WIRED OR WIRELESS
HART COMMUNICATION
HAS YOU COVERED!
Envision a plant . . .

. . . where people are watchful and attentive while your business responds to change quickly and efficiently. Now picture an operation that delivers non-stop production while confidently expanding your capabilities into the future. Imagine no further. This is the vision and promise behind VigilantPlant, the clear path to operational excellence.

vigilantplant™

The clear path to operational excellence
The Yokogawa FieldMate Versatile Device Management System is a new PC-based integrated software tool that handles parameter setting for intelligent field devices, regardless of their make or field communication protocol. FieldMate speeds up device configuration and problem solving, and automatically stores a work log for a traceable field maintenance database that consolidates the maintenance work flow and facilitates the sharing of maintenance know-how.

Hear the pulse of your plant = Diagnose with the most, one tool for all.

For more information and free trial software, visit promo.us.yokogawa.com and enter key code AD9710.
Unlock Your Smart HART® Multivariable Transmitter’s Hidden Secrets

The full potential of your smart transmitter has been locked up way too long. Set it free with our HIM Smart HART Loop Interface and Monitor.

Converting HART to 4-20mA
The HIM converts HART digital data to 4-20mA signals that your DCS or PLC control system can handle. A multivariable mass flow transmitter, for example, measures three variables: differential pressure or raw flow, pressure, and temperature. From these non-primary measurements, it calculates mass flow, and sends this on 4-20mA wires back to your control system. The problem is, the non-primary measurements, and the valuable data they provide, never make it out of the field. The solution is the HIM. It “breaks out” non-primary measurements, and sends them as 4-20mA signals to your control system.

Take Full Advantage of In-Place “Legacy” Smart HART Transmitters.
The HIM is your key to leaving trusted (and paid for) smart transmitters in place, yet still take advantage of all the process and diagnostic information they have to offer.

HART is a registered trademark of the HART Communication Foundation.
The process control industry has been in need of a wireless solution that establishes a global standard. The HART Communication Foundation has created that wireless standard. The main benefit of a standard is to insure that devices from multiple suppliers work together—thereby lowering risk and cost for both the supplier and the user. Wireless technology has matured to the point that it now can be safely applied in industrial control and monitoring applications. Measurements that were cost-prohibitive now can be measured and included in your control and monitoring strategies.

We were in a unique position to develop a wireless communication standard for the process industries. Drawing on the technical resources and expertise of more than 200 member companies, we created a new wireless technology that expands the capabilities of the HART Protocol while protecting the global installed base of 26+ million HART devices.

WirelessHART™ is an exciting new communication capability defined in the latest HART Protocol standards that establishes the first open and interoperable wireless communication standard for process automation. WirelessHART™ focuses on the needs of the industry, providing a simple, reliable, and secure technology for wireless transmission of process and diagnostic data from intelligent field devices.

If you think you know HART, look again! New features have been added to the already feature rich set of diagnostics and process information—for both wired and wireless applications.

WirelessHART™ is simple, reliable, and secure.

**SIMPLE**
- Easy setup often using the existing tools, work practices and experience for fast installation
- Seamless integration to existing host, DCS or asset management applications
- Self-organizing adaptive network

**RELIABLE**
- Channel-hopping to avoid interference
- Time-synchronized communication
- Redundant, self-healing network

**SECURE**
- Robust, multi-tiered, always-on security
- Device authentication and passwords
- Industry-approved data encryption

Why wireless? Wireless provides a cost-effective alternate communication path for many legacy control systems, enabling access to the intelligent information in field devices.

This supplement will help you learn about HART and how to use both wired and WirelessHART™ to your best advantage. You will learn what WirelessHART™ is, where it can be used, how it expands the benefits of HART technology, and what you need to know to start installing and integrating HART data with a host, DCS or asset management application.

WirelessHART™ provides the same safe, easy, dependable experience that users know and expect from HART-enabled products. So remember—wired or wireless, HART has you covered!

To tell us how you use HART, write us at info@hartcomm.org.

For more on HART® and WirelessHART™, go to: [www.hartcomm.org](http://www.hartcomm.org) or [www.controlglobal.com](http://www.controlglobal.com).

**HART® and WirelessHART™ are trademarks of the HART Communication Foundation.**
“HART is the de facto standard in this industry and will remain so for a significant time. It is standard in all our devices,” says Hans Georg Kumpfmüller, Siemens AG, Germany. Not only a de facto standard, HART technology also is established in IEC global standards. In IEC61804, HART EDDL technology is established in cooperation with Fieldbus Foundation and Profibus Nutzerorganization (PNO). In IEC 61158, the HART Application Layer and Services are part of the standard. IEC 61784-1 establishes the HART Communication Profile.

“I see HART 7 as the reliable, low-cost solution for users to use more of the power in their installed HART-enabled devices,” says Thomas Holmes, CEO of MACTek Corporation, a manufacturer of HART modems. “The additional features included in HART 7 step up the game, opening opportunities for improved asset management, lower operating cost, and less downtime.”
HART technology is one of the most widely used fieldbus communication standards in the world. Seventy percent of the process measurement and control devices shipped worldwide each year use HART communication, adding to the over 41% of installed devices that already use HART communication—for a total of over 26 million devices shipped and installed worldwide.

As devices have changed, applications have changed, and requirements have changed, HART has also changed to keep pace. All the things you knew and loved about HART Communication before are still true, but with the new capabilities of HART 7, there’s a whole lot more. HART Communication is not your daddy’s protocol!

“The HART protocol was originally a hybrid analog-digital technology,” says Peter Zornio, Chief Strategic Officer, Emerson Process Management. “By contrast, WirelessHART™ (part of HART 7) is an all-new, all-digital mesh networking technology. What’s been retained in WirelessHART™ and enhanced in HART 7 for both wired and wireless are the tools, technologies, and practices used to configure devices from multiple vendors in a standard manner and integrate their data into host systems.”

