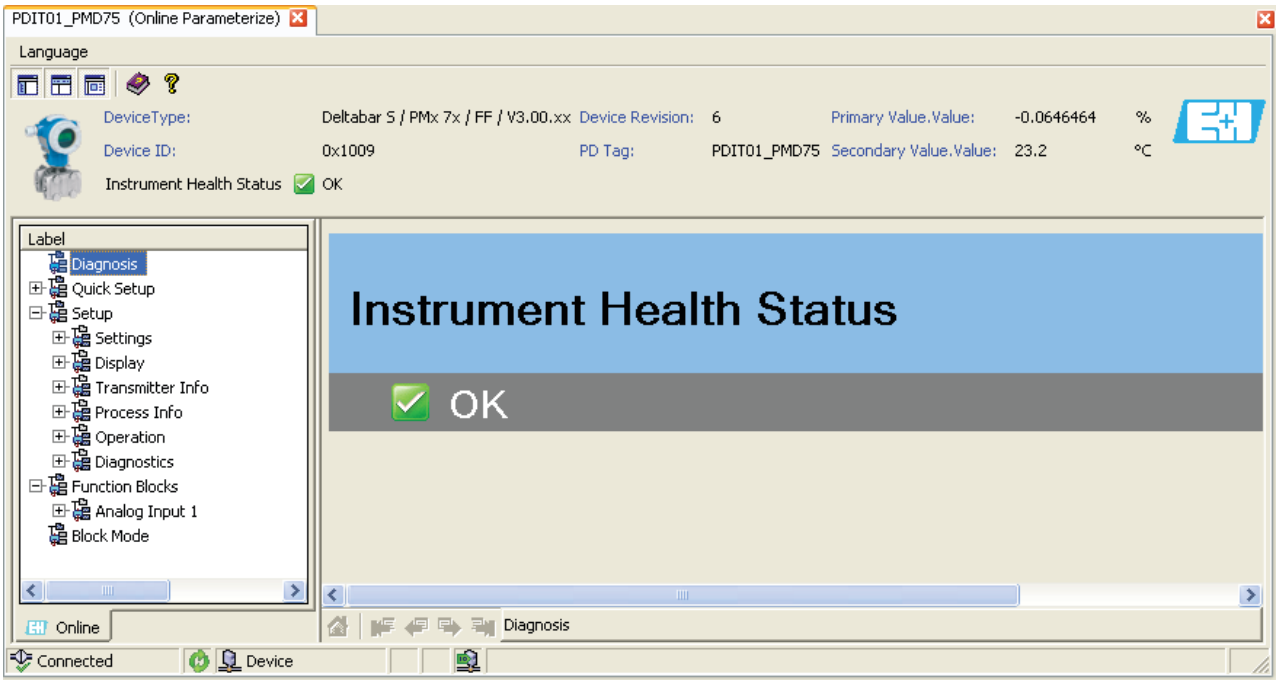

Figure 2-8. Online Parameterize.

8. From now on, you can use *FieldCare* commands to set up the transmitter for your experiments. The following sections show you how to perform some specific configuration procedures.

Unlocking the device

9. Open the Online Parameterize window.

10. Make sure that the device is not locked. If it is locked, the (key) symbol is shown on the display. There are two reasons why the device can be locked: a dip switch is activated under the display (Figure 2-9) or the device was locked remotely, via software (Figure 2-10).

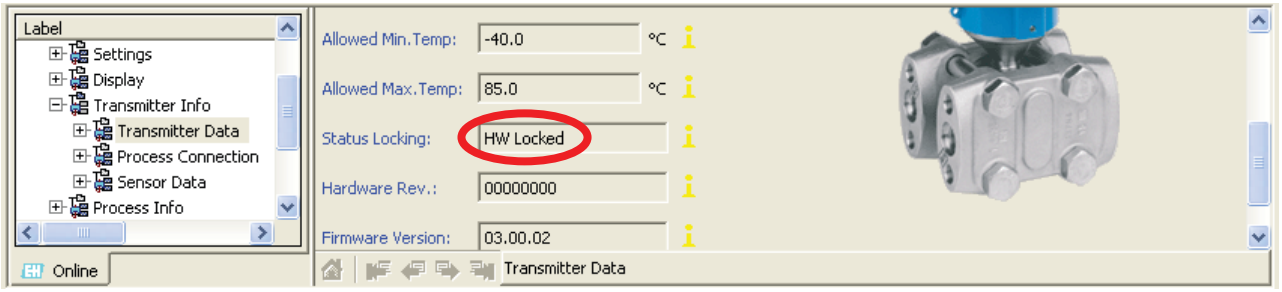

Figure 2-9. LOCKSTATE: Hardware (HW) locked.

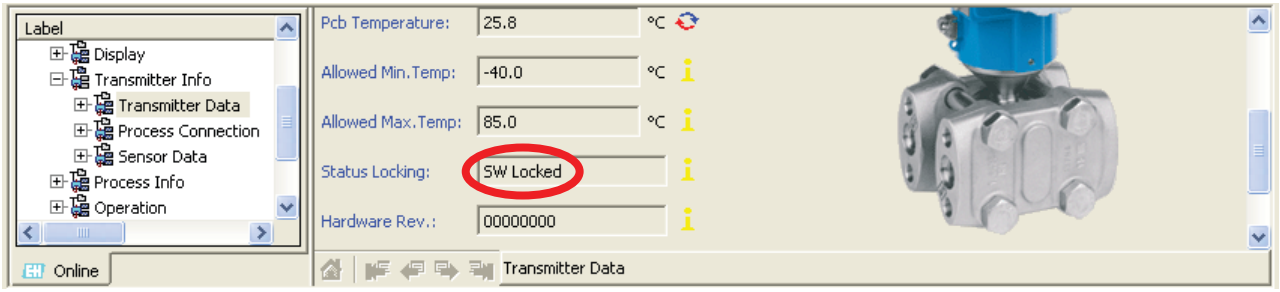

Figure 2-10. LOCKSTATE: Software (SW) locked.

11. If the dip switch is activated, position it in the unlocked position (down), as shown in Figure 2-11.

Figure 2-11. Position of the locking dip switch.

To lock the device remotely, set the *OPERATING MENU ► OPERATION ► INSERT PIN No.* parameter to “0”.

12. If the device was locked via software, put the *DIAGNOSTIC* block *Actual* mode to *OOS* and enter “100” for *Setup ► Operation ► Insert Pin No.* parameter. Put the block mode back to *Auto*.

Setting the language

To set the language used on the transmitter’s display:

13. Open the Online Parameterize window.

14. Select *Block Mode* in the parameters tree. Change the *DISP* (display transducer block) *Target* mode to *OOS* as shown in Figure 2-12. Click *Apply* to confirm your choice. The *Actual* mode should change accordingly within a few seconds.

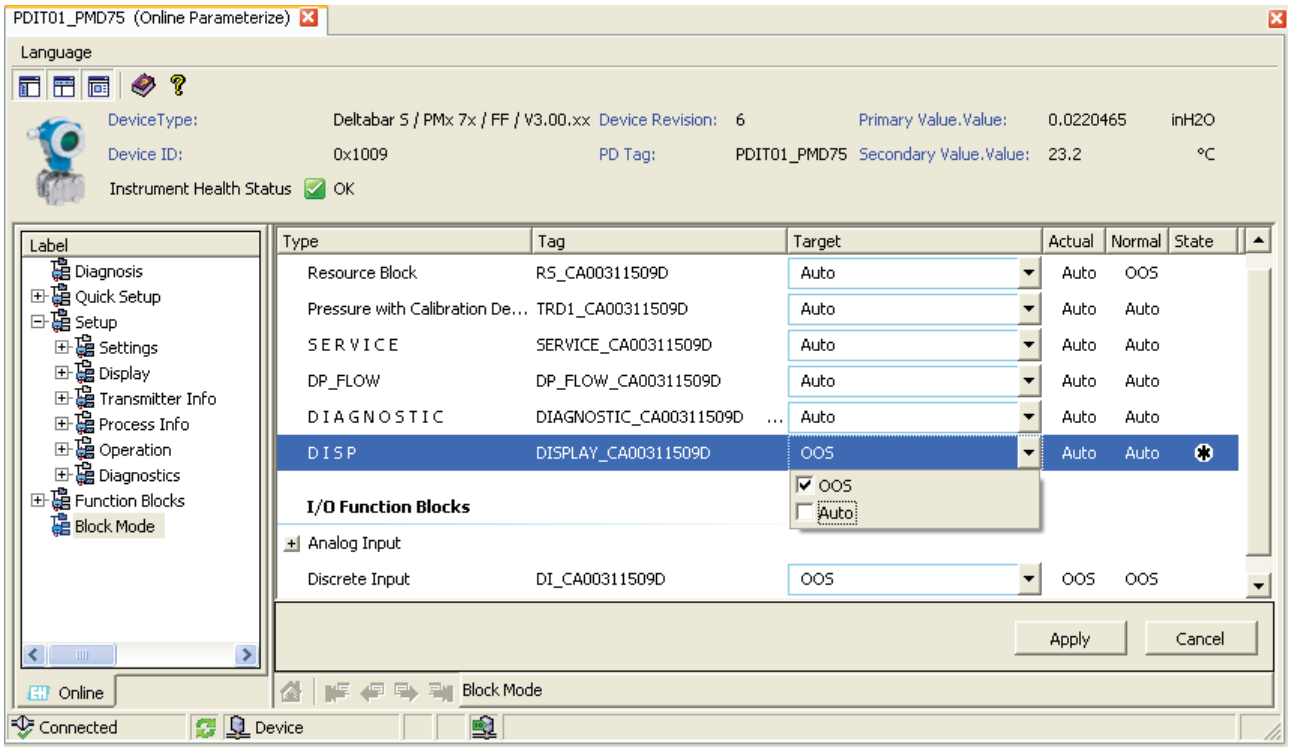

Figure 2-12. Changing DISP block mode.

