

## Intelligent Device Management: Device Diagnostics

Device diagnostics can be carried out using a handheld communicator in the field, a laptop in the workshop, or from intelligent device management software as part of asset management solution, either from a dedicated maintenance console or integrated in the operator console (see separate white paper on integrated operation). Electronic Device Description Language (EDDL) is the technology used by device manufacturers to control how the device diagnostics is displayed to the technician. EDDL makes diagnostics of intelligent devices easier thanks to user guidance such as wizards and help, and provides unparalleled consistency of use.

### Device Diagnostics

The diagnostics is performed by the device itself, that is, self-diagnostics or self-tests. HART, FOUNDATION fieldbus, PROFIBUS, or WirelessHART protocols are used to communicate the result of the self-diagnostics to the handheld communicator or intelligent device management software. Each protocol has a different mechanism for reporting diagnostics and therefore perform differently. That is, the computer software or handheld is used for display.

In a vast majority of cases diagnostics is embedded in the device itself as firmware so that the device is monitored continuously. In some rare cases when the device is unable to perform the test, the test must be conducted from computer software, with the drawback it is not continuous, it is active only when the computer software is running. Different communication technology is associated with different power availability for the device, and thus different levels of sophistication are possible for the diagnostics.

### Device Integration

Plants have a mix of simple and sophisticated (complex) devices from different manufacturers using different communication protocols. The diagnostics available depends on the type of device:

- Pressure transmitter: sensor failure, plugged impulse line, sensor temperature limits exceeded
- Temperature transmitter: sensor failure, thermocouple degradation
- Valve positioner: Partial Stroke Testing (PST), travel histogram, step-response, valve signature, pressure sensor failure, abnormal drive current, travel deviation, reversal count alert, accumulated travel alert, I/P converter plugged, pneumatic relay leak, valve stuck, actuator leak, low supply pressure, high supply pressure, position feedback sensor failure, etc.
- Flowmeter (Coriolis, magnetic, ultrasonic etc.): flow tube stiffness, magnetic field strength, coil resistance, electrode resistance, grounding, noise, empty pipe, flow profile, turbulence, Speed of Sound
- pH analyzer: glass electrode impedance, reference electrode impedance

The diagnostics available vary greatly from one manufacturer to the next

### Poor Hosts

Original DD technology from 1992 made it possible to troubleshoot all devices using the same handheld field communicator or laptop software. Before DD only proprietary solutions existed. The original DD technology from 1992 already included "wizards" (aka "methods") which is a kind of script created by the device manufacturer to guide the technician through more sophisticated test procedures, for instance valve step response test requiring the steps to be predefined and lastly a prompt validation sequence before the self-test actually starts. Wizards thus make diagnostics and troubleshooting easy. Help and conditionals were also part of original DD technology. Wizards,

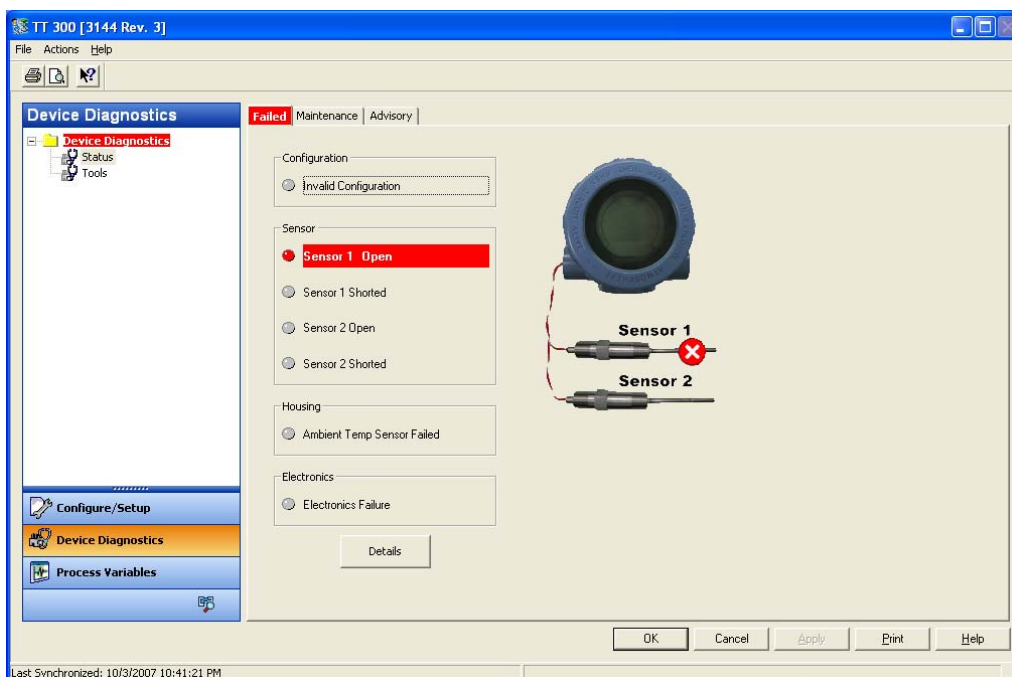
conditionals, and help are explained further in the section on EDDL. However, not all devices provided wizards in their DD file and not all intelligent device management software supported wizards. That is, on many systems and for many types of devices, advanced diagnostics in the past was not so easy, particularly for FOUNDATION fieldbus devices which in the past had to set the correct mode, in the correct block, write value to correct parameter, and remember to return block mode. At the same time the technician also had to remember to inform operations. All of this in addition to the actual troubleshooting task itself such as verifying valve moment, or stability etc. Lack of wizards was not a problem with the DD technology itself; it was poor implementation in many early products. However, for some devices, the manufacturer may chose to display test results graphically, such as a valve signature, vibration spectrum, or signal waveform. This was not supported by original DD technology. Thus diagnostics of some devices was not supported using DD. The EDDL enhancements are now mandatory for all Foundation fieldbus compliant host systems. This includes graphics, menu system, wizards, and conditionals. This is generally also supported for HART devices.

## Device Troubleshooting Made Easy

EDDL technology provides a vast array of possibilities for the device manufacturer to organize the diagnostics display and make the device user-friendly, and also to add graphics such as waveforms for valve signatures and vibration spectrum etc. Depending on the type of device, the manufacturer uses different EDDL elements. No device uses all EDDL capabilities. EDDL supports both basic and advanced diagnostics for simple as well as sophisticated (complex) devices. Below are a few examples of devices to give an idea of what device manufacturers have done to make their devices easy and fast to troubleshoot and repair. Thanks to EDDL wizards, device diagnostics for FOUNDATION fieldbus is now just as easy as HART.

### *Temperature Transmitter Diagnostics*

A temperature transmitter is a relatively simple device, but high-end models have some interesting diagnostics. When a sensor fails, the diagnostics display pin-points which sensor it is and what the problem is. Device manufacturer experts often include conditional images to clearly illustrate the problem.



**Figure 1** Temperature transmitter diagnostics indicates sensor failure

Details of the problem are revealed at the click of a button permitting the technician to determine that the problem is not with the transmitter but with the sensor. Because problem areas are highlighted, lots of time is saved.

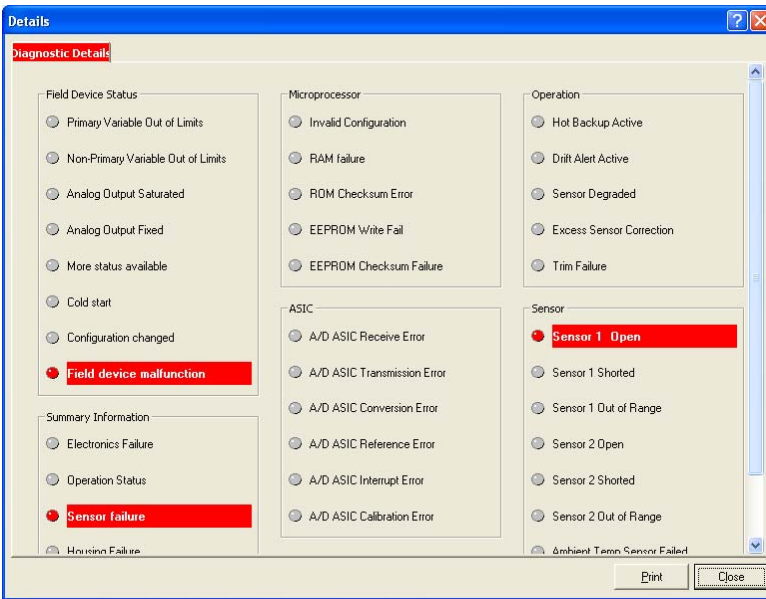


Figure 2 Detail diagnostics display

In the past, temperature transmitters were primitive devices with rudimentary diagnostics only able to diagnose if the sensor was dead or alive. Today, temperature transmitters have sophisticated diagnostic able to detect if the temperature sensor is slowly degrading, and alerts before the sensor fails completely.

