Complex Technology Made Simple

Technical Reference

Hart Reference Guide

for B-Series Hardware

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Preface

Before You Begin

Important ***The device warranty is void if the device is not installed in accordance with the specified installation requirements. Read and thoroughly understand the installation requirements before attempting to install the device. If you have any questions, contact your Kurz customer service representative before attempting installation.***

Using this Manual

Kurz Instruments, Inc., documentation includes manuals, product literature, Adobe Acrobat PDF files, and application online Help files. The Kurz Instruments CD contains all the available documentation files. To read PDF files, download the free Adobe Acrobat Reader from www.adobe.com.

The Kurz Instruments Web site provides additional information:

- **World Wide Web:** www.kurzinstruments.com
- **Email:** service@kurzinstruments.com
- Documentation links to the most current manuals and literature

You can access device support in the following ways:

- **Main:** 831-646-5911
- **Phone:** 800-424-7356
- **Fax:** 831-646-8901

Manual Conventions

The following table lists conventions used in the Kurz Instruments, Inc., documentation, and gives an example of how each convention is applied.

Table 1. Conventions used in this manual

Convention	For Example
Text type, click, or select (for example, field names, menus, and commands) are shown in bold.	Check the **Configuration File** checkbox.
Text appearing in a display or window is shown in courier.	`PRESS ENTER TO` `SET METER DATA`
An arrow (→) is used to separate a menu name from its menu command.	Select **Start→All Programs→Kurz Instruments→KzComm**.
Simplified directory structures and path names are used in examples. Your folder names may be different.	Programs Files\Kurz Instruments\KzComm.

Chapter 1

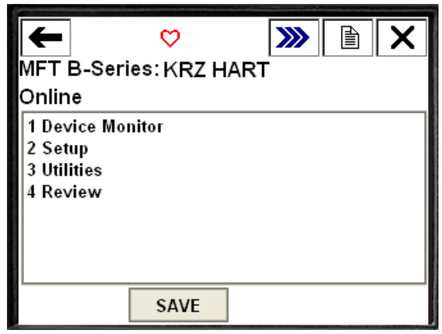
HART Interface

Overview

This chapter provides information specific to the B-Series HART flow meter using examples from an Emerson 375 Handheld Communicator. Refer to your HART master device guide for information about connecting to a HART loop or directly to a HART device. Refer to the Emerson user guide for information about the icons and buttons appearing in the examples.

B-Series HART Functionality

When the HART Communicator powers on, it automatically connects to a current loop and searches for an active HART-enabled B-Series device. A device name and "online" indicate an active connection.



- **Device Monitor** allows you to monitor dynamic variables.
- **Setup** allows you to set and change configuration parameters.
- **Utilities** allows you to perform calibration, maintenance, diagnostic, and utility functions.
- **Review** allows read-only access to all process and configuration data.

The Hot Key menu is available by selecting the triple arrow button ( ). The Hot Key menu provides quick access to frequently used menus:

- Device Monitor
- Range Values
- Calibrate 4-20 mA Output
- Loop Test
- Start Purge
- Reset Device

Table 1-1 through Table 1-4 provide brief descriptions for HART menus and functions available with your B-Series flow meter. Additional information is provided for some of the more common menus and functions.

Table 1-1. Device Monitor Menu

Variable	Function	Description
PV	Primary variable	Primary variable value.
SV	Secondary variable	Secondary variable value.
Temperature	Tertiary variable	Current process temperature.
Totalized Flow	Quaternary variable	An accumulation of flow going past the sensor.
Loop Current	4-20mA signal	4-20mA signal of primary variable.

Table 1-2. Setup Menu

Menu	Function	Description
Basic Setup	**Tag**	Short device name.
	Long Tag	Full device name.
	PV Units	Primary variable units.
	Flow Area	Manual method for specifying the flow area.
	Calculate Flow Area	Assisted method for specifying the flow area.
	Analog Output	Set the analog output range of the 4-20 mA output. **Loop Current Mode** **PV LRV** – manual method for entering the lower range value **PV URV** – manual method for entering the upper range value **Calibrate LRV** – assisted method for calibrating the lower range value **Calibrate URV** – assisted method for calibrating the upper range value
Flow Correction Coefficients	**Flow Rate DAMP**	Meter output filter time constant.
	Total CF	Total correction factor.
	Correction Bias	Flow independent correction factor
	Number of Corrections	Number of flow dependent correction factors.
	Correction Data Sets	Provides up to eight VCF data sets. Each data set has a reference value and test data.
Flow Cal Data	**Std Temp**	Flow calibration reference temperature.
	Std Absolute Pressure	Flow calibration reference pressure.
Purge Setup	**Auto Purge OnOff**	Automatic purge trigger.
	Interval	Frequency of automatic purge.
	Width	Length of time purge solenoid is open.
	Hold Time	Length of sensor recovery time.
	Start Purge	Manual method for starting a purge.

Table 1-2. Setup Menu (continued)

Menu	Function	Description
Drift Check Setup	**Auto Drift Check OnOff**	Automatic drift check trigger.
	% FS at Zero	Percent of the full-scale of the independent voltage source at that position.
	Duration at Zero	Length of time to perform drift check at that position.
	% FS at Mid	Percent of the full-scale of the independent voltage source at that position.
	Duration at Mid	Length of time to perform drift check at that position.
	% FS at Span	Percent of the full-scale of the independent voltage source at that position.
	Duration at Span	Length of time to perform drift check at that position.
	Interval	Frequency of automatic drift check.
	Run Drift Check	Manual drift check.
Device Information	Various read-only data related to the B-Series device.	Provides the following results: Manufacturer, Cfg Chng Count, Universal Rev Model, Descriptor, Fld Dev Rev Tag, Message, Software Rev Long Tag, Date, Num Req Preams Poll Addr, Last Cal Date, Write Protect Dev ID, Final Asmbly Num

Table 1-3. Utilities Menu

Menu	Function	Description
Common	**Reset Config Changed Flag**	Resets the flag indicating a configuration parameter has been changed since the device was last connected to the HART network.
	Reset Device	Sends a command to the device to perform a reset.
	Loop Test	Verifies the 4-20 mA output.
	Calibrate 4-20 mA Output	Resets the digital-to-analog signal comparison from expected output to actual output.
	Calibrate LRV	Set the lower range value for the 4-20 mA signal.
	Calibrate URV	Set the upper range value for the 4-20 mA signal.
Device Specific	**Drift Check**	Manually starts a drift check with the following results: Vin Zero Vout Zero % Drift at Zero Vin Mid Vout Mid % Drift at Mid Vin Span Vout Span % Drift at Span
	Start Purge	Manually starts a purge.
	Reset Device	Power cycles the flow meter.
	Reset Totalizer	Resets the totalized flow accumulator.
Diagnostic Measurements	**Total CF**	Total correction factor.
	Input Voltage	Provides access to the following functions: VPs VRtlc Rp Power VIph VExtln Rp Resistance VLI VTemp Rtc Resistance VLeakSense Vcal Sensor Wire R VRtch Rp Current Sensor Leak R
	Sensor Output	Provides access to the following functions: Rp Current Rt Resistance Rp Power Sensor Wire R Rp Resistance Sensor Leak R