15. Go to *Setup* ▶ *Display*, select the desired language (Figure 2-13), and press *Enter* to confirm your choice.

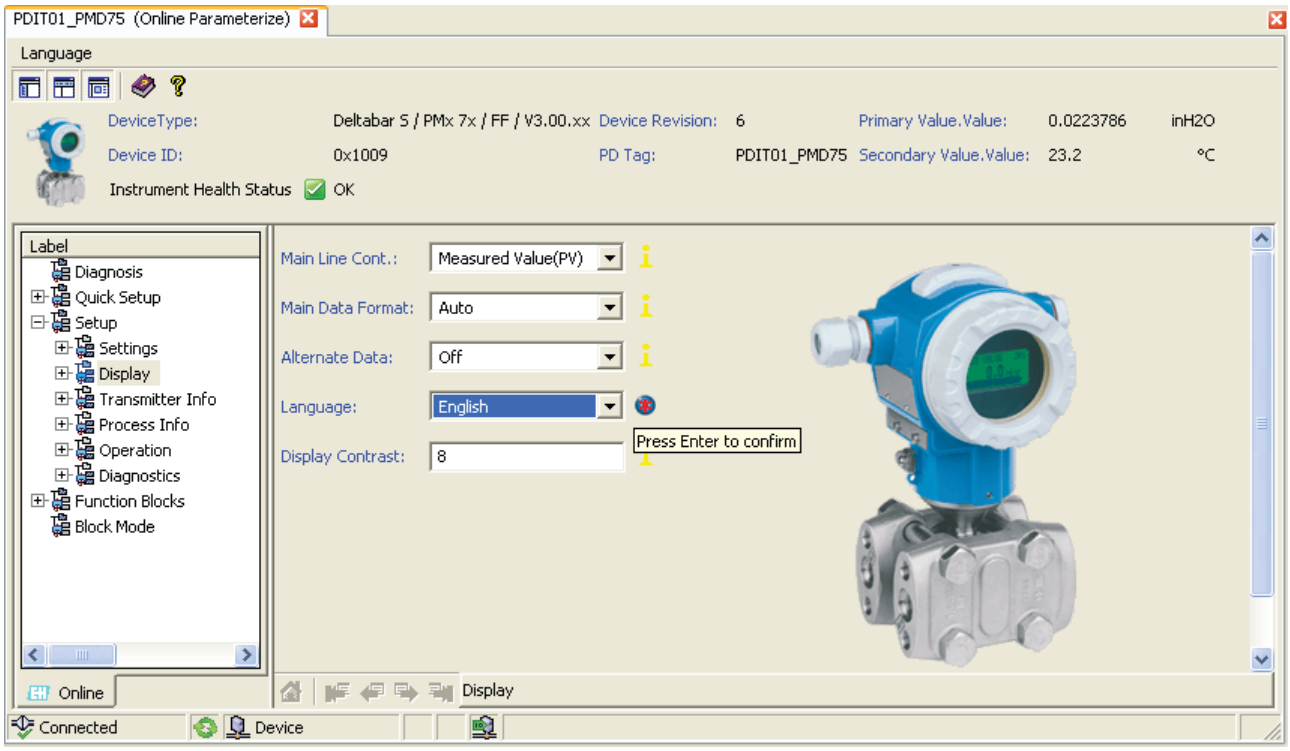

Figure 2-13. Display block Online Characterization.

16. Select *Block Mode* in the parameters tree. Return the *DISP* (display transducer block) *Target* mode to *Auto*, and click *Apply* to confirm your choice.

Resetting to factory settings

It can sometimes be preferable to start with a fresh configuration when using the transmitter, especially if you are not familiar with it. Note that resetting the unit to the factory settings has no effect on the language used on the display. To reset the transmitter to the factory settings:

17. Open the Online Parameterize window.

18. Select *Block Mode* in the parameters tree. Change the *DIAGNOSTIC* (transducer block) *Target* mode to *OOS* and click *Apply* to confirm your choice. The *Actual* mode should change accordingly within a few seconds.

19. Go to *Setup* ► *Operation* and type “7864” for *Enter Reset Code* parameter value (Figure 2-14). Confirm your choice by pressing *Enter*.

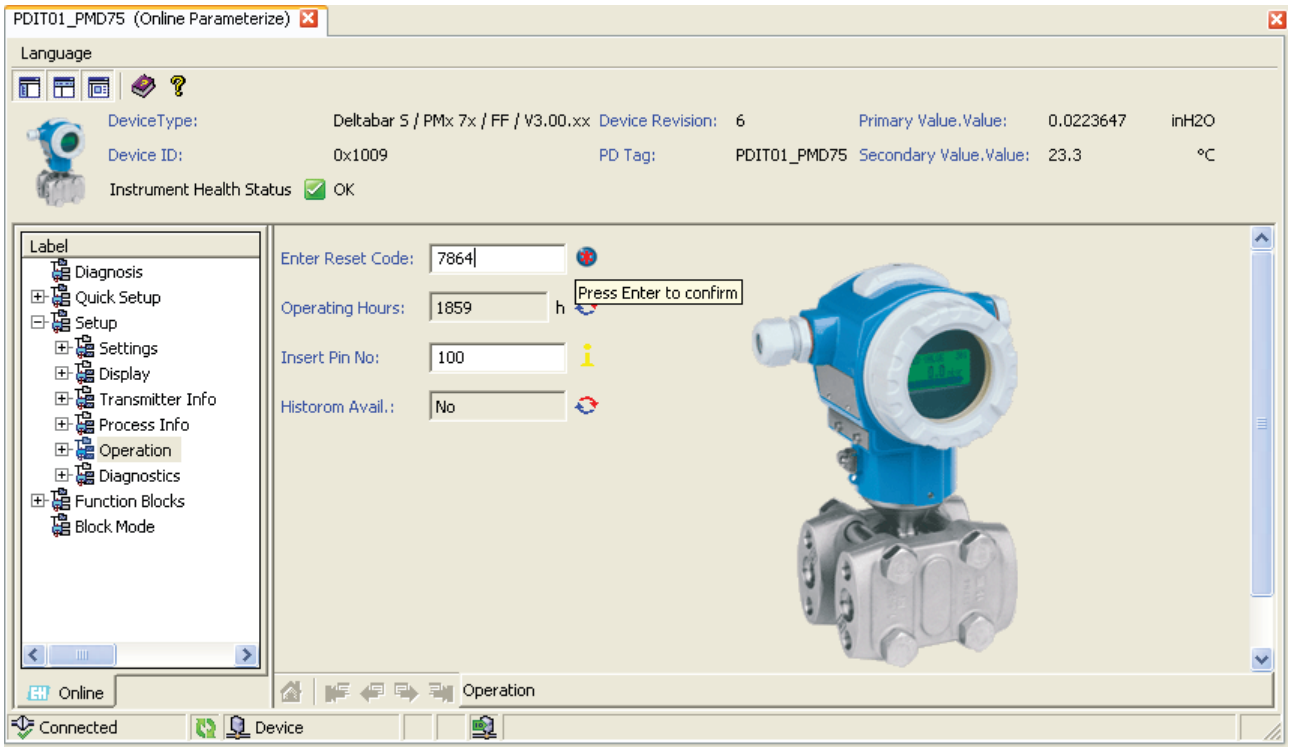

Figure 2-14. Resetting to factory settings.

20. The unit will reboot with the factory settings and you will lose communication with the device. If the device does not reconnect automatically after a few minutes, close the project and restart the macro for scanning the FF network with the bridge.

Commissioning

When the DP transmitter is powered, it takes a few seconds to boot. At the end of the boot process, the transmitter automatically displays the MEASURED VALUE screen. The information shown on this screen depends on the last configuration saved by the user. Refer to the *Resetting to factory settings* section above if you need a clean configuration. Follow one of the procedures below to configure the DP transmitter for pressure, flow, or level measurement.

Commissioning for differential pressure measurements

Follow the procedure below to configure the DP transmitter to behave as a differential pressure measurement device.

Pressure measurement is the default device mode.

21. Open the Online Parameterize window.

22. Select *Block Mode* in the parameters tree. Change the *DP_FLOW* **and** *Pressure with Calibration Device* blocks *Target* mode to *OOS* and click *Apply* to confirm your choices.

23. Go to *Setup* ▶ *Settings* ▶ *Basic Setup* as shown in Figure 2-15 and make the following choices:

- Set *Primary Value Type* to *differential pressure*. Confirm your choice by pressing *Enter*.
- Set *PRESS. ENG. UNIT* to the desired unit, usually kPa or psi. The factory setting is inH_2O. Confirm your choice by pressing *Enter*.
- Set *Scale Out. Decimal* according to the number of decimals that you wish to see on the display.
- Verify that the *DAMPING_VALUE* parameter is set to an appropriate value. This parameter affects the speed at which the transmitter reacts to a change in the differential pressure sensed. The default value is two seconds, which is appropriate for most uses.

