

Section 6 **Advanced Pressure Diagnostics for FOUNDATION fieldbus**

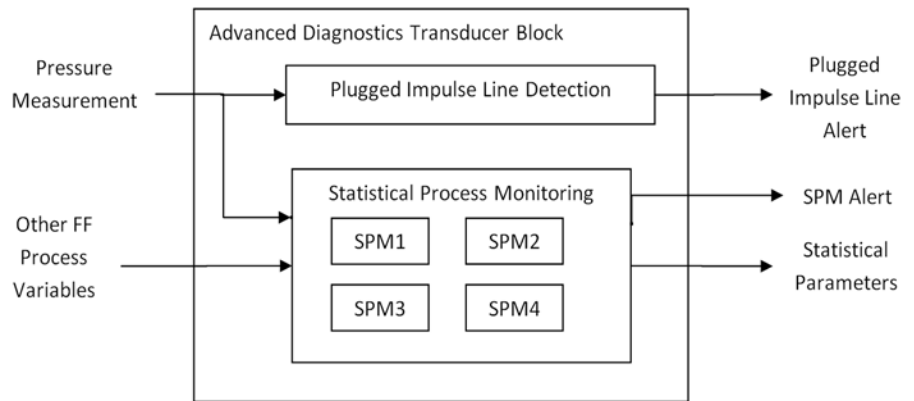
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OVERVIEW

The 3051S FOUNDATION fieldbus Pressure Transmitter with Advanced Diagnostics Suite is an extension of the Rosemount 3051S Scalable Pressure transmitter and takes full advantage of the architecture. The 3051S SuperModule™ Platform generates the pressure measurement. The Foundation fieldbus Feature Board is mounted in the PlantWeb housing and plugs into the top of the SuperModule. The Advanced Diagnostics Suite is a licensable option on the Foundation fieldbus feature board, and designated by the option code “D01” in the model number.

The Advanced Diagnostics Suite has two distinct diagnostic functions, Statistical Process Monitoring (SPM) and Plugged Impulse Line Detection (PIL), which can be used separately or in conjunction with each other to detect and alert users to conditions that were previously undetectable, or provide powerful troubleshooting tools. Figure 6-1 illustrates an overview of these two functions within the Fieldbus Advanced Diagnostics Transducer Block.

Figure 6-1. Advanced Diagnostics Transducer Block Overview



Statistical Process Monitoring (SPM)

The Advanced Diagnostics Suite features SPM technology to detect changes in the process, process equipment or installation conditions of the transmitter. This is done by modeling the process noise signature (using the statistical values of mean and standard deviation) under normal conditions and then comparing the baseline values to current values over time. If a significant change in the current values is detected, the transmitter can generate an alert. The SPM can perform its statistical processing on either the primary value of the field device (e.g. pressure measurement) or any other process variable available in one of the device's other Fieldbus function blocks (e.g. the device sensor temperature, control signal, valve position, or measurement from another device on the same fieldbus segment). SPM has the capability of modeling the noise signatures for up to four process variables simultaneously (SPM1-SPM4). When SPM detects a change in the process statistical characteristics, it generates an alert. The statistical values are also available as secondary variables from the transmitter via AI or MAI Function Blocks if a user is interested in their own analysis or generating their own alarms.

Plugged Impulse Line (PIL) Diagnostics

The Advanced Diagnostics Suite also implements a plugged impulse line detection algorithm. PIL leverages SPM technology and adds some additional features that apply SPM to directly detect plugging in pressure measurement impulse lines. In addition to detecting a change in the process noise signature, the PIL also provides the ability to automatically relearn new baseline values if the process condition changes. When PIL detects a plug, a "Plugged Impulse Line Detected" PlantWeb alert is generated. Optionally, the user can configure the PIL to, when a plugged impulse line is detected, change the pressure measurement status quality to "Uncertain", to alert an operator that the pressure reading may not be reliable.

IMPORTANT

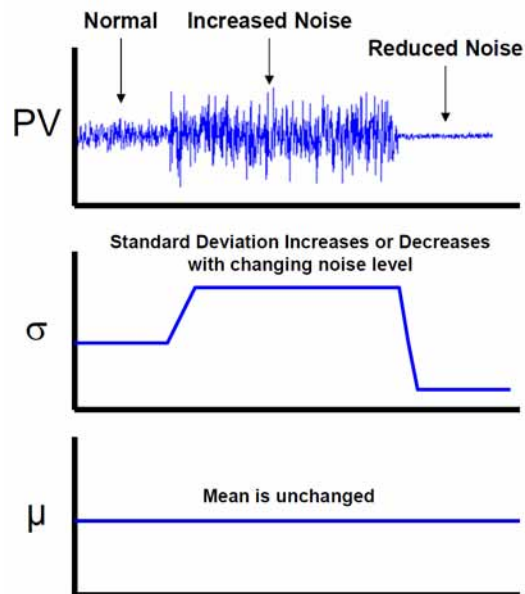
Running the Advanced Diagnostics Block could affect other block execution times. We recommend the device be configured as a basic device versus a Link Master device if this is a concern.

STATISTICAL PROCESS MONITORING TECHNOLOGY

Emerson has developed a unique technology, Statistical Process Monitoring, which provides a means for early detection of abnormal situations in a process environment. The technology is based on the premise that virtually all dynamic processes have a unique noise or variation signature when operating normally. Changes in these signatures may signal that a significant change will occur or has occurred in the process, process equipment, or transmitter installation. For example, the noise source may be equipment in the process such as a pump or agitator, the natural variation in the DP value caused by turbulent flow, or a combination of both.

The sensing of the unique signature begins with the combination of a high speed sensing device, such as the Rosemount 3051S Pressure Transmitter, with software resident in a FOUNDATION fieldbus Feature Board to compute statistical parameters that characterize and quantify the noise or variation. These statistical parameters are the mean and standard deviation of the input pressure. Filtering capability is provided to separate slow changes in the process due to setpoint changes from the process noise or variation of interest. Figure 6-2 shows an example of how the standard deviation value (σ) is affected by changes in noise level while the mean or average value (μ) remains constant. The calculation of the statistical parameters within the device is accomplished on a parallel software path to the path used to filter and compute the primary output signal (e.g. the pressure measurement used for control and operations). The primary output is not affected in any way by this additional capability.

Figure 6-2. Changes in process noise or variability and affect on statistical parameters



The device can provide the statistical information to the user in two ways. First, the statistical parameters can be made available to the host system directly via Foundation fieldbus communication protocol or FF to other protocol converters. Once available, the system may make use of these statistical parameters to indicate or detect a change in process conditions. In the simplest example, the statistical values may be stored in the DCS historian. If a process upset or equipment problem occurs, these values can be examined to determine if changes in the values foreshadowed or indicated the process upset. The statistical values can then be made available to the operator directly, or made available to alarm or alert software.

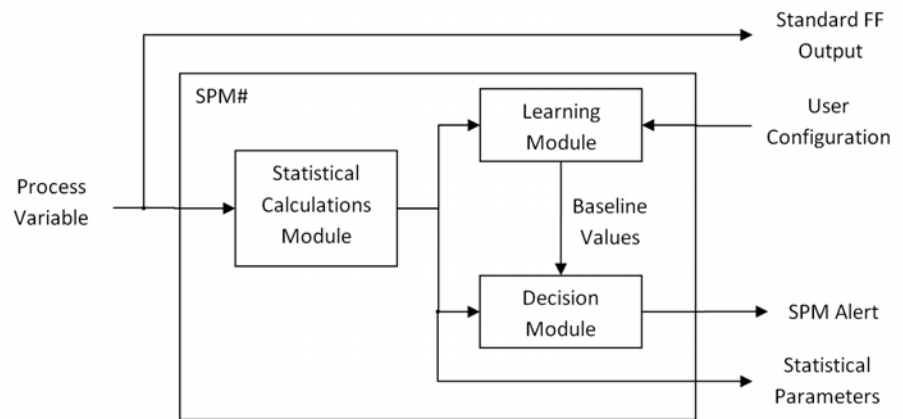
Second, the device has internal software that can be used to baseline the process noise or signature via a learning process. Once the learning process is completed, the device itself can detect significant changes in the noise or variation, and communicate an alarm via PlantWeb alert. Typical applications are change in fluid composition or equipment related problems.

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SPM Functionality

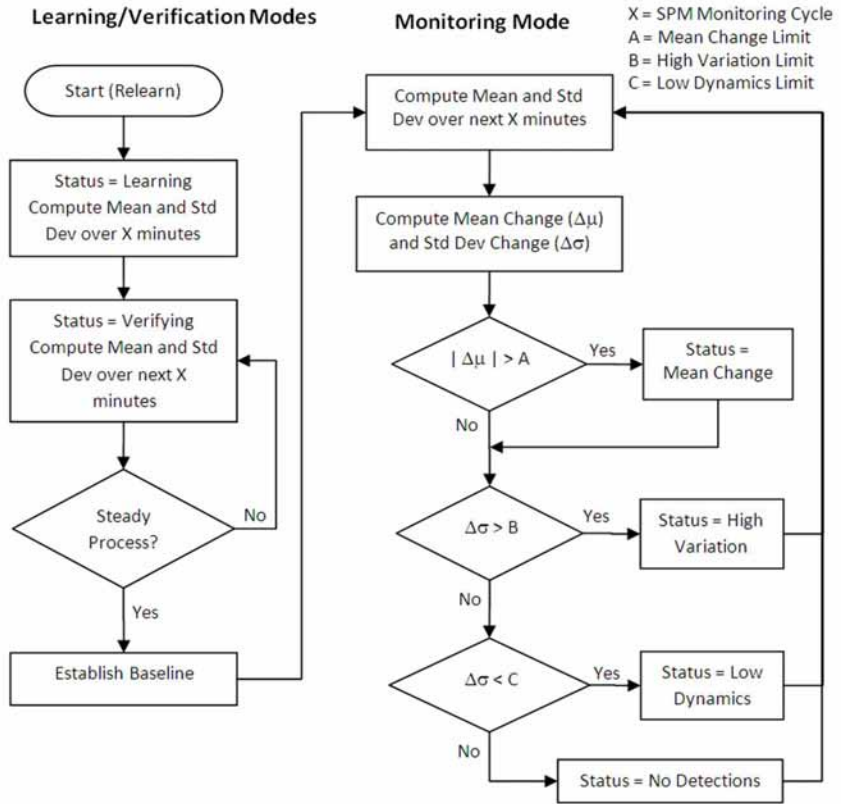
A block diagram of the Statistical Process Monitoring (SPM) diagnostic is shown in Figure 6-3. Note from Figure 6-1 that the 3051S FF has four Statistical Process Monitoring blocks (SPM1-SPM4). Figure 6-3 illustrates just one of the SPM blocks. The process variable (which could be either the measured pressure or some other variable from the fieldbus segment) is input to a Statistical Calculations Module where basic high pass filtering is performed on the pressure signal. The mean (or average) is calculated on the unfiltered pressure signal, the standard deviation calculated from the filtered pressure signal. These statistical values are available via handheld communication devices like the 375 Field Communicator or asset management software like Emerson Process Management's AMS™ Device Manager, or distributed control systems with Foundation fieldbus, such as DeltaV.

