



TAKING DIAGNOSTICS TO THE NEXT LEVEL

ENDRESS+HAUSER

The FOUNDATION fieldbus specification was created from the ground up to allow suppliers to add their own competitive advantage to the technology. At the same time, we provide a standard infrastructure for your process automation requirements. Endress+Hauser is one supplier that has used the Foundation's new FF-912 Diagnostics specification to address a wide range of diagnostic data from field devices, from the process to the sensing element to the device electronics. The world of device diagnostics is about to expand exponentially.



TAKING DIAGNOSTICS TO THE NEXT LEVEL

ENDRESS+HAUSER SIMPLIFIES ACCESS TO FOUNDATION FIELDBUS DIAGNOSTICS

EXECUTIVE SUMMARY

FOUNDATION fieldbus has a unique approach to management of device diagnostics. The publish/subscribe structure of FOUNDATION fieldbus means that diagnostic information is available immediately to a wide range of workers in the plant. The challenge is to organize that data in a way that turns it into useful information for the right people at the right time. That's why the Fieldbus Foundation created the Fieldbus Diagnostic Profile addition to our specification. The Field Diagnostic Profile incorporates the NAMUR NE 107 recommendations, which state the diagnostic data should be presented in a standard manner, with standard coloring and symbology, so it is easily understandable by the different worker roles that must have access to the information.

As with all our technology specifications, Fieldbus Foundation provides a standard framework on how data should be handled and provided to those that need it. The suppliers in turn have the ability to add their own competitive advantage by providing ways to manage an even wider range of diagnostic information within our standard structure. This is what Endress+Hauser have done with their approach to FOUNDATION fieldbus standard diagnostics, and they are making this approach available to other automation suppliers as well.

Endress+Hauser is one of the world's leading process automation suppliers. The company was one of the founding members of the Fieldbus Foundation, and has a long history of involvement standards making bodies and committees. The company's new approach to categorizing fieldbus diagnostics has value not just because it can provide a wide range of diagnostic information about its devices, from

NAMUR NE 107



Diagnostic data is not worth much unless those that need it get it in a timely fashion

That is why end user organization NAMUR wrote the NE 107 recommendation, "Self-Monitoring and Diagnosis of Field Devices."

Fieldbus Foundation has now incorporated these recommendations into our specification, and it is changing the way we use diagnostics.

Please share your comments and feedback with us. Just email us at larry.obrien@fieldbus.org



electronics to sensing element to the process itself. The Endress+Hauser approach also gives the company the ability to form new diagnostic models based on the information from and relationships between multiple devices in the plant. This brings the diagnostic capability to the asset, unit, and plant level. Endress+Hauser also wants to make this diagnostic capability available to other vendors.

FOUNDATION Fieldbus and the Diagnostics Storm

Better diagnostics is one of the great promises of digital networking technology for field devices. All “intelligent” devices can provide some level of diagnostics. There are several key differences with FOUNDATION fieldbus that make it unique in its ability to provide diagnostics. Two of these key differences are the sheer volume and frequency of diagnostic data provided. FOUNDATION devices can handle multivariable measurements and transmission of multiple diagnostic data at the same time.

The diagnostics do not stop at the sensor/actuator. Diagnostic data can be provided for electronics failures, configuration or servicing failures that are primarily human intervention issues, and application issues or process issues that affect the measurement. These multiple levels of diagnostics add up, until you reach the point where you could have over 20 diagnostic parameters for FOUNDATION fieldbus devices, with more complex devices and actuators having hundreds of parameters. In order to get useful information out of these diagnostics, you must have a good way to manage and organize this information. Some diagnostic parameters are manufacturer-specific, and at the end of the day, this can be a real challenge. Parameters from device to device may not be the same. Based on the root cause

of a diagnostic, however, diagnostics can be categorized or assigned to different functional areas, such as electronics, configuration, application, and so on.