Table 1-4. Review Menu

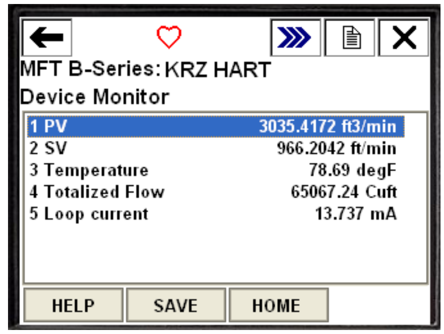
Menu	Function	Description
HART Device Data	Various read-only data related to the B-Series device.	Provides access to the following functions: Manufacturer, Cfg Chng Count, Universal Rev Model, Descriptor, Fld Dev Rev Tag, Message, Software Rev Long Tag, Date, Num Req Preams Poll Addr, Last Cal Date, Write Protect Dev ID, Final Asmbly Num
Process Variables	**PV**	Primary variable.
	SV	Secondary variable.
	Temperature	Current temperature of flow.
	Totalized Flow	An accumulation of flow going past the sensor.
Diagnostic Measurements	**Total CF**	Total correction factor applied to existing flow.
	Input Voltage	Provides access to the following functions: VPs, VLeakSense, VExtln Vlph, VRtch, VTemp VLI, VRtcl, VCal
	Sensor Output	Rp Current, Rp Power, Rp Resistance, Sensor Wire R, Sensor Leak R
Device Status	**Loop Current**	4-20mA representation of the deivce primary variable.
	Electronic Temp	Degrees Fahrenheit or Celsius.
	Run TIme	Number of runtime hours for the device.
	Device Error Status	Shows more than 45 fields (including functions, reserved, and unused) and the status as either On or OFF.
Basic Setup	**Tag**	Abbreviated meter name.
	Long Tag	Full meter name.
	PV Units	Engineering unit of the device primary variable.
	Flow Area	Cross-sectional area of the process pipe or duct.
	Analog Output	Provides access to the following functions: Loop Current Mode PV LRV PV URV

Table 1-4. Review Menu (continued)

Menu	Function	Description
Flow Correction Coefficients	**PV DAMP**	Meter output filter time constant.
	Total CF	Total correction factor applied to existing flow.
	Correction Bias	Flow independent correction factor.
	Number of Correction Pts	Number of flow dependent correction factors.
	Correction Data Sets	Provides up to eight VCF data sets. Each data set has a reference value and test data.
Flow Cal Data	**Std Temp**	Flow calibration reference temperature.
	Std Absolute Pressure	Flow calibration reference pressure.
Purge Setup	Various settings related to the B-Series device.	Provides access to the following functions: **Auto Purge OnOff** – Enable/disable automatic initiation. **Interval** – Frequency of automatic purge cycle (from 1 to 1,440 minutes). **Width** – The length of time the purge solenoid is held open (up to 32,000 milliseconds). **Hold Time** – Amount of time to allow the sensor to recover from the purge before resuming the meter output update (up to 32,000 milliseconds).
Drift Check Setup	Various settings related to the B-Series device.	Provides access to the following functions: **Auto Drift Check OnOff** – Enable/disable automatic initiation of the drift check cycle. **% FS at Zero** – Amplitude of the output signal for the zero flow check (FS=3.3V). **Duration at Zero** – Duration at the zero flow check voltage level (from 5 to 600 seconds). **% FS at Mid** – Amplitude of the output signal for the midrange flow check. **Duration at Mid** – Duration at the midrange flow check voltage level (from 5 to 600 seconds). **% FS at Span** – Amplitude of the output signal for the full range flow check. **Duration at Span** – Duration at the full range flow check voltage level (from 5 to 600 seconds). **Interval** – Frequency of the automatic drift check cycle (up to 18,000 hours).

Device Monitor Menu

The **Device Monitor** menu provides dynamic variables and loop current. Selecting a variable shows only that variable in the view area.



The primary variable (PV) can be mapped to the B-Series measured flow rate or measured velocity. Mapping is determined by selecting the respective PV units, as shown in the following table.

Table 1-5. Primary Variable Units Mapping

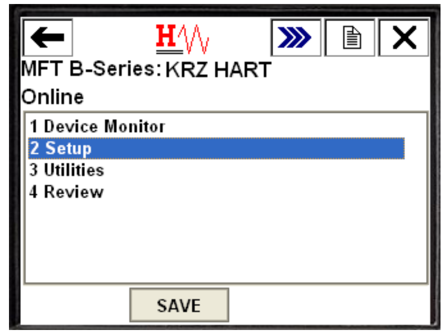
PV = Flow Rate	PV = Velocity
ft^3/min	ft/min
ft^3/h	m/s
L/min	
m^3/h	
kg/min	
kg/h	
lb/min	
lb/h	

If flow rate is mapped to PV, then velocity is mapped to the secondary variable (SV). If velocity is mapped to PV, then flow rate is mapped to SV. The B-Series tertiary variable (TV) and quaternary variable (QV) are mapped to temperature and totalized flow, respectively.

The flow meter measures and reports Standard Flow Rate and Standard Velocity referenced to the Standard Temperature and Standard Pressure programmed into the flow meter. Changes made to the PV units are sent to the B-Series flow meter, which then makes changes to the analog output configuration to ensure the correct measured flow data is sent to the analog output channel.

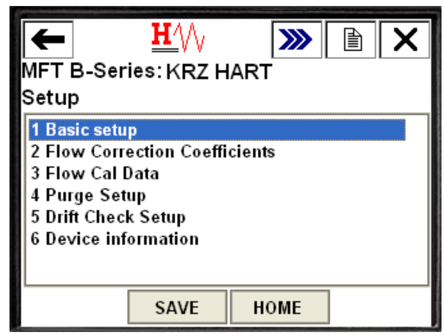
Basic and Advanced Configuration Options

The **Setup** menu contains provides several options for changing the flow meter's basic and advanced configuration parameters.



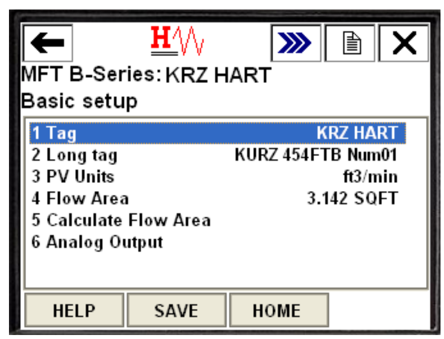
Note Unsent changes are highlighted in yellow that will be lost if you power cycle the flow meter before sending the changes. The **Save** button changes to **Send** when there are changes that need to migrate to the B-Series device.

The **Basic Setup** menu contains parameters that you configure when you first install the flow meter.



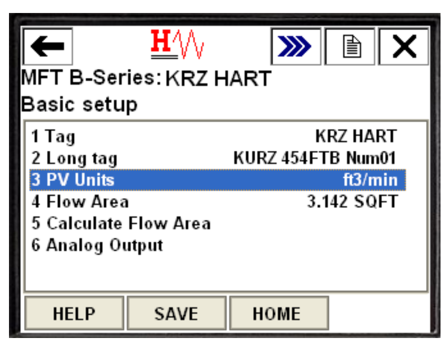
Tag Function

Tag opens a keyboard used for entering the HART short tag name that is mapped to the B-Series tag name appearing near the top of the screen ("KRZ HART"). Press **Enter** to accept the tag name, and then press **Send** to send the change to the B-Series flow meter.



Process Variable Units Function

The **PV Units** function allows you to change the process variable assigned to the primary variable.



A warning prompt appears confirming that you want to change the units followed by a list of PV units.

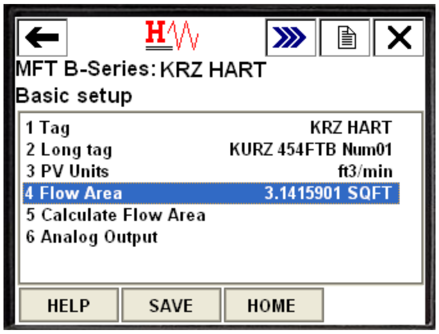
Table 1-6. Process Variable Units

HART Menu	Actual Measurement	Measurement Description
ft^3/min	SCFM	Standard Cubic Feet per Minute
ft^3/h	SCFH	Standard Cubic Feet per Hour
L/min	SLPM	Standard Liters per Minute
m^3/h	SCMH	Standard Cubic Meter per Hour
kg/min	KGM	Kilograms per Minute
kg/h	KGH	Kilograms per Hour
lb/min	PPM	Pounds per Minute
lb/h	PPH	Pounds per Hour
ft/min	SFPM	Standard Feet per Minute
m/s	SMPS	Standard Meters per Second

The flow meter measures and reports Standard Flow Rate and Standard Velocity referenced to the Standard Temperature and Standard Pressure programmed into the flow meter.

