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WirelessHART Field Device Installation and Configuration

The self-configuring capabilities of WirelessHART networks simplify the installation and configuration of WirelessHART field devices.

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WirelessHART devices are based on the HART (Highway Addressable Remote Transducer) protocol, which has become the global standard for sending and receiving digital information using 4-20mA analog wiring between smart devices and handheld devices or host systems. Typical WirelessHART devices include temperature, pressure, flow, level and other process variable transmitters (Figure 1).

IEC62591 WirelessHART devices are based upon established HART technology. These devices use the WirelessHART bi-directional communication protocol to provide data access between intelligent wireless field instruments and handheld devices or host systems. Host systems can include control, monitoring, asset management or maintenance management systems.

Before putting a WirelessHART device into service, Device Parameter verification must be performed. Just as with a wired device, the parameter list depends on the device type. From a device and sensor perspective, most of the parameters will be identical if not completely the same as for the equivalent wired device. For expediency, Device Parameter verification can be done prior to putting the device into service, either

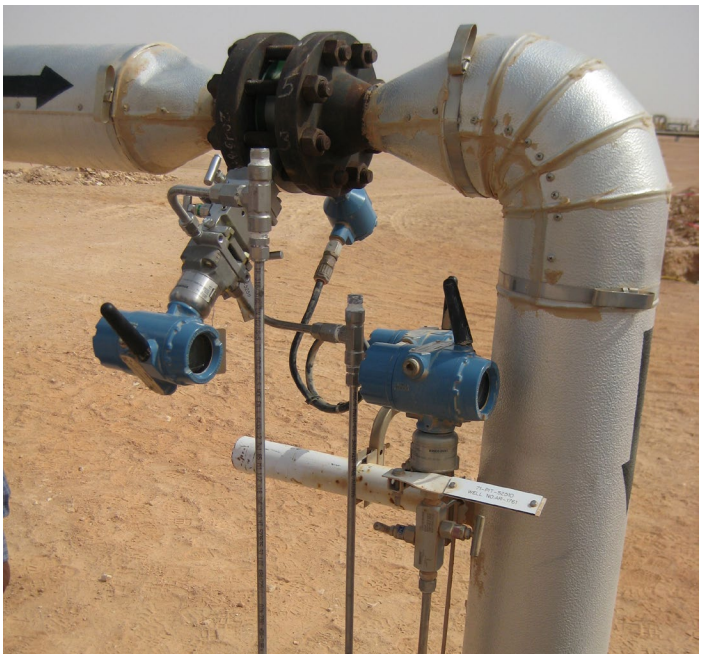

Figure 1, wireless transmitters installed in field. This wireless installation measures steam flow injection rates in this oil and gas field by utilizing differential pressure, gauge pressure and temperature measurements. In the foreground are Rosemount 3051S differential pressure and 3051S gauge pressure transmitters. Visible in the background is the temperature connection head for the obscured Rosemount 648 wireless temperature transmitter.

by the device supplier or by the end user in their instrument shop.

In the instrument shop, a HART Field Communicator can be used to configure both wired and wireless HART field devices. The Field Communicator will require the proper device descriptor for configuration.

Host system configuration depends on the requirements of the host system. Some host system suppliers extend the remote management capabilities offered for wired HART devices to WirelessHART devices, and thus require minimal configuration. Other host systems may not have built-in support for the HART protocol, and may thus require additional configuration.

Frequency Planning and Configuration

WirelessHART mesh networks are self-configuring and self-healing, so setup and operation is greatly simplified as compared to networks requiring users to designate communication paths and other parameters. Each device in a WirelessHART network can act as a repeater, creating multiple possible paths of communication among the field devices and the WirelessHART Gateway (Figure 2). The network automatically and dynamically selects the best communication paths to the gateway.

At least one gateway is required for each installation, with some installations requiring more. Reference 1, the Gateway Capacity Estimator, gives information to assist users in calculating the number of required gateways.

There is no frequency planning required for WirelessHART networks. By design, the protocol utilizes every channel in the 2.4 GHz range by channel hopping during the course of normal communications.

A separate white paper is available from Emerson which covers coexistence testing between WirelessHART and Wi-Fi devices (Reference 2). Users may wish to create site governance policies to manage and track deployment and coexistence of Wi-Fi and WirelessHART networks.

