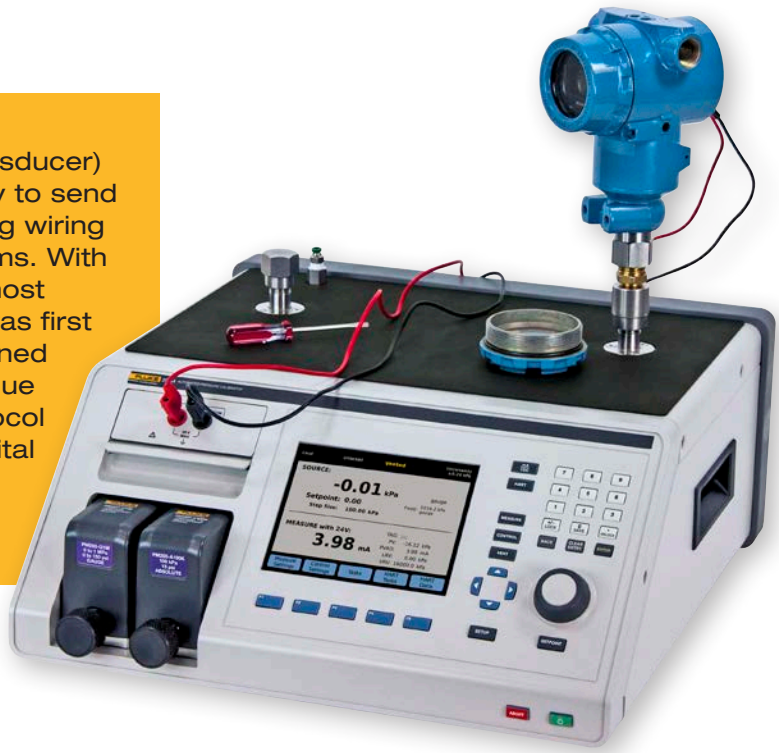
APPLICATION NOTE

Simplifying the maintenance of HART pressure transmitters with the 2271A Industrial Pressure Calibrator



HART (Highway Addressable Remote Transducer) Protocol is an open standard used globally to send and receive digital information using analog wiring between smart devices and control systems. With over 30 million[1] devices installed it is the most popular protocol used in the field. HART was first available in the late 1980's, and quickly gained in popularity mainly due to its ability continue to support the older 4-20 mA analog protocol while adding the significant benefits of digital smart instrumentation.

Maintaining HART instruments is critical to product quality, production or plant efficiency and ensuring a green environmental footprint. While smart transmitters offer significantly better performance and functionality than their older analog transmitters, this comes at a cost of increased maintenance complexity.

Maintaining these smart devices requires three types of equipment; sourcing equipment, measurement equipment and digital communication equipment. Using all these separate devices can make the maintenance time consuming and difficult. The Fluke Calibration 2271A Industrial Pressure Calibrator combines all three of these types of equipment into a single bench instrument with built-in routines that can automate and streamline the maintenance of these transmitters.

This application note provides some basic information about the HART protocol and explains how the 2271A can help improve the efficiency and effectiveness of maintenance teams.

HART Protocol

The HART Protocol is based on the Bell 202 Standard[2] to superimpose digital information on the conventional 4-20 mA analog signal. Maintained by an independent organization, the HART Communication Foundation, the HART protocol is an industry standard developed to define the communications protocol between intelligent field devices and a control system. The HART Protocol defines physical connection technology as well as commands used by applications. There are three classes of HART commands: Universal, Common Practice, and Device Specific. Universal commands are required to be implemented by all HART devices. They are primarily used by a controller to identify a field device and read process data. Common Practice commands define functions that are generally applicable only to field devices. These include commands to change the range, select engineering units and perform self-tests.

The third set of commands, Device Specific, are different for each device. Device Specific commands implement unique configuration and adjustment functions. It is important to note that while devices from different manufacturers that externally implement similar functionality—for example, differential pressure measurement—may have completely different hardware and a similarly different Device Specific command set.

[1]HART Communication Foundation website
[2]Bell System Technical Reference, PUB 41212, Data Sets 202S and 202T Interface Specification, July 1976

What is a HART transmitter?

A traditional analog transmitter is fairly simple and straightforward. Typically, there are two types of possible adjustments: zero and span. Configuring, testing and calibration are all accomplished by changing these two adjustments to set the correct relationship between the input pressure and the 4–20 mA output.

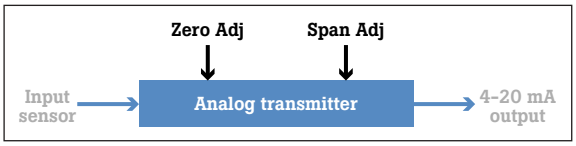


Figure 1. Analog transmitter block diagram

HART transmitters are considerably more complex. Like the older analog transmitters, HART transmitters have the same pressure input and 4–20 mA output, but in addition to the analog current loop output, there are a number of digital variables and settings contained in the device. Accessing these digital parameters requires the use of a HART configurator or communicator, and is critical to maintaining these devices. In fact, with many HART devices there is no way to maintain them without being able to gain access to the digital parameters.