### WHAT’S IN HART 7

The current generation of the HART Communication Protocol is HART 7. The HART 7 feature that has already received the most interest publicly since its release in September 2007, is WirelessHART™, an evolutionary extension to the HART Protocol. According to Sean Ireland, wireless product manager for Siemens Energy and Automation, “This would be rated extremely high in importance, both to us and our customers. Wired and wireless products must work together in a common network.”

But HART 7 is significantly more than WirelessHART™. There are significant differences and improvements between HART 5 and HART 6, the most commonly installed and used versions of HART, and HART 7—and not just wireless, either.

“There will be increased diagnostic capability built into the instrument,” says ABB’s Gareth Johnston, “and the ability to report by exception, based on time or event.” But in keeping with the HART Communication Foundation’s long-standing commitment to the users of the HART protocol, HART 7 is fully backward-compatible with all the HART versions that came before it.

The fact that WirelessHART™ is simply part of the HART 7 standard shows off an important

### Diagnosing problems on any HART device works the same as diagnosing problems on any other HART device, regardless of vendor.

<table>
<thead>
<tr>
<th>Feature Summary</th>
<th>Revision</th>
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<tr>
<td><strong>Feature</strong></td>
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<tr>
<td>PV with Status</td>
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<tr>
<td>Device Status</td>
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<td>Broadcast Messaging</td>
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<tr>
<td>Device Configuration</td>
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<td>Multi-Variable Reads</td>
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<tr>
<td>PV with Status</td>
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<tr>
<td>32 Character Tag</td>
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<tr>
<td>All Variables with Status</td>
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<tr>
<td>Digital Loop Check</td>
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<td>Enhanced Multi-Variable Support</td>
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<td>Manual ID of Device by Host</td>
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<td>Visual ID of Device</td>
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<td>Synchronized Sampling</td>
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<tr>
<td>Time or Condition based Alerts</td>
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<td>PV Trends</td>
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<td>Wireless Co-Existence</td>
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<td>Wireless Diagnostics</td>
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characteristic. Wired HART and WirelessHART™ are intended to be used together seamlessly, as integral parts of a digital field sensor and control network. They operate the same way, program the same way, and are useable interchangeably, wired and wireless.

ABB’s Johnston says, “WirelessHART™ is the logical migration of the current HART technology to a wireless environment.” He continues, “Customers now have the capability to maintain their current legacy 4-20 mA loops and unlock the power of HART instrument data via HART wireless.”

What do the HART users get? Johnston continues, “This will enable customers to obtain real-time asset monitoring data. This data will permit them to better manage the health of their instruments, thus insuring a reliable measure of their process.”

HART IS A GLOBAL STANDARD AND WORKS ANYWHERE

The HART protocol is enshrined in several IEC global standards, and the WirelessHART™ portion of HART 7 has been submitted for ballot as an additional IEC standard. HART has become both an IEC and de facto global standard because it is easy to use, simple to understand, flexible, and adaptable, and it can be used anywhere in the world. WirelessHART™, because it uses the 2.4 GHz band, can also be used almost everywhere in the world without licensing challenges.

NEW FEATURES IN HART 7 FOR WIRED DEVICES

In Table 1, you can see what’s been added to HART 7: new capabilities for increased intelligence and communication throughput efficiency, with new features such as enhanced data publishing for process variables, configuration change and device diagnostic status alerts, with support for “Publish by Exception” and “Automatic Event Notification.” Another exceptionally valuable new feature: “Time-Stamped Data,” applies to device process variables, diagnostics status, and configuration change events. This new feature supports broader use of multivariable device applications.
capabilities in control systems and permits users to employ better forensics in the event of problems. Measurements or actions can be triggered at a specific time, and HART 7 allows synchronized operation across multiple devices.

In HART 7, Process Variable Trends can now be sent as 12 sequential time-stamped data points of the same process variable in a single packet, effectively multiplying communication throughput for the selected process variable. “This makes it easy to setup a plant-wide asset management system,” says Endress + Hauser vice president Victor Wolowec.

Faster configuration uploads are now possible in HART 7 with multiple read commands in one transaction.

Plus, HART 7 adds a number of additional standardized device diagnostic and status parameters such as “device memory,” “power,” and maintenance and environmental variables.

**WIRELESSHART™ FUNDAMENTALS**

WirelessHART™ is an evolutionary extension to the wired HART Communication protocol that enables wireless communication with field devices. It is built on established standards and proven technologies, while preserving fundamental HART principles of low-cost digital connectivity, interoperability, and backward compatibility. This preserves the investments of both users and suppliers in wired HART technology, while providing a path forward to the wireless future. There are four WirelessHART™ specifications built on the 13 core HART specifications.

“WirelessHART™ is an important milestone,” says Yokogawa’s Kaoru Sonoda, communications and diagnosis for field instrumentation group manager.

WirelessHART™ is real, scalable, useable in all the ways HART wired devices are, capable of talking to any control system or asset management system over any backbone or protocol, and at least 17 companies are in the process of producing WirelessHART™ devices for sale. And every single one of them interoperates with each other, and...
with all the wired HART devices that have ever been made by any vendor.

**USING THE NEW FEATURES OF HART 7 FOR WIRED HART DEVICES**

The first versions of HART were designed to bring smart field devices into the world of control and automation, and they succeeded wildly. Even today, many HART devices are operated in strictly analog mode, and the HART smarts are used strictly for setup and calibration.

Yet the push toward added value from intelligent field devices has also led to the use of HART devices in many control systems for enhanced system integration—taking the digital signal through HART multiplexers directly into the control system, for additional process variables, online diagnostics, and better alarm management.

Now, with HART 7, the HART protocol integrates wired and wireless devices into a common control network and adds additional functionality to improve alarm management and maintenance diagnosis.

“The unsolicited messaging capability is probably one of the most immediate benefits,” says Scott Saunders, vice president of sales and marketing for Moore Industries-International. “All plants are doing more with less personnel. Having HART slave devices that are able to perform predictive maintenance on their own is a real plus.”

