



Instruction Sheet

Introduction

How HART® Works

The HART® (Highway Addressable Remote Transducer) Protocol uses Frequency Shift Keying (FSK) to superimpose digital signals on top of the analog 4 to 20 mA current loop. This allows two-way digital communication to occur and allows additional information beyond the normal process data to be communicated to the 9900. This digital signal can contain data such as device status, diagnostics, etc.

The HART protocol provides two simultaneous communication channels: a 4 to 20 mA analog signal and a digital signal. The analog signal communicates the primary measured value using the 4 to 20 mA current loop.

Additional information is communicated using a digital signal superimposed on the 4 to 20 mA signal.

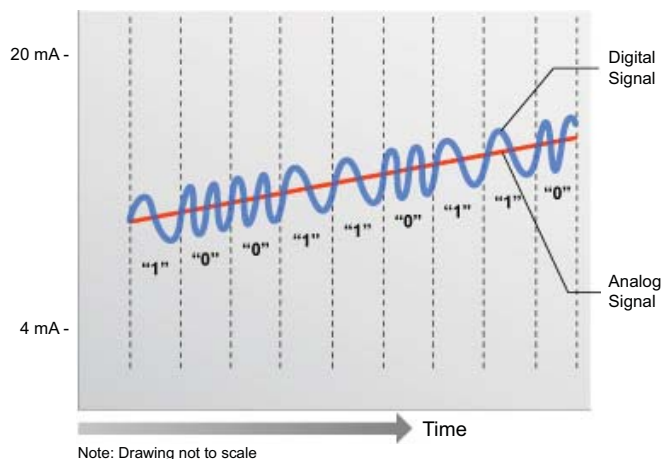
Communication occurs between two HART-enabled devices, in this application a Signet 9900 Transmitter and a PLC or handheld device, using standard wiring and termination practices. The HART Protocol communicates at 1200 bits per second without interfering with the 4 to 20 mA signal and allows the PLC or handheld device to communicate two or more updates per second to and from the 9900.

The HART protocol operates according to the master-slave method. Any communication activity is initiated by the master, usually a programmable logic controller (PLC) or a data acquisition system. HART accepts two masters: the primary master - usually the control system (PLC) - and the secondary master - a PC laptop or handheld terminal used in the field.

HART field devices - the slaves - never send without being requested to do so. They respond only when they have received a command message from the master. Once a transaction (i.e., a data exchange between the control station and the field device) is complete, the master will pause for a fixed time period before sending another command, allowing the other master to break in. The two masters observe a fixed time frame when taking turns communicating with the slave devices.

As deployed in the 9900 application, HART allows remote verifying, testing, adjusting and monitoring of primary and secondary device variables. Features available in the 9900 Transmitter with H COMM Module installed:

- **Adjust 4 mA:** Allows fine-tuning to compensate for errors in other equipment connected to the 9900. Adjust the minimum and maximum current output.
- **Adjust 20 mA:** Allows fine-tuning to compensate for errors in other equipment connected to the 9900. Adjust the minimum and maximum current output.
- **Supports Multi-Drop Mode:** Allows up to four 9900 Transmitters be installed in Multidrop mode.
- **Supports all Universal HART Protocol Revision 7.2 commands**
- **Supports many Common Practice Commands**
- **Makes Primary and Secondary values available at PLC.** Secondary values are sensor-dependent and are available with pH, Conductivity, Resistivity, Salinity and Level sensors.



Frequency Shift Keying
Digital over Analog

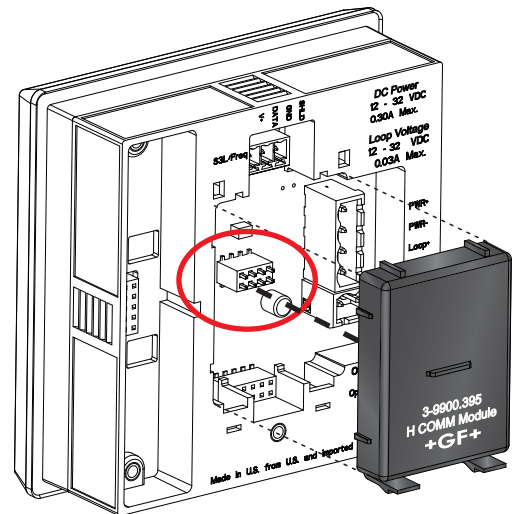
Installation

If the 9900 Base Unit will be mounted in a panel, plug-in modules may be installed either before or after the base unit is mounted. If the 9900 Base Unit will be mounted using the accessory wall mount bracket, install plug-in modules first. If the Direct Conductivity/Resistivity Module will be included in your unit, install the H COMM module first and then install Conductivity/Resistivity Module over the H COMM Module.

