FIELDVUE™ Instruments
A Planning Guide for Effective Use
HART® Implementations

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You've purchased a FIELDVUE instrument.....Now what???
How do you get the most value out of it?

- •Where do you start?
- •What's the best way to install it?
- •Where do you set your alerts?
- •Online/offline?
- •Diagnostics? When? How?

The answer is....... ***<u>Start out with a good foundation and build on it!</u>***

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I. Introduction

1. Scope

The purpose of this guide is to help you develop a plan to use the FIELDVUE instrument more effectively.

We have made every effort to present meaningful and realistic information. The topic area is so broad that it is difficult to cover all possibilities in a single comprehensive document. However, the contents of this document should provoke thought process and work practice changes surrounding the full value of a digital technology coupled with state-of-the-art diagnostics.

This guide begins with a short discussion of the FIELDVUE instrument product line and the associated ValveLink software tools, features and the functionalities they encompass. This is followed by methods to effectively implement FIELDVUE instruments in the following situations:

- Startup and commissioning
- Normal operations
- Turnarounds

These sections are intended to provide you with *suggested initial settings*. Also included are recommended changes and/or additions to existing work practices that allow you to realize the full value of FIELDVUE instrument diagnostics.

A more detailed discussion of alerts and diagnostics, examples of specific value-add features such as scheduler, alert log, batch runner, etc., and troubleshooting can be found in the appendices.

If you have any questions regarding these subjects, please contact your Emerson sales office.

2. Plantweb Digital Ecosystem Discussion

Plantweb digital ecosystem leverages the power of intelligence in field devices to securely improve the Industrial Internet of Things (IoT) with measurable business performance improvement. The digital intelligence in the field devices is used to provide the data for predictive diagnostics and to improve performance of final control elements and measurement instruments.

The basis for the Fisher design philosophy, or what makes for a good control valve, is superior dynamic responsiveness. The key characteristics of superior dynamic performance are:

- Does the valve react to small changes in input signal (1/4%-1%)?
- Does the valve move fast enough?
- Does the movement provide the right installed gain for the PID process loop tuning to work over the operating flow range?

The ability to “tune” FIELDVUE instruments to the valve/actuator assembly provides the required dynamic responsiveness which:

- allows operations to push setpoints closer to constraints,
- allows for more aggressive PID tuning,
- allows continuous use of Model Predictive or Advanced Control strategies,
- drives more efficient plant operation, increased throughput, lower energy and utility costs, better quality, and less rework.

The diagnostics capability of the FIELDVUE instrument optimizes control valve assets and provides:

- increased availability,
- increased uptime,
- decreased unscheduled outages for control valve problems,
- faster problem identification and resolution,
- increased maintenance effectiveness,
- lower maintenance costs by pinpointing problems and eliminating unnecessary expenditures on parts, labor, or downtime, and
- Increased plant safety.

It is this combination of expertise in process control and control valve design, digital intelligence in the positioner, and open communications protocols such as HART and FOUNDATION™ fieldbus, that deliver a positioner capable of superior dynamic responsiveness as well as a “data server” capable of diagnostics.

3. FIELDVUE Instrument Background

FIELDVUE instruments are microprocessor based digital valve controllers. These digital valve controllers have the ability to precisely position a control valve assembly using a setpoint received from a control system. More than just a digital positioner, they also perform control valve diagnostics, alert you of critical information before it affects the process, and communicate using HART, Fieldbus, or PROFIBUS protocol.

The first generation FIELDVUE instrument was the DVC5000 (HART) released in 1994. This was the first loop powered digital valve controller available on the market. The next release was the DVC5000f (Fieldbus) in 1998. The third generation instrument, the DVC6000 (HART) was released in 2000 and included many enhancements in control and diagnostics functionality. The addition of multiple sensors and double-acting capability gave the instruments industry-leading functionalities. The DVC6000f (Fieldbus) was released in 2004 and added Fieldbus communications as well as ground breaking control performance. Options for remote mount travel sensor and extreme temperature construction are also available.

The DVC2000 was released in 2004. New functions included the use of a local user interface, multilingual display, integrated limit switches, position transmitter, and non-contact feedback.

The fourth generation instruments, the DVC6200 and DVC6200f, were released in 2009, while the DVC6200p (PROFIBUS) was released in 2012. These instruments incorporate the linkage-less non contact feedback design to make a good product even better. New functions include the position transmitter or 1 switch, 316 SST model, remote unit, and HART 7 communication option.

4. ValveLink Software Background

ValveLink software is the companion tool used to get the most value out of FIELDVUE positioning instruments. While there are a variety of packages available in the industry with the ability to configure, calibrate and view alerts, only ValveLink software can perform valve assembly diagnostics.

ValveLink software has the ability to be installed and used in various forms:

- ValveLink Solo working with a HART multiplexer, HART modem or FOUNDATION fieldbus
- ValveLink SNAP-ON for AMS Device Manager
- ValveLink DTM
- ValveLink PLUG-IN for PRM®
- ValveLink Mobile for AMS Trex or 475 Communicator

You will receive the most value from integrated HART or Fieldbus installations. The preferred method is to have a maintenance station on an Emerson system, such as DeltaV, or Ovation, with AMS Device Manager, due to the advanced integration, the ability to easily view needed information, and the ability to automate batch features.

5. ABC Asset Criticality Assessment

All assets in the plant are not equal. Final control assemblies, transmitters, sensors, pumps, and other process control equipment have different degrees of criticality. The results of a criticality assessment can provide valuable information that can be used to determine how each asset should be monitored and maintained. Typically A rated assets are the most critical and have the most effect on plant operations. They require more monitoring and receive the highest work order priority. If the final control assembly is an A asset, it should be tiered to a PD level. B assets are of lesser criticality. The B critical final control element is typically tiered to an AD level. The ABC ranking should enable you to define the critical valve assemblies in your plant, the alerts required, and the frequency for inspecting these assets. Emerson's Asset Management can help you get started with this assessment in your plant. For more information, contact your Emerson sales office.

II. Startup and Commissioning

The following steps are recommended guidelines for the setup, calibration, and configuration of a FIELDVUE instrument. These steps can be performed using AMS Device Manager, ValveLink software, AMS Trex or 475 Communicator with ValveLink Mobile or DD, and most other HART host tools that use DD technology:

- General recommendations to successfully set up FIELDVUE Instruments are:

  - Always use the Setup Wizard (Do not use the Setup Wizard after the instrument is setup on a valve assembly. You could accidentally reset the unit to factory defaults, erasing all of the custom configuration that is in the instrument)
  - Always try to use Auto Travel Calibration (Auto calibration of travel is always required if the instrument is removed from the valve assembly for maintenance purposes)
  - Always enable the Alert Record in the instrument (Clear the Alert Record after commissioning)

- Create and follow a startup and commissioning plan. At a minimum, the plan should include the following:

  - Review your application - gather valve data, serial cards, etc.
    - Determine cutoffs/limits and travel alerts, if applicable.
    - Mount instrument properly
    - Run Setup Wizard
      - Run Performance Tuner if actuator was not listed in Setup Wizard
    - Enable below Alerts for visibility to basic valve assembly health information:
      - Travel Deviation: 5% for 10 seconds
      - Supply Pressure: 3 psi above upper benchset for spring & diaphragm, 10 psi below nominal instrument air supply for piston actuators
      - Drive Signal
    - Reset Cycle Counter and Travel Accumulator to Zero (0)

  - Ensure Valve Alerts are enabled, this will allow alerts to be written to the instrument alert record (on-board alert storage utility)
      - Set Instrument Date & Time
      - Clear Alert Event Record
      - Enable Triggered Profile on PD units
      - Use Travel Deviation as the Triggered Event for throttling control valves
      - Use Collection Variables of Travel Set Point, Travel, Drive Signal, and Supply
      - Use Trigger Record Length of 60 seconds. The DVC6200/DVC6000 can hold approximately 20 minutes of triggered data sets.

Note

Triggered data in the device will show up on the alert record as Diagnostic Data Available.

- When alert scanning using a DCS with HART cards or multiplexers, the following additional settings are recommended:

  - Device Alerts
      - ValveLink SNAP-ON, scan all valves as fast as possible, A critical valves more often than B and C critical valves
      - ValveLink Solo automatically scans at maximum speed possible for system

  - PD One Button Sweep using Scheduler
      - A critical valves, one per week
      - B critical valves, one every two weeks
      - C critical valves, once a month

- PD Friction using Scheduler (ensure upper and lower friction values are set up in PD Diagnostic Trends of Friction
    - A critical valves, two per month
    - B critical valves, one per month

The following table provides a more detailed list of recommended initial settings. These are “best practices”, which have been derived from the current installed base. They are general guidelines that may need to be modified based upon the specific application. When starting with an alert strategy, keep the number of alerts enabled to a minimum. Start with Travel Deviation, Supply Pressure Low, and Drive Signal Out of Range. These alerts are the most critical for throttling control valves. If you set too many alerts to start with, they may be seen as nuisance alerts and have a tendency to be ignored.

DVC6200 (HW2) Parameters

Setup Parameter	Factory Default Alert Settings	Recommended Initial Alert Settings	Notes
Control Mode	Analog (RSP)	Analog (RSP)	
Restart Control Mode	Resume Last	Resume Last	
Burst Mode Enabled	No	No	Set to Yes if a Tri-Loop is used
Burst Mode Command	Loop Current/PV/SV/TV/QV	Loop Current/PV/SV/TV/QV	
HART Tag	As Specified on Order	Fill in Plant Information	Tag from DCS, P&ID, etc.
Message	Blank	Fill in Plant Information	
Descriptor	Blank	Fill in Plant Information	
Date	Factory Calibration Date	Set to Current Date	
Valve Serial Number	Blank	Fill in Valve Serial Number	
Polling Address	0	0	
Max Supply Pressure	1.378 Bar	1.378 Bar	Should be 5 psi above upper benchset or actuator Maximum or digital valve controller Maximum.
Feedback Connection	Default Array	Default Array	Can be corrected to actual array
Zero Power Condition	Valve Closed	Valve Closed	Determined by Setup Wizard
Travel Sensor Motion	Clockwise/Away from Top of Instrument	Clockwise/Away from Top of Instrument	Determined by Setup Wizard
Analog Input Units	mA	mA	% for DeltaV
Analog In Range High	20 mA	20 mA	100% for DeltaV
Analog In Range Low	4.0 mA	4.0 mA	0% for DeltaV
Pressure Units	Bar	Bar	End User to Determine
Temperature Units	C	C	End User to Determine
Tuning Set	H	H	Determined by Setup Wizard
Input Characteristics	Linear	Linear	
Set Point Filter Lag Time	0 Sec	0 Sec	
High Limit/Cutoff Select	Hard Cutoff	Hard Cutoff	End User to Determine
Low Limit/Cutoff Select	Hard Cutoff	Hard Cutoff	End User to Determine
High Limit/Cutoff Point	99.46%	99.46%	This parameter is dependent on service and trim type eg. CAVIII or standard. For example in BFP Recirc with a Reverse Acting valve you might want this set at 92% whereas for standard trim 99.46% might be acceptable

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DVC6200 (HW2) Parameters (continued)

Setup Parameter	Factory Default Alert Settings	Recommended Initial Alert Settings	Notes
Low Limit/Cutoff Point	0.50%	0.50%	This parameter is dependent on service and trim type eg. CAVIII or standard. For example in BFP Recirc with a Direct Acting valve you might want this set at 12% whereas for standard trim 0.5% might be acceptable.
SP Rate Open	0 %/sec	0 %/sec	
SP Rate Closed	0 %/sec	0 %/sec	
Integral Enabled	Enabled	Enabled	
Integral Gain	10 repeats/minute	10 repeats/minute	
Integral Deadband*	0.26%	0.26%	*See table below (page 7)
Travel Hi/Lo Alert Enabled	Disabled	Disabled	End User to Determine
Travel Hi Hi/Lo Lo Alert Enabled	Disabled	Disabled	End User to Determine
Travel Alert High Point	125%	125%	End User to Determine
Travel Alert Low Point	-25%	-25%	End User to Determine
Travel Alert High-High Point	125%	125%	End User to Determine
Travel Alert Low-Low Point	-25%	-25%	End User to Determine
Travel Alert Deadband	1%	3%	
Travel Deviation Alert Enabled	Yes	Yes	
Travel Deviation Alert Point	5%	5%	
Travel Deviation Time**	10 sec	5 sec	**See table below (page 7)
Pressure Deviation Alert Enable	Yes	Yes	
Pressure Deviation Alert Point	0.345 bar	5 psi	
Pressure Deviation Time	5 sec	10 sec	
Cycle Counter Alert Enable	No	No	This is a good tool to track problems. The end user needs to keep track of problems such as packing leaks, travel sensor failures, actuator diaphragm failures, etc. Upon the first problem showing up, this number needs to be recorded in the CMMS or AMS and reset. Repair the problem and record the number when the next problem occurs. This will give a history of good data that will allow us to enable this alarm and then generate a work order to address the problem before it fails.
Cycle Counter Alert Point	500000	500000	
Cycle Cnt/Tvl Accum Deadband	1%	3%	
Cycle Counter	0	0	Verify 0 on initial setup
Travel Accumulator Alert Point	2147483647	500000	
Travel Accumulator Deadband	1%	3%	
Travel Accumulator	0	0	Verify 0 on initial setup.
Local Autocal Button	Enabled	Enabled	

