Options for HART Data System Integration

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Your field devices and actuators want to tell you more of what is happening in the plant, all you have to do is listen.

There is a resource present in your plant that can help facilitate asset management, but if you're like most companies, you aren't using it, or you aren't using it to the extent that you could. That resource is HART, and many, if not most of the field instruments deployed in your process probably have it. This article will discuss how HART works, and the variety of ways you can integrate HART data from process sensors and actuators in your plant.

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Most companies have hand-held communicators that use HART, and that becomes the main method for setting up new field devices or changing configuration settings in the plant. The underused aspect is the variety of ways that new and installed instruments can communicate with the automation system, delivering the main process variable, additional variables, and diagnostic information. In fact, HART can be the main technical enabler for a device management program.

What HART Can Do

The information available via HART can tell a great deal about individual field devices, how they're performing, and the networks serving them. The diagnostic information can warn you if there are individual device problems, loop current faults, or if a device needs maintenance. It can help ensure the accuracy of process variable data, that individual instruments are ranged correctly, and if there are deviations in the communication.

But beyond diagnostics, HART can also deliver the secondary process variables available on most smart devices already installed in your plant. Any instrument purchased over the last 10 or 15 years is probably ready to send that information if you have the means to integrate it in your control and asset management systems.

Configuring Communications

There are two methods for transactions between the host and device. The most common is a master/slave approach where the host requests information from the slave device. The device sends information only when requested.

Devices can also be configured to publish process data in a burst mode. This only works for specific process data commands, but the host can still request other information as needed.

Choosing master-slave or burst will be driven by the needs of the process and criticality of a specific process variable. Each device can use either approach as the situation dictates.

Multi-Drop: HART as a Fieldbus

In normal applications the primary process variable is transmitted via the 4-20 mA analog signal, and the additional variables are carried within the superimposed digital information. This may be the traditional

method, but it requires a cable for every device. HART can transmit the primary variable with the digital information if desired, making each field device entirely digital.

When using that method, multiple devices can be connected via a single cable wired in parallel, similar to a fieldbus, reducing the amount of cabling. Up to 15 devices can be connected on one segment, using a handheld communicator to assign the poll address for each. The 4-20 mA signal is fixed at a low value, typically 4 mA, so the loop can carry power to each device. Communication follows a master/slave pattern with the host polling each device such that it can send process variables and diagnostic information.

This approach does not provide the constant updating of the primary process variable as the normal 4-20 mA loop would, but if a small amount of latency can be tolerated, it can deliver a reliable stream of process data.

More Than One Variable

Most field instruments available today are actually multi-variable devices, even if this is not an obvious feature (Figure 2). Pressure sensors, flowmeters, and other instruments gather additional information to correct the primary variable or to monitor another aspect of performance. For example, many types of pressure sensors need a temperature data to compensate the pressure value. This temperature or other secondary information can be sent to the host via HART.

While these secondary variables might not be used for critical control, they are available and can help fill in gaps of information coverage without additional intrusions into the process or buying more hardware. Many host systems can be set up to access this data, with the best way being natively HART-enabled I/O at the host system (Figure 3, left).

This method allows delivery of information easily and as quickly as possible with effortless integration to control and maintenance platforms. All variables are available from every device using a minimum of cabling and hardware. Unfortunately, many systems running in process plants were installed before HART enabled I/O cards were common, so finding smart devices deployed in conventional 4-20 mA I/O card situations is typical. Users and system vendors have created many work-around approaches to fill this gap.

Loop Converters

A HART loop converter is an individual modem that can read the HART data lifted off an individual loop. Loop converters are typically designed to access a secondary process variable and convert the digital signal representing this variable to a 4-20 mA signal.

Such a unit can send the signal to a larger automation system, and/or convert the data and display it in appropriate engineering units. Depending on the sophistication of the device, it can be programmed with relay outputs for alarms or other functions.

Individual converters are useful when a small group of devices need to be addressed, but when larger numbers are required, there are better ways to deal with the situation.

