HART® Transmitter Calibration Made Easy

Application Note

Introduction

In today's process plants, most new field instruments are *smart* digital instruments. *Smart* implies a microprocessor-based instrument with extra functionality and digital compensation, supporting multiple sensor types or multiple variables. These instruments generally offer better accuracy, long-term stability, and reliability than conventional analog instruments.

The most common class of smart instruments incorporates the HART protocol, with more than five million HART instruments in use in 100,000 plants worldwide. HART, an acronym for Highway Addressable Remote Transducer, is an industry standard that defines the communications protocol between smart field devices and a control system that employs traditional 4-20 mA wiring.

Two capabilities are required to properly service HART instruments: precision analog source and measure capability and digital communication capability. Until recently, this required two separate tools, a calibrator and a communicator. Today, the capabilities of those two tools are available in a single HART Documenting Process Calibrator that can help you quickly and effectively service HART instruments.

HART® COMMUNICATION PROTOCOL

HART calibration is required!

A common misconception is that the accuracy and stability of HART instruments eliminate the need for calibration. Another misconception is that calibration can be accomplished by re-ranging field instruments using only a HART communicator. Still another misconception is that the control system can remotely calibrate smart instruments. *These are not true.* All instruments drift. Re-ranging with just a communicator is not calibration. A precision calibrator or standard is required. Regular performance verification with a calibrator traceable to national standards is necessary due to:

1. Shifts in performance of electronic instruments over time, due to exposure of the electronics and the primary sensing element to temperature, humidity, pollutants, vibration, and other field environmental factors.
2. Regulations governing occupational safety, consumer safety, and environmental protection.
3. Quality programs such as ISO 9000 standards for all instruments that impact product quality.
4. Commercial requirements such as weights, measures, and custody transfer.

Regular calibration is also prudent since performance checks will often uncover problems not directly caused by the instrumentation, such as solidified or congealed pressure lines, installation of an incorrect thermocouple type, or other errors and faults.

A calibration procedure consists of a verification (As Found) test, adjustment to within acceptable tolerance if necessary, and a final verification (As Left) test if an adjustment has been made. Data from the calibration are collected and used to complete a report of calibration, documenting instrument performance over time.

All instruments, even HART instruments, must be calibrated on a regular, preventive maintenance schedule. The calibration interval should be set short enough to insure that an instrument never drifts out of tolerance, yet long enough to avoid unnecessary calibrations. Alternatively, the interval may be determined by critical process requirements, e.g., calibration before each batch.

How are HART instruments *properly* calibrated?

To calibrate a HART instrument consistent with its application, it is very helpful to understand the functional structure of a typical HART transmitter.

HART instruments consist of three distinct sections (see Figure 1). Proper HART calibration may involve either or both sensor trim and output trim. Adjusting range values (LRV and URV) without a calibrator is not calibration. Performing an output trim while ignoring the input section is not proper calibration. *Adjusting range values with a calibrator may be a practical calibration alternative for instruments operated in 4-20 mA analog mode, provided that the PV and PVAO are not used for process control.*

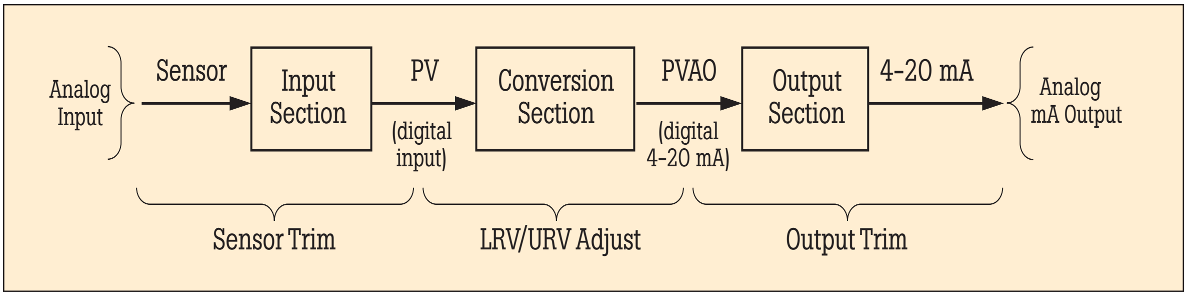

Figure 1.