Figure 6-3. Diagram of 3051S
FF Statistical Process
Monitoring



SPM also contains a learning module that establishes the baseline values for the process. Baseline values are established under user control at conditions considered normal for the process and installation. These baseline values are made available to a decision module that compares the baseline values to the most current values of the mean and standard deviation. Based on sensitivity settings and actions selected by the user via the control input, the diagnostic generates a device alert when a significant change is detected in either mean or standard deviation.

Figure 6-4. Flow Chart of 3051S
 FF Statistical Process
 Monitoring



Further detail of the operation of the SPM diagnostic is shown in the Figure 6-4 flowchart. This is a simplified version showing operation using the default values. After configuration, SPM calculates mean and standard deviation, used in both the learning and the monitoring modes. Once enabled, SPM enters the learning/verification mode. The baseline mean and standard deviation are calculated over a period of time controlled by the user (SPM Monitoring Cycle; default is 15 minutes). The status will be “Learning”. A second set of values is calculated and compared to the original set to verify that the measured process is stable and repeatable. During this period, the status will change to “Verifying”. If the process is stable, the diagnostic will use the last set of values as baseline values and move to “Monitoring” status. If the process is unstable, the diagnostic will continue to verify until stability is achieved.

In the “Monitoring” mode, new mean and standard deviation values are continuously calculated, with new values available every few seconds. The mean value is compared to the baseline mean value, and the standard deviation is compared to the baseline standard deviation value. If either the mean or the standard deviation has changed more than user-defined sensitivity settings, an alert is generated via FOUNDATION fieldbus. The alert may indicate a change in the process, equipment, or transmitter installation.

NOTE:

The Statistical Process Monitoring diagnostic capability in the Rosemount 3051S FOUNDATION fieldbus Pressure Transmitter calculates and detects significant changes in statistical parameters derived from the input process variable. These statistical parameters relate to the variability of and the noise signals present in the process variable. It is difficult to predict specifically which noise sources may be present in a given measurement or control application, the specific influence of those noise sources on the statistical parameters, and the expected changes in the noise sources at any time. Therefore, Rosemount cannot absolutely warrant or guarantee that Statistical Process Monitoring will accurately detect each specific condition under all circumstances.

SPM CONFIGURATION AND OPERATION

SPM Configuration for Monitoring Pressure

The following section describes the process of configuring and using the Statistical Process Monitoring diagnostic.

Most Advanced Diagnostics Applications require using the device's pressure measurement as the SPM input. To configure the first SPM Block (SPM1) to monitor the pressure set the following parameters:

SPM1_Block_Tag = TRANSDUCER

NOTE:

By default, as shipped from the factory, the tag of the sensor transducer block is "TRANSDUCER". DeltaV does not change the transducer block tags when the device is installed and commissioned. However, it is possible that other Fieldbus host systems may change the transducer block tags. If this happens, SPM#_Block_Tag must be set to whatever tag was assigned by the host.

SPM1_Block_Type = TRANSDUCER Block

SPM1_Parameter_Index = Pressure (inH₂O @ 68 °F)

SPM1_User_Command = Learn

(optional) SPM_Monitoring_Cycle = [1 – 5] minutes (see "Other SPM Settings" on page 6-7)

(optional) SPM_Bypass_Verification = [Yes/No] (see page 6-7)

Apply all of these above changes to the device. Finally, set

SPM_Active = Enabled with 1st-order HP Filter

After SPM is enabled, it will spend the first 5 (whatever the SPM_Monitoring_Cycle is set to) minutes in the learning phase, and then another 5 minutes in the verification phase. If a steady process is detected at the end of the verification phase, the SPM will move into the monitoring phase. After 5 minutes in the monitoring phase, SPM will have the current statistical values (e.g. current mean and standard deviation), and will begin comparing them against the baseline values to determine if an SPM Alert is detected.

SPM Configuration for Monitoring Other Process Variables

Advanced users may wish use SPM to monitor other Fieldbus parameters available within the pressure transmitter. Examples of such parameters would include module sensor temperature, PID control output, valve position, or a process measurement from another device on the same Fieldbus segment. Configuration of SPM for other process variables is similar to what is done for pressure, except that the Block Tag, Block Type, and Parameter Index parameters are different.

Note that # should be replaced by the number of the SPM block which you are configuring (1, 2, 3, or 4).

SPM#_Block_Tag

The tag of the Fieldbus transducer or function block that contains the parameter to be monitored. Note that the tag must be entered manually – there is no pull-down menu to select the tag. SPM can also monitor “out” parameters from other devices. To do this, link the “out” parameter to an input parameter of a function block that resides in the device, and set up SPM to monitor the input parameter.

SPM#_Block_Type

The type of block which was entered into SPM#_Block_Tag. This could be either a Transducer block, or one of the function blocks.

SPM#_Parameter_Index

The parameter (e.g. OUT, PV, FIELD_VAL) of the transducer or function block which you want to monitor.

See “Example Configuration of SPM using Function Block” on page 6-12 for an example of this using DeltaV.

Other SPM Settings

Additional information on other SPM settings is shown below:

SPM_Bypass_Verification

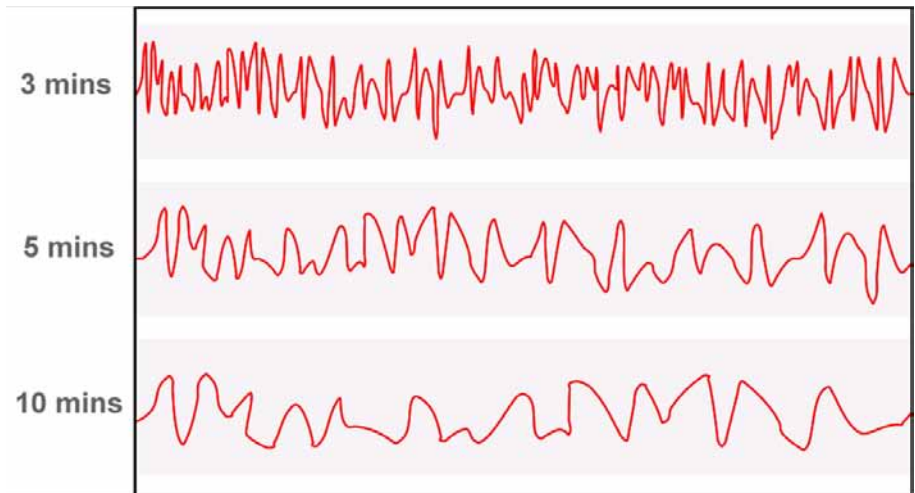
If this is set to “Yes”, SPM will skip the verification process, and the first mean and standard deviation from the learning phase will be taken as the baseline mean and standard deviation. By skipping the verification, the SPM can move into the monitoring phase more quickly. This parameter should only be set to “Yes” if you are certain that the process is at a steady-state at the time you start the Learning. The default (and recommended) setting is “No”.

SPM_Monitoring_Cycle

This is the length of the sample window over which mean and standard deviation are computed. A shorter sample window means that the statistical values will respond faster when there are process changes, but there is also a greater chance of generating false detections. A longer sample window means that mean and standard deviation will take longer to respond when there is a process change. The default value is 15 minutes. For most applications a Monitoring Cycle ranging from 1 to 10 minutes is appropriate. The allowable range is 1 to 1440 minutes (for software revisions 2.0.x or earlier, the minimum SPM Monitoring Cycle is 5 minutes).

Figure 6-5 illustrates the effect of the SPM Monitoring Cycle on the Statistical Calculations. Notice how with a shorter sampling window there is more variation (e.g. the plot looks noisier) in the trend. With the longer sampling window the trend looks smoother because the SPM uses process data averaged over a longer period of time.

Figure 6-5. Effect of the SPM Monitoring Cycle on the Statistical Values



SPM#_User_Command

Select “Learn” after all the parameters have been configured to begin the Learning Phase. The monitoring phase will start automatically after the learning process is complete. Select “Quit” to stop the SPM. “Detect” may be selected to return to the monitoring phase.