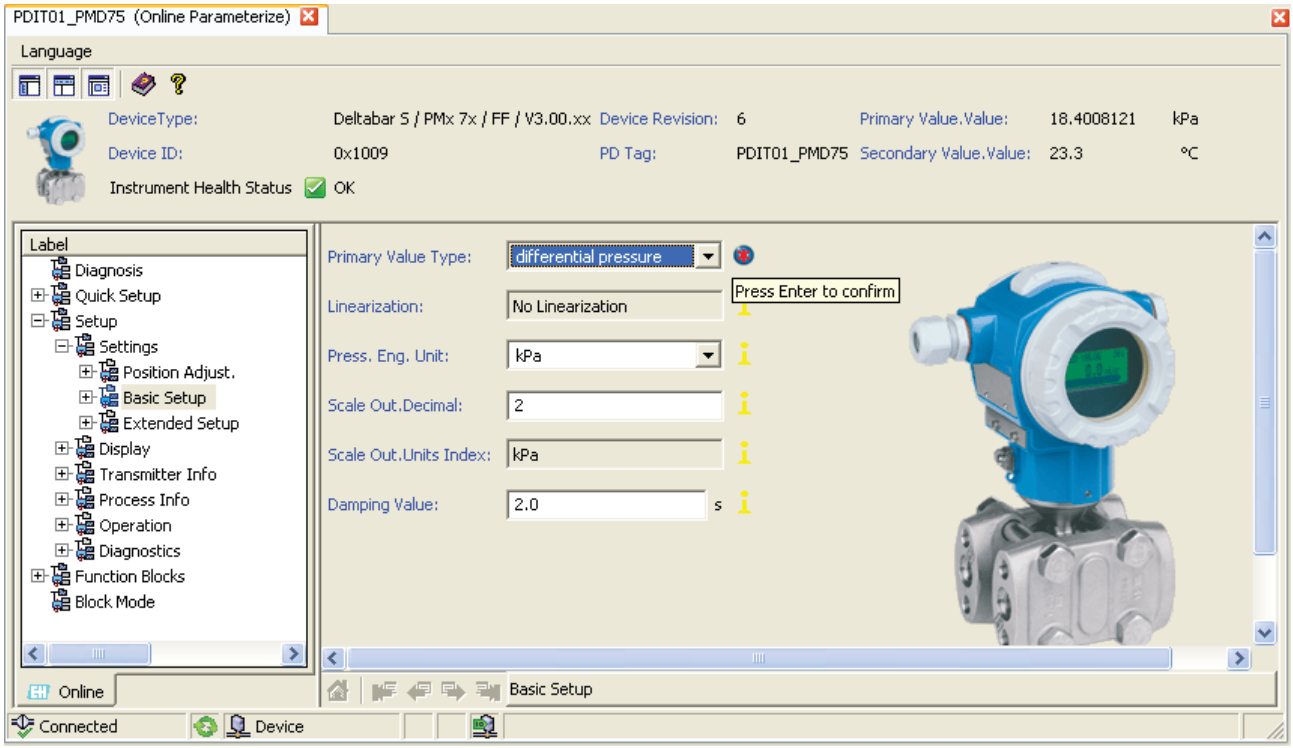

Figure 2-15. BASIC SETUP screen.

24. Go to *Setup* ▶ *Settings* ▶ *Position Adjust.* as shown in Figure 2-16. Select *Confirm* under *Pos. Zero Adjust* and press *Enter* to set the new zero.

Keep in mind that the zero must be adjusted every time you reposition the unit or impulse lines. The measurements are very sensitive to displacements, even though they are of very small magnitude.

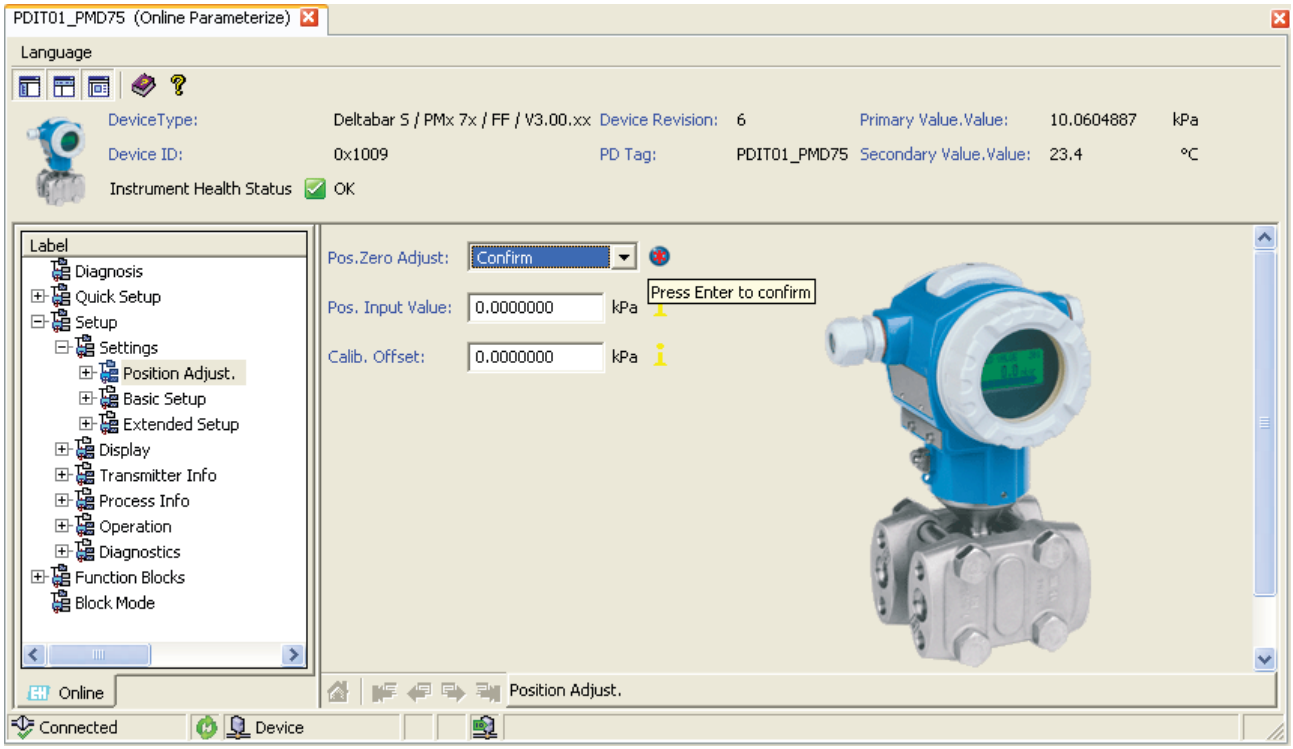

Figure 2-16. Position Adjust screen.

25. Select *Block Mode* in the parameters tree. Return the *DP_FLOW* **and** *Pressure* blocks *Target* mode to *Auto*. Also, change the *Analog Input 1 Target* mode to *OOS*. Click *Apply* to confirm your choices.

26. Go to *Function Blocks* ► *Analog Input 1* and make the changes illustrated in Figure 2-17 and Figure 2-18:

- Set *Transducer Scale.Units Index* to the same unit as *PRESS. ENG. UNIT* above (e.g., kPa).
- Enter the value corresponding to maximum pressure in the selected unit next to *Set Transducer Scale.EU at 100%*.
- Select *Indirect* for *Linearization Type*.

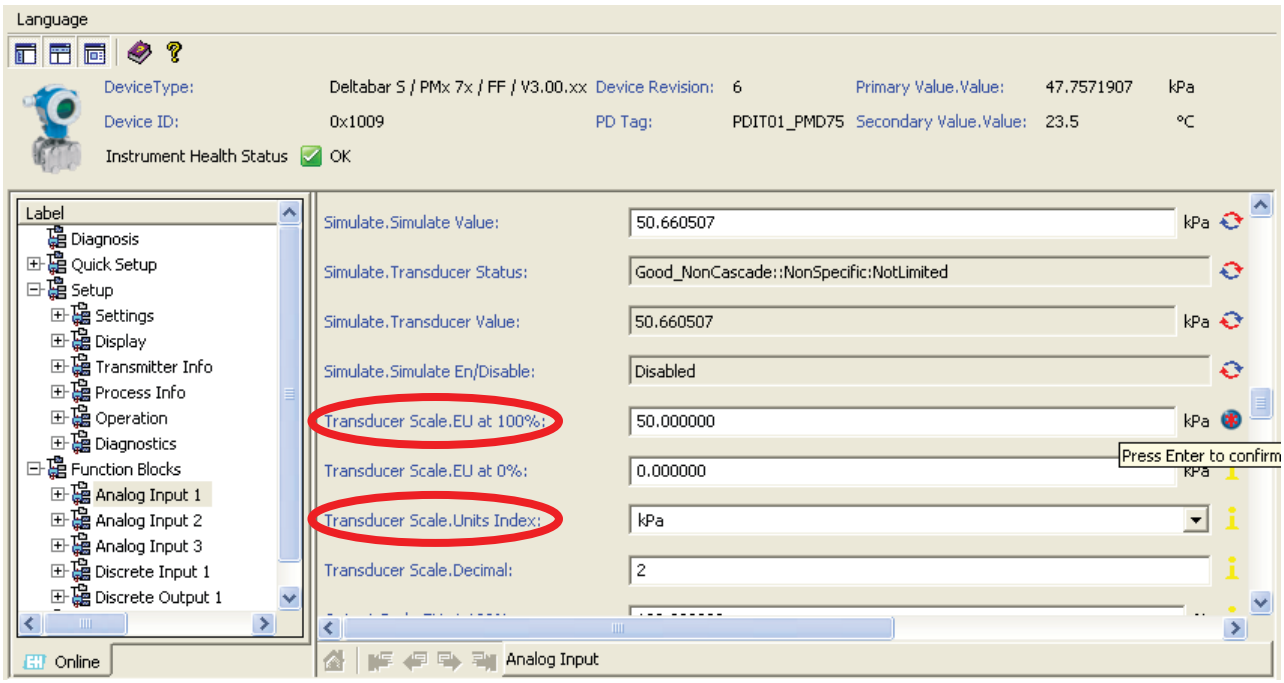

Figure 2-17. Transducer Scale.

