HART Protocol : Architecture, Working, Differences & Its Uses

Tarun Agarwal

10–12분

At present in industrial automation, different types of smart field devices are utilized but monitoring every device is very difficult within the industry by authorities or field engineers. So generally, this kind of monitoring is achieved with smart devices, which allow data transfer between different connected devices inside and outside of the industry to the major monitoring system. So, the HART protocol was introduced in 1980 and builds on the Bell 202 standards. This protocol has become an industry standard, so used in industrial automation. So, this article discusses an overview of the **HART protocol** – working with applications.

What is HART Protocol?

The term HART in HART protocol stands for "Highway Addressable Remote Transducer" which is an open standard protocol used worldwide to transmit & receive digital data with analog wiring in between smart devices & control systems. This protocol is very popular, so above 30 million devices across the globe are powered with the HART protocol. This protocol is used to establish communication among host systems as well as smart field devices in industries.

HART protocol gained more popularity due to its capability to support the older 4-20 mA based analog protocol, while including

the major advantages of digital smart instrumentation.
This protocol describes physical connection technology and also commands utilized by different applications. Hart commands are three types Universal, Common Practice & Device Specific. Universal-type commands are implemented through all HART devices. These commands are mainly used by a controller for identifying a field device as well as reading process data.

Common Practice type commands are used to describe different functions that are normally applicable to field devices only. These devices include commands for changing the range, choosing engineering units & execute self-tests.

Device-specific type commands are not the same for every device. These commands execute unique configuration & modification functions. So, it is very significant to note that when devices from various manufacturers implement similar functionality externally. For instance, differential pressure measurement may include different hardware completely and also different device-specific command sets.

HART Protocol Architecture

HART protocol operates in two network configurations like point to point and multi-point which are discussed below.

### Point to Point Network Configuration

In the point-to-point network configuration, for communicating a single process variable, the fixed 4–20 mA signal is utilized whereas extra process variables, and design parameters are digitally transmitted with the HART protocol. So, the 4–20 mA analog signal is not changed by the HART signal & can be utilized in a normal way. The HART communication digital signal provides the right of entry to secondary variables & other data can be utilized for maintenance, commissioning, operations & diagnostic purposes.
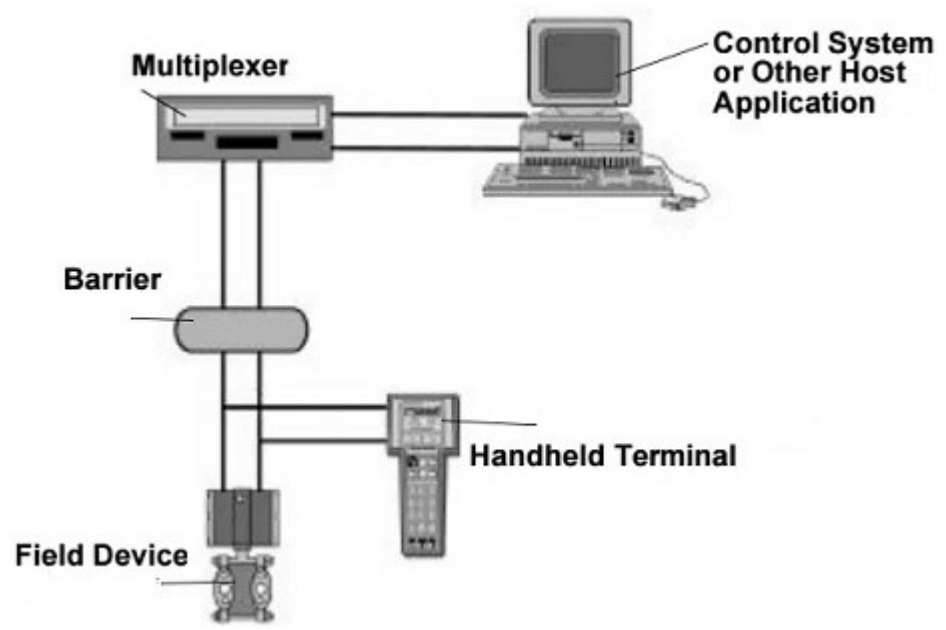