SPM_Active

The SPM_Active parameter starts the Statistical Process Monitoring when “Enabled”. “Disabled” (default) turns the diagnostic monitoring off. Must be set to “Disabled” for configuration. Only set to “Enabled” after fully configuring the SPM. When Enabling SPM, you may select one of two options:

Enabled with 1st-Order HP Filter

Applies a high-pass filter to the pressure measurement prior to calculating standard deviation. This removes the effect of slow or gradual process changes from the standard deviation calculation while preserving the higher-frequency process fluctuations. Using the high-pass filter reduces the likelihood of generating a false detection if there is a normal process or setpoint change. For most diagnostics applications, you will want to use the filter.

Enabled w/o Filter

This enables SPM without applying the high-pass filter. Without the filter, changes in the mean of the process variable will cause an increase in the standard deviation. Use this option only if there are very slow process changes (e.g. an oscillation with a long period), which you wish to monitor using the standard deviation.

Configuration of Alerts

In order to have SPM generate a PlantWeb alert, the alert limits must be configured on the mean and/or standard deviation. The three alert limits available are:

SPM#_Mean_Lim

Upper and lower limits for detecting a Mean Change

SPM#_High_Variation_Lim

Upper limit on standard deviation for detecting a High Variation condition

SPM#_Low_Dynamics_Lim

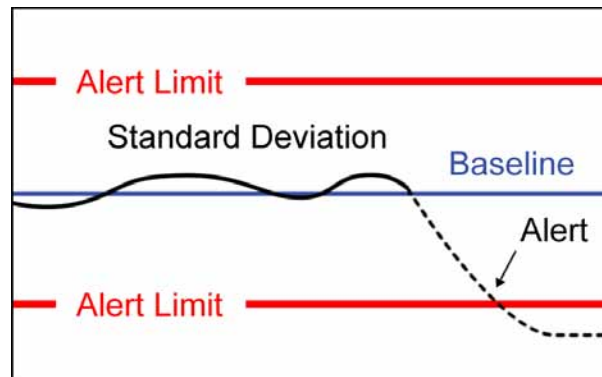
Lower limit on standard deviation for detecting a Low Dynamics condition (must be specified as a negative number)

All of these limits are specified as a percent change in the statistical value from its baseline. If a limit is set to 0 (the default setting) then the corresponding diagnostic is disabled. For example, if SPM#_High_Variation_Limit is 0, then SPM# does not detect an increase in standard deviation.

Figure 6-6 illustrates an example of the standard deviation, with its baseline value and alert limits. During the monitoring phase, the SPM will continuously evaluate the standard deviation and compare it against the baseline value. An alert will be detected if the standard deviation either goes above the upper alert limit, or below the lower alert limit.

In general, a higher value in any of these limits leads to the SPM diagnostic being less sensitive, because a greater change in mean or standard deviation is needed to exceed the limit. A lower value makes the diagnostic more sensitive, and could potentially lead to false detections.

Figure 6-6. Example Alerts for Standard Deviation



SPM Operations

During operation, the following values are updated for each SPM Block (e.g. SPM1-SPM4)

SPM#_Baseline_Mean

Baseline Mean (calculated average) of the process variable, determined during the Learning/Verification process, and representing the normal operating condition

SPM#_Mean

Current Mean of the process variable

SPM#_Mean_Change

Percent change between the Baseline Mean and the Current Mean

SPM#_Baseline_StDev

Baseline Standard Deviation of the process variable, determined during the Learning/Verification process, and representing the normal operating condition

SPM#_StDev

Current Standard Deviation of the process variable

SPM#_StDev_Change

Percent change between the Baseline Standard Deviation and the Current Standard Deviation

SPM#_Timestamp

Timestamp of the last values and status for the SPM

SPM#_Status

Current state of the SPM Block. Possible values for SPM Status are as follows:

Status Value	Description
Inactive	User Command in "Idle", SPM not Enabled, or the function block is not scheduled.
Learning	Learning has been set in the User Command, and the initial baseline values are being calculated
Verifying	Current baseline values and previous baseline values or being compared to verify the process is stable.
Monitoring	Monitoring the process and no detections are currently active.
Mean Change Detected	Alert resulting from the Mean Change exceeding the Threshold Mean Limit. Can be caused by a set point change, a load change in the flow, or an obstruction or the removal of an obstruction in the process.
High Variation Detected	Alert resulting from the Stdev Change exceeding the Threshold High Variation value. This is an indicator of increased dynamics in the process, and could be caused by increased liquid or gas in the flow, control or rotational problems, or unstable pressure fluctuations.
Low Dynamics Detected	Alert resulting from the Stdev Change exceeding the Threshold Low Dynamics value. This is an indicator for a lower flow, or other change resulting in less turbulence in the flow.
Not Licensed	SPM is not currently purchased in this device.

In most cases, only one of the above SPM status bits will be active at one time. However, it is possible for "Mean Change Detected" to be active at the same time as either "High Variation Detected" or "Low Dynamics Detected" is active.

PlantWeb Alert

When any of the SPM detections (Mean Change, High Variation, or Low Dynamics) is active, a Fieldbus PlantWeb alert in the device "Process Anomaly Detected (SPM)" will be generated and sent to the host system. However, note that there is just one SPM PlantWeb alert, and it applies to all the detections on all four SPM blocks.

Trending Statistical Values in Control System

SPM Mean and Standard Deviation values may be viewed and/or trended in a Fieldbus host system through the AI or MAI function blocks.

An Analog Input (AI) block may be used to read either the mean or the standard deviation from any one of the SPM Blocks. To use the AI block to trend SPM data, set the CHANNEL parameter to one of the following values:

Table 6-1. Valid SPM Channels for the AI Block

Channel	SPM Variable
12	SPM1 mean
13	SPM1 standard deviation
14	SPM2 mean
15	SPM2 standard deviation
16	SPM3 mean
17	SPM3 standard deviation
18	SPM4 mean
19	SPM4 standard deviation

See Table 3-1 for a complete listing of valid Channels for the AI Block.

The SPM Mean and Standard Deviation are always displayed in the unit inches of water, regardless of the measurement unit configured in the transducer block for the primary pressure measurement. Therefore, when configuring an AI Block to read one of the SPM values, the engineering unit of the XD_SCALE parameter must be set to “inH2O at 68 °F”.

The OUT_SCALE parameter should be set to the engineering unit and range which are desired for the mean and standard deviation output. For example, it is possible to use the OUT_SCALE parameter to convert mean and standard deviation to some other pressure unit. See “Analog Input (AI) Function Block” on page 3-8 for additional details on setting the XD_SCALE, OUT_SCALE, and L_TYPE parameters of the AI function block.

The Multiple Analog Input (MAI) function block can be used to read the mean and standard deviation from all four SPM blocks simultaneously. The Channel of the MAI block must be set to 11. The mapping between output parameters of the MAI and the SPM values is shown in Table 6-2:

Table 6-2. SPM Output Values for the MAI Block

Parameter	SPM Variable
OUT1	SPM1 mean
OUT2	SPM1 standard deviation
OUT3	SPM2 mean
OUT4	SPM2 standard deviation
OUT5	SPM3 mean
OUT6	SPM3 standard deviation
OUT7	SPM4 mean
OUT8	SPM4 standard deviation

The output values from the MAI block are always in the unit inH₂O.

SPM Configuration with EDDL

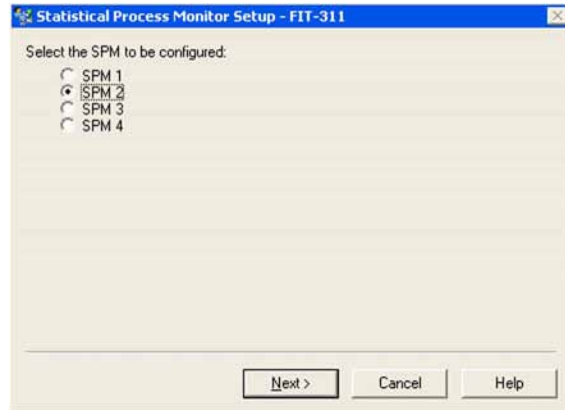
For host systems that support Electronic Device Description Language (EDDL), using SPM is made easier with step-by-step configuration guidance and graphical displays. This section of the manual uses AMS Device Manager version 10.5 for illustrations, although other EDDL hosts could be used as well.

The SPM Configuration Wizard can be launched by clicking the button “Statistical Process Monitor Setup” from the page Configure > Guided Setup

This Wizard will take you step-by-step through the parameters that need to be set in order to configure SPM. On the first screen (Figure 6-7), select which SPM block (1, 2, 3, or 4) that you want to configure.

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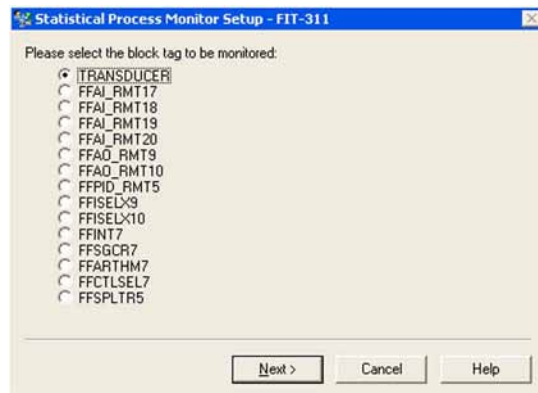
Figure 6-7. SPM Configuration Wizard - Selecting the SPM to Configure



The Wizard will then take you through the process of setting the parameters corresponding to the Block Tag, Block Parameter, Monitoring Cycle, and Bypass Verification.

On Fieldbus hosts that support Device-Dashboard functionality (e.g. AMS Device Manager 10.0 and later), you will be able to select from a list of valid function and transducer blocks (Figure 6-8), rather than having to manually enter the block tag. Once this parameter is selected, the SPM#_Block_Type parameter will be determined automatically. For non-device-dashboard hosts (e.g. AMS Device Manager 9.0 and previous) you will have to manually enter the Fieldbus block tag that was assigned by the host system, and select the Block Type.