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DVC6200 (HW2) Parameters (continued)

Setup Parameter	Factory Default Alert Settings	Recommended Initial Alert Settings	Notes
Supply Pressure Alert Enable	Yes	Yes	
Supply Pressure Alert Point	0.345 bar	3 psi above upper benchset.	10 psi below nominal for piston actuators.
Drive Signal Alert Enable	Yes	Yes	
Inst Time Invalid Enable	No	No	
Cal in Progress Enable	No	No	
Autocal in Progress Enable	No	No	
Diag in Progress Enable	No	No	
Diag Data Avail Enable	No	Yes	
Integrator Sat High Enable	No	No	
Integrator Sat Low Enable	No	No	
Pressure Fallback Enable	Yes	Yes	

*Integrator - Enabled and configured as follows:

Integrator Parameter	PTFE Packing	Graphite Packing	Enviro-Seal PTFE and Graphite ULF Packing
Integrator Dead Zone	0.26%	0.5%	0.7%

**Travel Deviation Alert - Enabled and configured as follows:

Actuator Diaphragm Area	PTFE Packing	Graphite Packing	Enviro-Seal PTFE and Graphite ULF Packing
<= 100 in^2	Alert enabled Alert Point = 2% Alert Time = 2 sec	Alert enabled Alert Point = 3% Alert Time = 2 sec	Alert enabled Alert Point = 5% Alert Alert Time = 3 sec
> 100 in^2 to <= 200 in^2	Alert enabled Alert Point = 2% Alert Time = 2 sec	Alert enabled Alert Point = 3% Alert Time = 5 sec	Alert enabled Alert Point = 5% Alert Alert Time = 5 sec
> 200 in^2 to <= 300 in^2	Alert enabled Alert Point = 3% Alert Time = 5 sec	Alert enabled Alert Point = 5% Alert Time = 8 sec	Alert enabled Alert Point = 5 % Alert Alert Time = 10 sec
> 300 in^2	Alert enabled Alert Point = 3% Alert Time = 5 sec	Alert enabled Alert Point = 5% Alert Time = 10 sec	Alert enabled Alert Point = 5 % Alert Alert Time = 10 sec
Notes: 1. Travel Deviation Alert Point % and Travel Deviation Time set to around twice to three times what the valve's response when its new and healthy. 2. Alternatives are to use the step response test to determine the time it normally takes for a 5% step and then set the Travel Deviation Time to 2 times that value. Another option would be to use twice the T63 time			

1. Baseline Data Gathering Procedures

It is important to get a good set of baseline data. This accomplishes two critical tasks: it ensures that the current operating state of the control valve assembly is correct; and when a control valve has a problem the current data can be compared to the baseline data to quickly pinpoint the issue. Valve outages can then be planned with the correct parts, tools, and manpower. Most importantly, impact on the cost of operations will be minimized.

➧ Using ValveLink Software or ValveLink SNAP-ON for AMS

Take baseline data:

1. Import valve "birth certificate" if purchased from factory
2. Fill out valve and actuator spec sheets under Detailed Setup of ValveLink software. (Factory assemblies have been shipping with the spec sheet stored in the instrument since 2008).
3. After spec sheet is verified, read instrument and upload information into Database Dataset, save Dataset.
4. If HC, AD, or PD, run Status Monitor at 4, 12, and 20 mA (or 0%, 50%, and 100% input signal) with digital valve controller In Service and save each dataset.
5. If AD/PD
   - 5.1. Valve Step Response (0-100-0 Step Test)
   - 5.2. Valve Step Response (Performance Test)
   - 5.3. Total Dynamic Scan (DVC6200, DVC6000 or DVC2000)
   - 5.4. Valve Signature, Drive Signal, Dynamic Error Band (DVC5000)
   - 5.5. One Button Sweep (PD only)
   - 5.6. Run Valve Friction diagnostic (PD only)
6. Make sure the Alert Record is enabled and clear.

➧ **Using AMS Trex or 475 Communicator with ValveLink Mobile App**

Take baseline data:

1. Fill out or verify valve and actuator spec sheets under Setup Icon of ValveLink Mobile software.
2. Save Detailed Setup under Setup Icon.
3. Under Status Icon, if HC, AD or PD run Status Monitor at 4, 12, and 20 mA (or 0%, 50%, and 100% input signal) with digital valve controller In Service and save each dataset.
4. If AD/PD
    4.1. Valve Step Response (Stroking Time Test)
    4.2. Valve Step Response (Performance Test)
    4.3. Total Scan (DVC6200, DVC6000, or DVC2000 instrument)
    4.4. One Button Sweep (PD Only)

Note

ValveLink Mobile data can be imported to ValveLink Solo for more detailed analysis.

➧ **Using AMS Trex or 475 Communicator with HART Application App**

Take baseline data:

Using the AMS Trex or 475 Communicator (HART Application overview screen) at 12 mA (or 50% input signal), copy the below data into the computerized maintenance management system (CMMS):

1. Analog In
2. Valve Setpoint
3. Travel
4. Drive Signal
5. Pressures
    5.1. Output A
    5.2. Output B (double-acting piston)
    5.3. A-B
    5.4. Supply (AD or PD only)
6. Make sure the Alert Record is enabled and clear.

III. Normal Operations

The goal is to move away from preventative maintenance tasks (PMs) into a predictive maintenance (PdM) mode where we rely fully on the instrument to inform you of a pending issue. If there are no active alerts, there should be no maintenance. If an alert is active, maintenance activities should be planned based upon the criticality of the control valve application and the alert.

1. Using ValveLink Software in Conjunction with Multiplexers or ValveLink Integrated System (ex. DeltaV or Ovation with AMS)

- Configure the Alert Monitor to monitor all valves based on the criticality ranking of the valve. On PD units, setup the ValveLink Scheduler to run a PD One Button Sweep and Valve Friction test on a periodic basis based on criticality ranking.

- HART Alert Troubleshooting and Correction

- Alerts such as Travel Sensor Fail require a specific course of action like changing the feedback potentiometer on a DVC6000 or checking the wiring on the DVC6205. Refer to Appendix A for a list of these alerts.

1. Other alerts such as the Travel Deviation Alert can be caused by many things and require a systematic approach to determining what the exact problem is. A recommended approach is:
   - 1.1. Run Status Monitor at the current operating position. Check Supply Pressure, Drive Signal, and Travel Pressure State.
   - 1.2. Compare current to baseline values to try to identify the problem. Check the ValveLink Alerts page to see how the current Active Alert values compare with the Alert Point.
   - 1.3. If unit is PD, check for triggered profile.
   - 1.4. Correct any problems discovered.
   - 1.5. If problems cannot be solved continue on with step 2. Use of PD and step 3. Use of AD.
2. Use of PD
   - 2.1 Run One Button Sweep before performing any other diagnostic analysis.
   - 2.2 Correct the problems identified by One Button Sweep.
   - 2.3 If One Button Sweep does not clearly determine the problem, run a Valve Friction Test. Identify any problems and correct.
   - 2.4 If problems cannot be determined continue on with step 3. Use of AD.
3. Use of AD
   - 3.1 Contact operations to have the valve taken out of service if possible.
   - 3.2 DVC6200/ DVC6000 / DVC2000 - Perform a Total Scan and compare results with baseline results.
   - 3.3 DVC5000 - Perform a Valve Signature, Drive Signal and Dynamic Error Band test and compare results with baseline data.
   - 3.4 Determine the problem and correct it.
4. When the problem is corrected, reset the instrument Date & Time if required and Clear the Instrument Alert Record.
5. If the problem still cannot be determined, contact your nearest Emerson sales office or Life Cycles Services Center for support.

2. Roving Laptop Using ValveLink Solo or ValveLink SNAP-ON for AMS

1. Set up routes to periodically monitor control valves.
2. Read the instrument Alert Record periodically with the laptop.
   - Monitoring frequency needs to be determined through a Criticality Ranking of all control valves.
   - Critical valves should be monitored at least 1x per week. Other valves may be monitored monthly, quarterly, semi-annually, etc. depending upon their Criticality Ranking.
3. If the Alert Record is clear, move to the next valve in the route.

<u>OR:</u>

If the Alert Record is not clear, perform the following steps for HART Alert-Troubleshooting and Correction:

1. Alerts such as Travel Sensor Fail require a specific course of action like changing the feedback potentiometer on a DVC6000 or checking the wiring on the DVC6205. Refer to Appendix A for a list of these alerts.
2. Other alerts such as the Travel Deviation Alert can be caused by many things and requires a systematic approach to determining what the exact problem is. A recommended approach is:
   - 2.1. Run Status Monitor at the current operating position. Check Supply Pressure, Drive Signal, and Travel Pressure State.
   - 2.2. Compare current to baseline values to try to identify the problem. Check the ValveLink Alerts page to see how the current Active Alert values compare with the Alert Point.
   - 2.3. If unit is PD, check for triggered profile.
   - 2.4. Correct any problems discovered.
   - 2.5. If problems cannot be solved continue on with step 3. Use of PD, or step 4. Use of AD.
3. Use of PD
   - 3.1. Run One Button Sweep before performing any other diagnostic analysis.
   - 3.2. Correct the problems identified by One Button Sweep.
   - 3.3. If One Button Sweep does not clearly determine the problem, run a Valve Friction Test. Identify any problems and correct.
   - 3.4. If problems cannot be determined continue on with step 4. Use of AD.
4. Use of AD
   - 4.1. Contact operations to have the valve taken out of service if possible.
   - 4.2. DVC6200 / DVC6000 / DVC2000 - Perform a Total Scan and compare results with baseline results.
   - 4.3. DVC5000 - Perform a Valve Signature, Drive Signal and Dynamic Error Band test and compare results with baseline data.
   - 4.4. Determine the problem and correct.
5. When the problem is corrected, reset the instrument Date & Time if required and Clear the Instrument Alert Record.
6. If the problem still cannot be determined, contact your nearest Emerson sales office or Life Cycle Services Center for support.

3. Valves with AMS Trex or 475 Communicator Monitoring Only with ValveLink Mobile App

1. Set up routes to periodically monitor control valves.
2. Read the instrument Status Alerts periodically with the Communicator's ValveLink Mobile App.
   - Monitoring frequency needs to be determined through a Criticality Ranking of all control valves.
   - Critical valves should be monitored at least 1x per week. Other valves may be monitored monthly, quarterly, semi-annually, etc. depending upon their Criticality Ranking.
3. If the Status Alerts are clear, move to the next valve in the route.

<u>OR:</u>

If an Alert is active on the Status Alerts screen, perform the following steps for HART Alert Troubleshooting and Correction:

1. Alerts such as Travel Sensor Fail require a specific course of action like changing the feedback potentiometer on a DVC6000 or checking the wiring on a DVC6205. Refer to Appendix A for a list of these alerts.
2. Other alerts such as the Travel Deviation Alert can be caused by many things and requires a systematic approach to determining what the exact problem is. A recommended approach is:
   - 2.1. Run Status Monitor at the current operating position. Check Supply Pressure, Drive Signal, and Travel Pressure State.
   - 2.2. Compare current to baseline values to try to identify the problem.
   - 2.3. Correct any problems discovered.
   - 2.4. If problems cannot be solved continue on with step 3. Use of PD, or step 4. Use of AD.
3. Use of PD
   - 3.1. Run One Button Sweep before performing any other diagnostic analysis.
   - 3.2. Correct the problems identified by One Button Sweep.
   - 3.3. If One Button Sweep does not clearly determine the problem, run a Valve Friction Test. Identify any problems and correct.
   - 3.4. If problems cannot be determined continue on with step 4. Use of AD.
4. Use of AD
   - 4.1. Contact operations to have the valve taken out of service if possible.
   - 4.2. DVC6200/DVC6000/DVC2000 - Perform a Total Scan and compare results with baseline results.
   - 4.3. Determine the problem and correct.
5. When the problem is corrected, reset the instrument Date & Time if required.

Note

The Instrument Alert Record cannot be accessed or cleared with ValveLink Mobile.

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6. If the problem still cannot be determined, contact your nearest Emerson sales office or Life Cycle Services Center for support.

4. Valves with AMS Trex or 475 Communicator Monitoring Only with HART App

1. Set up routes to periodically monitor control valves.
2. Read the instrument Service Tools - Alert Condition periodically.
   - 2.1. Monitoring frequency needs to be determined through a Criticality Ranking of all control valves.
   - 2.2. Critical valves should be monitored at least 1 time per week. Other valves may be monitored monthly, quarterly, semi-annually, etc. depending upon their Criticality Ranking.
3. If the Alert Record is clear, move to the next valve in the route.
4. If the alert record is not clear, perform the following steps:
   - 4.1. Record the information contained in the Alert Record.
   - 4.2. Record the following values at the current operating position:
     - a. Analog In
     - b. Setpoint
     - c. Travel
     - d. Drive Signal
     - e. Pressures
       - e.1. Output A
       - e.2. Output B
       - e.3. A-B
       - e.4. Supply (available on AD and PD units)
   - 4.3. Compare values with baseline data.
   - 4.4. Determine the cause of discrepancies and correct.
   - 4.5. If the problem cannot be solved, contact your Emerson sales office or Life Cycle Services Center for support.
5. When the problem is corrected, reset the instrument Date & Time if required and Clear the Instrument Alert Record.

