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FIELDBUS TECHNOLOGY
(PART 1 OF 5)

BY DICK CARO

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Analog process instrumentation required a dedicated wire pair running from the instrument in the field directly to the termination junctions on the controller. The pair can consist of several cable runs, including the instrument to a junction box, junction box to marshalling cabinet, marshalling cabinet to other marshalling cabinets, and the control room marshalling cabinet to the correct termination wiring on the multifunction or dedicated loop controller. Power for the analog instrument is typically supplied at the field marshalling cabinet. All of this is carefully designed to assure that there is electrical continuity between the instrument in the field and the controller terminations. Each termination should be field tested to assure this continuity. This checkout usually entails a technician at each end to "ring-out" the connection. In effect, the address of the field instrument is determined by the termination on the controller.

Fieldbuses were created to eliminate much of this wiring complexity by sharing wires among several field instruments, and by addressing the field devices using software. By doing this, it became possible to also reduce the cost of wiring and termination design and engineering, since a continuous wire pair was no longer required for each instrument since addressing no longer depended upon controller termination location, but was handled using software. Further, installation labor could be reduced since verification of the connections of one (long) wire pair for each device was no longer necessary.

The term “fieldbus” has become generic and is frequently applied, especially in Europe, to any network used in industrial automation: process control, factory automation, materials handling, or motion control. In North America, the term “fieldbus” is usually associated with the versions used exclusively for process control, especially FOUNDATION™ Fieldbus and PROFIBUS-PA. Adding to the confusion, the Fieldbus Foundation uses the term "FOUNDATION™ Fieldbus" to name the particular set of specifications representing their particular version of the process control-oriented fieldbus.

FIELDBUS TECHNOLOGY
(PART 2 OF 5)

BY DICK CARO

E-ZINE FEBRUARY 2010

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HART was an interim development in the late 1980's stemming from the original SP50 work on Fieldbus for suppliers to retain the 4-20mA analog transmission and conduct a digital data exchange in the same two-wire loop. Technology at the time restricted the data rate to 1200 bps when the analog signal was present.

During the ANSI/ISA SP50 and IEC SC65C/WG6 standards committee deliberations, there were many candidates in favor of an all-digital fieldbus technology. It was agreed to adopt a totally new technology at the protocol layer in order to meet all of the requirements with a single set of rules. The protocol developed by the committee became the basis for FOUNDATION™ Fieldbus. Another group of suppliers, dissatisfied with this decision, proceeded to use a then existing protocol to develop the PROFIBUS specifications.

The final IEC standard (IEC 61158) includes both PROFIBUS in both PROFIBUS-DP and PROFIBUS-PA forms, FOUNDATION™ Fieldbus H1, FOUNDATION™ Fieldbus HSE, as well as ControlNet, Interbus, WorldFIP, P-Net, and SwiftNet. Since most of these are not used in commercial process control networks, only PROFIBUS and FOUNDATION™ Fieldbus forms are discussed in this report. HART is also used in process control, but is not part of this standard.

In this report, fieldbuses used for process control --- HART, PROFIBUS-PA, and FOUNDATION™ Fieldbus --- are discussed in order of increasing complexity and capability. Each fieldbus has its advantages and disadvantages, so the reader should evaluate the desired network capabilities and implementation issues given the requirements of each installation. In some applications, some plants use more than one fieldbus type to meet their needs.

FIELDBUS TECHNOLOGY
(PART 3 OF 5)

BY DICK CARO

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HART began as an ISA SP50 proposal to enable backwards compatibility with analog field instrumentation. HART transmits its digital data superimposed on a 4-20 mA signal allowing the field instrument to continue to supply its primary data value in analog form with secondary data in digital format. However, due to the limitations of the analog current loop, the digital data rate at the time of design was limited to 1200 bps. The consensus has generally been to keep HART in its present form and to use PROFIBUS-PA or FOUNDATION™ Fieldbus if more digital capability is required. However, faster communication can be achieved by implementing the HART C8PSK specification that can operate at 9600 bps simultaneously with existing 1200 bps HART field instruments. As of this writing (mid-2007), a wireless version of HART is being developed but there have been no public information releases about it.

HART is the most widely used fieldbus and is anticipated to maintain this market position in the immediate future. The installed base of HART instruments is large since many suppliers of field instrumentation have discontinued producing pure analog instruments and supply only HART devices. In many cases, HART instruments have a lower overall production cost as compared to analog instruments, since one model can cover many common ranges of analog instruments. This enables suppliers and users to stock fewer devices in inventory.

The single most appealing factor in the popularity of HART instruments is the capability to change their range while in use, without being removed from the process. Further, the ability to change the range remotely from anywhere that the HART wiring is accessible, reduces the cost of instrument maintenance by reducing the need to have physical access to an instrument to make changes. Wireless HART extends this idea by making access to any wireless HART-enabled instrument accessible via the wireless link without needing to access wiring at all.

HART transmitters and control valve positioners have the ability to diagnose problems before they become serious. The HART processor can have direct access to various parts of the field instrument and can detect excessive internal temperatures, non-responsive components, and stickiness of control valves, before operational problems occur. However, this requires either a diligent field instrumentation team to check the HART digital data, or the ability to run diagnostics in controllers equipped to directly read HART data values and diagnostic results. Newer distributed control systems (DCS) often have this capability, but distributed control systems (DCS) without a direct HART interface (only 4-20mA) do not. Reliance on the field instrument maintenance team with a portable handheld HART reader has generally proven impractical to take advantage of the features offered by HART digital diagnostics.

HART devices are wired the same as 4-20 mA analog instrumentation, including the requirement for continuity of the wire pair from the field instrument to the controller's terminations. Most new controllers can accept the digital content of HART on the same terminations that are used for the 4-20 mA analog primary variable measurement value.