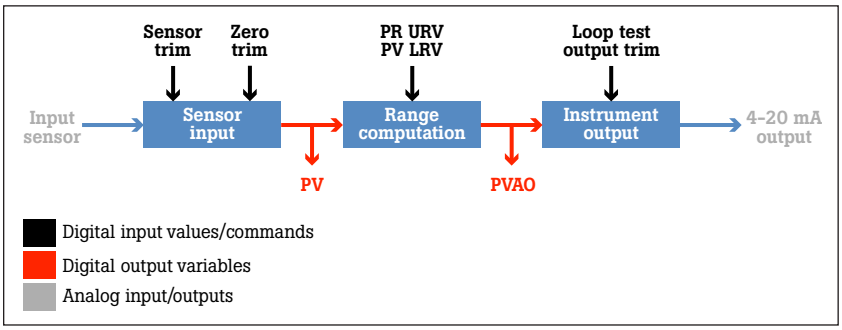


Figure 2. HART Smart transmitter block diagram

What types of maintenance are required?

Complete maintenance of a HART transmitter involves three distinct operations: configuration, calibration and adjustment. Often configuration tasks can be accomplished only with a communicator, but adjustment and calibration require equipment that can accurately source pressure and measure current. Most communicators do not have the capability to measure or source analog values.

Configuring a HART transmitter consists of communicating with the transmitter and verifying its configuration data. It is beyond the scope of this application note to list the many different types of pressure transmitters and configurations, but common configuration parameters are listed below:

Transmitter model	Type	Tag ID
Range	Date	Descriptor
Message	Minimum and maximum sensor limits	Minimum span
Upper range and lower range limits (URV, LRV)	Transfer function (linear, square root, etc.)	Damping
Transmitter S/N	Sensor S/N	Firmware version
Hart address	Security settings	Measurement variables

Calibrating a HART transmitter means to test and adjust its response so that the output accurately corresponds to the input throughout a specified range. To do this, an accurate source of pressure is required to apply a precisely known value to the transmitter. The output of the transmitter can then be compared to the known applied value, and an adjustment can be applied if needed. It is not possible to perform a calibration without comparing the transmitter's response to a known, physical pressure.

Adjustment is the act of correcting the transmitter's operation so that the output precisely matches the configured transfer function. In a common HART pressure transmitter there are several possible adjustment procedures:

- Reranging: sets the lower and upper range points at required pressures, similar to adjusting zero and span on an analog transmitter.
- Analog Output Trim: adjusts the transmitter's analog output to match external standards. This essentially adjusts the transmitters digital-to-analog converter.
- Zero Trim: adjusts the input sensor to compensate for pressure offsets, typically due to installation and orientation.
- Sensor Trim: adjusts the factory sensor. This adjusts the analog-to-digital converter to compensate for sensor errors.

The adjustments that need to be performed on a HART transmitter will depend upon how the transmitter outputs are used. If only the 4–20 mA analog output signal is used, then Reranging, Analog Output Trim and Zero Trim are appropriate adjustments. If the transmitter's digital outputs are used then Sensor Trim is necessary.

How the Fluke Calibration 2271A makes HART maintenance easier

The Fluke Calibration 2271A is a complete pneumatic pressure calibrator with a built-in electrical module that can measure the analog output of a HART Transmitter. This electrical measurement module also has a HART communicator that implements Universal and Common Practice commands. Having measure, source and digital device communication in a single device greatly simplifies configuring, calibrating and adjusting a HART transmitter.

The 2271A has several pre-configured HART tasks to automate and streamline common maintenance procedures:

- Trim PV Zero applies a specified offset pressure and performs a zero trim on the input sensor of the transmitter
- Trim Current Output commands the analog output to 4 mA and 20 mA values and performs an Analog Output Trim
- Trim by Re-Ranging applies accurate pressures to the input of the transmitter and adjusts the Lower Range Value (LRV) and Upper Range Value (URV), such that the analog 4–20 mA outputs are correct. This is similar to manipulating the Zero and Span adjustments on a purely analog transmitter. If the HART device is used only in analog service this can be an acceptable practice. If the HART device is used in digital service, re-ranging may not be appropriate, and a HART communicator that implements device specific commands that enables Sensor Trim in combination with the 2271A is recommended.
- Write LRV/URV allows quick setting of Lower and Upper Range Values.
- Hart Diagnostics executes a self-diagnostic routine in a HART device, not all HART devices implement self-diagnostics.
- Write PV Unit changes the Primary Variable engineering units within the HART device, for example to change from Bar to kPa.
- Write Tag provides a facility to change the short or long tag in the HART device
- Write Message enables you to write a short message (32 characters max) into the HART device
- Description writes a description message (16 characters max) to the HART device

Conclusion

The 2271A is an ideal solution for calibration laboratories and instrumentation shops that need to maintain HART pressure devices. By combining accurate pressure generation, a wide range of accurate pressure modules and basic electronic measurement with HART communication, the 2271A becomes the one piece of equipment that is needed for HART pressure device maintenance.

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Electrical | RF | Temperature | Pressure | Flow | Software

Fluke Calibration
PO Box 9090,
Everett, WA 98206 U.S.A.

Fluke Europe B.V.
PO Box 1186, 5602 BD
Eindhoven, The Netherlands

For more information call:
In the U.S.A. (877) 355-3225 or Fax (425) 446-5116
In Europe/M-East/Africa +31 (0) 40 2675 200 or Fax +31 (0) 40 2675 222
In Canada (800)-36-Fluke or Fax (905) 890-6866
From other countries +1 (425) 446-5500 or Fax +1 (425) 446-5116
Web access: http://www.flukecal.com

Printed in U.S.A. 6/2016 6008142a-en