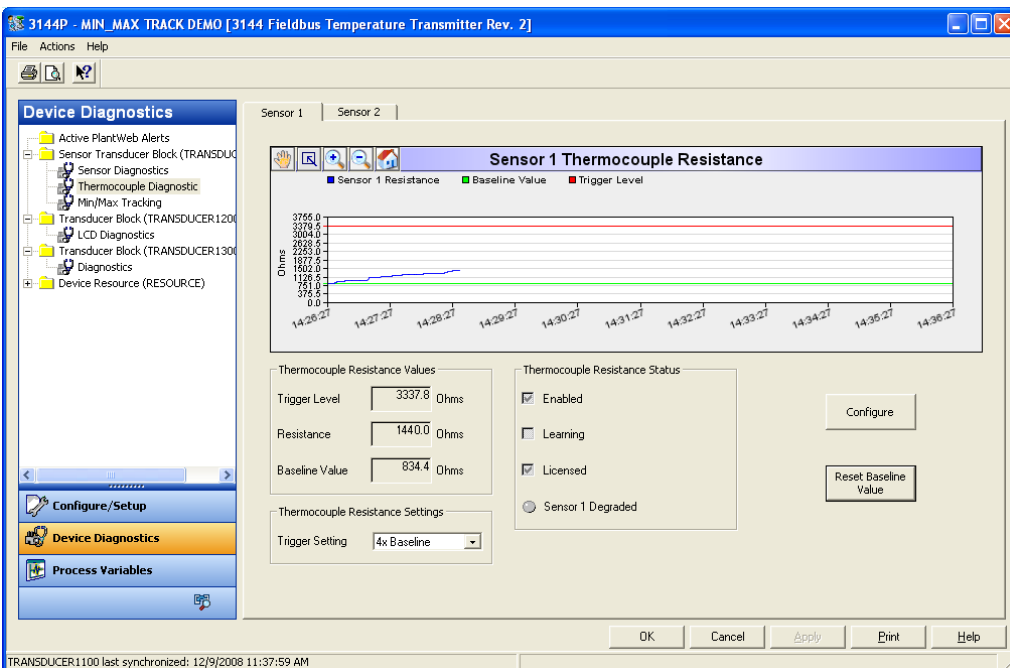


Figure 3 Diagnostics setup and result from the same screen using EDDL

### Pressure Transmitter Diagnostics

In the past, pressure transmitters were primitive devices with rudimentary diagnostics only able to diagnose if the sensor was dead or alive. Today, pressure transmitters have sophisticated diagnostic able to detect if the impulse line is plugging and other abnormal conditions such as detecting unexpected liquids in gas flow, or unexpected aeration in liquids, loss of agitation, and leaks.

In the past, pressure transmitters were not as intelligent as they are now, and original DD did not have the graphics display capability. Back then, intelligence and display for diagnostics had to be in dedicated programs or plug-in software that ran in a computer, for instance plug-in software for plugged impulse line detection. Devices are getting ever more intelligent, and as devices get more intelligent, they are able to perform all functions internally round-the-clock. The result is graphically presented using EDDL, without the need for external software.

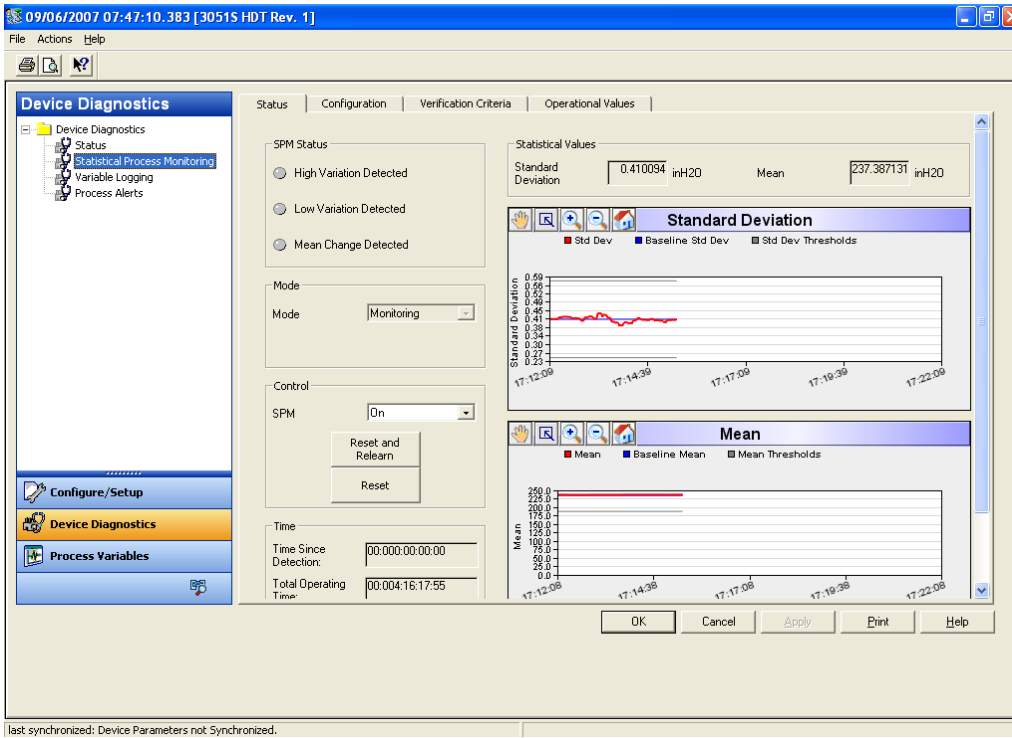


Figure 4 strip charts for standard deviation and mean for visualization of process noise

### Valve Positioner Diagnostics

A valve positioner is a sophisticated device with advanced diagnostics to monitor the health of the complete assembly including valve body, actuator, and the positioner itself. The positioner manufacturer organizes the diagnostics information logically using a hierarchical tree, tabbed cards, and frames thereby structuring the information to make the valve assembly easy to troubleshoot, on any control system.

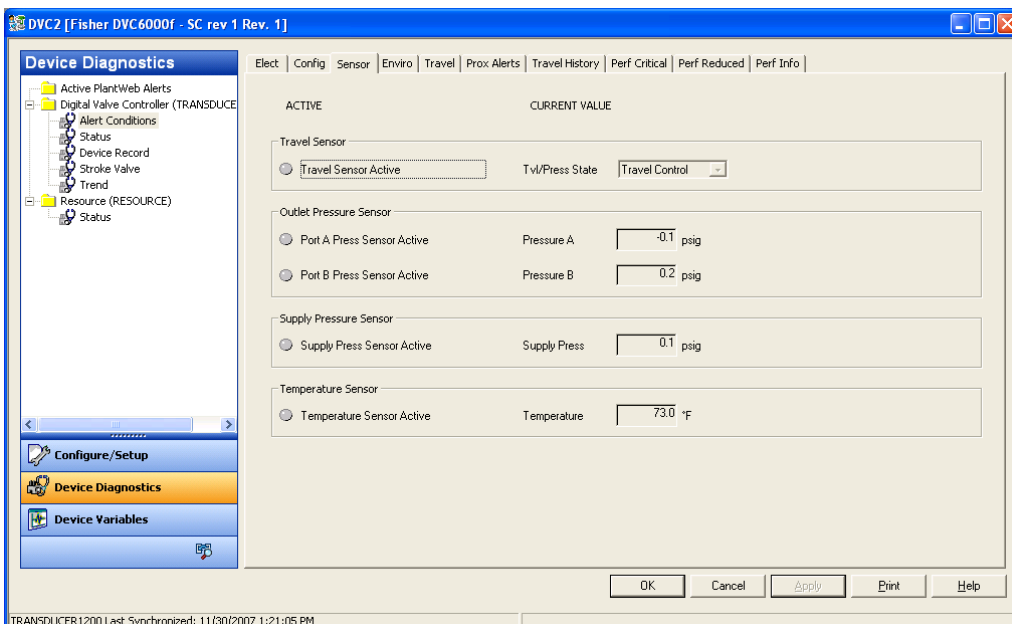
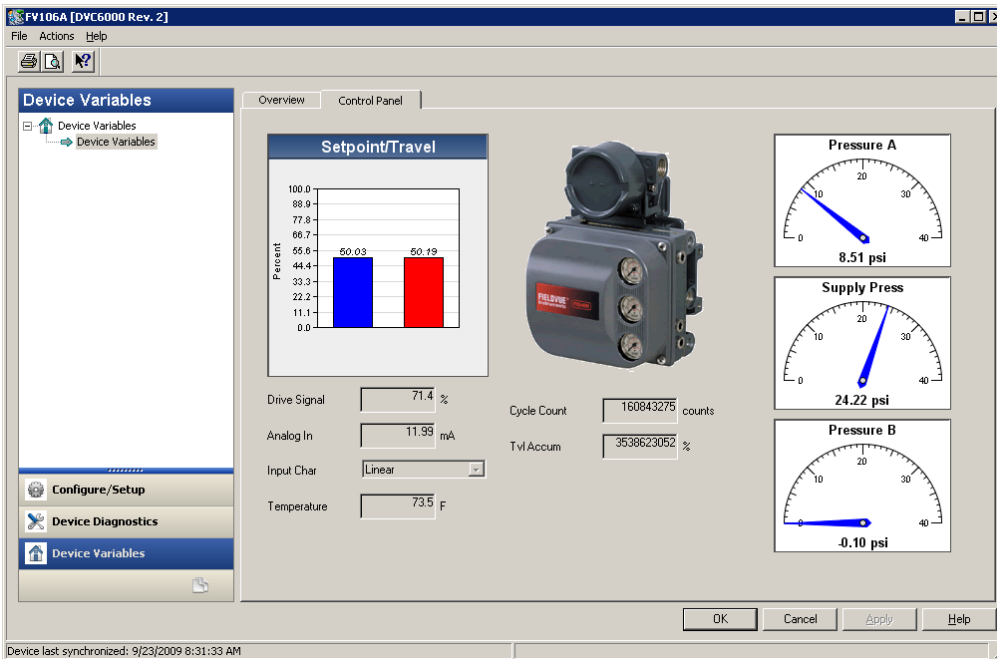