To install the H COMM module, carefully align the module pins into its plug (see illustration) and push the module straight in until the tabs on the bottom edge snap into place.

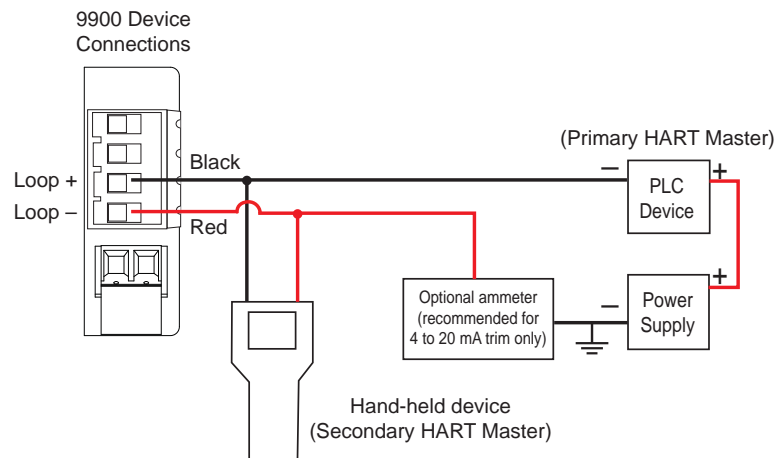
To uninstall, squeeze tabs, grasp the module and pull straight out.

Be careful not to bend the pins when installing or removing the module to or from the base unit.



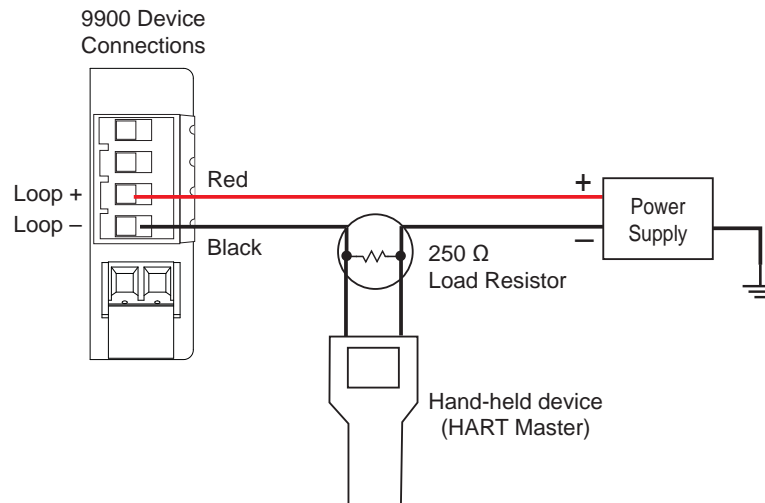
Connecting HART with a Loop-powered sensor

(Typical installation)



Connecting HART to a Hand-Held Master Device

(Typical installation)



NOTE: From this point forward the term “9900 Transmitter” or “Transmitter” will assume the H COMM Module is installed unless otherwise noted.