Flow Area Function

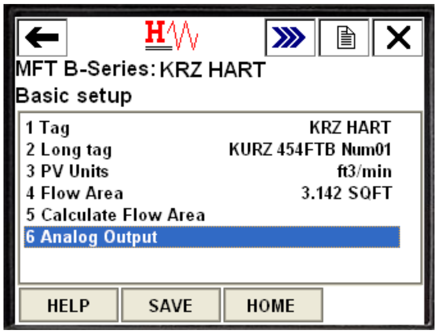
If you know the flow area, you can enter the value directly by selecting **Flow Area**. **Flow Area** opens a keyboard used for entering the flow.



The **Calculate Flow Area** function guides you through the dimensions of standard pipes/ducts (round or rectangular) and determines the Flow Area. For odd-shaped pipes/ducts, you must manually calculate the flow area.

The **Calculate Flow Area** prompts you for the pipe/duct shape (round or rectangular), followed by a keyboard for the inside diameter or inside height and width. You are then prompted to accept or decline the value that will be sent to the flow meter.

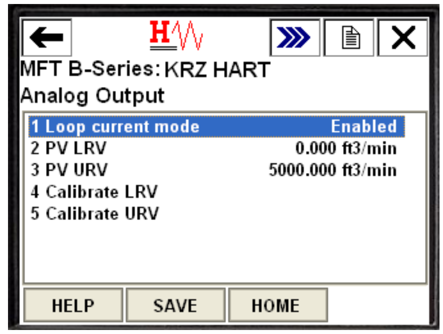
The **Analog Output** function allows you to set the analog output range for the 4-20 mA output.



You can manually enter the Analog Output upper (URV) and lower (LRV) range values or use the Calibrate methods to change the range of the flow meter.

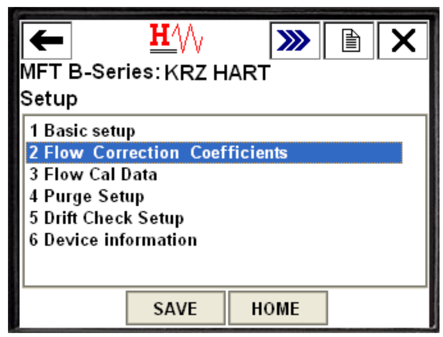
Note The Calibrate methods are also available in the Common Utilities menu.

The Calibrate methods walk you through a series of prompts for setting the lower and upper range values.



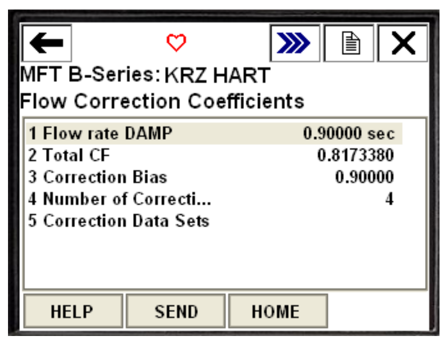
Flow Correction Coefficients Function

The B-Series flow meter uses various correction factors for velocity profile issues that affect the measured flow. The flow correction factors are obtained from the field calibration procedure and then entered into the flow meter using the **Flow Correction Coefficients** function.



The Total Correction Factor (CF) is a multiplicative combination of all the flow correction factors. Refer to *Variable Correction Factor Setup and Operation* for complete information about the B-Series correction factors.

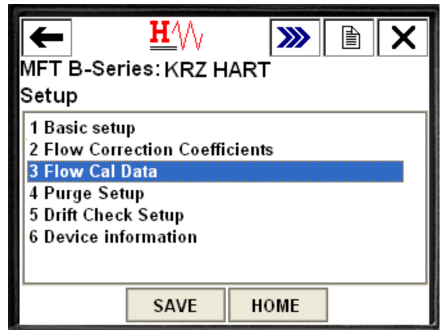
The Kurz meter supports up to 8 VCF data sets. Each data set is a pair of referenced and observed flow/velocity data (flow rate for in-line meters and velocity for insertion meters).

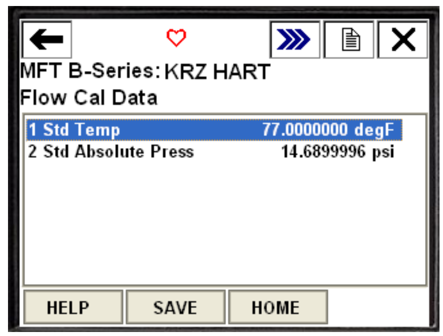


For example, if you select Correction Data Sets you will have the option to select up to four sets. Selecting one of the sets allows you to set the reference value and test data for that set. The reference value is the actual/true velocity or flow rate. Test data is the indicated velocity or flow rate as measured by the flow meter.

Flow Cal Data Function

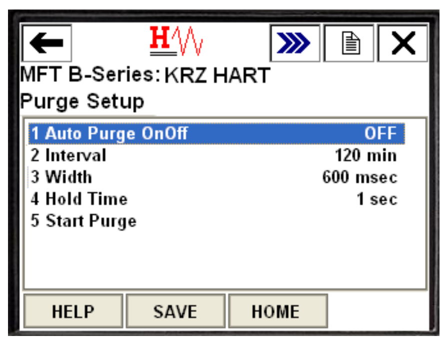
Flow Cal Data contains the Standard Reference Temperature and Pressure conditions of the process gas. Your actual temperature and pressure values should be used if those values are different from the information provided for factory calibration.





Auto Purge Function

The B-Series has an optional **Auto Purge** function that allows you to clean the sensor using a high velocity gas to blow off any dirt build-up on the sensor sting. The cleaning sequence can be automatically triggered.



If your flow meter includes the Auto Purge function and you want to trigger Auto Purge, set Auto Purge to ON and define an interval.

- The purge **Width** is the length of time the purge solenoid is held open.
- The **Hold Time** allows the sensor to recover from the purge cleaning in order to minimize a large flow spike following the purge. The Hold TIme is the total time for the entire purge cycle.

For example, a 1 second (1000 milliseconds) hold time with a 600 millisecond purge width reflects a purge relay pulsed for 600 milliseconds followed by 400 milliseconds of idle time for sensor recovery.

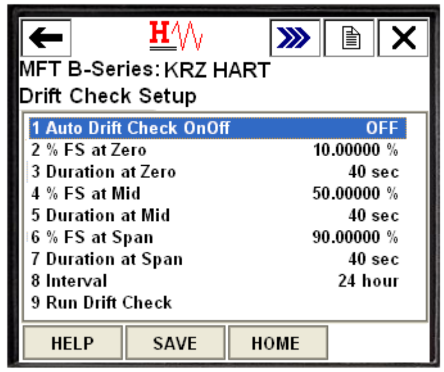
During the Hold Time, the Analog Output (AO) value is frozen at the pre-purge value to minimize any disruption to a control loop during the purge cleaning cycle.

Once you have configured Auto Purge, select **Start Purge** to initiate a purge cleaning. A warning message prompt and confirmation prompt appear before the command is sent to the flow meter.