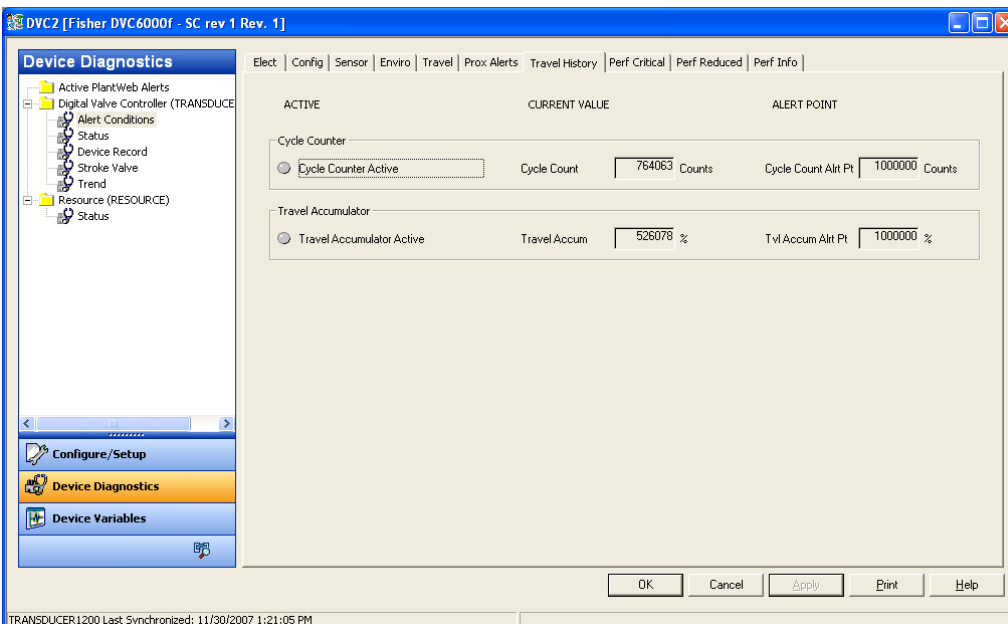
Figure 5 a wealth of diagnostics is available organized in tree, tabs, and frames

Visual dial gauges are one way device manufacturers chose to present the information. Numeric values are very accurate, but numerical values running up and down make it hard to see if the value is increasing or decreasing, or changing faster or slower. For a valve positioner, dial gage graphics makes it easy to visualize the actuator chambers vent or fill with air, just like the mechanical gauges for on the positioner itself. Thus EDDL graphics helps resolve problems with the pneumatics.



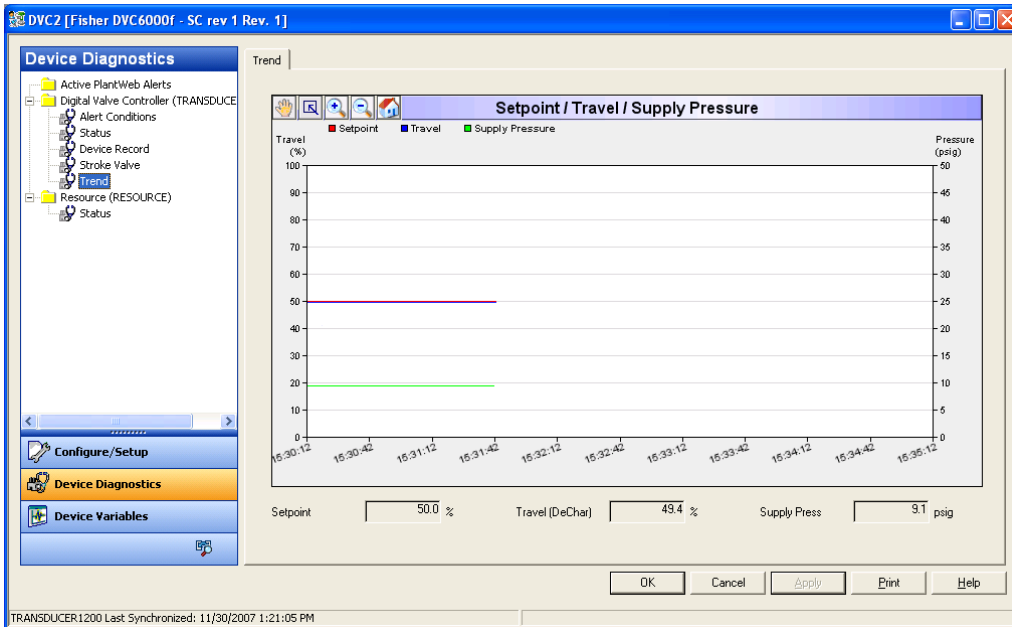
**Figure 6 EDDL dial gauge graphics visually show actuator pressure change**

A valve positioner also tracks operational statistics such as total travel and the number of reversals (cycles). This is used as a more accurate estimate of actual wear and tear for more precise prediction of remaining life and scheduling of maintenance such as replacement or stem packing or seat etc.



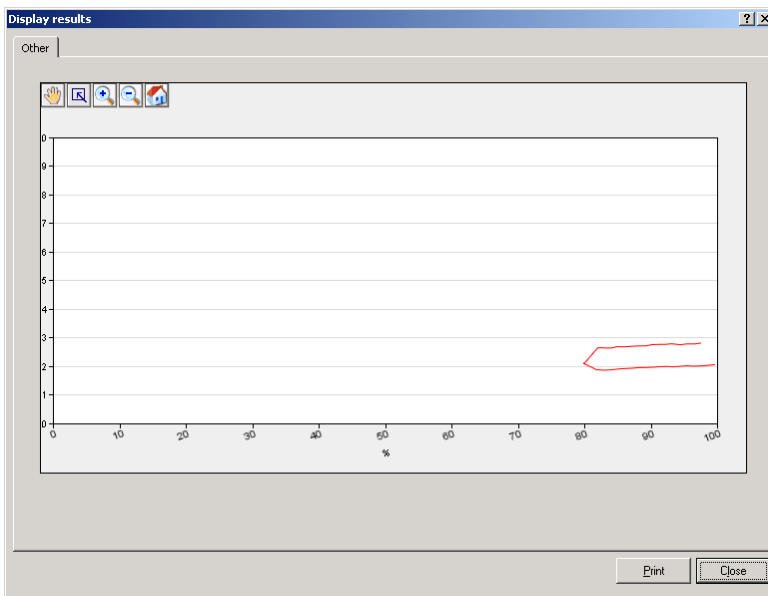
**Figure 7 operational statistics are used as a basis for predictive maintenance scheduling**

Strip chart for trending is helpful for certain adjustments and therefore provided by the device manufacturer. Multiple values are often displayed in the same graphics.



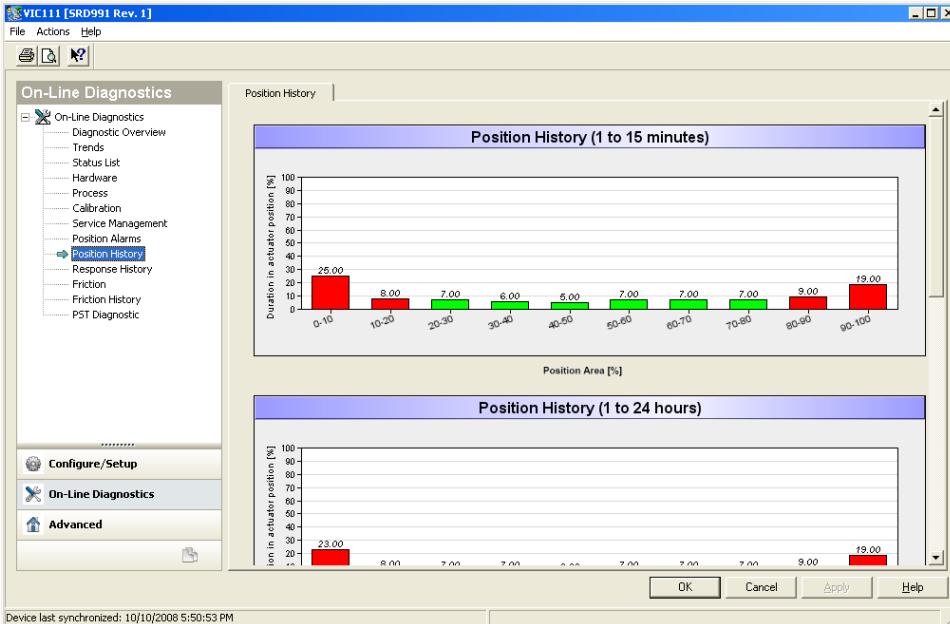
**Figure 8** valve assembly behavior is easily visualized in a strip chart

Valve positioners are also used to monitor emergency shutdown valves for which they periodically perform Partial Stroke Testing (PST). The results from the test are rendered graphically as a signature using EDDL.



