Beamex

Calibration White Paper

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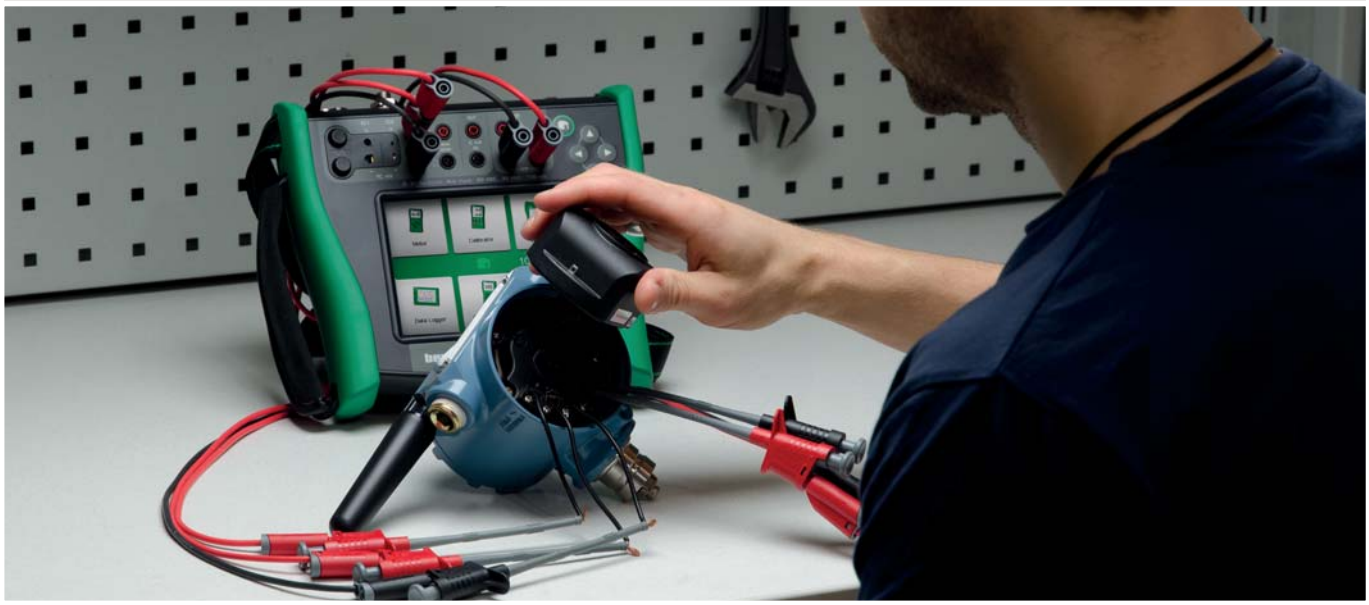

Calibrating *Wireless*HART transmitters

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WORLD-CLASS CALIBRATION SOLUTIONS

Calibrating *Wireless*HART transmitters

***Wireless*HART transmitters are becoming more popular. What are they and how do they differ from wired HART transmitters? Why do the *Wireless*HART transmitters need to be calibrated and how is the calibration done?**

A very brief history of HART

The HART (Highway Addressable Remote Transducer) protocol was developed in the mid-1980s by Rosemount Inc. for use with a range of smart measuring instruments. Originally proprietary, the protocol was soon introduced for free use, and in 1990 the HART User Group was formed. In 1993, the registered trademark and all rights in the protocol were transferred to the HART Communication Foundation (HCF). The protocol remains open and free for all to use without royalties (Source: HCF).

HART is a digital communication protocol that enables communication with a field device. The communication allows you to read and write settings, read measurement results, receive diagnostic data, etc.

Wired HART signal

The wired HART Protocol uses Frequency Shift Keyed (FSK) digital communication signal superimposed on top of the 4-20mA standard analog signal. The wired HART transmitter is compatible with analog control systems.

HART is a digital communication protocol that enables communication with a field device.

*Wireless*HART

*Wireless*HART was approved and ratified by the HCF Board of Directors, and introduced to the market in September 2007, becoming the first officially released industrial wireless communication standard. The *Wireless*HART network uses IEEE 802.15.4 compatible radios operating in the 2.4GHz radio band. Each device in the mesh network can serve as a router for messages from other devices. The *Wireless*HART transmitter does not have an analog mA signal. It only has the digital signal which is available wirelessly, or through a screw terminal.

Since the transmitter is wireless, power cannot be fed via cables; instead, the transmitter needs a battery for power. The battery life and communication speed are inversely proportional. Sometimes wireless transmitters can be programmed not to send a wireless signal very often which lengthens the lifespan of the batteries. The communication speed can also be increased if necessary. It is possible to use *Wireless*HART even on a control circuit. In practice, the *Wireless*HART transmitters are usually used in monitoring applications, which tend to change slowly, as well as in applications that are difficult to wire.

