HART® benefits in Flow Measurement

Introduction

Elster-Instromet Flow Computers have the ability to be used with SMART Field Devices. They benefit from complete digital signal handling of HART temperature, pressure and differential pressure transmitters through proven high-speed microprocessor technology. SMART transmitters guarantee the full accuracy of the measurement is preserved. Ambient temperature dependence of signals is eliminated and the system performance is solely limited to the inherent accuracy of the transmitters. Over 100 worldwide manufacturers utilise the HART protocol in over 560 different products, from simple temperature transmitters to multivariable transmitters.

What is SMART & HART

SMART Field Device:

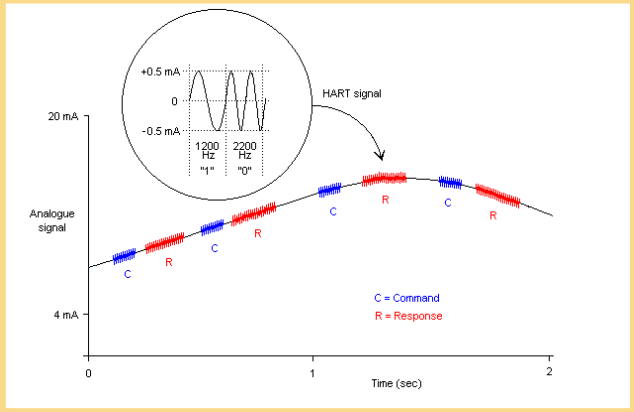
A SMART Field Device is a microprocessor-based process transmitter that supports two-way communications with a host, digitizes the transducer signals, and digitally corrects its process variable values to improve system performance. Many transmitters contain sophisticated signal processing algorithms to perform the measurements or control action required. The value of a SMART field device lies in the quality of the data it provides.

HART stands for:

Highway **A**ddressable **R**emote **T**ransducer

HART is an open protocol that was originally developed in the late 1980's by Fisher Rosemount to communicate with SMART Field Devices. Over the years it has become a de facto standard for communicating with SMART devices in the Process industry.

The HART protocol is a powerful communication technology used to realize the full potential of digital field devices whilst preserving the traditional 4-20mA signal. The HART protocol extends the system capabilities for two way digital communication with smart instruments.



HART offers the best solution for SMART Field Device communications and has the widest base of support of any field device protocol worldwide. More instruments are available with the HART protocol than any other digital communications technology. Almost any process application can be addressed by one of the products offered by HART instrument suppliers. Unlike other digital communication methods the HART protocol gives a unique communication solution that it is backward compatible with currently installed instrumentation. This ensures that investments in existing cabling and current control strategies remain secure into the future.

The HART digital signal is superimposed onto the standard 4-20mA signal. It uses Bell 202 standard Frequency Shift Keying (FSK) signal to communicate at 1200 baud. The digital signal is made up of two frequencies, 1200Hz and 2200Hz, representing bits 1 and 0 respectively. Sine waves of these two frequencies are superimposed onto the analogue signal cables to give simultaneous analogue and digital communications. As the average value of the FSK signal is always zero there is no effect on the 4-20mA analogue signal. A minimum loop impedance of 230 Ohms is required for communication.

Master / Slave

HART is a master-slave protocol - this means that a field device only replies when it is spoken to. Up to two masters can connect to each HART loop. The primary master is usually the FC (Flow Computer). The secondary master can be a hand held configurator or the DCS (Distributed Control System), or another PC running an instrument maintenance software package. Slave devices include transmitters, actuators and controllers that respond to commands from the primary or secondary master. The digital communication signal has a response time of approx. 2-3 updates per second without interrupting the analogue signal.

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HART Fundamentals

- Field-proven, global industry standard.
- Two communication channels simultaneously on the same pair of wires.
- 4-20 mA analogue channel: for fastest possible data transfer of control signal.
- Digital channel: for read/write access to all device data.
- 35-40 data items, standard in every HART device.
- Advanced diagnostics and intelligent multivariable devices.
- Many cost effective solutions for integration with plant systems.
- Unmatched range of products and worldwide support.

