Smart Process Instrumentation

MODEL VR-1500 HART®
SMART PRESSURE TRANSMITTER
Operating Information

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1.0 INTRODUCTION

The VR-1500 is a smart, two-wire, transmitter. It is electrically isolated, compatible with HART® communications and is available in a variety of gauge, absolute and differential pressure ranges. The VR-1500 is simple to configure and operate, and provides all the performance benefits of a smart transmitter.

Many of these performance benefits are achieved through the micro-processor technology, the on-board electrical standards and the advanced factory calibration techniques. The digital signal processing allows independent zero and full scale settings, digital filtering, custom curve fitting and local display of variables in a variety of engineering units. Other advanced features such as automatic self diagnostics and the exceptional ambient temperature stability are continuously employed but work in the background and are not readily visible. You will see the results in take form in the output accuracy under even trying conditions.

The VR-1500 gives you a variety of configuration choices that let you choose the way to configure your transmitter that is the easiest for you. You can order it from the factory already set-up for your application. You can configure the transmitter via the optional two-line, plug-in display and keyboard. You can use the generic configuration tools in most any HART hand-held communicator or you can use the Accutech Transmitter Manager software on a personal computer.
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This manual is divided into several sections. After a brief *INTRODUCTION*, the sections on *UNPACKING* and *INSTALLATION* contain much useful information for the first time installer. The section called "*IN A HURRY?"* helps you get the transmitter operating quickly. These sections should be all that you will need to commission most of your VR-1500 transmitters.

For more complex installations, the balance of this manual gives more detailed information on installation and configuration. These sections also direct you to appropriate resource tools that are available from Accutech to address your special requirements. There are also sections on diagnostics and trouble-shooting which should give you solutions to common difficulties encountered when installing pressure and differential pressure products.

We look forward to your achieving a successful installation of your VR-1500 and we want you to know that we are here to help should you need it.

2.0 UNPACKING

Remove the Packing List and check off the actual equipment received. If you have any questions on your shipment, please call Accutech Customer Service at (978) 568-0500 or (800) 879-6576. Upon receipt of shipment, inspect the container for any signs of damage in transit. Especially take note of any evidence of rough handling. Report any apparent damage immediately to the shipping agent.

Please note that sometimes units are assembled with accessories when shipped. Inspect the shipment carefully if you think that something is missing. This is rare, as we take considerable care to pack units for shipment, but it does sometimes happen. Please give us a call and we may be able to resolve this matter quickly over the phone.

> Please note that the carrier will not honor any claims for damage unless all shipping materials are saved for their examination. After examining and removing the contents, save the packing material and the carton in the event that a reshipment is necessary.

The transmitter you received should compare to the photographs below. Please note that for a full identification of the product, you will need to check the product label and the model code information shown in the "SPECIFICATIONS" section of this manual.

GP/AP Standard Housing

AP/GP Window Housing for Display Option

DP Standard Housing with or without Display Option

Figure 2.1

3.0 MECHANICAL INSTALLATION

The VR-1500 pressure and differential pressure transmitters are rugged devices, but they will give much better service if installed with careful consideration as noted in this manual. They may be utilized in liquid service, steam or gas service so long as care is exercised to prevent exposing the sensing elements to excess pressure or temperature. Installation practices have a lot to do with these service parameters and the life that you can expect from your VR-1500. The main considerations for installation are covered below. For level measurement and more complex installations, please see the section of this manual entitled “APPLICATIONS INFORMATION”

General Considerations:

Give careful consideration to the environment where you will be installing your instrument. Avoid installations that expose the device to excess temperature, high vibration, considerable shock or expose it to dripping condensate or corrosive materials. Also avoid installing the device in an unserviceable location.

In many installations, metallic conduit is used for the instrumentation wiring. Virtually all conduit networks allow small amounts of air to enter and exit. With this air comes water vapor. Oftentimes, the water vapor condenses inside of the conduits causing liquid water to form. It does not take much water to cause damage to instrumentation wiring. Some consideration for conduit condensate is generally a good practice and will save you a lot of headaches with all of your instrumentation wiring.

Be sure you have chosen the materials of construction for the wetted portions of your device to be compatible with the fluids that they will see in service. Frequently, materials that do the most damage to instruments are not those that make up the bulk of the primary fluid. Particulates, sludge, solids, unwanted condensed vapors and other extraneous materials often creep in to instruments to cause damage. Most often these problems can be avoided with some thought at the time of installation. The practices noted below are generally recommended, but they can only act as a guideline and cannot cover all possible variations. The final installation must be made at the discretion and approval of the user. You must be the judge of the actual installation.

For Gauge and Absolute Pressure Sensing:

If the process temperature of the fluid to be measured is less than 250°F (120°C), the GP and AP transmitters may be installed with the process in a ½"NPT female coupling as shown in the following photo.

Figure 3.1

In a typical installation, the sensor will be threaded directly into a threaded port in the vessel or piping where pressure is to be measured. When attaching the threaded process connection to the port, be sure to apply wrenches only on the hexagonal flats provided near the bottom of the pressure sensor.

WARNING: DURING INSTALLATION DO NOT APPLY FORCE TO THE INSTRUMENT HOUSING. USE A PROPER WRENCH ON THE HEXAGONAL FLATS PROVIDED ONLY. FAILURE TO USE CORRECT INSTALLATION PROCEDURE CAN CAUSE DAMAGE TO THE INSTRUMENT AND CREATE A SAFETY HAZARD.

For Differential Pressure Devices:

Installing a differential pressure transmitter is a little more complex. Unlike gauge and absolute pressure measurement devices, differential pressure transmitters are rarely mounted directly into the process. Almost always, some sort of piping or tubing is used to make the connections. These lines are generally referred to as "impulse" lines.

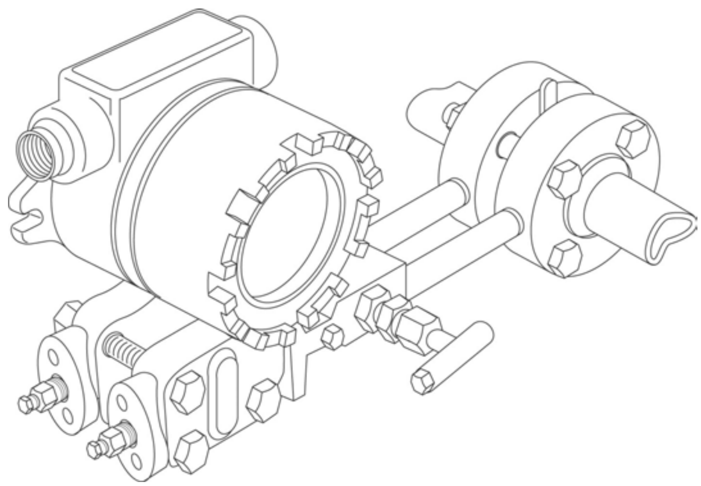
Instrument manifolds are also often used with differential pressure transmitters. The most common is a three valve manifold, shown in Figures 3.2, 3.3 and 3.4. These manifolds are available from Accutech as accessories, or they may be purchased from one of many manifold suppliers.

In operation, process materials need to fill the impulse lines and the manifold. For proper measurements, it is important that the material in the impulse lines be applied equally to both sides of the differential pressure measuring device. For this reason, installation practices for differential pressure transmitters are different for liquid, for gas and for steam service. General considerations for these three types of installation are shown on the following pages.

Differential Pressure Devices in Liquid Flow Service:

In liquid service, you want all of the impulse lines to be completely full of liquid. It is generally best practice to place the process taps in the side of the liquid process line. This minimizes the entrance of gas bubbles, which tend to form at the top of the process line. It also tends to minimize the entrance of sludge and particulates that tend to accumulate in the bottom of the line.

1. Tap into the side of the process line.
2. Mount the transmitter beside or below the taps.
3. Position the vents level with or above the point where the impulse lines connect to the transmitter. This will give the best way to vent all of the air out of the impulse lines and flanges.

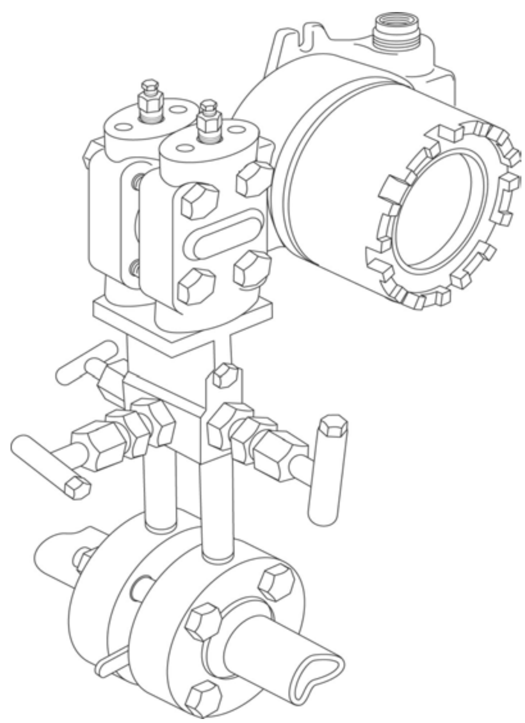


Installation in Liquid Service, Figure 3.2

Differential Pressure Devices in Gas Applications:

Here you want the impulse lines and manifold to be full of gas. Placing the taps in the top of the line generally prevents liquid from entering the transmitter. Mounting the transmitter above the process piping allows any liquid or condensate that does form in the impulse lines to drain back into the process piping.

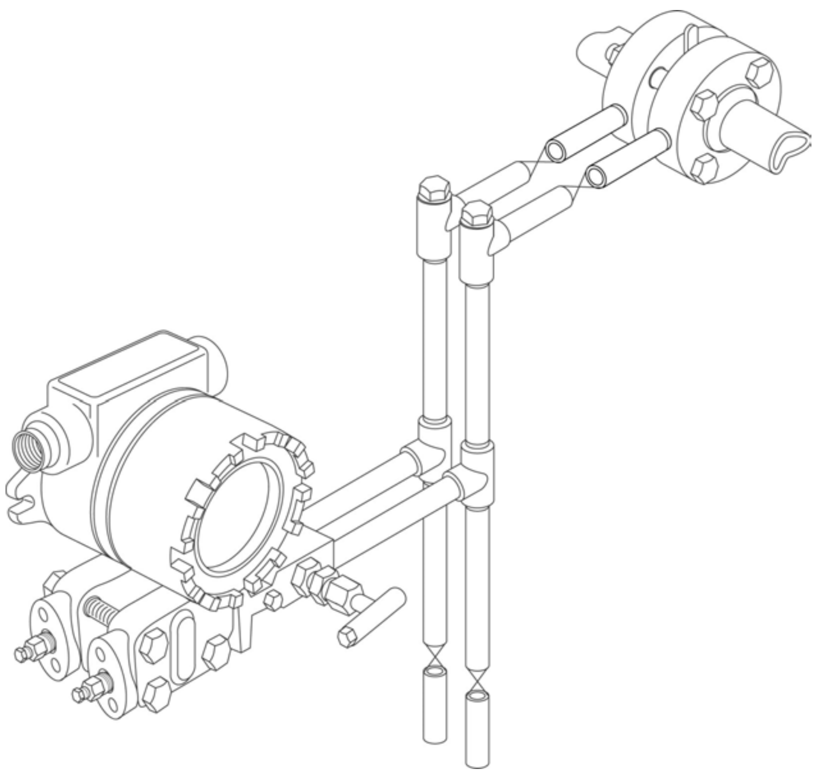
1. Tap into the top of the line
2. Mount the transmitter above the taps



Installation in Gas Service, Figure 3.3

Differential Pressure Devices in Steam Applications:
Steam service is slightly more complex. Here, you want to tap into the side of the steam lines to keep from collecting sludge and particulates. Process steam temperatures almost always exceed the working temperatures for the differential pressure transmitter. To surmount this problem, allow the impulse lines to condense and cool the steam by exposing the impulse lines to the general ambient temperature. Make the vertical section of the impulse lines long enough to make sure the steam condenses in the impulse lines. A good rule of thumb is that each foot of condensate line reduces the temperature by 20ºF. Example: Saturated steam at 15 psig is approximately 250ºF. To lower the temperature at the transmitter to 200ºF, take 50ºF divided by 20ºF per foot = 2.5 feet of condensate piping. Drain valves on the vertical portion of the condensate lines are generally a good idea to help keep the system clean and free from a build-up of sludge.

1. Tap into the side of the steam line.
2. Run vertical impulse lines to allow the steam to condense and cool. Mount the transmitter below the line taps but above the drain valves.
3. Fill the impulse lines with water when commissioning the device.



Installation in Steam Service, Figure 3.4

Impulse Piping:
The piping between the process and the transmitter must accurately convey the process pressure to the transmitter sensor. In transferring the pressure, there are several sources of error. These are: leaks, pressure loss due to friction (particularly if purging is used in the application), gas that is trapped in a liquid line, liquid that is trapped in a gas line, temperature induced density variations between the legs, other density variations between the measurement legs. The actual installation must be made to minimize these errors.

There are a number of general considerations that normally constitute good practice in installing impulse piping. These include:

- Keep the impulse lines as short as possible
- Slope the impulse lines as appropriate for the installation to keep stray liquids out of the transmitter if it is measuring gas.
- Slope the impulse lines appropriately to keep stray gas bubbles out of the transmitter if it is measuring a liquid pressure difference.
- Don't tap into high points in process liquid applications
- Don't tap into low points in process gas applications
- Size the impulse lines to avoid friction effects and to prevent blockage
- Vent all the gas from liquid lines at installation
- If using a fill fluid, fill both legs to the same level
- When purging, put the purging connections near to the process taps and do not purge through the transmitter
- Keep corrosive materials and high temperature materials from entering the transmitter
- Prevent solid sediments from the impulse lines and allow for cleaning them
- Do not let the liquid material in impulse lines freeze
- Keep liquid heights balanced on both legs of a liquid installation

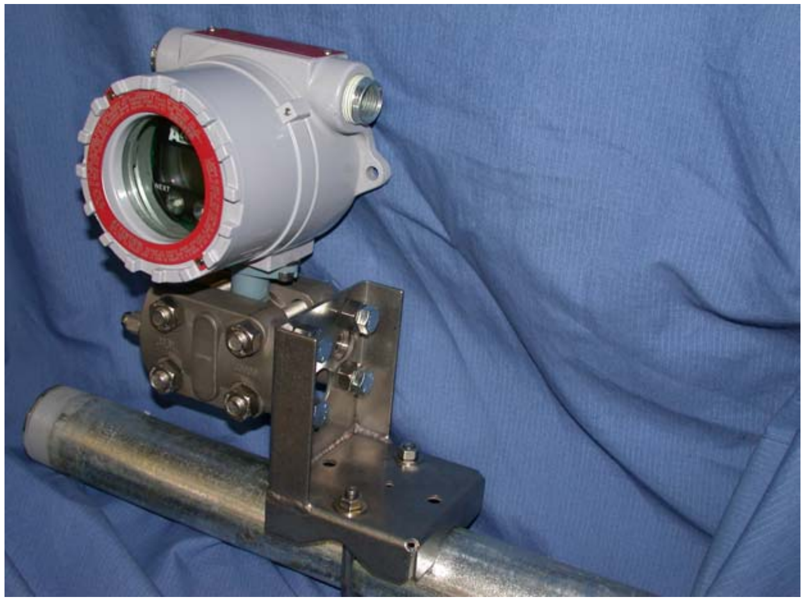
Mechanical Support:

Depending on your application, additional mechanical support for your transmitter may, or may not be required. Generally, the GP/AP Standard Housing does not require additional mechanical support.

With many DP and some Gauge Pressure applications, you may need more mechanical support than what is furnished from the impulse lines or taps. The PY-2 Pipe Yoke, or the PB-2S Brackets can be used to provide support for Windowed DP and GP housing installations. These accessories are available from Accutech, or you can fabricate your own mechanical mounting brackets.

PY-2 Bracket, Figure 3.5

The optional PB-2S bracket let's you mount a DP or GP/AP transmitter or sensor to a 2" pipe. It can be used with either windowed or standard GP/AP housings.

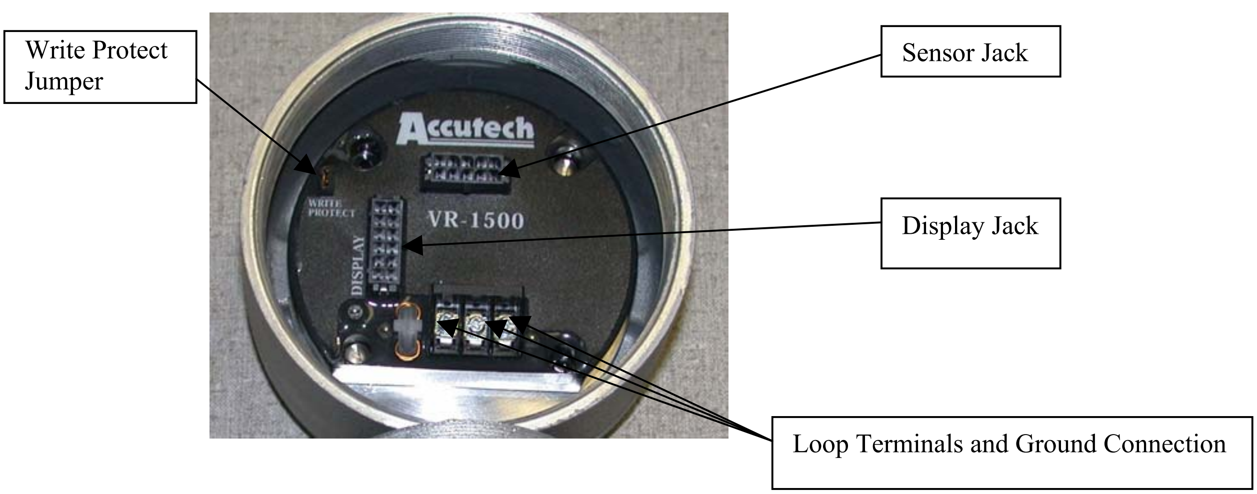


PB-2S Bracket, Figure 3.6

<u>Split Architecture Installations:</u>
The VR-1500 sensor and its associated electronics may be mounted separately. This application is known as "Split-Architecture". With Split Architecture, you can mount the sensor where you need it, next to the process tap, for instance. You can then mount the transmitter where you want it, in a more convenient location for getting a local reading, for example. These applications are covered in the section of this manual entitled "APPLICATIONS INFORMATION".

4.0 ELECTRICAL INSTALLATION

Once you remove the screw-on cover from the VR-1500, you will see the various electrical connections. The VR-1500 has a three position terminal strip with screw terminals for the output loop. There are plug-in jacks for the pressure sensor and for the display. There is also a write protect jumper for disabling the communications capability.



Transmitter Electronics without Display Adapter, Figure 4.1

If you see a transmitter electronics module that looks like the one in Figure 4.1, skip the Display Adapter section and go to the Output Terminals. Otherwise:

<u>Display Adapter</u>
When you open the transmitter cover, if you don't see the top surface of the transmitter electronics like it is shown in this picture, you have a display on your transmitter. To connect your transmitter, you will need to remove the display and its supporting adapter.

To remove the display and its supporting adapter, first unplug the display from the Display Adapter. To unplug the display, simply grasp the display on both its side edges. Pull straight out towards you like you are unplugging an electrical plug from a socket. This is exactly what you are doing. The display simply unplugs from the Display Adapter. There are two mechanical alignment pins and two pairs of gold plated electrical contact pins that make the connections.

Once you have removed the display, you will see four holes around the circumference of the Display Adapter. One pair of these holes has a set of machine screws that hold the Display Adapter to the housing. Be careful when removing these screws not to lose them. Some of these screws may not be captive screws and you will need these screws again!

If you are making this installation in a precarious place, we suggest you loosen one Display Adapter screw fully but leave the screw in the hole. Then remove your screwdriver and cover the hole with a small piece of tape once the screw has been completely unfastened. Repeat for the other screw. When you are ready to put the Display Adapter back, the screws might need to go back into the other pair of holes in the Display Adapter. The important thing at the moment is not to lose the screws. The screws will not get lost if they are in the hole and it is covered by a piece of tape. Otherwise, the screws will fall out and get lost when you are not looking.

Now you can gently ease the Display Adapter off from the top of the transmitter electronics. The transmitter electronics should now look like the picture above. The Display Adapter has an electrical plug that plugs into the display jack on the top surface of the electronics module. Generally, this display jack does not need to be removed.

After you have made your output connections, you will be ready to reinstall the display. When you do, make sure the display connector is plugged into the display jack. Then you can secure the Display Adapter to the mounting posts on the electronics module with the screws provided. The Display Adapter may be installed in any one of four orientations so that the display will be upright once the installation is completed. This may require you to put the mounting screws into the other pair of holes in the Display Adapter.

<u>Output Terminals</u>
The output terminals are marked "**+**" and "**-**". These are the terminals for the two 4-20mA output connections. The center terminal on the output terminal strip is the ground connection.

The **+** and **-** terminals are generally connected to a power supply that has a nominal 24 Volt DC voltage. The power supply must be capable of supplying at least 23mA for the VR-1500. It should have less than 2% ripple.

The **+** and **–** terminals of the transmitter are connected to the corresponding polarity terminals of the power supply. A load resistor, typically 250Ω, may be connected in series with either terminal of the transmitter. For HART® digital communications, the 250Ω resistor must be connected in the loop. The maximum series resistance (R_s) in the circuit (including lead wire resistance) can be calculated using the formula:

$$R_s = \frac{(V_s - 12)}{0.023}$$

The following chart gives maximum series resistance, where V_s is the supply voltage:

Maximum Series Resistance, R_s	Supply Voltage V_s
1300 Ω	42.0 VDC
520 Ω	24.0 VDC
417 Ω	21.6 VDC
250 Ω	18.0 VDC
0 Ω	12.0 VDC

The wiring for the output should be a twisted pair. You may find that a twisted, shielded wiring pair provides better electrical noise immunity in your facility. If so, it is recommended that the shield from the output wiring be terminated on the ground lug of the transmitter. The ground is the center terminal on the three terminal output terminal strip.

When grounding the wiring shield, it is highly recommended to make only one connection from any one shield to an electrical ground. If the cable shield is grounded at both ends, it is very possible that the electrical ground potential at opposite ends of the cable could be at different electrical potential levels. Under these circumstances, a current will flow through the cable shield. Current flowing in the output wiring shield is very detrimental to proper operation of the VR-1500, or to any transmitter.

Ground loops defeat the purpose of the shield and they are hard to diagnose. Ground potentials at different parts of the plant vary considerably. They tend to be intermittent and as a result difficult to find and fix. Good wiring practice is the best prevention.

For your output wiring, use 24 AWG or larger wiring. If you need to exceed a distance of 5,000 feet for your output wiring, please call the factory for applications assistance.

For installation in hazardous environments, be sure to follow the proper electrical codes for safe installation.

After you have made your electrical output connections, you will generally find that only one conduit connection is used. Be certain to plug and seal the unused connection properly.

When installing the transmitter with conduit, be sure to consider installing a drip loop in the conduit with a drain that is lower than the transmitter housing. This is a good practice with all field mounted instruments and will help keep the inside of your conduit free from water that may condense inside of the instrument conduit.

