



# Enhanced FOUNDATION Fieldbus Physical Layer Diagnostics with the DeltaV System

This document provides possible solutions that allow enhanced Ff (FOUNDATION fieldbus) physical layer diagnostics using the Pepperl+Fuchs FieldConnex® Fieldbus Power Hub family of Ff power supplies, power conditioners, and diagnostic modules when connected to the DeltaV system.



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## Introduction

Of the issues preventing proper operation of FOUNDATION fieldbus (Ff) segments, the leading causes have consistently been related to the fieldbus physical layer. For instance, problems with the segment occur if one of the terminators is not installed, the voltage level on the segment is not correct, the cable is improperly wired, noise is introduced on the wires, and the list goes on. These physical layer problems often can be corrected with relatively little effort, once the root cause is determined. Without the availability of good tools for collecting and analyzing the Ff segment's physical layer diagnostics, considerable time can be spent chasing the cause of the problem. However, end-users may perceive these potential network infrastructure problems and the need for a network diagnostic tool as complications of using fieldbus versus 4-20 mA signals. Therefore, any diagnostic tool must be easy to use and have the ability to eliminate the user's concerns with physical layer installation and operation. Several 3<sup>rd</sup>-party manufacturers offer diagnostic tools for identifying problems with the FOUNDATION fieldbus physical layer. This whitepaper will focus on three such solutions from Pepperl+Fuchs, an Emerson Process Management Alliance Program member company.

## Description of Hardware and Software from Pepperl+Fuchs

**FieldConnex Fieldbus Power Hub** – The Fieldbus Power Hub (see Figure 1 below) consists of a DIN rail-mounted motherboard which supports plug-in modules that provide redundant power for one, two, or four fieldbus segments plus one diagnostic module. Two HD2-FBPS-1.500 isolated power supplies plug into the motherboard to power each segment. Please visit <http://www.easydeltav.com/keytechnologies/fieldbus/vendors.asp> for a list of the specific Pepperl+Fuchs products tested for interoperability with the DeltaV system.