**ABOUT INTEROPERABILITY, INTERCHANGEABILITY AND COEXISTENCE**

A major reason for the success of the HART protocol is backward-compatibility and Electrical Interchangeability. HCF’s definition of these terms is rigorous:

- Freedom to use any manufacturer of HART devices and mix manufacturers and products in the same network
- Controllers use the same commands with all devices, and there are standardized diagnostics in every device
- Same toolset works with all manufacturers, and one EDD works on all EDD-enabled hosts
- Freedom to use any revision of the HART protocol or of the device without mandatory upgrades to tools or applications

“There is no necessity for existing HART 5 users to move to HART 7 because they are satisfied with existing features,” Yokogawa’s Sonoda points out. “However some users intend to move to HART 7 from HART 5 so they can use the new functions of HART 7.”

**PROTOCOL VERSATILITY**

The watchword of the modern HART 7 standard is protocol versatility—a key to interoperability.

You can use “traditional” HART, which is a 4-20 mADC current loop, with a digitally encoded signal: a 1200 bps Frequency Shift Keyed (FSK) sine wave modulated on the current signal that enables bidirectional communications of configuration, process variables, and diagnostics information to and from the intelligent device. Or you can use the High-Speed HART PSK specification. This specification provides for a digitally encoded signal on a 4-20 mADC current loop, but this time, it is Phase Shift Keyed at 9600 bps; eight times faster than “traditional” HART FSK signalling. And, of course, PSK HART is completely backward-compatible with FSK HART.

In addition, HART Communication can be run over RS485 (Modbus), Profibus and Profinet, Ethernet, OPC, and WirelessHART™.

**DEFINED COMMAND SET**

Interoperability also requires a defined command set that every device must do. Every HART device must accommodate the Universal Command set, and be able to perform Identity Verification (Unique ID, Tag, Descriptor, etc.), as well as read device dynamic variables, loop-current values, diagnostics, and other variables in the device.

Every device should also use the Common Practice Commands, such as device management commands for ranging, loop-current setup, sensor trim, and other standard capabilities. Most HART devices support the Common Practice Commands.

In addition, every WirelessHART™ device must support the defined set of Wireless Commands required for setup, operation, performance monitoring, and diagnosis of the WirelessHART™ network. The Wireless Command...
Easy to install explosion-proof seals save time and money
Our new explosion-proof feed-through provides a safe and efficient way to implement explosion-proof protection in hazardous areas for all industries. The feed-through installs directly in standard conduit entries in your explosion-proof enclosures — without requiring a poured seal, conduit or expensive wiring. An incorporated minifast® quick-disconnect eliminates field terminations and is compatible with TURCK’s FM-approved cordsets.

FM-approved for Class I, Div. 2 applications
The feed-through is fully potted with a force-resistant compound tested to 9,000 psi; exceeding FM requirements by 50 percent. The high-quality, 316 stainless steel housing and keyed connector eliminates incorrect wiring and accommodates standard power in hazardous locations.
set specifically defines all requirements for joining, security, message routing, diagnostic reports, bandwidth allocation, and other necessary capabilities to ensure interoperability, proper performance, and network coexistence. Key required diagnostics include remaining battery life (in days), average communication latency, and packet loss counter (normally “0”).

**UNIVERSAL DIAGNOSTICS**

All HART devices have an interoperable universal set of diagnostics. These universal diagnostic alerts are designed for continuous monitoring by HART-enabled control and intelligent I/O systems, for immediate detection of loop-integrity and/or device problems.

- Device malfunction (check device immediately)
- Configuration change (somebody reconfigured the device, go see if it was done right)
- Cold start or reset (there may be power supply problems, check it out)
- More status available (here is where HART’s native EDDL capability permits a DD enabled host application to retrieve additional device specific diagnostics)
- Loop current fixed (the loop current should not be used for control—this may or may not be an error, go see)
- Loop current saturate (the loop current range has been exceeded, use the digital value for measurement, go see why the device is overranged)
- Non PV out of limits (this varies by device type. For example, a multivariable transmitter with a temperature measurement may have exceeded operating range—go verify the device is working properly)
- PV out of limits (go find out why the device is over-ranging or under-ranging)

Every HART device conforms to this universal diagnostics set, meaning that diagnosing problems on any HART device from any manufacturer works the same way.

**INTEROPERABILITY = INTEGRATION CHOICE**

The most important feature of HART 7 is the integration versatility of the technology. Wired or wireless, HART offers unparalleled ease in integration with systems. Using EDDL, OPC, and XML, HART 7 communicates with any advanced control, simulation, asset management or enterprise integration system.

All major control system suppliers offer HART-enabled I/O as standard equipment. Almost all major field device manufacturers offer HART-enabled devices.

A significant number of third-party products support integration with legacy control systems using a variety of devices such as Multiplexers (HART to RS-485) and Gateways (HART to Ethernet, HART to Modbus, HART to Profibus, etc.) and Single-Loop Monitors (devices that convert digital values and alerts to analog signals and contact closures that older DCS and SCADA systems can use) ... and of course, there’s wireless.

**HART 7 COMMUNICATIONS: INTERFACING WITH THE REST OF THE WORLD**

Wired or wireless, HART 7 easily interfaces with the rest of the world. “One of the many strengths of a HART device,” says MACtek’s Holmes, “is that the 26-plus million installed devices work on any analog or digital control system or PLC.”

“Clear end-user advantages also result,” says Emerson’s vice president of wireless, Bob Karshnia, “since HART 7 didn’t change what didn’t need to be changed. Users with working HART systems can continue to use HART 5 host system products and add supplemental HART 7 functionality to the host when ready, and then continue to add HART 5 or HART 7 products going forward.”
NO MORE WIRES!

NEW!

VIATOR®
BLUETOOTH INTERFACE

CONNECT YOUR PC TO ANY HART® DEVICE UP TO 100 METERS AWAY!

GO WIRELESS WITH THE NEW BLUETOOTH MODEM FROM MACTek!

