
Mobile transmitters on a *Wireless*HART® network

1.0 Introduction

Wireless measurement transmitters give users the required data reliability as well as the installation and operation flexibility needed for unique measurement applications. When considering a wireless measurement solution, it is important to evaluate project requirements against the pros and cons associated with wireless equipment. There are many advantages to using a wireless solution over a wired solution, such as plug and play installation, mobile functionality, and flexibility.

*Wireless*HART was originally designed to be used with stationary transmitter communications. However, with a carefully engineered custom solution, it is also possible for *Wireless*HART to be used for mobile transmitter communication, as well. This ability opens the door to many more application options.

2.0 Wireless advantages and challenges

Wireless measurement systems have many strengths over wired systems. Wireless systems offer users greater flexibility with installation, mobility, and operating location. Custom engineered wireless networks constructed using mobile transmitter best practices also provide advantages as transmitters can move between process areas while staying on the network. Although there are many advantages to using wireless systems, it is important to understand the challenges that may come along with these systems.

Wireless advantages

- Operating location flexibility
- Minimal wiring required (as well as wire routing)
- Measurement devices/transmitters can be mobile
- Quick and easy installation

Wireless mobile transmitter advantages

- Capable of moving from area to area while staying on the network
- Easy and flexible installation (plug and play)
- High data reliability when network configuration is optimized
- Flexible transmitter locations (transmitters aren't restricted by wiring but must stay within range/line-of-sight to the gateway antenna)
- No wire management required (no need for wire routing), also not restricted by wiring length (freedom in motion, zero wire tethers to restrict motion)
- Power module allows for transmitters to be installed without access to a power supply
- Wireless transmissions do not require communication wiring to be routed to operation location

Wireless challenges

- Risk of missed updates if network is configured incorrectly
- Possible wireless interference when installed in an area with high wireless activity
- Battery life limitations
- Mobility range restricted by wireless network coverage (antenna range/wireless network coverage)

Wireless mobile transmitter challenges

- Possible trial and error to get the network to function as desired
- May require on-site visit by service engineers to optimize network configuration
- Extra time needed to engineer the custom solution

2.1 Network layout/gateway antenna configuration and location

Gateway antenna configuration and location are the most important design aspects of any wireless network. Having the correct gateway antenna and correct location will allow for a robust and reliable network with high data reliability. This is especially true in a mobile network.

A heat map shows expected wireless signal strength across an area for a specific network configuration. Heat maps are useful because they can help the design team determine which antenna configuration or location provides the best wireless coverage of the area. If an on-site visit is possible, heat maps should be created with different antenna configurations and/or locations within the process area.

If a site visit is not possible, the design should consider the environment that the network will occupy. Will the process area have multiple rooms? Where will the

transmitters travel to and from (path of travel, all possible areas that transmitter would travel to)? How large of an area should the wireless network cover? Are there many obstructions in the area to block the signal? What barriers are there and of what material are the barriers made? Is there heavy wireless use by other kinds of networks in that area?

Splitting gateway antennas

While designing a wireless measurement network to be used with mobile measurement transmitters, it is important to consider gateway antenna placement. A typical *WirelessHART* network uses a single gateway antenna, but when transmitters are mobile it is often true that a single gateway antenna cannot provide adequate coverage across the entire process area. This is because the areas are often separated or physically blocked from each other. In these cases, it is necessary to split the single gateway antenna into multiple.

When determining where multiple antennas should be located and how many antennas to use, the application's process flow should be taken into consideration. You must know the general transmitter path of motion, so that the network designer will know what areas of the process flow the wireless network must cover.

If the application requires multiple gateway antennas to cover the entire process area, EIRP (Effective Isotropic Radiated Power) must be calculated at each antenna to ensure that the antenna signal strength does not exceed the FCC limits. EIRP is measured in dBi and can be calculated using transmit strength, antenna gain, and cable losses.

$$EIRP = \text{transmit strength} + \text{antenna gain} - \text{cable loss}$$

2.2 HART[®] protocol

HART is a communication protocol developed by Rosemount, used to transfer data between measurement devices and a central control. It is based on a legacy 4 – 20 mA analog communication standard widely used around the world in many different types of applications. By measuring the analog current, HART is able to convert that into digital data. There is also a wireless version of this named *WirelessHART*. *WirelessHART* operates in the 2.4 GHz band and is based on Dust Network's Time Synchronized Mesh Protocol (TSMP). TSMP is optimized for long battery life; use in interference areas and self-organizing networks such as mesh networks. Devices utilizing TSMP are assigned communication time slots by the Dust Network manager used by the transmitters to send their communications back to the central controller (gateway). Dust Network's TSMP manager essentially controls the communications between the transmitters and the network gateway. When given the choice, this network manager will prefer a lower quality direct communication connection between the transmitter and the gateway opposed to a higher quality multi-hop communication connection (network managers prefer direct connections between transmitter and gateway versus a multi-hop connection).

WirelessHART was developed by the HART Communication Foundation, intended for use with wireless measurement devices that spend their process life stationary. It was

recently discovered that *Wireless*HART can also be used as a communication protocol for wireless transmitters in motion. For *Wireless*HART transmitters to have high data reliability while in motion, best practices must be followed.

*Wireless*HART is optimized for the following:

- Low power consumption for longer battery life
- Use in heavy wireless interference areas
- Implementation in self-organizing networks

2.3 Mobile transmitter best practices

Transmitters

- Must have line-of-sight to a gateway antenna, ensuring a direct communication pathway between transmitter and gateway
- Should not move beyond the range of the wireless network coverage limits
- Update rates should be configured as slow as the application will allow

Gateway antennas

- If there are barriers between areas, gateway antennas should be split to create uniform coverage through entire process area.
- Gateway antennas must not have line-of-sight to each other (reduce risk of multipath interference).
- EIRP at each antenna should be designed to comply with FCC regulations:
 - If required, amplifiers can be used to boost signal strength
 - If required, attenuators can be used to reduce signal strength

Network

- Transmitters must always operate within range of the wireless network
- Network should be installed in an area with low wireless activity

3.0 Conclusion

*Wireless*HART measurement transmitters can be used for both stationary and mobile applications. If used for a mobile measurement application, transmitters should always have a direct connection to the gateway. This will allow for high data reliability with reliable wireless connectivity. Measurement applications that require mobile transmitters must have their wireless networks custom engineered for their specific application. Multiple gateway antennas can be used if transmitters are moving between process areas ensuring transmitters always have line-of-sight to a gateway antenna no matter their location in the process area. Following these mobile transmitter best practices will create a reliable and robust wireless network system.

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