IV. Turnarounds

The diagnostic capabilities of FIELDVUE instruments can provide significant reductions in the amount of control valve maintenance required during an outage. Studies have shown that by utilizing diagnostics instead of the “tear apart and inspect method,” 30% of the valves require no maintenance and 40% require only minor adjustments. Just 30% require significant repairs. This means that 70% of the labor that would have been used to tear apart and inspect the control valves can now be utilized for more value-add tasks during the outage.

Before turnaround begins and while valve is in service:

- Run Status Monitor at the valves current travel position and save dataset.
- Use of PD (these tests can be automated on an integrated system via ValveLink Scheduler)

1. Perform a One-Button Sweep to see if any issues have been identified.
2. Perform PD Valve Friction test (can only be done with ValveLink Solo and ValveLink SNAP-ON)

After turnaround begins and valve is out of service:

- Use of AD (ensure output of control system is left at 12 mA and supply is available to the control valves)

1. DVC6200/DVC6000/DVC2000 - Run Total Scan and compare with baseline data.
2. DVC5000 - Run Valve Signature, Drive Signal, Dynamic Error Band and compare with baseline data.

Note

For valves with discrepancies that need to be repaired and must have prepared work orders with applicable job plans, order repair parts and stage tools needed for job.

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3. Perform Startup and Commissioning steps as outlined in Section 2 and save new baseline data with ValveLink software.
4. Close out work order.

After turnaround:

- Clear Instrument Alert Record and Reset Clock and Configuration Change setting.
- These steps can be automated on an integrated system via ValveLink Batch Runner.

1. Perform a One-Button Sweep to see if any issues have been identified.
2. Perform PD Valve Friction test (ValveLink Solo, ValveLink SNAP-ON and ValveLink DTM only)

V. Summary

Customer needs of capital project effectiveness, operational excellence, and maintenance effectiveness were taken directly to the drawing board when Fisher engineers developed FIELDVUE instruments and ValveLink software. The goal of this document is to allow you to extract the full value of the instrument and the software. It is a compilation of best practice information that will help you:

1. **With new instruments--**Configure the FIELDVUE instrument, Startup, Commission, and gather baseline "As New" data from the valve assembly.
2. **During normal operations--**Use the power of FIELDVUE and ValveLink software during normal plant operation to move from preventative control valve maintenance to predictive maintenance
3. **During outages--**Use the power of FIELDVUE and ValveLink software during turnarounds to quickly and effectively perform control valve diagnostics, problem identification, and timely, cost effective resolution.
4. **Advanced users** of FIELDVUE instruments and ValveLink software will find within this guide
    - useful definitions of device parameters and the potential benefit of that parameter
    - explanation of device diagnostics capabilities, with detailed examples and screen captures
    - explanation of Value Add features, with detailed examples and screen captures

Plant valve specialists, an extensive inventory of valve assemblies, and annual turnarounds are no longer general practice. Users that have migrated to a predictive maintenance culture take advantage of microprocessor based technologies and value add software packages. This guide is an attempt to educate and enable you to realize the value within FIELDVUE instruments and deliver business results to your operations.

VI. Appendix A Alerts

There are many alerts available for FIELDVUE instruments. Many of these alerts are configurable to be set to trip at a certain point. The tables below list the alerts for the DVC2000, DVC6000/DVC6200, and DVC6200 (HW2) instruments with a brief definition of each.

DVC2000 Instrument

Travel High	Configuration Changed	Pressure Sensor Fail	Integrator Saturated Low
Travel Low	Internal Sensor Out of Limits	Drive Current Fail	Shutdown Activated
Travel High High	Variable Out of Range	Critical NVM Fail	Replace Main Board
Travel Low Low	In Calibration Mode	Flash Integrity Error	Check Mounting
Travel Deviation	Auto Tvl Cal Failed	Ref. Voltage Failure	Check Supply
Cycle Count	Diagnostic in Progress	Alert Record Not Empty	Check I/P Converter
Travel Accumulator	Travel Sensor Fail	Alert Record Full	Loop Current Validation
Drive Signal	Temp Sensor Fail	Integrator Saturated High	

DVC6000/DVC6200 Instrument

Travel High	Supply Pressure Alert	Travel Sensor Fail	Power Starvation Alert
Travel Low	Configuration Changed	Temp Sensor Fail	Alert Record Not Empty
Travel High High	Diagnostic in Progress	Pressure Sensor Fail	Alert Record Full
Travel Low Low	Loop Current Validation Alert	Drive Current Fail	Integrator Saturated High
Travel Deviation	Internal Sensor Out of Limits	Critical NVM Fail	Integrator Saturated Low
Cycle Count	Variable Out of Range	Non-Critical NVM Failure	Instrument Time Invalid
Travel Accumulator	Calibration in Progress	Flash Integrity Failure	Shutdown Activated
Aux Input	Auto Tvl Cal Failed	Ref. Voltage Failure	Pressure Control Mode Active
Drive Signal Out of Range	Diagnostic Data Available	No Free Time	Multi Drop Operation

DVC6200 (HW2) Instrument

Travel High	Diagnostic in Progress	Pressure Sensor Fail	Alert Record Not Empty
Travel Low	Loop Current Validation Alert	Drive Current Fail	Alert Record Full
Travel High High	Internal Sensor Out of Limits	Critical NVM Fail	Integrator Saturated High
Travel Low Low	Calibration in Progress	Non-Critical NVM Failure	Integrator Saturated Low
Travel Deviation	Auto Tvl Cal Failed	Minor Loop Sensor Failure	Instrument Time Is Approx
Cycle Count	Diagnostic Data Available	Flash Integrity Failure	Shutdown Activated
Travel Accumulator	Travel Sensor Fail	Ref. Voltage Failure	Pressure Fall Back Active
Drive Signal Out of Range	Temp Sensor Fail	Manual Reset Required	Output Circuit Error
Supply Pressure Alert	Port A Overpressured	Supply Pressure Low	Supply Pressure High
Configuration Changed			

Travel Alert High / Low / High High / Low Low (Can be enabled or disabled)
Percent of ranged travel. Value of the travel which, when exceeded, activates the specific travel alert point.

Scaling: -25% to 125%.

Benefit: Can be used with a safety interlock scheme to protect process equipment.

Travel Deviation - % (Can be enabled or disabled)
Percent of ranged travel. Checks the difference between the target and the ranged travel. If the difference exceeds the Travel Deviation Alert Point for more than the Travel Deviation Time, the Travel Deviation Alert is active; it remains active until the difference is less than the Deviation Alert Point.

Benefit: Provides indication that the valve is not tracking the control signal from the DCS adequately. This could also indicate potential mechanical problems or calibration issues.

Cycle Count (Can be enabled or disabled)
A count of how many times the valve has changed direction of travel. Each time the valve changes direction, it is considered a cycle. The Cycle Count Alert is active when the value exceeds the Cycle Count Alert point. It clears after you reset the Cycle Count to a value less than the alert point.

Benefit: The Cycle Count Alert can be used to detect valve dithering, vibration, or improper tuning. It can also be used as a historical life-cycle indicator to help predict wear of packing, diaphragm, and other wear-prone components of the assembly. This alert should be used in conjunction with the travel accumulator alert below.

Travel Accumulator - % (Can be enabled or disabled)
Percent of ranged travel. Checks the difference between the Travel Accumulator value and the Travel Accumulator Alert Point. The Travel Accumulator Alert is active when the Travel Accumulator value exceeds the Travel Accumulator Alert Point. It clears after you reset the Travel Accumulator to a value less than the alert point.

Benefit: Used in conjunction with the cycle count alert mentioned above. High cycle and low travel accumulation could be an indication of high frequency valve oscillation.

Aux (Auxiliary) Input (Can be enabled or disabled) Not available in DVC2000/DVC6200 (HW2)
Indicates whether the contacts connected to the auxiliary terminals are open or closed.

Benefit: The input could be used to detect an external switch contact.

Drive Signal (Can be enabled or disabled)
The signal to the I/P converter from the printed wiring board. It is the percentage of the total microprocessor effort needed to drive the positioner to full output from port A. If an instrument shows drive signals consistently greater or less than the device specific range, consider running additional diagnostic tests.

Benefit: Indication of the health of the instrument and valve. A high drive signal can indicate excess friction in the valve trim or plugging of the I/P. A low drive signal can indicate excess packing wear or a mechanical failure of the valve.

Supply Pressure Alert (Can be enabled or disabled)
When the alert is active this indicates Supply Pressure has fallen below the alert point. If the device is not authorized for supply pressure readings N/A is displayed in the Enabled column and an alert point value will not display.

Benefit: Can indicate insufficient compressor sizing or high demand for instrument air during a plant upset condition. This condition can result in an unstable valve.

Configuration Changed (*Cannot* be disabled)
Indicates that the instrument's configuration has changed and the Configuration Changed flag has not been cleared by ValveLink software or another primary master.

Benefit: Notifies you that some setting has changed within the instrument and that possible unauthorized access or changes have been made.

Loop Current Validation Alert (*Cannot* be disabled)
Indicates that the analog input is at the limit of the instrument's ability to read it.

Benefit: Can indicate a controller card that is bad or out of calibration.

Internal Sensor Out of Limits (*Cannot* be disabled)
Indicates a possible problem with either the pressure sensor, printed wiring board assembly, or both.
Benefit: Provides visibility to fundamental health of the device.

Variable Out of Range (*Cannot* be disabled)
Indicates a possible problem with one or more of the following:
- Actual analog input signal
- I/P converter
- Pneumatic relay
- Printed wiring board assembly

Benefit: Provides visibility to the fundamental health of the device.

Calibration in Progress (*Cannot* be disabled)
Indicates that ValveLink software is currently running a calibration sequence on the instrument.
Benefit: Shows that the valve is unavailable for control.

Auto Tvl Cal Failed (*Cannot* be disabled)
Indicates that the previous attempt to calibrate the travel failed.
Benefit: On DVC6200/DVC2000 check to make sure valve travel doesn't go past white lines on array. On DVC6000 check linkage. On large actuators calibration may have timed out, change tuning set to expert to lengthen calibration time. Could also indicate an issue with the valve health.

Diagnostic in Progress (*Cannot* be disabled)
Indicates that ValveLink software is currently running a diagnostic test on the instrument.
Benefit: Shows that the valve is unavailable for control.

Travel Sensor Fail (*Cannot* be disabled)
Indicates a possible failure of the travel sensor assembly. A failure is indicated when the sensed travel is outside the range -25% to 125% of the calibrated travel.
Benefit: Indicates that the instrument mounting and sensor adjustment are out of spec or the electrical connection from the travel sensor is improperly plugged into the printed wiring board assembly. Valve travel position could be inaccurate.

Temp Sensor Fail (*Cannot* be disabled)
Indicates the instrument temperature sensor reading is outside the range of -60 to 100°C.
Benefit: The temperature reading is used internally for temperature compensation of inputs (impacts performance of the device).

Pressure Sensor Fail (*Cannot* be disabled)
Indicates the output pressure is outside the range -25 to 125% of the calibrated pressure for more than 30 seconds.
Benefit: Knowledge of pressure sensor failure tells you that diagnostics could be inaccurate. Check instrument supply pressure and o-rings between the PWB and housing.

Drive Current Fail (*Cannot* be disabled)
Indicates that the drive current to the I/P converter is not flowing as expected. Check the connection between PWB and I/P module.
Benefit: Tells you that the instrument is not functioning.

Critical NVM Fail (*Cannot* be disabled)
Indicates Non-Volatile Memory (NVM) integrity test failed. NVM is critical for instrument operation.
Benefit: Indicates the general health of the instrument. Replace PWB.

Non Critical NVM Fail (*Cannot* be disabled)
Indicates a failure with NVM that is not critical for instrument operation. Restart instrument, if alert still is active replace PWB.
Benefit: Indicates the general health of the instrument.

Flash Integrity Error (*Cannot* be disabled)
Indicates that there is a problem with the flash ROM (read only memory) and the operating code for the device is corrupted. Resolve this failure by restarting the instrument, if alert still is active replace the PWB.
Benefit: Indicates general health of the instrument.

Ref. (Reference) Voltage Failure (*Cannot* be disabled)
Indicates a hardware failure. Resolve this failure by replacing the printed wiring board (PWB).
Benefit: Indicates general health of the instrument.

No Free Time (*Cannot* be disabled)
Indicates that the instrument is unable to complete all of its configured tasks. This failure does not occur with a properly functioning instrument.
Benefit: Indicates general health of the instrument.

Power Starvation Alert (*Cannot* be disabled)
Indicates that the instrument does not have enough power to allow the instrument to function properly.
Benefit: Indicates possible miscalibration of the A/O controller card.

Alert Record Not Empty (*Can* be disabled)
There are 11 slots (DVC6000/DVC6200) or 20 slots (DVC2000/DVC6200 HW2) for alerts in the alert record. If any one of these slots has an alert, the Alert Record Not Empty indicator will be activated.
Benefit: Indicates an alert has occurred. Informs you that an event has occurred since the last time the record was emptied, prompting you to check the alert log for details.