No routing configuration of the WirelessHART mesh network is required. The gateway will automatically establish the logical and best paths, thus no user intervention is required. The gateway communicates with the wireless devices via the WirelessHART protocol. The gateway is hard-wired to the host system(s), typically via a Modbus or an Ethernet link (Figure 3).

Figure 2, gateway installed in field. This WirelessHART Gateway communicates with multiple WirelessHART field devices via a wireless mesh network, and with host systems via a hard-wired connection.

Figure 3, Host System in Control Room. Each WirelessHART Gateway is connected to one or more host systems, which are typically installed in the control room.

Configuring a Device to Join the Network

Ideally, wireless devices should be powered up in order of proximity from the gateway, beginning with the closest. This will result in a simpler and faster network installation. Users should enable Active Advertising on the gateway to ensure new devices join the network faster.

Unlike wired devices, each wireless device can be pre-commissioned to join a network as soon as its process connections are complete. The process to do this is very simple and requires only a few basic configuration parameters. A HART communicator with the device's WirelessHART device descriptor (DD) is required, and this is readily available from the device or the handheld communicator supplier.

Joining a Device to a Network

To communicate with the gateway, and ultimately the host system, the WirelessHART device must be configured to communicate over the wireless network. This step is the wireless equivalent of connecting wires from a field device to the host system. Two configuration parameters are required:

1. **Network ID** – Each gateway at a facility or location should be programmed with a unique Network ID. All authenticated WirelessHART field devices with the same Network ID will communicate on the same network and gateway.

2. **Join Key** – A 128-bit security key is used to authenticate wireless field devices when joining the network, including encryption of the join request. A common Join Key may be used among all devices on a given network, or each device may have a unique join key. The Join Key information is displayed in hexadecimal format via a web browser or a handheld communicator, resulting in a 32-character hexadecimal field.

Join Key Management

- The gateway Administrator can configure the Join Key to be a single key for all devices in the network, or unique per device. A Common Join Key is only visible to the Administrator on the gateway. Individual Join Keys are invisible to all users. Only the Administrator can change the Join Key(s).

- A Common or Individual Join Key can be changed in the gateway at any time. This change is securely propagated through the WirelessHART mesh network, and renders the old Join Key(s) obsolete. Using an Emerson 375 or 475 handheld communicator to configure device Join Keys allows for a large deployment of devices to be completed quickly, and for the Join Key(s) to be changed afterward. This protects the network from a malicious hacker or a careless insider.

For tighter security that is easier to use, device technicians can use the Emerson AMS Device Manager application and a HART modem to configure the WirelessHART devices before they are installed and joined to the WirelessHART network. When using the AMS Device Manager's graphical interface, the Join Key is assigned to the device without the user seeing the hexadecimal representation of the key.

Update Rates

The user-specified interval at which a wireless field device will detect a measurement and transmit the measurement to the gateway is the update or sample rate. The update rate has the largest impact on power module life, with frequent update rates depleting power module life quickly, and vice versa.

The update rate is independent of the radio transmissions required for mesh peer-to-peer communication, hopping via multiple devices to transmit a measurement back to the gateway, and communications from the host system to the wireless field device via the gateway.

Wireless field devices may have one of three power options: power module, energy harvesting or line power. Power modules will have a life determined by the update rate of the wireless field device, network routing for other wireless field devices, and efficiencies of the sensor and electronics. Reference 3, the Power Module Life Estimator, provides information regarding power module life. Devices with energy harvesting or line power can operate indefinitely at very fast update rates.

Typically, the primary consumer of power is the process sensor and electronics in the WirelessHART field device. Using the WirelessHART radio or acting as a repeater for other WirelessHART field devices requires minimal power.

WirelessHART field devices report their battery voltage to the gateway, and have an integrated low voltage alarm so the user can either schedule maintenance or take corrective action. Each WirelessHART device is pre-configured to generate an alert at pre-defined levels to warn of battery expiration in the power module. These alerts can be detected by an asset management platform, or by dedicated wireless network management software such as the AMS Wireless SNAP-ON planning and monitoring tool.