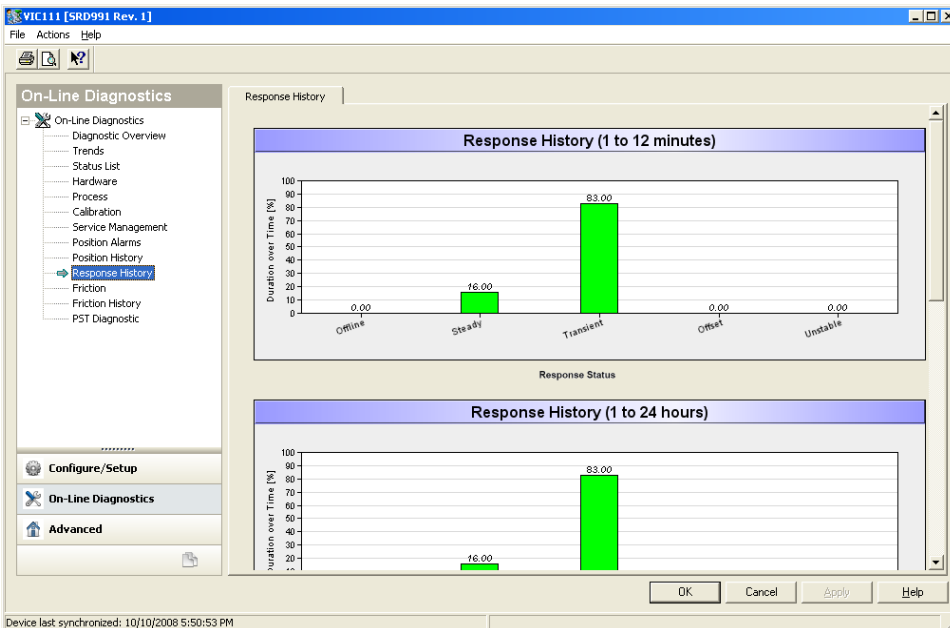
**Figure 9** EDDL rendering of valve Partial Stroke Test (PST) results

The position histogram illustrates in which position the valve stem spends most of its time. This helps identify wrong valve sizing.



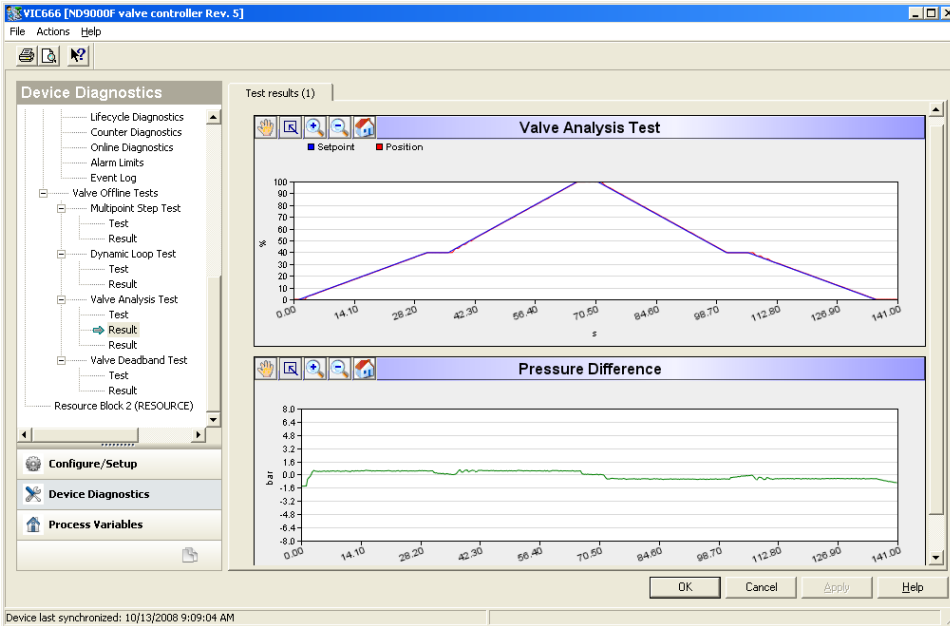
**Figure 10 Valve positioner position histogram**

Side-by-side bar-charts helps in comparing related performance indexes



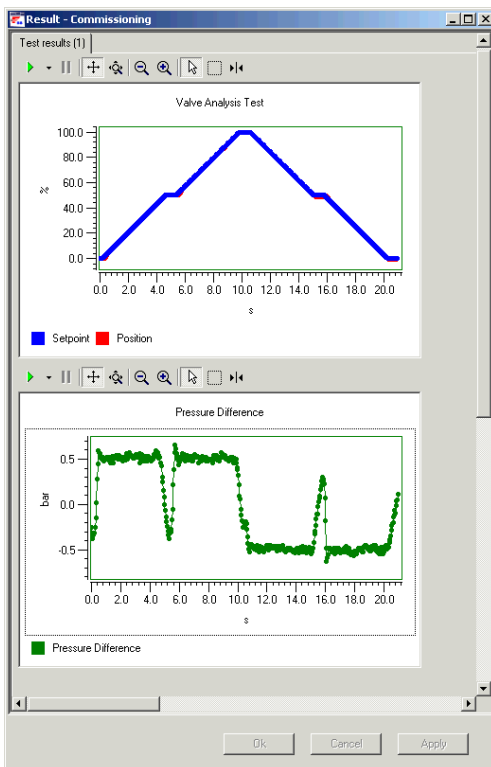
**Figure 11 Valve positioner response history bar-chart**

Some valve diagnostics such as step-response test and valve signature etc. are rendered graphically using EDDL



**Figure 12 Positioner valve analysis**

Since EDDL is an international standard (IEC 61804-3) diagnostics results from the devices can be visualized in device management software from different manufacturers.



**Figure 13 Valve positioner test results displayed graphically**

Some valve tests must be configured before the test is run.

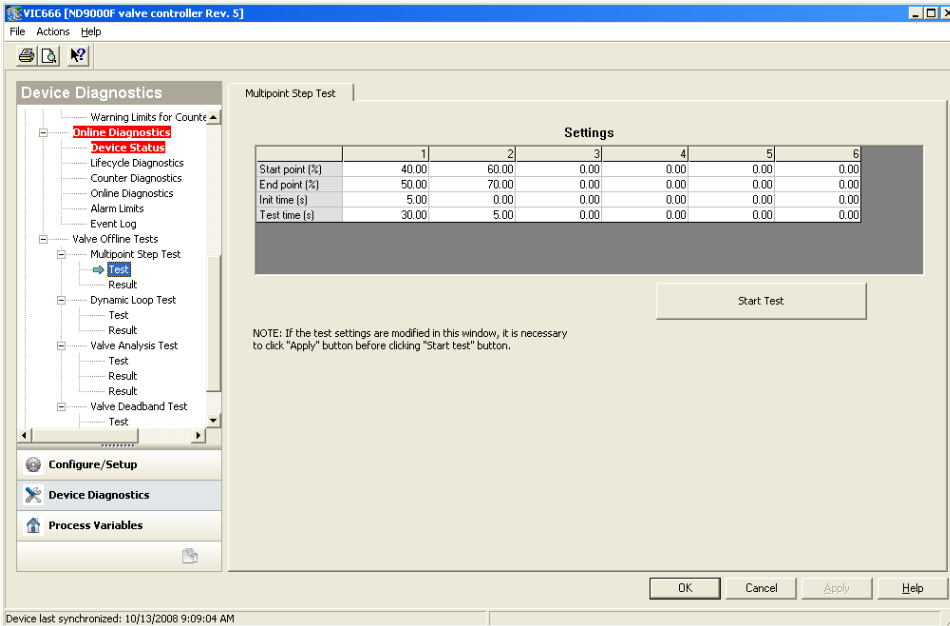


Figure 14 Valve positioner step response test setup

Valve positioners may also maintain an audit trail internally logging events such as failures in case the plant does not have device management software to provide this functionality.