Any existing wired HART transmitter can also be made wireless by adding the wireless adapter available from many instrument manufacturers. If the control system is analog, reading only the mA signal, an additional *Wireless*HART host system can be built to process all of the additional information available in the HART devices. This can include information that is not available via the analog control system, for example, advanced diagnostics and predictive maintenance.

HART status and the future

Over 30 million HART devices are installed and in service worldwide. The wired HART technology is the most widely used field communication protocol for intelligent process instrumentation. The HART share equals nearly half of the installed base of intelligent transmitters. Various studies estimate growth for HART in the future as well. The new *Wireless*HART standard seems to be a new booster for the HART protocol. Data from studies predicts exponential growth for *Wireless*Hart over the next 10 years.

What is meant by “calibration”

According to international standards, calibration is a comparison of the device being tested against a traceable reference instrument (calibrator) and documentation of this comparison. Although calibration does not formally include any adjustments, in practice, adjustments are possible and often included in the calibration process.

What is meant by “configuration”

Configuration of a HART transmitter means changing

the transmitter settings and parameters. The configuration is typically done with a HART communicator or with configuration software.

It is important to remember that although a communicator can be used for configuration, it cannot be used for metrological calibration. Configuring parameters of a HART transmitter with a communicator is not metrological calibration and it does not assure accuracy. For a real metrological calibration, a traceable reference standard (calibrator) is always needed.

How to calibrate a wired HART transmitter

It is good to remember that a HART transmitter has two different outputs that can be used and calibrated: the analog mA output and the digital HART output. In most cases, customers still use the analog output.

To calibrate the analog output, generate or measure the transmitter input and at the same time measure the transmitter output. A dual function calibrator able to handle transmitter input and output at the same time is needed, or alternatively two separate single-function calibrators; for example if someone wants to generate a pressure input and measure it accurately with a calibrator and at the same time measure the analog mA output with an mA meter.

The calibration process changes slightly if you want to calibrate the digital HART output. Obviously it is still needed to generate/measure the transmitter input the same way as for an analog transmitter, using a calibrator. To see what the transmitter digital HART output is, some kind of HART communicator with the ability to show the digital HART signal is needed. A HART transmitter can have several digital variables depending on the transmitter type.

In the case of analog or digital output, you would progress through the range of the transmitter at a few points and record the input and output signals to document the calibration.

How to calibrate a *Wireless*HART transmitter

Firstly, it is good to remember that, although the *Wireless*HART transmitter has a different output than the wired HART transmitter, the *Wireless*HART transmitter also needs to be calibrated. As the calibration verifies the transmitter accuracy, i.e. the relationship between the physical input and transmitter output, the need for calibration does not change, whether wireless or wired, digital or analog.

The input of a *Wireless*HART transmitter needs to be generated (or measured) the same way as the analog or wired HART transmitter, using a reference standard or a calibrator. The output of the transmitter needs to be read at the same time. A *Wireless*HART transmitter does not have any analog output; it only has a digital output. The digital output can be read in two different ways.

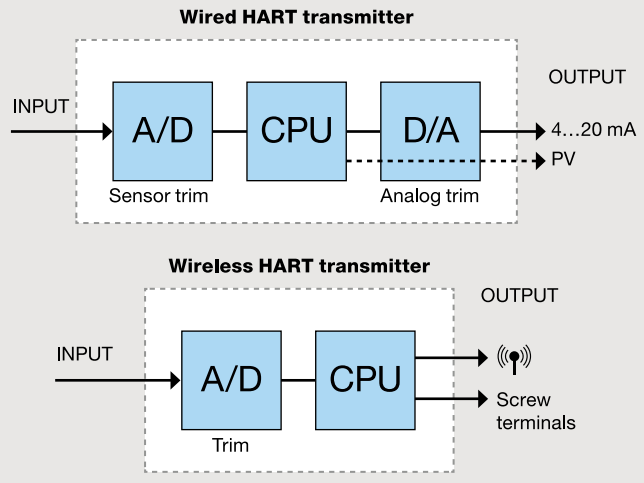
One way is to read the output signal wirelessly, but the wireless signal can be very slow. Depending on the transmitter configuration, it may be transmitting its output only once per minute. In any case, the wireless signal is not really suitable for calibration. For example, in the case of a pressure transmitter calibration, there may be small leaks in the pressure connections or hoses, causing the input to change rather frequently. If the output is read very seldom, there could be a significant uncertainty and error between the saved calibration input and output data. Also, if there is any need to trim (adjust) the transmitter, or make any other configurations, these cannot be done wirelessly.