FOUNDATION fieldbus also has a publish/subscribe architecture. Data is continuously transmitted to any source that subscribes to it. The role-based diagnostics provided by FOUNDATION fieldbus facilitates the right people getting the right information at the right time.

FOUNDATION fieldbus also supports alarm and event notification. Diagnostic data and alerts can be provided instantly; status is constantly updated; information is

Sensor/Actuator element failures
Tube temperature sensor defect
Exciter coils defective
Carrier tube temperature sensor defective
Electronic failures
Critical Failure Fault
EEPROM Failure
Totalizer Checksum Fault
Configuration/servicing failures
Board Incompatibility
Software Update in progress
Communication I/O Failure Fault
Simulation active
Configuration error
Process induced failures
Oscillation Amplitude Limit
Excitation Current Limit
Fluid Inhomogeneous
Noise Limit
Sensor Asymmetry Exceeded Fault
Corrosion
Erosion
Coating -Build Up
Air Entrainment
Slug Flow
Cavitation
Empty Pipe



Instrument issues

Human intervention issues
(during commissioning, setup, function check and service activities)

Application issues or process conditions affecting measurement

Sample Diagnostic Parameters of a FOUNDATION Fieldbus Flowmeter

constantly being recorded and time-stamped. This is also unique to FOUNDATION fieldbus. Time stamping ensures that you will know exactly when the diagnostic appeared, even if you get the actual diagnostic information at a later time.

These elements of increased volume and frequency of diagnostic data can provide many advantages, but care must be taken to turn the data into useful information and careful attention must be paid to managing this information. Not every diagnostic alert should be considered an alarm for the operator to act upon. According to the ISA 18.2 standard for alarm management, for example, an alarm must require a response from the operator. The increased volume and frequency of information means that mechanisms must be put into place to filter and contextualize information to make it easier for end users to manage, so that people only see what they need to see when they need to see it. It soon became clear to the Fieldbus Foundation that we needed to update our specification to address the management of diagnostic data and make it easier for end users.

FOUNDATION Fieldbus Turns Diagnostic Data into useful Information

The FOUNDATION fieldbus specification is an open spec that is continuously evolving. The standard can adapt to changes in technology as they come into the marketplace. The Fieldbus Foundation developed the Field Diagnostic Profile portion of our specification to describe a base parameter set and characteristics common to all devices supporting the Field Diagnostic features. Rather than introduce significant changes to the current Foundation protocol, the new Field Diagnostic Profile specification builds upon the existing, powerful diagnostic capabilities of Foundation fieldbus equipment, and at the same time, adds a greater degree of organization so field instruments can represent their diagnostics in a more consistent way.

The FOUNDATION fieldbus Field Diagnostics Profile Specification was defined to make it easier for end users to access and configure the diagnostics in fieldbus devices, regardless of which manufacturer's device or system is used. The Diagnostic Profile includes a standard and open interface for reporting all device alarm conditions and provides a means of categorizing alert conditions by severity. The technology facilitates routing of alerts to appropriate consoles based on severity categories selected by the end user. In other words, it sends the right information to the right person at the right time without flooding the operator with alarms that are irrelevant to his duties. The Field Diagnostic Profile also provides recommended corrective actions and detailed help, as well as an indication of the overall health of the device. The Field Diagnostic Profile specification puts all the mechanisms in place that are needed to provide context to diagnostic data and turn it into useful information.

NAMUR NE 107

NAMUR is an international association of process automation industry end users that publishes recommendation documents to help end users by sharing best practices and to guide suppliers and industry foundations on future technology and product development. NAMUR represents approximately 15,000 process control experts, of whom approximately 300 are active in 33 working groups. Member companies include names like Novartis, BASF, Bayer, Evonik, Shell and Clariant.

FF Standard Diagnostic Alarm	NE107 Status Signal (5.1)
SD_FAIL_ALM	Failure 
SD_OFFSPEC_ALM	Out of Specification 
SD_MAINT_ALM	Maintenance Request 
SD_CHECK_ALM	Function Check 

NE 107 Status Signals and Symbols

Of particular concern to NAMUR is the role of the operator and maintenance technician and their impact on plant reliability and uptime. Unplanned downtime is one of the primary enemies of the process industries.