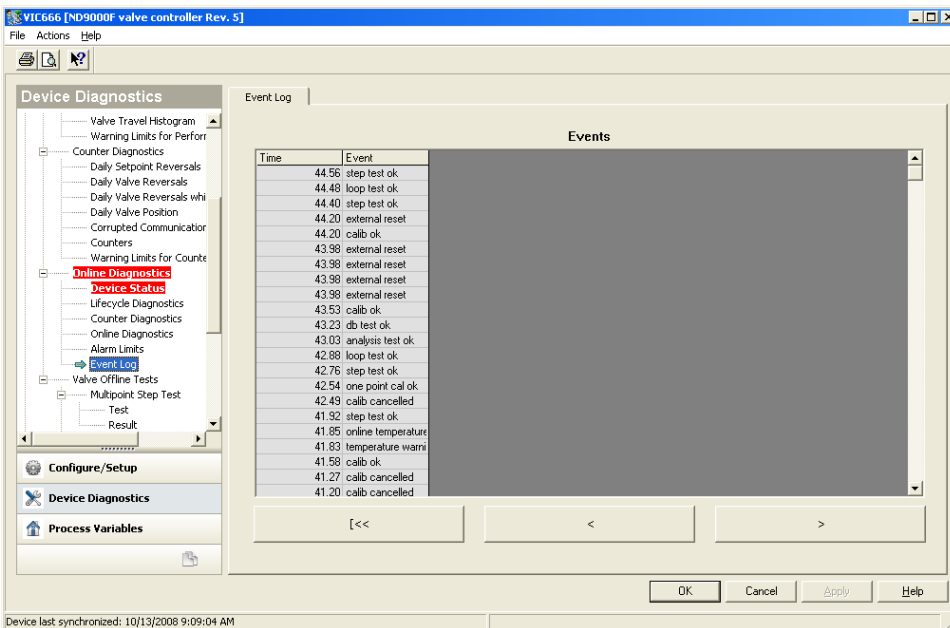


Figure 15 valve positioner event log

Drive signal graph is another diagnostic used to for troubleshooting of the positioner.

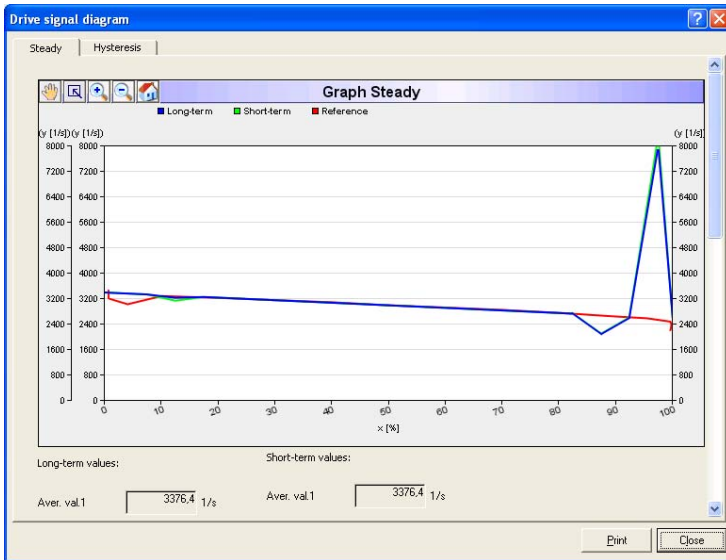


Figure 16 Valve positioner drive signal diagram

### Vibration Transmitter

Vibration transmitters are slightly different in that they essentially are dedicated diagnostics devices. That is, the diagnostics is not so much for the transmitter itself, as it is for the machinery it is monitoring. They monitor equipment like motors, pumps, fans, agitators, conveyor belts, and gears etc. to detect developing fault conditions like imbalance, misalignment, looseness, and late-stage bearing problems.

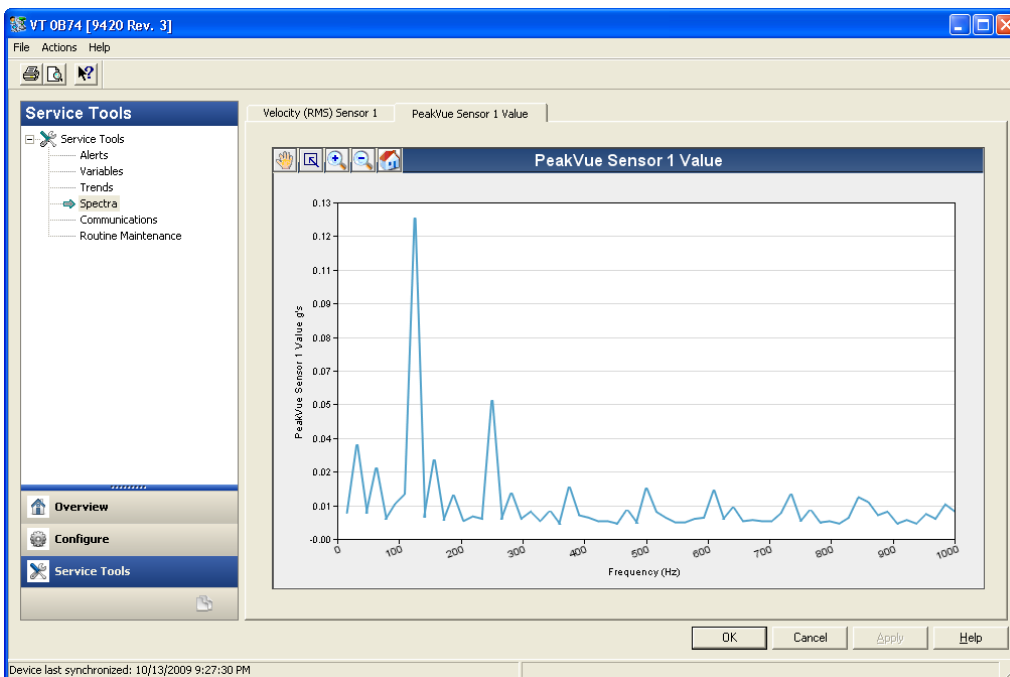
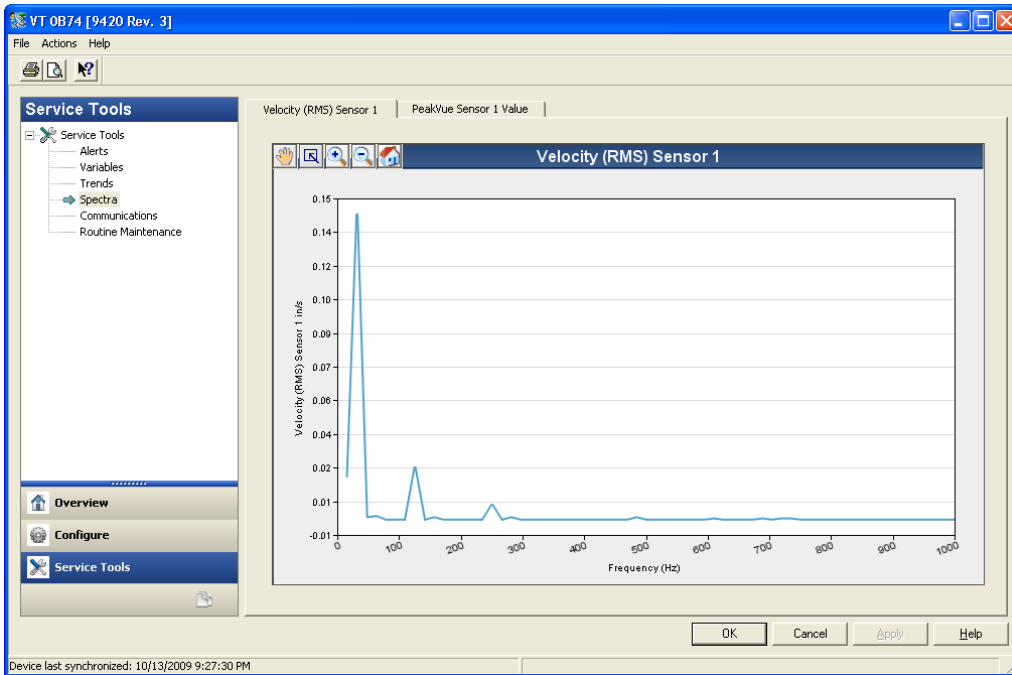