Alert Record Full (*Can* be disabled)
Alert Record Full is activated when all slots have alerts stored and there is no room for storing any more alerts.
Benefit: Advises you when the record is full and should be reviewed for possible deletion of out-of-date records. Failure to do so will result in new events not being recorded.

Integrator Saturated High / Low (*Can* be disabled)
Integrator high and low action limits. When either limit is reached, the Integrator Saturated alert is activated and integrator action stops.
Benefit: Advises you that the integrator is turned on and has saturated to its max output. This can be caused by an air leak or leak in the actuator.

Pressure Control Mode Active (*Enabled* when pressure fallback is selected)
Active when the device is in pressure fallback and acting like an I/P transducer. On a high friction valve there may be some difficulty in getting to setpoint.
Benefit: Indicates the positioner has gone into pressure control mode. Check the linkage and wiring on a DVC6000, the array on a DVC6200/DVC2000, and the wiring and array on the remote mount DVC6200.

Check Mounting (*Cannot* be disabled)
DVC2000 alert only. Same as travel sensor fail alert in the DVC6200.
Benefit: Indicates the valve position feedback is valid but outside of the operating range. Check the mounting bracket and array for misalignment.

Minor Loop Sensor (*Cannot* be disabled)
This is a new alert for the DVC6200 HW2. It is active if the pneumatic relay is outside the valid range for the MLF (minor loop feedback)
Benefit: Advises you there is no feedback from the relay or PWB for minor loop. This can affect positioner tuning. Replace PWB or relay.

Diagnostic Data Available (*Enabled* when Triggered Profile is set up)
Active when diagnostic data has been collected by the instrument and is being stored in the instrument.
Benefit: Advises you that the positioner has triggered profile data in its memory and ValveLink should be used to extract this data.

VII. Appendix B Diagnostics

1. FIELDVUE Diagnostics Overview

Diagnostics in this context are defined as “valve assembly diagnostics,” not just instrument diagnostics. Instrument diagnostics fall under the category of alerts.

FIELDVUE instruments are identified and sold by diagnostic functionality tiers. The tiers are AC, HC, AD, PD, ODV, and SIS. Availability of tiers depends upon the FIELDVUE instrument you have. Below is a table identifying instrument type and appropriate tiers available.

Instrument	AC	HC	AD	PD	ODV	SIS
DVC2000	✓	✓	✓	✓	—	—
DVC6000	✓	✓	✓	✓	✓	✓
DVC6200	✓	✓	✓	✓	✓	✓

Diagnostic Tier Definitions:

AC: Auto Calibration. Use HART communications for configuration and calibration, but no alerts or diagnostics are available. Only communicate with AMS Trex or 475 Communicator.

HC: HART Communicating. No diagnostics available. All alerts/alarms (except instrument supply pressure) are available with DVC2000/DVC6000/DVC6200.

AD: Advanced Diagnostics. A combination of HART Communicating alerts listed above and the following tests: Dynamic Scan (Valve Signature, Dynamic Error Band, Drive Signal test) and Step Response are available. These tests physically move the valve, requiring the valve to be isolated from the process.

PD: Performance Diagnostics. A combination of Advanced Diagnostics tests listed above, and the following tests that are performed while the valve assembly is in service/in-situ and responding to the control system set point. These tests do not interfere with control valve response to set point changes

- I/P & Relay Integrity Test
- Air Mass Flow Test
- Relay Adjustment Test
- Supply Pressure Test
- Travel Deviation Test
- Valve Friction
- Performance Profile
- Triggered Profile

ODV: Optimized Digital Valve. Advanced Diagnostics, Performance Diagnostics and Partial Stroke valve testing are available. Partial Stroke testing physically moves the valve *while* the valve is in service responding to control system set point changes. Also includes special optimized tuning for specific valve applications such as compressor anti-surge and turbine bypass.

SIS: Safety Instrumented System. Advanced Diagnostics, Performance Diagnostics and Partial Stroke valve testing are available. This tier is specifically suited for valve emergency shutdown safety system applications.

2. Performance Diagnostics Overview

The most advanced FIELDVUE instrument diagnostics are called **Performance Diagnostics**. These diagnostics are a major step forward in the valve industry, and provide significant value to users.

Performance Diagnostics key features:

- On-line, In-Service, In-situ, <u>Non-intrusive</u>
- Provides <u>predictive</u> diagnostic information (prognostics)
- Red/yellow/green light dashboard provides a quick visual indicator of the issue and severity
- Defines the specific problem, the possible cause, and recommended actions.
- Relational graphic trending (electronic strip chart) of valve related variables such as pressure, travel, travel set point, etc.
- In-situ analysis and trending of Friction
- In-situ analysis and trending of Deadband
- Triggered Profile allows onboard storage of data for later analysis

3. Performance Diagnostics - Test Details (In Service Testing)

PD is the overarching name for a series of valve assembly diagnostic tests that ValveLink software can run while the valve is in-service/in-situ. Multiple sensors in the FIELDVUE digital valve controller monitor:

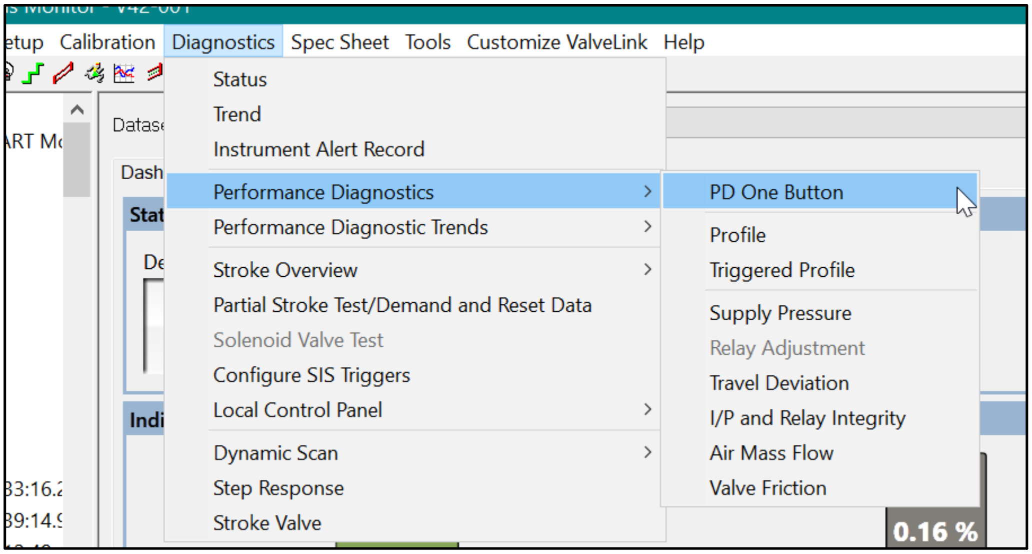
- input current from controller
- supply pressure to the device
- output pressure to the actuator
- valve position
- on board temperature
- drive signal of the internal I/P transducer
- relay position

Using the data collected above, the following diagnostic tests can be performed:

- One-Button Sweep
- Profile
- Triggered Profile
- Supply Pressure
- Relay Adjustment (double-acting only)
- Travel Deviation
- I/P and Relay Integrity
- Air Mass Flow
- Valve Friction

The One Button Sweep test is really a combination of Supply Pressure, Relay Adjustment, Travel Deviation, I/P and Relay Integrity, and Air Mass Flow. Each test is run sequentially for approximately 20 seconds.

To access PD diagnostics in ValveLink software, go to the Diagnostics menu and select Performance Diagnostics. Select the appropriate test from this menu.

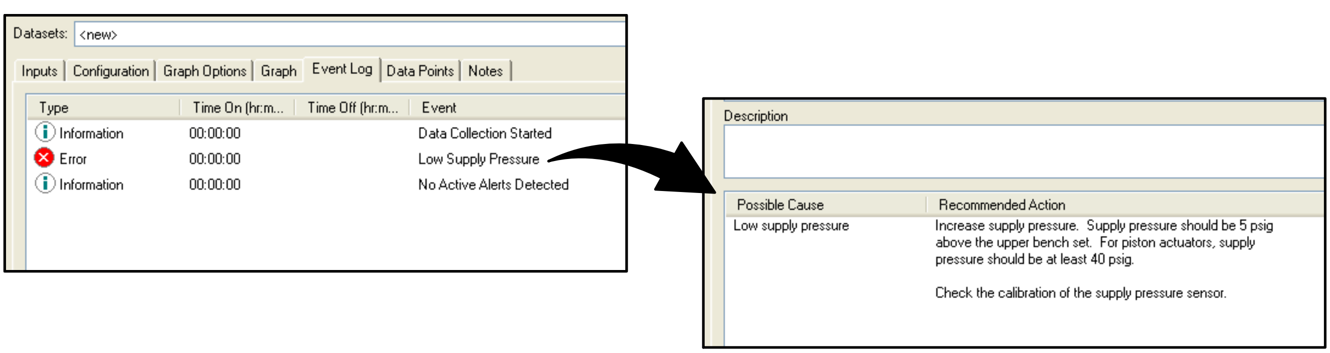


The Profile diagnostic test gathers user defined information - it's like an extremely fast electronic strip chart. This diagnostic can be used to help troubleshoot difficult issues where existing tests do not meet user needs. An example is a valve that is beginning to oscillate. The Profile test can track what came first - a change in air pressure to the actuator causing the movement, or if valve movement occurred before actuator pressure changed. This can help pinpoint if a hydraulic phenomena such as negative flow gradients are causing the valve to go unstable, or if the valve has a tuning issue due to a tuning set or accessories configured incorrectly.

The Profile test allows you to define specifically what variables to capture and plot. The variables available are:

- Travel Set Point
- Travel Set
- Drive Signal
- Actuator Pressure A
- Actuator Pressure B
- Supply Pressure
- Relay Position
- Travel Deviation
- Input Set Point
- Input Current
- Pressure Set Point
- Pressure Feedback

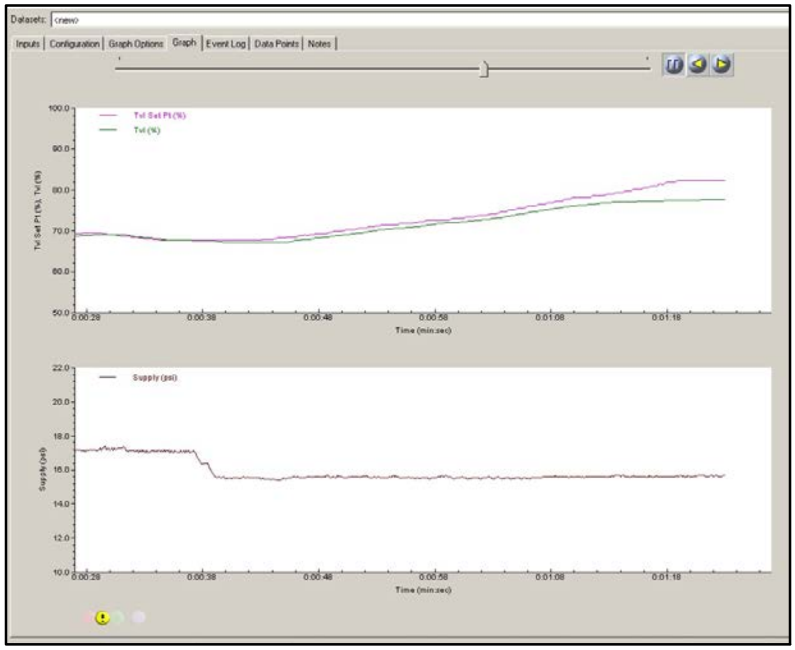
This test does not provide any red/yellow/green light evaluation, it only provides data, unless there is a major problem such as low supply pressure.

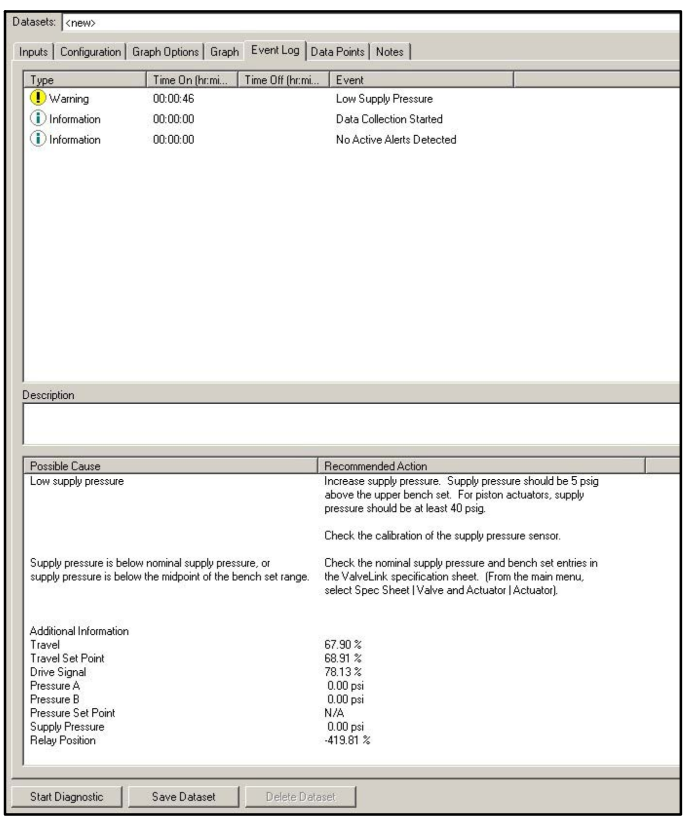


HART communication limitations only allow us to pass back four of the above variables at a time with a DVC6000/DVC6200 or a DVC2000 instrument. DVC5000 instrument's can provide only a subset of these variables: Travel, Travel Set point, Drive Signal, Actuator Pressure, and Input Current.