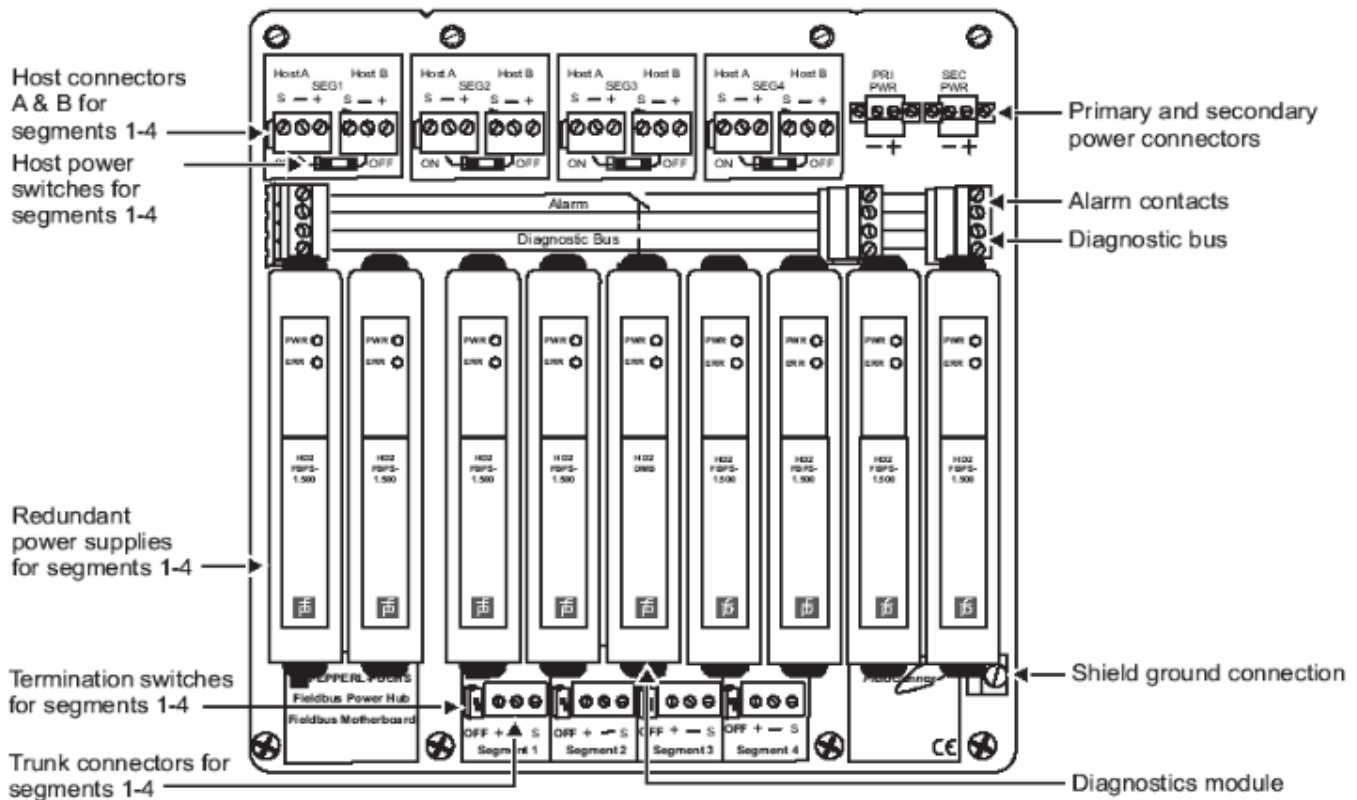


Figure 1—Power Hub with Four Redundant Segments and a Diagnostics Module

**Power Supply Modules** – These modules are part of the FieldConnex Power Hub product line, and provide full galvanic isolation between the bulk power supply and the fieldbus segment. Different power supply modules exist with voltage regulated and limited energy levels according to the specifications of FNICO, Entity and FISCO standards. A maximum output current of 500 mA is available to power field devices. See Figure 1 for a schematic including power supply modules.

**Power Conditioner Modules** – These modules are part of the FieldConnex Power Hub product line, and provide current limiting circuits between the bulk power supply and the fieldbus segment without galvanic isolation. Power conditioner modules carry only passive components.

**Diagnostic Modules** – Two diagnostic modules are compatible with the FieldConnex Power Hub system:

- 1) *Basic Diagnostic Module* - The Diagnostic Module HD2-DM-B is a system component of the FieldConnex Power Hub. It provides basic system diagnostics. It checks the bulk power supplies to determine whether they are working in the proper voltage range and monitors the connected trunks for overload or shortcircuit. Each Power Hub Module is checked for proper function; in case of redundant versions, a system integrity check is performed. Malfunctions are indicated by LEDs and can be transmitted by a voltage-free contact

connection. The module can be plugged onto the different motherboards in combination with various other modules.

- 2) *Advanced Diagnostic Module - A* - The Advanced Diagnostic Module HD2-DM-A is part of the FieldConnex Power Hub product range. When wired to the Pepperl+Fuchs FieldConnex Expert Diagnostic Manager software package using the Diagnostic Bus connectors on the FieldConnex Power Hub, it provides critical analysis of signal and segment parameters (e.g. bulk power loss or short circuit), as well as detailed measurement of specific system and node physical layer values (e.g. noise or jitter levels and unbalance detection). The integrated oscilloscope function visualizes the communication on each segment. Continuous monitoring of all relevant physical layer parameters can proactively detect degradation before the segment communication fails.



Figure 2—Power Hub Diagnostics Module

**Mobile Advanced Diagnostic Module** – The Mobile Advanced Diagnostic Module DM-AM (see Figure 3 on the next page) is a USB-powered universal tool to analyze the physical layer parameters of a fieldbus segment. The module includes an integrated USB 2.0 interface for convenience and portability in the field. It can be connected anywhere on the fieldbus network. As a part of the Pepperl+Fuchs FieldConnex Expert Diagnostic Manager software package, it provides basic analysis of signal and segment parameters (e.g. measurement of specific system and node physical layer values, increasing noise or jitter levels, and unbalance detection). It also provides basic analysis of advanced functions such as alarming, trending, report generation and oscilloscope function. The



integrated oscilloscope function enables visualization of the communication on a segment. Monitoring of relevant physical layer parameters can allow proactive detection of degradations before the segment communication fails.



Figure 3—Mobile Advanced Diagnostics Module

**Pepperl+Fuchs FieldConnex Expert Diagnostic Manager software** – The Expert Diagnostic Manager is a powerful tool with the capability to track a large number of critical physical layer parameters and simplify the complex parameter interactions. This software package provides alarm history collection and additional tools to help the user decipher the root cause of the alarm or warning. The software is typically installed on a non-DeltaV PC. The Advanced Diagnostic Module communicates the diagnostic data to the PC using a RS-485 network connection.

NOTE: The specifications listed here may not be the latest information. Please consult <http://www.pepperl-fuchs.com/> for accurate specifications on these products.

## Options for Diagnostic Integration with the DeltaV System

Use of the diagnostic tools from Pepperl+Fuchs can help reduce the user's concerns regarding implementation, engineering, maintenance, and uncertain reliability of the FOUNDATION fieldbus network's physical layer. It is believed that the Basic Diagnostic Module will provide an adequate level of information for many customers, and should be the default solution quoted for fieldbus projects primarily due to its low cost. However, the Advanced Diagnostic Module offers several compelling value propositions resulting in greater network reliability.