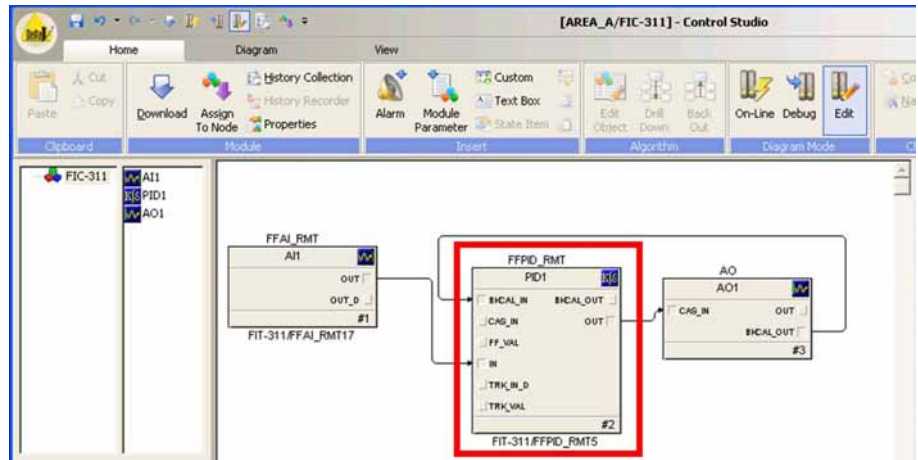
Figure 6-8. Device Dashboard Supported Hosts can Select Function Block for SPM



Example Configuration of SPM using Function Block

The following is an example of how to configure SPM using one of the function blocks within the transmitter. Figure 6-9 illustrates an example from DeltaV Control Studio of the PID Function Block (highlighted) within the 3051S Pressure Transmitter being used for Control in the Field. Note in this example that “FIT-311” is the tag given to the device when it was commissioned, and “FFPID_RMT5” is the tag of the function block that was automatically assigned by DeltaV.

Figure 6-9. Example of PID Control within a Pressure Transmitter



Using SPM, it is possible to detect problems in the control loop. For example, an increase in the cycling or oscillation of the control loop could be indicated by an increase in the standard deviation.

If SPM has already been enabled, it must first be disabled, before any additional SPM blocks can be configured. First, set

SPM_Active = Disabled

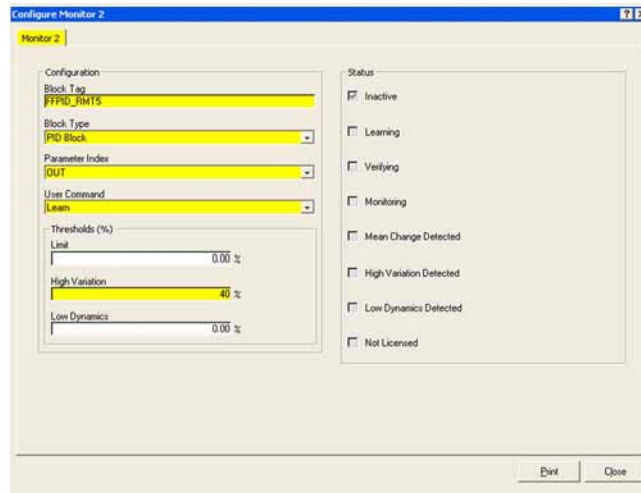
Next, to configure SPM2 to monitor the PID control loop, you would set the parameters as shown in Figure 6-10.

SPM2_Block_Tag = FFPID_RMT5

SPM2_Block_Type = PID Block

SPM2_Parameter_Index = OUT

Figure 6-10. Example Configuration of SPM Using a Function Block



Set the High Variation Limit (or other limits) as desired, and set the user command to “Learn” in order to begin the learning process for this SPM Block. Finally, verify that SPM_Monitoring_Cycle and SPM_Bypass_Verification are set as desired, and set the SPM_Active Parameter to “Enabled” (with or without the filter)

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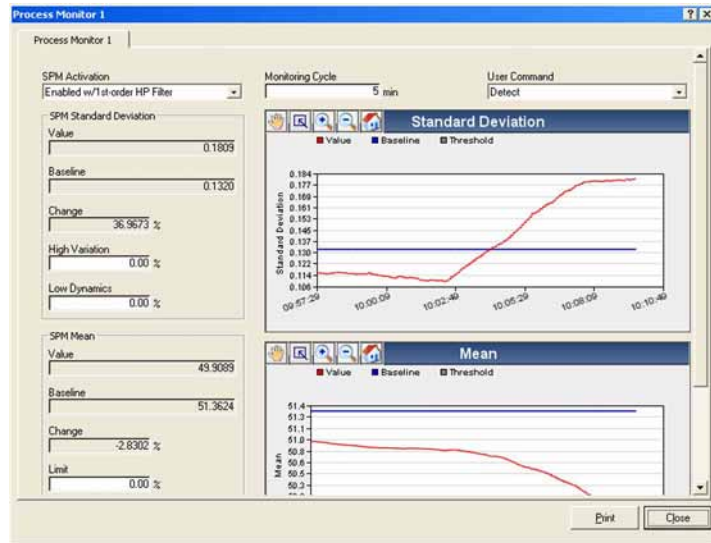
EDDL Trending of Mean and Standard Deviation

Once the SPM has been enabled, the EDDL user interface allows for easy viewing and trending of mean and standard deviation. To open up the trending screen, go to

Service Tools > Trends > SPM and click the desired “Process Monitor #” button

The EDDL Screen will show an on-line trend of mean and standard deviation, along with the baseline values, percent change, and detection limits (Figure 6-11).

Figure 6-11. EDDL Trend of Mean and Standard Deviation



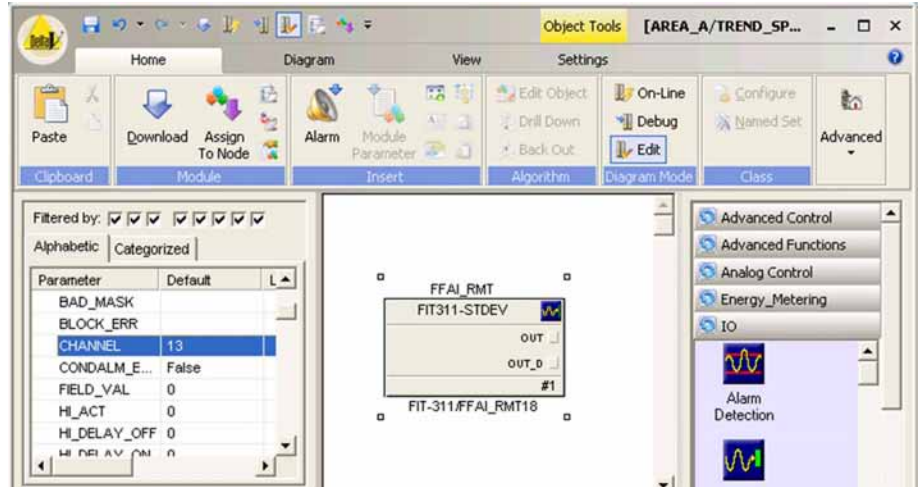
Note that data shown on the EDDL trends are not stored in a process historian or other database. When this screen is closed, all of the past data in the trends plots are lost. See “Trending SPM Data in DeltaV” on page 6-14 for configuring SPM data to be stored in a historian.

Trending SPM Data in DeltaV

Refer to “Trending Statistical Values in Control System” on page 6-10 for general information about accessing the SPM data through the AI and MAI function blocks. This section shows a specific example of how SPM Data can be accessed within the DeltaV host system, saved into the process historian, and used to generate a process alert.

In DeltaV Control Studio, add an AI function block, and assign it to one of the AI function blocks in the 3051S Device. Set the CHANNEL to one of the valid SPM channel values from Table 6-1 on page 6-11. For example, set the CHANNEL to 13 for SPM1 Standard Deviation, as shown in Figure 6-12.

Figure 6-12. Example AI Function Block for Trending Standard Deviation in DeltaV



Set the units and scaling for the function block as follows:

XD_SCALE = 0 to 1 in H₂O (68 °F)

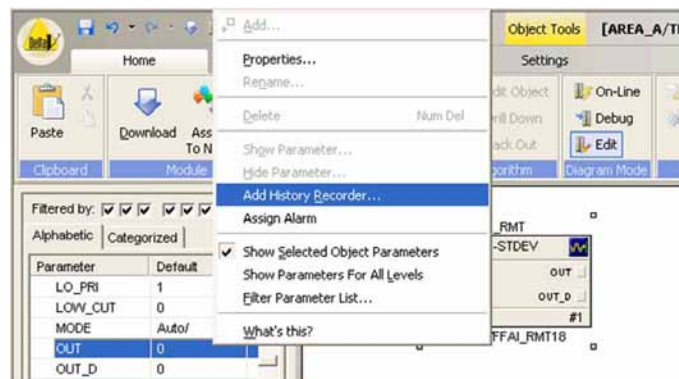
OUT_SCALE = 0 to 1 in H₂O (68 °F)

L_TYPE = Indirect

Note that the range set in the OUT_SCALE parameter will be the range that is shown by default when the variable is trended in the DeltaV Process History View. Standard deviation typically has a range much narrower than the process measurement, and so the scaling should be set accordingly. Also note that the units for XD_SCALE must be set to in H₂O (68 °F), but the units for OUT-SCALE can be set to any desired engineering unit.