The Supply Pressure diagnostic test evaluates the instrument air supply pressure and volume. Diagnostic parameters used are travel, travel set point, and supply pressure.

The root cause for one out of every ten control valves that has been identified as having a problem is lack of air supply volume or pressure. This can cause a valve to go unstable or not allow it to reach full travel.





What kind of issues can this diagnostic detect?

a) Low supply pressure

b) High supply pressure

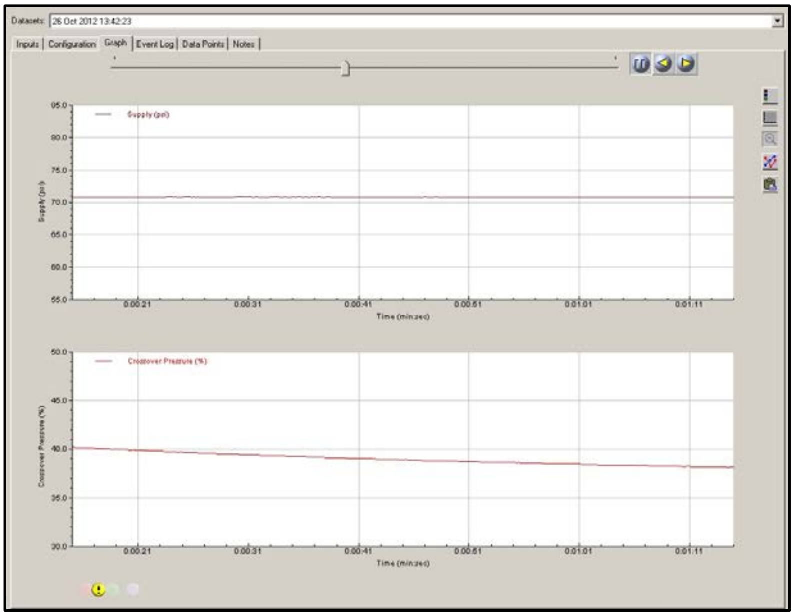
c) System pressure droop

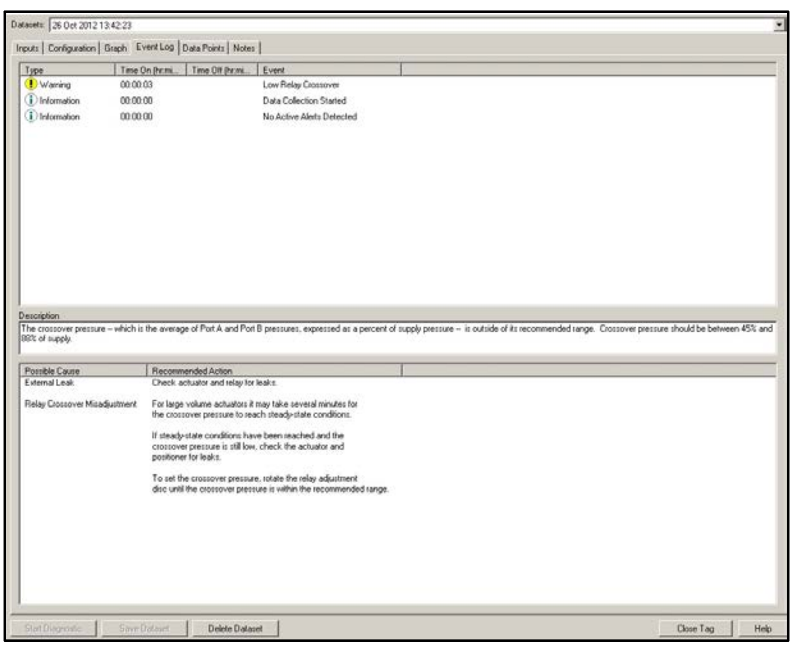
d) Pressure sensor out of calibration

e) Incorrect Benchset specified

The Relay Adjustment diagnostic test evaluates the relay adjustment when the DVC6200/DVC6000 instrument is used on double-acting piston actuators. The relay adjustment sets the pneumatic crossover pressure point of the actuator. The diagnostic parameters used are travel set point, actuator pressure A, actuator pressure B, and supply pressure.

In high vibration applications, it is possible for the instrument to be shaken so violently that the relay crossover wheel can begin to move. This changes the actuator pneumatic crossover point, meaning the valve is no longer calibrated correctly. This will look like the valve has a setpoint offset. The Relay Adjust diagnostic can detect this situation.



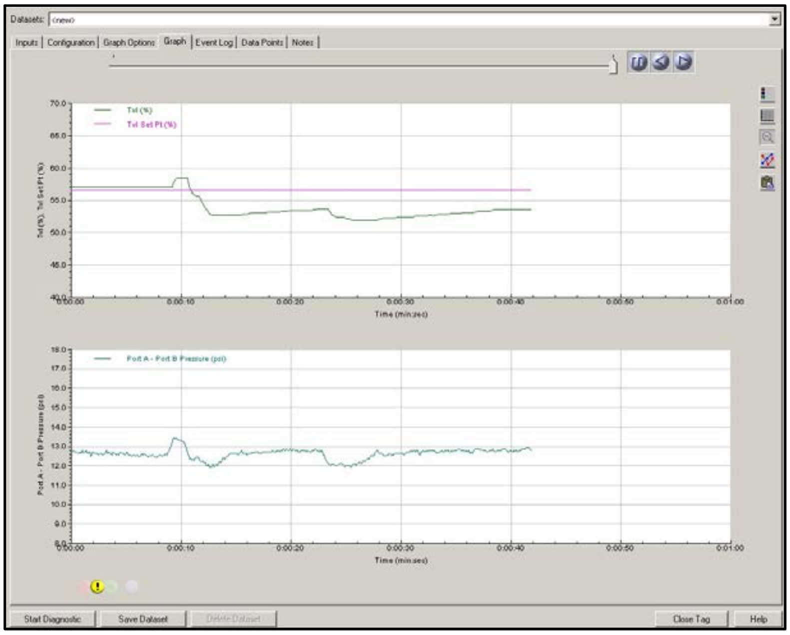


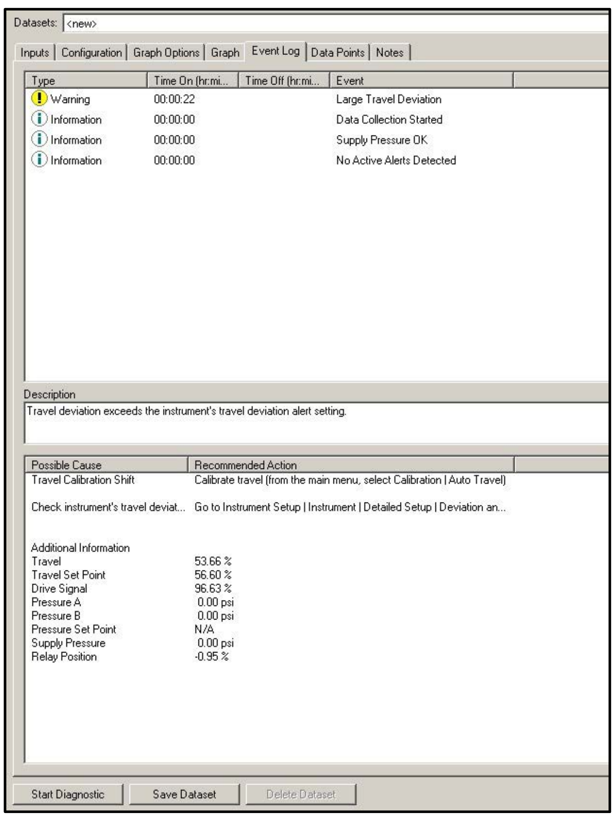
What kind of issues can this diagnostic detect?

a) Relay Jammed
b) Relay crossover misadjusted
c) Crossover pressure low
d) Crossover pressure high
e) Port A Relay diaphragm failure
f) Port B Relay diaphragm failure
g) External leaks
h) Fail assist spring weakening or broken

The Travel Deviation diagnostic test evaluates the reasons why a valve assembly is deviating from the set point. The diagnostic parameters used are travel, travel set point, and actuator pressure.

Travel deviation occurs most frequently in applications with vibration or temperature cycling. Travel deviation looks like a continuous offset, or an offset that lasts for a period of time. This directly impacts the valve's ability to accurately control the process.





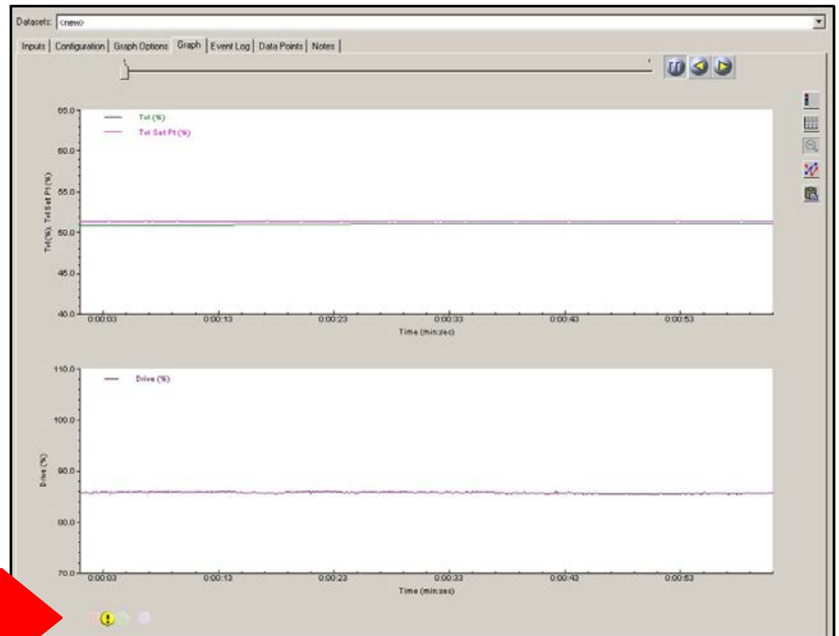
What kind of issues can this diagnostic detect?

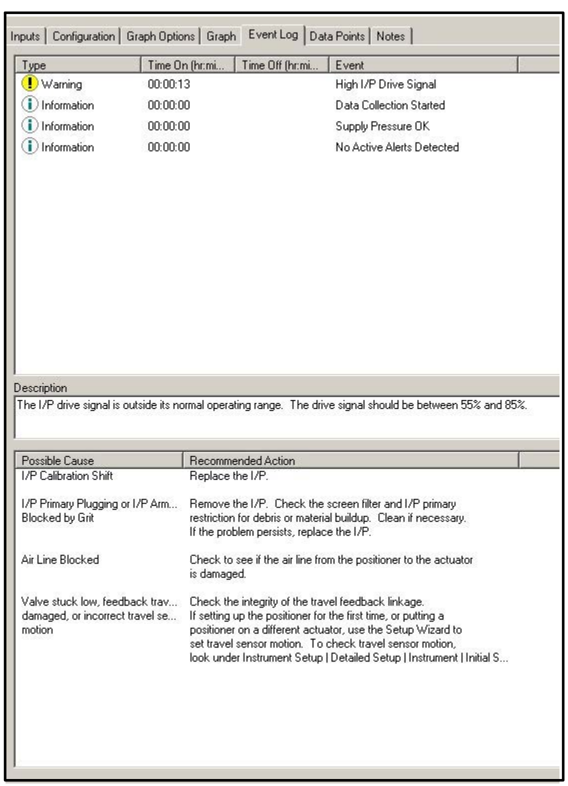
a) Travel calibration shift
b) I/P or relay fault
c) Supply pressure low
d) Blocked instrument supply air line
e) Valve stuck
f) Internal leaks
g) External leaks

The I/P and Relay Integrity test evaluate the physical condition of the I/P and Relay components of the FIELDVUE instrument. Diagnostic parameters are relay hall effect sensor position, travel, travel feedback position, and the drive signal.

If you are having an I/P issue from plugging of the primary orifice, the valve may initially be close to set point and operations may not be aware of an impending issue.