Maintenance	Although the output signal is valid, the wear reserve is nearly exhausted or a function will soon be restricted due to operational conditions e.g. build-up of deposits.
Off Specification	Off-spec means that the device is operating outside its specified range or a internal diagnostic indicates deviations from measured or set values due to internal problems in the device or process characteristics (e.g. bubble formation in flow metering or valve sticking).
Check Function	Output signal temporarily invalid (e.g. frozen) due to on-going work on the device.
Failed	Output signal invalid due to malfunction in the field device or its peripherals.

Definition of NE 107 Status Signals

According to ARC Advisory Group (www.arcweb.com), unplanned downtime accounts for the equivalent of 20% of all production in the process industries. A single unplanned shutdown can wipe out your plant profit for the year. In the same piece of ARC research, it states that 40 percent of unplanned downtime events can somehow be traced back to the operator or the human in the loop. We need not always blame the human in the loop, however, since that person may be working on faulty information or may not have the right information presented to them at the right time.

NAMUR NE 107 categorizes internal diagnostics into four standard status signals — failure, function check, out of specification and maintenance required, (also known as FCSM). Each of these categories can also contain greater detail. In the case of failure, for example, can the failure be traced to the device or the process? Is maintenance required immediately, or is the requirement more for long-term maintenance?

The ultimate result of this is a series of new field diagnostic alarms that correspond to the four primary diagnostic categories outlined by NAMUR in its document. Several standardized and therefore manufacturer independent parameters are available to configure the NAMUR category, the priorities, and the filter mechanisms for the alarms. With NAMUR NE 107 diagnostics built in, you can turn off diagnostics you do not need or configure how the diagnostics are reported. This supports the configurability mandate of NE 107. Providing recommended actions and enabling simulation allows the information to be presented in greater context.

IMPLEMENTATION OF THE FOUNDATION FIELDBUS DIAGNOSTIC PROFILE

NAMUR Diagnostic Categories

The Field Diagnostic specification stipulates that diagnostic data be provided in primary groupings that correspond to the NE 107 recommendations. The four primary alarm and alert categories according to NE 107 include:

- Maintenance
- Off Specification

- Check Function
- Failed

“**Maintenance**” means that although the output signal is valid, the wear reserve is nearly exhausted or a function will soon be restricted due to operational conditions e.g. build-up of deposits. “**Off Spec**” means that means that the device is operating outside its specified range or an internal diagnostic indicates deviations from measured or set values due to internal problems in the device or process characteristics. This may include something like overpressure or increased valve stiction. Even if the device is off spec, it could still give a valid measurement or could still work properly. “**Check Function**” means that the output signal is temporarily invalid (e.g. frozen) due to on-going work on the device. “**Failed**” means the output signal is invalid due to malfunction in the field device or its peripherals.

Instrument versus Process Conditions

It is also valuable to make a distinction between instrument conditions and process conditions. The ability to differentiate between instrument and process conditions can prevent an unplanned shutdown and result in significantly increased process reliability. Instrument conditions include problems with the sensor, electronics, and configuration. Process or environment issues include those related to the process itself, while instrument failures due to operating outside of specified operating conditions should be grouped with instrument failures.

Information	
Root	Group
Instrument	Sensor including process connection and sensor electronic
	Electronic
	Configuration e.g. Linearization
Process/ Environment	Process

Diagnostics and the Host System

Diagnostic information from FOUNDATION fieldbus devices will be required by a variety of different host systems, from DCS hosts to plant asset management systems, handheld devices, Field Diagnostics should provide enough information through its use that the first level of response can be determined without additional documentation. The DD help or text displayed for the enumerated value that is associated with the Recommended Action can contain a huge amount of information to support this. Some hosts will be able to use the alert mechanism to vector the Field Diagnostics to different locations. The Maintenance and Check Function may go to the maintenance console and/or a maintenance log file. The Failed and Off Specification may pop up in front of the Operator. This is for the host and user to decide.