If you want the standard deviation to be logged to DeltaV Continuous Historian, you need to add the appropriate parameter to the historian. Right-click on the OUT parameter of the AI Block, and select the option “Add History Recorder ...” (Figure 6-13)

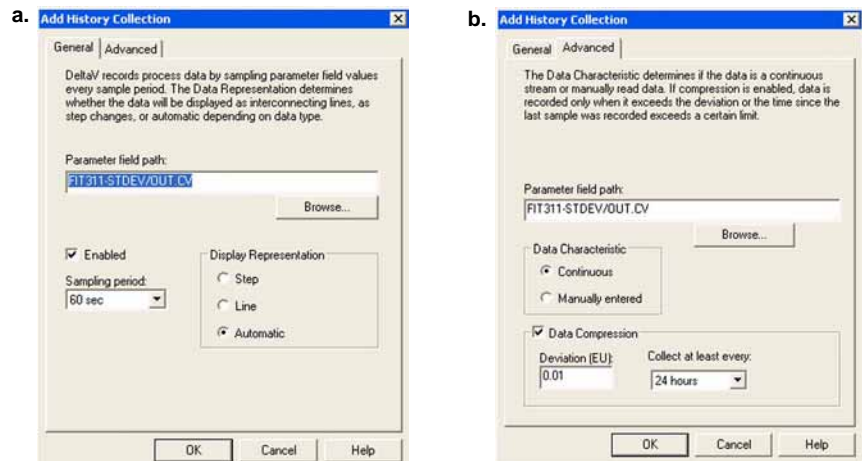
Figure 6-13. Adding History Recorder from DeltaV Control Studio



Follow through the “Add History Collection” dialog (Figure 6-14), to add the parameter to the DeltaV Historian with the desired sampling period, compression, etc. By default the sampling period is 60 seconds, as shown in a. of Figure 6-14. However, there are many diagnostics applications where one may want to look at changes in the standard deviation much faster than this. In that case, you will want to set the sampling period to something smaller.

When adding a standard deviation for history collection in DeltaV, it is recommended that you not use the default data compression settings. By default, the DeltaV Historian will log a new data point only when the process value deviates by 0.01 or more. There are many diagnostics applications where it is useful to look at changes in the standard deviation that are smaller than this. Therefore, it is recommended that when logging the standard deviation, either the Data Compression should be disabled (by unchecking the appropriate box in b. of Figure 6-14 on page 6-16) or the Deviation (EU) should be set to a much lower value, for example, 0.001 or 0.0001.

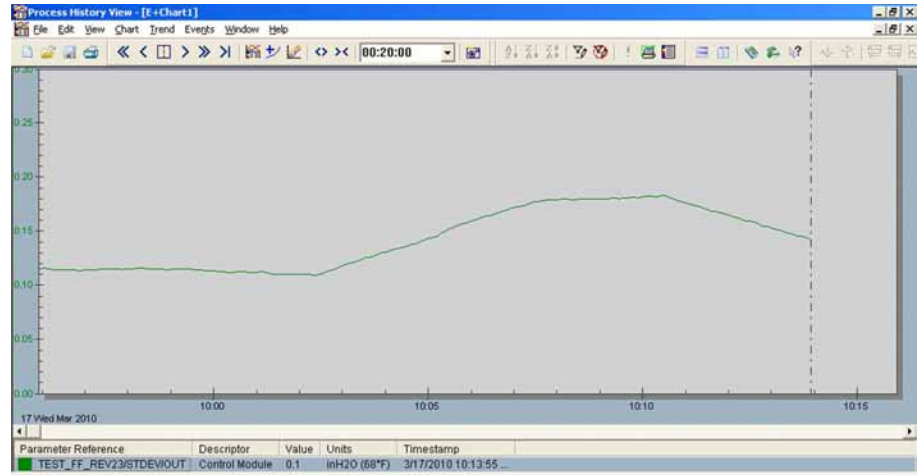
Figure 6-14. DeltaV Add History Collection: a.) General Configuration b.) Advanced Configuration



Refer to the DeltaV Books Online for more details on the DeltaV Continuous Historian.

After the SPM value has been saved to the historian, when the DeltaV Process History View is opened for the selected parameter, the graph will be populated with the historical data currently in the database (Figure 6-15).

Figure 6-15. Trend of Standard Deviation in DeltaV Process History View



Finally, when the SPM data is trended in DeltaV, it is possible to configure HI and/or LO alarms on the mean or standard deviation via the AI Block. This can be done by right-clicking on the AI Function Block in Control Studio, and selecting the option "Assign Alarm". The Block Alarm configuration window will let you set up desired alarm limits. Refer to the DeltaV Books Online for detailed information on configuring alarms.

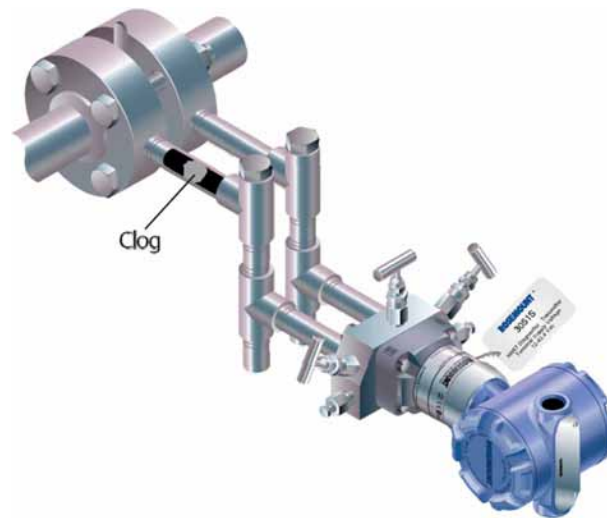
PLUGGED IMPULSE LINE DETECTION TECHNOLOGY

Introduction

Pressure transmitters are used in pressure, level, and flow measurement applications. Regardless of application, the transmitter is rarely connected directly to the pipe or vessel. Small diameter tubes or pipes commonly called impulse lines are used to transmit the pressure signal from the process to the transmitter. In some applications, these impulse lines can become plugged with solids or frozen fluid in cold environments, effectively blocking the pressure signals (Figure 6-16). The user typically does not know that the blockage has occurred. Because the pressure at the time of the plug is trapped, the transmitter may continue to provide the same signal as before the plug. Only after the actual process changes and the pressure transmitter's output remains the same may someone recognize that plugging has occurred. This is a typical problem for pressure measurement, and users recognize the need for a plugged impulse line diagnostic for this condition.

Rosemount 3051S

Figure 6-16. Basics of Plugged Impulse Line



Testing at Emerson Process Management and other sites indicates that Statistical Process Monitoring technology can detect plugged impulse lines. Plugging effectively disconnects the transmitter from the process, changing the noise pattern received by the transmitter. As the diagnostic detects changes in noise patterns, and there are multiple sources of noise in a given process, many factors can come into play. These factors play a large role in determining the success of diagnosing a plugged impulse line. This section of the product manual will acquaint users with the basics of the plugged impulse lines and the PIL diagnostic, the positive and negative factors for successful plugged line detection, and the do's and don'ts of installing pressure transmitters and configuring and operating the PIL diagnostic.

Plugged Impulse Line Physics

The physics of Plugged Impulse Line Detection begins with the fluctuations or noise present in most Pressure and Differential Pressure (DP) signals. In the case of DP flow measurements, these fluctuations are produced by the flowing fluid and are a function of the geometric and physical properties of the system. The noise can also be produced by the pump or control system. This is also true for Pressure measurements in flow applications, though the noise produced by the flow is generally less in relation to the average pressure value. Pressure level measurements may have noise if the tank or vessel has a source of agitation. The noise signatures do not change as long as the system is unchanged. In addition, these noise signatures are not affected significantly by small changes in the average value of the flow rate or pressure. These signatures provide the opportunity to identify a plugged impulse line.

When the lines between the process and the transmitter start to plug through fouling and build-up on the inner surfaces of the impulse tubing or loose particles in the main flow getting trapped in the impulse lines, the time and frequency domain signatures of the noise start to change from their normal states. In the simpler case of a Pressure measurement, the plug effectively disconnects the Pressure transmitter from the process. While the average value may remain the same, the transmitter no longer receives the noise signal from the process and the noise signal decreases significantly. The same is true for a DP transmitter when both impulse lines are plugged.

The case of the Differential Pressure measurement in a flow application with a single line plugged is more complicated, and the behavior of the transmitter may vary depending on a number of factors. First the basics: a differential pressure transmitter in a flow application is equipped with two impulse lines, one on the high pressure side (HP) and one on the low pressure side (LP) of the primary element. Understanding the results of a single plugged line requires understanding of what happens to the individual pressure signals on the HP and LP sides of the primary element. Common mode noise is generated by the primary element and the pumping system as depicted in Figure 6-17. When both lines are open, the differential pressure sensor subtracts the LP from the HP. When one of the lines are plugged (either LP or HP), the common mode cancellation no longer occurs. Therefore there is an increase in the noise of the DP signal. See Figure 6-18.