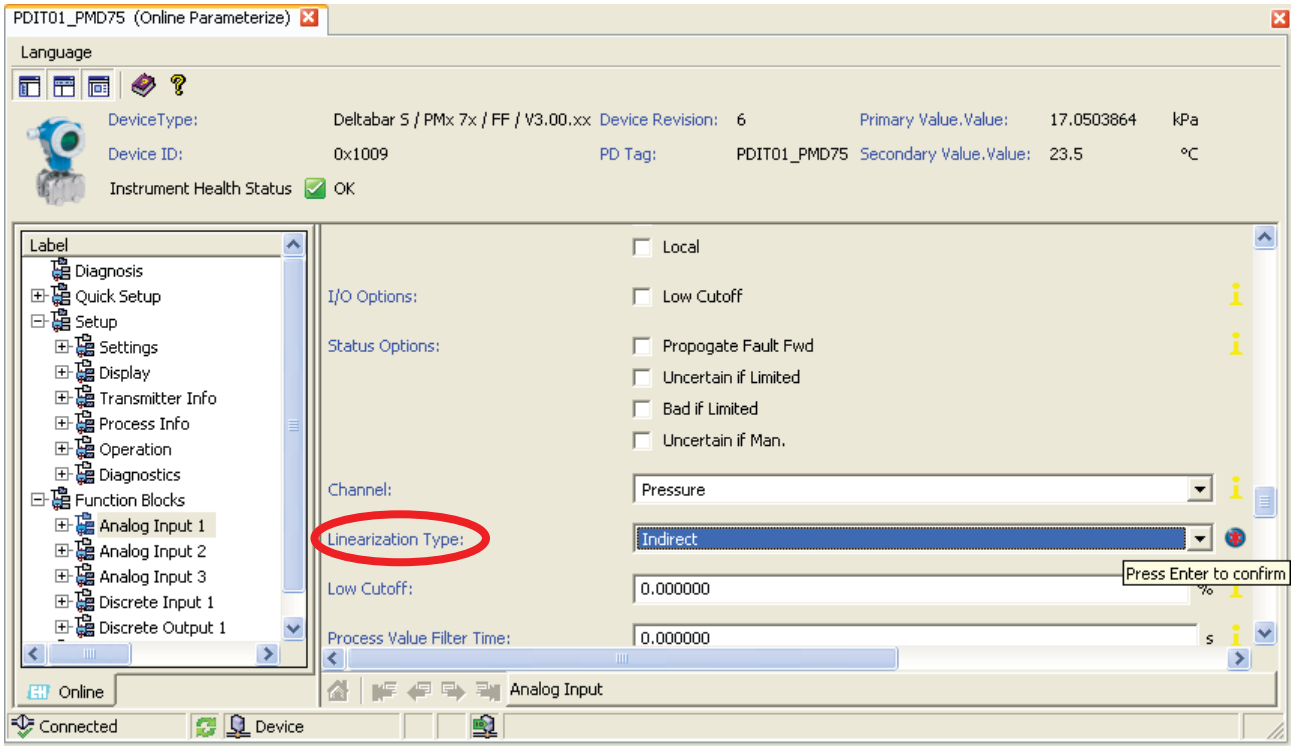

Figure 2-18. LinearizationType: Indirect.

27. Select *Block Mode* in the parameters tree. Return the *Analog Input 1* block *Target* mode to *Auto*.

28. The unit is now configured to send the sensed pressure differential into a 0-100% range over the FF network.

The device converts automatically to 0-100% values from the entire working range of the DP transmitter (i.e. 0-50 kPa (0-7.3 psi) for the low-range or 0-1600 kPa (0-240 psi) for the high-range transmitter).

Commissioning for flow rate measurements

The DP can be used to automatically convert the sensed pressure differential to a flow rate value. To configure the DP for flow rate measurement, perform the procedure below.

Keep in mind that using the low-range DP transmitter may limit the maximum flow you can measure when you use a device such as a Venturi tube.

29. Open the Online Parameterize window.

30. Select *Block Mode* in the parameters tree. Change the *DP_FLOW* **and** *Pressure with Calibration Device* blocks *Target* mode to *OOS* and click *Apply* to confirm your choices.

31. Go to *Setup* ► *Settings* ► *Basic Setup* as shown in Figure 2-19 and make the following choices:

- Set *Primary Value Type* to *Flow*. Confirm your choice by pressing *Enter*.
- Set *PRESS. ENG. UNIT* to the desired unit, usually kPa or psi. The factory setting is inH_2O. Confirm your choice by pressing *Enter*.
- Make sure that *Flow-Meas. Type* is set to *Volume p. cond*.
- Set *Unit Flow* to the desired unit (usually *L/min* or *gal/min*).
- Set *Scale In.EU at 100%*, *Max Press. Flow*, and *Max. Flow* according to your primary element pressure curve. In the example below, the DP transmitter is configured for use with a Venturi tube, in SI units with 49 kPa corresponding to 57 L/min.
- Verify that the *DAMPING_VALUE* parameter is set to an appropriate value. This parameter affects the speed at which the transmitter reacts to a change in the differential pressure sensed. The default value is two seconds, which is appropriate for most uses.

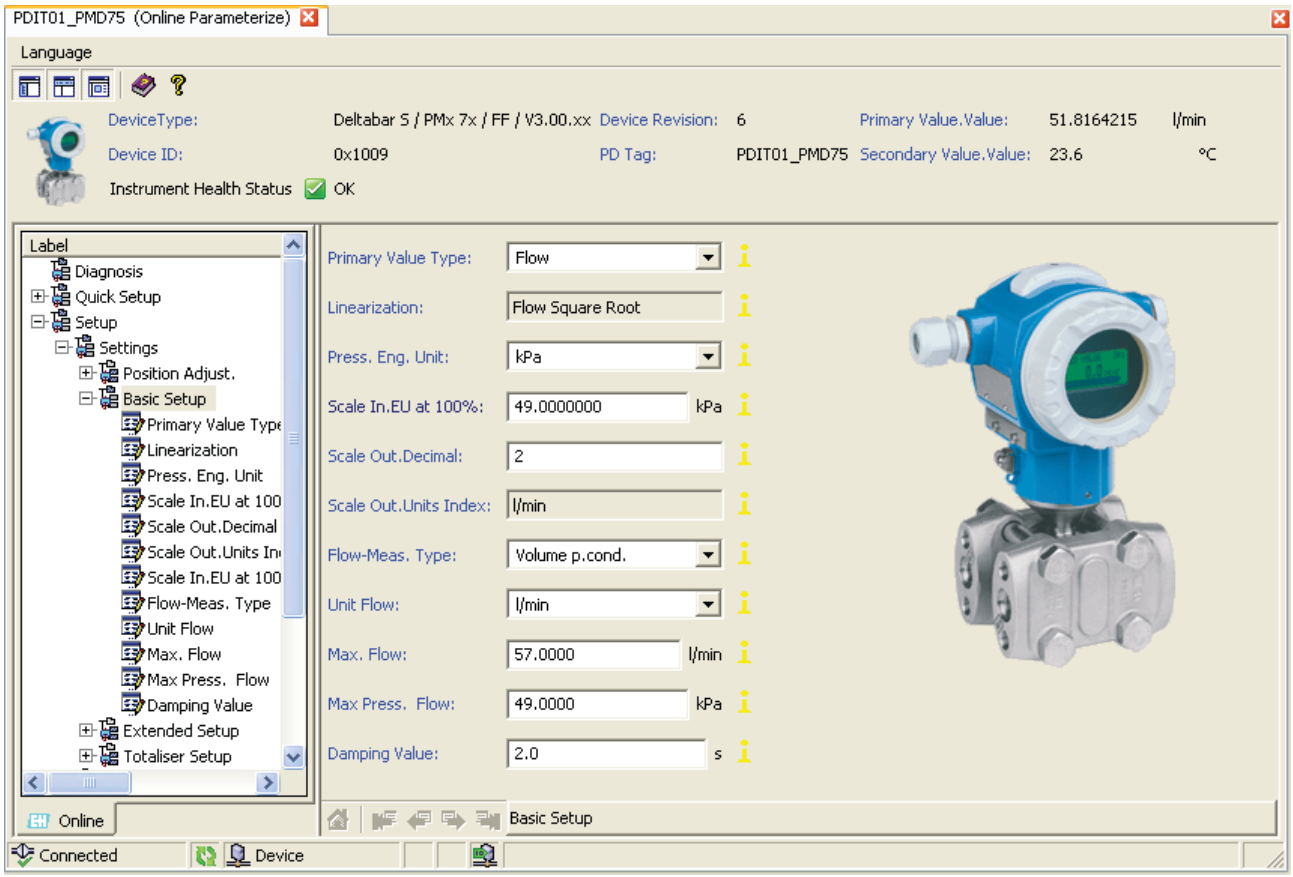

Figure 2-19. BASIC SETUP screen.