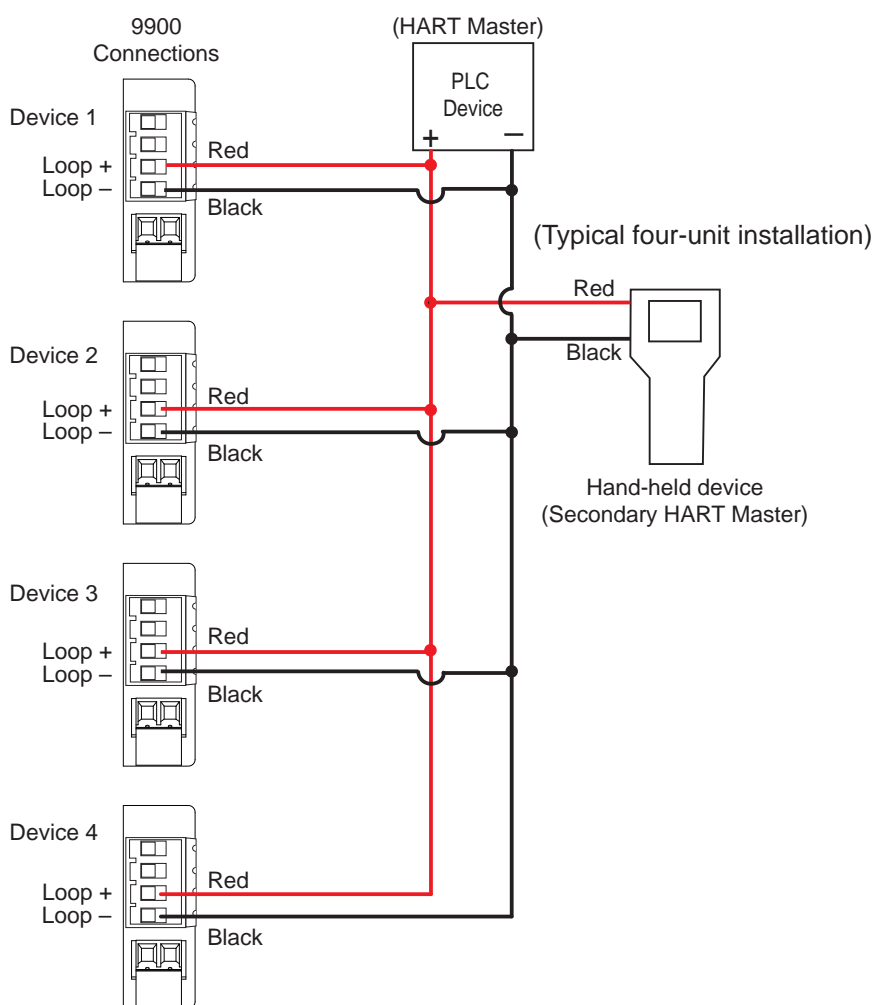
Multi-Drop Mode

Up to four 9900 Transmitters can be connected in Multi-Drop mode using the H COMM Module.

To ensure proper operation in Multi-Drop mode, configure each 9900 Transmitter with its own poll address using a configuration tool (laptop or hand-held device).

After configuring the 9900 Transmitter for multi-drop function, reset the Transmitter (remove power for five seconds then apply power) before use.

Connecting HART in Multi-Drop mode



Operation

Loop Powered systems require a minimum of 24 VDC. If connecting with DC, nominal 12 VDC is acceptable. (See Power Wiring section in the Signet 9900 Transmitter Operating Instructions manual.)

In LVL/VOL mode, the primary variable will always represent Level, the secondary variable will always represent Volume. In pH, Conductivity, Resistivity and Salinity systems the secondary variable represents the temperature.

Loop Current Trim Procedure

The Loop Current HART commands allow a Master HART device to update a loop current value in the 9900 Transmitter and to perform a two-point calibration (zero and span) of the loop current.

1. Use Command 40 (Enter/Exit Fixed Current Mode) to update the 4.00 mA current.
2. Using the measured value of your reference instrument (either a digital multimeter or the HART Master device), set the zero trim using Command 45 (Trim Loop Current Zero). The transmitter will then trim its calibration and return the loop current value in the response message. The response value may differ slightly from the value sent by the Master due to rounding.
3. Use Command 40 (Enter/Exit Fixed Current Mode) to update the 20.00 mA current.
4. Using the measured value of your reference instrument (either a digital multimeter or the HART master device), set the span trim using Command 46 (Trim Loop Current Gain). The transmitter will then trim its calibration and return the loop current value in the response message. The response value may differ slightly from the value sent by the Master due to rounding.
5. Repeat steps 1 through 4 as needed to gain the accuracy desired. Once the loop current is calibrated to your satisfaction, return the device to normal operation by issuing Command 40 (Enter/Exit Fixed Current Mode) with a value of 0.0. This will take the 9900 out of fixed current mode.

Note: With the H COMM Module installed, the following functions are not accessible via the 9900 keypad:

- Trim Loop Current
- Test Loop Current

These functions are only accessible via the HART interface.

Changes to Units of Measure in Transmitter

HART devices can be used to change the units of measure in a 9900 Transmitter. After an update, you must cycle power to the 9900 Transmitter (remove power for 5 seconds, then restore power). In a flow system, the units update automatically and it is not necessary to cycle power to the 9900 Transmitter.

HART Commands

Universal Commands

All HART Rev. 7.2 Universal Commands are supported:

CMD ID	Function
0	Read Unique Identifier
1	Read Primary Variable
2	Read Loop Current And Percent Of Range
3	Read Dynamic Variables And Loop Current
6	Write Polling Address
7	Read Loop Configuration
8	Read Dynamic Variable Classification
9	Read Device Variable With Status
11	Read Unique Identifier Associated With Tag
12	Read Message
13	Read Tag, Descriptor, Date
14	Read Primary Variable Transducer Information
15	Read Device Information
16	Read Final Assembly Number
17	Write Message
18	Write Tag, Descriptor, Date
19	Write Final Assembly Number
20	Read Long Tag
21	Read Unique Identifier Associated With Long Tag
22	Write Long Tag
38	Reset Configuration Changed Flag
48	Read Additional Device Status

Command 0 – Read Unique Identifier

Returns device type, device and software revision levels, device status, and codes for the manufacturer and product information.