VIATOR PC MODEMS – THE INDUSTRY STANDARD

MACTek®
Measurement and Control Technologies

PC With HART Communication Software & Bluetooth

✓ Intrinsically safe for use in hazardous areas
✓ Wireless range up to 100 meters
✓ Use for wireless configuration, troubleshooting & data acquisition
✓ Supports all HART devices
✓ Easy to use
✓ Rugged & reliable industrial design
✓ RoHS compliant

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**Nutz and Boltz of WirelessHART™**

*WirelessHART™* is real, dependable, scalable, and you can use it now

**HOW WIRELESSHART™ WORKS**

There are many wireless protocols, but there is only one wireless protocol deliberately built as an extension of an existing wired sensor network protocol and to work with the applications, tools, and people you already have: *WirelessHART™*.

In short, *Wireless + HART = WirelessHART™*. “*WirelessHART™* was designed by the industry experts who created the HART Communication technology,” says Ed Ladd, director of technology programs for the HART Communication Foundation, “and drawing on the experience of more than 26 million installed HART-enabled field devices, *WirelessHART™* is designed to address the critical demands of industrial plant environments and to complement, work alongside, and extend the capabilities of wired HART.”

“*WirelessHART™*,” says Emerson’s chief strategic officer, Peter Zornio, “removes the limits and unleashes the HART technology in a way that wasn’t possible when channeled through conduit.”

*WirelessHART™* is also unique in that it provides for an adapter that is not just a wire replacement or a protocol converter, but an intelligent HART-enabled device and powerful system integration tool. This adapter now makes it easier than ever to leverage the intelligence in existing HART devices already installed in your plant. The *WirelessHART™* adapter can be attached to any existing wired HART device, enabling wireless access to the “stranded data” inside the intelligent HART device. Consequently, the *WirelessHART™* adapter provides a cost-efficient connection for integrating the intelligent capabilities of HART devices into control and asset management systems.

“The wireless adapter makes this transition very easy,” says Thomas Holmes, CEO of MACTek Corporation. “By using the installed device, say a HART 5 device from any supplier, the user can add a wireless adapter allowing HART data from the device to be communicated to the gateway.” Any manufacturer’s gateway will work.
**WirelessHART™**, like every other portion of the HART 7 specification, is completely backward-compatible with all previous versions of the HART specification, and wireless adapters can be installed on any existing HART device, regardless of protocol version.

**THE MESH**
The main secret to the success of WirelessHART™ installations is the mesh. Using the global standard IEEE 802.15.4 2.4 GHz radio and channel-hopping technology, WirelessHART™ installations are flexible, secure, reliable, and simple.

All field devices have the same wireless capabilities, and as the number of devices in the mesh grows, the more secure and reliable it becomes. The more devices in the mesh, the greater the number of pathways exist from any single device to an access point, from an access point to any single device, or from a device to another device.

At the same time, the user experience mimics using wired HART, with the same tools and practices users have become familiar with. The same command structure is also used in WirelessHART™, and WirelessHART™ is compatible with HART-enabled control systems and EDDL.

“End users get a state-of-the-art standard wireless infrastructure,” says Emerson’s Zornio, “supported by a full set of vendors they know and trust, so they can invest with confidence. At the same time,” Zornio goes on, “WirelessHART™ builds on the experience, knowledge, work practices, and investments end users have made in HART over the last 15+ years.”

**EVERY DEVICE IS A ROUTER**
The WirelessHART™ network consists of field devices, adapters, access points, and gateways. Somewhere on the network, either built into a gateway or separately, are the Network Manager and the Security Manager. No devices are network end points, or reduced function devices to be orphaned by changing signal conditions.

Every WirelessHART™ field device and adapter is also a router. Since every device is a router, the result “path diversity.” Path diversity means that messages route around obstacles and interference sources regardless of the physical location of the device in the network.

The Network Manager maintains and updates routes. It establishes links between neighboring devices, and it allocates bandwidth. There is a single Network Manager (can be redundant) in a WirelessHART™ network that can manage multiple gateways and access points. The number of access points needed is determined by the number of devices and average update period, using a simple formula (see “HART 7: Installing and Making Systems Work” in this issue). Geographic location may also be a factor. The more devices you add, the more access points. Multiple access points per gateway mean redundancy and faster throughput, and even better “path diversity.”

All communication paths in the mesh network are continuously exercised (primary and redundant). All WirelessHART™ devices are routing-capable to maximize the number of possible redundant pathways, increase the reliability, and simplify network design.

WirelessHART™ technology’s priority-based routing enhances reliability. Its first priority is to keep the network operational. Second is to deliver the process monitoring and control data. Third, enable management and troubleshooting of the devices. Fourth, deliver the alarms. All alarms are time-stamped and latched. That way alarms are never lost, and the alarm log details in what order the problems occurred.

User deployment and operation is simple. WirelessHART™ devices are configured using the same tools as wired HART devices. Only the Join Key and Network ID need to be loaded into the device for it to join the network. These items can be loaded by the user or preloaded at the factory, and the device does the rest. The device joins the network and, working with the Network Manager, it embeds itself in the mesh. The Network Manager then continuously grooms the mesh to ensure reliable, low-latency communications as plant conditions change and evolve.

Because every WirelessHART™ device is also a router, any device can direct and re-transmit data
Finally, the promise of wireless is delivered. Built on the open, interoperable WirelessHART™ and the insight you need to reach your plant’s full potential. Shattering the physical, economic and your people the freedom to perform. From self-organizing field networks to wireless asset and more.

Discover your plant’s limitless potential at EmersonSmartWireless.com
industrial Wi-Fi standards, Emerson Smart Wireless unlocks technical barriers to the information you need, and giving people tracking, it’s everything wireless has always promised.
from any other device. Users do not have to maintain, stock, and learn how to operate two kinds of field devices.

EVERY DEVICE REPORTS BATTERY LIFE IN DAYS AND AS A PV

Some of the most important process variables are those that today are not measured because the cost of wiring them into the control system is simply unmanageable. These include remote level measurements and asset-management information. In such applications, low-power sensors, many operating on batteries, are critical to making these measurements economically viable. Battery-operated WirelessHART™ devices make these measurements practical.

In keeping with the spirit and tradition of HART to “keep it simple,” the HART 7 standard requires that battery life be reported as a PV (process variable) and reported in “days remaining.” This key performance indicator enables operators and maintenance personnel to see simply and clearly when a battery in a given WirelessHART™ device must be changed.