Distinctions should be made between Instrument and Process Diagnostics

The 32 Bit Bitstring and Extended Parameters

Even with all the structure we have placed on Field Diagnostic Profile, the conditions are not expected to identify explicitly the root cause of the condition, but rather to identify actions to be taken to fix the problem, including the following:

- Replacing the device
- Replacing a part of the device
- Correcting a configuration problem
- Fixing something outside of the device

Fieldbus Foundation provides a 32-bit bitstring for suppliers to allow them to distinguish between 31 levels of device failures in increasing level of priority at the bit level. If there are more than 31 device diagnostic events, the developer must group them by definition into these bits. Then, by using the Fieldbus Foundation “EXTENDED” parameters in the resource block, more detailed information can be made available about these conditions to allow maintenance or operations to determine the root cause of the problem. For example, bit 31 could be related to an additional 32 bit parameter could represent a diagnostic event. The relationship between the high-level standard 32-bit string of parameters and the EXTENDED parameters is something that is hard coded in the firmware. The device vendor may add as many of these parameters as are necessary to describe what lower level conditions may be the root cause.

ENDRESS+HAUSER EXPANDS ON FOUNDATION FIELDBUS DIAGNOSTIC PROFILE

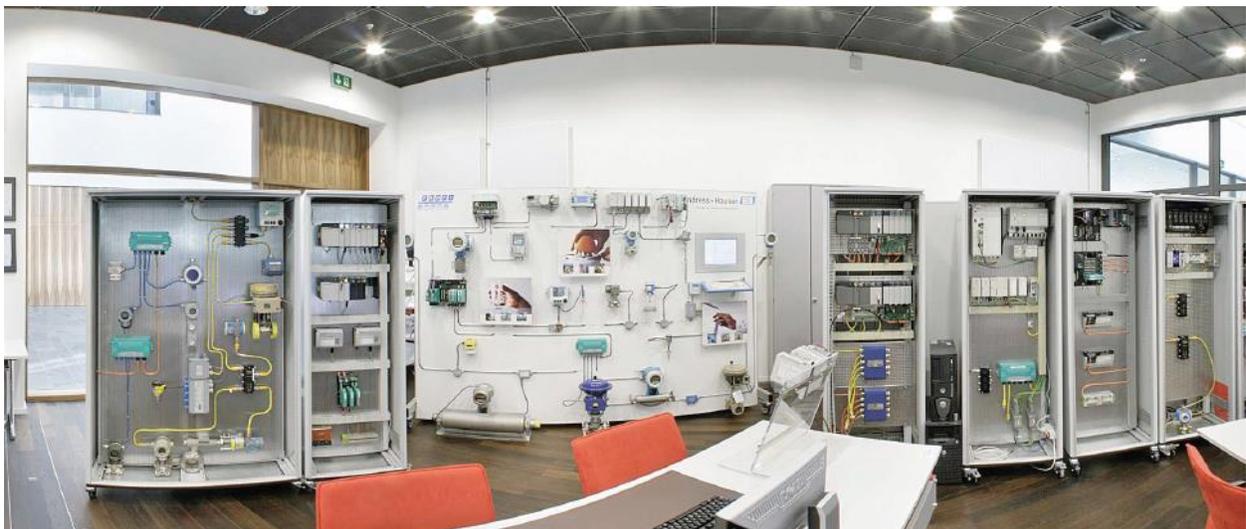
Endress+Hauser



People for Process Automation

Endress+Hauser is one of the world's leading process automation suppliers. The company was one of the founding members of the Fieldbus Foundation, and has a long history of involvement

standards making bodies and committees. At their location in Reinach, Switzerland, the company maintains a Fieldbus Test and Competence Center called “System World” that is well equipped with field devices and systems of all the leading manufacturers. System World is used for system integration, interoperability, and certification tests. All this testing is done in addition to the testing and registration that is done at the Fieldbus Foundation to ensure the highest levels of interoperability.