HART Data overview

- Digital data: 35-40 valuable data items in every HART device.
- Device identification: Device Tag, Supplier info, Device Type and Revision, Device Serial Number.
- Calibration data: upper and lower range values, upper and lower sensor limits, Process Variable (PV) damping, last calibration date.
- Process variables: primary variable plus secondary measurements and multivariable parameters.
- Status/Diagnostic alerts: device malfunction, configuration change, power fail restart, loop current fixed or saturated, primary or secondary variable out of limits, communication error, etc..

HART Benefits

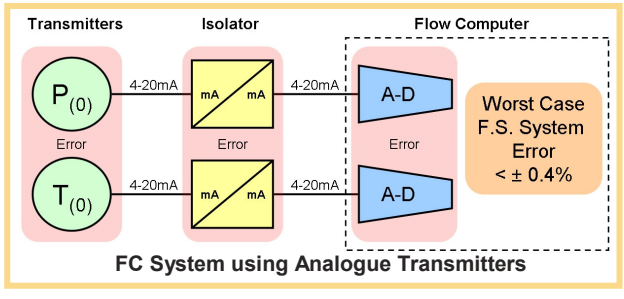
- Highly accurate and robust communication unlocks value in smart devices.
- Simple, cost-effective, high-value, low-risk, feature-rich, easy to use and maintain.
- Lower cost through faster commissioning and simplified maintenance.
- Real-time diagnostics and predictive maintenance alerts enable problem detection.
- Benefits multiply by real-time integration with plant control, safety, and asset management systems.
- Lower installation cost and simplified wiring when using multi-drop HART communication.

HART Multivariable Devices

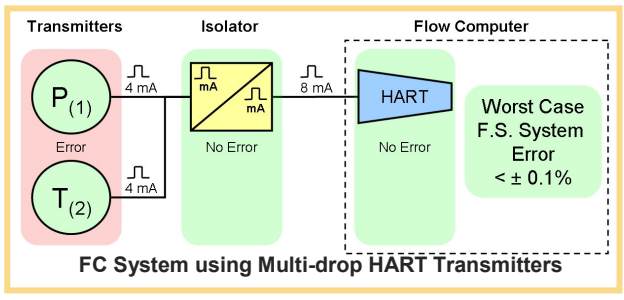
- Pressure Transmitters:
  (process pressure absolute or gauge, ambient temperature, status)
- Temperature Transmitters:
  (process temperature, cold junction compensation value, ambient temperature, status)
- Differential Pressure Transmitters:
  (differential pressure, static pressure, ambient temperature, status)
- Coriolis Meter:
  (mass flow, density, temperature, status)
- Valve Positioners:
  (target stem position, actual stem position, actuator pressure, output signal to actuator)

Identify benefit opportunities

Many flow measurement applications still use (4-20 mA) analogue signals for process parameters although most field devices (transmitters) support HART communication. Most users access HART enabled variables only when maintenance staff go to the field to calibrate them. Often a hand held communicator or a PC running instrument maintenance software is connected for this purpose. With HART, you can avoid that situation and you've already paid for that HART transmitters anyhow. So why not using the HART process variables continuously and benefit from all opportunities. Some beneficial examples could convince you more.



FC System using Analogue Transmitters



FC System using Multi-drop HART Transmitters

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HART reduces System Errors

Lets compare two Flow Computer systems, one using transmitters in the conventional analogue mode (4-20 mA) and one using the same transmitters in a multi-drop HART communication mode.

The sample diagram for the analogue system shows a typical configuration consisting of a Pressure and Temperature Transmitter, intrinsically safe Isolators and a Flow Computer. Since the process variables are transferred by analogue signals each individual device in the chain will contribute to the overall system error. The transmitters because they convert primary process variables using micro-processors into analogue signals (D-A converters), the isolators (DC-DC converters), and the Flow Computer (A-D converters). Each time a signal is converted an error will be introduced due to linearity or ambient temperature coefficients. Even if you start with accurate transmitters the overall worse case system error can reach ±0.4% at full scale.