Red/Yellow/Green Light Dashboard





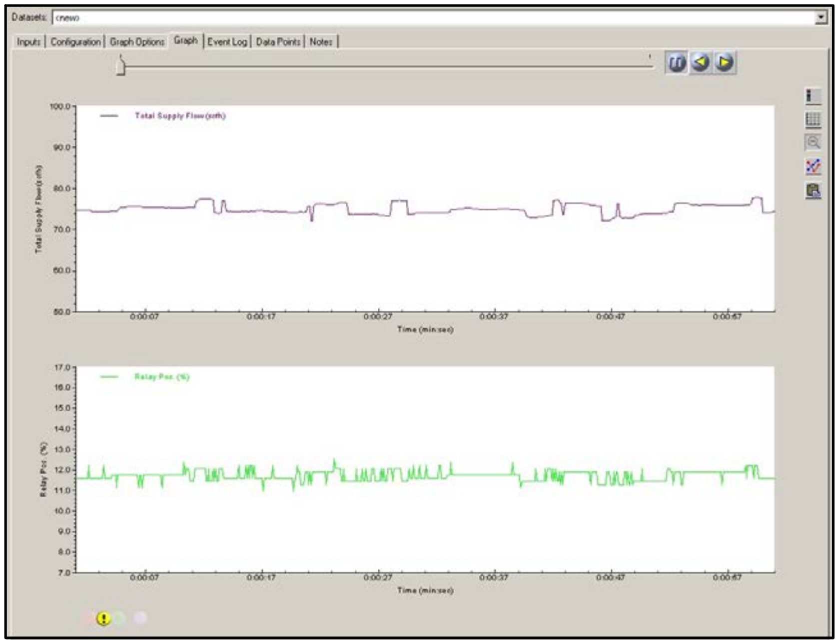
What kind of issues can this diagnostic detect?

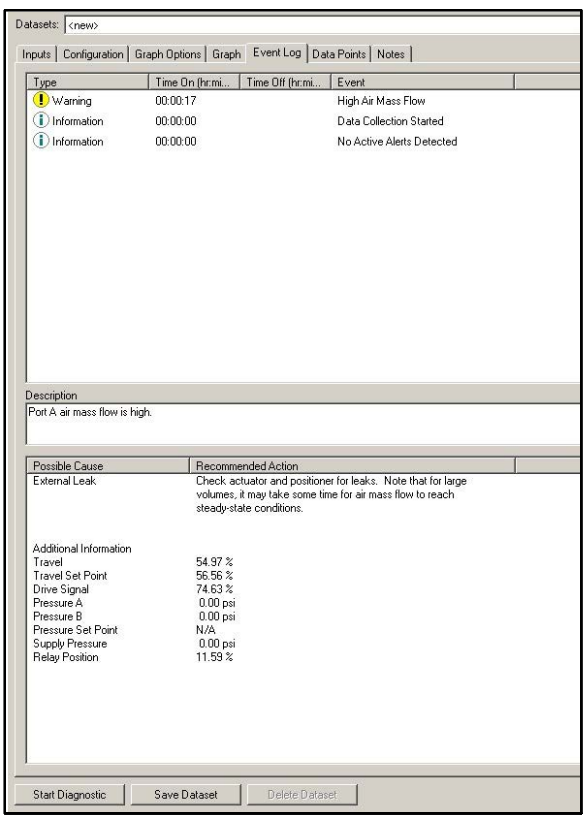
a) I/P beginning to plug
b) I/P O-ring failure
c) Relay diaphragm failure
d) Supply pressure low
e) I/P calibration shift
f) Valve stuck low
g) Feedback linkage damaged
h) Actuator air line blocked or damaged
i) Actuator crossover adjustment wrong

The Air Mass Flow test calculates the total air received and used by the DVC6200/DVC6000. It has the ability to calculate the flow rate provided by the instrument air supply, and the output to the actuator. For double-acting actuators, it can discriminate between positive and negative flow rates from each side of the piston. Diagnostic parameters used are the relay hall effect sensor position, supply pressure, actuator pressure A, and actuator pressure B for analysis.

A very common piston actuator problem is a faulty piston O-ring. This appears as a valve that is no longer calibrated and “wanders” around the setpoint. In reality, the actuator has lost its stiffness and the process pressures are pushing the valve plug around.

Piston O-rings can fail over time when continuously exposed to high temperatures. This failure is one of the hardest failure modes to troubleshoot. PD can specifically define this situation.





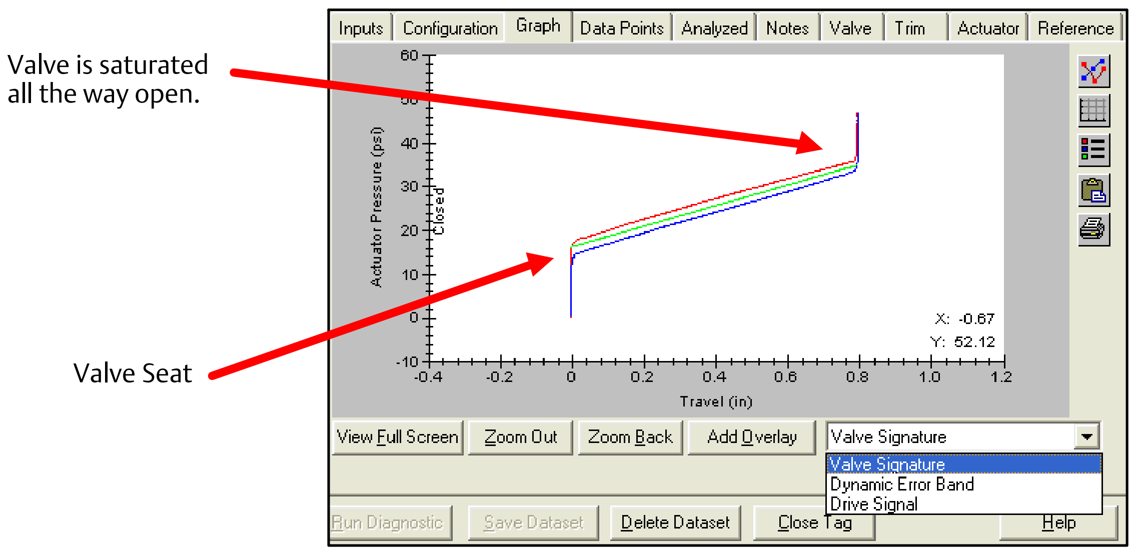
What kind of issues can this diagnostic detect?

a) Kinked, cracked, or loose tubing
b) Piston actuator O-ring failure
c) Actuator diaphragm leak
d) Incorrect regulator setting
e) Filter regulator plugging

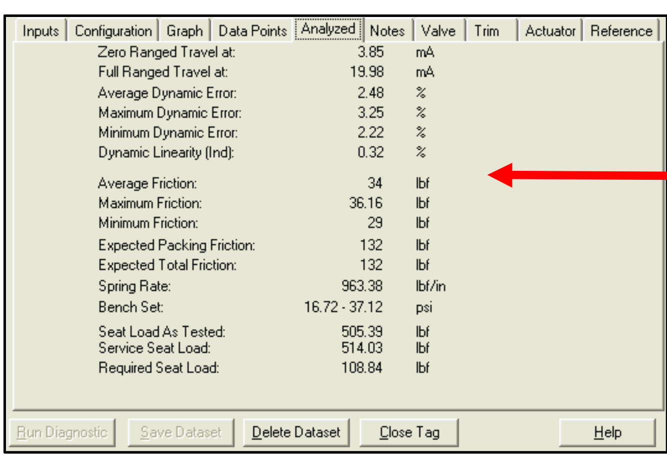
4. Advanced Diagnostics - Test Details (Out of Service Testing)

Advanced Diagnostic tests actively diagnose and troubleshoot instruments and control valves. Using Advanced Diagnostics, you can run interactive tests that move the valve, poll for data, and display the data graphically. In most cases this means that you are *isolating the valve from the active process* and are performing a dynamic stroke of the valve assembly. The two tests included in the Advanced Diagnostics tier are the Dynamic Scan and Step Response Test. The Dynamic Scan test consists of a Valve Signature, Dynamic Error Band, and Drive Signal data. It requires a person with expertise in valve assembly construction and plot analysis to interpret the results of the test as no “answer" is provided at the conclusion of these tests. There is no reason that you cannot become an expert also. When looking at graphs, look for abnormalities; any change indicates something could be potentially wrong. Each valve and actuator type will have its own distinct graph. Comparing the existing graph to the base line data is a good place to start.

Valve Signature: Plots actuator PRESSURE versus valve TRAVEL. The test calculates friction, seat load, spring rate, and a myriad of other variables. It is the only test that lets you see the condition of the valve seat. It is primarily used to determine valve and actuator mechanical condition. Issues such as worn seat, worn/bent stem, insufficient air supply, incorrect bench set, insufficient frictional forces, and stuck valve are examples of the issues that can be found using this test.



Example of a Valve Signature and analyzed data with a spring and diaphragm actuator



Zero Ranged Travel at:	3.85	mA
Full Ranged Travel at:	19.98	mA
Average Dynamic Error:	2.48	%
Maximum Dynamic Error:	3.25	%
Minimum Dynamic Error:	2.22	%
Dynamic Linearity (Ind):	0.32	%
Average Friction:	34	lbf
Maximum Friction:	36.16	lbf
Minimum Friction:	29	lbf
Expected Packing Friction:	132	lbf
Expected Total Friction:	132	lbf
Spring Rate:	963.38	lbf/in
Bench Set:	16.72 - 37.12	psi
Seat Load As Tested:	505.39	lbf
Service Seat Load:	514.03	lbf
Required Seat Load:	108.84	lbf

Analysis of valve assembly

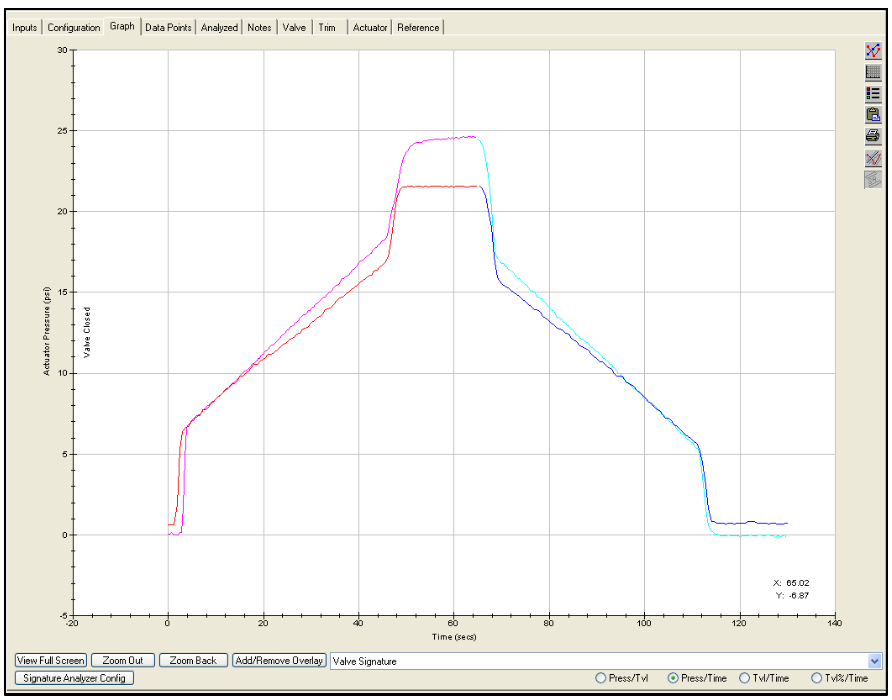
Valve spec sheet must be filled out to perform this detailed analysis.

Dynamic Error Band: The Dynamic Error Band test plots valve TRAVEL versus INPUT setpoint. This test calculates min/max/average dynamic error and dynamic linearity. The dynamic error band test shows a picture of the performance of the entire valve assembly, including the instrumentation.

Drive Signal: Plots INPUT setpoint in percent of ranged travel versus the DRIVE SIGNAL of an instrument in percent of maximum drive signal current. The drive signal gives you a measure of just how “hard" the instrument is working while trying to position a valve. Standard drive signal ranges are from 55 - 85%. It is not uncommon, however, to see the drive signal vary outside this range during sudden movement of the valve assembly. High drive signal measurements mean that the instrument is working very hard to position the valve correctly. This can be an indication of a sticking valve, an I/P that is starting to plug up with debris from the air supply system, or extreme vibration that has caused the I/P calibration to shift.

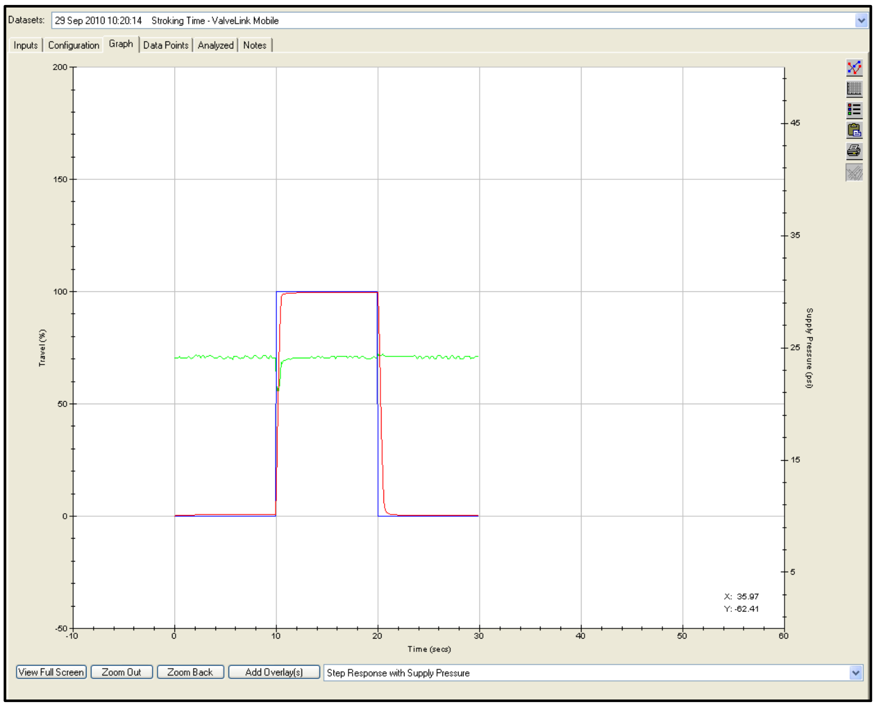
Valve Signature: The Valve Signature can also be plotted in Pressure versus Time, Travel versus Time, and Travel % versus Time test plots. Pressure/Time is another way of plotting the valve signature. It is most often used to look at fill and exhaust of the actuator. At the upper part of the graph if there are no air leaks we expect to see the pressure equal supply. Notice below there are two separate valves that are shown overlaid. As seen in the graph, one valve assembly has a higher supply pressure. Notice the upper curve; it is indicative of air leaking past the O-rings of a 667 actuator.