Figure 2.

New tool speeds calibration

Today, instrument maintenance is moving out of the shop and into the field. This reduces process interruptions and avoids the time and expense of returning instruments to the shop. Portable communicators and calibrators are often used together to complete field calibrations. However, the desire to carry less equipment and to perform maintenance in the field has created a need for a new class of calibration tool.

The new 754 Documenting Process Calibrator from Fluke is a powerful yet easy-to-use tool for field calibration of HART instrumentation. Pressing a single key enters the HART mode and displays the essential HART information in the Active Device Screen, shown in Figure 2. Additional HART functionality is accessed with only a few more keystrokes, per the menu tree in Figure 3.

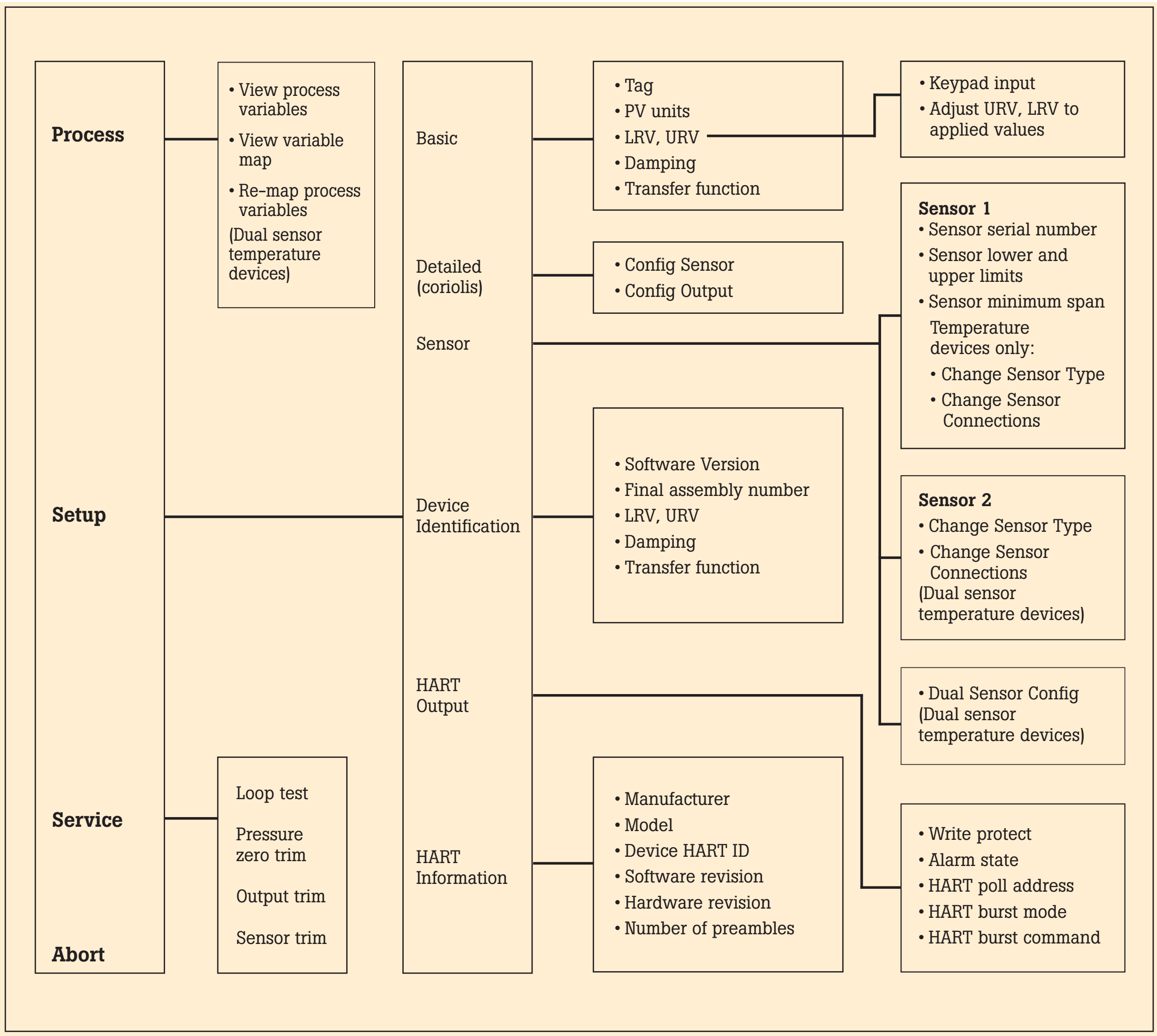

Figure 3.

No communicator is required!

The 754 requires no external box or communicator for everyday HART calibration and maintenance. It supports many popular models of HART transmitters, with more device-specific command support than any other HART field calibrator.

- Interrogate HART devices to determine type, manufacturer, model, tag-ID, PV, and PVAO
- Perform automated HART sensor trim and output trim for selected devices
- Adjust ranging, damping, and other basic process–configuration settings
- Read and write HART tag and message fields to re-label smart transmitters
- Clone additional transmitters with basic HART configuration data

Example 1

Calibration of a Rosemount 3051 HART Pressure Transmitter

Basic connections

This example assumes that the transmitter is isolated from the process and is not electrically connected to a loop power supply. Make basic connections to the 3051 per the diagram in Figure 4. A separate 250 ohm resistor is not necessary because the 754 incorporates a resistor in series with the loop supply through its mA jacks. The 3051 in this example is configured for mbar units.