**Start-up and Commissioning:** The Advanced Diagnostic Module is able to generate reports of the physical layer statistics that can streamline start-up and commissioning of FOUNDATION fieldbus systems. Together with the Expert Diagnostic Manager software, the Advanced Diagnostic Module can baseline the fieldbus network and archive the data for future use.

**Monitoring:** The Advanced Diagnostic Module continuously monitors each segment for compliance to a programmable set of alarms. The alarms can be triggered via a simple solid-state relay output from the Advanced Diagnostic Module. Multiple Advanced Diagnostic Modules can be connected to one another, or can be wired individually to provide greater alarm visibility. When connected to the Pepperl+Fuchs Expert Diagnostic Manager software, the Advanced Diagnostic Module can be used to evaluate many physical layer characteristics of the network, and provide warnings of potential problems before they occur. A time-stamped historian is also available to log alarms from the Advanced Diagnostic Module.

**Troubleshooting:** The Advanced Diagnostic Module, used with the Expert Diagnostic Manager software, identifies faults and has a built-in digital oscilloscope to facilitate quick analysis.



The Advanced Diagnostic Module is the preferred solution for integration with the DeltaV system because it offers the most comprehensive fieldbus physical layer diagnostics solution. The Advanced Diagnostic Module solution should be offered as a value-added option to the Basic Diagnostic Module solution.

Finally, the Mobile Advanced Diagnostic Module offers a portable alternative to the Basic Diagnostic Module and the Advanced Diagnostic Module, but is not capable of integrating with the DeltaV system. Therefore, using the Mobile Advanced Diagnostic Module is not specifically recommended for use with DeltaV systems.

The following options exist for integrating the Pepperl+Fuchs products with the DeltaV system.

### 1) Pepperl+Fuchs FieldConnex Power Hub with Basic Diagnostic Module (Recommended Solution)

When the Fieldbus Power Hub is powered and functioning within its specifications, the alarm circuit provides a closed-contact circuit. A failure of either (1) input power supply, (2) any fieldbus power supply module, or (3) an over-current or short on any fieldbus output, opens the alarm circuit. The alarm circuit is galvanically isolated from the fieldbus segments and input power supplies. The alarm pins at the last unit must be connected together to complete the circuit. To receive an alarm in the DeltaV system upon detection of any of the conditions above by the Basic Diagnostics Module, connect the alarm contacts on the Power Hub motherboard (see Figure 1 on page 4) to a discrete input channel on a DeltaV discrete input card, and create a control module in the DeltaV system that includes an alarm triggered on the input's change of state.

*Benefits of this integration method:*

- Constant, online monitoring for fault conditions
- Simple and straightforward installation
- Minimal configuration in the DeltaV system
- Cost-effectiveness
- Upgradeable to the Advanced Diagnostic Module as customer desires

*Limitations of this integration method:*

- Non-specific alarming (i.e. Basic Diagnostic Module can not pinpoint the cause of the segment problem)
- Resulting DeltaV alarm has a one-to-many-causes relationship with the Basic Diagnostic Module which makes a specific, predetermined response to the alarm more difficult.

### 2) Pepperl+Fuchs FieldConnex Power Hub with Advanced Diagnostic Module (Preferred Solution)

The Advanced Diagnostic Module is capable of analysis of signal and segment parameters (e.g. bulk power loss or short circuit), as well as detailed measurement of specific system and node physical layer values (e. g. noise or jitter levels and unbalance detection). By using the Diagnostic Bus connections (see Figure 1 on page 4) on the Power Hub motherboard, the Advanced Diagnostic Module allows serial communication with the Pepperl+Fuchs FieldConnex Expert Diagnostic Manager software package for continuous monitoring of detailed physical layer parameters. Because the Advanced Diagnostic Module is equipped with a diagnostic solid-state relay output, integration with the DeltaV system can be easily accomplished by connecting the relay output to a DeltaV discrete input card. This integration offers a simple mechanism to alert the user when a problem occurs that requires more detailed evaluation using the Pepperl+Fuchs FieldConnex Expert Diagnostic Manager software package.



This solution is the sole responsibility of Pepperl+Fuchs.

Figure 4 below shows a comparison of the diagnostic alarms available from the Basic Diagnostic Module and the Advanced Diagnostic Module.

