FLOW COMPUTERS

HART® benefits in flow measurement

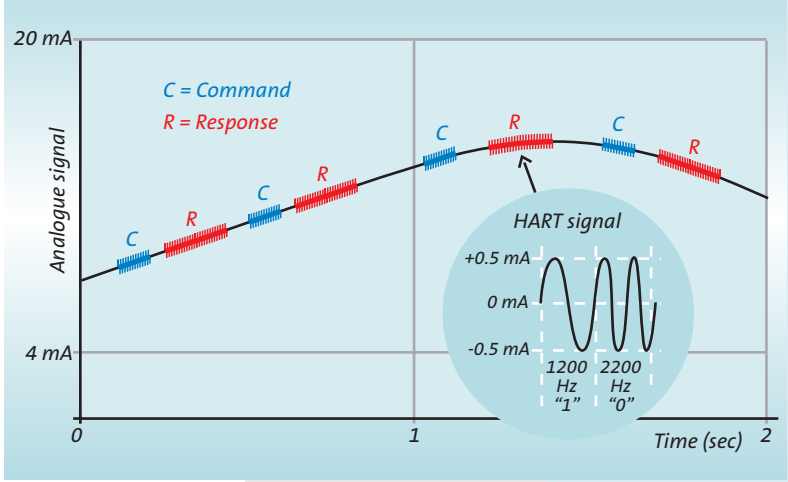
Elster-Instromet flow computers can be used with SMART field devices. They benefit from fully digital signal handling provided by HART temperature, pressure and differential pressure transmitters using proven high-speed microprocessor technology. SMART transmitters guarantee that the full accuracy of 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 global manufacturers utilise the HART protocol in over 560 different products, from simple temperature transmitters to multivariable transmitters.

What is SMART & HART?

A **SMART field device** is a microprocessor-based process transmitter that supports two-way communication 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.

Analogue signal with superimposed HART signal



The HART protocol is a powerful communication technology used to realise the full potential of digital field devices while preserving the traditional 4-20 mA 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 communication and is the most widely supported field device protocol worldwide. There are more instruments available with the HART protocol than with any other digital communication 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 provides a unique communication solution that is backward compatible with currently installed instrumentation. This ensures that investments in existing cabling and current control strategies will remain secure in the future.

The HART digital signal is superimposed onto the standard 4-20 mA signal. It uses the Bell 202 standard Frequency Shift Keying (FSK) signal to communicate at 1200 baud. The digital signal is made up of two frequencies, 1200 Hz and 2200 Hz, representing bits 1 and 0 respectively. Sine waves of these two frequencies are superimposed onto the analogue signal to allow for simultaneous analogue and digital communication. As the average value of the FSK signal is always zero, the 4-20 mA analogue signal is not disturbed. 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. A maximum of two masters can be connected 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.

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 control signal data transfer.
- Digital channel: for read/write access to all device data.
- 35 – 40 data items as standard in every HART device.

- Advanced diagnostics and intelligent multivariable devices.
- Many cost-effective solutions for integration with existing 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 information, 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 are multiplied thanks to real-time integration with plant control, safety and asset management systems.
- Lower installation cost and simplified wiring when using multi-drop HART communication.