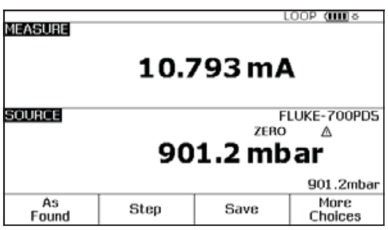

Figure 4.

Procedure

1. Power on the Fluke 754 Calibrator. Press the red HART key followed by the **Loop Power** softkey and the 754 will display the basic HART information for the 3051 (Figure 5).

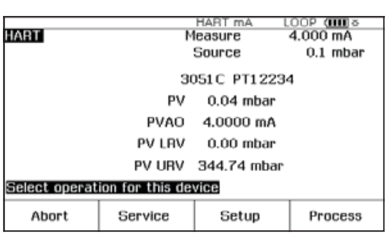

Figure 5.

2. Press the HART key again and you are prompted to select the 754 configuration (Figure 6). Selecting **MEAS mA, SOURCE mbar** will configure the calibrator to measure the analog mA output and the pressure being applied simultaneously to the transmitter input and the pressure module. (Selecting **MEAS PV, SOURCE mbar** will configure the 754 to evaluate the digital PV output from the transmitter.) Press ENTER to select.

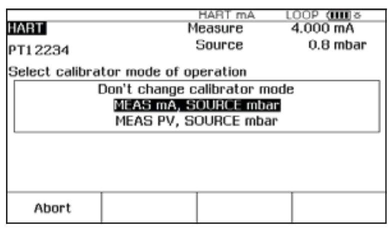

Figure 6.

3. Vent the pressure line and press CLEAR (ZERO) to zero the pressure module. Press the **As Found** softkey, and then press ENTER to select **Instrument** for a linear transmitter calibration. (If the 3051 is configured for square root output, select √ **Instrument**.) Notice that the calibration template is automatically completed with the exception of Tolerance. Fill in the appropriate test tolerance and press **Done**.
4. Press the **Manual Test** softkey to begin calibration. Apply the input pressures as instructed in the SOURCE screen. Press the **Accept Point** softkey when the correct pressure is applied for each point. When the test is complete, the error summary table is displayed (Figure 7). Test errors exceeding the tolerance are highlighted. When done viewing the table, press the **Done** softkey. Press **Done** again to accept, or ENTER to change the tag, serial number or ID fields.