Security

Security features included with WirelessHART networks include:

- AES-128 encryption (NIST/IEEE compliant) for all communications within the WirelessHART mesh network and the gateway

- Individual device session keys to ensure end-to-end message authenticity, data integrity, receipt validation, and secrecy (non-eavesdropping by other devices in the mesh network) through data encryption

- Hop-by-hop CRC and MIC calculations to ensure message authentication and verification regarding the source and receiver of communications

- Devices must have a "join key" pre-configured on the device. This can either be a Common Join Key, or optionally an Individual Join Key for each device.

Configuring Host Systems

In some installations, not all data collected from the WirelessHART field devices belongs in the control system, as some points of measurement may just be used for monitoring or asset management.

Although most WirelessHART field devices are used for monitoring purposes, they can also be used for real-time control in certain applications.

The host system integration philosophy should be such that data from a WirelessHART field network is delivered to the appropriate end user. The WirelessHART data can be routed though shared network resources. To give some examples:

- Data collected on consumption of power from rotating equipment may go to the utilities manager
- Data collected on vibration spectra of rotating equipment may go to an asset management system
- Data collected on temperature alarms for rotating equipment may go to operators in a non-obtrusive way, and to the reliability manager

Properly defining an integration strategy will ensure an efficient collection of data from WirelessHART field devices, and proper dissemination of this information to the right end users. Some end users may be currently using application specific databases into which data is manually collected and uploaded. With the ability to integrate WirelessHART data using standard interface protocols, these existing databases can be automatically populated with information from WirelessHART field devices.

Traditionally, host integration between the gateway and the host systems has been via a Modbus hardwired connection and the OPC protocol. With the release of HART-IP, the familiar HART protocol can be used over a TCP/IP network (which may be wired or wireless) for the host integration connection. This enables direct access to WirelessHART field devices from the host systems without the need to perform any intermediate mapping.

Alarm Configuration

As previously discussed, each WirelessHART device is configured with an update rate which varies from one second to many minutes. The update rate thus affects the time between an alarm condition and when it can be detected.

For the purpose of this discussion, each WirelessHART device is assumed to have a fixed scan rate, which is the pre-configured rate at which the device sensor is energized and a reading of the process variable is made.

When assigning an alarm to a process variable, the following factors should be considered when determining an appropriate scan rate:

- **Process Time:** What is the expected rate of change for the process variable? How rapidly does a process variable approach abnormal operating conditions? This calculation should accommodate sudden process swings which may move the process variable outside the normal operating range.
- **Operator Response Time:** What is the time for an operator to respond to an alarm and correct the fault?

Users should set an update time for each WirelessHART device which exceeds the process response time to ensure that any changes or disturbances in the process variable are captured within the planned update time of the field device.

Conclusion

This is the third of a five-article series on wireless instrumentation and infrastructure. This article covered WirelessHART field device installation and configuration. For more detail on these and other subjects listed below, please see Reference 4.

The first article showed how wireless can be used to cut operating expenses in capital-constrained environments. It can be found at: http://www.automation.com/automation-news/wireless-cuts-operating-expenses-in-capital-constrained-environments

The second article covered wireless device system planning, design, test and commissioning. It can be found at:

http://www.automation.com/automation-news/todays-featured-news-headlines/wireless-device-network-planning-and-design

The next two articles in this series will be published in the upcoming issues of automation.com as follows:

Article 4, Apr 2016, Reliability and Maintenance of Wired versus Wireless Networks. Discusses reliability and maintenance issues.

Article 5, Jul 2016, Adding to Existing Wireless Networks. A detailed discussion of how to add instruments to existing wireless networks.

Upon conclusion of this five-article series, the reader will be prepared to justify, design, install and maintain wireless instrumentation and wireless networks.

Figures, all courtesy of Emerson Process Management

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3. Power Module Life Estimator: http://www3.emersonprocess.com/rosemount/PowerModuleLifeCalculator/Default.aspx

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About the Author

Mr. Shamsi has been an automation professional for 25 years and his career spans a broad range of industries, in roles from technical leader to project management. He presently works for Emerson Process Management where he directs Emerson's global wireless consulting and execution solutions on large capital projects. He specializes in working with clients and contractors to implement technology solutions to improve operational efficiency.

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