Endress+Hauser System World Tests Interoperability of Fieldbus Devices with Various Hosts

As a supplier, Endress+Hauser is in a unique position. They are not just a field device supplier – Endress+Hauser is one of the leading Plant Asset Management software suppliers through its FieldCare offering, and they have a registered FOUNDATION fieldbus HSE linking device. As a result, the company has quite a bit of experience dealing with the diagnostic data that comes from fieldbus devices as well as manufacturing the devices themselves. They are a device supplier, but also a solutions provider.

It is not surprising that Endress+Hauser would be one of the first suppliers follow the Field Diagnostic Profile specification and incorporate NE 107 diagnostics capabilities into its devices. It is the company’s involvement with the information management side of fieldbus diagnostics that makes its approach unique. To elaborate, many fieldbus devices have in excess of 31 diagnostic events. We mentioned previously that some devices can have over a hundreds of possible diagnostic events. It follows therefore that the first layer of manufacturer defined specific conditions should provide some higher level of organization which can then be used to drill down into further levels of diagnostics for specific devices. This is where the FOUNDATION leaves room for suppliers to add their competitive advantage to our standard specification, and this is what Endress+Hauser has done with their implementation of FOUNDATION fieldbus diagnostics. Endress+Hauser is also eager to share this implementation with other device suppliers that may be experiencing similar issues.

Endress+Hauser uses the last 16 bits of the 32 bit string to categorize diagnostics in terms of severity. Because you have to group the diagnostic events as soon as there are more than 31, Endress+Hauser decided to have a standard area that can be used to group the diagnostic events independent from the

Standard Area		Configurable Area		Status 1	Status 2	Simulation			
Bit#	Diagnostic Event	Failure		Function Check		Out of Specification		Maintenance Required	
		enable	mask	enable	mask	enable	mask	enable	mask
31	Highest Severity Sensor	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
30	Highest Severity Electronic	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
29	Highest Severity Configuration	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
28	Highest Severity Process	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
27	High Severity Sensor	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
26	High Severity Electronic	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
25	High Severity Configuration	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
24	High Severity Process	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
23	Low Severity Sensor	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
22	Low Severity Electronic	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
21	Low Severity Configuration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20	Low Severity Process	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19	Lowest Severity Sensor	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
18	Lowest Severity Electronic	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
17	Lowest Severity Configuration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
16	Lowest Severity Process	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Endress+Hauser Standard Graphics in Device Diagnostic Profile

That enables the use of diagnostic faceplates that can be used for different device types. Each category of severity corresponds to the major FCSM diagnostic categories in NE 107. Severity classes have been created to be able to setup default groups for a default setting.

The user can make changes to these relationships depending on their requirements. For example, if a certain device is OFFSPEC it could be Highest Severity. On the other hand, the failure of a relatively unimportant monitoring device may not be high severity, so the user has the flexibility to change these relationships depending on their requirements. For each of these four categories, diagnostics are grouped into further subcategories that represent the major characteristics of the device versus the process conditions. Diagnostic categories for the device include the Sensor, Electronics, Configuration, and the Process. From this high level, diagnostics can be categorized further, depending on the specific type of device.

The remaining bits in the 32-bit string are designated as the “Configurable Area”. Only specific diagnostics can be mapped into the configurable area. These are typically application related diagnostics such as lost echo from a radar device. An electronic defect will typically not be placed in the configurable area, because this usually means the failure of a device. If a diagnostic is put into the configurable area, it must be removed from the standard area. In the configurable area, one bit is linked/mapped directly to one diagnostic event. The user is free to select from a range of configurable diagnostics as shown.