Command 1 – Read Primary Variable

Returns the numeric value of the Primary Variable (the 4 to 20 mA current loop) and the unit code for that value (e.g. '45.3' and 'Degrees Celsius').

Command 2 – Read Loop Current and Percent of Range

Returns the loop current value of the 4 to 20 mA current loop and the percent of range (e.g. '12.0' and '50%').

Command 3 – Read Dynamic Variables and Loop Current

Returns the loop current value of the 4 to 20 mA current loop, as well as the numeric value of the Secondary Variable (if present) and the Secondary Value's unit code.

Command 6 – Write Polling Address

Enables (or disables) Multi-Drop mode. While in Multi-Drop mode, loop current is held at a fixed value and is no longer available for signaling. Also sets the polling address of the device for Multi-Drop mode.

Command 7 – Read Loop Configuration

Reads the polling address of the device and the loop configuration (see Command 6).

Command 8 – Read Dynamic Variable Classifications

Returns the classification code for the Primary Variable and Secondary Variable (if present).

Command 9 – Read Device Variable with Status

Returns the value, status, variable code, variable classification and unit code of up to four device variables.

Command 11 – Read Unique Identifier Associated with Tag

Returns all identity information associated with the device, i.e., the device type, device revision level and Device ID. Issued using the 'tag'.

Command 12 – Read Message

Read back the message stored in the device. See Command 17.

Command 13 – Read Tag, Descriptor, Date

Reads the tag, descriptor and date values contained within the device. See Command 18.

Command 14 – Read Primary Variable Transducer Information

Reads transmitter serial number, unit code, upper and lower limits and minimum span for primary variable.

Command 15 – Read Device Information

Returns the alarm selection code, transfer function code, upper and lower range values, write protect code and unit code.

Universal Commands - Cont.

Command 16 – Read Final Assembly Number

Returns the assembly number of the device. This will be defined by the customer. See Command 19.

Command 17 – Write Message

Write a message to be stored in the device. See Command 12.

Command 18 – Write Tag, Descriptor, Date

Writes the tag, descriptor and date values into the device. See Command 13.

Command 19 – Write Final Assembly Number

Writes the final assembly number of the device. See Command 16.

Command 20 – Read Long Tag

Read the 32-byte long tag. The 'long tag' is separate from the 'tag' that is used in Commands 13 & 18.

Command 21 – Read Unique Identifier Associated with Long Tag

Returns all identity information associated with the device - the device type, device revision level and Device ID. Issued using the long tag.

Command 22 – Write Long Tag

Write the 32-byte long tag. See Command 20.

Command 38 – Reset Configuration Changed Flag

Resetting the device's configuration changes counter back to 0.

Command 48 – Read Additional Device Status

Returns extended device status information.

Supported HART Common Practice Commands

The following Common Practice Commands are supported.

CMD ID	Function
40	Enter/Exit Fixed Current Mode
45	Trim Loop Current Zero
46	Trim Loop Current Gain
54	Read Device Variable Information

Command 40 - Enter/Exit Fixed Current Mode

The loop current of the 9900 is set to the value transmitted in the command (in milliamperes). Setting a level of '0' exits Fixed Current Mode. If the device is in Multi-Drop mode, Error Code 11 will be returned.

Command 45 – Trim Loop Current Zero

The 9900 will trim its offset of the loop current to match the loop current value sent to it. This is typically performed at 4.00 milliamperes to optimize calibration.

Command 46 – Trim Loop Current Gain

The 9900 will trim the gain of the loop current to match the loop current value sent to it. This is typically performed at 20.00 milliamperes to optimize calibration.

Command 54 – Read Device Variable Information

Returns serial number, limits, damping value and minimum span for a selected device variable.

Unit Codes

The H COMM module uses standard HART Foundation Protocol 7.2 unit codes. The unit code allows the HART Master to interpret and display the units of measure (e.g., GPM, PPB, °F, etc.) with two exceptions.

The following Unit Codes will not be interpreted by the HART Master:

Code	Measurement Unit
240	Cubic Centimeters
244	Parts per Thousand

A HART Master will display these unit codes instead of the units of measure that the code represents.

Ordering Information

Mfr. Part No.	Code	Description
3-9900.395	159 001 697	H COMM Module



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