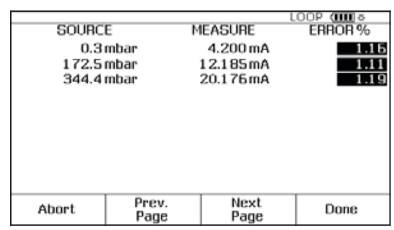

Figure 7.

5. If the As Found test failed (i.e., there were highlighted errors in the error summary table), adjustment is necessary. Press the **Adjust** softkey. Select **Sensor Trim** and press ENTER. (Do not select **Pressure Zero Trim**. It is the same as trimming the lower sensor point at zero, which is useful for pressure transmitters that do not offer Sensor Trim.) The 754 screen should look like Figure 8.

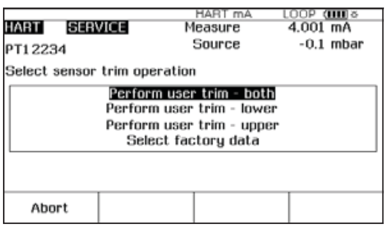

Figure 8.

6. Select **Perform user trim – both** and press ENTER. Zero the pressure module (vented to atmosphere) by pressing CLEAR (ZERO). Press the **Continue** softkey and you are prompted for the Lower Trim value. For best results, apply the LRV pressure and press **Fetch** to load the value being measured by the pressure module. Press **Trim**. Then press **Continue** to move to the Upper Trim. As before, apply the URV pressure, press **Fetch**, and press **Trim**. If the 3051 is used with the digital PV output, skip to step 8 and perform the As Left test. If the 4–20 mA analog output is used in the process, continue on to step 7.

7. Select **Output Trim** and press ENTER. The value of the primary variable (PVAO) is in the upper right corner of the display. This is normally a 4 mA signal. The mA value, as constantly measured by the Fluke 754, is in the center of the display. Press the **Fetch** softkey to load the measured mA value. Press **Send** to *send* the value to the 3051 to trim the output section for the 4 mA value. Press **Continue** for the 20 mA trim and repeat this step.

8. After completing Output Trim, press the **Done** softkey and proceed with the As Left verification test. Press the **As Left** softkey. Press **Done** and then press **Manual Test**. Apply the requested pressures and press **Accept Point** when the readings are stable. On completion an error summary table is displayed. If none of the errors are highlighted (Figure 9), the 3051 passes the calibration test. If errors are highlighted, the test has failed and further adjustment is required. Return to step 5 for adjustment of the 3051.

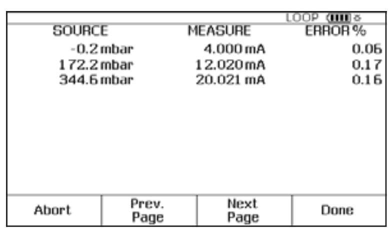

Figure 9.

Example 2

Calibration of a Rosemount 3144 HART Temperature Transmitter

Basic connections

This example assumes that the transmitter is isolated from the process and is not electrically connected to a loop power supply. Make basic connections to the 3144 per the diagram in Figure 10. A separate 250 ohm resistor is not necessary because the 754 incorporates a resistor in series with the loop supply through its mA jacks. The 3144 in this example is configured for a type K thermocouple sensor with a span of 0 °C to 300 °C.