Type of Check	Basic Diagnostics HD2-DM-B	Advanced Diagnostics HD2-DM-A		
	Alarm output, all alarms are always enabled	Alarm output, all alarms can be individually enabled/disabled		
		Maintenance required alarm, configurable limit	Out-of-specification alarm, fixed limit	Hysteresis
Minimum Bulk Power Supply Voltage	✓	✓	✓	✓
Maximum Bulk Power Supply Voltage	-	✓	✓	
Power Supply module mismatch	✓	n.a.	✓	n.a
Power Supply module failed	✓	n.a.	✓	n.a
Minimum Fieldbus Voltage	✓	✓	✓	
Maximum Fieldbus Voltage	-	✓	✓	✓
Minimum Fieldbus Current	-	✓	-	
Maximum Fieldbus Current	-	✓	-	✓
Minimum Fieldbus Signal Level	-	✓	✓	
Maximum Fieldbus Signal Level	-	✓	✓	✓
Unbalance to positive signal pole	-	✓	✓	✓
Unbalance to negative signal pole	-	✓	✓	✓
Fieldbus noise	-	✓	✓	✓
Fieldbus jitter	-	✓	✓	✓

Figure 4—Comparison of Available Alarm Outputs from Basic and Advanced Diagnostic Modules

*Benefits of integration using the Advanced Diagnostic Module:*

- Constant, on-line monitoring for fault conditions
- Minimal hardware integration and configuration needed in the DeltaV system
- User configurable alarm and warning levels for preventative maintenance
- Does not require any interaction with the fieldbus wiring
- More detailed Ff physical layer monitoring possible than with the Basic Diagnostic Module
- Proactive diagnosis of issues possible before segment communication problems occur

*Limitations of integration using the Advanced Diagnostic Module:*

- Additional wiring required to setup a RS-485 network connection to the PC containing the Pepperl+Fuchs FieldConnex Expert Diagnostic Manager
- After alarm annunciation within DeltaV, user must utilize the Pepperl+Fuchs FieldConnex Expert Diagnostic Manager software to fully diagnose the problem
- Resulting DeltaV alarm has a one-to-many causes relationship with the Advanced Diagnostic Module solid-state relay output, which makes a specific, predetermined response to the alarm more difficult



### 3) Pepperl+Fuchs FieldConnex Power Hub with Mobile Advanced Diagnostic Module (Optional Solution, not specifically recommended for use with DeltaV systems)

The Mobile Advanced Diagnostic Module provides many of the same capabilities as the Advanced Diagnostic Module, but with the added feature of portability. Also, the Mobile Advanced Diagnostic Module can be attached to any point on the Ff segment. This module is also used in conjunction with the PACTware/FieldConnex software package, but the software is typically installed on a laptop to take advantage of the module's portability.

This solution is the sole responsibility of Pepperl+Fuchs.

Because the Mobile Advanced Diagnostic Module is used intermittently, no connection to the DeltaV system is possible.

#### *Benefits of this implementation:*

- Portability: one module can server many Power Hubs (i.e. Ff segments).
- Detailed Ff physical layer diagnostics and analysis when used with the PACTware/FieldConnex software.
- Economical: pay for only one or two Mobile Advanced Diagnostic Modules as opposed to one Advanced Diagnostic Module per Power Hub.

#### *Limitations of this implementation:*

- Requires installation of multiple software programs.
- Area classification/zone concerns when using laptop PC in the field.
- No ability to continuously log data because the connection is intermittent
- Requires interaction with the fieldbus wiring

## Summary

The Pepperl+Fuchs products discussed can help diagnose or even prevent the leading causes of FOUNDATION fieldbus problems, physical layer issues. The need for advanced FOUNDATION fieldbus physical layer diagnostics is consistent with our PlantWeb message, and the Pepperl+Fuchs products discussed in this whitepaper possess several key features including decreased CAPEX during plant start-up, reduced OPEX via troubleshooting capabilities, and competitive differentiation.

For DeltaV Ff installations, integration option 1 is recommended. Integration option 1, using the Basic Diagnostic Module with the FieldConnex Fieldbus PowerHub provides the user with the minimum level of physical layer monitoring, and will allow highly competitive bid proposals when the project is under price pressure. Integration option 2, using the Advanced Diagnostic Module and FieldConnex Fieldbus PowerHub, should be promoted as a value-added alternative the Basic Diagnostic Module solution. The Advanced Diagnostic Module is the preferred solution because it provides the customer with the most complete, and easily integrated, fieldbus physical layer monitoring solution. This permanently mounted diagnostic module is preferred over the Mobile Advanced Diagnostic Module described in option 3 since it continuously monitors the health of the network, and thus provides a more reliable fieldbus installation. The Advanced Diagnostic Module should be considered as an optional tool for technicians and maintenance personnel with a higher level of FOUNDATION fieldbus knowledge, but integration Option 3 is not specifically recommended for use with the DeltaV system because no integration of data is possible.