Sensor Jack

There is a jack for the sensor connections on the top of the transmitter. It receives the 10-pin connector plug from the sensor. Generally, this is installed at the factory and will not need to be reconnected in the field.

Display Jack

There is a jack labeled "**Display"** on the top surface of the transmitter electronics. This jack receives the connector from the Display Adapter. If your transmitter has a display, you will have already removed the Display Adapter in order to connect the loop output wires.

The display plug does not normally need to be removed. To reinstall the display, make sure the display connector is plugged into the display jack and then secure the Display Adapter to the mounting posts in the enclosure with the screws provided. Be sure to seat the posts on the Display Adapter firmly into their mating holes on the transmitter electronics before fastening the screws. The Display Adapter may be installed in any one of four orientations so the display will be upright once the installation is completed.

The optional DK-2 Two-line, Plug-in Display and Keyboard then simply plugs into the Display Adapter.

Write Protect Pins
The pins labeled "**Write Protect"** must be connected, or "jumpered" together, to enable any configuration or set-up of the transmitter. If the pins are open, all configuration capabilities are disabled. The jumper connector supplied may be used for this purpose.

Test Points
There are two test points on the surface of the electronics module. These are designed for making a convenient connection from an electrical test meter. The test loop nearest the "**+**" terminal is the "**+**" connection. The test loop nearest the "**-**" terminal is the "**-**" connection. You can connect a voltmeter across these test points to check the voltage drop across the transmitter. (A third test point is located just to the side of the + test point. This is used in the factory and does not have a field function.)

5.0 COMMISSIONING

Be careful when commissioning your transmitter. Transient pressure shock waves that can overpressure the sensor causing zero shifts. These are most always generated on the upstream side of the instrument. By design, minimum zero shift is generated when the transmitter is over-pressured on the + side. Sensors are protected for overpressure on either side to the full pressure rating of the process flanges. However, stresses induced during overpressure will cause a temporary zero shift. It is therefore recommended that during commissioning and zeroing, every attempt should be made to prevent over pressuring the sensor on either side. The procedures outlined below will allow commissioning and zeroing without over pressurizing.

In the event that the sensor is subject to significant overpressure, steps must to taken to re-establish the neutral instrument zero. If the sensor is or has been over pressurized on the + side, any zero drift caused by the overpressure will be negligible after a fairly short period of time -- about three hours. If the sensor has suspected to have been over pressurized on the - side, overpressure equal to the static line pressure of the process should be applied to the + side and the zero allowed to neutralize for several hours.

Flow Measurement
For liquid Service Commissioning using a three valve manifold.
1. Check overall installation to ascertain that all fittings, plugs, vents and bolts are secure, leak free and ready for service.
2. All manifold and line shutoff valves, if installed, should be in the closed position.
3. Open manifold bypass valve and both line shutoff valves if installed. This will put a zero differential pressure across the sensor.
4. Slowly crack open the + Upstream manifold block valve until the sensor is at line pressure. Then fully open this + Upstream manifold block valve.
5. Crack open the + and - side vent plugs until all air is purged out of the transmitter and the manifold. Close the vents tightly.
6. Check ZERO output and adjust if necessary.
7. Open the - Downstream manifold bock valve fully.
8. Close the manifold bypass valve. The sensor is now in service.

For Liquid Service Zeroing using a three valve manifold:
Differential Pressure Sensors in flow service need to be periodically re zeroed. The procedure for re-zeroing assumes that the sensor in service and that the line shut-off valves are open, that the + and - manifold valves are open and that the manifold bypass valve is closed. To then re-zero the transmitter use the following procedure:
1. Open the manifold bypass valve fully
2. Close the - Downstream manifold block valve.
3. Check the zero output and adjust if necessary. If you suspect gas or air in the impulse lines, these should be purged per section 5 above.
4. Open the - Downstream manifold block valve
5. Close the manifold bypass valve. The sensor is now in service.

6.0 IN A HURRY?

Once your transmitter is installed and the electrical connections have been made, getting it up and running is pretty easy. If you are in a hurry, this short set of instructions and references will help get the transmitter running. You may even want to get it running on a bench in the electrical shop, using these directions, before installing it in the field.

These simple instructions will be suitable for most installations. However, some installations, such as the installation of a remote sensor are a bit more complicated. For these more difficult installations, you will want to follow the more detailed instructions found in the later sections of this manual.

Factory Configuration

Your transmitter has been configured and tested at the factory with the sensor assembly that is purchased with the system. It will have all appropriate electrical connections made between the transmitter, sensor and optional display (Display Adapter). Other set-up parameters have also been set as indicated below. Most pressure transmitters use these configuration parameters and you may be able to install the device directly as it has been configured at the factory. This makes the installation and commissioning very straight-forward.

Output	Linear with Pressure (or with differential pressure)
4.00 mA	Set to equal zero pressure
20.00 mA	Set to equal 100.00 % of the full scale of sensor
Engineering Units	PSI for the AP and GP, Inches of Water for the DP
Failsafe	High (23.00 mA)
Damping	None

> ***NOTE:*** *Even when "In a Hurry," the use of an appropriate power supply is important. A 24VDC supply having a current handling capacity of at least 0.023A is commonly used. Always use a DC (direct current) supply, or suitable size battery. Never connect the transmitter directly to 115 VAC.*

You may also have ordered your transmitter configured for your individual needs at the factory. If so, it will already be configured to your order and tagged appropriately.

If the configuration is set, you can now power-up the unit and you are ready for the last step. Just be sure to make a final check that you have not inadvertently connected the transmitter to a 110 or 115V power source, or fried transmitter might be on the menu for lunch.

Position Adjust

If you are in a hurry, you are almost done. For the final step, you will need to check the "position zero" reading on the transmitter. The VR-1500 is a sensitive device. Its elevation and its orientation in the field may be different from the orientation in the factory where it received its last configuration. This is particularly true with the differential pressure devices and with the GP 30 and the AP 30 units. To compensate for position changes, you may need to perform a sensor position adjustment once the unit is installed.

For this step, power the unit and apply zero pressure. Be sure that the unit is installed in its final location or that it is oriented exactly as it will be in its final installation. If you have a differential pressure device, you will also need to go through a series of operations to fill the impulse lines to the device.

With zero pressure on the device, it should have a reading that is nearly "zero". This will be most evident if you have a display plugged into the transmitter. The display does not need to be permanently installed and you may remove the display after using it for set-up.

In hazardous or potentially hazardous environments, be certain to follow your safety procedures if you are going to have the unit powered up and the housing cover removed.

If you have a transmitter pressure reading of "zero", (that is, the transmitter reading is within the specified accuracy of ±0.07% of the full scale value when zero pressure is applied), you are ready to put everything back together, put the cover on, secure it and you are finished. If your "zero" reading is outside of this value, you will need to execute the position zero adjustment by following the configuration described in the configuration sections of this manual for the Display, PC or Hand-held Terminal configuration.

These few instructions should get most installations up and running. The more complex installations will require more complex configurations or installation are described in the balance of this booklet.

7.0 DISPLAY MODE CONFIGURATION

The DK-2 plug-in display and keyboard provides local indication of the process pressure, the pressure difference or the flow. In operation, the upper line of the display shows the numeric value of the process variable. There is a center line bar graph indicating the output from 0% to 100% of the transmitter 4-20 milliamp output value. The lower line on the display is alphanumeric. It generally identifies the device and shows the engineering units of the process variable. The alphanumeric display line is also used to show the tag information, the actual milliamp output value and various diagnostic messages. The alphanumeric display line can be configured to scroll through a number of different parameters if you wish.

The DK-2 can also be used to configure the transmitter. To configure the VR-1500 using the *Display Mode*; the DK-2 Two-line, Plug-in Display / Keyboard is required (along with the Display Adapter). The display and adapter are available as an installed option at the time of purchase of the transmitter, or can be added at any time. These inexpensive options make reconfiguration or re-ranging the transmitter very simple. Without the use of a calibrator, or any other tools, the transmitter can be set up for new range limits and engineering units much like one would set a digital watch. The examples shown in this manual are generally those for the GP-250 transmitter. Small variations in the menus are present in the AP and DP devices. Generally, these discrepancies are noted.

<u>Entering the Display Mode</u>

To Start the *Display Mode*, first connect the transmitter to an appropriate DC power supply. With a standard factory configuration, the display should read a value on the top line with the lower line scrolling other information.

34.780 0%-------------- 100% vr-1500	34.780 0%-------------- 100% xmitter	34.780 0%-------------- 100% pSI

To enter the "Display Mode, Press the NEXT key and then press the ENTER key on the DK-2. To activate the NEXT and ENTER keys, a slow, deliberate push of the key is required. This prevents any casual, inadvertent activation of the transmitter into one of the configuration modes. Accessing the configuration mode requires pushing both the NEXT and ENTER keys for the same reason.

The display should read:

DISPLAY	MODE?

The *Display Mode* 'rule-of-thumb' is if the answer to the question on the screen is 'NO' – press NEXT; and if the answer to the question on the screen is 'YES' – press ENTER.

Here, you would like to enter the "Display Mode". Therefore, the answer to the 'Display Mode?' question is 'yes,' therefore press ENTER. A flow chart summarizing the operation of the *Display Mode* appears at the end of this manual.

Note that when more than seven characters are required to describe a function, the display keeps sequencing through two or more screens or may use common abbreviations. In this manual, the sequencing of the display is indicated by placing the two or more parts of the message adjacently. With some functions, the DK-2 display indicates a numeric value and unit of measurement on the top line of the display in addition to the message on the lower display line.

Display Mode Configuration Menus

The Display Mode will allow the user to do the following:

- Review Transmitter Set-up (DISPLAY STATUS)
- Select / Change Engineering Units (SELECT PRESS UNITS)
- Select a Square Root Output Function, for DP transmitters only, (SET SQUARE ROOT)
- Zero position adjust of sensor (SENSOR POSIT-N ADJUST)
- Change the 4mA – Lower Range Value (CHANGE ZERO)
- Change the 20mA – Upper Range Value (CHANGE FULL SCALE)
- Set Line Frequency Filter / Speed (LINE FREQ FILTER)
- Select / Change Failsafe report value (SELECT XMITTER FAIL SAFE)
- Trim the 4.0 mA output current (TRIM 4MA)
- Trim the 20.0 mA output current (TRIM 20MA)
- Apply Zero(4mA) Sensor Pressure (SENSOR ZERO TRIM)
- Apply Full Scale(20mA) Sensor Pressure (SENSOR FULL SCALE TRIM)
- Reset Applied Sensor Pressure (RESET SENSOR TRIM)
- Trim Display Value (OFFSET)
- Select / Change Language of Display Mode (SET LANGU AGE)

Each of these functions is presented in sequence on the DK-2. If the indicated function need not be performed, press NEXT, and the next function on the menu will be displayed on the screen. To perform any function press the ENTER key. Entering a given function will initiate additional screens to be displayed which enable you to perform the function. These are described in detail below and summarized on the flow chart found in the back of this manual.

Review Transmitter Set-up

The DISPLAY STATUS is the first function in the sequence. It displays the following information. Press the NEXT or ENTER key to sequence through the screens within the DISPLAY STATUS function.

DISPLAY	STATUS?

Press ENTER. This will indicate the current configuration, such as shown in this example:

7.00 Version	7.00 NUMBER

Pressing the NEXT key will take you through the menu information.

No DIAG	FAULT

This window shows that there are no diagnostic faults. Pressing the NEXT key takes you to:

GP 250

This identifies the transmitter and the sensor full-scale rating. Pressing the NEXT key shows you the units:

PSI

Pressing NEXT again takes you to the lower range value and then to the upper range setting.

0.000 LRV

Pressing the NEXT key:

250.000 URV

Pressing NEXT gives you the fail-safe settings

FAIL	SAFE	HIGH

And then the offset information

OFFSET	CURVE	OFF

Select / Change Engineering Units

The SELECT PRESSURE UNITS function allows you to change the engineering units of the transmitter. Changing the engineering units changes the Zero and Full Scale values to the equivalent value for the new engineering units. Press ENTER to select a new engineering unit. Use the NEXT key to scroll through the choices. Press ENTER when you have reached your choice.

SELECT	PRESS	UNITS?

Press ENTER. *Please note: Units shown will change depending on the sensor type.*

PSI ?

NEXT

```
BAR ?
```

NEXT

```
MBAR ?
```

NEXT

```
GM/SQCM
```

NEXT

```
KG/SQCM
```

There are additional choices for engineering units including PASCAL, KPASCAL, TORR, ATMS, PER FS (percent of full scale), SPECIAL, IN H2O, IN HG, FT H2O, MM H2O and MM HG. Press ENTER when you have reached your desired choice. The Differential Pressure device has the unit choices shown in Table 7.1

percent (%)	pascal	gallons / second	**STD ft^3 / min**
special	Kilopascal	millions of gal / day	**ft^3 / hr**
inches of Water	torr	Liters / sec	**cubic meters / min**
inches of Mercury	atmospheres	millions of liters / day	**barrels / sec**
feet of Water	Megapascal	cubic feet / sec	**barrels / min**
millimeters of Water	inches water @ 4°C	cubic feet / day	**barrels / hr**
millimeters of Mercury	mm water @ 4°C	cubic meters / sec	**barrels / day**
Pounds per in^2 (PSI)	ft^3 / min	cubic meters / day	**gal / hr**
bar	gallons / min	Imperial gal / hr	**Imperial gal / sec**
millibar	Liters / min	Imperial gal / day	**Liters / hr**
grams / cm^2	Imperial gal / min	normal cubic meters / hr	**gallons / day**
Kg / cm^2	**cubic meters / hr**	**normal liters / hr**	

Table 7.1 Differential Pressure Engineering Units

Sensor Zero Position Adjust

The SENSOR POSIT-N ADJUST function allows you to adjust for sensor position after the sensor is installed. The VR-1500 sensors are extremely sensitive. This sensitivity lets you measure very low values, but it also means that the sensors are sensitive to their mounting orientation.

Sensor	Posit-n	Adjust?

Press ENTER. The current value is read on top line of display. Several screens will scroll:

SET SENSOR TO ZERO ENTER TO CONT NEXT TO EXIT

At this point, you should be certain to have a zero pressure applied to the device. Press ENTER and transmitter will advise you to wait approximately 30 seconds. During this time, the transmitter will be recording its reading and setting this reading to equal zero.

Note: If you make a mistake, you can either perform the re-zero adjustment again or you may reset the sensor trim using the "RESET SENSOR TRIM" command.

Change 4mA – Lower Range Value (Zero)

Pressing the NEXT key brings you to the next menu selection which is to change the lower range output value. This function is displayed as CHANGE ZERO.

0.00 change	0.00 zero?

Press ENTER.

000.00 plus?

This indicates that the existing ZERO value is set to a 'plus', or positive value. The question mark '?' indicates that you must press ENTER to keep the value positive. Press NEXT to switch to negative and the press ENTER to accept. Repeatedly pressing NEXT will toggle between PLUS? and MINUS? After pressing ENTER to accept keeping the value positive, the display reads:

000.0 hundrd?

The leftmost digit position will start blinking (shown here in a different font) asking if the Hundreds position needs to be changed. To change the 0 to a different value, press NEXT. The digit will increment 1 2 3 4 5 6 7 8 9 0. Stop pressing NEXT at the desired numeral and press ENTER to accept the numeral.

When the Hundreds numeral is selected, the Tens position will start blinking. Choose a desired numeral for the Tens position and the Ones position will start blinking. This process will continue until you have chosen a numeral for each choice. You will be returned to the Change Zero? prompt with the new 4mA value displayed on the top line.

The value choices are determined by the sensor full scale value for a chosen engineering unit. Be certain to select you engineering units before changing the zero (4mA) value. In some cases, prompts for a 100K (One Hundred Thousand) will be displayed, while in other case prompts for 1kth (Thousandths) will be displayed.

Change 20mA – Upper Range Value (URV)

100.00 change	100.00 full	100.00 scale?

Press ENTER to change the full scale value. Changing the full scale value utilizes the same procedure as Changing Zero – see above.

Set Line Frequency Filter / Speed

The LINE FREQ FILTER function allows the user to set the 60Hz / 50Hz line filter. Electrical noise in North America is especially heavy at 60 Hz. In Europe, noise is concentrated at 50Hz. Selecting the line frequency filter for the line frequency gives added noise suppression at this frequency.

LINE	fREQ	FILTER?

Press ENTER when prompted LINE FREQ FILTER? Press NEXT to scroll through the selection of 60 Hz or 50 Hz.

Press ENTER to accept desired filter mode.

Select Transmitter Failsafe

The SELECT FAIL SAFE allows you to choose the desired condition in case the transmitter is reporting a failure condition. Press ENTER when prompted. Press NEXT to scroll through the various options.

SELECT	XMITTER	FAIL	SAFE ?

You can now choose to drive the loop current High (to 23mA) under a transmitter failure, or you can drive the transmitter to the low current value or you can turn the function off.

Press ENTER to accept the desired failure mode.

Trim 4mA Output Current

This function allows you to trim the 4.00mA output current to your plant standard if you desire.

TRIM	4 MA ?

Caution, the 4mA output has been carefully set at the factory. It is unusual that this value needs to be adjusted. Please be very careful to use a very good calibration reference source if you are going to change the 4mA value or you could wind up decalibrating the device instead of calibrating it.

> ***Note:*** *This function is only for the purpose of adjusting the 4.00mA limit of the transmitter loop current to be exactly 4.00mA according to the plant's local standard. This is **NOT** for the purpose of ranging the transmitter!*

Use the LRV function to adjust the lower range value of the transmitter. If trimming the 4.00mA limit is still desired then press ENTER. The transmitter will now output a milliamp current equal to its internally set 4mA. This 4 mA value should be read on an external meter and compared to a local standard. It is advisable to use a very good ammeter to make these comparisons. It is very possible that the transmitter will be more accurate than a great many ammeters. In this case, trimming will make the transmitter less accurate rather than more accurate! To trim the transmitter, arrange your 4mA milliamp meter in the loop and compare the value shown on the transmitter display to the plant standard.

Once trimming the 4.00mA value has been selected, the display will alternate as follows:

RAISE	MA OUT ?

Pressing the NEXT key the display then alternates:

lower	Ma out ?

When it is decided whether to raise or lower the output current, press ENTER and the display changes to one of the following depending on whether the raise or lower function has been selected.

NEXT=+

If it is decided to raise the 4mA value; or,

Next = -

if it has been decided to lower the 4mA value.

Now every time the NEXT key is pressed, the display blinks, and the 4.0mA output limit decreases (-), or increases (+). The decrease or increase is in approximately 3.5 micro ampere increments.

If you decide not to trim the output, simply press “ENTER” to return to the “TRIM 4mA” menu.

> ***Note:*** *The 4.00mA limit is factory calibrated to a precision standard. Using the Output Trim function voids the NIST traceability of calibration. Do not arbitrarily trim the output unless a qualified and accurate local standard is available to measure the adjusted 4.00mA output! Also note that the 4.0mA limit should not be trimmed by more than about ±50µA, or transmitter operation may be impaired.*

Once the desired trim is reached, press ENTER to return to one of the corresponding TRIM 4MA screens. At this point you may still go back and do further trimming of the 4.0mA limit by pressing the ENTER key. Pressing the NEXT key changes to the next function.

Trim 20mA Output Current

This function allows you to trim the 20.00mA output current to your plant standard if you desire. The 20mA output has been carefully set at the factory. It is unusual that this value needs to be adjusted. Please be very careful to use a very good calibration source if you are going to change the 20mA value or you could wind up decalibrating the device instead of calibrating it.

> ***Note:*** *This function is only for the purpose of adjusting the 20.00mA limit of the transmitter loop current to be exactly 20.00mA according to the plant's local standard. This is **NOT** for the purpose of ranging the transmitter!*

TRIM	20 MA ?

Trimming of the 20.0mA current limit is done in exactly the same manner as was described for trimming the 4.0mA point. The same precautions apply. After completing the trim 20.0mA pressing the NEXT key brings up the Sensor Zero Trim.

Sensor Zero Trim

The SENSOR ZERO TRIM function allows you to apply pressure from a standard to the transmitter for determination of the 4mA value. Pressing ENTER when prompted takes you into this function.

sensor	zero	Trim ?

The measurement value the transmitter is currently reading is now displayed on the top line of the DK-2 while the bottom line of the display reads:

Apply	Lrv to	sensor

then	press	enter

At this point you should apply an external pressure to the transmitter that corresponds to the Lower Range (4mA) Value. Press ENTER when desired pressure is applied or press NEXT to exit this function.

Sensor Full Scale (20mA) Trim

The SENSOR FULL SCALE TRIM function allows the user to apply pressure from a standard to the transmitter for determination of the 20mA value. This function works exactly the same way as the sensor zero trim function noted above.

SENSOR	FULL	SCALE	TRIM ?

Reset Applied Sensor Pressure

The RESET SENSOR TRIM function resets the measurement values applied through SENSOR ZERO TRIM and SENSOR FULL SCALE TRIM back to the factory defaults. Press ENTER when prompted

Reset	sensor	Trim ?

To reset to the factory set trim values, press ENTER. You will then be asked to

CONFIRM	RESET ?

Press ENTER to conform the reset, or press NEXT to exit this function.

Trim Display Value (Offset)

The display offset function allows you to enter a zero shift in the display values independently of the 4-20 milliamp output current. This shifts readings across the entire transmitter range by the amount entered.

0.00 OFFSET ?

Press ENTER when prompted. You can now enter a display offset in the identical fashion as changing the zero and full scale values.

Select or Change the Language of Display Mode

The SET LANGUAGE function allows for *Display Mode* Configuration in English, German, French or Spanish. Press ENTER when prompted SET LANGUAGE?

Set	Langu-	Age

Press NEXT key allows you to scroll through the languages of English, Duetsch, French or Espanol.

Press ENTER to accept desired *Display Mode* Configuration language.

Return to Operate Mode

The last entry in the display menu allows you to return to the operate mode. Pressing ENTER returns to the operate mode. Pressing NEXT cycles you back to the top of the display menu.

r e t u r n	t o	o p e r a t e	m o d e ?

8.0 HAND-HELD TERMINAL CONFIGURATION

8.1 INTRODUCTION

The VR-1500 transmitter may be used in conjunction with a conventional HART Hand-held Terminal, or Communicator. All HART Hand-held terminals are loaded at the factory with a variety of descriptions of various HART devices. These descriptions are known as the Device Descriptions or DD's. Each DD is a software program that formulates the necessary commands that are issued to the HART device. Each DD is specific to a device.

The DD's for various devices may be loaded into the hand-held communicator when it was manufactured. The DD's may also be revised and or reloaded at any HART DD loading center. We maintain such a site at Accutech. If you need the DD's in your Hand-held communicator updated, or if you would like to add the VR-1500 DD, please call Accutech Customer Service at (978) 568-0500 or (800) 879-6578.

This section covers the operation of a HART Hand-held terminal with the VR-1500 DD. We have chosen to use the HC 275 Communicator as the example.

All HART Hand-held terminals also have a default DD loaded. This DD is known as the Generic DD. The Generic DD has a few commands and may be used rerange a transmitter. The Generic DD commands are covered separately at the end of this section.