Zero-Span Auto Drift Check Function

The **Auto Drift Check** function is a diagnostic test that compares an independent 4-20mA test output against the actual 4-20 mA output to verify the proper calibration of the 4-20 mA output. The independent voltage source has a range of 0 to 3.3 Volts. The Auto Drift Check test provides three voltage tests:

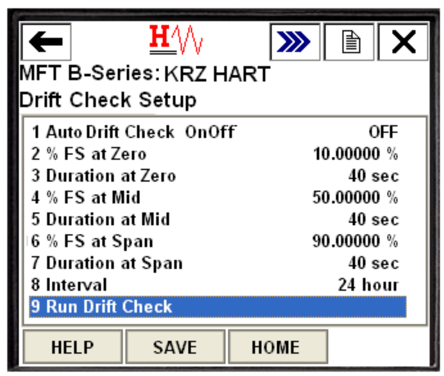
- Zero check
- Mid check
- Span check



For each Drift Check test level, you must configure the amplitude of the output signal and the duration that the output signal is applied. The amplitude is given as a percent of the full scale independent voltage source (3.3V). For example, entering 10.0 for **%FS at Zero** means that 0.33V (10% of 3.3V) is applied to the 4-20mA output for the Zero Drift Check. Each **Duration** option is the time the 4-20mA output is forced at that percent level of the specified check.

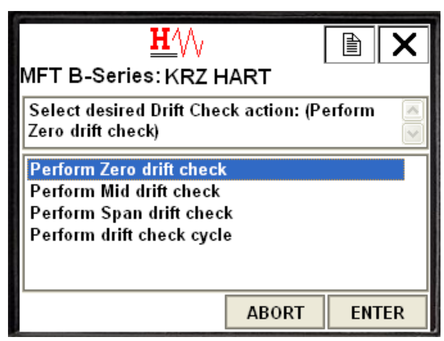
This function complies with the EPA's daily emission monitoring requirement. The Run Drift Check function is also available under the Device Specific Utilities menu.

A Drift Check can be configured to automatically run at a specific interval by setting Auto Drift Check ON and specifying an interval. You can also start a manual drift check by selecting **Run Drift Check**.



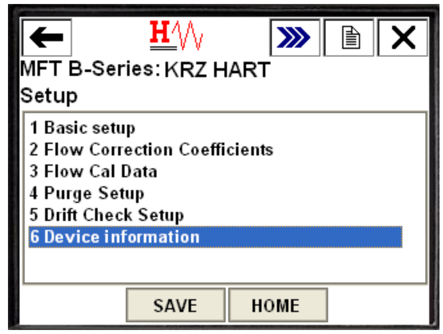
The Run Drift Check function allows you to run individual or all drift check tests. Informational prompts appear after you select a test check.

Note While the Drift Check is running, the 4-20 mA output (loop current) represents the configured percent of Full Scale (of 3.3V), not the PV reading.



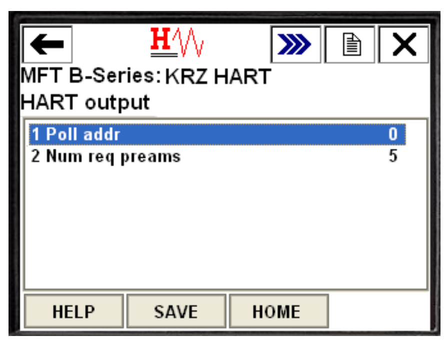
Device Information

The **Device Information** menu contains the HART universal and common variables.



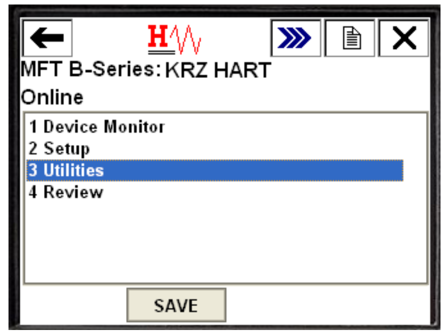
Most fields provide variable information in the adjacent column.

Select the **HART Output** option to view additional information.



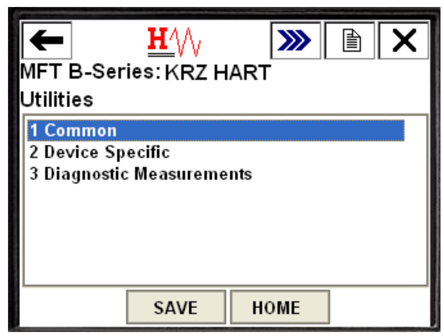
Utilities Menu

The **Utilities** menu provides diagnostic methods and data for B-Series maintenance and troubleshooting.



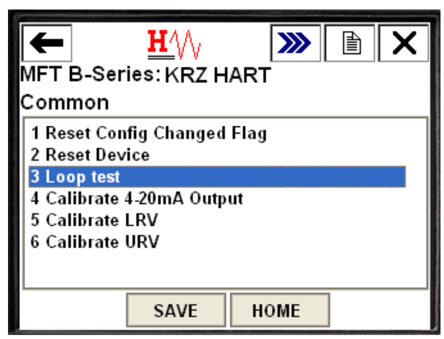
Common Functions

The **Common** menu contains options all HART registered devices are required to support.

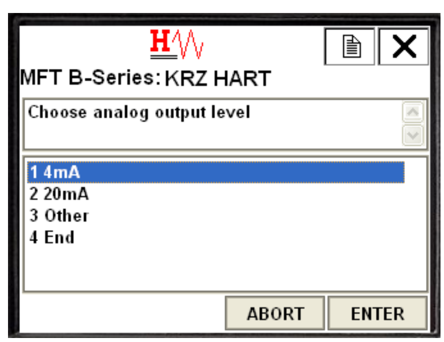


Loop Test Function

The **Loop Test** allows you to verify the 4-20 mA output of the flow meter. A precision ampere or current meter is required to verify the output during the test.



A warning prompt appears followed by the option to select the analog output level.



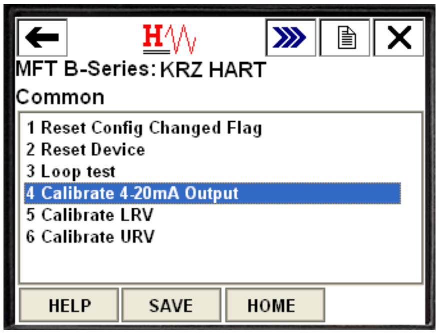
An informational prompt appears where you can verify the reading on your ampere or current meter is showing 4.0 mA. If another value appears, select **Calibrate 4-20 mA Output** in the **Common** menu.

You can select a midrange output level by selecting **Other**, which provides a keypad for entering an analog output level.

Exit the loop test and return to the normal operating mode by selecting **End**. A series of informational prompts appear.

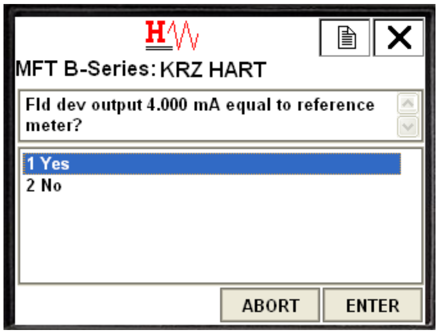
Calibrate 4-20 mA Output Function

The **Calibrate 4-20 mA Output** function refers to modifying the method of digital-to-analog signal conversion. The default conversion method uses comparison and characterization of the expected output values. You can change the expected output values to the values actually reported by a calibrated, accurate output measurement device, such as an ampere or current meter.



When you select **Calibrate 40-20 mA Output**, a series of warning and informational prompts appear, followed by a keypad for entering the lower range value (LRV).

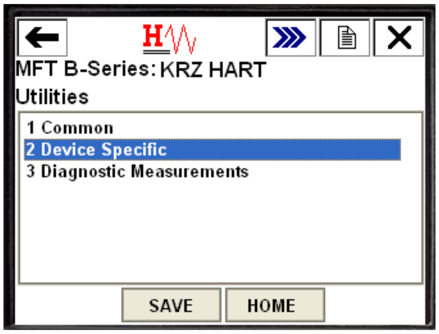
You are then prompted to confirm the lower range value, followed by an informational prompt.