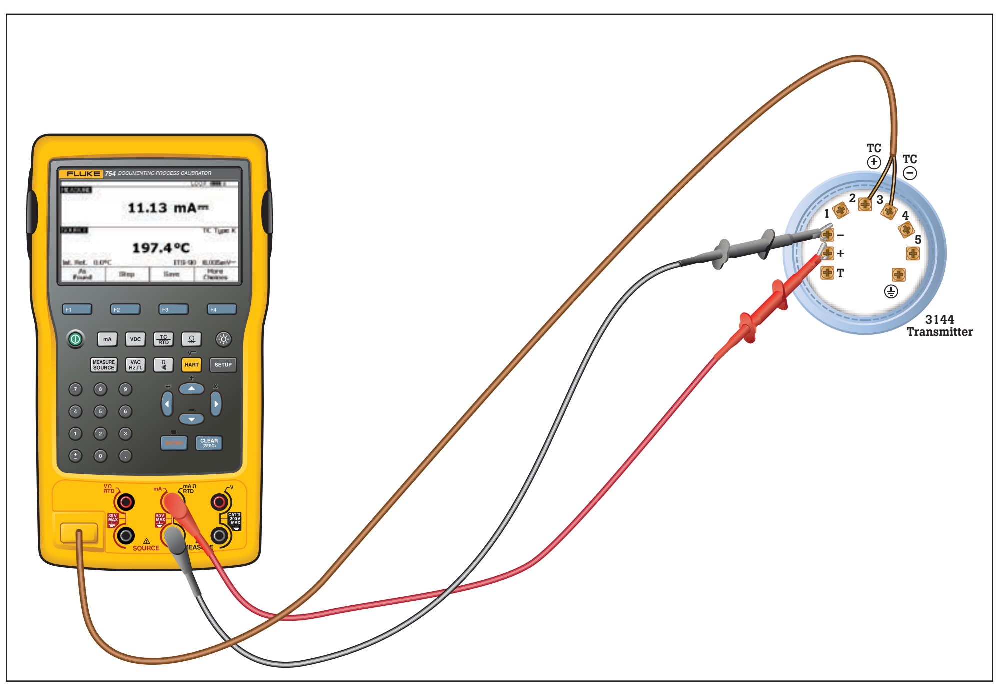

Figure 10.

Procedure

1. Power on the Fluke 754 HART Calibrator. Press the red key followed by the **Loop Power** softkey. Press ENTER to bypass the warning screens and the 754 will display the basic HART information for the 3144 (Figure 11).

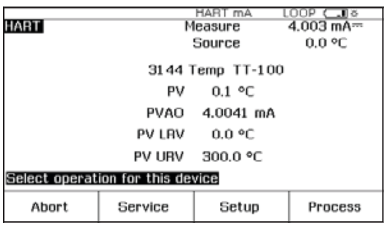

Figure 11.

2. Press the HART key again and you are prompted to select the 754 configuration (Figure 12). Selecting **MEAS mA, SOURCE T/C typ K** configures the calibrator to measure the analog mA output of the transmitter and source the correct temperature stimulus at the 3144 input. (Selecting **MEAS PV, SOURCE T/C typ K** will configure the 754 to evaluate the digital PV output from the transmitter.) Press ENTER to select.

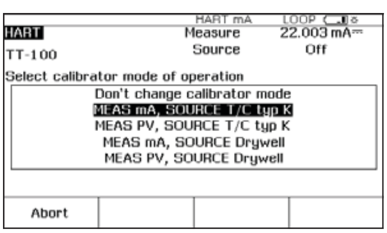

Figure 12.

3. Press the **As Found** softkey, and then press ENTER to select **Instrument** for a linear transmitter calibration. Notice that the calibration template is automatically completed with the exception of the Tolerance. Fill in the appropriate test tolerance and press the **Done** softkey.

4. Press the **Auto Test** softkey to begin calibration. Once the test is complete, an error summary table is displayed (Figure 13). Test errors exceeding the tolerance are highlighted. When done viewing the table, press the **Done** softkey. Press **Done** again to accept, or ENTER to change the tag, serial number or ID fields.

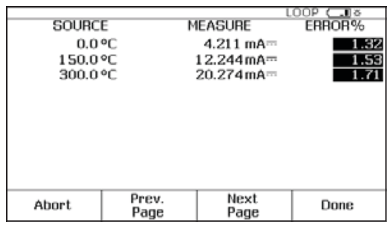

Figure 13.

5. If the As Found test failed (i.e., there were highlighted errors in the error summary table), adjustment is necessary. Press the **Adjust** softkey. Select **Sensor Trim** and press ENTER. Select **Perform user trim – both** and press ENTER. The 754 screen should look like Figure 14.

6. For best results, press **LRV** to apply the LRV for the Lower Trim value. Press **Trim** and then **Continue** to move to the Upper Trim. Press **URV**, press **Trim**, and then press **Done**. If the 3144 is used with the digital PV output, skip to step 8 and perform the As Left test. If the analog 4-20 mA output is used in the process, continue on to step 7.