8.1.1 HC275 CONNECTIONS

The HC275 HART Communicator can interface with a transmitter from any wiring termination point in the current output loop. To interface the Communicator, connect it with the appropriate connectors in parallel with the instrument or load resistor. All connections are non-polarized.

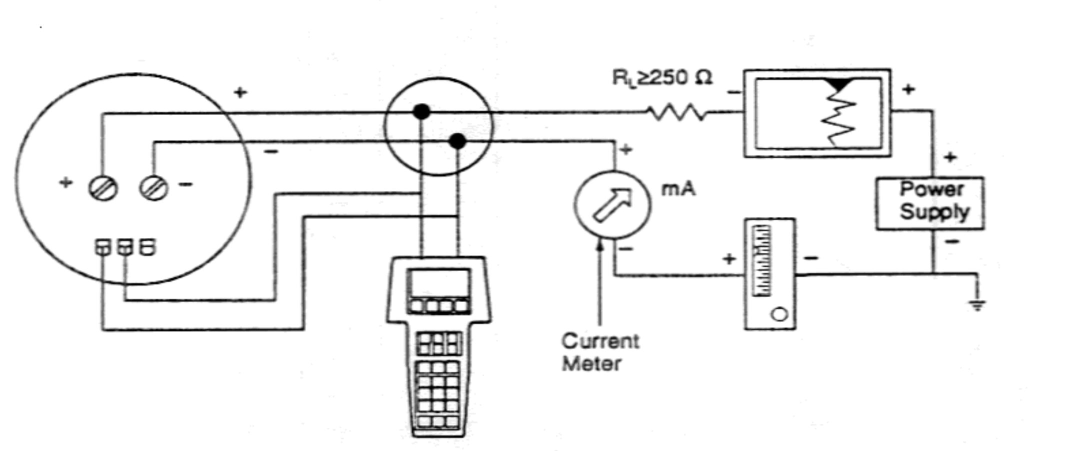


Figure 8.1 Connecting the HART Communicator to a Transmitter Loop.

For Canadian Standards Association (CSA) and Factory Mutual (FM) wiring connections, see the HC275 Manual.

Note: Please note the R_L resistor noted in the diagram. For the HART Communicator to function properly, a minimum of 250 Ohms ***must*** be present in the loop. The HART Communicator does not measure loop current directly.

> **WARNING**
>
> Explosions can result in death or serious injury. Before connecting the HART Communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with safe field wiring practices. For CSA and FM wiring connections, see the HC275 Manual.

8.1.2 HC275 FUNCTION KEYS

I/O

ON / OFF Key
Use this key to power on and power off the HC275.

⇑

UP Arrow Key
Use this key to move the cursor up through a menu or list of options. You can also use it to scroll through lists of available characters when editing fields that accept both alpha and numeric data.

⇓

DOWN Arrow Key
Use this key to move the cursor down through a menu or list of options. You can also use it to scroll through lists of available characters when editing fields that accept both alpha and numeric data.

⇐

LEFT Arrow and Previous Menu Key
Use this dual-function key to move the cursor to the left or move back to the previous menu.

⇒

RIGHT Arrow and Select Key
Use this dual-function key to move the cursor to the right or to select a menu option.

>>>

HOT Key

Use this key to quickly access important, user-defined options when connected to a HART-compliant device. When the HC275 is turned off and you press the Hot Key, it automatically powers up and displays your predefined Hot Key Menu. When powered up Online, pressing the Hot Key immediately displays the Hot Key Menu. See the HC275 manual for more details on configuring your Hot Key menu.

Disabled Off Key

When performing certain operations, the message “OFF KEY DISABLED” indicates that you cannot turn the HART Communicator off. This feature helps you avoid situations when the power to the HART Communicator might unintentionally be turned off while the output of the device is fixed or when you are editing a device variable.

Software-Defined Function Keys

Use the four software defined function keys, marked F1 through F4, located below the LCD screen to perform functions indicated by the dynamic labels. On any given menu, the label appearing above a function key indicates the function of that key for the current menu. As you move among menus, different function key labels appear over the four keys. For example, in menus providing access to Online help, the HELP label appears above the F1 key. In menus providing access to the Home Menu, the HOME label appears above the F3 key.

8.1.3 GETTING TO KNOW THE HC275
The HC275 is generally used in two operating modes - Online (connected to a device) and Offline (not connected to a device). The initial menu screen displayed on the HC275 is different for Online and Offline operation.

Powering the Communicator when it is connected to a device displays the Online Menu. All setup and configuration of the ACCUTECH VR-1500 Temperature Transmitter can be performed using the Online Menu. If the Online Menu does not appear, the Device Description of the ACCUTECH VR-1500 has not been loaded into the HC275, or you may not be properly connected to the device. See final portion of Section 7 entitled “Utility” in the Offline menu for Simulation / Reviewing Installed Devices.

Powering the communicator when disconnected from a device displays the message “No Device Found.” Press OK and the Main Menu appears. To access the Main Menu (Offline), from the Online Menu when connected to a device, press the left-arrow key. Please refer to Section 8.3 for Offline Configuration.

```
HART COMMUNICATOR
 1➔ Offline
 2   Online
 3   Frequency Device
 4   Utility
```

Main Menu

```
Pressure
VR-1500  Online
 1➔ Display Data
 2   Review Setup
 3   Transmitter Setup
 4   Xmtr Identifiers
 5   Diagnostics
      SAVE
```

Online Menu

Figure 8.2 Powering Up Offline or Online

8.1.4 HOT KEY MENU

The Hot Key Menu is a user-definable menu holding up to 20 options of your most frequently performed tasks. It can be accessed from any other menu by pressing the Hot Key on the HC275. You can customize the menu to contain the options you use most often. Customization is described on page 31 of the HART Communicator Manual (April 1996). The VR-1500 Hot Key menu has the following default items:

```
Pressure
Hot Key
 1➔ Display Data
 2   Review Setup
 3   Transmitter Setup
 4   Xmtr Identifiers
 5   Diagnostics
      SAVE
```

These functions are identical to the Online Menu described in Section 8.2 of this manual. Please refer to the appropriate sections described in the following Online Menu functions.

8.2 VR-1500 HART ONLINE MENU

The Online Menu is the main menu providing access to all VR-1500 information and setup functions. Please see the VR-1500 HART Command Flowchart in the back of this manual. It provides the following options:

```
Pressure
VR1500 Online
 1➔ Display Data
 2   Review Setup
 3   Transmitter Setup
 4   Xmtr Identifiers
 5   Diagnostics
      SAVE
```

8.2.1 DISPLAY DATA

The Display Data Menu displays the current measurements of the transmitter. All items in this menu are Read Only. No variables can be changed. Refer to the Transmitter Setup section to change transmitter configuration.

PRESSURE

This is the dynamic Primary Variable ('PV') - process pressure, differential pressure, or flow and the related engineering units. This value is automatically updated as the process pressure changes.

PV AOut

The dynamic Analog Output in milliamps. This value is also automatically updated.

% Range

The Primary Variable expressed as a percentage of the range, based upon the LRV and URV.

LRV

This is the Lower Range Value and the related engineering units. When the sensor sees this value as an input, the transmitter's analog output will be set to equal 4mA.

URV

The Upper Range Value and the related engineering units. When the sensor sees this value as an input, the transmitter's analog output will be set to equal 20mA.

8.2.2 REVIEW SETUP

Review Setup is a Read Only review of the configuration options for the transmitter. These include:

Review Input

Selecting the "Review Input" command will display the Sensor Information on the device.

LRV

Displays the Lower Range Value (4 mA) and the related engineering units.

URV

Displays the Upper Range Value (20 mA) and the related engineering units.

Snsr Offset Curve

Indicates if the Sensor Offset Curve System has been enabled.

Sensor Fail Det.

Indicates if the option to detect sensor failures is enabled.

Failsafe Report

Indicates if the Failsafe reporting is enabled and the Failsafe mA value selected.

Line Frequency & Filter

Displays the Line Frequency & Filtering level selected.

Damping

Displays the Damping value selected.

Xmtr Serial Number

Displays the transmitter's serial number.

8.2.3 TRANSMITTER SETUP

The Transmitter Setup Menu provides virtually all the functions used to configure the transmitter. The following five options are provided, each leading to the display of a sub-menu of configuration options:

```
Pressure
Xmtr Setup
 1➔ Input Setup
 2   Output Setup
 3   Failsafe Setup
 4   Trim
 5   Other Setup
       SAVE   HOME
```

8.2.3.1 Input Setup

Configuration options associated with the input to the transmitter are specified using the Input Setup Menu.

Pressure or Flow Units

This allows you to select the engineering unit of measure for your transmitter. With the Gauge and Absolute Pressure transmitters, there are about 20 units to choose from. These are listed in Table 8.1. For the DP device, there are about 50 units to choose from that include both pressure and flow units. These are noted in table 8.2. The “Spcl” or “Special” unit can be used if the unit of measure that you desire is not included in the standard unit tables.

percent (%)	millimeters of Water	grams / cm^2	**atmospheres**
special	millimeters of Mercury	Kg / cm^2	**Megapascal**
inches of Water	pounds per in^2 (PSI)	pascal	**inches water @ 4°C**
inches of Mercury	bar	Kilopascal	**mm water @ 4°C**
feet of Water	**millibar**	**torr**	

Table 8.1 Gauge & Absolute Pressure Transmitter Engineering Units

percent (%)	pascal	gallons / second	**STD ft^3 / min**
special	Kilopascal	millions of gal / day	**ft^3 / hr**
inches of Water	torr	Liters / sec	**cubic meters / min**
inches of Mercury	atmospheres	millions of liters / day	**barrels / sec**
feet of Water	Megapascal	cubic feet / sec	**barrels / min**
millimeters of Water	inches water @ 4°C	cubic feet / day	**barrels / hr**
millimeters of Mercury	mm water @ 4°C	cubic meters / sec	**barrels / day**
Pounds per in^2 (PSI)	ft^3 / min	cubic meters / day	**gal / hr**
bar	gallons / min	Imperial gal / hr	**Imperial gal / sec**
millibar	Liters / min	Imperial gal / day	**Liters / hr**
grams / cm^2	Imperial gal / min	normal cubic meters / hr	**gallons / day**
Kg / cm^2	**cubic meters / hr**	**normal liters / hr**	

Table 8.2 Differential Pressure Engineering Units

Snsr Offset Curve

The VR-1500 provides the ability to correct or characterize the Primary Variable value being read by offsetting it to a 22 point curve. This offset curve can be extremely useful to linearize a particular sensor or orifice plate. The offset curve can be used to convert pressure, or level data to volumetric information in an odd shaped tank. It can be used as a strapping table in a horizontal cylindrical tank. Two of the points can be used to make a linear offset, such as would be used in a unit conversion.

The transmitter uses this data to construct a piece-wise linear offset curve.

Any number of points of data can be entered from 2 to 22. In entering the data, you will first be asked to select the number of points of data to be entered. Next, you will be asked to enter each indicated value and then to enter the actual value that corresponds to that indicated value.

When the Snsr Offset Curve has been selected, the HC275 displays the next question:

ENTER THE NUMBER OF PAIRS OF VALUES (Min -2, Max - 22)

The points selected, up to twenty-two, are entered in the following menu:
Please note that the Indicated Values must be entered from low to high. All values must be entered in the same Engineering Units selected earlier.

POINT 0
Indicated Value? 0.0000000
Actual Value? 0.0000000

POINT 1
Indicated Value? 0.0000000
Actual Value? 0.0000000

POINT 2
Indicated Value? 0.0000000
Actual Value? 0.0000000

etc.

You can select as few as two (2), or as many as twenty-two (22) points. These data points can be located anywhere over the operating range of the selected sensor. Often the points are distributed over the operating region within the 4.0mA and 20.0mA settings of the transmitter. Note that once the correction table is entered, it can be alternately enabled or disabled without the need to re-enter the data. For more information, see ACCUTECH Technical Application Note 204A.

Flow Setup

The flow set-up menu allows the transmitter to display volumetric or mass flow as well to provide a HART digital output in the same flow units. To use the flow set-up capabilities, follow the instructions below. It is very important that you perform the set-up in the order given. Before you begin this section of the menu set-up be certain that you have selected the proper engineering units that you wish to work in. If these units are flow units, it is very important they be specified before doing the setup as the setup parameters change automatically when the engineering units change. If you change the units after making the setup, you will need to go back through the entire setup process after changing the engineering units.

For differential pressure transmitters, you have the option of having the output vary with the pressure difference or with the flow.

In Case 1: the transmitter output varies directly with the pressure difference.

Case 1: Output = K_1 * (Differential Pressure) where K_1 is a constant

In Case 2: the transmitter output varies with the square-root of the pressure difference.

Case 2: Output = $K_2 * \sqrt{\text{(Differential Pressure)}}$ where K_2 is a constant

For Case 2, the transmitter will be set-up with the Square-Root Mode turned to “ON”. The transmitter output will be the flow across the differential pressure transmitter if the constant K_2 is properly specified. You can use the information below to properly determine the value of K_2 and to determine the set-up parameters that allow you to read the transmitter output in the engineering units of flow.

STEP 1: Set Mass Flow

Select the **Flow Setup** sub-menu from the Input Setup submenu. The **Flow Setup** sub-menu allows you to set up the transmitter to read volumetric flow or mass flow. If you desire a mass flow output, you will need to turn on the **Mass Flow** and then specify the density of the material. The density correction is handled as a constant. There is no dynamic compensation for temperature induced changes in the product density.

STEP 2: Set Square Root Mode

The Square Root Mode sets the transmitter to output according to the Case 2 equation. Here the output is proportional to the square root of the differential pressure. For flow output, the Square Root Mode should be turned "ON".

STEP 3: Specify the Square-Root Truncation Point

You should then check and specify the square-root truncation point. To avoid the extremely high gain of a square-root output when approaching zero flow, the square-root output transitions from square-root to linear when it approaches zero. This is a smooth transition. It should be set to occur at about 0.5% of the URV. When you change units, the square-root truncation point gets changed automatically. You will need to check this value. You should set it to about 0.5% of the URV or to another transition point that you may specify.

STEP 4: Specify the Square Root Flow Full Scale value

This step involves determining and then specifying the **Square Root Flow Full Scale** value. This process is a little more involved, but the calculations are worth the effort if you would like to read the output of the transmitter directly in engineering units.

NOTE

Do not confuse the sensor **Square Root Flow Full Scale** value with the transmitter's Upper Range Value (URV). The sensor **Square Root Flow Full Scale** value is the theoretical flow that would occur to produce exactly the full scale pressure drop of the sensor.

The transmitter's Upper Range Value is the value you determine you want to equal 20 mA transmitter output. The URV may be equal to, lower than or much lower than the sensor **Square Root Flow Full Scale** value.

To calculate the **Square Root Flow Full Scale** value, remember the flow equation from Case 2 above:

In Case 2: $\text{Output} = K_2 * \sqrt{\text{(Differential Pressure)}}$

Where K_2 is a constant and the Output is the flow.

To solve this equation for K_2, you will need to know a flow value in your chosen engineering units and a pressure drop that corresponds to this flow. Only one point needs to be known, but it obviously must be a non-zero point. More accurate results are obtained if a value is chosen that is near the upper end of the flow and differential-pressure range.

Example:
Suppose, for example, that you were using a DP-250 sensor and you knew that a certain orifice plate developed a 100" of water pressure difference when the volumetric flow through that orifice was 250 gallons per minute. In this example, you have a display on the VR-1500 and you want to have the HART digital output and the display read the flow directly in the units of gallons per minute.

1) First, you would select the engineering units of gallons per minute.
2) Second, you would select the Square Root Mode output by turning the Square Root Mode to "ON".
3) Third, you would check the Square-Root Truncation point and set it equal to about 0.5% of your URV.
4) Now you need to calculate the **Square Root Flow Full Scale** value.

To find the **Square Root Flow Full Scale** value, you would solve the Case 2 equation for K_2 using the known value point that you have. The solution for the value of K_2 would be equal to 25.

$$\text{Output} = K_2 * \sqrt{\text{(Differential Pressure)}}$$

$$250 = K_2 * \sqrt{(100)}$$

$$K_2 = 250/10$$
$$K_2 = 25$$

Now, knowing the value of K_2 to be equal to 25, you can calculate the theoretical flow at the full-scale pressure drop of the sensor. The full-scale pressure drop of the various sensors in a number of different units is given in Table 8.3 below.

Sensor	BAR	PSI	FT H_2O	Inches H_2O	Inches Hg	Mm Hg
DP-25	0.064	0.92824	2.14325	25.71901	1.88992	48.00397
DP-250	0.640	9.28243	21.43251	258.19014	18.89920	480.03968
DP-1600	4.000	58.01520	133.95320	1608.43840	118.12000	3000.24800

Table 8.3

(Note: If you have selected a unit that does not appear in Table 8.3, to calculate your value of K_2, you will need to calculate the theoretical sensor full-scale flow using the appropriate conversion factors, but normally, you can find the appropriate value from Table 8.3.)

Now, you are ready to find the theoretical **Square Root Flow Full Scale** value. To find the theoretical **Square Root Flow Full Scale** value, you would now enter the value you had determined for K_2 back into the Case 2 equation. Then solve for the **Square Root Flow Full Scale** value using the full-scale value for the sensor's differential pressure.

Following our example, you would multiply the value you determined for K_2, i.e. 25, times the square root of the sensor full-scale pressure drop from Table 8.3, expressed in inches of H_2O. This value would be equal to 25 times the square root of 258.19014, or 25 times 16.038. This to give you the theoretical **Square Root Flow Full Scale** value of (25 x 16.037) = 400.92 gal/min.

Square Root Flow Full Scale $= K_2 * \sqrt{\text{(Differential Pressure)}}$

Square Root Flow Full Scale $= 25 * \sqrt{(258.19014)}$

Square Root Flow Full Scale $= 25 * 16.037$

Square Root Flow Full Scale = 400.92 gal/min

You can then enter this value of 400.92 into the Flow-Set-up of the Configurator for the **Square Root Flow Full Scale** value.

STEP 5: Verification

You can verify the setup of the transmitter by using the same Case 2 equation. With this equation, you can calculate the flow for any pressure drop. This allows you to verify the transmitter set-up on a dead-weight tester by applying a known pressure drop.

For example, suppose you wanted to verify the transmitter calibration at a pressure drop of 80” H_2O.

From Case 2 equation, the flow should equal:

$$\textbf{Flow at 80" } \mathbf{H_2O} = K_2 * \sqrt{\text{(Differential Pressure)}}$$

$$\textbf{Flow at 80" } \mathbf{H_2O} = 25 * \sqrt{(80)}$$

$$\textbf{Flow at 80" } \mathbf{H_2O} = 25 * 8.94$$

$$\textbf{Flow at 80" } \mathbf{H_2O} = 223.60 \text{ gal/min}$$

Thus, if you set a pressure drop of 80” H_2O on your dead-weight tester, the transmitter should read 223.60 gal/min. Any other calibration check point may be calculated in the same manner.

The transmitter is now set-up to output flow directly in engineering units. You can select the 4-20mA output from the OUTPUT SETUP menu for whatever range you desire. The transmitter will read out in the engineering units of Gallons per Minute. In our example, you could select the transmitter Upper Range Value to be equal to any amount up to 400.92 gal/min. If you choose the URV to be 200 gal/min, you would get an output reading of 20 milliamps at a flow of 200 gal/min. The sensor would be reading a pressure drop of 64 inches of H_2O at this URV, although there would be no output in the units of inches of water.

You may find it necessary to correct for non-linearities in the orifice plate. These corrections may be done by using the 22 point piece-wise linearity correction discussed under Section 8.2.3.1 **Sensor Offset Curve**. Now that you have set the transmitter up to read in flow units, you can enter the indicated and actual values for the **Sensor Offset Curve** in units of flow. Working in the actual engineering units makes the linearity correction easy and you can readily adjust the VR-1500 transmitter to calibration data you have taken or that you have received from a cal lab.

Totalizer

The VR-1500 provides the ability accumulate a total flow. The various choices for “ON-OFF” and display of total flow and instantaneous flow are listed.

Reset Totalizer

This function resets the totalizer to zero.

8.2.3.2 Output Setup

The Output Setup Menu provides the following options:

```
Pressure
Output Setup
 1➔ Set LRV
 2   Set URV
 3   Apply LRV
 4   Apply URV
 5   Set Damping
HELP SAVE   HOME
```

Set LRV

This is the set-up command that is normally used to set the transmitter's Lower Range Value. When the sensor sees the pressure that has been set to equal the LRV, it will set the analog output to equal 4 mA. With the hand-held configurator, the current LRV value is displayed, and a new value may be entered using the number keys. Press the ENTER key (F4), to enter the new value, or the ABORT key (F3) to retain the current value.

Caution: This step will change your 4-20 mA output reading. Be sure to remove the loop from automatic control when setting the LRV.

Set URV

This is the command that is normally used to set the Upper Range Value, or 20 mA output point. The current URV value is displayed, and a new value may be entered using the number keys. Press the ENTER key (F4), to enter the new value, or the ABORT key (F3) to retain the current value.

Caution: This step will change your 4-20 mA output reading. Be sure to remove the loop from automatic control.

Apply LRV

Use this option to re-range the transmitter by applying the process pressure measurement corresponding to the LRV (4mA) output value. The transmitter reads the process pressure and enters this value as the new LRV. **Caution:** This step will change your 4-20 mA output reading. Be sure to remove the loop from automatic control.

The following message will be displayed:

WARN-Loop should be removed from automatic control

After removing the loop from automatic control, press the OK key (F4) to continue. The transmitter will read the input signal and display the process variable and the current LRV on the HC275 screen. Press the OK key to continue. The new LRV is displayed and the system will display:

Accept new value
Read new value
Abort

Choose Accept new value to have the new LRV sent to the transmitter. Choose Read new value to read and display a new LRV. Choose Abort to end the process without changing the LRV.

NOTE: The "Apply LRV" function changes the 4 milliamp output only. It does not change the digital output from the transmitter, nor does it change the digital reading on the display.

Internally, the transmitter has an input section and an output section. These two sections are independent. In the factory calibration, these two sections are set independently. The input section is tied to the digital value that the transmitter reads. The output section is calibrated against an electrical current standard. Bridging the gap between the digital section and the analog output section are the mathematical conversions that are done in the transmitter's microprocessor. This construction allows the transmitter output to be set independently from the transmitter's digital logic and is responsible for the great accuracy and stability of the device.

The "Apply LRV" and "Apply URV" commands only affect the analog output section of the transmitter. These commands do not change the digital values that the transmitter reads.

Suppose, for example, that you wanted to set a value of 10 PSIG as the transmitter LRV. You can do this a number of ways. The simplest way is to use the "SET LRV" command. This process is described in the previous section. To simply set the LRV, you select the engineering units for PSIG from the Input Setup menu. Then you go to the "SET LRV" command in the "OUTPUT SETUP" menu. From the "SET LRV" Command you type in the value of 10 for the Lower Range Value and you are finished. The transmitter knows what 10 PSIG is from its internal standards that are set at the factory. This set-up command is the easiest way to set-up the transmitter.

An alternative way to set up the transmitter would be to use the "APPLY LRV" command. Here, you would choose that the transmitter LRV be established from reading an external pressure value. In this example, you have chosen to set the output to 4mA when 10 PSIG is sensed on the transmitter.