A keypad appears for entering the upper range value (URV), followed by a confirmation prompt and informational prompts.

Device Specific Functions

The **Device Specific** menu products functions specific to the B-Series flow meter.

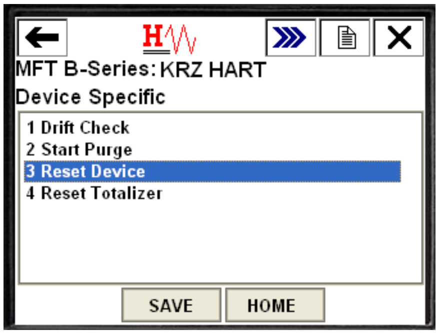


Drift Check is discussed on page 1-13, and Start Purge is discussed on page 1-12.

Reset Device

The Reset Device function allows you to power cycle the B-Series flow meter.

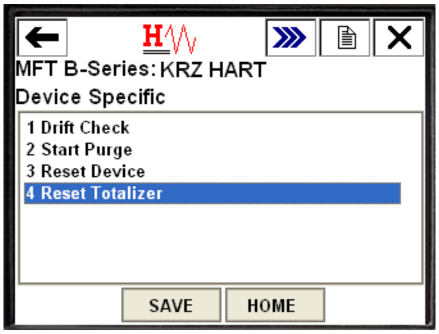
Warning, confirmation, and informational prompts appear with this function.



Reset Totalizer Function

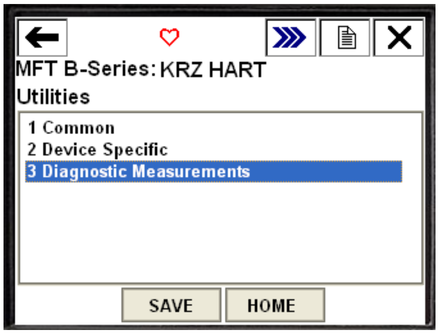
The **Reset Totalizer** function allows you to reset the totalized flow accumulator.

Confirmation and informational prompts appear with this function.



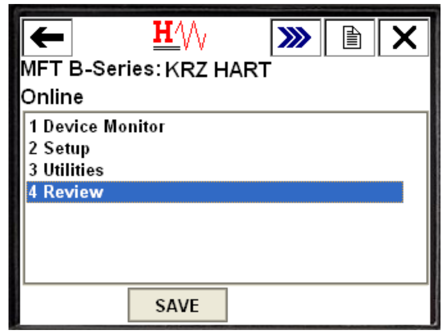
Diagnostic Measurements

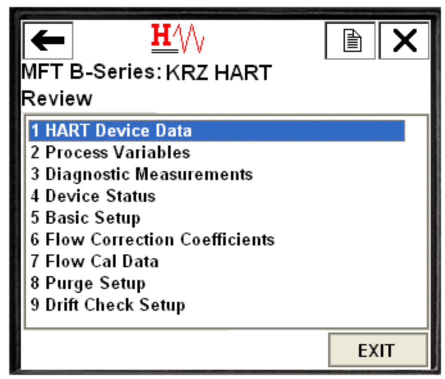
The Diagnostic Measurements menu provides diagnostic data for troubleshooting B-Series devices.



Review Menu

The Review menu provides read-only access to all parameter and configuration information.





Chapter 2

HART Connectivity

Overview

The B-Series v2.x thermal mass flow meter is available with a HART interface that complies with HART Protocol r7.0. The HART Field Communications Protocol is widely recognized as the industry standard for digitally enhanced 4-20 mA smart instrument communication. This feature allows the flow meter to communicate its device data over the same wiring used to transmit the 4-20 mA signals without disturbing the 4-20 mA analog signal.

Note You must have ordered the HART option when you configured the options for your Kurz device. HART functionality will not work without being factory installed.

Introduction

HART follows the master-slave protocol, where the slave field device communicates only when the master device initiates communication. HART communication supports primary and secondary master devices.

- The primary master device is typically a Distributed Control System (DCS), Programmable Logic Controller (PLC), or computer-based central control or monitoring system (for example, a Supervisory Control and Data Acquisition (SCADA) system).
- The secondary master is commonly a handheld communicator, laptop, or notepad used in the field.

Connecting with a HART Master

A HART master communicates with the flow meter in the 4-20 mA loop, provided there is a minimum of 250 ohm between the connection and the power supply. The HART master must be loaded with Device Descriptor (DD) files to access all B-Series capabilities. If a HART master does not have DD files, basic communication and configuration are available using the HART Universal and Common Practice commands but flow meter-specific commands (for example, Flow Area Setup) are unavailable.

- HART handheld communicators typically have clip-on leads to connect to the field device.
- A computer-based HART master uses a HART modem to communicate with the B-Series flow meter via the USB interface.

The HART Communication Foundation publishes a quarterly update of DDs for devices that have been certified as HART compliant. Older DD files are not always compatible with B-Series flow meters. The HART Communication Foundation also registers HART-compliant USB modems.

The HART master initially searches for an active B-Series flow meter on the 4-20mA loop to establish the connection and identify the device. Once the B-Series device is identified, the HART master locates and loads the flow meter DD files.

HART-Enabled Wireless Adapter

A HART-enabled B-Series flow meter can leverage the wireless capabilities of the HART protocol by installing a wireless HART adapter. This provides a simple and cost-effective method for adding flow measurement to an existing control system without installing additional wires.

The following examples use the Emerson Smart THUM Adapter that communicates with the Emerson Smart Wireless Gateway; however, other wireless HART products are available that would follow similar configuration. The THUM adapter attaches to one of the conduit ports on the flow meter head, as shown in Figure 2-1.

Figure 2-1. Emerson Smart THUM Adapter

With this setup, the THUM adapter extracts the HART data from the flow meter and then wirelessly transmits it to the Emerson Smart Wireless Gateway, which sends the data to a DCS or other host system.

Wiring a Flow Meter to an Adapter

The THUM Adapter must have at least 250 Ohms resistance to function properly in the 4-20 mA loop. The wired connection between the THUM Adapter and the B-Series flow meter is configured differently for self-powered or loop-powered flow meters.

- Self-powered or active-loop flow meters supply power to the 4-20 mA loop.
- Loop-powered or passive-loop flow meters use customer-supplied power to the 4-20 mA loop.

Note You must use the proper wiring configuration before powering on the flow meter.

The THUM wiring diagrams are examples from the Emerson *Wireless THUM Adapter Reference Manual*.

Before mounting and installing the flow meter into your pipe or duct, you should test configure the B-Series flow meter with the THUM adapter using a Field Communicator. Figure 2-2 provides the direct mount wiring connections for a test configuration.

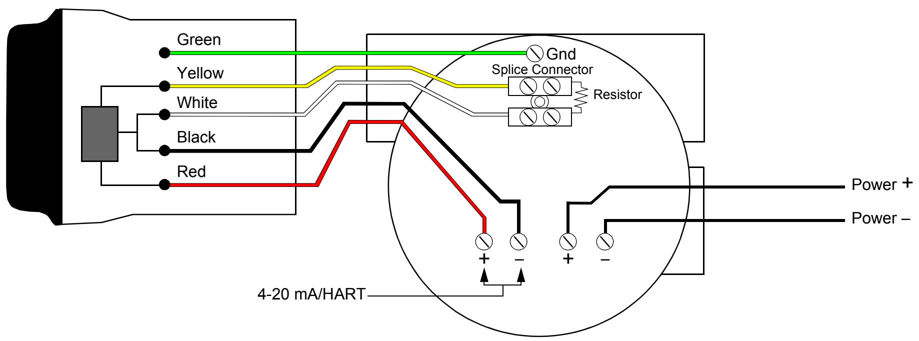


Figure 2-2. THUM wiring diagram for test configuration with a B-Series flow meter

A jumper is placed across the +24V / AO1+ for a self-powered flow meter (refer to the wiring diagrams in the *B-Series Hardware Reference Guide*).