HART field transmitters and control valve positioners are available from most of the same suppliers that sold analog equivalents. Typically, HART devices cost no more than the analog devices that they replaced.

FIELDBUS TECHNOLOGY
(PART 4 OF 5)

BY DICK CARO

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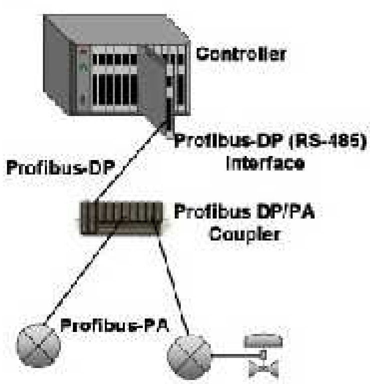
PROFIBUS-PA was built on the backbone of PROFIBUS-DP which was created to provide the data transfer needs for factory automation and materials handling in discrete parts manufacturing. It was designed to be the communications network for linking programmable logic controllers (PLC) together and with host computer systems and Human Machine Interface (HMI) used in the factory. However, the need to connect process control instrumentation has been a mission of the PNO (PROFIBUS Nutzerorganisation), the development group of PROFIBUS International. In general, PROFIBUS-PA was developed to meet the needs of the process industries that did not want or need Field Control.

PROFIBUS-PA was originally designed to have a two-level bus hierarchy. Both bus levels run the same protocols, but use different physical means to enable different bus speeds. PROFIBUS-PA uses the identical physical layer as FOUNDATION™ Fieldbus H1 that is specified in ANSI/ISA 50.02 Part 2 and IEC 61158 Part 2, Type 1. This enables bus power and intrinsic safety for process control applications. The upper level bus is PROFIBUS-DP using RS-485, as specified in IEC 61158-2.

No direct controller interface for PROFIBUS-PA is required since it is interfaced via a PROFIBUS-DP compatible RS-485 port. A PROFIBUS-DP/PA linking device or segment coupler is used to connect each PA segment to a DP bus. PROFIBUS-DP typically supplies power to each PA segment through the bus coupler or linking device.



The bus master, typically a multifunction controller, controls all data transmissions on PROFIBUS. Transmissions on PROFIBUS are asynchronous, so the controller itself synchronizes all of its own control loops. However, field instruments may execute local functions such as signal processing and alarm limit checking to off-load these functions from the shared controller.

The basic configuration of each field device is contained in a GSD (Gerätestammdaten: equipment master data) record published by the device supplier. In addition, each device may also process its data using an EDD (Electronic Device Description) produced and downloaded to the device. The EDD contains the specific database used by the device to process the raw measurement signals and check for alarm limit violations. The original form of EDD was proprietary for each device supplier, but they are now standardized by IEC 61804 Function Blocks for Process Control so that they will become uniform across suppliers. EDDs will be functionally similar to, but not exactly the same as, the signal processing Device Descriptions for FOUNDATION™ Fieldbus and HART.

FIELDBUS TECHNOLOGY
(PART 5 OF 5)

BY DICK CARO

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The Fieldbus Foundation is a non-profit membership organization with a charter to develop and support a set of specifications known as FOUNDATION™ Fieldbus H1 that is based on the ANSI/ISA 50.02 Fieldbus standard. This specification is also the same as Type 1 of the IEC 61158 international fieldbus standard. Additionally, the Fieldbus Foundation developed and supports Type 5 of IEC 61158, which is known as FOUNDATION™ Fieldbus HSE. Further, the Fieldbus Foundation contributed its function block specifications to the ongoing work of IEC SC65C/WG7 to develop the recently approved standard IEC 61804, Function Blocks for Process Control.

Not only does the Fieldbus Foundation support these specifications, but also it develops and administers tests to ensure compliance with these specifications. This allows fieldbus-based control systems supplied by one supplier to be used with field instruments and control valves from many different suppliers.

Devices and systems meeting all of the testing requirements, receive an official registration mark that is affixed to the device or system.

Suppliers are allowed to extend their products and systems in specific ways that maintain interoperability. While suppliers must implement the basic function blocks specified in the standard as specified by the Foundation, additional function blocks may be developed where the attributes of the function blocks are defined using a standardized Device Description. No interoperability testing is done on the Device Description, but the behavior of the Device Description is specified by the Foundation.

Fieldbus
Foundation
Registration Mark

Excerpted from The Consumer Guide to Fieldbus Network Equipment for Process Control

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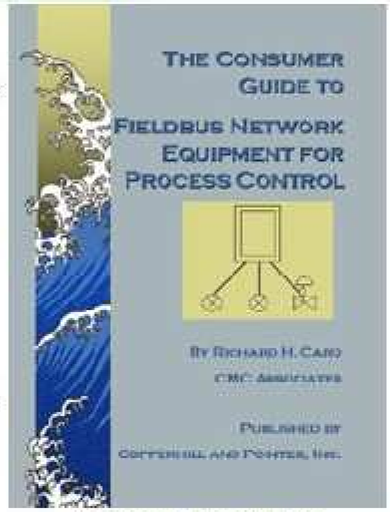
THE CONSUMER GUIDE TO FIELDBUS NETWORK EQUIPMENT FOR PROCESS CONTROL - 3RD EDITION

GUIDE DESCRIPTION



This updated independent guide to the world's fieldbus network equipment for process control is written by a leading expert in fieldbus technology. The information in this book will help you select a control system architecture compatible with your needs.

The guide contains technical information about evaluating and applying fieldbus network equipment including pointers for architecture and installation considerations. Tables include the types of fieldbus network equipment and selected features that are available from each supplier.

This guide is indispensable for designers, engineers, owners and end users of fieldbus equipment. Use this guide to help you choose your fieldbus network equipment.

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