Figure 17 EDDL graphics visualizes complex diagnostics results

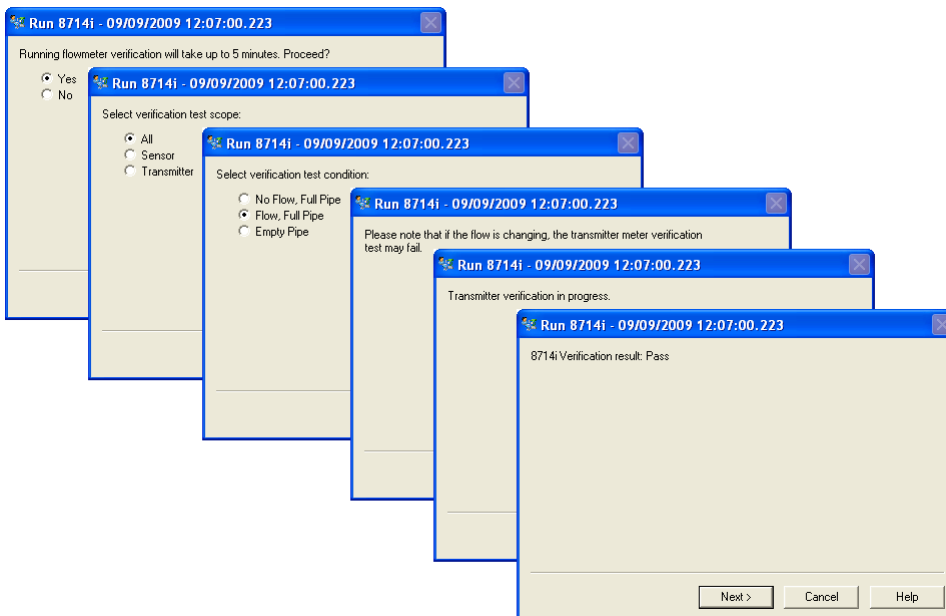
Graphs defined by the vibration transmitter manufacturer are displayed in the system the way the device manufacturer intended.



**Figure 18** The number of pens in the EDDL waveform graph is decided by the device manufacturer

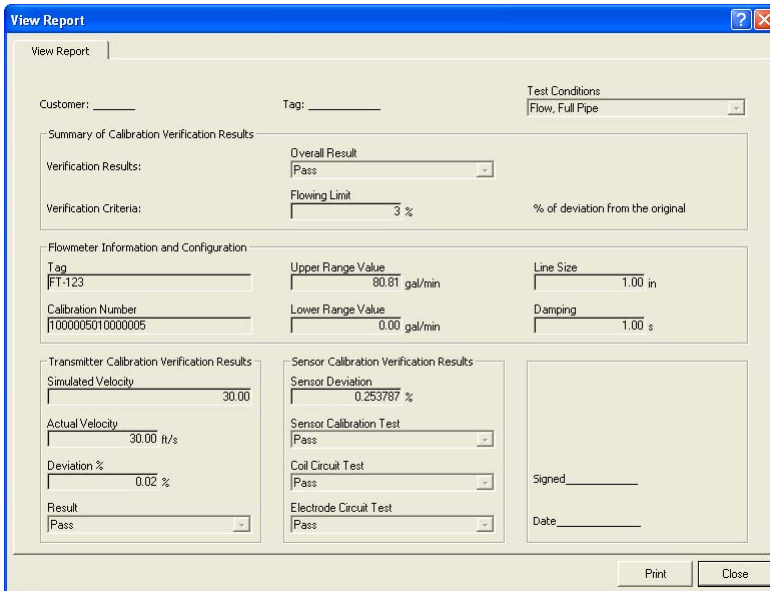
### ***Magnetic Flowmeter***

In-situ meter verification tests the complete performance of a magnetic flowmeter to detect change in magnetic field strength, coil resistance, or electrode resistance to determine if calibration is needed. EDDL makes it possible to initiate the meter verification from any control system supporting EDDL. Wizards created by the flowmeter manufacturer guide the technician step-by-step; no specialized training is required. Wizards may display percent completion for lengthy procedures so technicians know how much longer they need to wait.



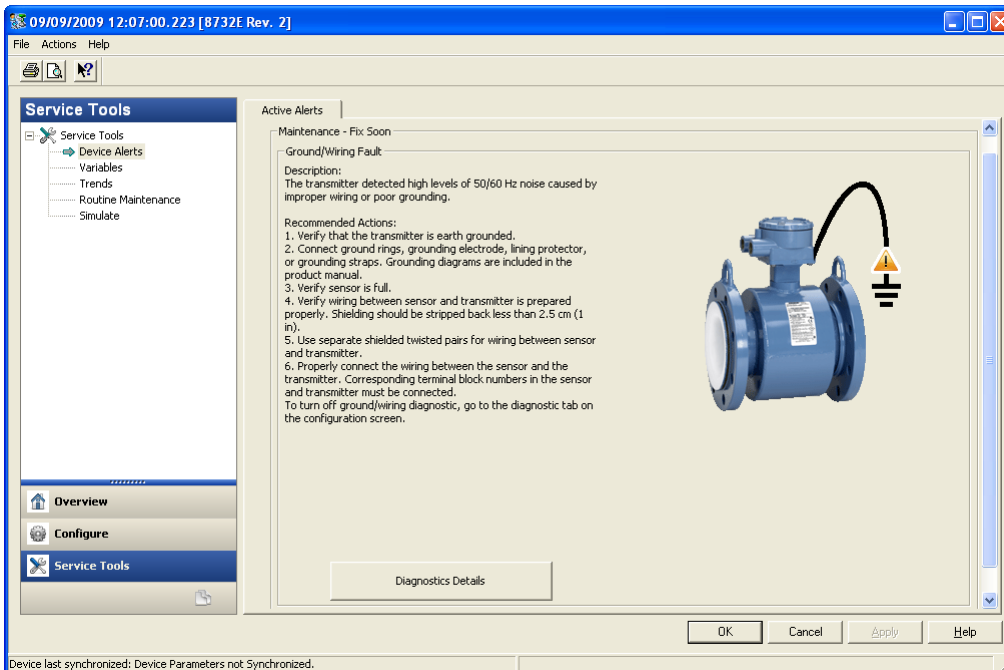
**Figure 19** EDDL wizard guides the user step-by-step through flowmeter verification

Advanced diagnostics does not necessarily mean the presenting incomprehensible numerical values or charts that need interpretation. On the contrary, truly advanced diagnostics offers clear, actionable information. For instance, a clear pass or fail result. Test results may automatically be presented in a report, ready for print out from any EDDL-based system.



**Figure 20** The meter verification report can be printed documenting the results

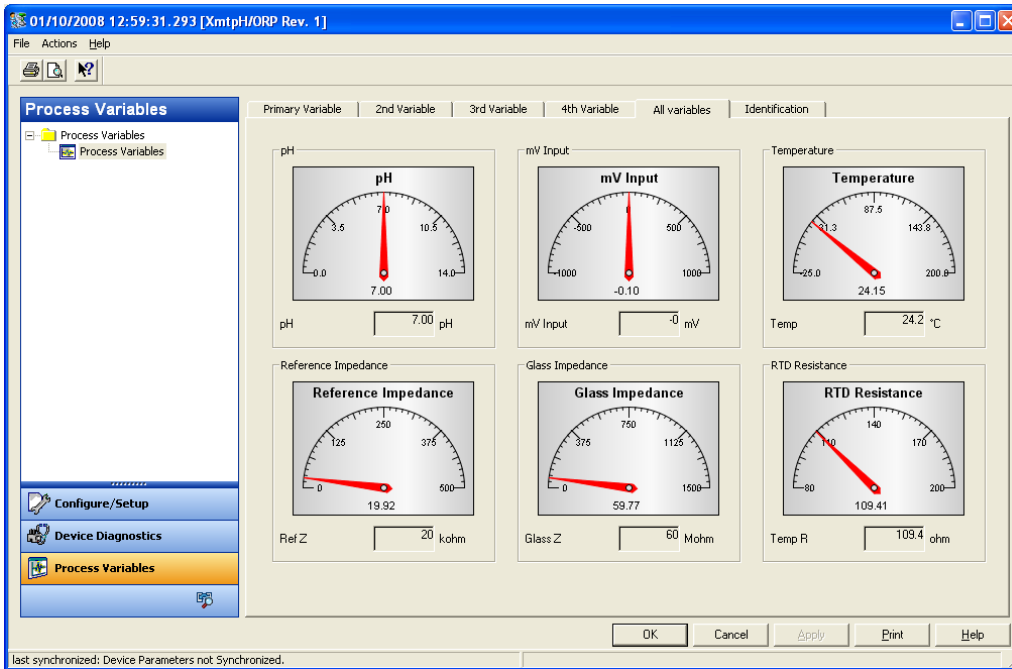
Some devices may combine illustrating graphics and explaining text on the same page



**Figure 21** Magnetic flowmeter diagnostics page with actionable help provided by manufacturer's expert

## ***pH analyzer***

Apart from measuring the pH, the analyzer continuously measures the impedance of the pH glass electrode and the reference electrode to detect sensor failure or degradation. High reference electrode impedance indicates the junction is plugged or that the filling solution or gel is depleted (dry).