You need a good grouping mechanism at the uppermost level in order to make the process of drilling down into more specific diagnostics easier. This also makes the task of configuration by the end user much easier. Most users expect that the automation suppliers will categorize diagnostics in a standardized way that will limit the amount of effort required by the end user to categorize and configure diagnostics should be as easy as possible.

Sometimes you do not need to know all the details behind a problem, you just need to know how to fix it and when you should fix it. Good diagnostics should provide this information, as well as more detailed information if it is requested by the end user. In some devices, there can be a huge amount of detailed diagnostic information.

		Failure		Function Check		Out of Specification		Maintenance Required	
		Priority 0		Priority 0		Priority 0		Priority 0	
Bit#	Diagnostic Event	enable	mask	enable	mask	enable	mask	enable	mask
15	#115 Sensor overpressure	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14	#120 Sensor low pressure	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13	#715 Sensor over temperature	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12	#717 Transmitter over temperature	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11	#718 Transmitter under temperature	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10	#720 Sensor under temperature	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9	#726 Sensor temperature error-overrange	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8	#727 Sensor pressure error-overrange	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7	#730 LRV user limits exceeded	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
6	#731 URV user limits exceeded	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
5	#732 LRV-Temp. user limits exceeded	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
4	#733 URV-Temp. user limits exceeded	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
3	#740 Calculation Overflow, bad configuratic	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
2	not assigned	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	not assigned	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Endress+Hauser Standard Graphics in Device Diagnostic Profile

So much so that some end users who do not have the knowledge about a specific device may get bogged down in details and fail to see what specific maintenance actions must be taken with a device. For example, a simple swap out of an electronics module could address a wide range of more complex electronics issues.

Two key items stipulated in NAMUR NE 107 are that diagnostic information should be relevant, and it should be actionable. If you get bogged down in a lot of detailed diagnostics but are unsure of what concrete action should be taken to address the diagnostic issues, the diagnostics themselves are not worth much. The customer should not have to spend a lot of time configuring diagnostics.

This is the purpose of the configurable diagnostics area, which is used to address the requirements of more complex devices where very specific diagnostic messages will need to be displayed. The configurable area means that the one single bit is related to one specific piece of diagnostic information. This could include specifying a safety distance for a radar level measurement device, for example.

Status Configuration

In addition to diagnostic data, FOUNDATION fieldbus also has mechanisms to indicate data quality. PV status can be labeled as Good, Bad, or Uncertain. Categories are defined as follows:

- BAD – PV Status is going to BAD
- UNCERTAIN – PV Status is going Uncertain
- GOOD – PV Status stays Good

Categorization of diagnostic information and measuring status are really two independent functions. With the Endress+Hauser implementation of FOUNDATION fieldbus diagnostic management, however, it is possible to change the PV status related to a certain diagnostic, if it is certain the PV status will exactly correspond to a specific diagnostic message. Even if they are separate functions from the process point of view, they can be very often related from the application perspective, but it can be difficult to determine what the relationship means.

Detailed Diagnostics

Endress+Hauser also provides an add-on for more detailed diagnostic information provided by the configurable diagnostics area. Endress+Hauser uses the standard parameter FD_RECOMMEN_ACT to transmit detailed information. As you may be able to deduce from the name of the parameter, the Detailed Diagnostics provide specific information about recommended corrective actions and detailed help to address the issue.

Utilizing Diagnostic Data from Multiple Devices

Certain diagnostic anomalies expressed in multiple field devices can indicate an anomaly or impending abnormal situation in the process. Placing a structure around which these diagnostics can be consistently managed makes these more advanced diagnostics possible. Being able to diagnose the overall health of a unit, area, or even the entire plant is predicated on this good diagnostic data at the most basic level of the measurement devices and actuators.