32. Go to *Setup* ► *Settings* ► *Position Adjust.* as shown in Figure 2-20. Select *Confirm* under *Pos. Zero Adjust* and press *Enter* to set the new zero.

Keep in mind that the zero must be adjusted every time you reposition the unit or impulse lines. The measurements are very sensitive to displacements, even though they are of very small magnitude.

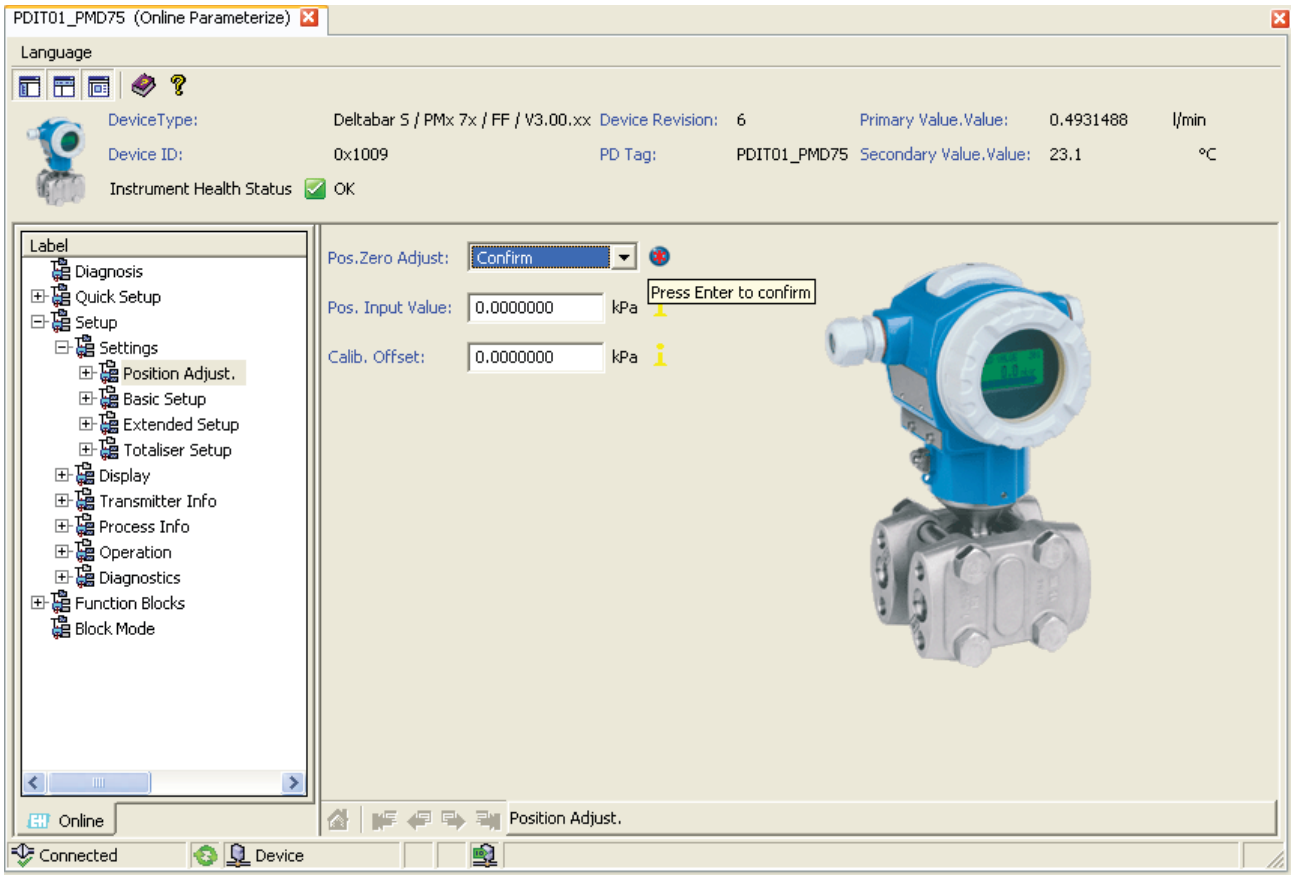

Figure 2-20. Position Adjust screen.

33. Select *Block Mode* in the parameters tree. Return the *DP_FLOW* **and** *Pressure* blocks *Target* mode to *Auto*. Also, change the *Analog Input 1 Target* mode to *OOS*. Click *Apply* to confirm your choices.

34. Go to *Function Blocks* ► *Analog Input 1* and make the changes illustrated in Figure 2-21 and Figure 2-22:

- Set *Transducer Scale.Units Index* to the same unit as *Unit Flow* (e.g., *L/min* or *gal/min*).
- Enter the value corresponding to maximum flow in the selected unit next to *Set Transducer Scale.EU at 100%* (e.g., 57 L/min).
- Select *Primary Value* for *Channel*.
- Select *Indirect* for *Linearization Type*.

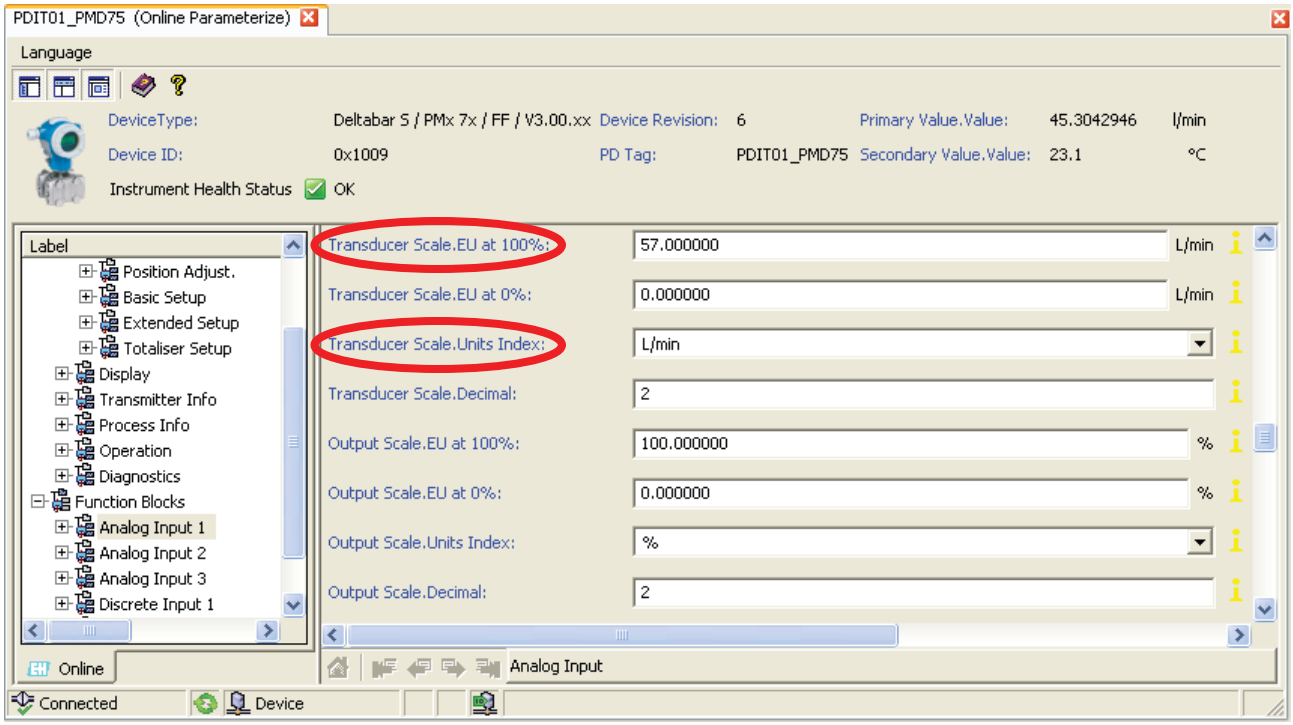

Figure 2-21. Transducer Scale.