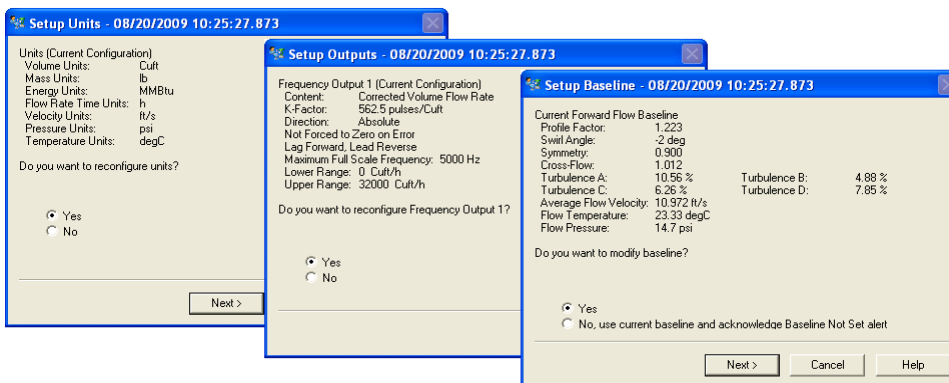


**Figure 22 pH analyzer 'dashboard'**

A low glass electrode impedance indicates the glass is cracked, while a high impedance suggests it's aging and nearing the end of its life.

### **Ultrasonic Flowmeter**

Ultrasonic flowmeter diagnostics requires some baseline values to be set. A setup wizard created by the flowmeter manufacturer's expert, using EDDL, guides the technician step-by-step, capturing the baseline values.



**Figure 23 Baseline capture is part of the setup wizard, guided step-by-step by EDDL wizards created by the flowmeter manufacturer**

The flow profile and measured Speed of Sound are easily visualized and compared in bar graphs to identify build-up on transducers.

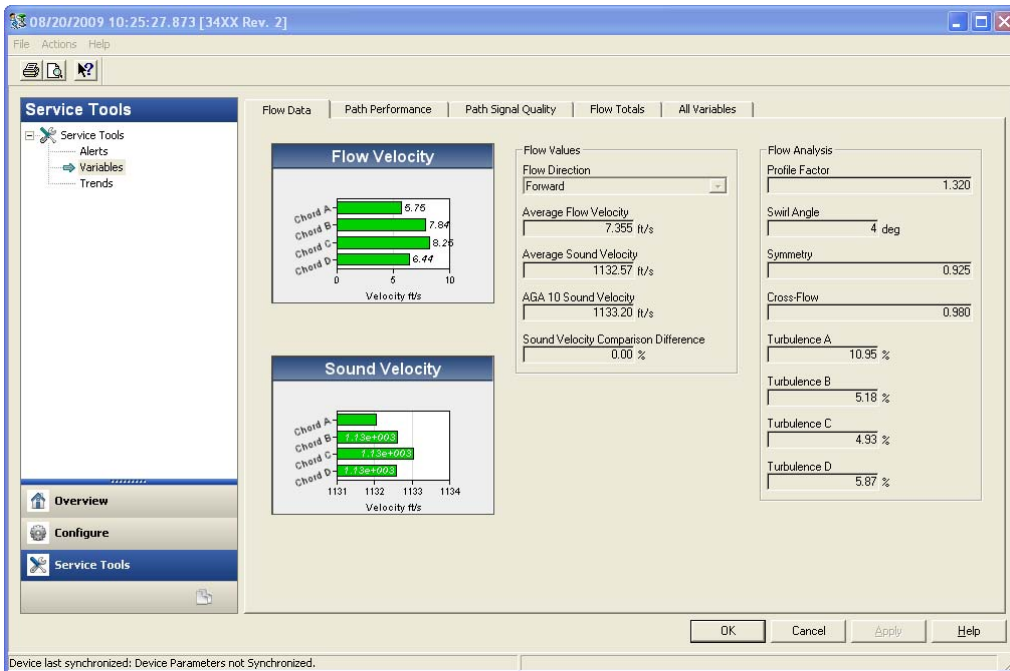


Figure 24 diagnostics depicted as EDDL bargraphs to visualize flow profile

### Illustrations and Context Sensitive Help

The device manufacturer's experts build their know-how about their device into help text associated with all diagnostic indicators, parameters, and wizards etc. to help in testing and the interpretation of diagnostics and deciding on the most appropriate action. The technician can easily access this expert help simply by clicking on the diagnostic indicator in question, and the help text will appear. This saves the technician the trouble of having to search through large manuals. The easily available help makes troubleshooting and resolution faster.

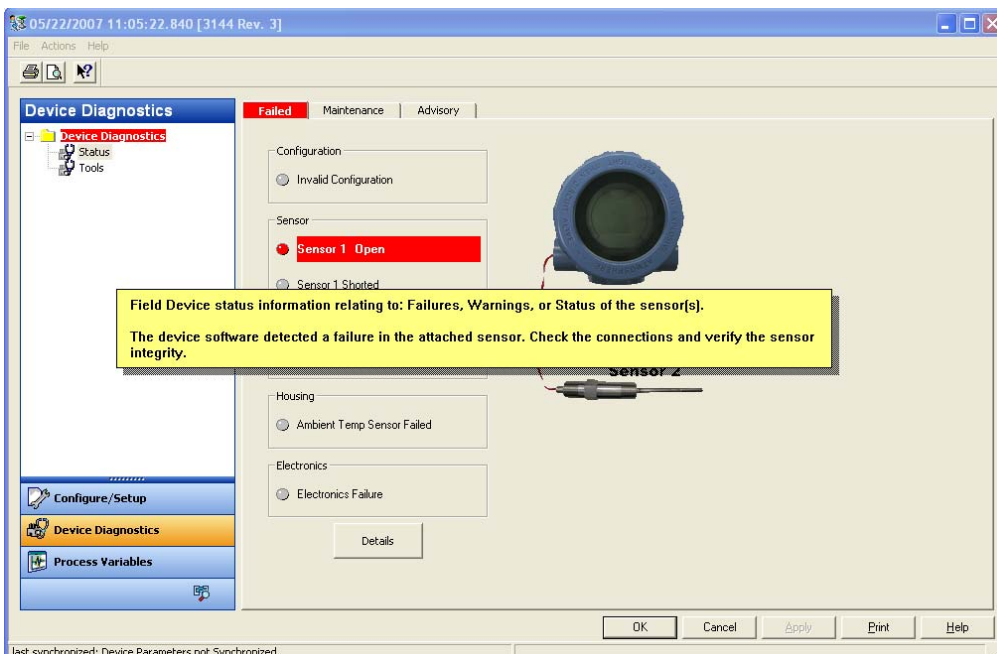
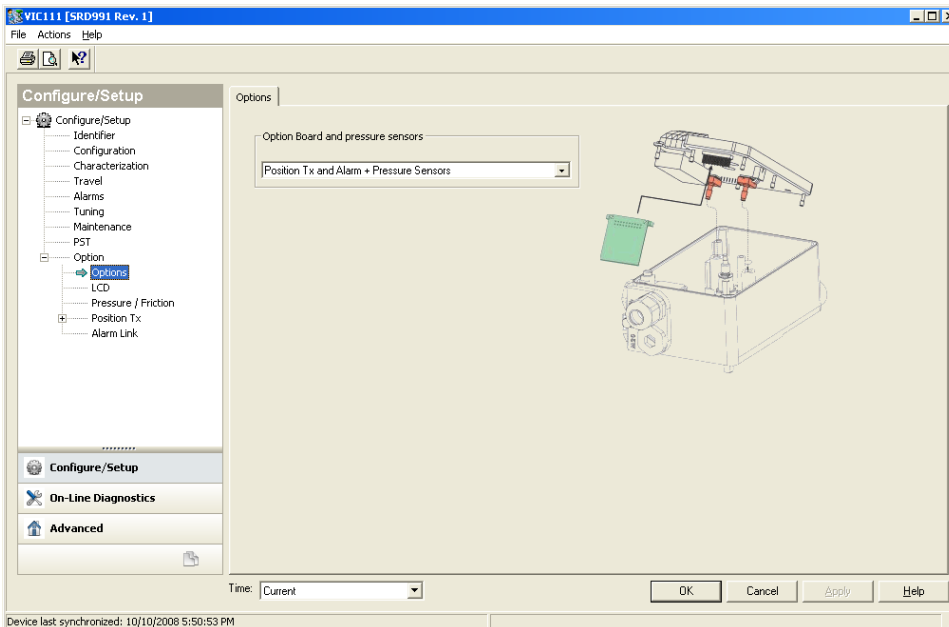


Figure 25 manufacturer expert know-how built into EDDL

Illustrations such as exploded views helps by guiding troubleshooting



**Figure 26** Valve positioner illustration of option boards

## Beyond Diagnostics

Software and communicators based on EDDL assist the technician in diagnosing and troubleshooting devices correctly and as quickly as possible.

### Notes

Annotations can be entered by the plant's experienced technicians over the years, and later retrieved by less experienced technicians any time. This mechanism channels knowledge from one technician to another.

### Manual

A softcopy of the manual including exploded view, spare parts list, and troubleshooting tips, as well as other documents related to the device type or plant location, for the device can easily be called up at a click of a button.