Using the "APPLY LRV" command, you would apply what you believed to be 10 PSIG to the transmitter at the appropriate time in the "APPLY LRV" function. This external pressure would be set to equal 10 PSIG on an external pressure gauge, for example. There is no guarantee that the transmitter will agree that the pressure that it sees is exactly 10 PSIG. In fact, the only pressure value that the transmitter knows is the one that it reads digitally, based on its factory calibration. All the transmitter knows to do is to make the transmitter output equal exactly 4mA when it sees a pressure that is exactly equal to the pressure that you have applied. Note that you have not told the transmitter what the value is that you have applied. In this case, the transmitter's digital output and the exact value shown on the display may be somewhat different from exactly 10.0 PSIG.

This process can be somewhat confusing, but if you remember that the "APPLY LRV" command affects only the analog output of the transmitter, it will become more clear. Generally, the SET LRV command and the APPLY LRV commands produce results that are quite accurate. However, If you wish to trim the digital values for an "exact" match to an external standard, you should use the "SENSOR TRIM" selection in the "TRIM MENU".

Apply URV

Use this option to re-range the transmitter by applying the process pressure measurement corresponding to the URV (20mA) output value. The transmitter reads the process pressure and enters this value as the new URV. The following message will be displayed:

WARN-Loop should be removed from automatic control

After removing the loop from automatic control, press the OK key (F4) to continue. The transmitter will read the input signal and display the process variable and current URV on the HC275 screen. Press the OK key to continue. The new URV is displayed and the system will display:

Accept new value
Read new value
Abort

Choose <u>Accept new value</u> to have the new URV sent to the transmitter. Choose <u>Read new value</u> to read and display a new URV. Choose <u>Abort</u> to end the process without changing the URV.

The note on LRV above applies equally to the URV.

Set Damping

Use this option to set the exponential damping of the input signal, measured in seconds. The current value is displayed, and a new value may be entered using the number keys. Press the ENTER key (F4), to enter the new value, or the ABORT key (F3) to retain the current value. The maximum value allowed is 32 seconds.

8.2.3.3 Failsafe Setup

The Failsafe Setup Menu allows you to specify the behavior of the VR-1500 when a failure is detected.

Sensor Fail Det.

This option enables or disables the detection of a sensor failure. It may be turned off if you do not desire this functionality.

Failsafe Report

The VR-1500 provides a Failsafe system which will set the transmitter to a specified milliamp level if a sensor or transmitter failure is detected. This Failsafe system will alert the user that there may be a problem with the sensor, transmitter, or wiring connections. Use the **Failsafe Report** option to configure the output value in the case of such a failure. The system will display the current Failsafe selection and allow you to specify any Failsafe value. The lowest value you may specify is 3.6mA. The highest value you may specify is 23mA.

8.2.3.4 Trim

The Trim section lets you to test the output current loop, make minor adjustments in the output current of the transmitter, and make minor adjustments in the digital values from the transmitter or to reset the transmitter to its original factory 4-20 mA Trim settings. These functions can be used for verification and calibration of the precision factory calibration of the transmitter's digital output or its 4.000 mA analog output or its 20.000 mA analog output to fully agree with the local standard at your plant site.

Note that the TRIM 4 mA and the TRIM 20 mA selections are not intended to make gross changes in the setting of the loop current limits. Do **NOT** use these functions to set or adjust the ZERO or the SPAN!

Note: *The 4.00 and 20mA limits are factory calibrated to a precision standard. Using the Output Trim function voids the NIST traceability of calibration. Do not arbitrarily trim the output unless a qualified and accurate local standard is available to measure the adjusted milliamp output! Also note that the limits should not be trimmed by more than about ±50μA, or transmitter operation may be impaired.*

Note that it is possible to reinitialize the transmitter back to its original factory trim condition. After selecting RESET ANALOG TRIM from the OUTPUT TRIM MENU, the transmitter returns the 4-20mA output to the digital values back to their original factory set numbers.

The Output Trim Menu provides the following functions:

```
Pressure
Trim
 1➔ Sensor Pos Adjust
 2   Sensor Trim
 3   Output Trim
 4   Xmtr Identifiers
 5   Diagnostics
HELP SAVE  HOME
```

Sensor Position Adjustment

This step allows you to check the "position zero" reading on the transmitter. The VR-1500 is a sensitive device. Its elevation and its orientation in the field may be different from the orientation in the factory where it received its last configuration. This is particularly true with the differential pressure devices and with the GP 30 and the AP 30 units. To compensate for position changes, you may need to perform a sensor position adjustment once the unit is installed.

For this step, power the unit. You will be asked to remove the loop from automatic control. Then apply zero pressure. Be sure that the unit is installed in its final location or that it is oriented exactly as it will be in its final installation. If you have a differential pressure device, you will also need to go through a series of operations to fill the impulse lines to the device.

With zero pressure on the device, press "OK". The transmitter will then automatically be adjusted to equal a zero reading. You can then return the loop to its automatic control.

Sensor Trim

The Sensor Trim selection provides the following choices:

```
Pressure
Sensor Trim
 1➔ Zero Trim
 2    Full Scale Trim
 3    custom 2pt Trim
 4    Reset Trim

HELP SAVE   HOME
```

The "SENSOR TRIM" function changes the values that the transmitter actually reads. As such, it changes the digital values from the device. These digital values are the ones that show up on the display as well as on the digital HART output. (This function is similar to a function known in other transmitters as the A/D Trim.)

The ZERO TRIM command lets you input a pressure equal to exactly the Lower Range Value. The transmitter reads the pressure it senses and sets this value to equal the value you have selected for the LRV.

The FULL SCALE TRIM command lets you input a pressure equal to exactly the Upper Range Value. The transmitter reads the pressure it senses and sets this value to equal the value you have selected for the URV.

In actual practice, the ZERO TRIM and the FULL SCALE TRIM commands are difficult to use. It is hard to set a stable pressure that is exactly equal to the LRV or to the URV. It is much easier to use the CUSTOM TWO POINT TRIM command. This command allows you to select a low pressure point and a high pressure point. You do not need to set either pressure exactly to the transmitter's URV or to its LRV. Simply set a stable pressure and type that pressure into the transmitter.

For our example, suppose you wanted to set a LRV of 10 PSIG and you wanted the display to read exactly 10.0 PSIG. You could set the transmitter up for a LRV of 10.0 PSIG using the SET LRV command. Then, using the CUSTOM 2PT command, you could establish an external pressure value of, say, 10.5 on your external pressure source and type in 10.5 in the CUSTOM 2Pt TRIM command. The transmitter would read exactly 10.5 PSIG when it saw a pressure value equaling the 10.5 PSIG that you had applied. The LRV would be extrapolated the small increment down to the LRV and it would then be trimmed to equal 10.0 as set in the SET LRV command.

Using these various trim functions, you can set the transmitter to exactly equal the values you wish, but in the vast majority of installations simply using the SET URV and SET LRV commands will be the simplest and best approach.

The RESET TRIM command is the "undo" function. It resets the original factory trim values for all sensor variables. (Note: the Reset Trim Command in the Sensor Trim menu resets the trim values only the Sensor Trim. The Output Trim, discussed below, is reset separately.)

Output Trim

The Output Trim selection provides the following choices:

```
Pressure
Output Trim
 1➔ Loop test
 2    Trim 4-20mA
 3    Reset Analog Trim

HELP SAVE   HOME
```

Loop test

The Loop Test allows manual manipulation of the Analog Output to a selected constant output value. This function should be used for verification of the transmitter output current loop against a plant standard, or can be used as a stable current source. You may select the transmitter to output 4mA, 20mA or any other analog output level between 3.6 mA and 23 mA.

Trim 4-20mA

This option allows the calibration of transmitter's Analog Output with an external reference or standard at the operating endpoints (4 and 20mA) of the Analog Output. Note that the TRIM 4-20mA selection is not intended to make gross changes in the setting of the loop current limits.

Do **NOT** use these functions to set the ZERO or the SPAN! They merely set the electrical output signal to equal 4mA and 20mA. No reference is made to the pressure settings at these outputs.

To trim the analog output, you will need to connect a reference meter to the current loop to measure the output of the transmitter. Once connected, you will follow the on-screen instructions and compare the reference meter reading to the transmitter indicated output. If the values differ, you will enter the reference meter values into the HC275, which the transmitter will now use as its reference points.

Caution: Be sure to use a suitably accurate reference meter. Very often it is possible to connect a "reference meter" that is less accurate than the VR-1500. In this case, you would actually be de-calibrating the transmitter output.

Reset Analog Trim

This option resets the Analog Output to the factory settings. This function restores the NIST traceability of the Transmitter Analog Output.

8.2.3.5 OTHER SETUP

The final item in the Transmitter Setup Menu is **Other Setup**. It is a submenu of five options used for configuring the VR-1500.

```
Pressure
Other Setup
 1➔ Xmtr Filtering
 2   Local Display
 3   HART output
 4   Xmtr Int Units

      SAVE   HOME
```

XMTR Filtering

Select the Xmtr Filtering option to set the **Line Frequency and Filtering**, the **Smart Smoothing** and the **Validation Count** parameters.

Line Freq & Filter

The power line frequency and filter can be set to the following:

```
Pressure
Line Frequency
 60 HZ
   50Hz
   60Hz
   250Hz

        ABORT ENTER
```

The current setting is displayed. Use the arrow keys to select a new value, and then press the ENTER key (F4) to set the new value. In most applications in North America, where the power line frequency is 60 Hz, the transmitter should be set to 60Hz. This selection may help to reduce susceptibility of the transmitter to power line-induced interference.

Smart Smoothing

The VR-1500 has the ability to average successive A/D readings to achieve its high level of accuracy. With the exceptional speed of the transmitter, this averaging is accomplished very quickly. This **Smart Smoothing** feature is different from Damping, as was previously described, and it normally does not interfere with operation in a control loop. Smart Smoothing works by establishing a narrow tolerance band which defines an acceptable deviation of one A/D reading to the next.

The tolerance band is defined by two parameters, a time value and a smoothing deadband. The factory default value of this tolerance band is time of about ten seconds and a smoothing deadband of about ± 5 microvolts referenced to the input. With Smart Smoothing turned on, each A/D reading is averaged if it is within the tolerance band surrounding the existing average A/D value. If a new A/D reading falls outside the tolerance band, the Smoothing Function is reset, and the new value is reported out immediately. This ensures that any significant change in the process variable is reflected in the transmitter output without delay. In this manner, the Smart Smoothing function differs from the damping function.

We have found that in the overwhelming number of applications, these factory set parameters will provide excellent performance. New changes will be reported immediately, giving no delay in a control loop. Steady state values will remain steady with no noise. Both of these characteristics are very desirable.

In the large majority of applications, there should be no need to alter the Smart Smoothing time value. Reducing the time of Smart Smoothing improves transmitter response time only to very small changes of input that are within the Smart Smoothing Deadband. The tradeoff is a small increase in the uncertainty of measurement, meaning that successive readings may vary slightly.

Smart Smoothing Value

The current Smart Smoothing value will be displayed, and the factory default is 10 seconds. The Smart Smoothing value can be adjusted from 0 seconds (turned off) to 32 seconds, In certain applications, where the process variable moves rapidly over a small range, and the transmitter is used in a control loop, it may be desirable to shorten the averaging time of Smart Smoothing to three (3) seconds or less, or to turn it off. Use the number keys to set a new value, and then press the ENTER key (F4).

Smart Smoothing Deadband

The deadband determines the "height" of the Smart Smoothing window, as the **Smart Smoothing Time Value** defines its "length". The factory default value of 1600 corresponds to about ±5μV. Adjustments to this value are best determined empirically depending on the specific application. If you find you need to adjust this value, it might be good to call the factory first to talk through your particular application.

Smart Smoothing Validation Count

Select **Validation Count** to specify the length of time the transmitter should attempt to validate information from the sensor. In a manner somewhat analogous to Smart Smoothing, the Validation Count specifies the number of A/D readings before the transmitter would respond to a variation in the input signal. The signal must be received longer than the Validation Count before the transmitter will recognize it as a valid signal. For extreme electrical noise, it may be desirable to increase the Validation Count.

The current value will be displayed on the HC275. Use the number keys to set a new value, and then press the ENTER key (F4). Any value between 0 and 100 counts is allowed. Factory default is 1 count. This default value of 1 count means that if the transmitter sees a sensor A/D reading that is abnormally high or low, it will take one more A/D reading before reporting the reading as a true value.

This function works well to eliminate the detrimental effects of electrical noise. The characteristic that is typical of electrical noise is that it is quick and produces abnormally high or low values. These are rejected by setting the validation count to a number higher than 0. A setting of 1 to 3 counts generally clears up the detrimental effects of electrical noise.

Local Display

The Local Display Menu allows you to specify parameters concerning the transmitter display. Each may be examined and set with the following options. After changing values press the SEND key (F2) to send all changes to the transmitter.

Display Settings

This menu entry alloys you to set various parameters of the local display.

Display Label

The DK-2 has the capability of displaying a 7 character alphanumeric message on its second line. You may put up to 20 characters in the Display Label. These will be grouped into 7 character groups and displayed sequentially on the second line of the DK-2 display.

Display Language

Use this option to select the language used in the Display Mode setup menus for the DK-2 Local Display / Keyboard. English, German, French, Spanish and Italian are available.

HART Output

The HART Output Menu reports parameters used by the HART Communication Protocol. These include:

Poll addr

This is the address used by a host system to identify the Transmitter when used in a Digital Communications network. The Transmitter address can be from 1 to 15. All transmitters on this digital network must be set up for Digital Output. The transmitter output would be fixed at 4 mA. Note that in your digital network you would have a HART Primary Master (may be used for data acquisition, maintenance or control) and Secondary Master (such as a HART Communicator for configuration, diagnostics and reporting purposes). Manufacturers of such devices should be contacted for more information on Digital Networking.

Burst mode

Use this option to enable or disable Burst Mode functionality for this device. Please refer to the HC275 Manual for more information on this subject.

Burst option

Use this option to specify the variables that will be bursted if Burst Mode is enabled. The options are:

PV – i.e. the Primary Variable
% range/current
Process vars/crnt

If you change any of these parameters, you must choose the SEND command to send these values to the transmitter when you have finished making your changes. Otherwise, the transmitter will not hear your request.

Xmtr Int Units

This function allows you to access the various internal parameters of the transmitter, such as the internal electronics temperature. Use the Internal Temp Unit option to specify the unit of measure for the Internal Temperature. You may select degrees Fahrenheit or Celsius, Rankine or Kelvin. The current setting is displayed. Use the arrow keys to select a new value, and then press the ENTER key (F4).

8.2.4 XMTR IDENTIFIERS

The Transmitter Identification menu provides options for setting and reviewing the device specific parameters.

8.2.4.1 Tag Setup

The items in the TAG Setup menu are used to uniquely identify a VR-1500 transmitter. Each may be modified. After changing values press the SEND key (F2) to send all changes to the transmitter.

Tag

An eight character label usually used to identify an individual field device. The tag is displayed on the top line of the HC275 display, next to the model name 'VR-1500'.

Descriptor

A 16 character (alphanumeric) text string that can be used to associate additional information with the transmitter.

Message

A 32 character (alphanumeric) text string that can be used to associate additional information with the transmitter.

Date

The date expressed as Month/Day/Year. This could be used to record the date the transmitter was configured.

8.2.4.2 Device Information

The following Read Only information about the transmitter is provided by the Device Information Menu.

Manufacturer

Model Number

Final Assembly run number

Revision #s

This command will report the Universal HART Command Revision, the Field Device Revision (Device Description), the Software Revision, and the Hardware Revision.

8.2.5 DIAGNOSTICS

The VR-1500 continuously performs self-diagnostics and self-tests to verify its healthy status. Should it find a fault, this information is recorded in the diagnostic section of the menu. Much of this diagnostic information is lost when the device is powered down. If you are troubleshooting a problem, it is advisable that you check the diagnostic section of the menu before you take the unit out of service. This may help in uncovering the source of the fault. The faults that are recorded by the Diagnostic menu are as follows:

8.251 Transmitter Internal Diagnostics

There are a number of potential faults that are associated with parameters internal to the device. These are noted below:

Internal Standards Faults

The transmitter has a number of internal reference standards that it uses for its automatic self calibration. These are checked periodically. Any faults detected are recorded here.

Internal Standards History

This the record of the historical faults detected in the standards.

System Faults

These are the faults detected in other parts of the transmitter, other than the standards. Examples would be the A/D or the EEPROM.

System History

This is the historical record of the electronic system noted above.

Sensor Faults

These are the faults that would be detected in the sensor.

Sensor History

Open Sensor Faults

This is a set of faults that would be associated with a detection of an open sensor.

Open Sensor History

Clear Historical Status

This command allows you to clear the historical fault record.

8.2.5.2 Transmitter Internal Variables

These are the values of various internal variables.

Electronics Internal Temperature

This is the temperature of the transmitter's electronic module

Sensor Temperature

This is the temperature of the sensor itself.

8.2.6 GENERIC DD COMMANDS

The Generic DD will issue a very restricted set of commands from the hand-held terminal to the Device. All HART devices respond to these commands, but the instrument functionality with the Generic DD is very restricted. You can use the Generic DD to rerange your transmitter and set its URV and LRV as well as to set the transmitter damping.

8.3 OFFLINE CONFIGURATION

The HC275 can be used for a variety of setup and configuration options while "Offline". A HART-compliant device does not have to be connected to use the Offline options, except when sending saved configuration data to a connected device. The Offline Configuration is described in further detail in the HC275 manual. Powering the Communicator when disconnected from a device displays the message "No Device Found." Press OK and the Main Menu appears. To access the Main Menu (Offline), from the Online Menu (when connected to a device); press the left-arrow key.

8.3.1 OFFLINE

Most people find that there are easier ways to configure HART transmitters off-line than by using a hand-held terminal. We recommend you consider using the Accutech Transmitter Manager program for this function. Information on the Transmitter Manager is contained in Section 9 of this manual.

If you want to use your hand-held communicator, you will find that not all of the variables that you will want are accessible. To access the offline capability from the HC275's Main Menu**,** press 1 or select with arrow keys and press the right arrow key to access the Offline Menu. From the Offline Menu you can access the options: *New Configuration* and *Saved Configuration*. Figure 8.3 below shows a Menu Tree for the Offline functions.

Use this option to compile a custom set of device configuration data for downloading to any HART-compatible device. You can download repeatedly to multiple devices so that they store identical configuration data.

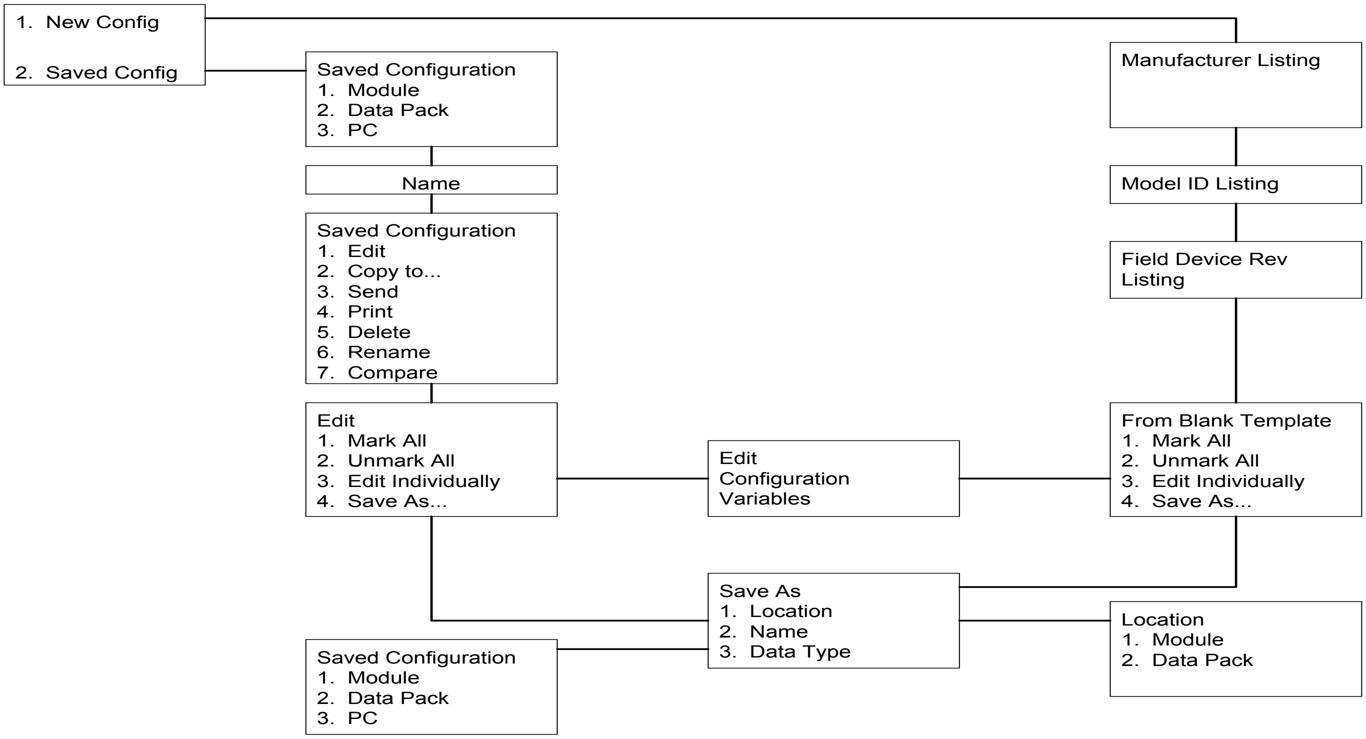


Figure 8.3 Offline Menu Tree

8.3.1.1 New Configuration

1. The Manufacturer Menu appears next and contains a list of manufacturers with device descriptions currently installed in your HART Communicator. When you select a manufacturer, the Model Menu appears.

2. The Model Menu contains a list of the currently installed device models for the selected manufacturer. When you select a device model for configuration, the Field Device Revision (Fld dev rev) Menu appears.

3. The Field Device Revision Menu contains the currently installed software revisions for the field device and Device Description (DD) for the specific model selected from the previous screen.
   If you are unsure of the device revision, connect the HC275 to the device and determine its device revision level. This information for the VR-1500 can be found in the *Device Information* option located in the *Transmitter Identification Setup* menu in the Online Device Setup Menu. You must select a software revision to access the Blank Template Menu screen as displayed in Figure 8.4.

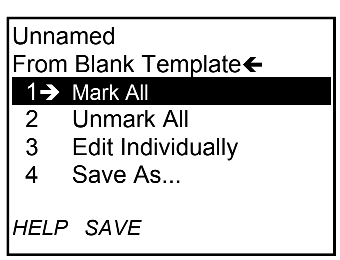


FIGURE 8.4 **Blank Template** Menu.

Mark All
Select **Mark All** to flag all configurable variables to be sent to an VR-1500 Pressure Transmitter or other HART-compliant device. Configuration Variables are those that appear when you edit variables in the configuration using the Edit Individually option.

Unmark All
Select **Unmark All** to remove the flags from all configurable variables in the configuration. Unmarked configuration variables are not sent to a connected HART compatible device.