Testing and Registration of Devices

Endress+Hauser has already begun the process of testing their fieldbus devices to the latest

Standard Area		Configurable Area		Status 1	Status 2	Simulation			
Bit#	Diagnostic Event	Failure		Function Check		Out of Specification		Maintenance Required	
		enable	mask	enable	mask	enable	mask	enable	mask
15	#740 Calculation Overflow, bad configuratic	<input type="checkbox"/>							
14	not assigned	<input type="checkbox"/>							
13	#115 Sensor overpressure	<input type="checkbox"/>							
12	#120 Sensor low pressure	<input type="checkbox"/>							
11	#715 Sensor over temperature	<input type="checkbox"/>							
10	#717 Transmitter over temperature	<input type="checkbox"/>							
9	#718 Transmitter under temperature	<input type="checkbox"/>							
8	#720 Sensor under temperature	<input type="checkbox"/>							
7	#726 Sensor temperature error-overrange	<input type="checkbox"/>							
6	#727 Sensor pressure error-overrange	<input type="checkbox"/>							
5	#730 LRV user limits exceeded	<input type="checkbox"/>							
4	#731 LRV user limits exceeded	<input type="checkbox"/>							
3	#732 LRV-Temp. user limits exceeded	<input type="checkbox"/>							
2	#733 LRV-Temp. user limits exceeded	<input type="checkbox"/>							
1	#740 Calculation Overflow, bad configuration	<input type="checkbox"/>							

Selecting a Configurable Diagnostic Event

version of the Fieldbus Foundation Interoperability Test Kit (ITK). All H1 ITK 6.0 tested devices support the latest advancements in field diagnostics per the Field Diagnostic Profile and the NAMUR NE107 recommendations. Host systems registered under the latest host profile testing and registration

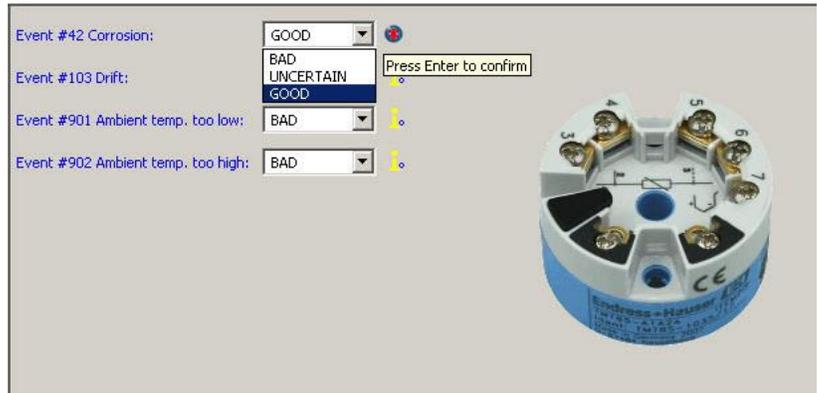
procedures will also be able to access and manage this diagnostic data. The first devices are registered already and many more are on the way.

An Open Concept

While this is the current implementation of Endress+Hauser's use of the FOUNDATION fieldbus Diagnostic Profile, the company has indicated that it is willing to make this implementation available to other suppliers, and it could be a possible future addition to the FOUNDATION fieldbus specification. The FOUNDATION Fieldbus specification is open, which means it is possible to enhance the spec when relevant and new technologies and approaches become available.

Conclusions

Endress+Hauser's implementation of the Fieldbus Foundation's Field Diagnostic Profile specification and NAMUR NE 107 diagnostics is an excellent example of how an



Data Quality Indication

automation supplier can utilize the FOUNDATION fieldbus standard while at the same time building in their own specific functionality for managing diagnostic data. The Endress+Hauser implementation of FOUNDATION fieldbus diagnostics also confirms to NAMUR's recommendations both through distinguishing between device and process problems, and by using the standard NAMUR diagnostic FCSM classifications as its standard diagnostic classification. The addition of a configurable area of diagnostics, detailed diagnostic information, and recommended actions is also in line with NAMUR NE 107 principles and enables end users to get easy access to key diagnostic information from more complex devices such as analytical equipment and Coriolis meters. Endress+Hauser's approach really represents a large leap forward in the application and management of fieldbus diagnostics.