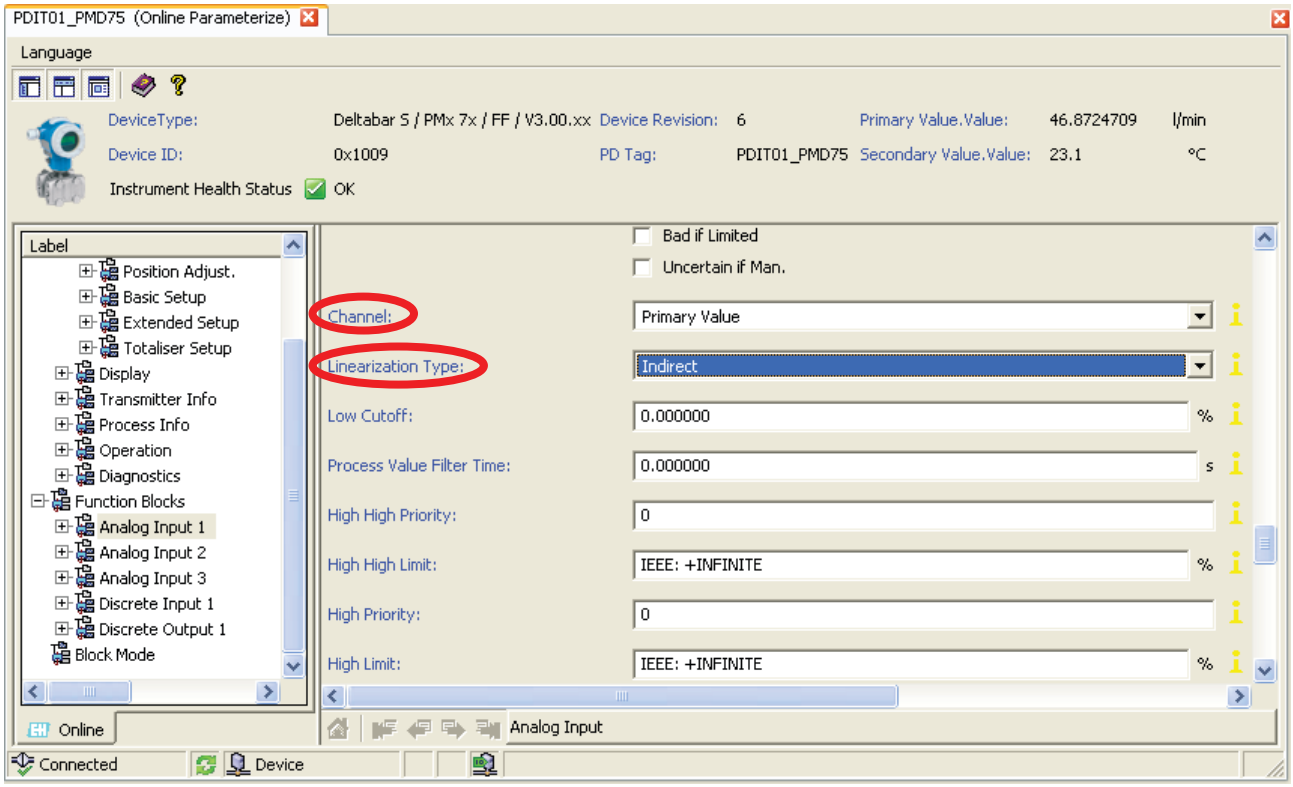

Figure 2-22. Channel and Linearization Type.

35. Select *Block Mode* in the parameters tree. Return the *Analog Input 1* block *Target* mode to *Auto*.

36. Open the *Setup* ► *Display* screen (Figure 2-23). Make sure *Main Line Cont.* is set to *Measured Value (PV)*. If not, set the *DISP* block to *OOS* mode, change *Main Line Cont.* to *Measured Value (PV)* and put the *DISP* block back to *Auto* mode.

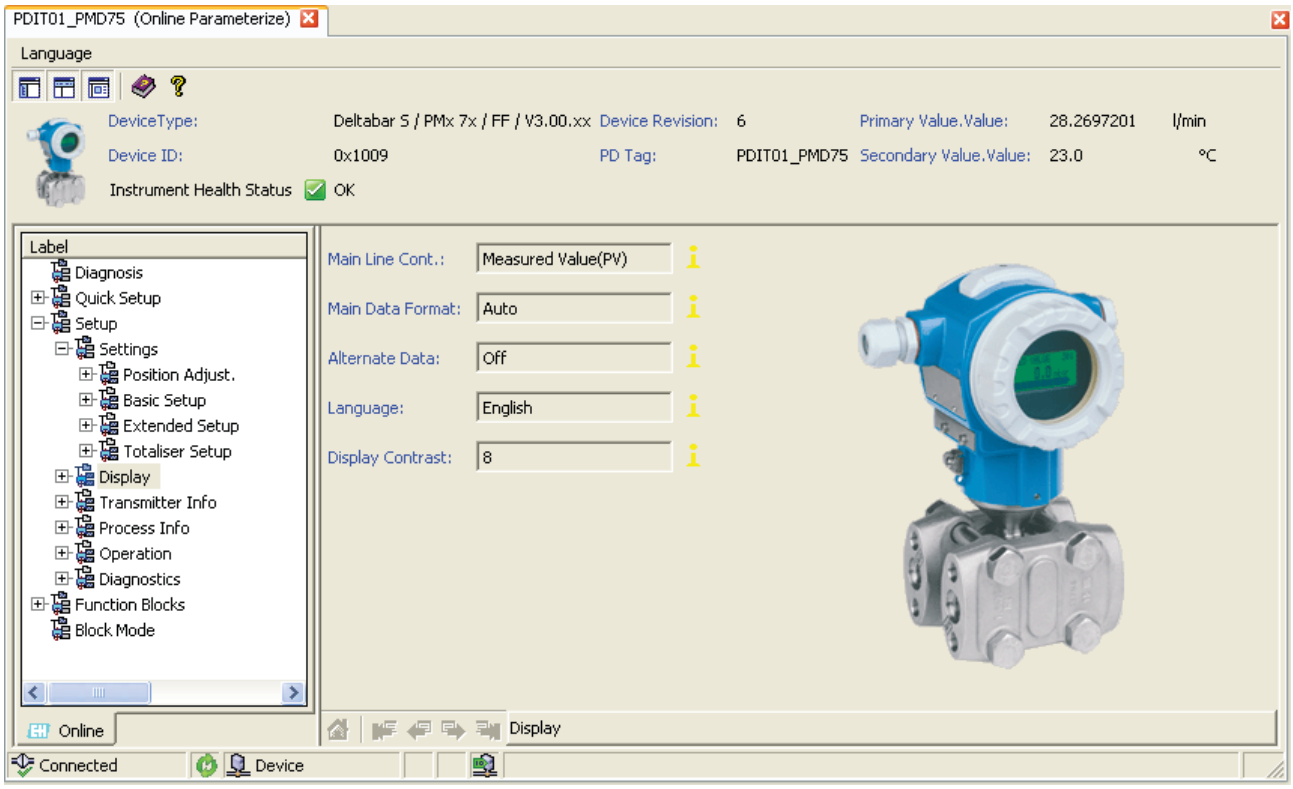

Figure 2-23. DISPLAY screen.

37. The unit is now configured to send a 0-100% proportional to the measured flow rate over the FF network. Notice that the ⎍ symbol shown at the left of the measured value on the display, indicating that the transmitter is currently working as a flowmeter.

Commissioning for level measurements

The DP transmitter can be used to automatically convert the sensed pressure differential to a level value. To configure the DP for level measurement, perform the procedure below while the DP transmitter is connected to the process column. The impulse line must be full of water (bleed your DP if necessary).

38. Open the Online Parameterize window.

39. Select *Block Mode* in the parameters tree. Change the *DP_FLOW* **and** *Pressure with Calibration Device* blocks *Target* mode to *OOS* and click *Apply* to confirm your choices.

40. Go to *Setup* ▶ *Settings* ▶ *Position Adjust.* as shown in Figure 2-24. Select *Confirm* under *Pos. Zero Adjust* and press *Enter* to set the new zero.

Keep in mind that the zero must be adjusted every time you reposition the unit or impulse lines. The measurements are very sensitive to displacements, even though they are of very small magnitude.

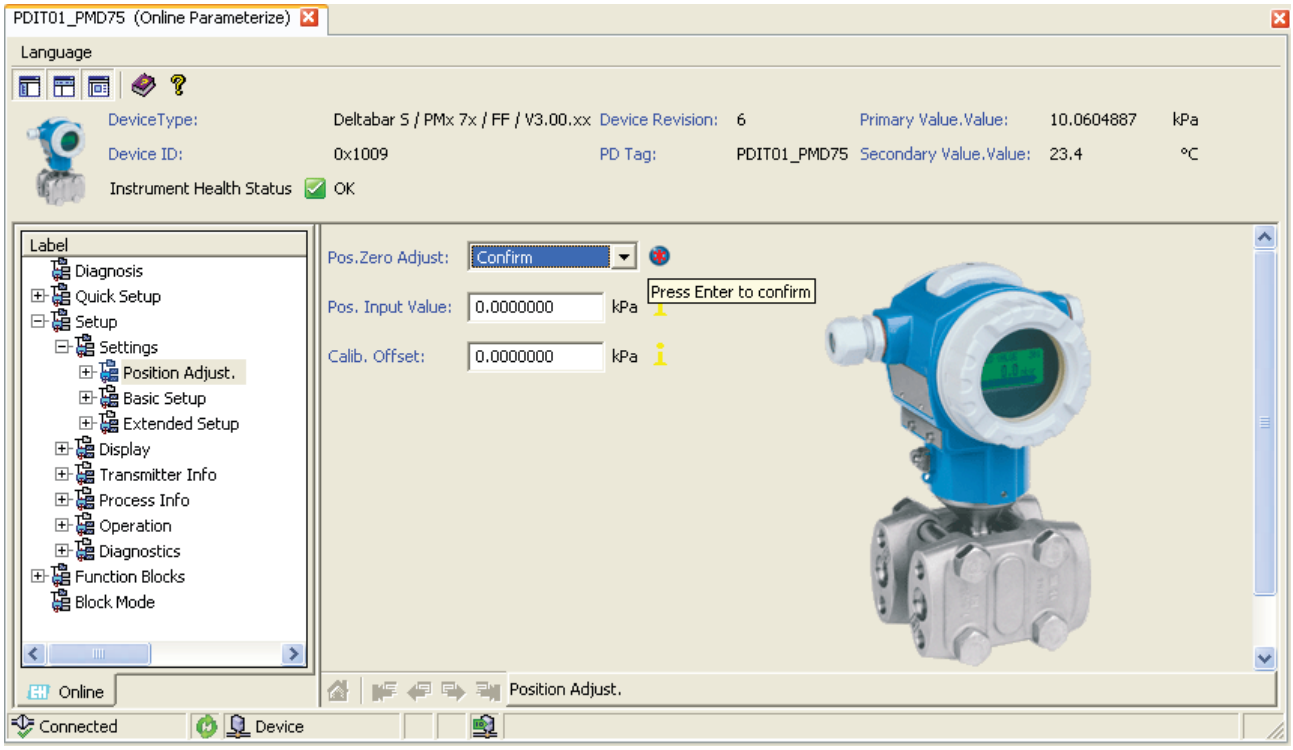

Figure 2-24. Position Adjust screen.