Travel versus Time will give you a plot that is another way of looking at the dynamic error band. It can be useful for comparison when zeroing in on a problem.

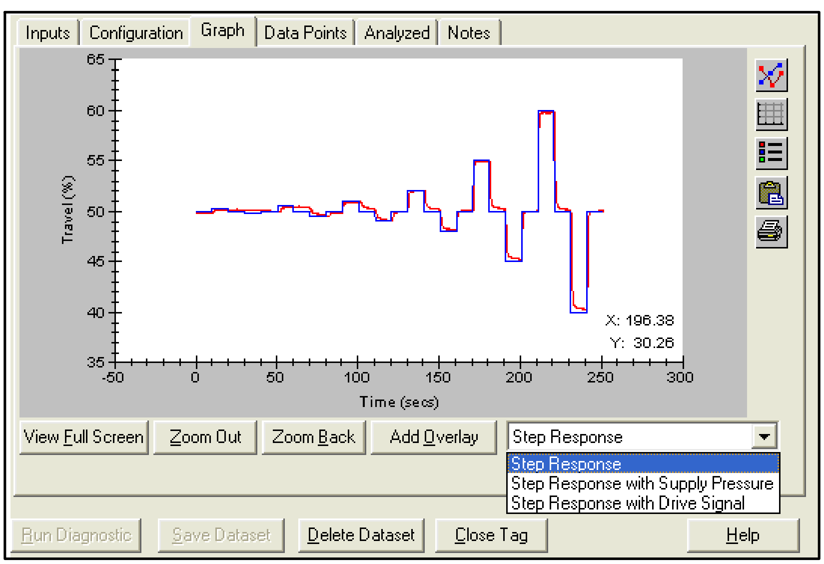


Pressure versus Time

Step Response: This test plots valve TRAVEL versus the TIME it takes to move through the specific steps. It checks the response of the entire valve assembly and gives you an indication of the effectiveness of the tuning of the instrumentation and accessories. Small steps are useful to determine dynamic performance. Large steps are useful in determining adequate supply pressure and accessory performance. Below is a plot of stroking time. This test was done using ValveLink Mobile on a 475 and imported into ValveLink for analysis. It is always good to look at this graph with supply pressure. Poor performance of valve assemblies can be caused by lack of supply volume.



Travel versus Time



Example of a Step Response Test

5. Advanced Diagnostics Look and Feel

Q: What are Advanced Diagnostics (AD) used for now that Performance Diagnostics (PD) are available?

A: Advanced Diagnostics are a companion tool for Performance Diagnostics functionality. There are some things that AD can identify that PD cannot - and vice versa. For example, a worn seat. Since the valve is not throttling in the seat, PD cannot detect a seat that is worn. However, AD has the ability to give you a visual indication that the seat is starting to wear. There is still tremendous value in performing a valve signature on a control valve assembly. Many customers use this technology to ensure a valve assembly has been rebuilt and is performing correctly before installation.

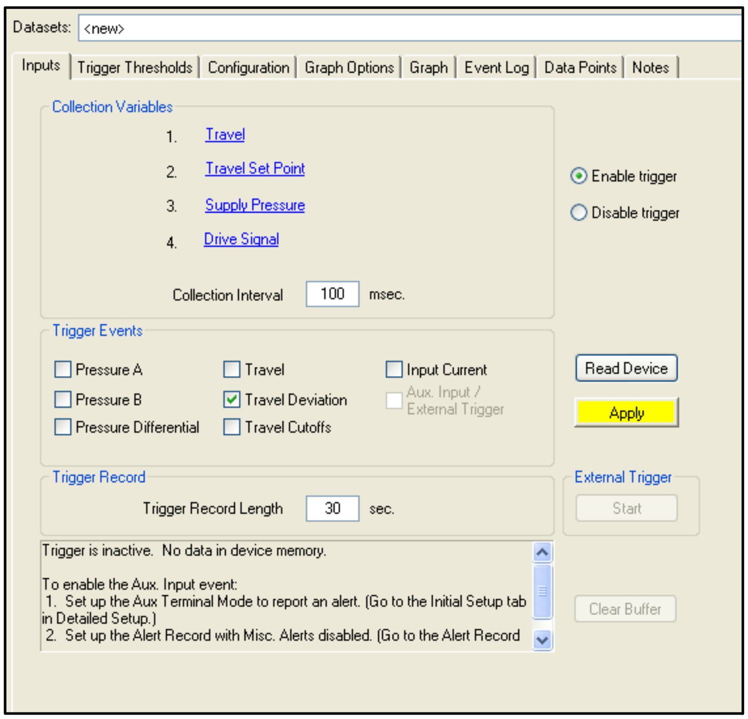
Q: Can my Performance Diagnostics tier instrument also perform Advanced Diagnostics tests?

A: Yes. PD includes AD functionality.

VIII. Appendix C Value-Add Features

Multiple tools have been developed in ValveLink software that provide you with more visibility to issues, as well as help you be more efficient using the advanced features.

Triggered Profile: The DVC6000/DVC6200 has the capability to capture PD information when certain events occur. These can be when the instrument is going into or out of cutoff, a travel deviation, or a combination of these two. For a throttling control valve, you should trigger off of travel deviation. If the travel deviates from set point for the percentage and time specified in detailed set up, the digital valve controller will store triggered data in the device for the time specified. Thirty seconds is a good time period to start with. The device can hold approximately 20 minutes of triggered data. Below is a typical setting for triggered profile.



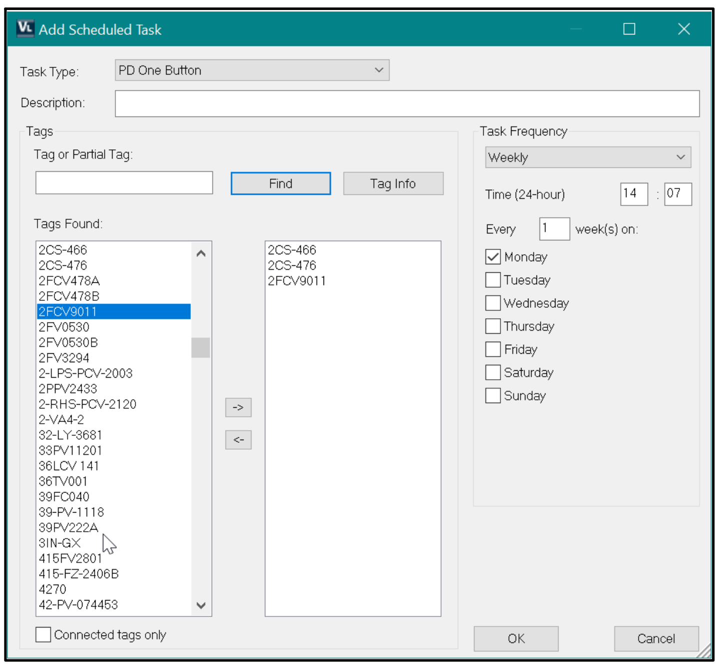
Scheduler: Scheduler is a tool that allows you to run various types of tests in a sequential manner at predefined intervals without user intervention. The resulting data is available for later viewing and analysis. The Scheduler gives you the capability to specify a time and date to automatically run a particular task on a particular device.

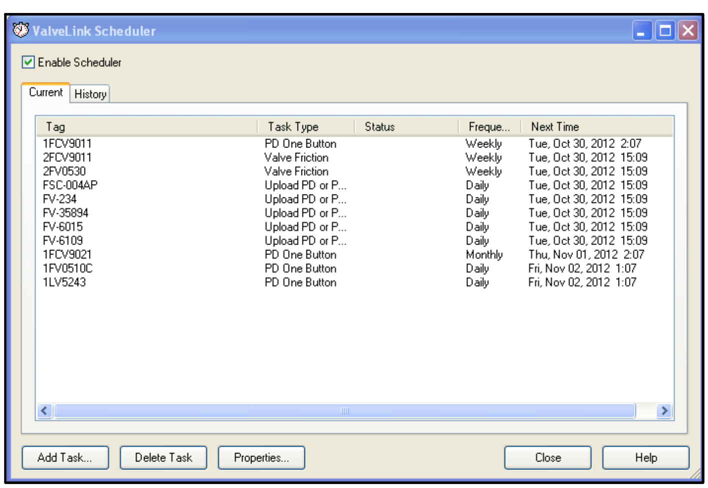
The Scheduler can perform these tasks:

- One Button Performance Diagnostics Sweep
- Partial Stroke Test (SIS or ODV instruments)
- Upload Triggered Profile
- Upload PST (Partial Stroke Test) data
- Valve Friction (Performance Diagnostics)
- Status Monitor

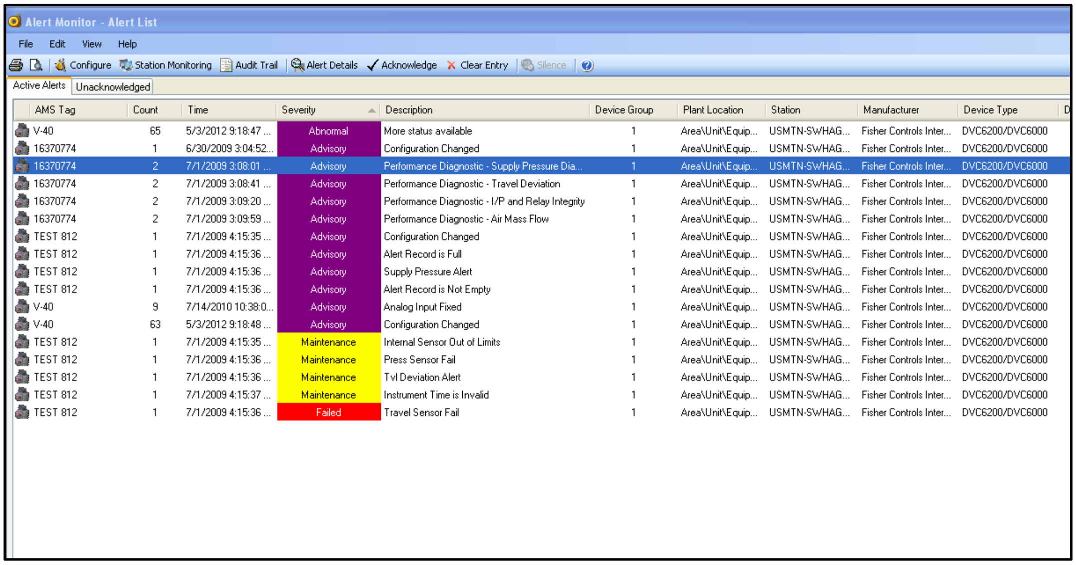
An unlimited number of tasks can be set up in the Scheduler on a daily, weekly, or monthly basis.

A history of all tasks completed is maintained in the History page of the Scheduler, indicating the problem found, the reason for the problem, and a solution to resolve the problem.



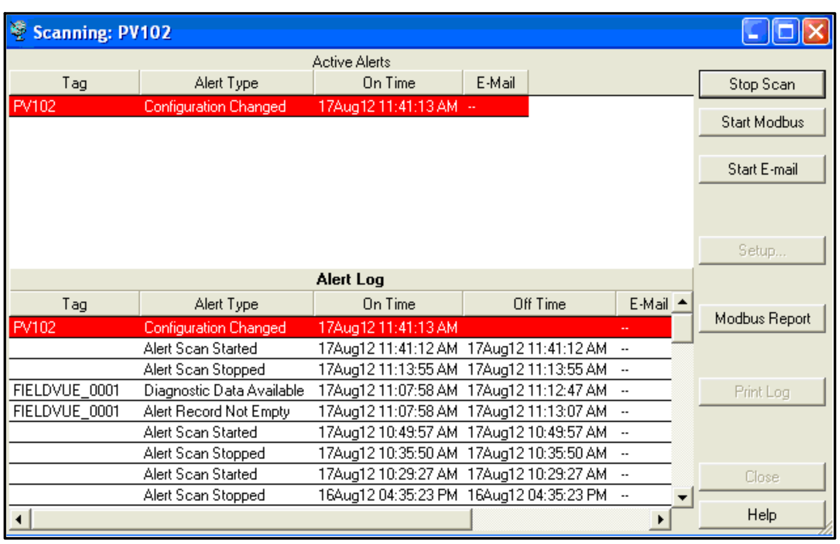


AMS Device Monitor Alert Log: If you are using ValveLink SNAP-ON, any alerts found by Scheduler will show up in the AMS Device Manager Alert Monitor.