The sample configuration diagram for the multi-drop HART system consists of exactly the same devices as the analogue system. Since the process variables are now transferred by digital HART protocol the overall worse case system error is reduced to ±0.1% at full scale. Only the conversion of the primary variables in the transmitters will contribute to the overall system error in a digital system and no conversion errors are added in the Isolators or Flow Computer. Without spending extra money you will greatly benefit when using HART. At the current prices for natural gas your savings will be significant.

And there is more to benefit from when using HART. With analogue signals you can only signalize errors and loop integrity when the analogue signals are out of range (4-20mA). Any influences or fluctuations caused by EMC or electrical noise can not be traced. With a digital HART protocol the loop integrity is monitored continuously and if a data package is corrupted a CRC error will be signalised to the Flow Computer immediately.

Beside the above advantages the multi-drop HART system will further reduce investment costs in terms of:

- Less isolators required (only one for each loop).
- Less wiring cost (one pair of wires for each loop).
- No calibration or re-calibration required for Isolators and Flow Computer input stages.
- Simple and very accurate verification of digital Flow Computer equations.

YOKOGAWA **ROSEMOUNT**
HART Pressure and Temperature Transmitters

Mode of operation

HART transmitters can be used in various modes of operation:

- **Analogue & HART mode (Address 0)**
  Only one transmitter can be used in a loop since the output current will be 4-20mA proportional to the PV. In this mode the Transmitter can be used with HART compatible devices using address 0 to access the data. In this mode the analogue signals (PV) can be taken from the isolators while digital HART address 0 is used to read the PV - Status into the Flow Computer.
- **HART Multi-drop mode (Address 1-31)**
  Multiple transmitters can be used in a loop. Each transmitter uses an address in the range 1-31. The analogue output current for each transmitter will be fixed to 4 mA and will not be proportional to the PV. If transmitters are used in HART multi-drop mode the number of transmitters in a loop should be considered to ensure the minimum supply voltage for each transmitter is guaranteed. Remember each transmitter pulls 4 mA from the isolator supply!
- **HART Burst (broadcast) mode**
  Only one transmitter can be used in a loop since the transmitter (slave) will continuously transmit standard HART reply messages (at higher speed) to the master system. This mode of operation is not support by the Elster-Instromet Flow Computers.

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Device Description Language & OPC

HART Device Description Language (DDL), extends interoperability beyond the Universal and Common Practice commands. A field device (slave) manufacturer uses DDL to create a software file with all relevant device characteristics, such that a DDL capable host can fully communicate with the device. A Device Description (DD) for a HART device is analogous to a printer driver in the personal computer world where the printer driver links an application to the printer such that it prints properly on the page. Universal hand-held communicators capable of configuring any HART-based instrument through DDL are available from several manufacturers. Other host applications that understand DDL are beginning to emerge. A central library of all HART-compatible Device Descriptions is managed by the HART Communication Foundation.

The HART Communication Foundation (HCF) recently announced the availability of the HART to Enterprise OPC server, or HART Server. Load this software into your PC, hook up to HART devices with a modem, and you gain real-time access to all the process-related information available in HART devices. With HART Server software you may have all the connective functionality you'll ever need.

The HART Server is OLE for Process Control (OPC)-compliant, so it can obtain information from HART devices and pass it along to any OPC client applications, such as SCADA software.

The Elster-Instromet Flow Computers that offer network TCP/IP pass through capabilities allow any remote PC or Supervisory System to access directly Pressure or Temperature Transmitters data connected to the Flow Computer using a manufacturer protocol. Remote serial diagnostics software can be used since the serial RS232 port is emulated in the PC or supervisory system.

SMAR

HART USB and Serial Interfaces HI321 - H311

Best Solution

The HART protocol provides users with the best solution and migration path for capturing the benefits of enhanced communication with smart instrumentation. No other communication technology can match the base of support or wide range of products that are available with HART today. The technology is easy to use and HART-compatible products are available from major instrumentation suppliers to address virtually all process measurement and control applications. The user will greatly benefit when using HART transmitters together with Elster-Instromet Flow Computers.

More HART Information

The HART Communication Foundation (HCF) provides more detailed information about the HART protocol. A free HART CD-guide can be obtained when visiting:

www.hartcomm.org

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