41. Go to *Setup* ▶ *Settings* ▶ *Basic Setup* as shown in Figure 2-25 and make the following choices:

- Set *Primary Value Type* to *Level*. Confirm your choice by pressing *Enter*.
- Set *Level Selection* to *Level Easy Pressure*. Confirm your choice by pressing *Enter*.
- Set *PRESS. ENG. UNIT* to the desired unit, usually kPa or psi. The factory setting is inH_2O. Confirm your choice by pressing *Enter*.
- Set *Output Unit Level Easy* to the desired unit, usually mm or inch. Confirm your choice by pressing *Enter*.
- Make sure that *Calibration Mode Level Easy* is set to *Wet*.
- While the column is empty, set *Empty Calib. Level Easy* to “0” and press *Enter*. The new zero is now set.

- Fill the column to the maximum level (100%) required for your current experiment. Set *Full Calib. Level Easy* to that value in the unit of your choice. Figure 2-25 is an example where a height of 30 inches corresponds to 100%.
- Verify that the *DAMPING_VALUE* parameter is set to an appropriate value. This parameter affects the speed at which the transmitter reacts to a change in the differential pressure sensed. The default value is two seconds, which is appropriate for most uses.

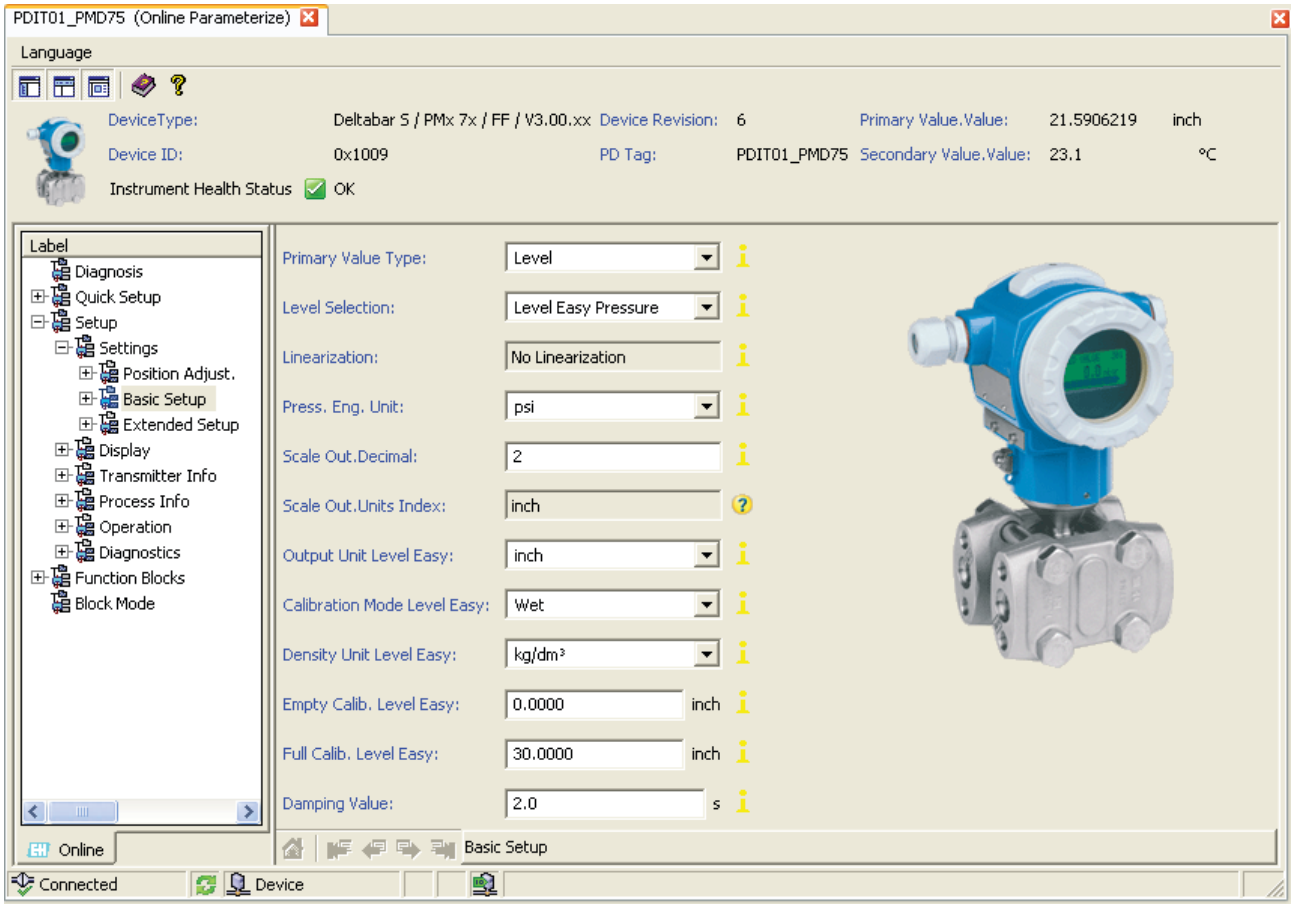

Figure 2-25. BASIC SETUP screen.

42. Select *Block Mode* in the parameters tree. Return the *DP_FLOW* **and** *Pressure* blocks *Target* mode to *Auto*. Also, change the *Analog Input 1 Target* mode to *OOS*. Click *Apply* to confirm your choices.

43. Go to *Function Blocks* ► *Analog Input 1* and make the changes illustrated in Figure 2-26 and Figure 2-27:

- Set *Transducer Scale.Units Index* to the same unit as *Output Unit Level Easy* (e.g., mm or inch).
- Enter the value corresponding to maximum level in the selected unit next to *Set Transducer Scale.EU at 100%* (e.g., 30 inches).

- Select *Primary Value* for *Channel*.
- Select *Indirect* for *Linearization Type*.

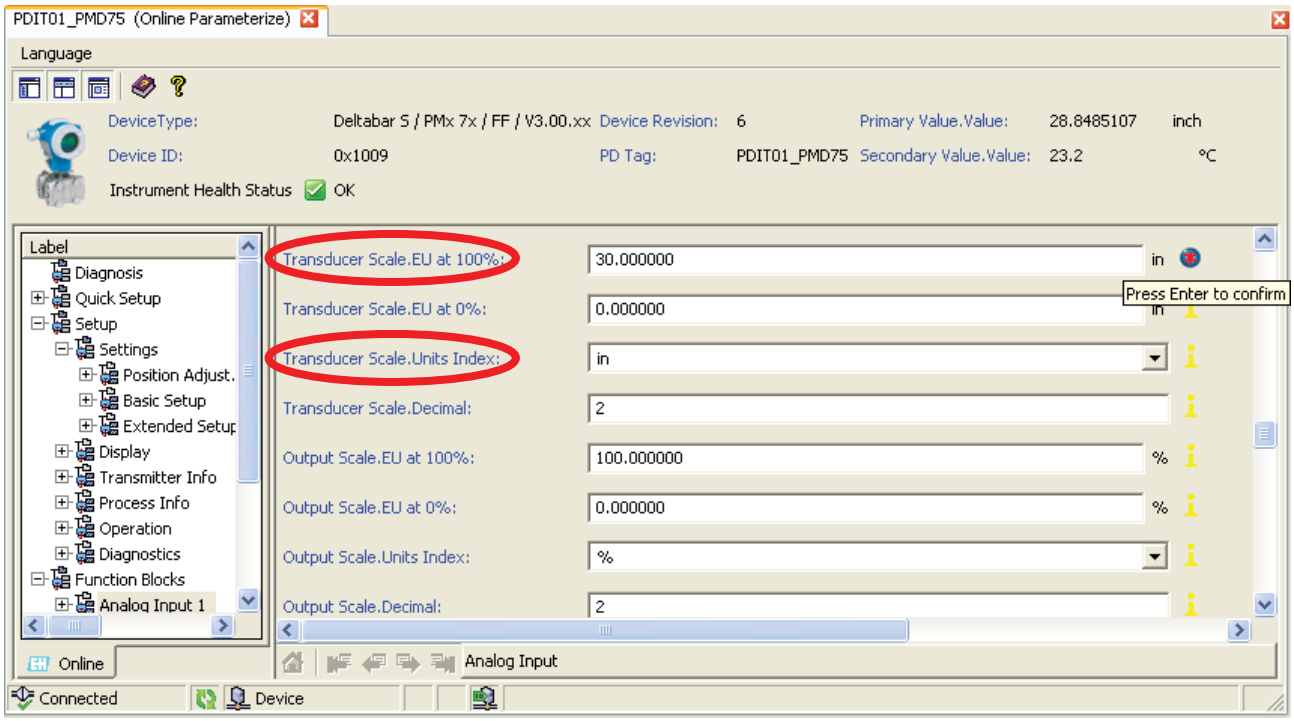

Figure 2-26. Transducer Scale.