Figure 6-17. Differential Pressure Signals under Different Plugging Conditions

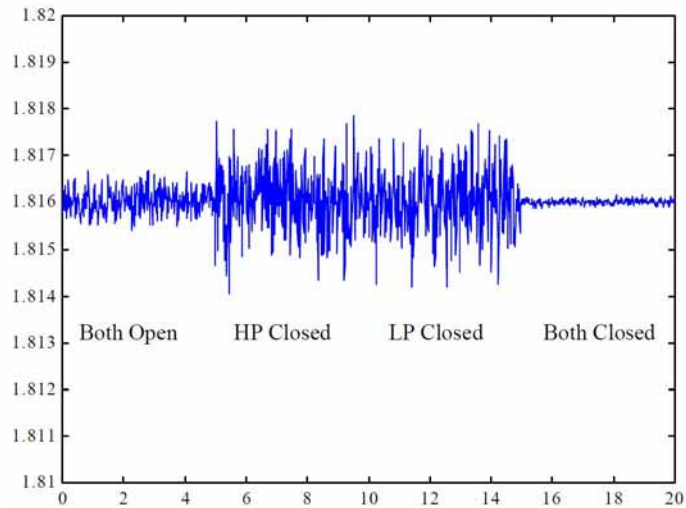
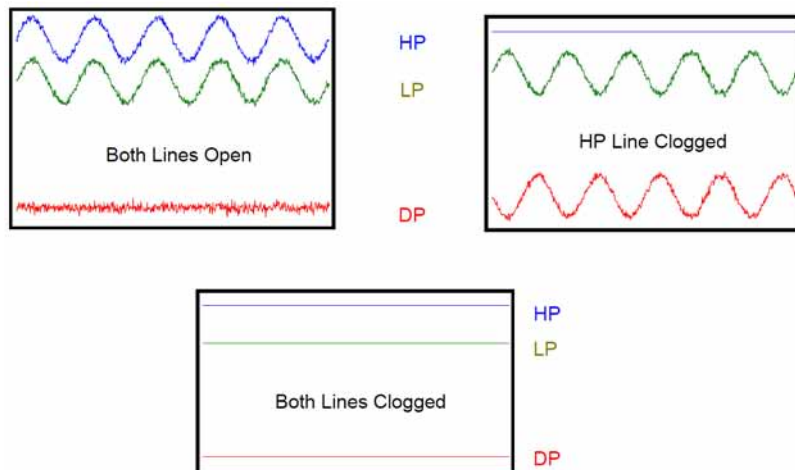


Figure 6-18. Differential Pressure (DP) Signals under Different Plugged Conditions



Plugged Line Detection Factors

However, there is a combination of factors that may affect the output of the DP transmitter under single plugged line conditions. If the impulse line is filled with an incompressible fluid, no air is present in the impulse line or the transmitter body, and the plug is formed by rigid material, the noise or fluctuation will decrease. This is because the combination of the above effectively “stiffens” the hydraulic system formed by the DP sensor and the plugged impulse line. The PIL diagnostic can detect these changes in the noise levels through the operation described previously.

The factors that may play a significant role in a successful or unsuccessful detection of a plugged impulse line can be separated into positive factors and negative factors, with the former increasing the chances of success and the latter decreasing the chances of success. Within each list, some factors are more important than others as indicated by the relative position on the list. If an application has some negative factors that does not mean that it is not a good candidate for the diagnostic. The diagnostic may require more time and effort to set up and test and the chances of success may be reduced. Each factor pair will be discussed.

Ability to Test Installed Transmitter

The single most important positive factor is the ability to test the diagnostic after the transmitter is installed, and while the process is operating. Virtually all DP flow and most pressure measurement installations include a root or manifold valve for maintenance purposes. By closing the valve, preferable the one(s) closest to the process to most accurately replicate a plug, the user can note the response of the diagnostic and the change in the standard deviation value and adjust the sensitivity or operation accordingly.

Stable, In-Control Process

A process that is not stable or in no or poor control may be a poor candidate for the PIL diagnostic. The diagnostic baselines the process under conditions considered to be normal. If the process is unstable, the diagnostic will be unable to develop a representative baseline value. The diagnostic may remain in the learning/verifying mode. If the process is stable long enough to establish a baseline, an unstable process may result in frequent relearning/verifications and/or false trips of the diagnostic.

Well Vented Installation

This is an issue for liquid applications. Testing indicates that even small amounts of air trapped in the impulse line of the pressure transmitter can have a significant effect on the operation of the diagnostic. The small amount of air can dampen the pressure noise signal as received by the transmitter. This is particularly true for DP devices in single line plugging situations and GP/AP devices in high pressure/low noise applications. See the next paragraph and “Impulse Line Length” on page 6-21 for further explanation. Liquid DP flow applications require elimination of all the air to insure the most accurate measurement.

DP Flow and Low GP/AP vs. High GP/AP Measurements

This is best described as a noise to signal ratio issue and is primarily an issue for detection of plugged lines for high GP/AP measurements. Regardless of the line pressure, flow generated noise tends to be about the same level. This is particularly true for liquid flows. If the line pressure is high and the flow noise is very low by comparison, there may not be enough noise in the measurement to detect the decrease brought on by a plugged impulse line. The low noise condition is further enhanced by the presence of air in the impulse lines and transmitter if a liquid application. The PIL diagnostic will alert the user to this condition during the learning mode by indicating "Insufficient Dynamics" status.

Flow vs. Level Applications

As previously described, flow applications naturally generate noise. Level applications without a source of agitation have very little or no noise, therefore making it difficult or impossible to detect a reduction in noise from the plugged impulse line. Noise sources include agitators, constant flow in and out of the tank maintaining a fairly consistent level, or bubblers.

Impulse Line Length

Long impulse lines potentially create problems in two areas. First, they are more likely to generate resonances that can create competing pressure noise signals with the process generated noise. When plugging occurs, the resonant generated noise is still present, and the transmitter does not detect a significant change in noise level, and the plugged condition is undetected. The formula that describes the resonant frequency is:

$$f_n = (2n-1) * C / 4L \quad (2)$$

where:

f_n is the resonant frequency,

n is the mode number,

C is the speed of sound in the fluid, and

L is the impulse length in meters.

A 10 meter impulse line filled with water could generate resonant noise at 37 Hz, above the frequency response range of a typical Rosemount pressure transmitter. This same impulse line filled with air will have a resonance of 8.7 Hz, within the range. Proper support of the impulse line effectively reduces the length, increasing the resonant frequency.

Second, long impulse lines can create a mechanical low pass filter that dampens the noise signal received by the transmitter. The response time of an impulse line can be modeled as a simple RC circuit with a cutoff frequency defined by:

$$\tau = RC \text{ and } \tau = 1/2 \pi f_c$$

$$R = 8 \nu L / \pi r^4$$

$$C = \Delta \text{Volume} / \Delta \text{Pressure}$$

where:

f_c is the cut-off frequency

ν is the viscosity in centipoises,

L is the impulse line length in meters

r is the radius of the impulse line.

The “C” formula shows the strong influence of air trapped in a liquid filled impulse line, or an impulse line with air only. Both potential issues indicate the value of short impulse lines. One installation best practice for DP flow measurements is the use of the Rosemount 405 series of integrated compact orifice meters with the 3051S Pressure transmitter. These integrated DP flow measurement systems provide perhaps the shortest practical impulse line length possible while significantly reducing overall installation cost and improved performance. They can be specified as a complete DP flowmeter.

NOTE

The Plugged Impulse Line diagnostic capability in the Rosemount 3051S FOUNDATION fieldbus Pressure Transmitter calculates and detects significant changes in statistical parameters derived from the input process variable. These statistical parameters relate to the variability of the noise signals present in the process variable. It is difficult to predict specifically which noise sources may be present in a given measurement or control application, the specific influence of those noise sources on the statistical parameters, and the expected changes in the noise sources at any time. Therefore, it is not absolutely warranted or guaranteed that the Plugged Impulse Line Diagnostic will accurately detect each specific plugged impulse line condition under all circumstances.

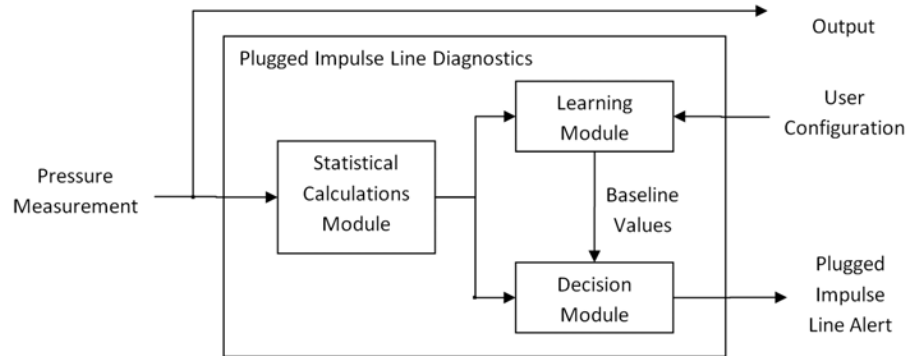
Plugged Impulse Line (PIL) Functionality

The Advanced Diagnostics Suite provides the Plugged Impulse Line (PIL) diagnostic, as an easy way to apply Statistical Process Monitoring technology specifically for detecting plugging in pressure measurement impulse lines. Similar to SPM, PIL also calculates the mean and standard deviation of the pressure measurement and generates an alert when the standard deviation exceeds an upper or lower limit.

Figure 6-19 illustrates a block diagram of the plugged impulse line diagnostic. Notice that it is very similar to the diagram for SPM shown in Figure 6-3. However, there are a couple of notable differences with PIL:

- The pressure measurement is fixed as the input
- Statistical values (mean and standard deviation) are not available as outputs
- The PlantWeb alert generated specifically indicates “Plugged Impulse Line Detected”

Figure 6-19. Overview of Plugged Impulse Line Diagnostics



PIL also includes some additional features to make it especially suitable for detecting plugging in pressure measurement impulse lines. PIL has the ability to:

- Automatically relearn new baseline values if the pressure measurement changes significantly
- Set the status quality of the pressure measurement to “Uncertain” if a plugged impulse line is detected
- Check for a minimum process dynamics during the learning process
- Adjust the verification settings
- Set separate learning and detection periods

Figure 6-20 shows a flow chart of the PIL algorithm. Note that this diagram shows the sequence of PIL steps using the default configuration settings. Information for adjusting these settings is found in “Configuration of Plugged Impulse Line Detection” on page 6-25. The specific steps that PIL goes through are as follows:

1. Learning Phase

PIL begins the Learning Process when the PIL is Enabled, when the User Command is set to “Relearn”, or when a Mean Change is detected during the Detection Phase. PIL collects the pressure values for 5-minutes and computes the mean and the standard deviation.

NOTE:

The length of the learning period is user-adjustable, with 5-minutes as the default value. During the Learning Phase the status is “Learning”.