Multiplexers

For an installation where a user wants to extract HART data from a large number of field devices but there are no native HART I/O cards installed in process automation system, the typical approach is a HART multiplexer. (Figure 3, right) These systems come in a variety of configurations and from a variety of manufacturers, but they have some basic characteristics that are common.

Multiplexers contain multiple HART modems that are ganged together such that they can extract and convert the digital data from a device while not interfering with the normal 4-20 mA loop signal. The I/O of the existing host device does not see a difference in the 4-20 mA, and it can continue to regulate the process just as it always has.

This approach is typically retrofitted to an existing control system and field wiring. The multiplexer takes the information from however many devices it handles, and typically sends the data to some sort of asset management system via an RS485 serial bus or Ethernet link. Communication is bi-directional so the asset management system can both read information from a field device and set its configuration.

The downside of working with multiplexers is that they can be complicated to install, since each individual field device needs to be connected. This effect can be minimized by making connections where the cables have already been brought together in one place like marshaling cabinets. Latency is also a factor since multiple networks have to share one HART modem. With careful planning and network management, multiplexers can still be a very effective and economical way to handle large deployments.

Handhelds and Single Modems

In many situations, a maintenance person or instrumentation engineer may need to configure or check the diagnostic information from an individual field device. There are many types of single HART modems and handheld communicators that can provide an interface easily and inexpensively. Such devices are not limited by manufacturer and can communicate with any instrument or actuator, thanks to the interoperability built into the HART protocol.

Small single modems can be inserted into a loop whenever needed in the plant or maintenance shop. Such devices can communicate with a laptop or other host system using USB, RS232, or even Bluetooth wireless.

Today’s handheld communicators and calibration devices are hugely versatile and can contain device descriptors for hundreds of devices. The maintenance technician can connect the unit to a field device and it can call up the relevant information from its memory. If necessary, the configuration can be changed or the diagnostic data retained for downloading back at the maintenance shop.

While these individual communication devices can be very useful, they have the inescapable limitation that they require a technician to be involved and can only communicate with one device at a time. By contrast, a fully HART-enabled I/O system can perform all of the above functions on any field instrument or actuator at any time from the control room or maintenance shop.

Work Practices: Commissioning and Maintenance

When new field devices are going to be installed or brought in for maintenance in the shop, HART can be the means to get them configured properly and tested before returning to operation. The ability to check and verify performance before installation can save an enormous amount of time compared to installing and then removing sensors that aren't ready for use. During the commission phase, HART information can be used to reduce the commissioning time.

Once a new device has had its HART tag name assigned and ranged for that application in the process, it can be ready for the next round of checks where HART information can be provide ease during the checks:

- Verification of the device's location, physically and I/O;
- Calibration;
- Configuration and loop check;
- Alarm and interlock validation; and,
- Online operation validation.

Similarly, field instruments and smart valve controllers can be checked in the shop before returning to operation. A well-developed maintenance program can prescribe a routine of tests tailored to an individual device or group via HART communication to check whatever attributes are most critical. Working through this procedure avoids problems and helps train new technicians.

Once back in place, transmitters and valves can be given final verification before resuming the process. Or, tests can be performed in-situ rather than in the shop. HART can help test a variety of critical attributes, including:

- Verify proper tag and location;
- Verify wiring and power supply;
- Check signal integrity and grounding;
- Re-zero, check range and span calibration;
- Verify analog trim for DCS output;
- Send simulated process variable to verify DCS reading;
- Capture new valve signature for baseline;
- Set alarms and security configuration; and,
- Configure and calibrate additional process variables.

Many device management platforms can record and catalog the results of these tests and adjustments for maintenance recordkeeping.

Work Practices: Partial Stroke Valve Testing

In a plant that is performing well, emergency shutdown (ESD) valves may go for years without having to perform their function. While avoiding upsets and accidents is a good thing, safety protocols require that ESD valves be tested to verify that they still work properly. Valves that aren't operated regularly can fail when called upon due to excessive stem friction, packing problems, air pressure leakage, or other maintenance issues.

ESD valve testing using a full stroke test (FST) is problematic since cycling these valves can interfere with production. Safety protocols therefore make provisions for partial stroke testing (PST) of ESD valves in many situations in a way that verifies their performance while minimizing operational disruptions.