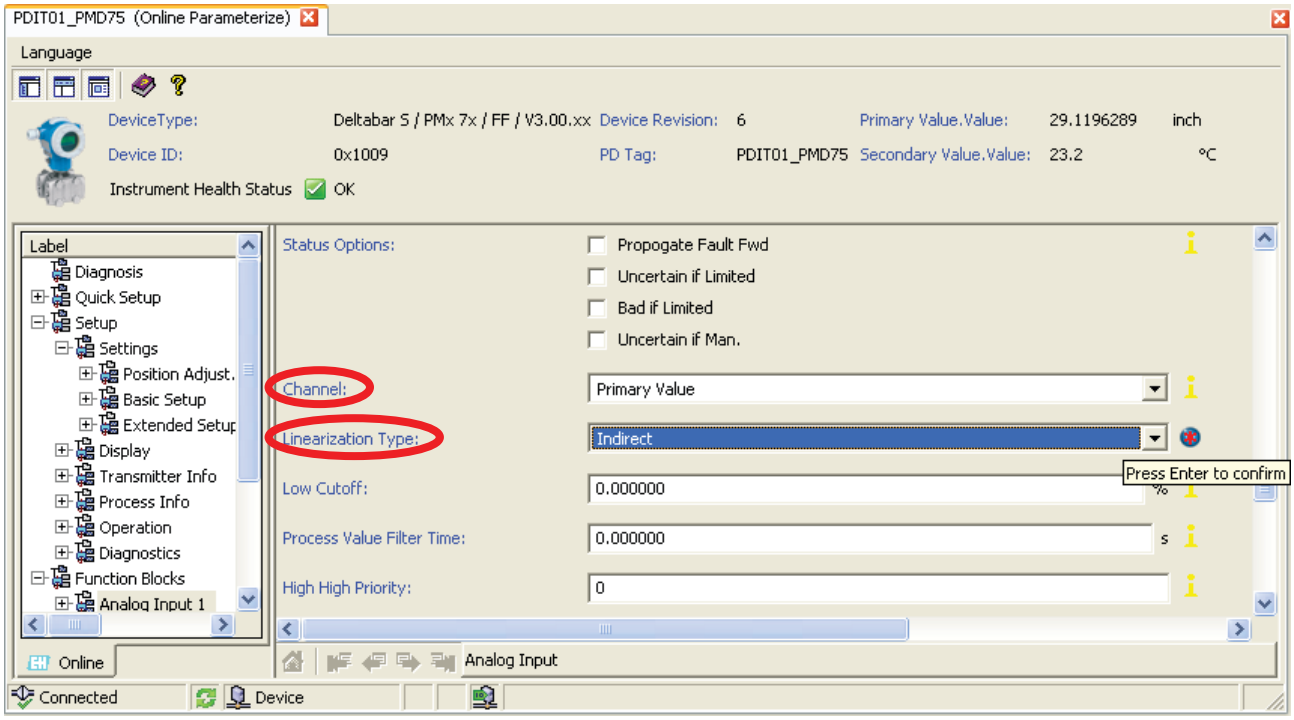

Figure 2-27. Channel and Linearization Type.

44. Select *Block Mode* in the parameters tree. Return the *Analog Input 1* block *Target* mode to *Auto*.

45. Open the *Setup* ► *Display* screen (Figure 2-28). Make sure *Main Line Cont.* is set to *Measured Value (PV)*. If not, set the *DISP* block to *OOS* mode, change *Main Line Cont.* to *Measured Value (PV)* and put the *DISP* block back to *Auto* mode.

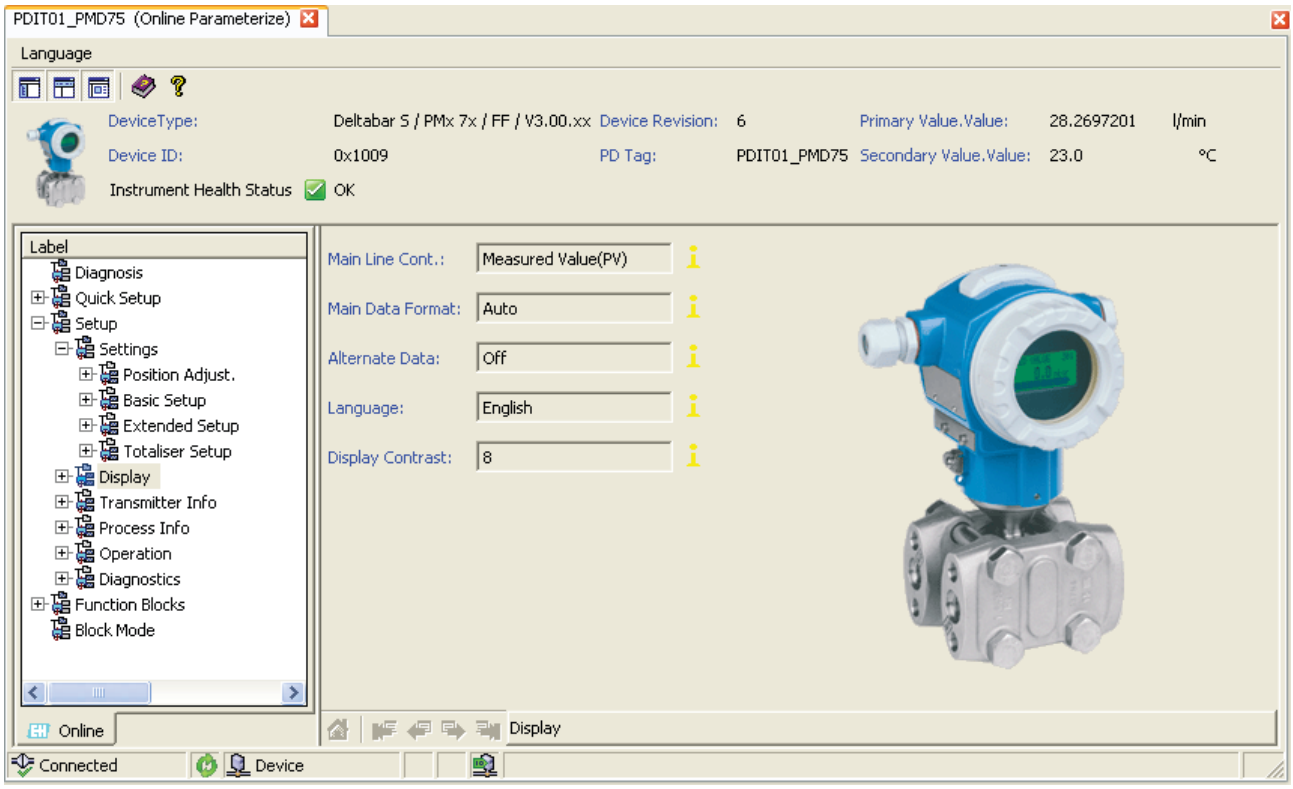

Figure 2-28. DISPLAY screen.

46. The unit is now configured to send a 0-100% output proportional to the measured level.

Testing the transmitter

Make sure to follow the safety instructions of the *Familiarization* manual regarding the Pneumatic Unit when making connections to the air outlets.

47. Connect the high-pressure inlet of the DP transmitter to a variable source of pressurized air, such as an outlet of the Pneumatic Unit.

In a level measurement configuration, you can vary the height of liquid in the process column instead of the air pressure to test the DP transmitter configuration.

48. Go to Setup ► Process Info ► Process Values. Vary the pressure applied to the DP transmitter and verify that *PRESSURE* and *Primary Value.Value* (pressure, flow, or level measurement in the unit of your choice) change according to the pressure variation.

Don't forget that flow measurements are proportional to the square root of the measured pressure!

49. Go to Function Blocks ► Analog Input 1. Make sure that *Output.Value* is a percentage that is proportional to the maximum process value expected. For instance, in the case of a level measurement where 30 inches correspond to 100% level, a 15-inch mark should result in an *Output.Value* parameter of 50%. This parameter is sent over the FOUNDATION Fieldbus network and hence, is very important to check. At the same time, the parameter status (*Output.Status*) should indicate *GOOD*.

If you wish to verify that the correct 0-100% value is passed over the FOUNDATION Fieldbus network, there are at least two ways to do so. The first one is to visualize the online value of the AI block OUT parameter in your RSFieldbus *project. Another one is to check the Logix block input value received by the PLC from within* RSLogix 5000.

50. Close the main switch to cut the power to the Instrumentation and Process Control Training System.

Conclusion

In this exercise, you have configured selected parameters of a FOUNDATION Fieldbus differential-pressure transmitter.

Review Questions

1. What is the default measurement mode of the differential-pressure transmitter?

Pressure measurement.

2. What are the two ways of locking the differential-pressure transmitter?

Actuating a dip switch and remotely, via software.

3. Why must the differential-pressure transmitter zero be adjusted whenever the setup is modified?

Measurements are very sensitive to displacements.

4. Which types of measurement can the differential-pressure transmitter accomplish?

Pressure, flow, and level measurement.

5. Which graphical tool can help you configure the differential-pressure transmitter for flow measurement?

Primary element pressure curve.

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