Point to Point Network Configuration

Multi Drop Network Configuration

This network configuration allows various devices to be connected with a single pair of wires. The communication within this configuration is completely digital since communication throughout the analog loop current is disabled as the current throughout every device is fixed at a minimum sufficient value for operation of the device normally 4mA.
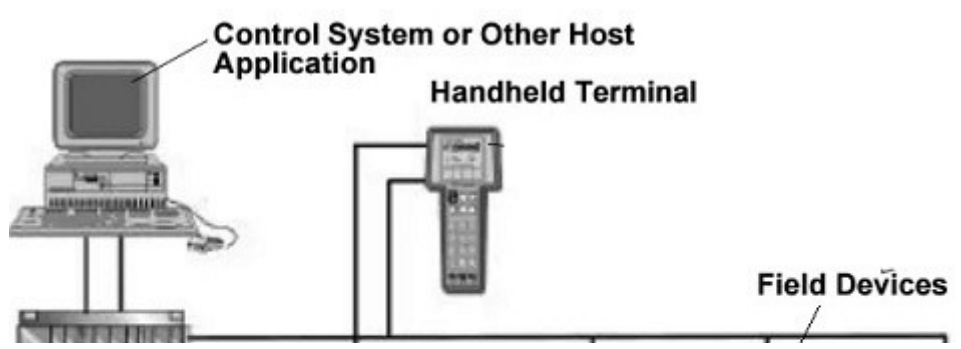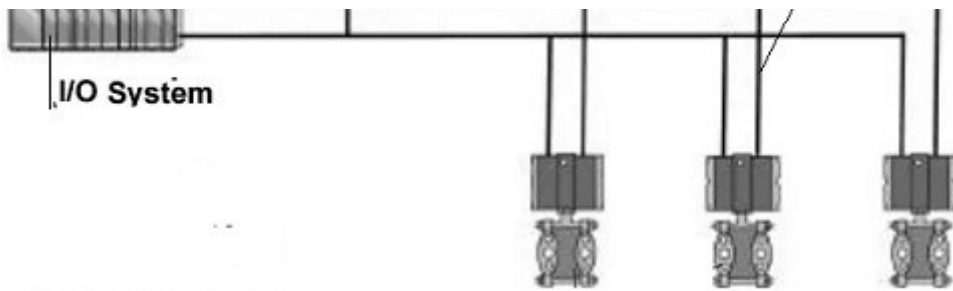
Multi Drop Network Configuration

How Does HART Communication Work?

The HART communication protocol uses the Bell 202 FSK (Frequency Shift Keying) standard to superimpose digital signals which are represented with two different frequencies like 1,200 Hz & 2,200 Hz. Here, 1,200 Hz frequency represents bit 1 whereas 2,200 Hz frequency represents bit 0 correspondingly.
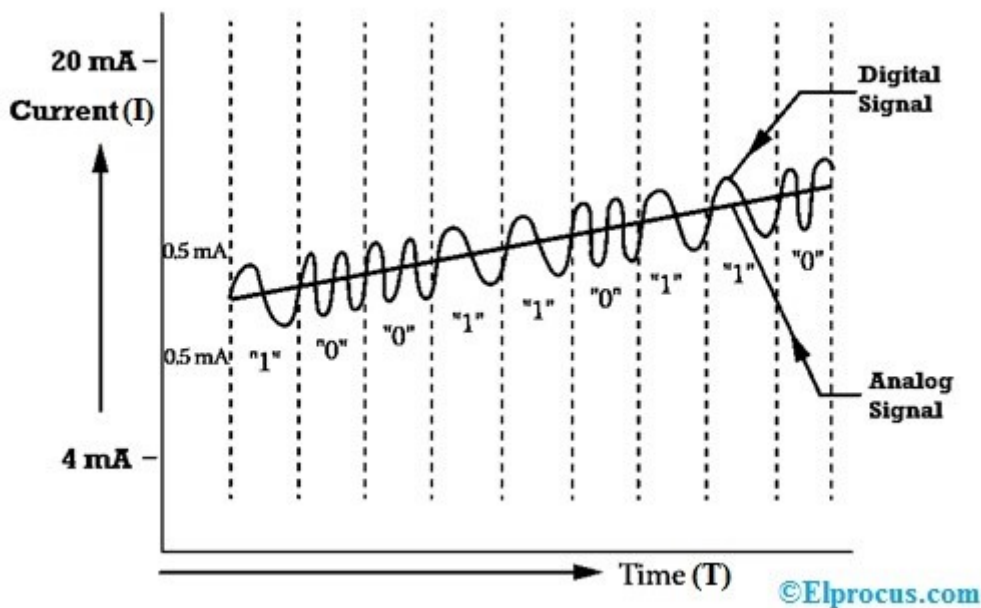
HART Protocol Working

When sine waves with these frequencies place over on DC analog signal cables then the data transfer occurs. So, during this transfer of data, the 4-20 mA signal is not affected due to the standard value of a frequency shift keying signal equivalents to zero. This protocol supports at a time two communication channels like 4-20 mA analog signal & digital signals.