Companies that use this technique perform PSTs at regular intervals, allowing for less frequent FSTs. The ways in which ESD valve testing fits into a larger safety program is beyond the scope of this discussion, but once the protocols are established and approved for a given plant, HART-enabled valve controllers makes PSTs easier to perform and document.

An asset management program can automate the mechanics of PST programs, performing the tests and gathering diagnostic information via HART via this straightforward method:

- Valves are categorized into device groups;
- Program sets schedules in keeping with larger safety system requirements; and,
- Program retains historical data from each test, allowing identification of trends that may indicate developing maintenance problems.

Your Next Step

Hopefully this discussion has convinced you that there are many ways in which HART can support improved plant performance and asset management. The most difficult step is often making the effort to put it to work. There are many stories of companies that have done it successfully and enjoyed the benefits of higher production and reduced maintenance costs, but implementation requires procedural and often cultural changes among your production, reliability, and maintenance teams.

HART won't deliver the performance of an advanced fieldbus such as Foundation Fieldbus or Profibus PA, but it is much less expensive to implement as it often can use existing instruments and valves. Table 1 shows some of the benefits that HART delivers.

The issues are not technical since hardware and software solutions are readily available. Often a successful HART-enabled maintenance program can trace its origin to a single enthusiastic individual that emerged as a champion, leading the company into a new period of improved performance and reduced costs.

Table 1: Advantages of HART

1. Existing instruments and valves can often be used
2. Existing 4-20 mA wiring can be used
3. Secondary variable information can be used to improve operations
4. Calibration is simplified
5. Instruments and valves can be accessed remotely
6. Certain operations such as valve testing can be performed automatically
7. Test and maintenance data can upload automatically to an asset management platform
8. Personnel training is easier than with more sophisticated communication protocols
9. High interoperability eliminates need to depend on one specific manufacturer