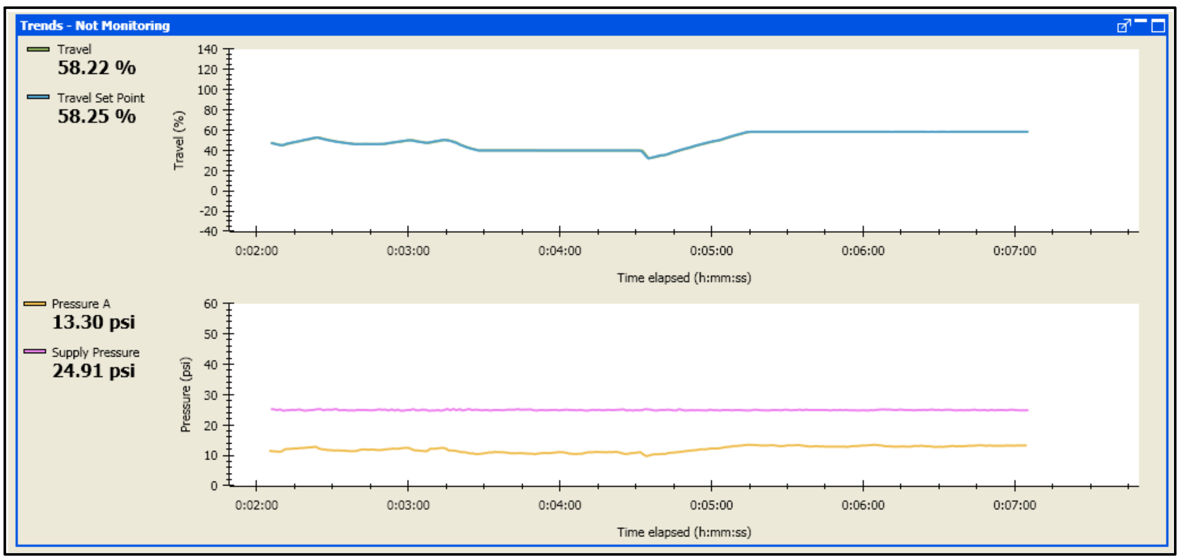
ValveLink Alert Log: In the Alert Log display area of the Network Scanning screen, ValveLink software lists alert information including group and tag, alert type, and date and time when an alert was “turned on” and the “turn off” time for all alerts. Alerts that are currently active (with no time off) are highlighted in the list. Use the scroll bar to view all of the information in the Alert Log area.

The alert log shows historical events; it does not identify alerts that are currently active. The Alert Log is configured to store a maximum number of alerts. After reaching the maximum number, ValveLink removes the oldest alerts from the end of the log. It also allows you to print the Alert Log. It is NOT possible to edit this log.

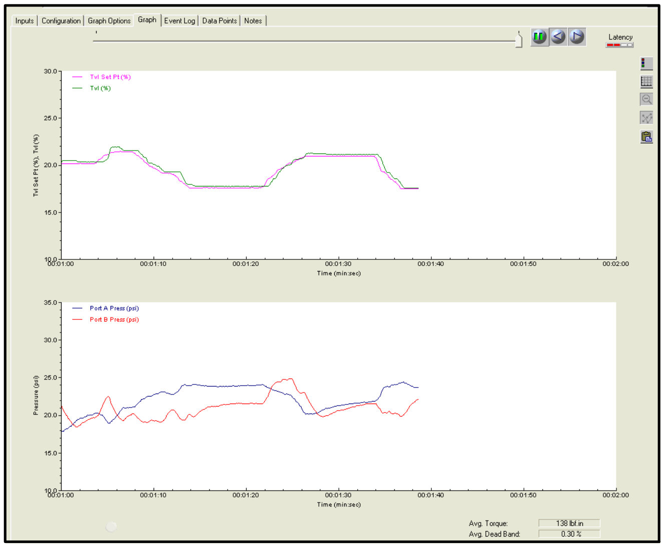


Status Monitor Trending: This is a new feature added to ValveLink version 12. Trending provides an easy visualization of valve response to a control system output using an electronic strip chart. Trending is a diagnostic intended to monitor standard instrument parameters during normal process operations. View live data received over the multiplexer network, archived data, or data saved in a dataset. The last six minutes of a devices trend will be saved when the Status Monitor is ended. The parameters that are recorded are:

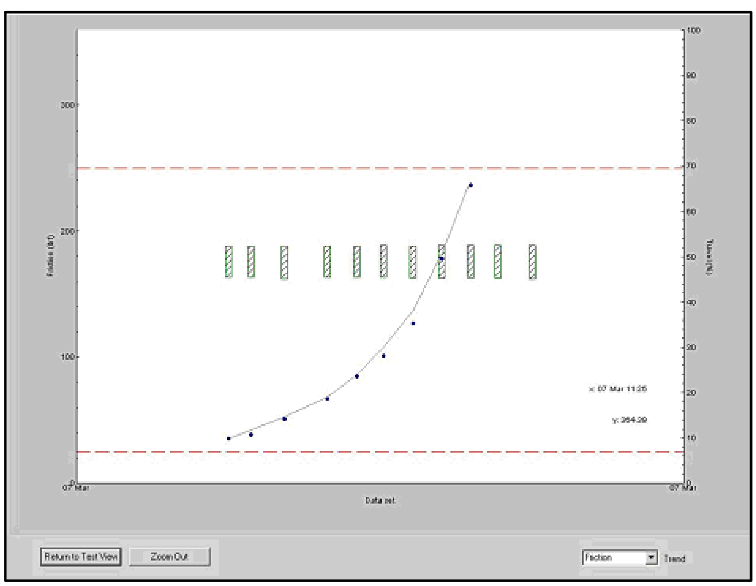
Travel
Travel Setpoint
Pressure A (A-B for a double-acting piston)
Supply Pressure (AD & PD units only)



Friction and Friction Trending:

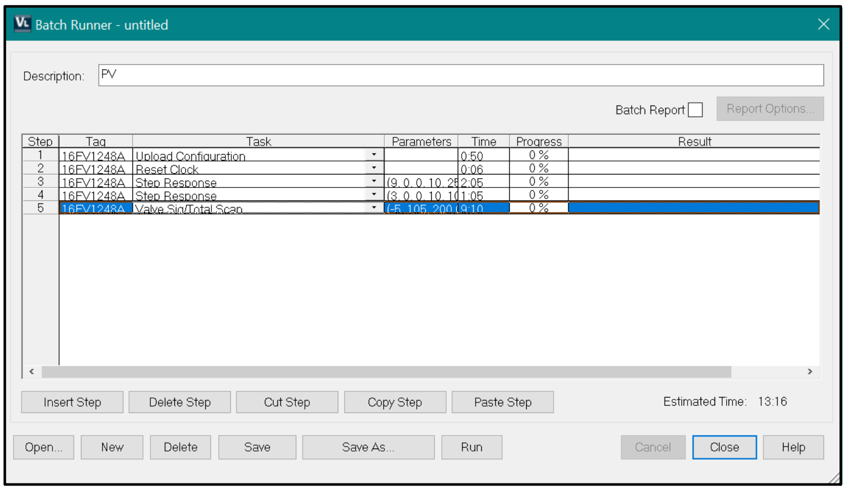


ValveLink PD diagnostics allow for friction calculations while the valve is in service and running. It does not move the valve, it only watches how a valve responds to a position change request from a control system. A single friction/torque calculation is nice, but determining the friction/torque over time is also very important. Trending of these parameters gives you a good idea of the health of the instrument and its pending issue. The dashed lines represent an upper or lower friction or dead band limit. Once the friction/dead band goes beyond this limit, ValveLink software can send an email notice to the appropriate personnel or post an alert to the Alert Monitor. Use the total expected friction from the valve signature analysis for the upper range and then 25% of that value for the lower range. If the valve has single TFE packing you can use 20% for this calculation. This feature can also be useful for finding build up and sticking on rotary products. This measurement is done with process flowing thru the valve, you may also find parts that are sticking or galling that didn't show up with testing that had the process isolated.



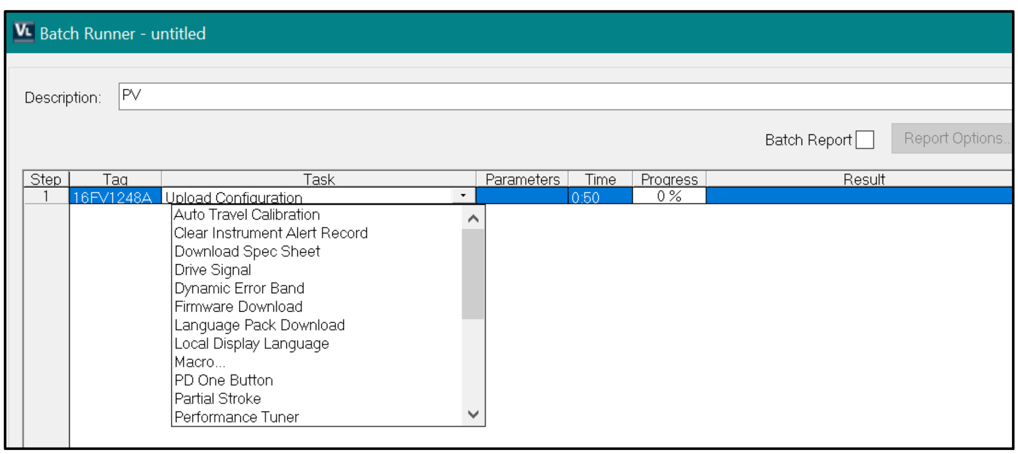
Batch Runner: Batch Runner allows you to preconfigure a set of tests for a valve, or a set of valves. You can reuse the batch whenever you need it, saving time and reducing the risk of errors. Many companies use this functionality by creating startup batches for the valves they have in specific plant areas. For example, they will set up a batch for all valves in the power house. They want all of valves in the power house to have the alert record cleared, clock reset, configuration flag reset, and upload the configuration in case of changes. This is easily setup in a batch and the batch can be run on all valves after startup.

Batch used in an integrated system is a very powerful tool. It allows you to mass edit large numbers of parameters for multiple control valves. Do not mix in-service diagnostics with out of service diagnostics on a batch. The batch runner will not take valves out of service or put them in-service, so some tests may not run.



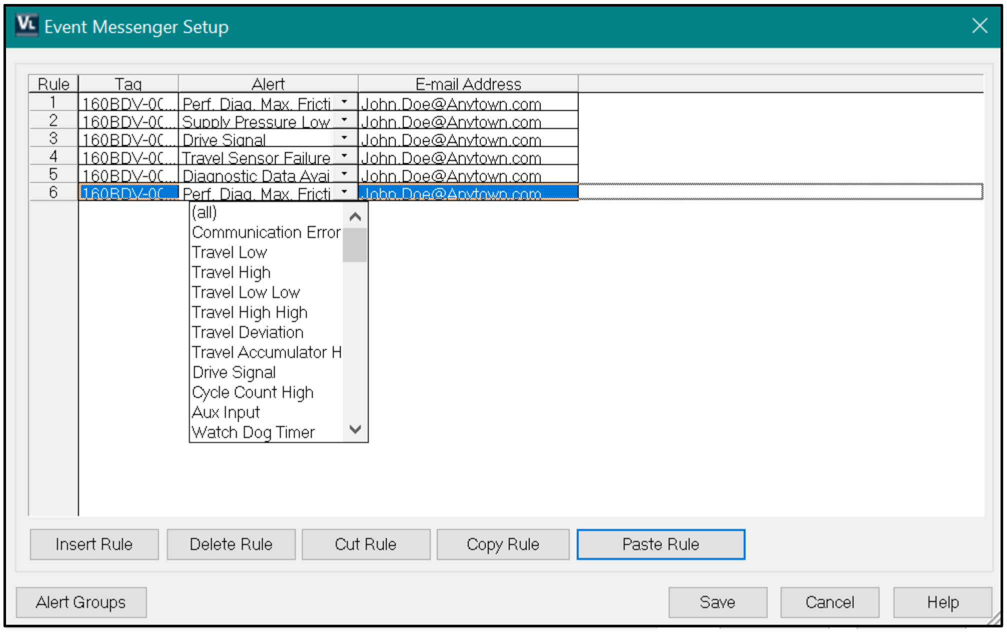
Numerous task can be performed using Batch Runner:

o Advanced Diagnostics
o Firmware Download
o Partial Stroke Tests
o Run Performance Tuner
o Reports
o Reset clock
o Reset Config Change flag
o Run Status Monitor
o Upload Configurations
o Auto Travel Calibration



Event Messenger: Event Messenger provides you an easy way notify appropriate personnel of issues. This tool makes use of the email system. Email can be directed towards a text message box, pager, or standard email inbox.

You can predefine what types of alerts for each specific valve or groups of valves go to which person. This is a very powerful tool in an integrated environment where the system extends across multiple areas of the plant. Different maintenance personnel can be notified as appropriate in this situation.



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