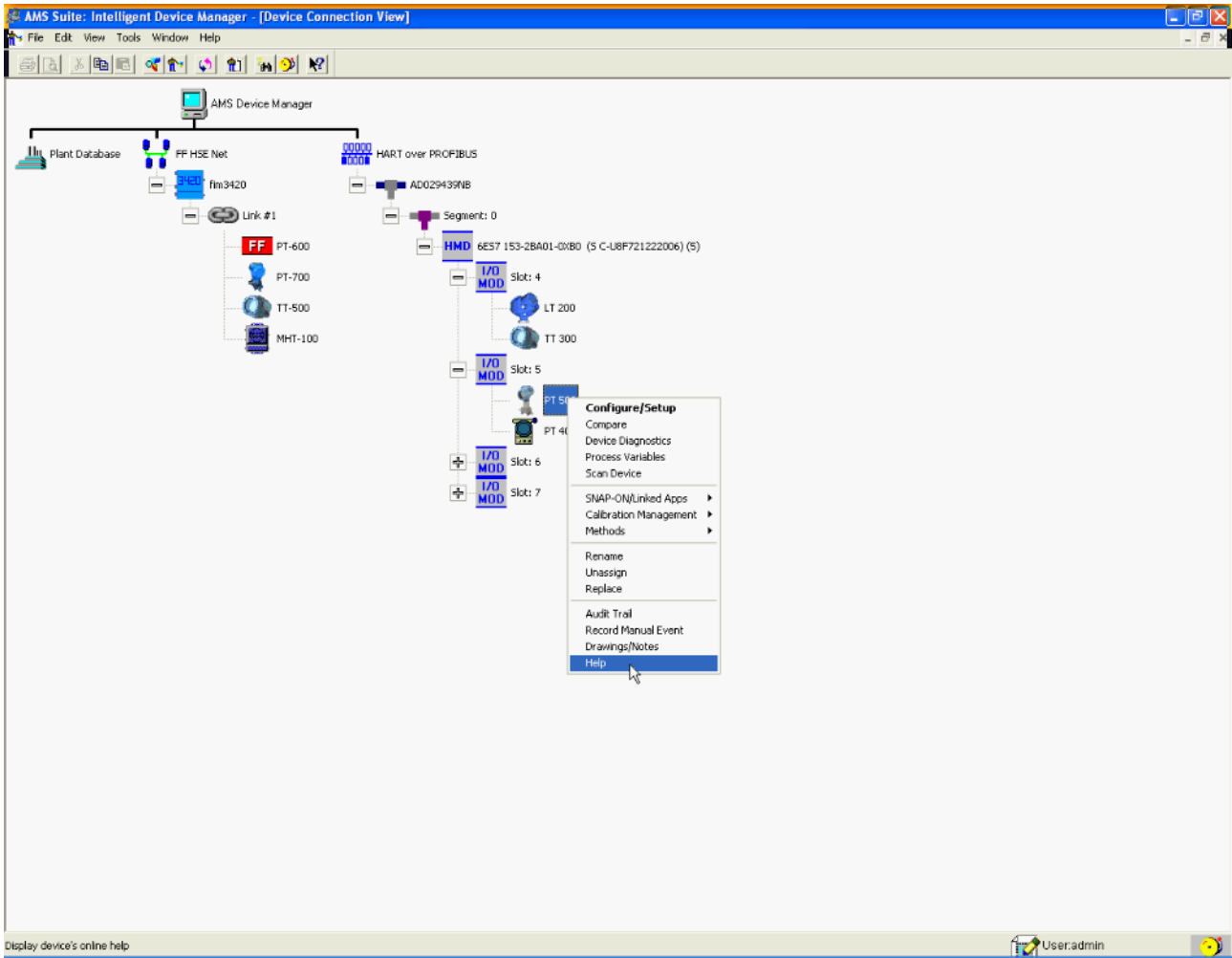


Figure 27 softcopy manual accessed at the click of a button

Once the softcopy manual is opened it is possible to navigate from the table of contents or search for specific words and using all the features in Adobe Acrobat to quickly find the answer.

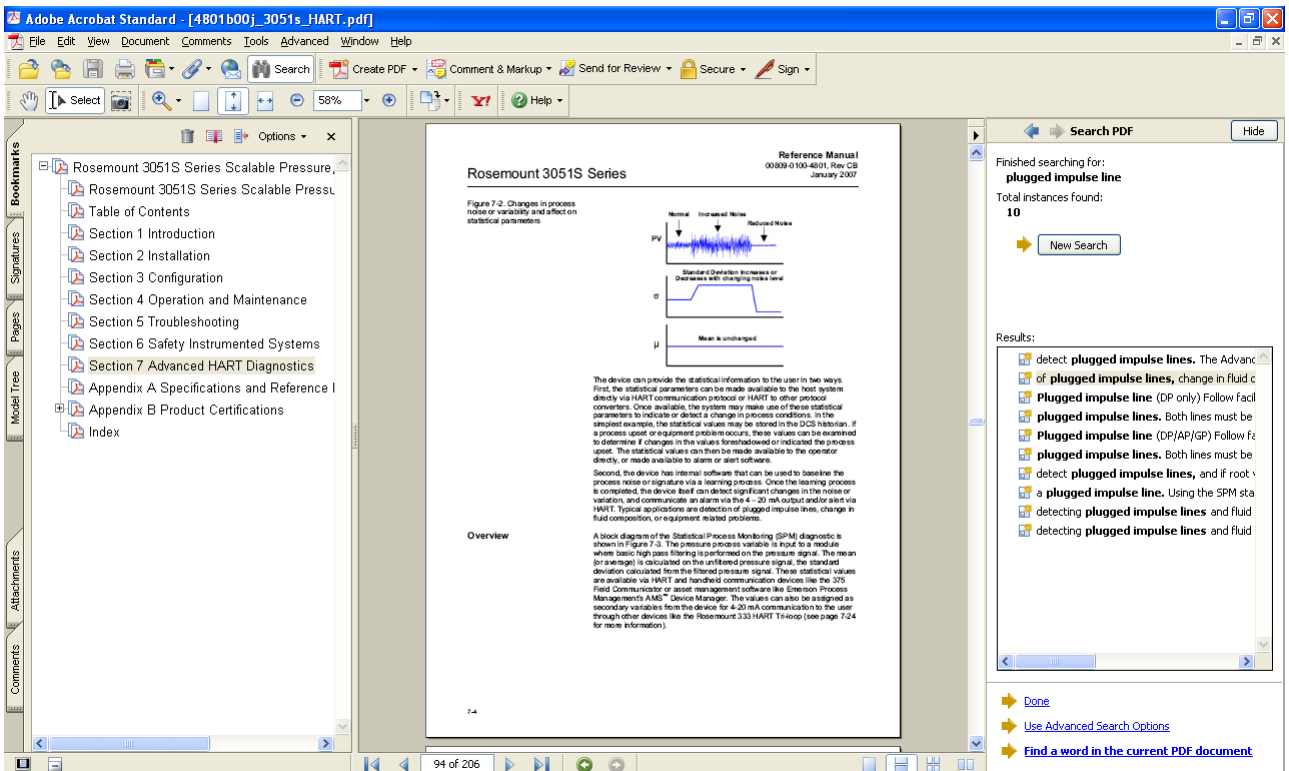


Figure 28 softcopy manual can be navigated or searched

## **Audit Trail**

EDDL-based device management software also supports audit trail functionality. This includes tracking of configuration changes, calibration records as well as failures.

## **Maintenance Schedule**

EDDL-based device management software is also able to schedule maintenance tasks such as inspection and calibration.

## **Single Solution**

Because EDDL is a text file from which the device page graphics is rendered by the device management software, the status indicators and help are rendered the same way for all devices regardless of protocol, manufacturer, or type. This consistency achieved thanks to EDDL makes use of device diagnostics easier and intuitive (see separate technical white paper on consistency of use). No other technologies can provide a comparable result.

## **Conclusion**

For plants that are looking for an easy solution to troubleshooting multiple types and versions of devices, EDDL technology is a perfect match. EDDL meets the need of plants to diagnose faults in all types of devices from a single software application using a single technology while at the same time making it fast and easy to keep the system up to date with new device versions. Plants should upgrade existing DD systems to EDDL with enhancements to enjoy the greater ease of use afforded by the standard graphical display.

Device diagnostics for troubleshooting is just one of the ways in which intelligent device management software based on EDDL reduces maintenance & operational cost. Please refer to other technical white papers on advanced diagnostics, configuration/setup, and system administration etc.

## **References**

IEC 61804-3 Ed. 1.0 English, Function blocks (FB) for process control - Part 3: Electronic Device Description Language (EDDL)

IEC/TR 61804-4 Ed. 1.0 English, Function blocks (FB) for process control - Part 4: EDD interoperability guideline

EDDL Brochure and Technical Description on [www.eddl.org](http://www.eddl.org) site

Jonas Berge, "Fieldbuses for Process Control: Engineering, Operation, and Maintenance", ISA, 2002, ISBN 1-55617-760-7