2. Sufficient Variation?

During the Learning and the Verify modes, the PIL checks that the noise level (e.g. the standard deviation) is high enough for reliable detection of plugged impulse lines. If the noise level is too low, the status goes to “Insufficient Dynamics”, and the PIL stops. PIL will not resume learning again until a “Relearn” command is given.

3. Verification Phase

PIL collects the pressure values for an additional 5-minutes (or same length as Learning period) and computes a second mean and standard deviation. During this phase, the PIL status is “Verifying”

4. Steady Process?

At the end of the 5-minute verification phase, the PIL compares the last mean and standard deviation against the previous mean and standard deviation to determine if the process is at a steady state. If the process is at a steady-state, then the PIL moves into Detection phase. If not, then PIL repeats the Verification Phase

5. Establish Baseline

At the end of the Verification Phase, if the process has been determined to be at a steady state, the last mean and standard deviation are taken to be the "Baseline" values, representative of the normal process operating condition.

6. Detection Phase

During the Detection Phase, the PIL collects pressure data for 1 minute and computes the mean and the standard deviation.

NOTE:

The length of this "Detection Period" is user-adjustable, with 1-minute as the default value.

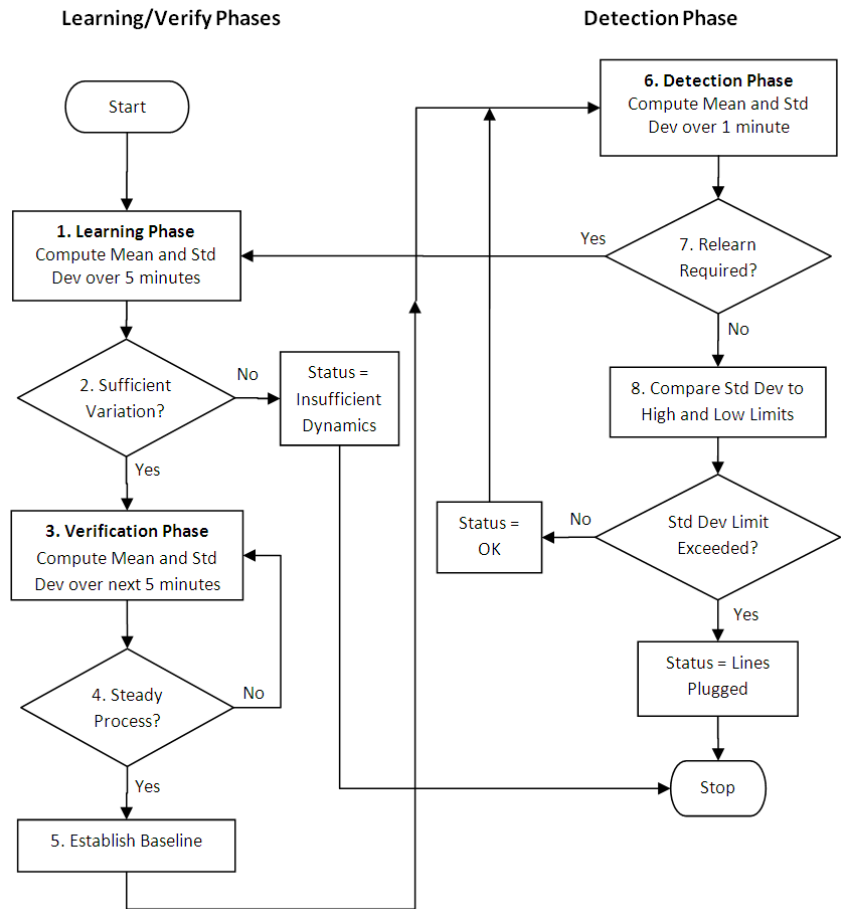
7. Relearn Required?

At the end of the 1-minute, PIL first compares the current mean with the baseline mean. If the two differ significantly, then the PIL goes back into the Learning Phase, because the process conditions have changed too much for a reliable detection of a plugged impulse line.

8. Compare Standard Deviations

If no relearn is required, the PIL compares the current standard deviation against the baseline standard deviation to determine if a plugged impulse line is detected. For all sensor types, the PIL checks if the standard deviation has decreased below a lower limit. For DP sensors, the PIL also checks if the standard deviation has increased above an upper limit. If either of these limits is exceeded, the status changes to "Lines Plugged" and the PIL stops, and will not resume again until a "Relearn" command is given. If a plugged impulse line is not detected, the status is "OK" and the Detection Phase is repeated.

Figure 6-20. Flow Chart for Plugged Impulse Line Diagnostics



CONFIGURATION OF PLUGGED IMPULSE LINE DETECTION

Basic Configuration

This section describes the configuration of the plugged impulse line diagnostic.

For some impulse line plugging applications there will be a very significant (> 80%) decrease in standard deviation. Examples of this would include a plug in the impulse line of a GP/AP measurement in a noisy process, or a plug in both impulse lines of a DP measurement. In these applications, configuring plugged impulse line detection requires nothing more than turning it on. To do this, set

PLINE_ON = Enabled

Once the PIL is enabled, it will automatically start the learning process, and move to the detection phase if there is sufficient variation and the process is stable.

Optionally, if, when a plugged impulse line is detected, you want to automatically have the status quality of the pressure measurement go to "Uncertain", set the parameter

PLINE_Affect_PV_Status = True

By default, the value of PLINE_Affect_PV_Status is “False”, meaning that the quality of the pressure measurement will not be changed if PIL detects a plugged impulse line. Setting this parameter to “True” will cause the status quality to change to “Uncertain” when a plugged impulse line is detected. Depending upon the DCS configuration, the “Uncertain” quality could be visible to the Operator, or it could affect the control logic.

If you ever want to re-start the PIL learning process, set the parameter

PLINE_Relearn = Relearn

Note for 3051S Software Version 1.11.x (x =5, 6, or 9)

For software revision 1.11.x, after the PIL has been enabled, it is necessary to restart the processor. The software revision can be seen via the parameter RB_SFTWR_REV_ALL the Resource Block (see Table A-1). In AMS Device Manager and the Field Communicator this parameter is labeled as “Software Revision String.”

To restart the processor, the sequence depends on the host system:

For AMS Device Manager, right-click on the device, and select the menu option Methods > Diagnostics > Master Reset. When prompted for the type of reset, select “Processor” or “Restart Processor”.

On a Field Communicator, choose the option Resource Block > Diagnostic Methods > Master Reset > Processor

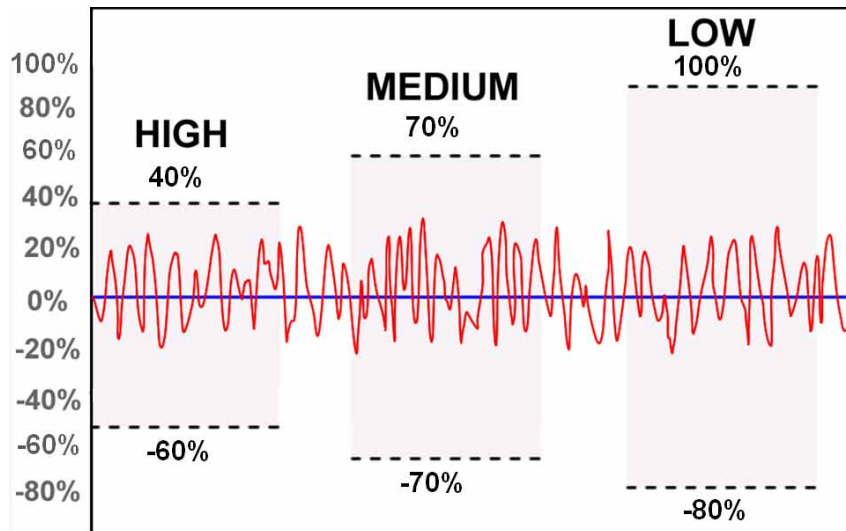
On most other fieldbus hosts, this is done by setting the RESTART parameter of the Resource block to the value: “Processor”

Configuration of Detection Sensitivity

Although a few impulse line applications can be configured just by enabling the PIL, the majority of applications will require configuring the detection sensitivity (that is, the upper and/or lower limit on the standard deviation at which an impulse line plug will be detected).

Figure 6-21 illustrates the basic detection sensitivity setting for PIL. In general, a higher sensitivity means that the PIL is more sensitive to changes in the process dynamics, while a lower sensitivity means that the PIL is less sensitive to process dynamics changes.

Figure 6-21. PIL Basic Detection Sensitivities



Detection sensitivities are specified as a percent change in the standard deviation from the baseline value. Note from Figure 6-21 that a higher detection limit (% change) actually corresponds to a lower sensitivity, because a greater change in the process dynamics is required to trigger a plugged impulse line alert. Likewise, a lower detection limit corresponds to a higher sensitivity.

In PIL, the Detection Sensitivity is determined by 3 parameters: PLINE_Sensitivity, PLINE_Detect_Sensitivity, and PLINE_Single_Detect_Sensitivity.

The **PLINE_Sensitivity** parameter provides the means to set a basic detection sensitivity (Figure 6-21). It can be set to the values: High, Medium (default), or Low. Each value has a corresponding upper and lower limit shown in the table Table 6-3. Note that setting the basic sensitivity affects both the upper and the lower detection limits.

Table 6-3. Basic PIL Detection Sensitivities

PLINE_Sensitivity Value	Upper Standard Deviation Limit	Lower Standard Deviation Limit
High	40%	60%
Medium	70%	70%
Low	100%	80%

So, for example, if the PLINE_Sensitivity is set to High, then a plugged impulse line will be detected if the standard deviation either increases by more than 40% above its baseline value, or decreases more than 60% below its baseline value.