INTEROPERABILITY AND INTERCHANGEABILITY

WirelessHART™, like all the rest of the HART 7 specification, is built on backward-compatibility and Electrical Interchangeability. HCF’s definition is rigorous: the freedom to use any manufacturer of HART devices, wired or wireless, and to mix manufacturers and products in the same wireless network.

With WirelessHART™, users may mix any number of manufacturers’ devices with any vendor’s Registered HART wireless adapter and any other vendor’s Registered HART wireless access point or gateway. The same HART Universal Commands are required in all WirelessHART™ devices, just as they are in HART wired devices. The same Universal diagnostics exist in every HART device, wired or wireless, and may be used in exactly the same way. The same tools work with all HART devices regardless of manufacturer, and the EDD for that HART device (wired or wireless) works on all EDD-compliant hosts.

And any of those devices may be replaced in kind by another HART-enabled device from any manufacturer with instantaneous interoperability.

This incredible flexibility is provided on top of the largest installed user base of devices in the world—more than 26 million HART-enabled devices as of mid-2008.

As Sean Ireland, wireless product manager for Siemens Energy and Automation notes, “WirelessHART™ gives us the opportunity to provide flexibility to the customer for installation, a lower cost for installation, the ability to enable new applications previously not accessible due to technology or cost limitations, and improved information availability, which should result in process improvements for our customers.”

PROPOSED GLOBAL STANDARD

WirelessHART™ was built on proven industry standards. The radio is based on the IEEE 802.15.4-2006 standard. WirelessHART™ is also built on the IEC HART Standard, IEC 61158, and on the IEC 61804-3 standard for EDDL. The wireless portion of HART 7 also has been submitted for ballot to become a global IEC standard.

The 2.4 GHz frequency band used in WirelessHART™ radios
Optimize your production, logistics and maintenance processes with automation solutions from Endress+Hauser. The perfect combination of high-quality instruments with our expertise in project management, fieldbus engineering, system integration, third-party supply, service and training enables you to increase productivity and lower costs. Our best-in-class solutions are always customized to your needs, so you're assured of having every piece of the puzzle in place. www.us.endress.com/automation
was selected because of its international availability. It is available, usually without licensing, in almost every country, and is reserved for industrial, scientific and medical uses, and other commercial communications needs. Many cordless telephones also operate in this band, as do other IEEE radio standards, such as 802.11 (a, b, g and n), the WiFi standard.

**WIRELESS HART™ BANDWIDTH USAGE**

Many wireless applications and protocols are in use already in the modern industrial plant: cellular and VoIP telephony, WiFi, WiMAX, Bluetooth, and other wireless sensor networks.

WirelessHART™ communication is designed to result in low bandwidth usage. The communication protocol is a channel-hopping TDMA protocol. This protocol has 100 10-ms “communication slots” per second over 15 channels, allowing multiple devices to communicate in the same slot, but at different frequencies. This avoids interference and reduces multi-path fading. WirelessHART™ also provides priority-based message routing so the network stays up, and alarms and critical data packets get the appropriate priority. The Network Manager continuously assesses network health and retries and may “blacklist” any of the 15 channels to reduce latency and prevent interference from existing networks that might be in use.

“No upper bound on bandwidth consumption can be estimated, assuming a large number of devices being in a single geographic region, so that any device in the region can hear all other devices in the region,” says Wally Pratt, chief engineer.

### EXPLODING THE MYTHS ABOUT WIRELESS HART™

<table>
<thead>
<tr>
<th>Myths about WirelessHART™</th>
<th>True or False</th>
<th>The Real Story about WirelessHART™</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitoring only, slow response, not capable of control</td>
<td>FALSE</td>
<td>WirelessHART™ is designed for both monitoring and control with sub-second response time (100 ms or better)</td>
</tr>
<tr>
<td>Local, small sensor networks only, not capable of plant-wide operation</td>
<td>FALSE</td>
<td>WirelessHART™ is designed to focus on measurement and control data and is deliberately designed to easily interface with any plant backbone, wired or wireless with more than 10,000 device nodes</td>
</tr>
<tr>
<td>Only a stopgap for early adopters</td>
<td>FALSE</td>
<td>WirelessHART™ is the only sensor network designed to complement the existing HART user base, with more than 26 million installed devices</td>
</tr>
<tr>
<td>Only passes HART commands, not very intelligent</td>
<td>FALSE</td>
<td>Wireless HART™ is designed to produce low-latency communications optimized for measurement and control applications using HART commands—universal across all manufacturers</td>
</tr>
<tr>
<td>Can’t interface with other sensor or plant level networks</td>
<td>FALSE</td>
<td>Profinet, Profinet, and Foundation Fieldbus will have defined WirelessHART™ interfaces. HART data already runs over wired networks including Ethernet, Modbus, Profinet, and Foundation Fieldbus.</td>
</tr>
<tr>
<td>Can interfere with existing plant wireless networks like WiFi and VoIP</td>
<td>FALSE</td>
<td>WirelessHART™ is designed with TDMA/CSMA mesh operation with channel-hopping communications to minimize interference with any existing wireless network</td>
</tr>
<tr>
<td>Eats up too much plant wireless bandwidth</td>
<td>FALSE</td>
<td>Even the largest conceivable WirelessHART™ sensor network (over 10,000 sensors and access points) would use up less than 10% of the available 2.4 GHz bandwidth in any industrial plant</td>
</tr>
<tr>
<td>Not cyber-secure</td>
<td>FALSE</td>
<td>WirelessHART™ uses 128-bit AES encryption with provisioning through a secure wired connection using HART handheld or communicator software, not over the air. Authentication and encryption are always on, providing end-to-end security throughout</td>
</tr>
<tr>
<td>No backbone specification</td>
<td>FALSE</td>
<td>WirelessHART™ uses any plant backbone infrastructure and incorporates plant IT standards within the backbone network. The Security Manager is flexible, uses existing or dedicated security, and is integrated into users’ plant and IT security systems—does NOT require HART-specific infrastructure</td>
</tr>
<tr>
<td>You can’t buy WirelessHART™ products yet, so you might as well wait for something better</td>
<td>FALSE</td>
<td>At least 17 vendors will have full product lines of WirelessHART™ devices available by the end of Q1 2009, including multiple vendors of WirelessHART™ adapters, and many will have devices for shipment before the end of 2008</td>
</tr>
</tbody>
</table>
**MFC 4150 HART® Communicator**