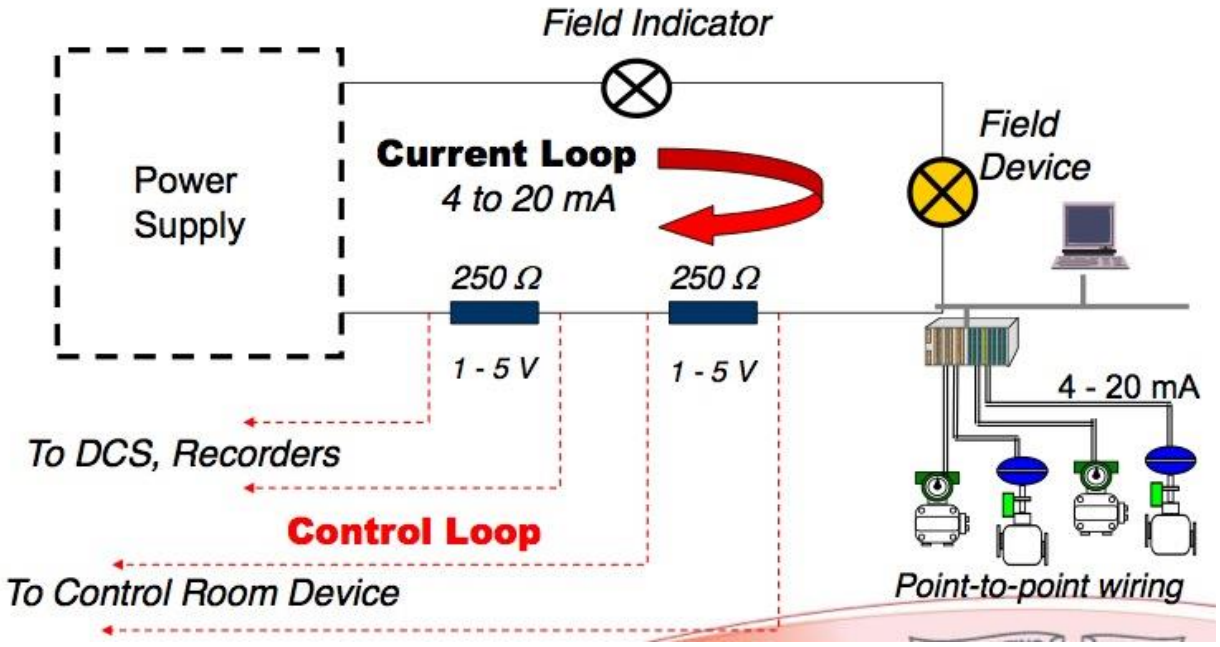

Figure 1. Caption: HART provides a means to access digital data superimposed on existing 4-20mA wiring, making it a low cost fieldbus option.

Figure 2, image of a HART transmitter. Pressure sensors, flowmeters, and other instruments usually gather other variables such as temperature these secondary variables can be accessed with HART.

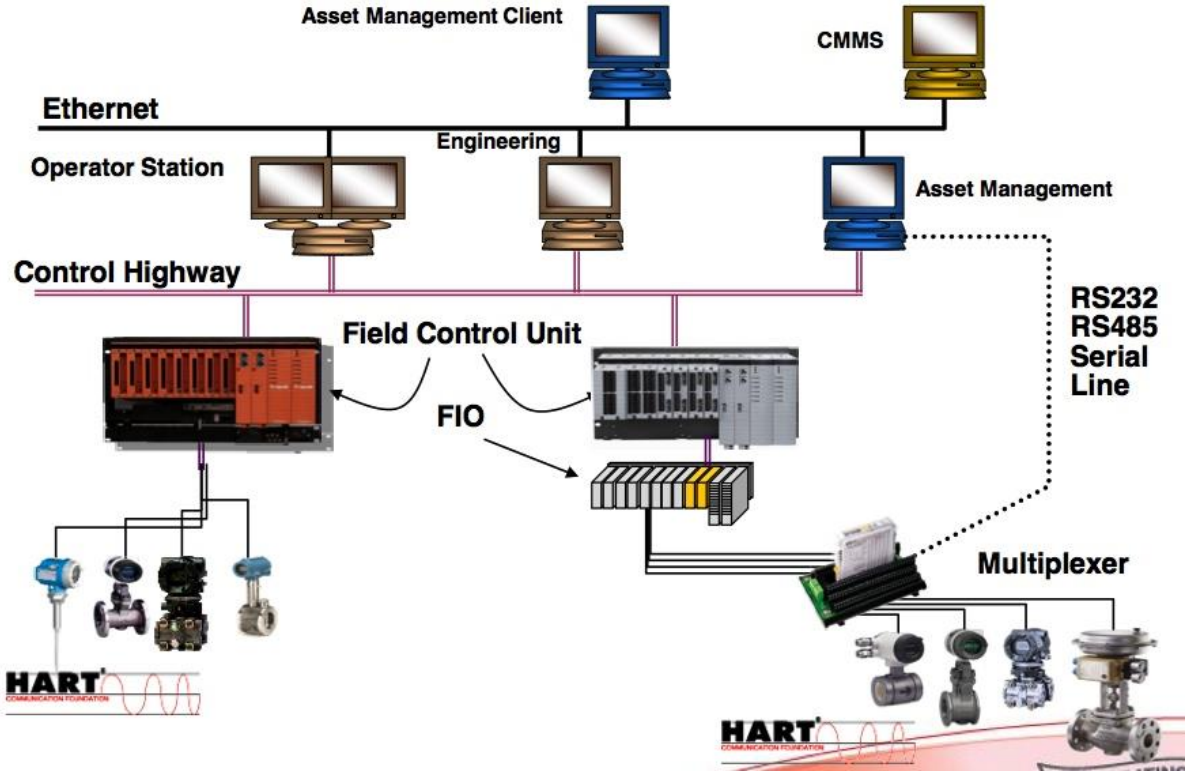

Figure 3. Caption: Native HART-enabled I/O (left field control unit) gathers HART information seamlessly. In systems where HART I/O isn't available, multiplexers can gather information and send it to an asset management system without interfering with the existing I/O flow (right control unit).