Self-Power Flow Meter

The wiring connection for self-powered B-Series flow meters is provided in Figure 2-3.

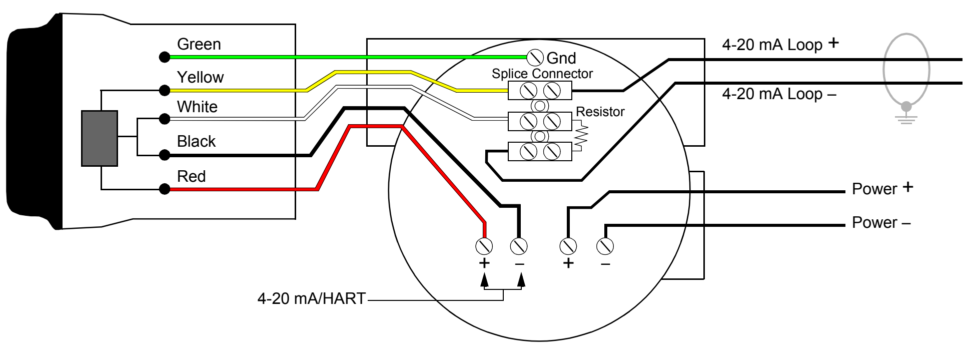


Figure 2-3. THUM wiring diagram for self-power B-Series flow meter

A jumper is placed across the +24V / AO1+ for a self-powered flow meter (refer to the wiring diagrams in the *B-Series Hardware Reference Guide*).

- The yellow wire connects to the positive (+) 4-20 mA field wiring.

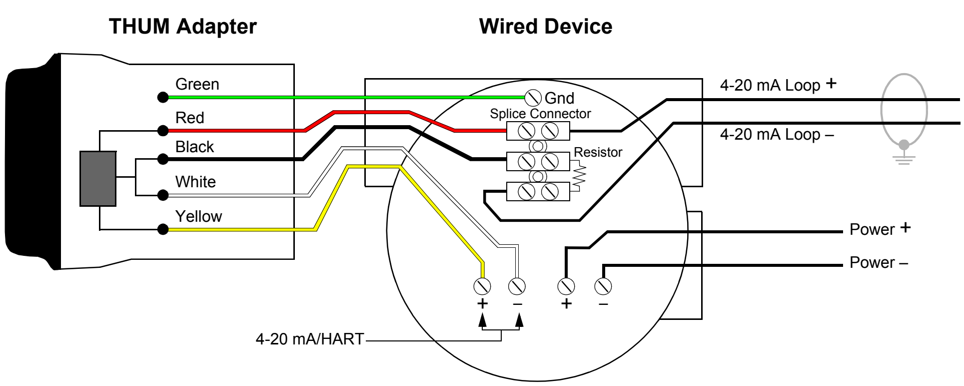
- The white wire connects to the negative (–) 4-20 mA field wiring.

Table 2-1. Self-Powered B-Series Wiring for Wireless HART Devices

	Sensor Control Board Terminals	THUM Adapter Wires
1	RPS	B-Series Sensor Wires
2	RPL	
3	RPH	
4	RTCL	
5	RTCH	
6	GND	Green
7	485 +	NC
8	485 –	
9	GND	Black
10	+ 24V	Jumper
11	AO1 +	
12	AO1 –	Red

Loop-Powered Flow Meter

The wiring connection for loop-powered B-Series flow meters is provided in Figure 2-4.



Note: Refer to the Emerson *Wireless THUM Adapter Reference Manual* for complete wiring requirements.

Figure 2-4. THUM wiring diagram for loop-power B-Series flow meter

For the THUM wiring:

- The red wire connects to the positive (+) 4-20 mA field wiring.
- The black wire connects to the negative (–) 4-20 mA field wiring.

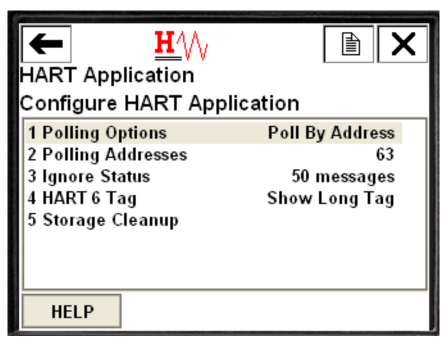
Table 2-2. Loop-Powered B-Series Wiring for Wireless HART Devices

	Sensor Control Board Terminals	THUM Adapter Wires
1	RPS	B-Series Sensor Wires
2	RPL	
3	RPH	
4	RTCL	
5	RTCH	
6	GND	Green
7	485 +	NC
8	485 –	
9	GND	
10	+ 24V	
11	AO1 +	Yellow
12	AO1 –	White

Configuring Handheld Communication

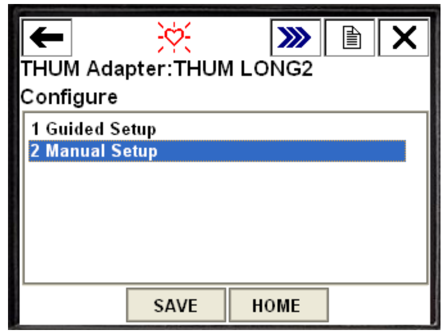
Connect a handheld communicator across the 250 Ohm resistor. The THUM adapter uses **63** as the default address. The handheld communicator polling address must match the adapter address.

Select **Poll By Address** on the handheld communicator.

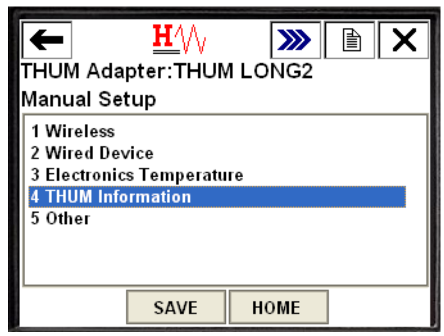


The **Show Long Tag** parameter determines how the THUM adapter name appears in the Emerson Smart Wireless Gateway web interface. If your site uses multiple wireless adapters, using a unique string for this parameter makes it easier to identify the specific adapter.

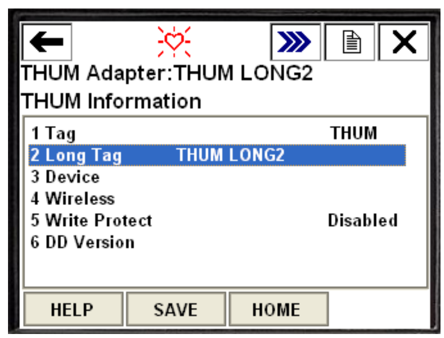
The Long Tag parameter string is set in the THUM Information menu.



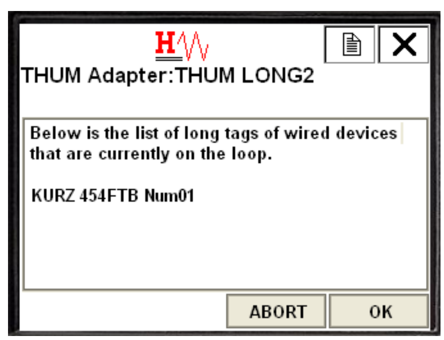
Select **Configure → Manual Setup → THUM Information**.



The long tag name for the THUM adapter appears.



To confirm the B-Series flow meter is properly wired to the THUM adapter, select **Service Tools → Maintenance → Other → List Wired Devices**.