The analog signal communicates the primary measured value with

the 4-20mA current loop whereas the additional device data is communicated through a digital signal that is overlaid on the analog signal.

The digital signal includes the information of the device like the condition of the device, diagnostics, calculated values, etc. So jointly, the two communication channels offer a very robust & low-cost communication solution that is very simple to utilize & configure. This protocol is frequently called a hybrid protocol because it combines both analog & digital communication.

The HART technology is differentiated as a master/slave protocol because the slave device only works once a master device is connected to it. Here, the slave device is a smart device, and the master device is a computer.

Modes of HART Protocol

Generally, for communication within the HART Protocol, the device used within the network is PLC or distributed control system that is chosen as the Master whereas other field devices are considered as slaves like sensors or actuators. But here the communication between master and slave mainly depends on the mode of communication to which the system is arranged. HART protocol network communicates in two modes like master/slave mode and burst mode.

Master/Slave Mode

This mode is also known as the request-response mode. In this type of mode, slave devices simply transmit data once a request from the Master device is issued. For each HART loop, two masters can be connected. So the primary master is normally a DCS (distributed control system), PC (personal computer), or PLC (programmable logic controller) whereas the secondary master is another PC or a handheld terminal. Slave devices are actuators, controllers, and transmitters that react to commands from the master devices.

Burst Mode

Some HART protocol-enabled devices simply support this communication mode. This mode allows faster communication like three to four data updates for each second. The master device in this mode instructs the slave device to transmit a typical HART reply message continuously. The master gets the message at high speed until it orders the slave to stop bursting. This mode is applicable where the above one HART device is necessary to communicate from the HART Loop.

HART Protocol Vs Modbus

The difference between the HART protocol and Modbus includes the following.

HART protocol	Modbus
HART is a hybrid protocol.	Modbus is a data communication protocol.
HART is extensively used in process & instrumentation systems which range from small automation to highly complicated industrial applications.	Modbus is normally used for transmitting signals from instrumentation & control devices to a data gathering system or main controller.
This protocol operates in two operational modes like point to point and multi-drop.	Modbus operates in two transmission modes like ASCII Mode or RTU Mode.

Advantages

The **advantages of the HART protocol** include the following.

- The devices which are enabled by the HART protocol simply allow the users to make the device use the finest data for optimizing their operational abilities.

- It decreases the downtimes because of the failure of equipment by recognizing the potential troubles before they happen.

- It reduces the inventory costs and maintenance of devices.

- It decreases wait times for problem recognition & problem resolution.

- It enhances safety integrity levels by using advanced diagnostics.

- The benefits of choosing the HART protocol mainly include; digital capability, analog capability, availability & interoperability.

- This protocol can also be utilized with different devices and sensors.

- HART protocol-based devices are extensively accepted in industries.

- This protocol increases system availability, progress regularity, etc.

Disadvantages

The **disadvantages of the HART protocol** include the following.

- The digital signal within the HART transmission is fairly slow.

- For a multi-drop arrangement, the analog signal is not accessible & the no. of devices that can split the transmission line is restricted.

- It can monitor one process variable only at any time.

- This type of protocol is somewhat slow as compared with other Fieldbus systems such as Profibus & Foundation Fieldbus. So this slow response time causes some difficulties within some industrial-based applications.

- Generally, the speed of the HART protocol is sufficient for simple monitoring systems wherever the process variables don't vary quickly.

Applications

The **applications of the HART protocol** include the following.

2024-02-20 오후 8:36

- HART protocol is used worldwide to transmit & receive digital data with analog wiring in between smart devices & control systems.

- This is a very popular protocol used in industrial automation.

- This protocol is mainly for analyzing smart devices.

- This is broadly utilized in process & instrumentation systems.

- This type of communication protocol is ideal for multivariable instruments which include mass flow meters wherever volumetric flow, mass flow, density, and temperature can be communicated toward the control system over a single cable.

- This protocol is mainly designed to use in industrial process control and measurement applications.

- HART protocol is mainly used in process industries for communication between different devices.

  Thus, this is an [operation of the HART protocol](). This protocol is the global standard used for transmitting & receiving digital data across analog wires in between smart field devices as well as monitoring or control systems such as DCS & PLC systems. This bidirectional communication protocol simply provides the right of entry to additional data between the field & the host controller ranging from a handheld device to an asset management system or plant controller. Here is a question: What is the full form of the HART protocol?