Multivariable HART devices

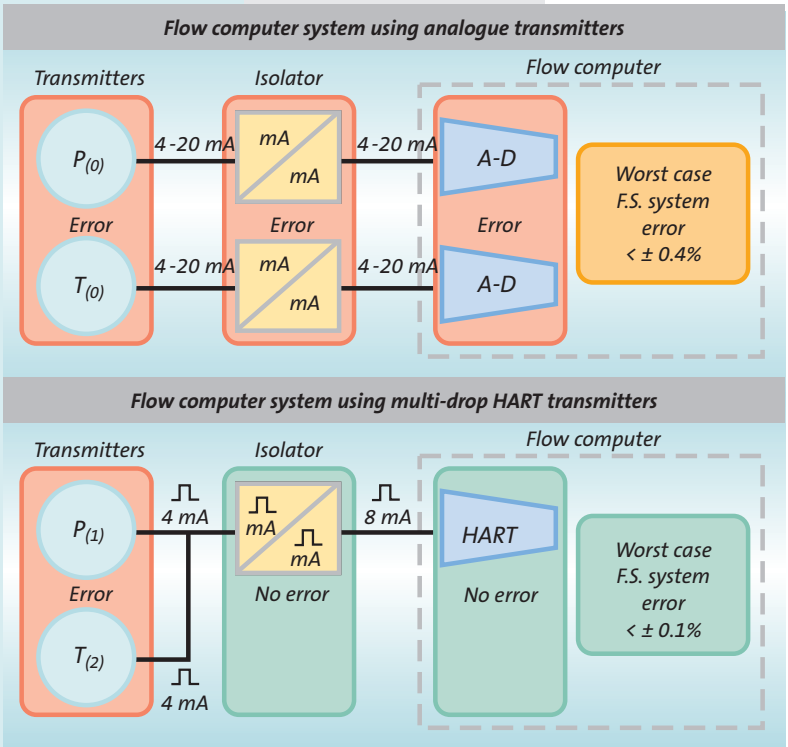
- Pressure transmitters:
  absolute or gauge process pressure, ambient temperature, status
- Temperature transmitters:
  process temperature, cold junction compensation value, ambient temperature, status
- Differential pressure transmitters:
  differential pressure, static pressure, ambient temperature, 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 only turn to HART-enabled variables if maintenance staff calibrate the devices in the field. A hand-held communicator or a PC running instrument maintenance software is often connected for this purpose. With HART, you can avoid that situation and the HART-capable transmitters had been bought anyway. So why not use the HART process variables all the time and benefit from all opportunities. Some beneficial examples should convince you.

HART reduces system errors

Let us compare two flow computer systems, one using transmitters in the conventional analogue mode (4-20 mA) and one using the same transmitters in multi-drop HART communication mode. The example 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 into analogue signals using micro-processors (D-A converters), the isolators (DC-DC converters) and the flow computer (A-D converter). 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 worst case system error can reach ± 0.4% at full scale.



The example configuration for the multi-drop HART system comprises exactly the same devices as the analogue system. Since the process variables are now transferred by the digital HART protocol, the overall worst 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 additional conversion errors will be introduced by the isolators or flow computer. Using the HART protocol will provide large benefits at no extra cost. Given the current prices for natural gas, your savings will be significant.

Yokogawa and Rosemount HART pressure and temperature transmitters

And there is even more to benefit from when using HART. With analogue signals, you can only report errors and loop integrity when the analogue signals are out of range (4-20 mA). Any interference or fluctuations caused by EMC or electrical noise cannot be traced. With the digital HART protocol, loop integrity is monitored continuously and if a data package is corrupt, a CRC error will be signalled to the flow computer immediately.

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

- Less isolators required (just 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.

Mode of operation

HART transmitters can be used in various modes of operation:

- **Analogue & HART mode (address 0)**
  Only one transmitter can be connected in a loop since the output current will be 4-20 mA, proportional to the PV. In this mode the transmitter can be used with HART-compatible devices using address 0 for data access. The analogue signals (PV) can then 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 is assigned an address between 1 and 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 selected so as to ensure the minimum supply voltage for each transmitter. Remember that each transmitter pulls 4 mA from the isolator supply!
- **HART Burst (broadcast) mode**
  Only one transmitter can be connected 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 supported by Elster-Instromet flow computers.

Device Description Language & OPC

HART Device Description Language (DDL) extends interoperability beyond the Universal and Common Practice commands. Field device (slave) manufacturers use DDL to create a software file with all relevant device characteristics so that a DDL-capable host can communicate fully 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 using 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, connect the HART devices via a modem, and you will gain real-time access to all the process-related information available in those HART devices. With HART Server software you will have all the connective functionality you will 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 application such as SCADA software.

Elster-Instromet flow computers with network TCP/IP passthrough capabilities grant any remote PC or supervisory system direct access to the data of pressure or temperature transmitters 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.

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 benefit greatly when using HART transmitters in conjunction with Elster-Instromet flow computers.

More information about HART

The HART Communication Foundation (HCF) provides more detailed information about the HART protocol. A free copy of the HART guide on CD-ROM can be ordered from: **www.hartcomm.org**

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