The flow meter appears with its HART long tag. This is the name that the THUM adapter reports to the gateway.

This confirms that the flow meter and wireless adapter are communicating.

Adding a Wireless Device to the Network

Once the flow meter and the wireless adapter are communicating, use the handheld communicator to configure the wireless adapter so it communicates with the wireless gateway that accesses the network.

Note Refer to your wireless gateway reference guide for default network ID and join key values.

1> Select **Configure → Guided Setup → Join Device to Network**.

A keyboard appears.

2> Enter the wireless HART network ID (five digits). Select **Enter**.

3> Enter the join key for the wireless HART network. Select **Enter**.

The join key information spans four fields.

In this example, the network ID is 12345 and the join key is 11111100, 22222200, 33333300, 44444400. This information is used to setup the wireless gateway.

4> After you enter the last join key, you are prompted to accept or re-enter the join key values. If the values appear correct, select **Enter**.

5> Power off the B-Series flow meter.

Configuring the Smart Wireless Gateway

Refer to your wireless gateway reference guide for complete configuration requirements and information. The following example uses steps from the Emerson *Smart Wireless Gateway Reference Manual*.

A computer must be configured to form a private network before communicating to the gateway. To configure the network settings:

1> Find and open the **Control Panel**. (It is generally found from the **Start** menu.)

2> Open **Network Connections**.

3> Select **Local Area Connection**.

4> Right-click the mouse and select **Properties** from the pop-up list.

5> Select **Internet Protocol (TCP/IP)**, and click **Properties**.

6> From the **General** tab, click **Use the following IP address**.

7> Set the IP address field to **192.168.1.12** and press **Tab**.

8> The subnet mask field should automatically fill with 255.255.255.0.

9> Click **OK** to close the Internet Protocol (TCP/IP) dialog box.

10> Click **Close** to close the Local Area Connection dialog box.

Internet proxies must be disabled through the computer browser:

1> Open the browser (the following steps use Internet Explorer, but other browsers offer similar functionality).

2> Select **Tools → Internet Options**.

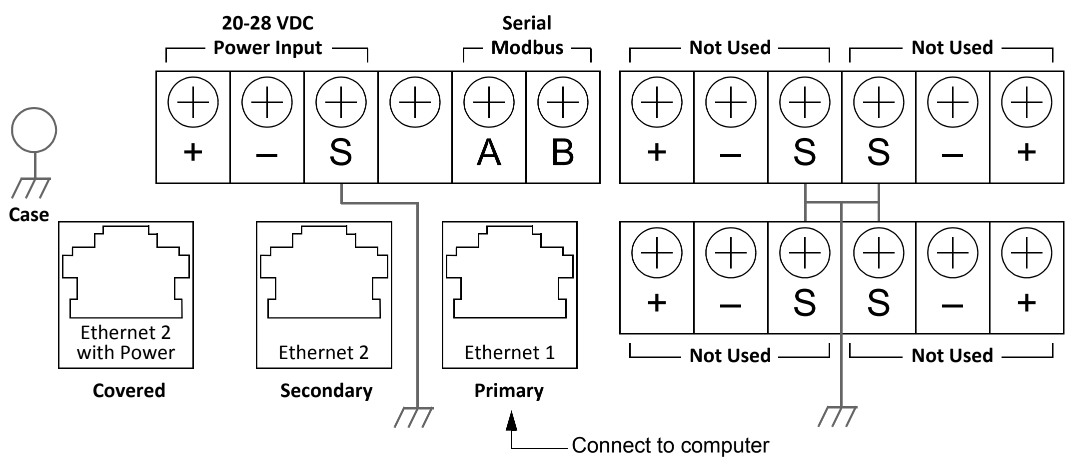
3> From the **Connections** tab, click **LAN Settings**.

4> Under Proxy Server, uncheck **Use a proxy server for your LAN**.

5> Click **OK** to close the Local Area Network (LAN) Settings dialog box.

6> Click **OK** to close the Internet Options dialog box.

The computer is now configured to communicate with the gateway, and it can be setup on an active network. Use an Ethernet cable to connect the computer to Ethernet port 1 on the wireless gateway, as shown in Figure 2-5. The Emerson Wireless Gateway is powered with a 24 VDC power supply with at least 500 mA.



Note: Refer to the Emerson *Wireless Gateway Reference Manual* for complete requirements.

Figure 2-5. Standard terminal block in the Emerson Smart Wireless Gateway

Refer to the Emerson *Wireless Gateway Reference Guide* for the steps on logging in and configuring the gateway. You will need the network ID and join key values you specified in "Configuring Handheld Communication."

Chapter 3

HART Field Device Specification

Overview

The B-Series flow meter uses thermal convection to measure mass flow. This guide provides functions and features specific to flow meters with the HART option. Refer to the *B-Series Hardware Reference Guide* and the *B-Series Operations Guide* for additional information.

Device Specifications

Refer to the *B-Series Hardware Guide* and *B-Series Operations Guide* general performance specifications.

Table 3-1 provides a basic description or configuration for a HART-enabled B-Series flow meter. Additional feature/parameter information is available in this guide.

Table 3-1. Default Configuration (HART Interface)

Feature / Parameter	Description / Default Setting
Number of common practice commands	10
Number of device-specific commands	17
Number of device variables	6 (PV, SV, TV, QV, percent range, loop current)
Host signals	One 4-20 mA, analog
Lower range value	0
Upper range value	100000
PV units	SCFM
Damping time constant	0.5 seconds
Number of response preambles	5
Alternate operating modes	None
Burst mode	None
Write protection/write-protect jumper	None
Fault indication jumper	None
Actuators	None

Power-Up & Reset

The B-Series flow meter performs self-test diagnostics during power-up. During this time (between 2 and 120 seconds), the device will not respond to HART commands and the analog output is set at the NE-43 alarm (<3.6 mA or >21.0 mA). When the self-test completes, an additional 20 seconds is required to support HART command activity.

Command 42 (Device Reset) causes the device to reset, which is identical to the power-up sequence.

Self-Test

The B-Series does not support Command 41 (Self Test) because periodic self-tests are part of standard operation for the B-Series flow meter. Self-tests also occur during power-up and device reset. Any errors or faults during self-test are recorded in the device-specific status bytes provided in the response to Command 48.

Response Time & Long Messages

The typical command response time is 50 ms. The minimum response time is 20 ms and the maximum is 100 ms.

Delayed response is not used.

The largest data field in a response occurs with Command 128 (Read Correction Factor Data) and Command 129 (Write Correction Factor Data). The response data field for these commands uses 70 bytes.

Nonvolatile Memory & Write Protection

The device configuration parameters is stored in EEPROM. New data is written to memory immediately following a write command.

The device does not have a write-protection function.

Modes & Damping

Fixed current mode is implemented with Command 40. The mode is cleared by power loss or device reset.

Damping is standard, affecting only the PV and the loop current signal.

Device Malfunctions

Device malfunctions are NAMUR NE43 compliant and are indicated by a down-scale (low output) or up-scale (high output) current. A low output less than 3.6 mA or a high output greater than 21.0 mA indicates a device malfunction. These settings are configurable through the flow meter local display/keypad or through a USB/RS-485 connection, and are not available through the HART interface.

Analog Output Channel

A two-wire, optically isolated 4-20 mA current loop is connected to two terminals marked AO1+ and AO1–. There is only one analog output for HART-enabled B-Series flow meters. HART communication is supported on this loop. The analog output can be configured to measure process flow rate, average velocity, or temperature. Process flow and velocity output are linearized and scaled according to a configured range specified through the HART interface. This output can be configured to correspond to the primary variable (PV).

Device Variables

Table 3-2 provides the device variables available through the HART interface.