**MFC 4150 Advantages**
- Quick start up and connect: 15 seconds!
- 60 hours battery life (w/o backlight)
- Update new device profiles and firmware from Meriam via the web.
- Clone / Upload / Download configurations.
- Off-line mode for editing / reviewing configurations.
- Document and store 200 configurations.
- As-found / As-left history with Meriam DMS software.
- 13-line, 128 x 128 graphic, backlit display.
- Dongle coordinates AC power adapter and serial communications.
- Full alpha-numeric keypad.
- Review / Edit on the fly.
- Quick Menu short cuts for commonly used commands.
- HART menu Home key.
- Dedicated text edit keys.
- Programmable lock-out settings.
- Contrast key for direct adjustment in any mode.
- Elastic hand strap, adjustable shoulder strap and soft carrying case.
- Left side thumb keys for one-handed navigation.

**Model Numbers**
- MFC 4150: CE, General Purpose
- MFC 4150X: CE, ATEX I.S., UL

WE’VE GOT
HART
ABILITY

**MFT 4010 Modular Calibrator with HART® Communicator**

**MFT 4010 Advantages**
- All-In-One Tool – Takes the place of multiple handheld instruments.
- Automation for HART Field Devices – Calibration is automated through auto setup of the calibrator based on the device settings; digital trims automate the device adjustment steps.
- Document As-found and As-left Calibration Results.
- Field Updates – Available via the web.
- Variety of positive-lock measurement modules available.
- Field Recertification – Sensor modules and integral V/I can be recalibrated for zero, span, & linearity.
- User Interface – 2.1” x 2.1” display, four soft keys (definitions change with mode requirements) and eight hard keys provide user interface. Display is configurable for 1 to 4 simultaneous measurements.
- Security Lockout – Lockout specific MFT settings or all at one time.
- Field Recertification – Sensor modules and integral V/I can be recalibrated for zero, span, & linearity.
- Diagnostics – self-tests upon power up and upon installation of sensor modules. Advisories are posted on the display.
- Dedicated DOF Memory – Memory for 500 HART device drivers.

**Model Numbers**
- MFT 4010-11-1-00: HART, CE
- MFT 4010-11-1-01: HART, CE, IS

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of the HART Communication Foundation. “The HART standard provides estimates on communication range that would define the boundary size (diameter) of the spherical region containing that large number of devices or access points in the network. The number of devices in the region does not limit the number of devices or access points in the network. The network can have many devices with multiple hops and cover an area much larger than the ‘region’ we are considering here.”

For example, if one were to have 10,000 WirelessHART™ devices located in a spherical region, meeting the above criteria with an average update period of 60 seconds, communicating through 15 access points, the bandwidth consumed would be approximately 4.3% The diameter of the spherical ‘region’ would depend on whether the installation is indoors or out and the configured transmit power setting for the devices. Consequently, the region can vary from 200 meters in diameter to less than 20 meters in diameter.

Extrapolating to a more general basis for industrial plant applications, the bandwidth consumption by a large WirelessHART™ network will be no more than 10% of the available bandwidth in the 2.4 GHz band in any industrial plant.

A WirelessHART™ network with any conceivable number of devices cannot consume all of the 2.4 GHz bandwidth in any installation. (For a bandwidth usage calculator for WirelessHART™ networks, see “HART 7: Installing and Making Systems Work” in this issue.)

COEXISTENCE WITH OTHER NETWORKS
“Coexistence is the ability of one system to perform a task in a given shared environment in which other systems perform their tasks and may or may not be using the same set of rules.” This is the IEEE’s definition of “coexistence” and serves to illustrate the difficulties faced by the HART 7 design team when they faced the creation of a wireless version of HART.

There are a very large number of wireless networks and devices that WirelessHART™ must coexist with, including cordless telephones, microwave ovens, WiFi, WiMAX and other wireless sensor networks, such as Zigbee and Bluetooth.

WirelessHART™ is designed using standardized IEEE radios, clear-channel assessment, blacklisting, channel-hopping, mesh-to-the-edge networks, and redundant path routing, to coexist with any other network in the 2.4 GHz band, and not only to not interfere with other networks, but also to not allow other networks to interfere with WirelessHART™.

INTERFACING WITH CONTROL SYSTEMS
A WirelessHART™ gateway is a remote I/O system for connecting WirelessHART™ devices to plant control and/or asset management systems (new or existing). Since WirelessHART™ is backward compatible with wired HART, the WirelessHART™ gateway allows integration to plant systems in the same way I/O systems do for traditional wired HART devices. Like existing remote I/O, gateways will offer a variety of host-side interfaces to standard industrial communication networks like Modbus, Profibus, Profinet, Foundation Fieldbus, OPC XML, RS-485, Ethernet, and others.

Every major asset management software vendor produces HART-enabled products that will interface directly with the digital data provided by the WirelessHART™ gateway. So all users have to do is connect either a native WirelessHART™ product or a WirelessHART™ adapter to an existing HART-enabled device, achieve communications at the gateway, and connect the gateway to their existing HART-enabled software, whether it is a control, asset-management, or CMMS system. This releases the “stranded” HART diagnostic information and makes it possible to implement state-of-the-art predictive maintenance where it was not cost-effective before.

WIRELESSHART™ SECURITY
Industrial control systems have traditionally been built with little regard for security. Denial-of-service attacks, spoofing of identities, authentication issues, industrial espionage, and terrorist attacks, along with invasion by organized crime and damage caused by disgruntled employees are among the threats faced by all control systems.

HART 7 permits a single system of secure communications. Critical measurements should be wired using HART-enabled instruments. Less critical measurements and control parameters can be wireless. But all HART 7 communications are secure.