NOTE:

For GP/AP sensors, the PIL does not check for an increase in standard deviation, and a plugged impulse line is detected only if the standard deviation goes below the lower limit. For DP sensors, the PIL checks for both an increase and a decrease in standard deviation.

The upper and lower detection limits can be set to custom values, using the parameters:

PLINE_Detect_Sensitivity

Adjusts the Lower detection limit. If this value is 0 (default), the Lower limit is determined by PLINE_Sensitivity. If this value is greater than 0, then it overrides the basic sensitivity value. This value can be set in the range 0 – 100%

PLINE_Single_Detect_Sensitivity

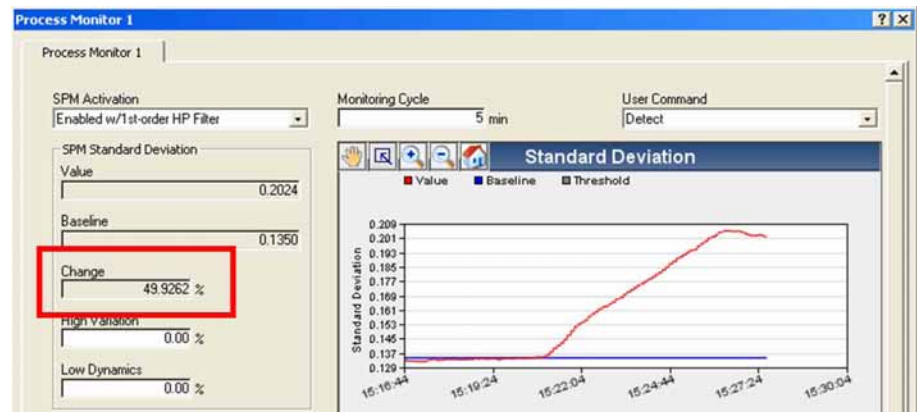
Adjusts the Upper detection limit. If this value is 0 (default), the Upper limit is determined by PLINE_Sensitivity. If this value is greater than 0, then it overrides the basic sensitivity value. This value can be set in the range 0 – 10000% (For software revisions 1.11.x or earlier, the allowable range for this parameter is 0-100%).

Determining the Detection Sensitivity

Determining what values to configure for the upper and lower detection limits can be done by configuring SPM to monitor and trend the standard deviation, and then looking at how the standard deviation changes when impulse line plug is simulated, by closing the transmitter root valves or manifold valves.

First SPM needs to be configured to monitor the pressure as described in “SPM Configuration for Monitoring Pressure” on page 6-6. After SPM has been configured, the standard deviation needs to be trended, either in an EDDL-supported host (such as AMS Device Manager, shown in Figure 6-22), or in the DCS as described in “Trending Statistical Values in Control System” on page 6-10.

Figure 6-22. Trend of Standard Deviation in AMS Device Manager



After configuring SPM, wait long enough for the SPM to begin updating the % change in standard deviation. This will take at least 2-3 times the SPM Monitoring Cycle.

While the standard deviation is being trended, the impulse line valve (e.g. manifold or root) must be manually closed. After the impulse line is closed off, note in the SPM trend how much the standard deviation has changed. In the example in Figure 6-22 the standard deviation has increased by 49.9%.

This process needs to be repeated for each impulse line plugging condition that needs to be detected. For DP measurements, this should be done for both the high side and the low side impulse line. Optionally, you may also wish to do this for both sides plugged. For GP/AP measurements, this process would be done only for the single impulse line.

Upper and lower detection limits are chosen based on the degree of standard deviation change that was observed when the impulse lines were plugged. These limits should be less than the observed change in standard deviation, but more than changes in standard deviation that happen under normal process conditions. A lower detection limit will result in a plug being detected earlier and more often, but could also lead to false detections. A higher detection limit will reduce the likelihood of false detections, but also increase the probability that an impulse line plug will not be detected.

A good “rule of thumb” is to set the detection limit to half of the observed change in standard deviation, but no less than 20%

Advanced PIL Configuration

PIL provides the ability for advanced users to fine-tune some of the algorithm settings

PLINE_Relearn_Threshold

This adjusts the limit at which the PIL will automatically relearn new baseline values if the process mean changes. By default, this threshold is:

2 inches of water for DP Range 1 (-25 to 25 inH₂O) sensors

5 inches of water for DP Range 2 (-250 to 250 inH₂O) sensors

1% of Primary Value Range for All Other Sensors

When PLINE_Relearn_Threshold is at 0 (default) the above values are used for the relearn threshold. When a positive number is entered here, this value (in % of Primary Value range) overrides the default relearn threshold values. For example, if the sensor is type DP Range 3 (-1000 to 1000 inH₂O), and PLINE_Relearn_Threshold is set to 2%, then PIL will relearn if the mean changes by more than 20 inH₂O.

NOTE

In software revisions 2.0.x and previous, the Relearn Thresholds for DP Range 1 and DP Range 2 are fixed at the above default values. The PLINE_Relearn_Threshold parameter affects the Relearn Threshold for only the other sensors. In software revisions 2.1.x and later, the PLINE_Relearn_Threshold affects the Relearn threshold for all sensor types.

PLINE_Auto_Relearn

This can be used to turn off the automatic relearning. If set to "Disabled", the PIL will not go back into learning mode, even if there is a large mean change. In most cases, this parameter should be kept at "Enabled" because without this check, a large change in a flow rate could also cause a change in the standard deviation, triggering a false detection.

PLINE_Learn_Length

The length of time over which mean and standard deviation are calculated during the Learning and Verification phases. Default is 5 minutes.

Allowable range is 1-45 minutes. If the process has a periodic change in the mean over time (e.g. a slow oscillation), a longer learning cycle may provide a better baseline.

PLINE_Detect_Length

The length of time over which mean and standard deviation are calculated during the Detection Phase. Default is 1 minute. Allowable range is 1-45 minutes. This value should not be longer than the PLINE Learning Cycle. A shorter value will in general allow a plugged impulse line to be detected more quickly. However, if the process has a dominant cycling or oscillation, this parameter should be set to longer than the period of oscillation.

PLINE_Learn_Sensitivity

The PLINE_Learn_Sensitivity parameters provide very specific adjustments to the sensitivity during the learning phase. Most of the time, it is sufficient to use the default values

- Insufficient Dynamics Check: Ignores the insufficient dynamic check if not selected. Use only when there is very low process noise. This could result in a plugged impulse line not being detected.
- 10%, 20%, and 30% Stdev. Change Check: Allows for 10, 20, or 30% change in Standard Deviation while in the learning state. If this value is exceeded, the algorithm will stay in the verifying state until the value is not exceeded.
- Three or six Sigma Mean Change Check: Allows for a three or six standard deviations change in the mean while in the learning state. If this value is exceeded, algorithm will stay in the verifying state until the value is not exceeded.
- 2% Mean Change Check: The mean value of the baseline calculation cannot vary more than 2% during the learning or verifying states. If this value is exceeded, algorithm will stay in the verifying state until the value is not exceeded.

You may want to increase or disable one or more of these learning sensitivity settings, if you find that the PIL continues to stay in the verification phase.

PIL Operation

During operation the PIL_Status indicates the current status of the algorithm. The valid values are:

OK	Algorithm is in the detection state, and no plugged impulse line is detected.
Inactive	The algorithm is not enabled.
Learning	Algorithm is currently learning the process characteristics
Verifying	Algorithm is comparing the learned baseline with the current process.
Insufficient Dynamics	The process does not have enough dynamics to detect an impulse line plug
Bad PV Status	The Sensor Transducer Status is Bad, therefore the algorithm is paused. Algorithm will resume when a good or uncertain status returns.
Not Licensed	The ADB is not currently purchased in this device.
Plugged Line	Algorithm has detected a plugged line condition. This could be either one line or both lines plugged for a DP transmitter, or the one impulse line plugged for a GP or AP transmitter.

PIL also indicates the timestamp of the last detection of a plugged impulse line via the parameters:

PLINE_History_Timestamp

Timestamp when the last plugged impulse line was detected.

PLINE_History_Status

Indicates whether or not the PIL_History_Timestamp is available.

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Plugged Impulse Line Configuration in EDDL

Host systems that support Electronic Device Description Language (EDDL) may use labels for the PIL configuration parameters that are slightly different from the Fieldbus parameter names described previously in this section. Table 6-2 below shows the correspondence between the fieldbus parameter names used in this document, and the labels used in EDDL hosts, such as AMS Device Manager.

Fieldbus Parameter Name	EDDL Label(s)
PLINE_ON	Plugged Line
PLINE_Learn_Length	Learning Cycle
PLINE_Sensitivity	Sensitivity Detection Detection Sensitivity
PLINE_Affect_PV_Status	Affect PV Status
PLINE_Relearn	User Command
PLINE_Auto_Relearn	Auto Relearn
PLINE_Relearn_Threshold	Relearn Threshold (% of URL)
PLINE_Learn_Sensitivity	Learning Sensitivity
PLINE_Detect_Length	Detecting Cycle
PLINE_Detect_Sensitivity	Custom Sensitivity
PLINE_Single_Detect_Sensitivity	DP Single Line Custom Sensitivity
PLINE_Status	Plugged Impulse Line Detection Commands Plugged Impulse Line Detection Status Plugged Impulse Line Status
PLINE_History_Status	Plugged Impulse Line History - Status
PLINE_History_Timestamp	Plugged Impulse Line History – Time Stamp

Viewing the Indication of a Plugged Impulse Line

When a plugged impulse line is detected, a PlantWeb alert is generated, and this alert can be seen in AMS Alert Monitor. Also (optionally), using the “Affect PV Status” parameter, the status of the pressure measurement can be made to change from “Good” to “Uncertain” when the line plug is detected. Dependent upon the DCS configuration, the uncertain status of the measurement may be indicated within the Operator Interface.