Table 3-2. Device Variables (HART Interface)

HART Class Code	Device Variable Number	Name	Units	Description
72	0, 246	PV	KGH, KGM, PPH, PPM, SCFH, SCFM, SCMH, SFPM, SLPM, SMPS	Primary variable (usually flow rate)
67	1, 247	SV	KGH, KGM, PPH, PPM, SCFH, SCFM, SCMH, SFPM, SLPM, SMPS	Secondary variable (usually average velocity)
64	2, 248	TV	degC, degF	Process temperature
71	3, 249	QV	Cubic feet, cubic meter, feet, kilograms, liters, meter, mounds	Totalized flow rate
72	244	Percent Range	none	Output % FS
72	245	Loop Current	mA	Analog Out mA

Dynamic Variables

Table 3-3 provides the dynamic variables available through the HART interface.

Table 3-3. Dynamic Variables (HART Interface)

Name	Units	Description
PV	KGH, KGM, PPH, PPM, SCFH, SCFM, SCMH, SFPM, SLPM, SMPS	Flow rate or average velocity
SV	KGH, KGM, PPH, PPM, SCFH, SCFM, SCMH, SFPM, SLPM, SMPS	Flow rate or average velocity
TV	degC, degF	Temperature of the process gas
QV	Cubic feet, cubic meter, feet, kilograms, liters, meter, mounds	Totalized flow

PV and SV are mapped to either flow rate or average velocity, respectively, depending on the units selected for PV. If PV is mapped to average velocity, then SV is mapped to flow rate.

Field Device Status

Table 3-4 provides the field device status and byte definition contained in the second data byte of the B-Series device response to any HART command.

Table 3-4. Field Device Status (HART Interface)

Bit Mask	Definition	Conditions to Set Bit
0x80 (bit 7)	Device malfunction	Any FaultIndex bit except bits 7, 28-31
0x40 (bit6)	Configuration changed	Any parameter change
0x20 (bit 5)	Cold start	Whenever a power cycle reboot occurs on the B-Series flow meter
0x10 (bit 4)	More status available	Set when any bits in the following status bytes are set: Device specific status 0 Device specific status 1 Device specific status 2 Device specific status 3 Device specific status 4 Device specific status 5 Extended device status Standardized status 0
0x08 (bit 3)	Loop current fixed	OperationStatus bit 1, Device specific status 5, bits 0, 1, 2, 3, 4
0x04 (bit 2)	Loop current saturated	OperationStatus bit 3
0x02 (bit 1)	Non-primary variable out of limits	FaultIndex bits 0-16
0x01 (bit 0)	Primary variable out of limits	FaultIndex bit 7

When bit 4 or bit 7 are set, the host should send Command 48 (Read Additional Device Status) to determine the exact nature of the status.

Refer to “B-Series FaultIndex Bit Definitions” on page 3-29 and “B-Series OperationStatus Bit Definition” on page 3-30 for the bit definitions of B-Series FaultIndex and OperationStatus.

Extended Device Status

Table 3-5 provides the extended device status and byte definition contained in byte 6 of Command 48 byte of the B-Series device response.

Table 3-5. Extended Device Status (HART Interface)

Bit Mask	Definition	Conditions to Set Bit
0x80 (bit 7)	Undefined	N/A
0x40 (bit6)	Undefined	N/A
0x20 (bit 5)	Undefined	N/A
0x10 (bit 4)	Undefined	N/A
0x08 (bit 3)	Undefined	N/A
0x04 (bit 2)	Critical power failure	Not used by B-Series
0x02 (bit 1)	Device variable alert	FaultIndex bits 7, 28-31
0x01 (bit 0)	Maintenance required	Any FaultIndex bit excluding 7, 28-31

Additional Device Status (Command 48)

Table 3-6 provides the additional device status (9 bytes) using Command 48 for the field device. This command should be sent whenever bit 4 (More Status Available) or bit 7 (Device Malfunction) is set in the Device Status byte to find the exact nature of the status (alert, warning, alarm, or malfunction).

Note Undefined bits are set to zero (0).

The bits in the FaultIndex are set or cleared by the self-test executed at power-up, following a reset, or following a self-test command. They are also set by any error or failure detected during continuous self-testing while the flow meter is operational.

Table 3-6. Additional Device Status (HART Interface)

Byte	Bit	Definition
Byte 0 Device Specific Status 0 B-Series FaultIndex Byte 0	0	RP resistance above high limit.
	1	RP resistance below low limit.
	2	RTC resistance above high limit.
	3	RTC limit below low limit.
	4	Wire resistance above high limit.
	5	Sensor RPS lead open circuit.
	6	High sensor or wire leakage current. S-GND below 100K ohms.
	7	Flow rate above design limit
Byte 1 Device Specific Status 1 B-Series FaultIndex Byte 1	0-1	Undefined.
	2	ADC failed to convert data.
	3	Sensor control stopped responding.
	4	Sensor control crowbar engaged.
	5	Sensor type does not match configuration.
	6	Abnormal sensor node voltages.
	7	Unable to write new configuration file.
Byte 2 Device Specific Status 2 B-Series FaultIndex Byte 2	0	Sensor type does not match board.
	1-7	Undefined.
Byte 3 Device Specific Status 3 B-Series FaultIndex Byte 3	0-3	Undefined
	4	HART warning - subsystem fail.
	5	Sensor leak warning. S-GND below 100K ohms.
	6	Power was applied (momentary).
	7	Change made to configuration (momentary).
Byte 4 Device Specific Status 4	0	Device in Diagnostic mode. B-Series SensorTestFlag is set.
	1	Fixed current output.
	2	Fault Event in B-Series device. Any bit in Faultindex is set except POWER_ON and CONFIG_CHANGE.
	3	Analog output is saturated.
	4	B-Series alarm 1.
	5	B-Series alarm 2.
	6-7	Undefined.

Table 3-6. Additional Device Status (HART Interface) (continued)

Byte	Bit	Definition
Byte 5 Device Specific Status 5	0	Zero drift test in progress.
	1	Mid span drift test in progress.
	2	Full span drift test in progress.
	3	Drift check cycle all tests.
	4	Purge start flag.
	5-7	Undefined.
Byte 6 Extended Device Status	0	Maintenance required.
	1	Device variable alert.
	2-7	Undefined.
Byte 7 Device Operating Mode	Not used by B-Series	Undefined.
Byte 8 Standard Status 0	Not used by B-Series	Undefined.

Universal Commands

All Universal Commands are implemented as specified in the HART Universal Command Specification (HF SPEC 127), including Command 38 (Reset Configuration Changed Flag) and Command 48 (Read Additional Device Status).

- For Command 3 (Read Dynamic Variables and Loop Current), it returns PV, SV, TV (temperature), and QV (totalized flow) for a total of 24 bytes of response data.
- For Command 9 (Read Device Variables with Status), the following device variable codes apply:
  - 00=PV
  - 01=SV
  - 02-TV
  - 03=QV

Common Practice Commands

Table 3-7 provides the implemented common practice commands.

Table 3-7. Common Practice Commands (HART Interface)

Command	Definition
34	Write PV damping value.
35	Write PV range values.
36	Set PV upper range value.
37	Set PV lower range value.
40	Enter/exit fixed current mode.
41	Perform device self-test.
42	Perform master reset.
44	Write PV units.
45	Trim AO1 DAC zero.
46	Trim AO1 DAC span.

The field device does not support Burst mode or the Catch Device variable.

Device-Specific Commands

Table 3-8 provides the implemented device-specific commands.

Table 3-8. Device-Specific Commands (HART Interface)

Command	Definition
128	Read correction factor data.
129	Write correction factor data.
130	Read current correction factor.
131	Read flow area.
132	Write flow area.
133	Read last calibration date.
137	Read purge parameters.
138	Write purge parameters.
139	Start purge cycle.

Table 3-8. