



MasterCAL

Calibrator

HART[®] Mode Users Guide

June 2004

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MasterCAL

HART Mode Users Guide

Calibrator HART Mode

Introduction

Warning

To avoid electric shock, read the Safety Information in the *MasterCAL Users Manual* before you use the Beta MasterCAL Calibrator.

With analog transmitters, you must make a hardware adjustment during calibration. With HART® (Highway-Addressable Remote Transducer) transmitters, adjustments are by remote command. These adjustments require the use of a communication tool as well as a calibrator. The Beta MasterCAL, hereafter called “calibrator,” provides communication and calibration functions in one tool.

This manual describes how to use HART mode, which is active when the calibrator is communicating over its serial HART interface to a HART transmitter. Refer to the *MasterCAL Users Manual* for safety, analog mode operating instructions, specifications, and other general information. All of the calibrator functions described in the *MasterCAL Users Manual* are available and can be used with HART transmitters. The only transmitters addressed in this manual are HART transmitters.

How to Contact Beta

To contact Beta in USA and Canada call:

Beta Calibrators Corporation
a unit of Martel Electronics
2309 Spinglake Road, #600
Farmers Branch, TX 75234-5875

800-537-2181


972-241-2200


www.betalibrators.com

Connecting to a HART Transmitter



To connect to and begin to communicate with a HART transmitter, refer to Figure 1 and proceed as follows:

Note

If you only want a communication connection to a transmitter that is powered in a loop, simply clip the HART alligator clips to the loop power terminals on the transmitter, press , and you are done.

1. Connect the calibrator mA jacks to the loop power terminals of the transmitter.
2. Plug the HART interface cable into the SERIAL PORT, then connect the alligator clips to the same terminals as in step 1. There is no right or wrong polarity.
3. Press the  key.

Note

The square-root symbol on  key is there only for calculator mode. At all other times, there is no square-root function associated with the  key.


4. If the transmitter is not powered by a loop power supply, press the Loop Power softkey to activate 24V loop power.


Note

The calibrator provides loop power through an internal series resistance of 250 Ω .

If the calibrator shows a measurement of 0 mA, check for reversed current leads.

If an external loop power supply is used, there must be a resistance of between 230 Ω and 270 Ω connected in series with the external loop supply and the transmitter.

5. The calibrator tries Poll Address 0 (single transmitter per loop). If no connection is made, press the Poll softkey to scan Poll Addresses 1 through 15 (multidrop).
6. Once the calibrator establishes communication with the transmitter, the Active Device screen appears. In the case of a multidrop configuration, you must choose a transmitter from a list, and press .

Loop 24V 			
HART			
Measure		19.118 mA	
Source		12.676 psi	
2088 PT-306-1			
PV		12.69 psi	
PVAO		19.1260 mA	
PV LRV		0.00 psi	
PV URV		14.20 psi	
Select operation for this device			
Abort	Service	Setup	Process

pe06s.bmp

The Active Device screen provides the following information for all transmitters, supported or generic:

- Poll address (if not 0)
- Model number and Tag ID
- PV (Primary Variable)
- PVAO (digital representation of the Analog Output)
- PV LRV (PV Lower Range Value)
- PV URV (PV Upper Range Value)
- Softkeys for accessing HART operation menus

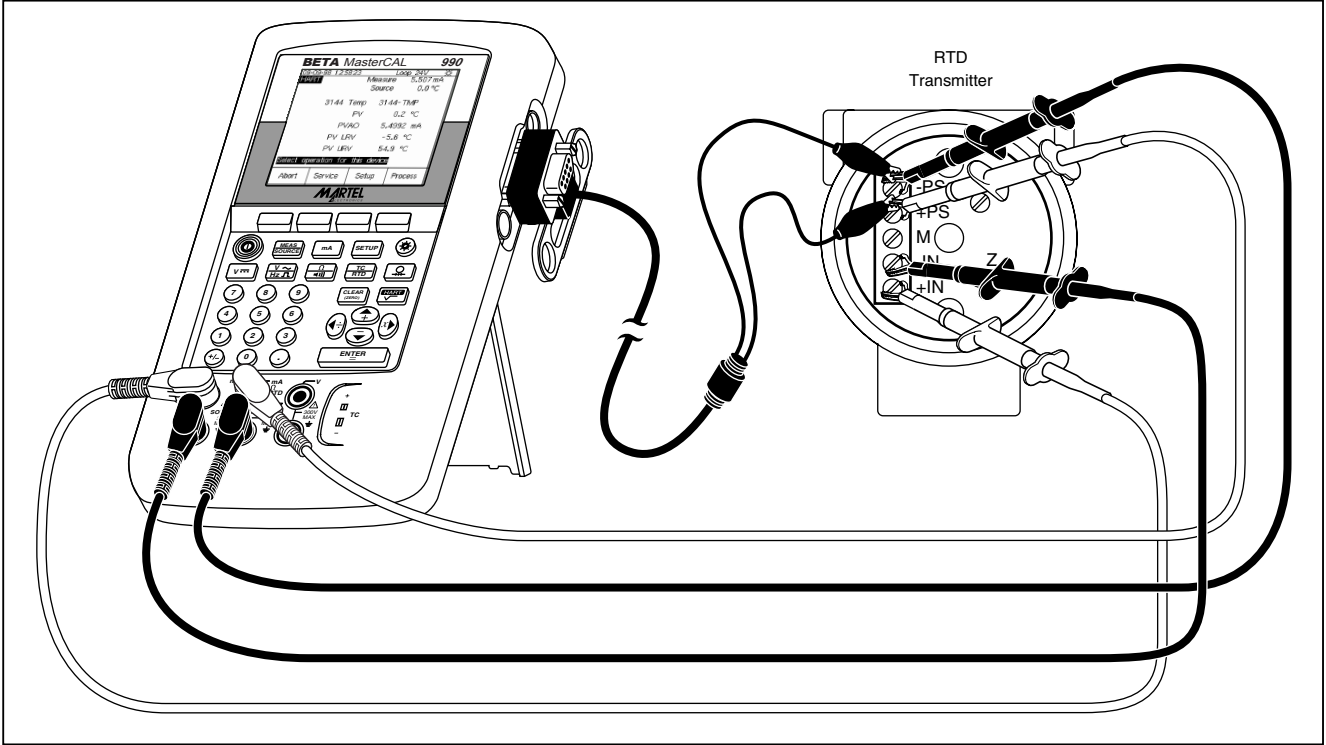


Figure 1. Connecting to a HART Transmitter

pe01c.eps

Supported vs. Generic Transmitters

The calibrator communicates with virtually all HART transmitters. In addition, the calibrator is programmed to use device-dependent commands for a selection of HART transmitters and their software versions. These are “supported transmitters.” All other transmitters are “generic.”


Table 1 shows the operations that are available for supported vs. generic transmitters in single point and multidrop configurations.

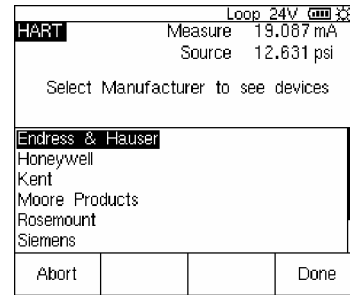
Note

Sensor trim is provided for supported transmitters, with a few exceptions, as identified in the list of supported transmitters that you can view on the display.

To display a list of supported transmitters and software versions:

1. If the calibrator is connected to a HART transmitter with the Active Device screen showing, press the **Abort** softkey, followed by **More Choices**.

2. If the calibrator is not connected to a HART transmitter, press the  key followed by **More Choices**.
3. Press the **Device Revs** softkey. The Browser screen appears.



pe07s.bmp







4. Press  or  to highlight the desired manufacturer, and press . A list of model numbers appears.
5. Press  or  to highlight the model number, and press . A list of software versions appears.

Table 1. Supported vs. Generic Transmitters (Devices)


Menu	Operation	Supported Transmitter		Generic Transmitter	
		Single Point	Multidrop	Single Point	Multidrop
Top Level	Active Device screen	●	●	●	●
Setup	Basic (read/write, cloning capability)	●	●	●	●
	Sensor (read only)	●	●	●	●
	Temperature Sensor (read/write)	●	●		
	Device Identification (read/write)	●	●	●	●
	HART Output (read/write)	●	●	●	●
	HART Information (read only)	●	●	●	●
Service	Loop Test	●	Not Available	●	Not Available
	Pressure Zero Trim	●	●	●	●
	Output Trim	●	Not Available	●	Not Available
	Sensor Trim	●	●	Not Available	Not Available
Process	Detailed process information	●	●	●	●

Communication Operations

Figure 2 shows the HART Mode menu tree. Availability of some elements in the menus depends on which transmitter you are using, and whether the transmitter is configured by itself on a current loop or in a multidrop connection.

Viewing Process Variables

From the Active Device screen press the **Process** softkey to view more device variables and their continuously updated values. To see additional information, press the **Next Page** softkey.

Loop 24V 			
HART PROCESS	Measure	3.982 mA	
	Source	Off	
2088 PT-306-1			
	Pres	-0.01 psi	
	% rnge	-0.063 %	
	AO	3.9910 mA	
		Next Page	Done

pe08s.bmp


Setup Operations

The **Setup** softkey provides access to the following five setup functions:

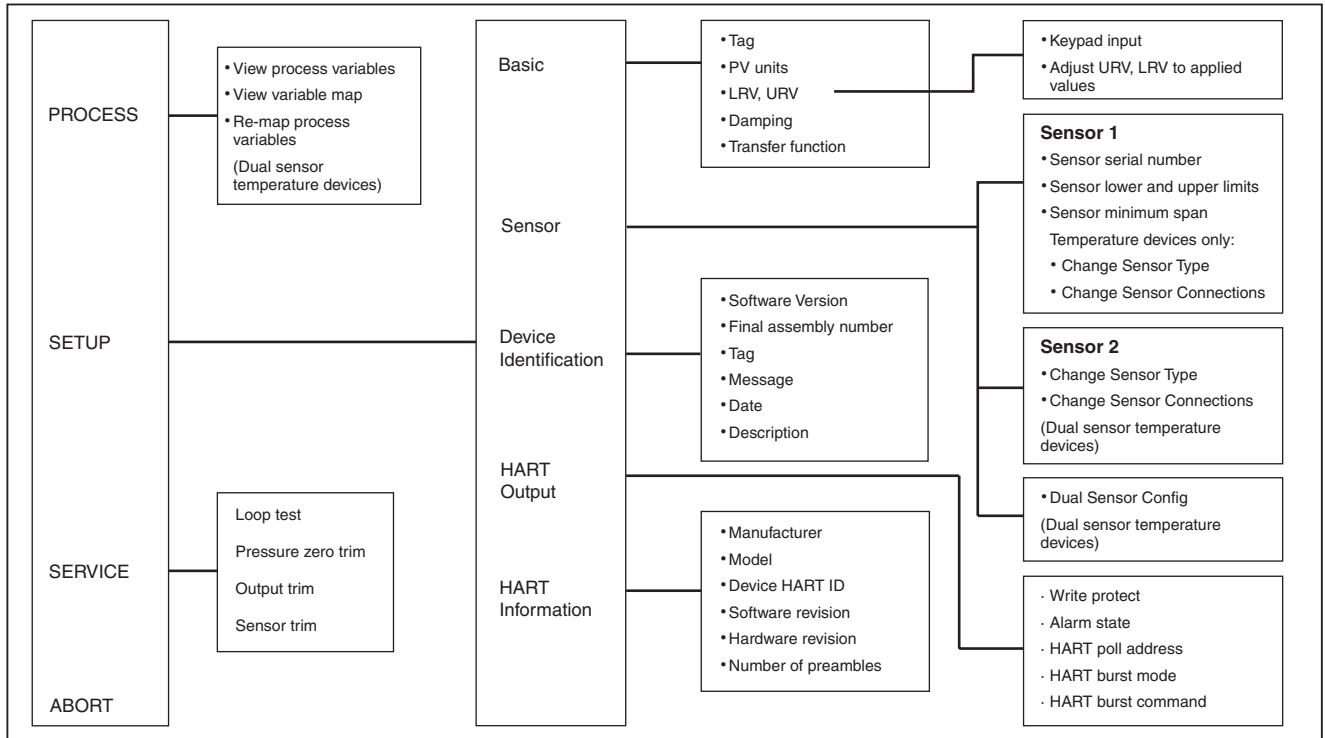
- Basic
- Sensor
- Device Identification
- HART Output
- HART Information

Basic

From the Active Device screen press the **Setup** and **Basic** softkeys to access the read/write Basic Setup screen. You can use this screen to clone a transmitter as described at the end of this manual.

Loop 24V 			
HART SETUP	Measure	3.985 mA	
Press ENTER to change item			
	Tag	PT-306-1	
	PV Unit	psi	
	Lower Range Value	0.00 psi	
	Upper Range Value	14.20 psi	
	Damping	0.0000 s	
	Transfer Function	Sq root	
Store Page	Recall Page	Reset Page	Done

pe09s.bmp



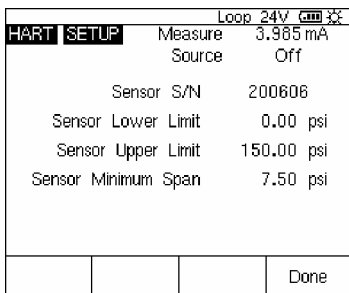
pe03f.eps

Figure 2. MasterCAL HART Mode Menu Tree

Sensor

From the Active Device screen press the **Setup** and **Sensor** softkeys to access the Sensor Setup screen. This is where you can view information about the sensor in the transmitter, including serial number, limits, and span. The limits shown are the absolute limits for the sensor. (The Upper Range Value (URV) and Lower Range Value (LRV) are different, and are viewable and programmable through the Basic Setup screen.)

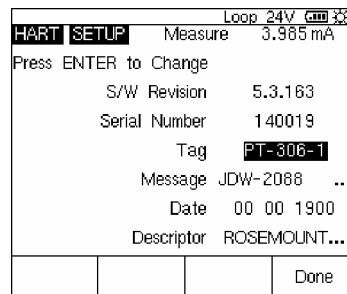
You can also program the Sensor Type and Sensor Connection registers in a supported temperature transmitter using this screen. (Screen examples do not reflect Temperature device menu items.)



pe10s.bmp

Device Identification

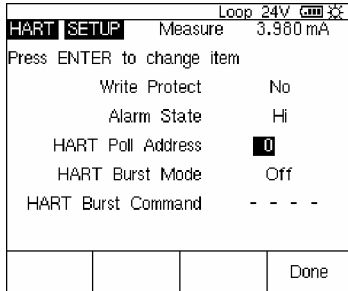
From the Active Device screen press the **Setup** and **Device Identification** softkeys to view information about the transmitter. You can program the Tag, Message, Date, and Descriptor registers in the transmitter using this screen.



pe11s.bmp

HART Output

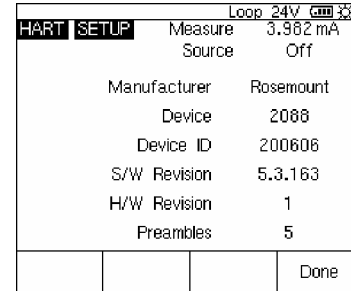
From the Active Device screen press the **Setup** and **HART Output** softkeys to access the read/write HART Output screen. Here you can change the Poll Address (0 = single transmitter, any other address = multidrop), and control burst mode.



pe12s.bmp

HART Information

From the Active Device screen press the **Setup** and **HART Information** softkeys to access the read-only HART Information screen. This screen shows more complete information about the transmitter model, hardware and software revision numbers, and how many preambles it sends.



pe13s.bmp

Service Operations

The **Service** softkey provides access to Loop Test, Pressure Zero Trim (where applicable), Output Trim, and Sensor Trim operations. For generic transmitters, only Loop Test, Output Trim, and Pressure Zero Trim are available. (See Table 1.) The trim (adjustment) operations are described later in this manual.


Note



Loop Test and Output Trim are not available if the transmitter is in multidrop mode.

Abort Softkey

The **Abort** softkey terminates the communication operation underway, and returns control to the previous screen. From the Active Device screen, **Abort** calls up the browser, in which you can view the list of supported transmitters.


Interaction between Analog Mode and HART Mode

Analog mode is normal calibrator operation, as described in the *MasterCAL Users Manual*. HART mode is activated when you press the  (HART) key. This action starts communication over the HART interface.

You can switch between HART and analog modes easily by pressing  (or pressing  to go to analog mode from HART mode), gaining the benefit of having the transmitter automatically set up analog mode for appropriate measure and source functions, if desired.

For supported transmitters, the transition to analog mode goes to the MEASURE/SOURCE screen, which provides an easy way to proceed with an “as found” calibration.

For generic transmitters, the transition to analog mode involves choosing the MEASURE or SOURCE screen, from which you select the appropriate function.

For supported or generic transmitters, when you press  to return to HART mode, the Active Device screen is displayed. The HART serial communication connection remains active as you switch between HART and analog modes.

Understanding HART Calibration

An analog transmitter has one stage of electrical conversion from a measured physical parameter to a 4-20 mA current loop output. A HART transmitter has the three stages shown in Figure 3.

Depending on how the transmitter is used in your application, you may need to test and adjust the Input stage, the Output stage, or both. For example, if your application requires the Primary Variable (PV) to be correct when read by a host computer, you must calibrate the Input stage.

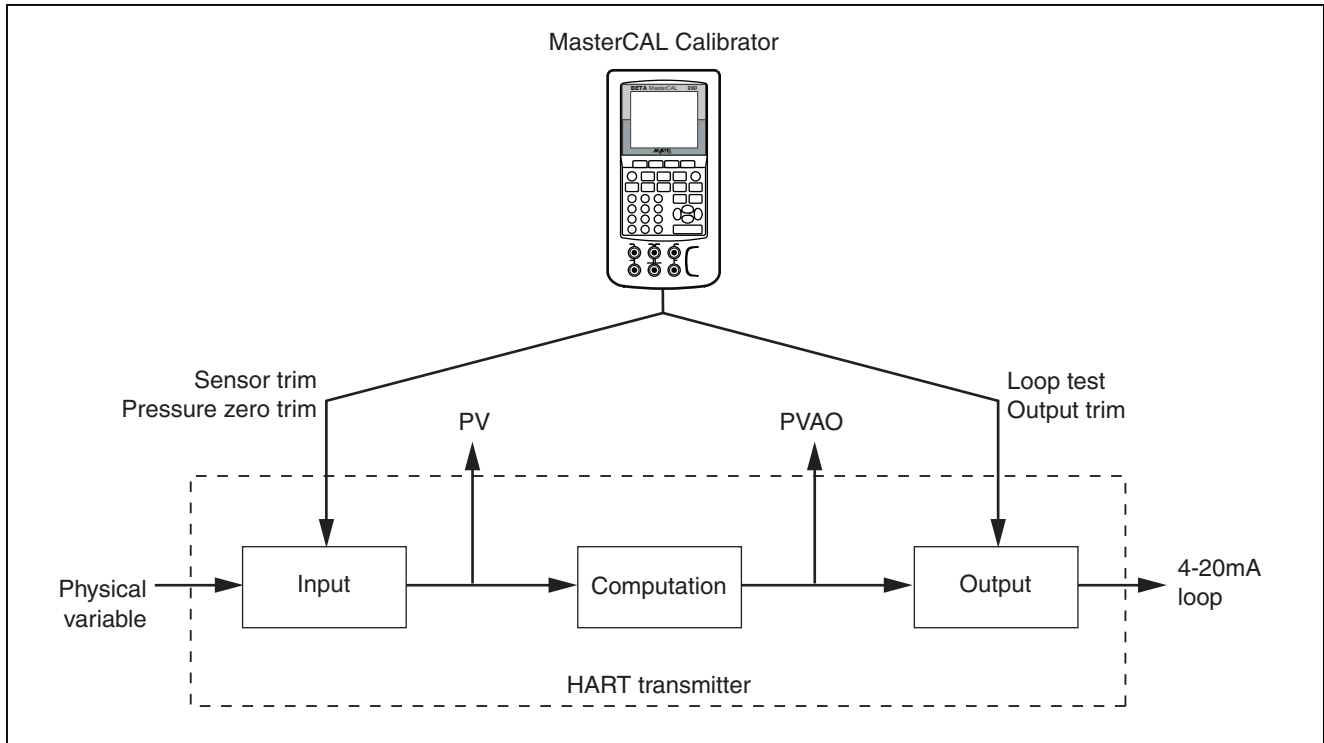
If your application requires that the 4-20 mA current output value accurately reflect what the Input stage is measuring, you must calibrate both the Input and Output stages.

Transmitters in multidrop systems, in which more than one is wired in parallel, do not use their Output stages at all. Their analog outputs are all held at an idling level of 4 mA no matter what the Input stage is measuring.

MasterCAL HART Mode Menus for Adjustment

In MasterCAL HART mode, adjusting the Input stage is called **Sensor Trim**. Adjusting the Output stage is called **Output Trim**. Both adjustments are made from the **Service** menu.

For pressure transmitters, there is another adjustment, called **Pressure Zero Trim**. This adjustment is the same as trimming the lower sensor point at zero. All three operations are run from the MasterCAL HART mode **Service** menu.



pe02f.eps

Figure 3. Block Diagram of a HART Transmitter



Calibrating a Supported HART Transmitter

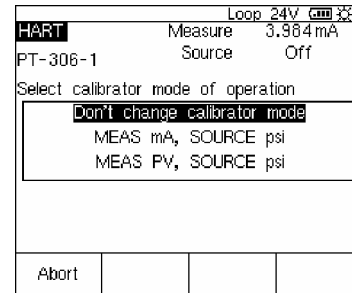
An “as found” and “as left” transmitter calibration has an easier, more automated process for HART transmitters than for analog transmitters. The calibration procedure is the same as described in the *MasterCAL Users Manual*, except for how you set up the calibration template, and how you adjust the transmitter.

Note







If you are starting a calibration procedure from a loaded Task, connect to the HART transmitter first and establish communication before you press Task in analog mode.

The following procedure assumes that you are familiar with using a MasterCAL Calibrator to calibrate analog transmitters, and are not running a loaded Task.

1. Make the appropriate measuring, sourcing, and HART interface connections between the calibrator and the transmitter, and press  to establish communication.
2. Press  to switch to analog mode.



pe14s.bmp

3. You are presented with a set of choices for analog mode. Use the  and  keys to select one of the measure/source choices. This is where you select measure mA (analog output), or measure PV, which does not involve the Output stage of the transmitter. See Figure 3.
4. Press .
5. Press the **As Found** softkey.
6. Use the  and  keys followed by  to select an instrument calibration procedure. You'll see that the calibration template is preloaded with appropriate data. You can make changes to any item if you wish.

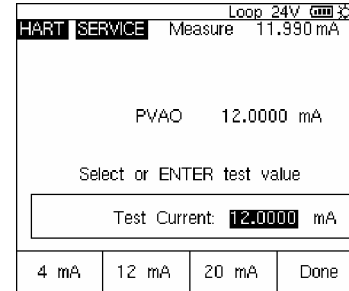
7. Proceed with calibration as usual (described in the *MasterCAL Users Manual*).
8. Press the **Adjust** softkey. This returns you to HART mode, and presents you with the Service menu for the transmitter.
9. Do an Output Trim, a Sensor Trim, or both. These are Service Operations, and are described later in this manual. When you have finished with the trim procedures, press the **Done** softkey.
10. Press the **As Left** softkey and repeat the calibration procedure to verify that the transmitter passes.

Loop Test

The Loop Test feature sends a command to the transmitter to set its output stage to a specified value. Use this to check the calibration of the output stage, or to check for proper reading on an external loop reading device.

To perform a Loop Test:

1. From the Active Device screen Press the **Service** softkey, followed by **Loop Test**.



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2. Press a softkey to command the transmitter to set its analog output to the corresponding value, or manually enter a value with the numeric keys.

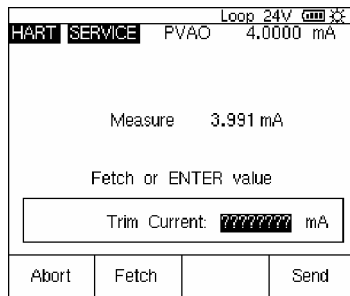
In the middle of the screen the transmitter acknowledges the selected PVAO (digital representation of the Output stage). The calibrator shows the measured value at the top of the screen, so you can use Loop Test as a quick way to check the calibration of the transmitter's Output stage.

Output Trim

An Output Trim adjusts the transmitter's Output stage. You can perform an Output Trim on both generic and supported transmitters.

To perform an Output Trim:

1. From the Active Device screen Press the **Service** softkey, followed by **Output Trim**.



pe16s.bmp

2. Press **Fetch** to load the mA value being measured by the calibrator into the dialog box.
3. Press **Send** to trim the low analog output point.
4. To trim the high analog output point, repeat steps 2 and 3, following the prompts on the display.

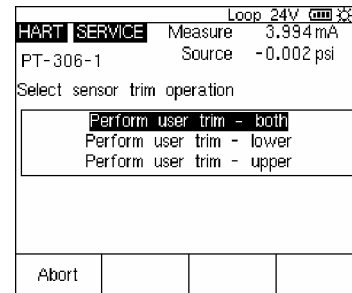
Sensor Trim

You can only perform a Sensor Trim on a supported transmitter. A Sensor Trim adjusts the Input stage of a HART transmitter. If your application does not use the Output stage of the transmitter, Sensor Trim is the only adjustment you need to make.





A Sensor Trim may involve one or more trim points. This is controlled by the transmitter's software. You can only perform a Sensor Trim on a supported transmitter.

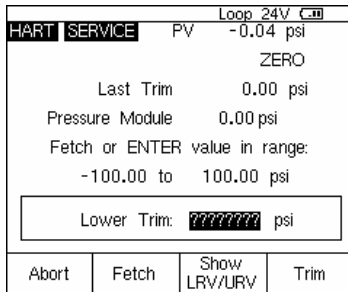
To perform a Sensor Trim, proceed as follows:

1. From the Active Device screen, press the **Service** softkey, followed by **Sensor Trim**.




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- Use the  and  keys to select the Sensor Trim operation, and press .
- Follow the instructions on the display. For pressure, there is a message to connect a pressure module to the calibrator, and another to press the  key to zero the pressure module.
- Press **Continue**.



pe18s.bmp

- Enter the trim value you want the calibrator to produce, and press , or in the case of a pressure transmitter (as above), press **Fetch** to load the value being measured by the Beta pressure module into the dialog box.
- Press **Trim**.
- If prompted to do so, repeat steps 2 and 3, following the prompts on the display, to trim the remaining points.

Note




Select trim points near the range limits unless the transmitter's documentation specifies otherwise.

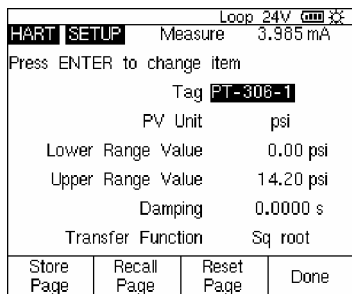
If you get an error message that for the selected trim point there is an excess correction, sometimes you can solve the problem by doing a series of Sensor Trims in small steps from the previous trim point toward the desired trim point.

Cloning a Transmitter




Cloning copies the Basic Setup information from one transmitter to another. You can clone generic and supported transmitters.

To use the calibrator to clone a transmitter:

1. Connect the calibrator to the transmitter you want to clone. You only need a communication connection.
2. From the Active Device screen, press the **Setup** softkey.
3. Use the  or  keys to select **Basic** from the list on the screen and press .



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4. Press the **Store Page** softkey to load the settings into the calibrator's memory (not the transmitter).
5. Disconnect the calibrator from the transmitter and connect it to the transmitter you want to configure. Press the **Abort** softkey to establish communication.
6. Press the **Setup** softkey, then select **Basic** to return to the Basic Setup screen.
7. Press the **Recall Page** softkey to refresh the calibrator display with the cloned parameter settings. The settings are not transmitted to the transmitter at this time.
8. Use the  or  and  keys to select parameters one at a time, change them, or leave them as cloned, and press the **Send** softkey to transmit them to the transmitter.

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