All of the *Wireless*HART transmitters also have screw terminals allowing a wired connection with the transmitter.

All of the *Wireless*HART transmitters also have screw terminals allowing a wired connection with the transmitter. While being connected via the screw terminals, the digital output can be read quickly enough for calibration purposes and any configuration or methods, such as trimming methods, are accessible. Therefore, the *Wireless*HART transmitter should be calibrated with a wired connection to the transmitter's screw terminals.

The input can be generated or measured with a reference calibrator. The output needs to be read with a HART communicator that is able to read the transmitter via the screw terminals. Since the *Wireless*HART transmitters are made according to the HART7 standard protocol, a communicator able to support the HART7 standard is needed. If there is a separate calibrator for the input and communicator for the output, the readings will need to be manually written down and the calibration documented. However, if there is a calibrator and communicator built into one device, the

Wired and *wireless*HART transmitter



A principled block diagram of a wired and wireless HART transmitter

input and output can be handled simultaneously with the same device. If the device also has a documenting feature, the calibration can be automatically documented without paper.

If a wired HART transmitter needs to be trimmed, the sensor section (A/D conversion), as well as the analog (D/A conversion) section, will also need to be trimmed. In the case of the *Wireless*HART transmitter, there is no analog section, so it is enough to trim the sensor section.

Why calibrate

A modern transmitter is advertised as being smart and very accurate. Sometimes people may say that there is no need for calibration at all because the transmitters are so "smart." Why should smart transmitters be calibrated then?

First of all, changing of the output protocol of a transmitter does not change the fundamental need for calibration.

There are numerous reasons to calibrate instruments initially and periodically. The main reasons are:

- Even the best instruments do drift with time, especially when used in demanding processing conditions.
- Regulatory requirements, such as quality systems, safety systems, environmental systems, standards, etc.
- Economic reasons: any measurement has direct economic effects.
- Safety reasons: employee safety as well as customer/patient safety.
- To achieve high and consistent product quality and to optimize processes.
- Environmental reasons.

The Beamex MC6 field calibrator and communicator

The new Beamex MC6 is a device that combines a field communicator and an extremely accurate multifunctional process calibrator.

With the Beamex MC6, the smart transmitter's input can be generated/ measured at the same time the digital output is read. Thus, they can be done simultaneously and the results can be automatically stored into the MC6 memory for later viewing or uploading to calibration software.

For configuration of the smart transmitters, the MC6 includes a field communicator for HART, *Wireless*HART, FOUNDATION Fieldbus H1 and Profibus PA protocols. All required electronics are built-in, including power supply and required impedances for the protocols.

The Beamex MC6 can therefore be used both as a communicator for configuration and as a calibrator to calibrate smart instruments with the supported protocols.

While a normal HART communicator can be used to configure and read the HART digital output, it alone cannot be used to calibrate or trim transmitters. You will need an additional calibrator for that purpose, which leads to a situation where you need two separate devices, which lack the automatic calibration procedure and documentation. Therefore, a device such as the Beamex MC6, is superior for calibration of wired or wireless HART transmitters.

Example

■ Let's take an example of calibrating an Emerson 648 *Wireless*HART temperature transmitter. The transmitter is configured for RTD measurement with sensor type Pt100 (Alpha385). Disconnect the RTD sensor and connect the MC6 to simulate the RTD sensor. Connect the MC6's HART terminal to the transmitter's screw terminals and configure the MC6 to read the Primary Variable (PV) of the transmitter, which is the digital output. The range to be calibrated is 0 °C to 100 °C (32 °F to 212 °F). Configure the MC6 to progress the input signal from 0 to 100 °C (32 °F to 212 °F) in steps of 25%, stepping up and down. Then configure the MC6 to wait 10 seconds in each step to allow the transmitter to stabilize. Of course the transmitters damping should be taken into account when deciding the calibration delay. In completing these steps, we have programmed the maximum error tolerance to 0.5% of the full scale.

When the connections are complete, calibration can begin. The calibration will go through the required input steps fully automatically, stopping for the delay, and then going on to the next step. Once the calibration is completed, a dialog will appear stating whether the calibration was successful or not (Pass/Fail). Next, save the calibration into the MC6's memory. Later on, upload the calibration results to calibration management software to be saved in the database and print a calibration certificate if necessary.

If the As-Found calibration failed, or you want to trim the transmitter, you can use MC6 HART communication. While trimming, it is possible to simultaneously simulate the required input with the MC6, so no other device is needed. Once the calibration is completed, run another automatic calibration procedure to perform an As-Left calibration.