WirelessHART™ is secure. The data is encrypted with 128-bit AES encryption, a strong cipher. Provisioning (hooking up a new device to the network) is accomplished by secure “join keys” which are entered into the device via a secure wired connection. All messages are encrypted and individual
Your job just got easier!

- SAMSON’s Series 3731 Explosion Proof Positioners will make you look at your valve in a whole new light. Not only does this positioner provide HART and FOUNDATION Fieldbus connectivity, it combines standard features with what is really needed in the field – ease of use. With a large local display, SAMSON’s single rotary pushbutton allows all internal positioner settings to be configured at the valve, in the hazardous area, without the need for any special tools or software. Available options include partial stroke testing, forced venting, analog position feedback and a software limit switch. By using SAMSON’s optional EXPERT valve diagnostics, which can be added at no additional cost, you will find that this exceptional positioner is the right product for any plant.

**SAMSON Series 3731: not just a positioner.**
session keys ensure that only valid devices can pass information in the network. End-to-end data encryption is employed to prevent sensitive data from being intercepted. Message Integrity Codes (MICs) are generated after the data is encrypted to sign the data end-to-end. Denial-of-service attacks are mitigated with channel-hopping and redundant paths provided by the mesh infrastructure. Password protection (secure keys), white lists, and black lists prevent unauthorized devices from joining the network and communicating on the network. The use of individual encryption codes and passwords on a point-to-point basis provides secure authentication for WirelessHART™.

**REGISTRATION PROGRAM FOR DEVICES**

Like all HART devices, all WirelessHART™ devices must undergo detailed testing before receiving the right to display the “HART Registered” mark.

Interoperability between different device suppliers is tested and guaranteed through this testing program. Using HART Communication Foundation standard testing tools, such as the Wi-analys device pictured on the left, suppliers test their device to confirm compliance and submit a Device and Test Report to the Foundation.

The HCF audits the Test Report and conducts an independent test to verify compliance to the standard. This is the only way for a supplier to obtain a “HART Registered Certificate” and only HCF-registered devices can claim to be WirelessHART™-compliant.

**WIRELESSHART™ SECURITY DIAGNOSTICS**

WirelessHART™ devices have all the same universal set of diagnostics as wired HART devices, plus additional standardized diagnostics specific to the wireless connection. Among the diagnostics available to all WirelessHART™ devices are

- Device malfunction—Simply stated, the number one alarm to monitor (check device immediately)
- Configuration change—System verification of configuration changes (confirm device reconfiguration was correct)
- Cold start or reset—Power supply problems (monitor for continued problems and repair as needed)
- More status available—More information exists to troubleshoot device (a DD-enabled host application can retrieve additional device specific diagnostics)

- Loop Current fixed—The analog output should not be used for control (may or may not be an error)
- Loop Current saturated—The analog range has been exceeded (the digital value should be used for the measurement)
- Non PV out of limits—Varies by device type: for example, a multivariable device with a temperature measurement may have exceeded operating range (verify device accuracy)
- PV out of limits—Device measurement range has been exceeded (verify device accuracy)
- Maintenance Required
- Device Variable Alert
- Low Battery
- Critical Power Failure

All devices build and maintain a list of neighbors. All devices report their neighbor list and network health. Some of the network health parameters include “average latency measurement” per device, “path down” alarms, “number of lost packets” (should be zero), and “devices-per-access-point” loading.

The WirelessHART™ specifications were built on proven industry standards with support from nearly all major vendors of automation systems and devices. The HART Protocol continues to be enhanced to meet the changing needs of the process industry and to adapt to new instrumentation technology, such as wireless. The backward compatibility of HART Protocol revisions ensures that an investment made in a HART device or system is protected into the future.

The wide adoption of WirelessHART™ by automation product manufacturers ensures that WirelessHART™ devices have the same security as investments that HART devices have proven to have for over 18 years.
Smart and innovative solutions — Make R.STAHL’s combination of years of experience and superior competence in the development of explosion-protected systems do the work for your automation technology. R.STAHL confidently offers the complete spectrum in the following areas: > Remote I/O IS1 > Fieldbus technology ISbus > I.S. isolators ISpac > Operating and monitoring systems HMI. Automation with R.STAHL, much more than just components.

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HART 7: Making Systems Work

HART 7 and WirelessHART™ work just like the HART you’re used to

With HART 7, users can integrate existing wired HART devices, new wired HART devices, and new WirelessHART™ devices in a single system with the same tools, configuration, calibration, and operation that have served them well for over 18 years now.

NEW TIPS AND TRICKS FOR WIRED HART
Connecting HART 7 wired devices will be exactly the same as connecting any wired HART device to the control system—simple and no different from what users have always done.

How soon will HART 7 devices be available?
“As soon as the HART Communication Foundation certifies our test sample,” says Hoffer Flow Controls’ vice president, Bob Carrell. Many other suppliers are actively developing HART 7 products for availability in Q3-Q4 of 2008 and Q1 of 2009.

In HART 7, the tag length has been increased to 32 characters (originally in HART 6). All process variables report status. There is a digital loop check feature and enhanced multi-variable support. There is local interface lock capability and manual ID of a device by the host. Peer-to-peer messages and visual ID of the device are both supported. (See the chart on page S-7.) Specifically new for HART 7 are report-by-exception, synchronized sampling, time- or condition-based alerts, a time-stamp feature, the ability to report PV trends, and, most significantly, WirelessHART™. These features include wireless coexistence, a detailed wireless diagnostics suite, support for wireless mesh and star topologies, priority-based wireless message routing, and state-of-the-art wireless security.

ADDING WIRELESSHART™ DEVICES TO AN EXISTING WIRED HART SYSTEM
“Just like a ‘wired’ instrument network, some planning of a wireless network is required to ensure good connections,” says Joseph Citrano, wireless program manager for asset optimization at Emerson Process Management. “In Smart Wireless,” he notes, referring to Emerson’s WirelessHART™ implementation, “planning is as simple as following a basic set of best practices.”