Edit Individually
Select **Edit Individually** to open the **Edit Individually** menu containing the numerous configuration variables. The following variables can be accessed:

- Failure Detect – ON, OFF
- Engineering Units
- Int Temp Units
- Damping.
- LRV
- URV
- Line Freq & Filter
- Smart Smoothing
- Deadband
- Validation Count
- Internal Temp Units
- Tag
- Descriptor
- Message
- Date
- Display Label

Example: To edit the LRV you would select edit individually the LRV from the main off-line menu by stepping through the NEXT key as required. You would then select the EDIT function. You can then type in the new LRV and mark it to send. Press the Exit function key to return to the Blank Template screen

Save As
Selecting the Save As... saves your new configuration to either the Memory Module or the Data Pack of the HC275. See Figures 8.5 and 8.8. The Memory Module holds up to 10 typical configurations, and contains the operating system software, and device application software in nonvolatile memory. The Data Pack stores up to 100 typical configurations in nonvolatile removable memory.

Unnamed
Save As... ←
1→ Location
2 Name
3 Data Type Standard

HELP SAVE

Figure -8.5   Save As... Menu

```
Unnamed
Location
  Module
  Data Pack

                        ESC    ENTER
```

FIGURE 8.6   Location Menu.

You may also use this menu to enter or edit the configuration Name and Data Type. Data Type Standard refers to a set of all editable variables when defining a new device configuration. Data Type Partial refers to a set of all marked variables. Data Type Full refers to a set of all device variables.

When all changes have been made, save your new configuration to a storage location and return to the Offline Menu screen.

8.3.1.2 Saved Configuration

Use the Saved Configuration menu to access configuration data stored in your HC275.

Press '2' from the Offline Menu and the Saved Configuration Menu screen appears as displayed in Figure 8.7.

```
HART Communicator
Saved Configuration        ←
 1→  Module Location
 2   Data Pack Contents
 3   PC


HELP
```

FIGURE 8.7   Saved Configuration Menu.

Select either Module Contents or Data Pack Contents to open your stored configurations. Both storage locations list all saved configurations by assigned Tag. See XPAND on next page for more configuration identification details.

The PC Saved Configuration option is not operational with this release.
Refer to the HC275 manual on page 27 for details on interfacing with a PC.

Figure 8.8 shows the Data Pack menu that displays a listing of device configurations stored in the Data Pack.

```
HART Communicator
Data Pack                  ←
 VR-1500




FLTR   XPAND
```

FIGURE 8.8   Data Pack Menu.

FLTR

The FLTR function key opens a menu that provides both Sort and Filter options. These options allow you to customize your view of saved device configurations.

Sort allows you to group and display device configurations according to your choice of Tag, Descriptor, or Name.

Filter allows you to customize your group for viewing according to what you entered with Sort by picking characters from the device Tag, Descriptor, or Name.

When setting up a Filter, you can use two special characters: the period (.) and the asterisk (*). The period replaces a single character of any value. The asterisk replaces zero or more alphanumeric characters of any value.

Example: if you entered A-*-.1, it should match all device tags starting with **A-,** followed by any **characters,** followed by -, followed by any **single** character, and ending with a 1. That means, devices starting with A- and ending in 1, out of your list of saved device configurations, will display as a group on the communicator's screen.

XPAND
The XPAND function key allows you to view the Tag, Descriptor, and Name for the current configuration. Selecting **Compress** returns you to the previous compressed screen with the current Tag or Descriptor or Name.

Press the Right Arrow key to open the Saved Configuration Menu, as shown in Figure 8.9**.**

```
VR-1500
Saved Configuration   ←
 1→ Edit
 2  Copy to...
 3  Send
 4  Print
 5  Delete
HELP
```

FIGURE 8.9 Saved Configuration Menu.

Edit
Selecting Edit displays the Edit Menu. These edit functions are the same as described under **Edit Individually**.

If you are editing online remember that only stored data may be edited, and if the data was stored as a Partial configuration, you must convert it to a Standard configuration before saving it.

Copy To...
Selecting Copy To... specifies the storage location where you want the copy to be stored. You may also change the configuration name when using this option.

Send
After completing your configuration, selecting **Send** will send your saved configuration to a 'connected' device.

Print
Not implemented with this release. This option is intended for the future. See Listen for PC on page 27 of the HC275 Manual (April 1996) for more information.

Delete
Selecting Delete will remove a saved configuration from the memory storage location. A confirmation message will appear. Press Yes or No to complete the function.

Rename
Select Rename to access the Configuration Name editing menu. After making name changes, enter and save the data to return to the previous storage location menu.

Compare
The Compare option compares a selected device configuration from a stored location with another device configuration. The HC275 compares device types, variables, marked lists, etc. Messages will appear indicating whether the configurations compared are the same or different. Press OK to return to the storage location and your list of device configurations. Find and make any necessary changes resulting from your comparisons.

In order to produce a 'Same / Differ' result, the following conditions must be met when comparing two configurations:

1. Device type (including manufacturer), device type number, device revision, and DD revision must match exactly.
2. Configurations can only be compared against other configurations containing the same set of variables. The communicator will notify you if this condition is not met.
3. The format of data storage must match exactly. The HC275 will notify you if this condition is not met.

User assigned configuration names are not considered as they will differ.

8.4 ONLINE

See the On-line Menu description in Section 8.2 of this manual.

8.5 FREQUENCY DEVICE

The Frequency Device function is not applicable for this device. See the HC-275 Manual for more details.

8.6 UTILITY

This menu contains several menus for customizing your HC275 to your needs. See the HC275 Manual for more details on these menus.

8.6.1 Configure Communicator

This menu allows you to customize your HC275 for Polling, Contrast, Off Time, and Ignore Diagnostics. Refer to the HC275 Manual for details.

8.6.2 System Information

This menu gives you specific information on your HC275 Motherboard, Module, and Data Pack.

8.6.3 Listen for PC

Refer to the HC275 Manual for details.

8.6.4 Storage Location

This menu allows you to customize the memory storage locations in your HC275. Refer to the HC275 Manual for details.

8.6.5 Simulation (Reviewing Installed Devices)

The HC275 Memory Module contains device descriptions for specific HART-compliant devices. These descriptions make up the application software that the communicator needs to recognize particular devices, including the ACCUTECH VR-1500. You can determine the device types loaded into your memory module through the Simulation function. You can also configure a device using the Simulation while Offline or not connected to a device, and then download this device configuration using the SAVE function previously described under the New Configurations section of this manual.

If you cannot find a specific HART-compliant device on your communicator, then the device description you are looking for is not programmed into the Memory Module. In this instance you are limited to programming the device using the generic device description. The generic device description will allow limited setup functions, such as setting the 4-20mA points (LRV and URV) and a few other generic functions.

Follow these steps to review the device descriptions programmed into your HART Communicator.

1. From within the Main Menu, press #4 to access the Utility Menu.
2. From within the Utility Menu, press #5 to access the Simulation mode.
3. The Manufacturer Menu appears. The Manufacturer Menu contains a list of each manufacturer with device descriptions currently installed in your HC275 memory.
   Once you select a manufacturer, the Model Menu appears. The Model Menu contains a list of currently installed device models provided by the selected manufacturer.
4. Review the different manufacturers and models to determine the installed HART compatible devices in your communicator.
5. If the desired Device Description is not installed in your communicator, you will need to return the HC275 to an Authorized Service Center to install the Accutech VR-1500 DD.
   ACCUTECH can arrange for such installations.

9.0 ACCUTECH TRANSMITTER MANAGER

9.1 INTRODUCTION

The Accutech VR-1500 Pressure Transmitter, along with the Accutech AI-1500 and AI-1000 Rev 2 Temperature Transmitter are designed to be used in conjunction with the Accutech Transmitter Manager. The Transmitter Manager is a software program that is used to configure Accutech Transmitters, store those configurations and to monitor performance of the field devices. The Accutech Transmitter Manager is available at no charge from the Accutech web-site **www.savewithaccutech.com**. It is also available at no charge to Accutech customers by calling Accutech Customer Service at (800) 879-6576.

The current revision of the Transmitter Manager is 3.0.6. It is updated frequently as PC operating systems change and as new features are added. We believe that the Transmitter Manager is intuitive to use, but the instructions for its use and the changes in the current revision are also noted on the website. You may wish to access this information if you have specific questions on the use of the Transmitter Manager that are not answered in this section of the manual.

9.2 CONNECTIONS

To use the Transmitter Manager, you need to connect the transmitter to your computer. This is accomplished as noted below. To interface to the VR-1500, you will need a HART Modem that can connect into the communications port of your PC. These modems are available from Accutech if you do not have one. The Part Number is “HART Modem”.

To use the Transmitter Manager, you need to have the modem that matches with the communications protocol of the transmitter. With the AI-1500 or VR-1500, this would be the HART Modem. For the AI-1000 Rev 2 product, you will need the LSK modem. The LSK Modem will not communicate to a HART device, nor will a HART modem communicate to an LSK device. You will need the HART Modem to talk with the VR-1500 product.

Generally the modem plugs into Communications Port 1 on the back of your PC. Your PC will need the Windows 98, Windows 2000 or Windows XP operating system and 30 MB of free disk space to work properly with the Transmitter Manager.

The HART Modem can interface with a transmitter from any wiring termination point in the current output loop. To interface the Modem to your PC, connect the Modem with the appropriate connectors in parallel with the instrument or load resistor. All connections are non-polarized. See Figure 9.1.

If the Transmitter Manager cannot communicate to the device, the *Network* screen will appear. You should verify that the transmitter is powered and that the proper modem connections are made and that you have included the 250 Ω Resistor. You may need to change the communications port indication if you have not connected the Modem to Comm Port 1. Then click the “Connect” button to connect to the transmitter.

Note: Please note the R_L resistor noted in Figure 9.1. For the HART Communicator to function properly, a minimum of 250 Ohms ***must*** be present in the loop. The HART Communicator does not measure loop current directly.

The HART modem available from Accutech is not intrinsically safe. Very few Personal Computers are rated for use in hazardous environments.

Accutech specifically recommends that neither the Transmitter Manager nor the Modem be used in a hazardous environment. If such usage is required it must be specifically approved and permitted by the safety officer at the site. Accutech can assume no responsibility for the safe usage of the Modem, the Transmitter Manager, or the PC that is the host. Determination of any potential hazardous is completely up the discretion of the local site.

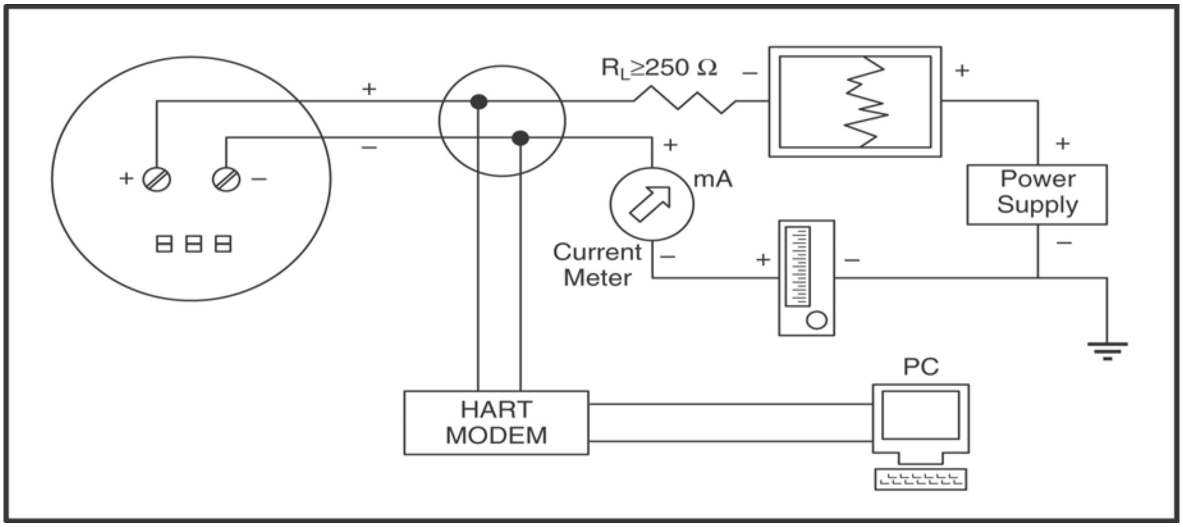


Figure 9.1 Connecting the HART Communicator to a Transmitter Loop.

WARNING

Explosions can result in death or injury. Do not connect the HART Modem in explosive atmospheres. Make sure the instruments are installed in accordance with all safe practices.

9.3 INSTALLATION

Install the Transmitter Manager on your PC following the instructions received with the program. We recommend you close all applications on your PC while running the Transmitter Manager. We cannot test the software with all PC applications software. Some programs use or contest the use of the communications port. For this reason, you will have a better experience with the Transmitter Manager if it is used by itself on your PC. This note is reflected in the first screen. You may also review the notes on the software revision you have on the first screen. After pressing “OK”, you will go to the “Display Data” screen.

9.4 DISPLAY DATA

The “Display Data” screen is shown below as Figure 9.2

Figure 9.2 Display Data Screen

The Screen should note that the transmitter is connected at the top of the screen, backlit in green. If no transmitter is connected, the message will reflect this fact and be backlit in red.

The "Display Data" screen is a read-only screen. It displays operating data and set-up information on the connected device. This is live data from the field device. The data is continuously updated until you press the "Escape" key. Once you have pressed the "Escape" key, you will pause the live reading of the data and you may then select a different screen to review. There are live instructions to this effect in the "Instructions" box that appears under the transmitter display.

9.5 SETUP

The "Setup" screen is particularly valuable. On this screen, you can set all of the normal parameters of the VR1500. You may make your selections by simply clicking on the appropriate box. The Setup Screen is shown below in Figure 9.3

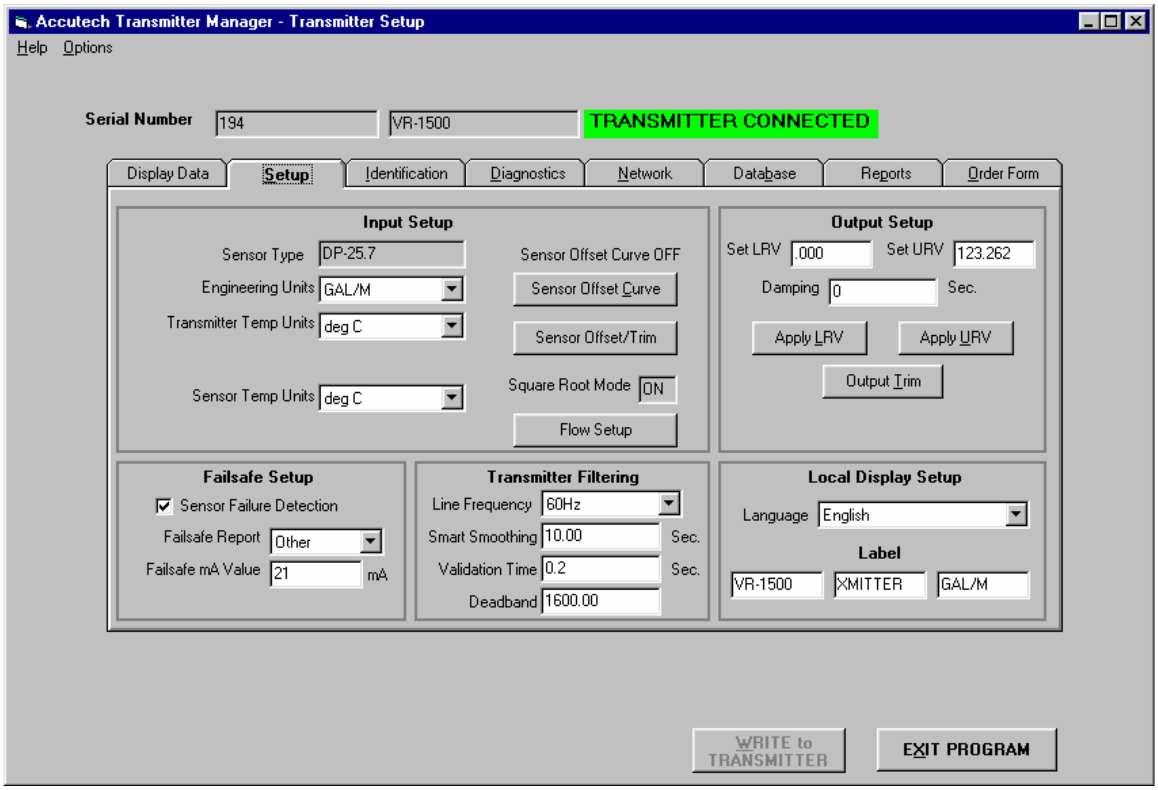


Figure 9.3 Setup Screen

9.5.1 INPUT SETUP

Engineering Units

This allows you to select the engineering unit of measure for your transmitter. With the Gauge and Absolute Pressure transmitters, there are about 20 units to choose from. These are listed in Table 9.1.

percent (%)	millimeters of Water	grams / cm^2	**atmospheres**
special	millimeters of Mercury	Kg / cm^2	**Megapascal**
inches of Water	Pounds per in^2 (PSI)	pascal	**inches water @ 4°C**
inches of Mercury	bar	Kilopascal	**mm water @ 4°C**
feet of Water	**millibar**	**torr**	

Table 9.1 Gauge & Absolute Pressure Transmitter Engineering Units

For the DP device, there are about 50 units to choose from that include both pressure and flow units. These are noted in table 9.2. The “Spcl” or “Special” unit can be used if the unit of measure that you desire is not included in the standard unit tables.

percent (%)	pascal	gallons / second	**STD ft^3 / min**
special	Kilopascal	millions of gal / day	**ft^3 / hr**
inches of Water	torr	Liters / sec	**cubic meters / min**
inches of Mercury	atmospheres	millions of liters / day	**barrels / sec**
feet of Water	Megapascal	cubic feet / sec	**barrels / min**
millimeters of Water	inches water @ 4°C	cubic feet / day	**barrels / hr**
millimeters of Mercury	mm water @ 4°C	cubic meters / sec	**barrels / day**
Pounds per in^2 (PSI)	ft^3 / min	cubic meters / day	**gal / hr**
bar	gallons / min	Imperial gal / hr	**Imperial gal / sec**
millibar	liters / min	Imperial gal / day	**liters / hr**
grams / cm^2	Imperial gal / min	normal cubic meters / hr	**gallons / day**
Kg / cm^2	**cubic meters / hr**	**normal liters / hr**	

Table 9.2 Differential Pressure Engineering Units

Sensor Offset Curve

The VR-1500 provides the ability to correct or characterize the Primary Variable by offsetting it according to values on a 22 point curve. This offset curve can be extremely useful to linearize a particular sensor or orifice plate. The offset curve can be used to convert pressure, or level data into mass or to convert pressure data to volumetric information in an odd shaped tank. It can be used as a strapping table in a horizontal cylindrical tank. Two of the points can be used to make a linear offset, such as would be used in a special unit conversion.

The transmitter uses this table of offsets to construct a piece-wise linear offset curve.

Any number of points of data can be entered from 2 to 22. (selecting zero points is the same as turning off this function) In entering the data, you will first be asked to select the number of points of data to be entered. Next, you will be asked to enter each indicated value and then to enter the actual value that corresponds to that indicated value.

When the Sensor Offset Curve has been selected, the Transmitter Manager displays a screen that allows you to select the number of offset points and to enter their values.

NUMBER OF PAIRS OF VALUES (Min -2, Max - 22)

The points selected, up to twenty-two, are entered in the following menu:
Please note that the Indicated Values must be entered from low to high. All values must be entered in the same Engineering Units selected earlier.

POINT 0
Indicated Value? 0.0000000
Actual Value? 0.0000000

POINT 1
Indicated Value? 0.0000000
Actual Value? 0.0000000

POINT 2
Indicated Value? 0.0000000
Actual Value? 0.0000000

etc.

You may select as few as two (2), or as many as twenty-two (22) points. These data points can be located anywhere over the operating range of the selected sensor. Often the points are distributed over the operating region within the 4.0mA and 20.0mA settings of the transmitter. Note that once the correction table is entered, it can be alternately enabled or disabled without the need to re-enter the data. For more information, see ACCUTECH Technical Application Note 204A.

When you have finished entering your data, you should see that the data that you have changed is backlit in yellow. When you have finished you may choose to write the data to the transmitter or to exit. Highlight your choice and continue.

Sensor Offset / Trim

The “SENSOR OFFSET / TRIM” section lets you make minor adjustments in the digital values from the transmitter or to reset the transmitter to its original settings. These functions can be used for verification and calibration of the precision factory calibration of the transmitter’s digital output to fully agree with your local plant standard. This menu selection also allows you to reset the sensor trim back to their original factory-set values.

Note that the 4-20mA Lower Range Value as well as the 4-20mA Upper Range Value and the output trim are in the Output Setup box of the setup screen. The Sensor Offset / Trim menu is intended only to make minor adjustments to the digital values seen by the sensor and displayed on the display or sent digitally over the HART output signal.

All the functions in the “SENSOR OFFSET / TRIM” menu change the values that the transmitter actually reads. As such, these functions change the digital values from the device. These digital values are the ones that show up on the display as well as on the digital HART output. (These functions are similar to the functions known in other transmitters as the A/D Trim.)

Sensor Position Offset/Trim

This step allows you to check the “position zero” reading on the transmitter. The VR-1500 is a sensitive device. Its elevation and its orientation in the field may be different from the orientation in the factory where it received its last configuration. This is particularly true with the differential pressure devices and with the GP 30 and the AP 30 units. To compensate for position changes, you may need to perform a sensor position adjustment once the unit is installed.

For this step, power the unit. You will be asked to remove the loop from automatic control. Then apply zero pressure. Be sure that the unit is installed in its final location or that it is oriented exactly as it will be in its final installation. If you have a differential pressure device, you will also need to go through a series of operations to fill the impulse lines to the device.

With zero pressure on the device, select the “SENSOR POSITION OFFSET / TRIM” button. The transmitter will then automatically read the applied pressure, set this equal to “zero” and reboot. You can then return the loop to its automatic control.

Trim to LRV (4mA) Point

The “TRIM to LRV (4mA) POINT” command lets you set up the transmitter digital values by using a pressure equal to exactly the Lower Range Value. The transmitter reads the pressure it senses and sets this value to equal the value you have selected for the LRV. Be sure when you select this function that you have oriented the transmitter exactly as it will be oriented in the field, that the impulse lines are full if you have a differential pressure device and that you have applied exactly the pressure to the device that corresponds to the LRV. The transmitter will read whatever pressure is applied, determine that that is the pressure that you want to equal the LRV point and set the transmitter accordingly.

Trim to URV (20mA) Point

The “TRIM to URV (20mA) POINT” command lets you do the same thing for the Upper Range Value. The transmitter reads the pressure it senses and sets this value to equal the value you have selected for the URV. Be sure to have the URV pressure applied to the device before selecting this command.

Trim to Custom 2 Points

In actual practice, the "TRIM to LRV and the TRIM to URV POINT" commands are difficult to use. It is hard to set a stable pressure that is exactly equal to the LRV or to the URV. It is much easier to use the "CUSTOM 2 POINTS" command. This command allows you to select a low pressure point and a high pressure point. You do not need to set either pressure exactly to the transmitter's URV or to its LRV. Simply set a stable pressure and type that pressure into the transmitter.

For our example, suppose you wanted to set a LRV of 10 PSIG and you wanted the display to read exactly 10.0 PSIG. You could set the transmitter up for a LRV of 10.0 PSIG using the output section of the set-up window. Then using the CUSTOM 2 POINTS command, you could establish an external pressure value of, say, 10.5 on your external pressure source and type in 10.5 in the CUSTOM 2Pt TRIM command. The transmitter would read exactly 10.5 PSIG when it saw a pressure value equaling the 10.5 PSIG that you had applied. The LRV would extrapolate the small increment down to the LRV and it would then be trimmed to equal 10.0 as set in output window set-up.

Using these various trim functions, you can set the transmitter to exactly equal the values you wish, but in the vast majority of installations simply using the SET URV and SET LRV commands in the Output Setup window will be the simplest and best approach.

Reset Sensor Trim to Factory

The "RESET SENSOR TRIM to FACTORY" command is the "undo" function. It resets the original factory trim values for all sensor variables. (Note: the "RESET SENSOR TRIM to FACTORY" command in the Sensor Trim menu resets the trim values only the Sensor Trim. The Output Trim, discussed below, is reset separately.)

Transmitter Temperature Units

This command lets you select the temperature units to display the transmitter temperature.

Sensor Temperature Units

This command lets you select the temperature units to display the sensor temperature.

Square Root Mode

For differential pressure transmitters, you have the option of having the output vary with the pressure difference or with the flow.

In Case 1: the transmitter output varies directly with the pressure difference.

Case 1: Output = K_1 * (Differential Pressure) where K_1 is a constant

In Case 2: the transmitter output varies with the square-root of the pressure difference.

Case 2: Output = $K_2 * \sqrt{\text{(Differential Pressure)}}$ where K_2 is a constant

For Case 2, the transmitter will be set-up with the Square-Root Mode turned to "ON". The transmitter output will be the flow across the differential pressure transmitter if the constant K_2 is properly specified. You can use the information below to properly determine the value of K_2 and to determine the set-up parameters that allow you to read the transmitter output in the engineering units of flow.

Flow Setup

The flow set-up menu allows the transmitter to display volumetric flow or mass flow as well to provide a HART digital output in the same flow units. To use the flow set-up capabilities, follow the instructions below. It is very important that you perform the set-up in the order given, starting by selecting the proper engineering units.

STEP 1: Select the Engineering Units. These units may be chosen from the choices in Table 9.2.

STEP 2: Specify the Flow Setup

Select the **Flow Setup** sub-menu from the Setup Window. The **Flow Setup** sub-menu allows you to set up the transmitter to read volumetric flow or mass flow. If you desire a mass flow output, you will need to turn on the **Mass Flow** and then specify the density of the material. The density correction is handled as a constant. There is no dynamic compensation for temperature induced changes in the product density.

You may next change the flow units if you have not specified them in Step 1.

For flow output, you will want to turn on the **Square-Root Mode** from the **Flow Setup** submenu.

STEP 3: Specify the Square-Root Truncation Point

You should then check and specify the square-root truncation point. To avoid the extremely high gain of a square-root output when approaching zero flow, the square-root output transitions from square-root to linear when it approaches zero. This is a smooth transition. It should be set to occur at about 0.5% of the URV. When you change units, the square-root truncation point gets changed automatically. You will need to check this value. You should set it to about 0.5% of the URV or to another transition point that you may specify.

STEP 4: Specify the **Flow Full Scale** value

This step involves determining and then specifying the **Flow Full Scale** value. This process is a little more involved, but the calculations are worth the effort if you would like to read the output of the transmitter directly in engineering units.

NOTE

Do not confuse the sensor **Flow Full Scale** value with the transmitter's Upper Range Value (URVL). The sensor **Flow Full Scale** value is the theoretical flow that would occur to produce exactly the full scale pressure drop of the sensor.

The transmitter's Upper Range Value is the value you determine you want to equal 20 mA transmitter output. The URV may be equal to or much lower than the sensor **Flow Full Scale** value.

To calculate the **Flow Full Scale** value, remember the flow equation from Case 2 above:

In Case 2: $\text{Output} = K_2 * \sqrt{\text{(Differential Pressure)}}$

Where K_2 is a constant and the Output is the flow.

To solve this equation for K_2, you will need to know a flow value in your chosen engineering units and a pressure drop that corresponds to this flow. Only one point needs to be known, but it obviously must be a non-zero point. More accurate results are obtained if a value is chosen that is near the upper end of the flow and differential-pressure range.

Example:
Suppose, for example, that you were using a DP-250 sensor and you knew that a certain orifice plate developed a 100" of water pressure difference when the flow through that orifice was 250 gallons per minute. In this example, you have a display on the VR-1500 and you want to have the HART digital output and the display read the flow directly in the units of gallons per minute.

1) First, you would select the engineering units of gallons per minute.
2) Second, you would select the Square Root Mode output by turning the Square Root Mode to "ON".
3) Third, you would check the Square-Root Truncation point and set it equal to about 0.5% of your URV.
4) Now you need to calculate the **Flow Full Scale** value.

To find the **Flow Full Scale** value, you would solve the Case 2 equation for K_2 using the known value point that you have. The solution for the value of K_2 would be equal to 25.

$$\text{Output} = K_2 * \sqrt{(\text{Differential Pressure})}$$

$$250 = K_2 * \sqrt{(100)}$$

$$K_2 = 250/10$$
$$K_2 = 25$$

Now, knowing the value of K_2 to be equal to 25, you can calculate the theoretical flow at the full-scale pressure drop of the sensor. The full-scale pressure drop of the various sensors in a number of different units is given in Table 9.3 below.

Sensor	BAR	PSI	FT H_2O	Inches H_2O	Inches Hg	Mm Hg
DP-25	0.064	0.92824	2.14325	25.71901	1.88992	49.00397
DP-250	0.640	9.28243	21.43251	257.19014	19.89920	480.03968
DP-1600	4.000	59.01520	133.95320	1607.43840	119.12000	3000.24800

Table 9.3

(Note: If you have selected a unit that does not appear in Table 9.3, to calculate your value of K_2, you will need to calculate the theoretical sensor full-scale flow using the appropriate conversion factors, but normally, you can find the appropriate value from Table 9.3.)

Now, you are ready to find the theoretical **Flow Full Scale** value. To find the theoretical **Flow Full Scale** value, you would now enter the value you had determined for K_2 back into the Case 2 equation. Then solve for the **Flow Full Scale** value using the full-scale value for the sensor's differential pressure.

Following our example, you would multiply the value you determined for K_2, i.e. 25, times the square root of the sensor full-scale pressure drop from Table 9.3, expressed in inches of H_2O. This value would be equal to 25 times the square root of 257.19014, or 25 times 16.037. This to give you the theoretical **Flow Full Scale** value of (25 x 16.037) = 400.92 gal/min.

$$\textbf{Flow Full Scale} = K_2 * \sqrt{(\text{Differential Pressure})}$$

$$\textbf{Flow Full Scale} = 25 * \sqrt{(257.19014)}$$

$$\textbf{Flow Full Scale} = 25 * 16.037$$

$$\textbf{Flow Full Scale} = 400.92 \text{ gal/min}$$

You can then enter this value of 400.92 into the Flow-Set-up of the Transmitter Manager for the **Flow Full Scale** value.

STEP 5: Verification

You can verify the setup of the transmitter by using the same Case 2 equation. With this equation, you can calculate the flow for any pressure drop. This allows you to verify the transmitter set-up on a dead-weight tester by applying a known pressure drop.

For example, suppose you wanted to verify the transmitter calibration at a pressure drop of 80” H_2O.

From Case 2 equation, the flow should equal:

Flow at 80” H_2O = $K_2 * \sqrt{\text{(Differential Pressure)}}$

Flow at 80” H_2O = $25 * \sqrt{(80)}$

Flow at 80” H_2O = 25 * 8.94

Flow at 80” H_2O = 223.60 gal/min

Thus, if you set a pressure drop of 80” H_2O on your dead-weight tester, the transmitter should read 223.60 gal/min. Any other calibration check point may be calculated in the same manner.

The transmitter is now set-up to output flow directly in engineering units. You can select the 4-20mA output from the OUTPUT SETUP menu for whatever range you desire. The transmitter will read out in the engineering units of Gallons per Minute. In our example, you could select the transmitter Upper Range Value to be equal to any amount up to 400.92 gal/min. If you choose the URV to be 200 gal/min, you would get an output reading of 20 milliamps at a flow of 200 gal/min. The sensor would be reading a pressure drop of 64 inches of H_2O at this URV, although there would be no output in the units of inches of water.

You may find it necessary to correct for non-linearities in the orifice plate. These corrections may be done by using the 22 point piece-wise linearity correction discussed under Section 9.5.1 **Sensor Offset Curve**. Now that you have set the transmitter up to read in flow units, you can enter the indicated and actual values for the **Sensor Offset Curve** in units of flow. Working in the actual engineering units makes the linearity correction easy and you can readily adjust the VR-1500 transmitter to calibration data you have taken or that you have received from a cal lab.

Totalizer

The VR-1500 provides the ability accumulate a total flow. The various choices for “ON-OFF” and display of total flow and instantaneous flow are listed.

Reset Totalizer

This function resets the totalizer to zero.

9.5.2 OUTPUT SETUP

Set LRV

This is the set-up command that is normally used to set the transmitter’s Lower Range Value. When the sensor sees the pressure that has been set to equal the LRV, it will set the analog output to equal 4 mA. With the Transmitter Manager, the current LRV value is displayed, and a new value may be entered using the number keys. The changed value will be backlit in yellow, reminding you to write this new information to the transmitter when you have finished setting all the parameters you wish to set.

Caution: This step will change your 4-20 mA output reading. Be sure to remove the loop from automatic control when setting the LRV.

Set URV

This is the set-up command that is normally used to set the transmitter's Upper Range Value. When the sensor sees the pressure that has been set to equal the URV, it will set the analog output to equal 20 mA. With the Transmitter Manager, the current URV value is displayed, and a new value may be entered using the number keys. The changed value will be backlit in yellow, reminding you to write this new information to the transmitter when you have finished setting all the parameters you wish to set.

Caution: This step will change your 4-20 mA output reading. Be sure to remove the loop from automatic control when setting the URV.

LRV, URV Description and Example

Internally, the transmitter has an input section and an output section. These two sections are independent. In the factory calibration, these two sections are set independently. The input section is tied to the digital value that the transmitter reads. The output section is calibrated against an electrical current standard. Bridging the gap between the digital section and the analog output section are the mathematical conversions that are done in the transmitter's microprocessor. This construction allows the transmitter output to be set independently from the transmitter's digital logic and is responsible for the great accuracy and stability of the device.

The "Apply LRV" and "Apply URV" commands only affect the analog output section of the transmitter. These commands do not change the digital values that the transmitter reads.

Suppose, for example, that you wanted to set a value of 10 PSIG as the transmitter LRV. You can do this a number of ways. The simplest way is to use the "SET LRV" command. This process is described in the previous section. To simply set the LRV, you select the engineering units for PSIG from the Input Setup menu. Then you go to the "SET LRV" command in the "OUTPUT SETUP" menu. From the "SET LRV" Command you type in the value of 10 for the Lower Range Value and you are finished. The transmitter knows what 10 PSIG is from its internal standards that are set at the factory. This set-up command is the easiest way to set-up the transmitter.

An alternative way to set up the transmitter would be to use the "APPLY LRV" command. Here, you would choose that the transmitter LRV be established from reading an external pressure value. In this example, you have chosen to set the output to 4mA when 10 PSIG is sensed on the transmitter.

Using the "APPLY LRV" command, you would apply what you believed to be 10 PSIG to the transmitter at the "APPLY LRV" function. This external pressure would be set to equal 10 PSIG on an external pressure gauge, for example. There is no guarantee that the transmitter will agree that the pressure that it sees is exactly 10 PSIG. In fact, the only pressure value that the transmitter knows is the one that it reads digitally, based on its factory calibration. All the transmitter knows to do is to make the transmitter output equal exactly 4mA when it sees a pressure that is exactly equal to the pressure that you have applied. Note that you have not told the transmitter what the value is that you have applied. In this case, the transmitter's digital output and the exact value shown on the display may be somewhat different from exactly 11.0 PSIG.

This process can be somewhat confusing, but if you remember that the "APPLY LRV" command affects only the analog output of the transmitter, it will become clearer. Generally, the SET LRV command and the APPLY LRV commands produce results that are quite accurate. However, If you wish to trim the digital values for an "exact" match to an external standard, you should use the "SENSOR OFFSET / TRIM" selection from the "INPUT SETUP" window.

Apply LRV

Use this option to re-range the transmitter by applying the process pressure measurement corresponding to the LRV (4mA) output value. The transmitter reads the process pressure and enters this value as the new LRV. The transmitter will read the input signal and display the process variable and the current LRV on the screen. You will then have the choice to:

Accept new value

Read new value
Exit

Choose Accept new value to have the new LRV sent to the transmitter. Choose Read new value to read and display a new LRV. Choose Exit to end the process without changing the LRV.

NOTE: The “Apply LRV” function changes the 4 milliamp output only. It does not change the digital output from the transmitter, nor does it change the digital reading on the display.

Apply URV
The “Apply URV” is done in the same manner as the “Apply LRV”.

Set Damping
Use this option to set the exponential damping of the input signal, measured in seconds. The current value is displayed, and a new value may be entered using the number keys. The maximum value allowed is 32 seconds. The new value is noted by backlighting the field in yellow reminding you that you will need to write the new value to the transmitter when you have finished making all the changes you desire.

Output Trim
The Output Trim selection provides the following choices:

1. Loop test
2. Trim 4-20mA
3. Reset Analog Trim

Loop test
The Loop Test allows manual manipulation of the Analog Output to a selected constant output value. This function should be used for standard verification of the transmitter output current loop against a plant standard, or can be used as a stable current source. You may select the transmitter to output 4mA, 20mA or any other analog output level between 3.6 mA and 23 mA.

Trim 4-20mA
This option allows the calibration of transmitter’s Analog Output with an external reference or standard at the operating endpoints (4 and 20mA) of the Analog Output. Note that the TRIM 4-20mA selection is not intended to make gross changes in the setting of the loop current limits.

Do **NOT** use these functions to set the ZERO or the SPAN! They merely set the electrical output signal to equal 4mA and 20mA. No reference is made to the pressure settings at these outputs.

To trim the analog output, you will need to connect a reference meter to the current loop to measure the output of the transmitter. Once connected, you will follow the on-screen instructions and compare the reference meter reading to the transmitter indicated output. If the values differ, you will enter the reference meter values into the Transmitter Manager Program, which the transmitter will now use as its reference points.

Caution: Be sure to use a suitably accurate reference meter. Very often it is possible to connect a “reference meter” that is less accurate than the VR-1500. In this case, you would actually be de-calibrating the transmitter output.

Reset Analog Trim
This option resets the Analog Output to the factory settings. This function restores the NIST traceability of the Transmitter Analog Output.

9.5.3 FAILSAFE SETUP

The Failsafe Setup Menu allows you to specify the behavior of the VR-1500 when a failure is detected.

Sensor Failure Detection
This option enables or disables the detection of a sensor failure. It may be turned off if you do not desire this functionality.

Failsafe Report
The VR-1500 provides a Failsafe system which will set the transmitter to a specified milliamp level if a sensor or transmitter failure is detected. This Failsafe system will alert the user that there may be a problem with the sensor, transmitter, or wiring connections. Use the **Failsafe Report** option to configure the output value in the case of such a failure. The system will display the current Failsafe selection and allow you to specify any Failsafe value. Selections are for Failsafe High, Failsafe Low or Other. If you select "Other", you then specify the failsafe mA value. The lowest value you may specify is 3.6mA. The highest value you may specify is 23mA.

9.5.4 TRANSMITTER FILTERING

Line Freq & Filter
The power line frequency and filter can be set to the following:

50 Hz
60 Hz
250 Hz

The current setting is displayed. Use the arrow keys to select a new value, and then enter this new value. In most applications in North America, where the power line frequency is 60 Hz, the transmitter should be set to 60Hz. This selection may help to reduce susceptibility of the transmitter to power line-induced interference.

Smart Smoothing
The VR-1500 has the ability to average successive A/D readings to achieve its high level of accuracy. With the exceptional speed of the transmitter, this averaging is accomplished very quickly. This **Smart Smoothing** feature is different from Damping, as was previously described, and it normally does not interfere with operation in a control loop. Smart Smoothing works by establishing a narrow tolerance band which defines an acceptable deviation of one A/D reading to the next.

The tolerance band is defined by two parameters, a time value and a smoothing deadband. The factory default value of this tolerance band is time of about ten seconds and a smoothing deadband of about $\pm$ 5 microvolts referenced to the input. With Smart Smoothing turned on, each A/D reading is averaged if it is within the tolerance band surrounding the existing average A/D value. If a new A/D reading falls outside the tolerance band, the Smoothing Function is reset, and the new value is reported out immediately. This ensures that any significant change in the process variable is reflected in the transmitter output without delay. In this manner, the Smart Smoothing function differs from the damping function.

We have found that in the overwhelming number of applications, these factory set parameters will provide excellent performance. New changes will be reported immediately, giving no delay in a control loop. Steady state values will remain steady with no noise. Both of these characteristics are very desirable.

In the large majority of applications, there should be no need to alter the Smart Smoothing time value. Reducing the time of Smart Smoothing improves transmitter response time only to very small changes of input that are within the Smart Smoothing Deadband. The tradeoff is a small increase in the uncertainty of measurement, meaning that successive readings may vary slightly.

Smart Smoothing Time Value

The current **Smart Smoothing Time Value** will be displayed, and the factory default is 10 seconds. The Smart Smoothing value can be adjusted from 0 seconds (turned off) to 32 seconds, In certain applications, where the process variable moves rapidly over a small range, and the transmitter is used in a control loop, it may be desirable to shorten the averaging time of Smart Smoothing to three (3) seconds or less, or to turn it off. Use the number keys to set a new value. The new value will be backlit in yellow reminding you to write this to the transmitter when you have completed all of your changes.

Smart Smoothing Deadband

The **Deadband** determines the "height" of the Smart Smoothing window, as the **Smart Smoothing Time Value** defines its "length". The factory default value of 1600 corresponds to about ±5μV. Adjustments to this value are best determined empirically depending on the specific application. If you find you need to adjust this value, it might be good to call the factory first to talk through your particular application.

Validation Time

Select **Validation Time** to specify the length of time the transmitter should attempt to validate information from the sensor. In a manner somewhat analogous to Smart Smoothing, the **Validation Time** specifies the number of A/D readings before the transmitter would respond to a variation in the input signal. The signal must be received longer than the **Validation Time** before the transmitter will recognize it as a valid signal. For extreme electrical noise, it may be desirable to increase the **Validation Time**.

The current value will be displayed on the screen. Use the number keys to set a new value, Any value between 0 and 10 seconds is allowed. Factory default is 0.1 second. This time value corresponds to approximately one A/D reading. The default value of 0.1 second means that if the transmitter sees a sensor A/D reading that is abnormally high or low, it will take one more A/D reading before reporting the reading as a true value. This function works well to eliminate the detrimental effects of electrical noise. The characteristic that is typical of electrical noise is that it is quick and produces abnormally high or low values. These are rejected by setting the validation count to a number higher than 0. A setting of 0.1 to 0.3 seconds generally clears up the detrimental effects of electrical noise.

9.5.5 LOCAL DISPLAY SETUP

This menu entry alloys you to set various parameters of the local display.

Display Label

The DK-2 has the capability of displaying a 7 character alphanumeric message on its second line. You may put up to 20 characters in the Display Label. These will be grouped into 7 character groups and displayed sequentially on the second line of the DK-2 display.

Display Language

Use this option to select the language used in the Display Mode setup menus for the DK-2 Local Display / Keyboard. English, German, French and Spanish are available.

9.6 IDENTIFICATION

This screen, shown in Figure 9.4 allows you to identify the field device.

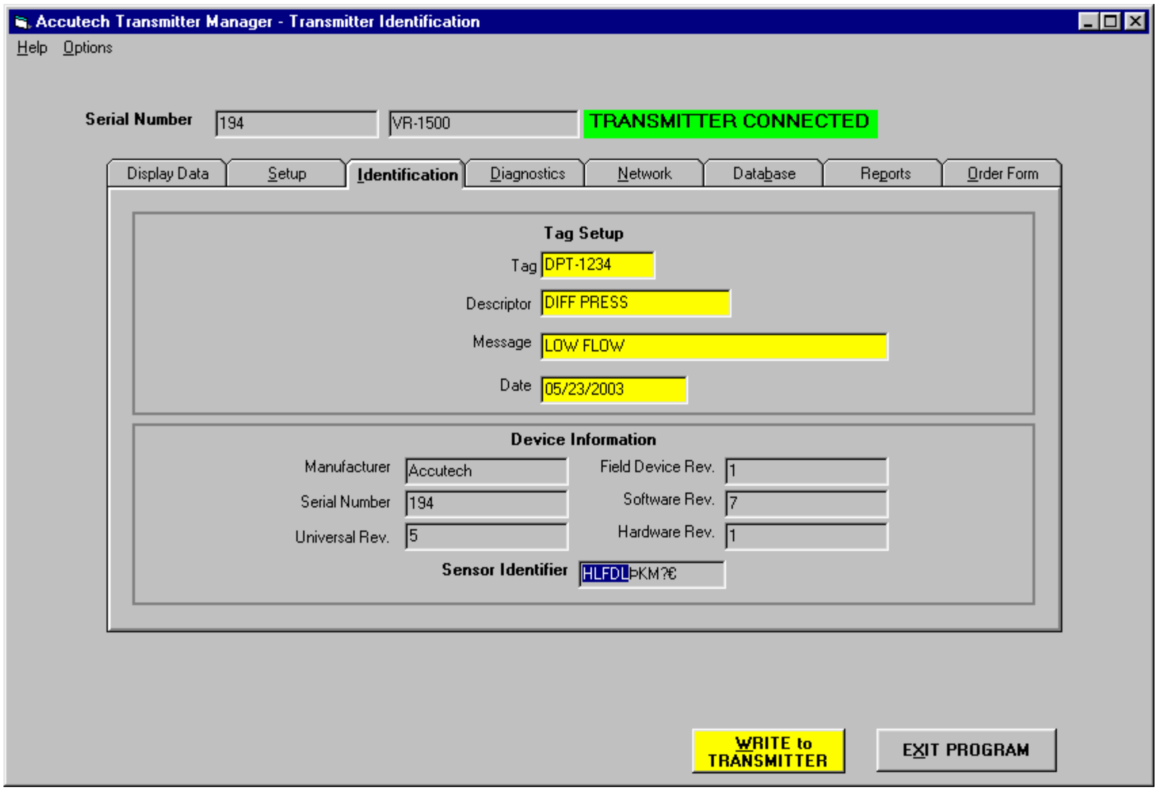


Figure 9.4 Identification Screen

Tag
An eight character label usually used to identify an individual field device. The tag is displayed on the top line of the HC275 display, next to the model name 'VR-1500'.

Descriptor
A 16 character (alphanumeric) text string that can be used to associate additional information with the transmitter.

Message
A 32 character (alphanumeric) text string that can be used to associate additional information with the transmitter.

Date
The date expressed as Month/Day/Year. This could be used to record the date the transmitter was configured.

Device Information
The following Read Only information about the transmitter is provided by the Device Information Menu.

Manufacturer

Serial Number

Final Assembly run number

Sensor Identifier

Revision #s
This command will report the Universal HART Command Revision, the Field Device Revision (Device Description), the Software Revision, and the Hardware Revision.

9.7 DIAGNOSTICS

This screen, shown in Figure 9.5 gives you various diagnostic information about the transmitter. The VR-1500 continuously performs self-diagnostics and self-tests to verify its healthy status. Should it find a fault, this information is recorded in the diagnostic section of the menu. Much of this diagnostic information is lost when the device is powered down. If you are troubleshooting a problem, it is advisable that you check the diagnostic section of the menu before you take the unit out of service. This may help in uncovering the source of the fault. The faults that are recorded by the Diagnostic menu are shown in Figure 9.5. This records both the current fault status as well as any historical status.

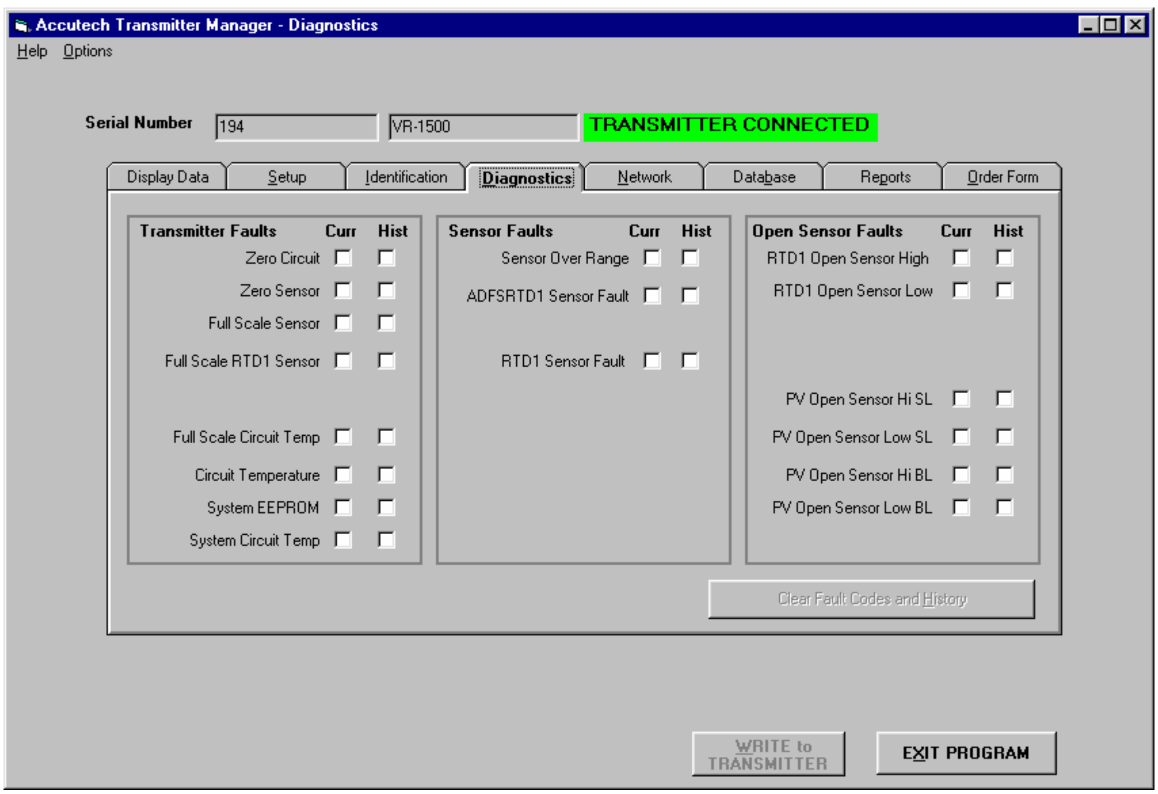


Figure 9.5 Diagnostics Screen

Internal Standards Faults
The transmitter has a number of internal reference standards that it uses for its automatic self calibration. These are checked periodically. Any faults detected are recorded here.

System Faults
These are the faults detected in other parts of the transmitter, other than the standards. Examples would be the A/D or the EEPROM.

Sensor Faults
These are the faults that would be detected in the sensor.

Open Sensor Faults
This is a set of faults that would be associated with a detection of an open sensor.

Electronics Internal Temperature
This is the temperature of the transmitter's electronic module

Sensor Temperature
This is the temperature of the sensor itself.

Clear Fault Codes and History
This button allows you to clear the historical fault record.

9.8 NETWORK

This screen, shown in Figure 9.6 gives you access to various network parameters. In this revision of the Transmitter Manager, the only parameter implemented is the designation of the PC communications port.

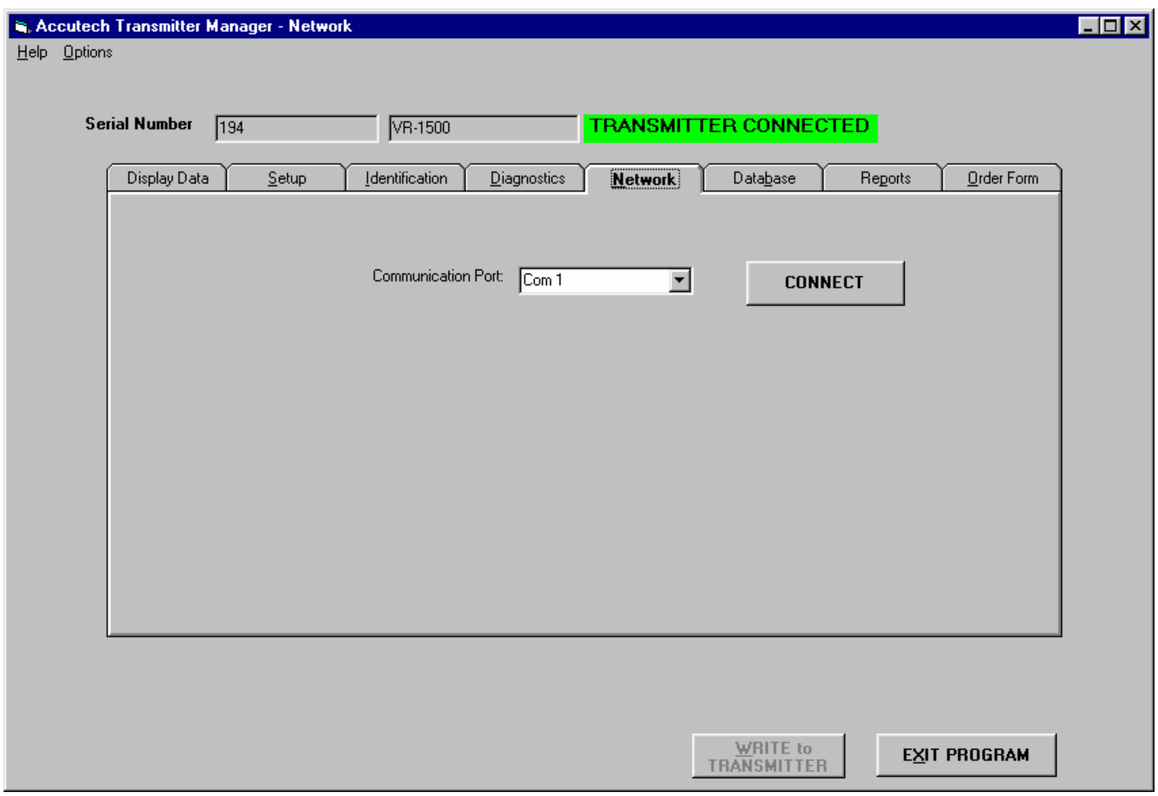


Figure 9.6 Network Screen

9.9 DATABASE

The database will allow you to store and retrieve information about a transmitter. This feature is not implemented in this release.

9.10 REPORTS

This screen, shown in Figure 9.7 allows you to prepare and print a hard copy report record of the set-up information about an individual transmitter. This feature is important for making file copies and preparing for various ISO and FDA audits. You may also use this section to write the transmitter configuration data to a file.

To close the report select the “X” box in the top right corner of the screen.

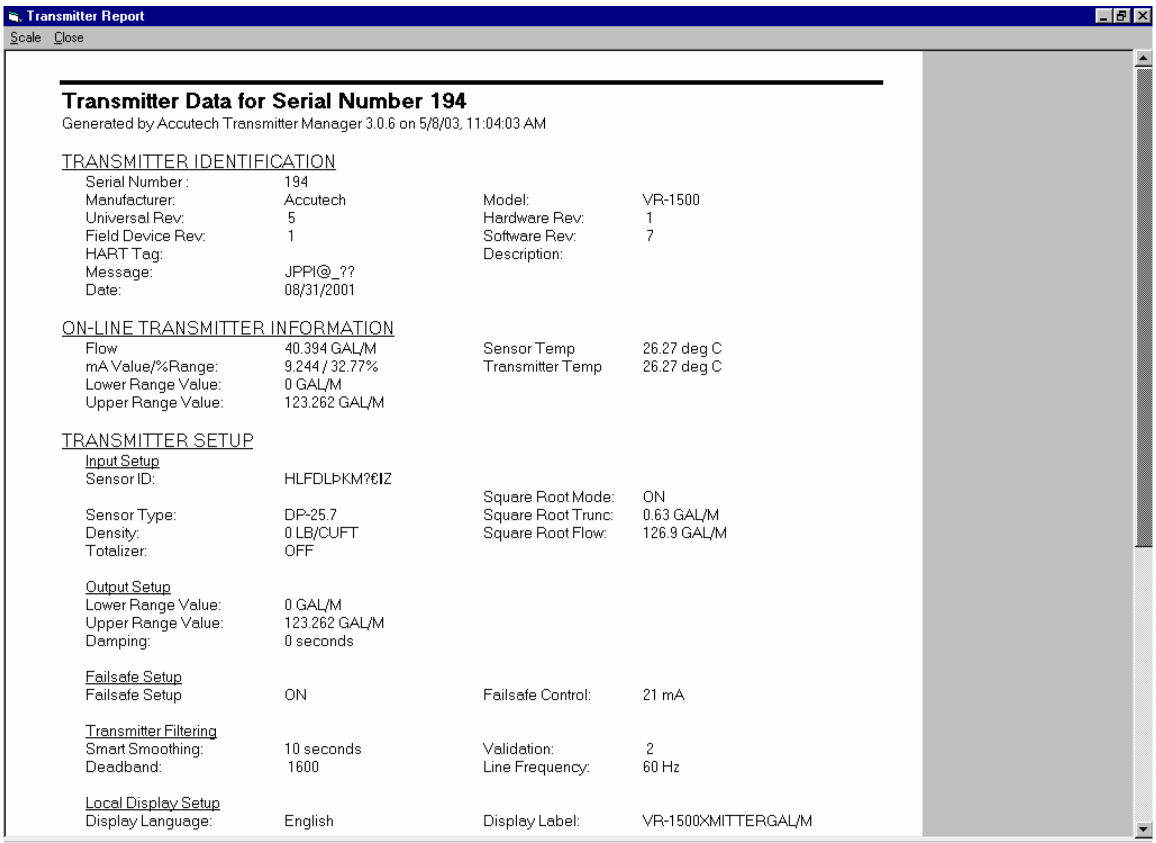


Figure 9.7 Transmitter Data Report

10.0 APPLICATIONS INFORMATION

10.1 INTRODUCTION

The VR-1500 family of pressure transmitters can be used to measure gauge pressure, absolute pressure, differential pressure, level and flow. The applications for gauge pressure, absolute pressure and pressure difference and flow are covered in the body of this manual. Level applications are a unique class of applications that often times require special considerations. Some of these considerations are noted below.

10.2 DENSITY CORRECTION

You may correct for the fluid density in a tank by using the 22 point correction covered in sections 10.5.1 and 7.2.3.1.

10.3 CONVERTING LEVEL TO VOLUME OR MASS

You can convert the level information that is measured as a pressure or pressure difference into a volume or mass of material in a tank. This can be done even with a very irregularly shaped tank. The 22 point correction curve can be used to advantage to make these conversions.

For example, suppose you had a cylindrical horizontal tank with plain, flat ends. You have installed a VR-1500 pressure transmitter to give you the tank level. The specific gravity of the material in the tank is 0.8 and the tank dimensions are as shown in Figure 10.1. The tank is vented and the lower tap is at the bottom of the tank and the transmitter inlet tap is located at a level that would indicate zero pressure just when the tank is empty.

Figure 10.1

You can use either a VR-1500 differential pressure transmitter or a VR-1500 gauge pressure device to measure this pressure. Generally, we recommend the differential pressure transmitters for these measurements because the tank heights are generally less than 20 feet. The differential pressure transmitters give better accuracy when making these small measurements.

For blanketed tanks, you can also connect the low pressure side of the DP transmitter back to the top of the tank.

In the tank example, the volume vs level relationship is given in the strapping table 10.1.

Height in Inches	Volume in gallons		Height in Inches	Volume in gallons
3”	37.1		54”	2,380.5
6”	103.9		57”	2,547.5
9”	189.4		60”	2,715.3
12”	289.0		63”	2,881.9
15”	400.3		66”	3,047.1
18”	521.4		69”	3,2101.1
21”	650.9		72”	3,370.3
24”	787.4		75”	3,527.3
27”	930.4		78”	3,680.3
30”	1,078.7		81”	3,828.6
33”	1,231.7		84”	3,971.6
36”	1,388.7		87”	4,108.1
39”	1,548.9		90”	4,237.6
42”	1,711.9		93”	4,358.7
45”	1,877.1		96”	4,470.0
48”	2,043.7		102”	4,655.1
51”	2,211.5		108”	4,750.0

Table 10.1

Here there are 34 data points. The correction curve can accommodate only 22 points. You would choose the points in the area of greatest interest remembering that the VR-1500 will do a piece-wise linear curve fit between the various points. Points near the bottom and top if the tank can be eliminated. Similarly, intermediate points near the center of the tank can be skipped as the volume varies quite linearly with height in this region.

In this example, the volume would be converted into pounds by multiplying the density of the material ($0.8*62.4\#/ft^3$). You would select the “SPECIAL” units for the EGU. You would enter the mass data you have calculated. Assuming that a height of 30” was a data point you had selected. You would enter the following data:

An indicated value of 24 would represent a height of 30” (30 * 0.8 = 24). This would correspond to a volume of 1,078.7 ft^3 or 53,848 pounds. You would enter the value of 53,848 as an actual value and 24 as an indicated value.

Repeating these calculations would allow you to construct the entire relationship you desired.

10.4 COMPENSATING FOR TRANSMITTER PLACEMENT

In many instances, a level transmitter cannot be mounted so that it is exactly level with the tank level when it reaches an empty point. Therefore, you must allow for an elevation or suppression depending on where the transmitter is mounted compared to the bottom of the tank. Elevation and suppression calculations may be made considering the physical elevation or suppression of the transmitter compared to the bottom of the tank and the density of the fluid in the tank. If there is a fluid in the low pressure side of the transmitter, the density of this material must also be considered. There are many good texts that work through these various calculations. See Purdy’s Instrument Handbook, or other texts available from the ISA for more detail on this subject.

10.5 LEVEL BUBBLERS

It is often advantageous to measure a tank level without contacting the material in the tank. This seemingly difficult task can be accomplished with the use of the VR-1500 and a bubbler as shown in Figure 10.2. Here equal flows of air are passed by the differential pressure transmitter. One of the flows is terminated in the top of the tank and the other is terminated in the bottom. The transmitter will measure the pressure difference between these two flows which will be equal to the height of the material in the tank above the bottom bubbler exit point.

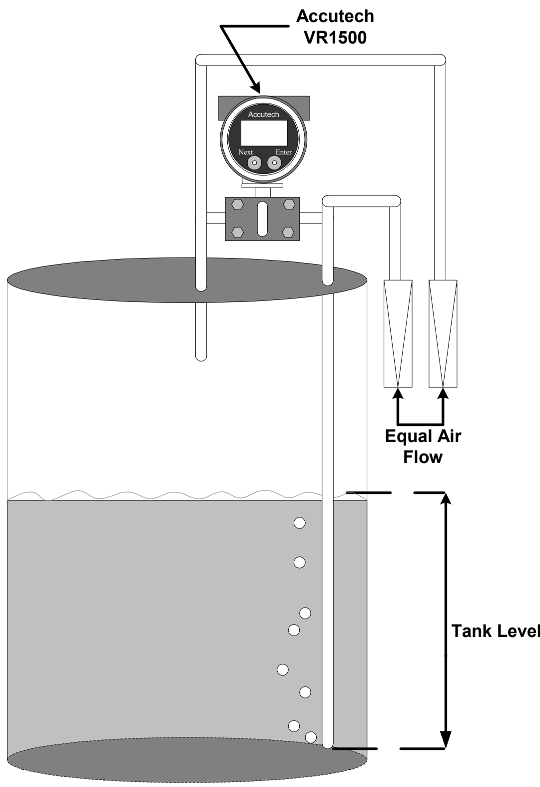


Figure 10.2 Liquid Level Bubbler Application

10.6 SPLIT ARCHICTECTURE

The split architecture system employed by the VR-1500 allows you locate the pressure sensor in a location that is remote from the transmitter electronics. This feature can be helpful in certain circumstances where the ambient temperature might exceed the limits of the electronics or where you would want to have the local display in a more convenient place to read.

This system basically involves ordering a sensor extension cable and a remote housing for the electronics. The sensor extension cable picks up the sensor cable in the primary housing. The remote housing provides an enclosure for the transmitter electronics and display. These parts may be ordered as the RMT-KIT kit from Accutech. More detailed installation instructions are provided with the kit.

11.0 ACCESSORIES & INFORMATION

Other accessories available from Accutech are:

PY-2	2" pipe yoke for XP-F series housings (for use with display housing only)
PB-2S	2" pipe mount bracket for sensor (DP Transmitters)
DK-2	Two-line plug-in smart local display (DP Transmitters)
ASU 15375	Display Adapter †
¼ NPT ADPT	Optional ¼" FNPT process connection adapter
½ NPT ADPT	Optional ½" FNPT process connection adapter
*	3 Valve Manifold 316 SS (additional manifolds quoted per specifications)
SS-TAG	Stainless Steel (Engraved) Tag
PS-TAG	Plastic (Engraved) Tag
PS-2412	Power Supply, 24/28 VDC, 1.2/0.8A
PS-2405	Power Supply, 24 VDC, 0.5A
HART® MODEM	HART® MODEM Communications Interface (1500 Series)
HC275 D9EI5D0000	HART® 275 Communicator With Disposable Alkaline Batteries

Split Architecture Applications

RMT-KIT	Two-line plug-in smart local display with *<u>Integral Keyboard</u>*, *<u>Display Adapter</u>* and *<u>Housing</u>* ***<u>with</u>*** *<u>Window</u>*. **Required –** terminal block for sensor head connection to remote electronic module
CABLE__(ft)	Specify cable length in feet from sensor head to remote electronic module
DIN-KIT (VR)	DIN rail mounting adapter for VR-1500 Electronic Module
XP-FN	Explosion proof housing ***<u>without</u>*** display option – Non Window
XP-FG	Explosion proof housing ***<u>with</u>*** display option – With Window

* Contact Accutech for individual configuration and part numbers.

† The DK-2 with the ASU 15375 Display Adapter can be used for setup and configuration for GP/AP transmitters installed in non-window housings, but cannot be installed permanently.

12.0 SPECIFICATIONS

MODEL	UPPER RANGE LIMIT	MINIMUM SPAN	ACCURACY	OVERLOAD LIMIT	SAFETY LIMIT
GP-30	30 PSIG	0.3 PSI	± 0.007 PSI	60 PSI	500 PSI
GP-250	250 PSIG	2.5 PSI	± 0.063 PSI	500 PSI	1,500 PSI
GP-1000	1000 PSIG	10.0 PSI	± 0.25 PSI	2,000 PSI	10,000 PSI
GP-5000	5000 PSIG	50.0 PSI	± 1.25 PSI	12,000 PSI	20,000 PSI
GP-23200	23206 PSIG	232.0 PSI	± 4.64 PSI	26,100 PSI	29,000 PSI
AP-30	30 PSIG	0.3 PSI	± 0.007 PSI	60 PSI	500 PSI
AP-250	250 PSIG	2.5 PSI	± 0.063 PSI	500 PSI	1,500 PSI
DP-25	25.7 In H_2O	0.26 In H_2O	± 0.005 In H_2O	5801 In H_2O	5801 In H_2O
DP-250	257.0 In H_2O	2.57 In H_2O	± 0.05 In H_2O	5801 In H_2O	5801 In H_2O
DP-1600	1607.0 In H_2O	16.10 In H_2O	± 0.32 In H_2O	5801 In H_2O	5801 In H_2O

SENSORS:

Gage, Absolute, Differential Pressure.
Constant Current Excitation.
Sensor assembly is complete with Explosion-Proof Housing for mounting VR-1500 electronics module or RMT-KIT for Split Architecture Applications.

ACCURACY:

Digital: ±0.07% of reading or the accuracy from the table above for the selected sensor, whichever is greater.

Analog: Digital Accuracy ± 2µA.

Accuracy includes hysteresis, linearity and repeatability of both the sensor and transmitter at reference conditions of 25°C.

STABILITY:

Combined Zero and Span Stability: Less than ±0.1% of sensor URL per year at 70°F

COMBINED ZERO & SPAN TEMP EFFECTS:

Less than ±0.07% of Sensor Upper Range Limit per 50°F for ambient ≥32°F and ≤158°F.

SENSOR EXCITATION:

1.0mA constant current source.

OUTPUT:

Analog, Two wire 4 to 20mA
Digital, HART ® Simultaneous Communication

OUTPUT RANGING ADJUSTMENTS:

Analog Zero 100% of sensor range, non interacting
Full Scale Normal or reverse acting
Digital Mode: (No ranging required)

TURNDOWN RATIO:

100:1 within specification

OUTPUT MINIMUM SPAN:

1% of selected sensor full-scale value

OUTPUT RESOLUTION:

Analog: 2.1uA
Digital: 6 significant digits

CUSTOM CURVE CAPABILITY:

22 Point user selectable via HART Communications

DYNAMIC RESPONSE:

Update Rate: 100 milliseconds, typical
Response to Step Change: 250 milliseconds to 63% (one time constant), minimum
Start-up Time: 7 seconds. Operation to specifications ≤30 seconds
Ambient Temperature Change: Self-correcting for ambient changes up to 20°C per hour.

POWER AND LOAD:

Power Requirements: 12-42 VDC (no load)
Load Limit: R(KΩ) = (V_{supply} – 12VDC) / (23ma)

MATERIALS OF CONSTRUCTION:

Stainless Steel Body and diaphragm
O-Ring Material: Viton C

PROCESS CONNECTION:

Gauge, Absolute: ½" MNPT, standard
DP: ¼" FNPT, standard

OPERATING TEMPERATURE RANGE:

Process: -40°F to +250°F
Ambient: -40°F to +185°F
Display: - 4°F to +158°F (Full Visibility)
-40°F to +185°F (Reduced Visibility)

SPECIFICATIONS (CONTINUED)

STORAGE TEMPERATURE RANGE:
-58°F to +185°F (-50°C to +85°C)

HUMIDITY LIMITS: 0 to 100%

AUTOMATIC DIAGNOSTICS:
Every 3 seconds the VR-1500 transmitter performs self-checks for zero, span, and transmitter malfunction.

DISPLAY: Optional Plug-in

HOUSING:
Explosion-proof housing with or without window, FM and CSA approved for Class 1, Div I and Div II Groups B, C & D, certification pending

LIMITED WARRANTY

This warranty is in lieu of all other warranties, expressed or implied. The Accutech VR-1500 series products (Product) are warranted by Adaptive Instruments LLC (The Seller) to be free from defects in workmanship and materials, under conditions of normal use and service, for a period of three years from the date of shipment. The Product or Products is further warranted to hold its original factory calibration within its specified tolerance, for a period of two years from the date of shipment under conditions of normal use and service. At its option, the Seller will repair, replace, or re calibrate, free of charge, any Product or Products found and determined to be defective by the Seller if returned to the Seller, per the procedure below, within two years of its original purchase.

To claim a repair or replacement under this warranty, a Return Material Authorization (RMA) number must be obtained from Adaptive Instruments Corporation or its operating division, Accutech, and the Product returned, postpaid to the Seller. Final warranty defect determination and determination of the cost, if any, to repair or replace will be made by the Seller upon examination of the returned Product. Returned units may be subject to an evaluation or re calibration charge as listed in the Seller's price list.

Defects arising from negligence, misuse, improper installation, accident, modification or alteration of this Product (or Products) are not warranted nor are Products that have been opened for on-site or field inspection or repair.

LIABILITY OF THE SELLER

Liability of the Seller is limited to repair or replacement of the Product or Products as outlined above. Purchaser assumes full responsibility for determining that the Product or Products purchased will meet the Purchaser's requirements or those of the Purchaser's customers. Purchaser agrees to indemnify, defend and hold the Seller harmless from any liability, loss, or damage, whatsoever, caused or alleged to be caused directly or indirectly by the Product or Products including, but not limited to any interruption of business, loss of business, personal injury or consequential damages resulting from the use or operation of the Product or Products.

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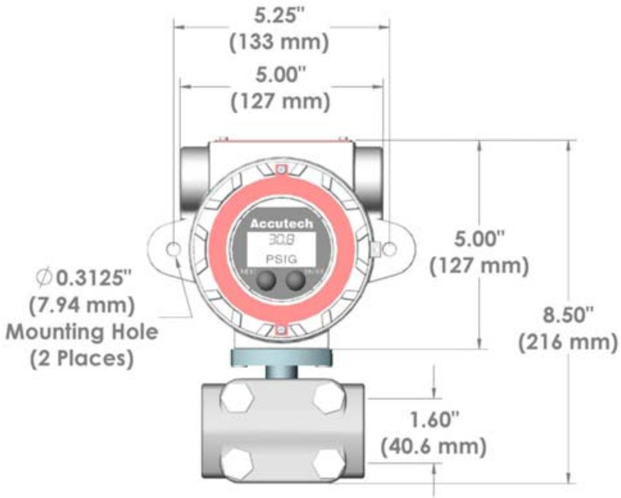
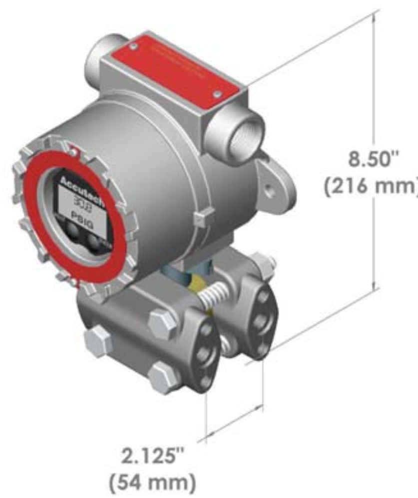
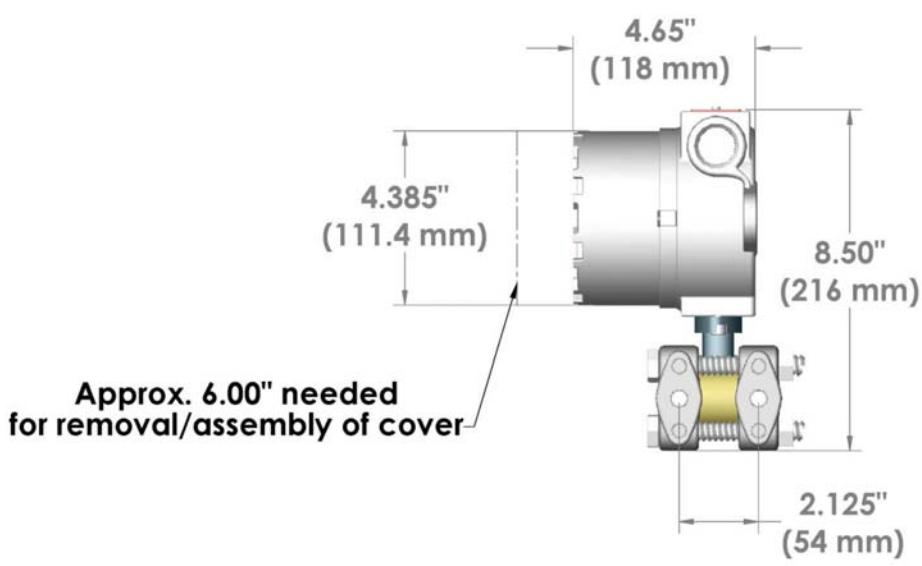
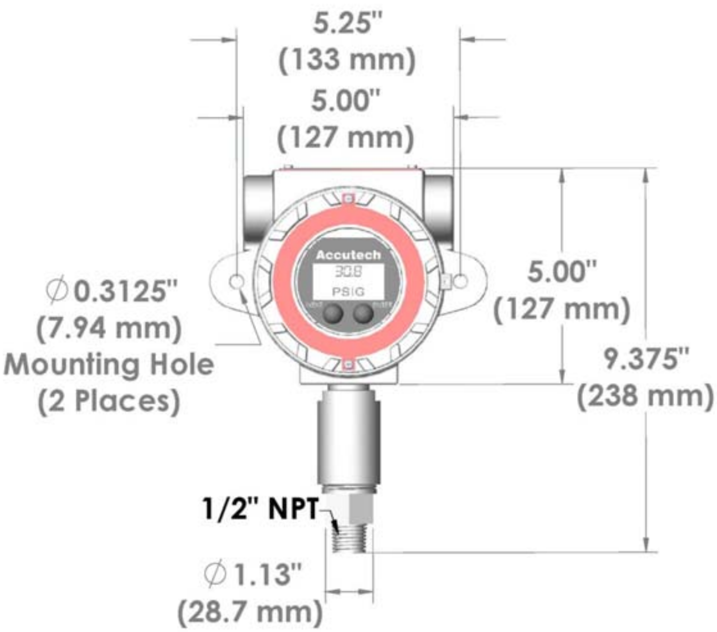
MECHANICAL DIMENSIONS



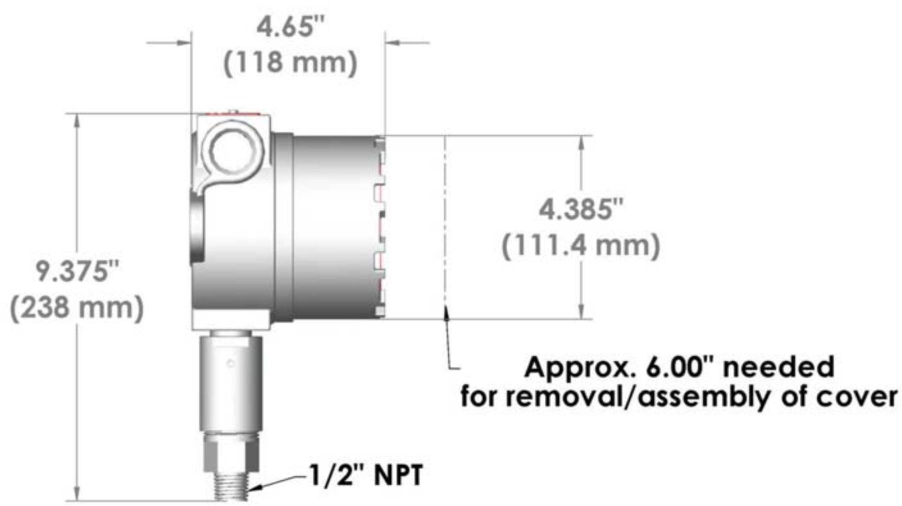


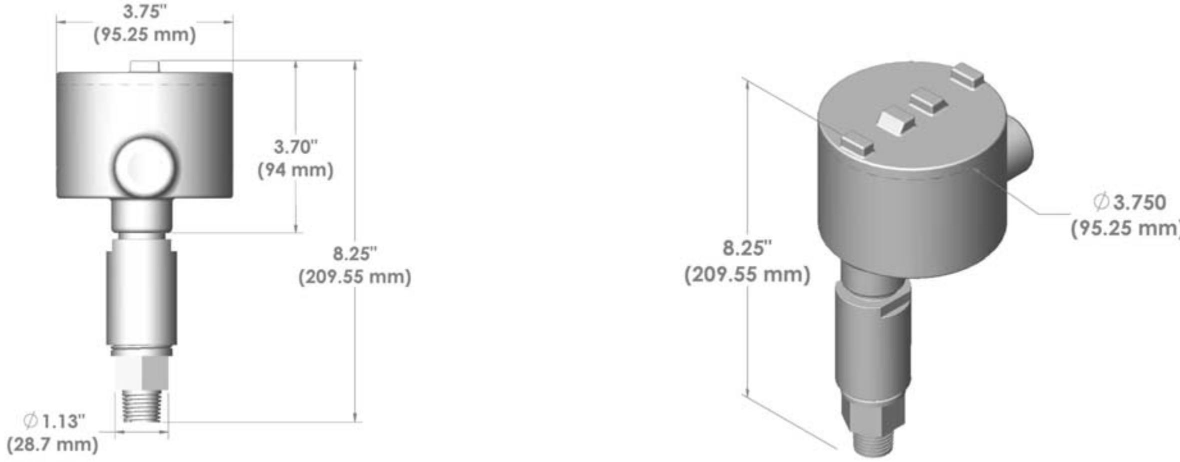
VR-1500 Differential Pressure



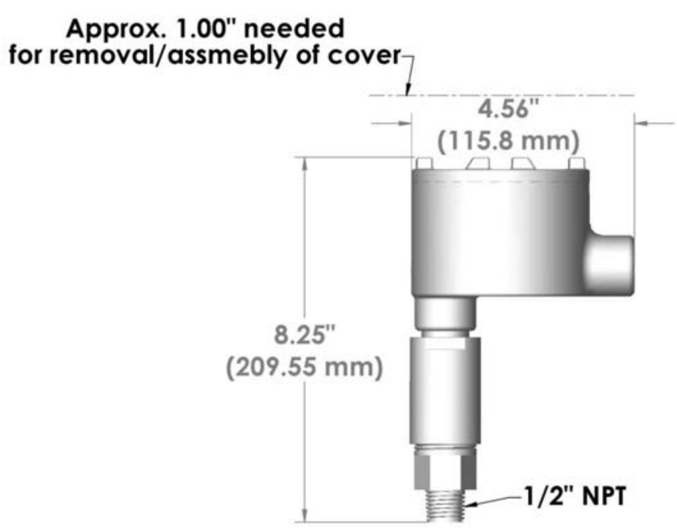


VR-1500 Gauge Pressure with Display



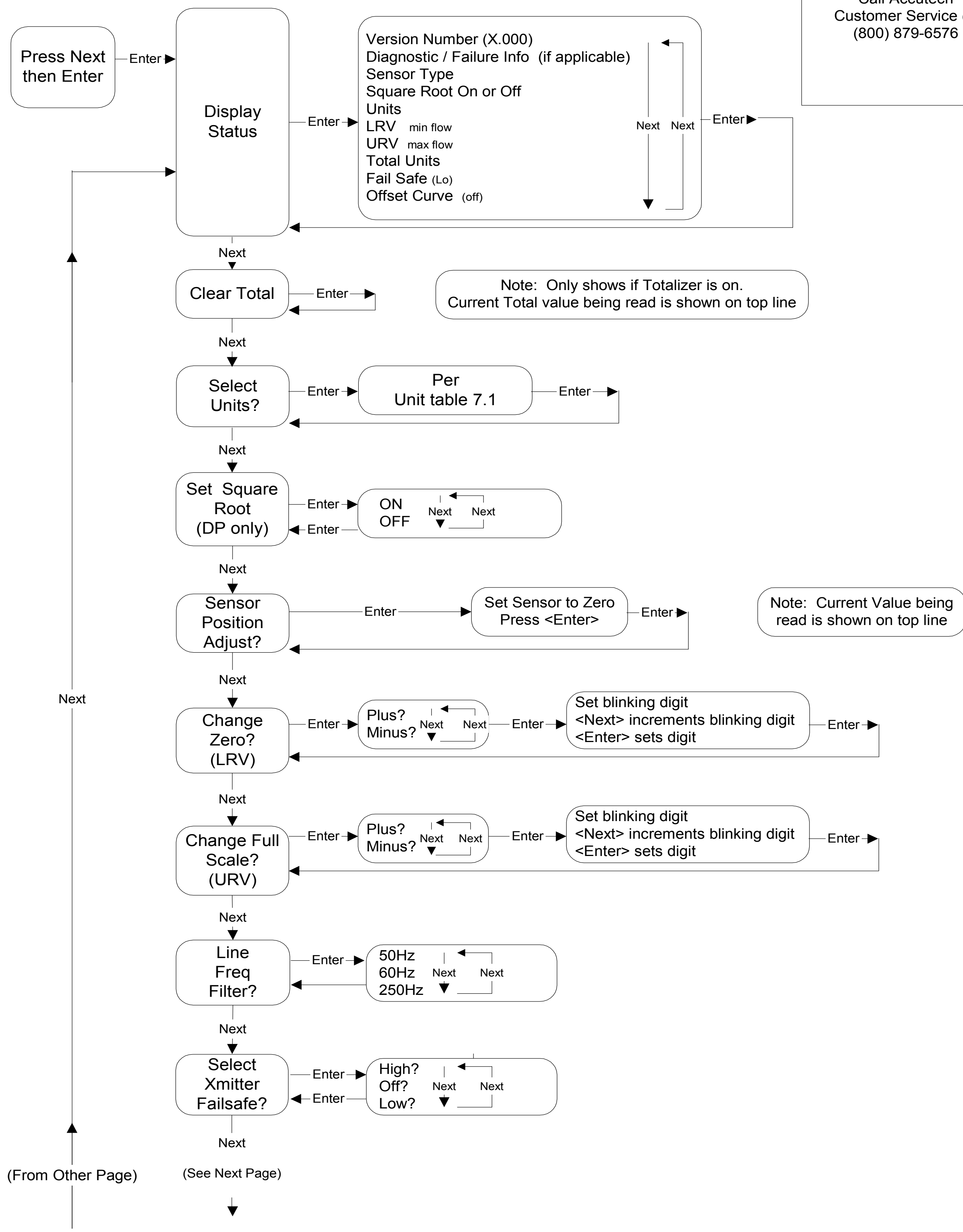


VR-1500 Gauge Pressure without Display



ACCUTECH VR-1500 Display Configuration Flowchart

QUESTIONS?
Call Accutech
Customer Service @
(800) 879-6576



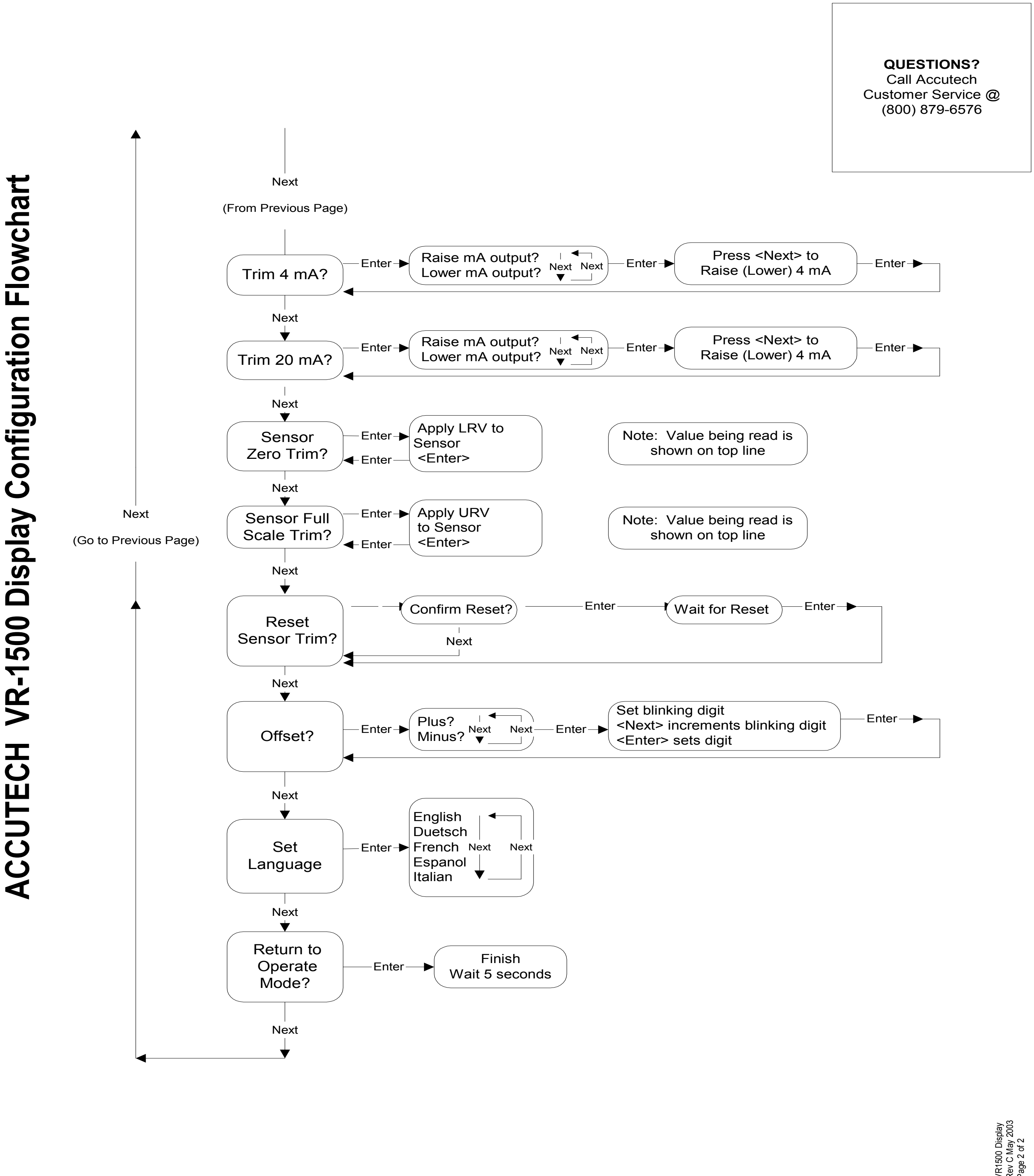


Figure 9-4
DK-2 Two Line Display Configuration Flowchart

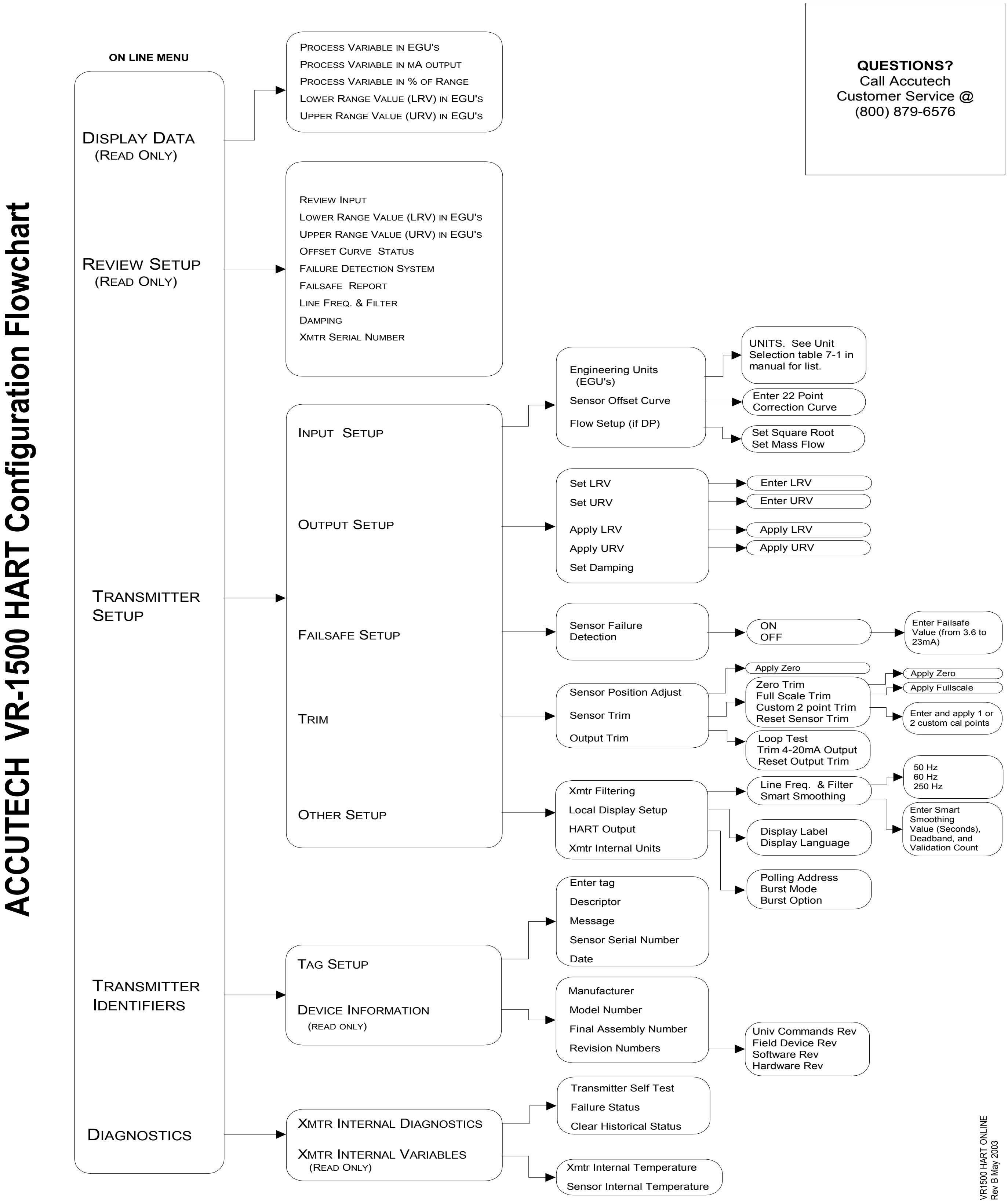


Figure 9-5
HART Online Configuration Menu