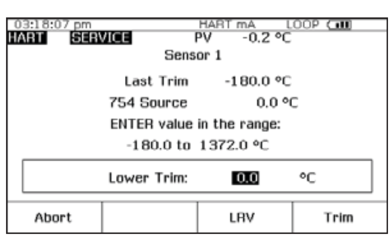

Figure 14.

7. Select **Output Trim** and press ENTER. The value of the primary variable (PVAO) is in the upper right corner of the display. (Figure 5). This is normally a 4 mA signal. The mA value, as constantly measured by the Fluke 754, is in the center of the display. Press the **Fetch** softkey to load the measured mA value. Press **Send** to *send* the value to the 3144 to trim the output section for the 4 mA value. Press **Continue** for the 20 mA trim and repeat this step.

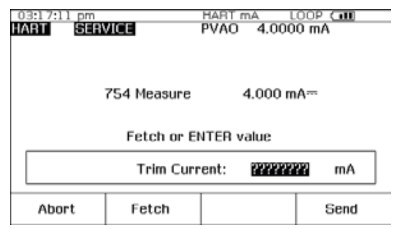

Figure 15.

8. After completing Output Trim, press the **Done** softkey and proceed with the As Left verification test. Press the **As Left** softkey. Press **Done** and then press **Auto Test**. On completion, an error summary table is displayed. If errors are highlighted, the test has failed and further adjustment is required. Return to step 5 for adjustment of the 3144.

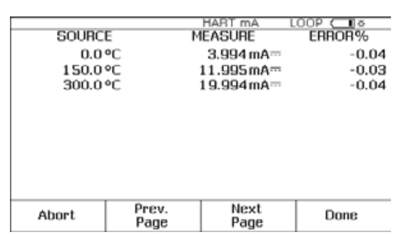

Figure 16.

Note on Uploading Results to Your PC

If you are using a 743/744 or 753/754, you may choose an instrumentation management software package from this list:

Fluke DPC/TRACK2™

AMS from Emerson Process Management, (formerly Fisher-Rosemount).

PRM (Plant Resource Manager) from Yokogawa Electric Corporation.

Prime Technologies

ProCalV5 calibration management software

meridium

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Ordering information

FLUKE-753 Documenting Process Calibrator
FLUKE-754 Documenting Process Calibrator-HART
Standard accessories include: Three sets of stackable test leads, three sets of TP220 Test Probes with three sets of "extended tooth" alligator clips, two sets AC280 Hook Clips, BP7240 Li-ion Battery Pack, BC7240 Battery Charger, C799 Field Soft Case, USB communication cable, getting started guide, instruction manual on CD-ROM, NIST traceable certificate of calibration, DPC/TRACK2 sample software that enables upload and printing of calibration records, three-year warranty. Model Fluke-754 includes HART communication cable.

FLUKE-750SW DPC/TRACK2 Software
Included with DPC/TRACK software: Software media, instruction manual, USB cable.

FLUKE-750-Pxx Pressure Modules
Included with each Fluke Pressure Module: Adapters, instruction sheet, NIST traceable calibration report and data, three-year warranty.

Accessories

Fluke-700PMP	Pressure Pump; 100 psi/7 bar
Fluke-700LTP-1	Low Pressure Test Pump
Fluke-700PTP-1	Pneumatic Test Pump; 600 psi/40 bar
Fluke-700HTP-2	Hydraulic Test Pump; 10,000 psi/700 bar
Fluke-700HTH-1	Hydraulic Test Hose
Fluke-700PRV-1	Pressure Relief Valve Kit for HTP
Fluke-700-IV	Current Shunt (for mA/mA applications)
Fluke-700PCK	Pressure Calibration Kit
Fluke-700TC1	TC Mini-Plug Kit, 9 types
Fluke-700TC2	TC Mini-Plug Kit, JKTERS
Fluke-700TLK	Process Test lead kit
754HCC	Smart Instrument Communication Cable
BC7240	Battery Charger
BP7240	Li-on Battery Pack
C700	Hard Carrying Case
C781	Soft Carrying Case
C799	Field Soft Case

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