WirelessHART™ systems from any manufacturer are commissioned in the same way. Citrano describes the process: “Devices are configured and commissioned with the same tools as are used with wired HART devices. The key difference between wired and wireless commissioning is that WirelessHART™ devices require the entry of a join key and network ID. These parameters are entered either with a HART 7-compliant HART communicator like the 375 Field Communicator or a HART 7-compliant asset management application like AMS Device Manager.”
DESIGNING WIRELESS HART™ NETWORKS

“Locate your wireless devices,” Ed Ladd, HART Communication Foundation’s (HCF) director of technology programs, says. “Install your access points and gateways, then add the device to the network and commission the device. It’s as easy as a traditional HART 4-20 mA installation, with the same tools and know-how.”

Just as with wired HART I/O, the wireless network starts with access points and the gateway at one end and the field devices at the other. The gateway is the remote I/O system connecting wireless devices and adapters to DCSs, PLCs and other plant automation systems. The gateway will have one or more access points that connect wireless devices to the gateway. Access points are the I/O modules of the gateway. The gateway can be redundant and support multiple access points. Redundant connection to the gateway is achieved by using more than one access point to connect groupings of wireless devices.

HART 7 gives you all the features of HART 5 and HART 6, along with many new features, including wireless connectivity.

Good engineering practice will generally assign a gateway to each plant area and/or unit operation, similarly to how automation system controllers and I/O systems are done today.

Access points can be geographically dispersed from the gateway electronics and in general should be located near the devices they will connect. Access point loading (number of devices that can be connected) is determined by the following simple formula:

\[
\text{NumDevices} = \text{Average update period (AUP)} \times 25
\]

Example 1 — 25 devices can be connected with an AUP or average reporting rate of 1 sec.

Example 2 — 250 devices can be connected with average reporting rate of 10 sec.

The same criteria apply to access points as to any traditional I/O: Do not crowd the I/O. When in doubt, use more access points. This increases the redundant pathways of the network and makes the network more robust at little additional cost.

To determine whether the WirelessHART™ network will coexist well with other 2.4 GHz networks in the same plant area, users may make use of the following formula:

\[
\text{Bandwidth Consumed} = \text{NumDevices} \times (0.0001\% + (0.02\% / \text{Average update interval}))
\]

where the 0.0001% is used for overhead (network health reports and the like, and the 0.02% is for data publishing and other network traffic.

Example 1—100 devices @ 1 sec avg. update interval: Bandwidth consumed = 2.01%

Example 2—1,500 devices at 60 sec avg. update interval: Bandwidth consumed = 0.65%

These are very conservative estimates that do not account for geography. For example, if the number of devices increases, the geographic area they occupy is sure to enlarge. As this happens, the amount of bandwidth consumed is quickly reduced (distance rapidly dilutes the RF energy).

A huge advantage of WirelessHART™ is the WirelessHART™ adapter. The adapter can be located anywhere along the current loop from the device to the I/O module. This allows any existing HART device to be adapted to wireless, but it also frees the designer from having to locate the device in a better reception area instead of where the device physically should belong. For instance, say a pressure transducer must be located at the centerline of a large steel vessel that is mounted only a foot above the floor. Instead of having to mount the transducer remotely, making for very long impulse lines, or remotely mounting the wireless antenna of a WirelessHART™ device, it is possible to use a wired HART device with a WirelessHART™ adapter for a simpler and less costly application.

DESIGN TOOLS FOR WIRELESS HART™ NETWORKS

Every vendor of WirelessHART™ devices is working on tools and guidelines for end users to help them design and install WirelessHART™ networks. “Currently,” says Endress + Hauser’s vice president, Victor Wolowec, “we are working on a detailed guideline for coexistence with other wireless networks. In addition we plan to have guidelines for site surveys, installation, and the operation phase.”

Samson AG’s product manager Guido Koenig agrees. “Samson has always provided technical information and engineering guides for digital communication. We will do that as well for HART 7.”
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Introducing the Hoffer HRT1 Indicator.
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TECHNOLOGY. TEAMWORK.
Many vendors are preparing design tool sets that make use of the capabilities of HART 7. Immediately upcoming for Emerson’s AMS is a new application to help users plan their WirelessHART™ networks. “This is a screen from the AMS Wireless Application planning functionality,” Citrano reports. (See center figures.)

“The planning mode allows users to customize their planning parameters to meet their specific needs,” he says. “In the lower screen image, the red circle around the pressure transmitter indicates that it does not meet the planning parameters chosen for this wireless network.”

According to Citrano, the application can also be used with networks that are already in operation.

“The upper screen shows the communication paths within the self-organizing network,” Citrano says. “This view helps users visualize the health and robustness of their WirelessHART™ network.”

Every WirelessHART™ network is self-organizing, so devices virtually maintain themselves. Each device can act as a router for other nearby devices, passing messages along until they reach the gateway. If there is an obstruction, transmissions are simply rerouted until a path to the WirelessHART™ gateway is found. As conditions change or new obstacles are encountered, these wireless networks simply reorganize and find a way to get the communication through.

On occasion, when a facility is seeing periods of high infrastructure activity or if devices are taken out of service, pinch points (communication bottlenecks) may develop. “Self-organizing networks can run indefinitely with bottlenecks,” Citrano says, “but users who are concerned with having an optimal wireless network may want to identify and take action to eliminate these pinch points.”

WirelessHART™ with EDDL enables applications such as the one described above to help users optimize their wireless networks by graphically displaying the communication pathways between devices to the gateway and alerting users to existing pinch points.

**IT AND WIRELESSHART™ SECURITY**

Plant engineers, operators, and maintenance workers can assure their IT departments that WirelessHART™ is secure and will not increase the overall plant exposure to malicious or accidental cyber incidents. WirelessHART™ uses 128-bit AES encryption, secure join keys, and individual session keys to ensure that only valid devices can join and pass information in the network. A WirelessHART™ device can only join the network through a secure, wired connection. End-to-end encryption is employed to prevent sensitive data from being intercepted. The use of individual encryption codes and passwords on a point-to-point basis provides secure authentication for WirelessHART™.

Wired or wireless, HART 7 is not your Daddy’s HART standard.
Unleash the power of your HART® devices.

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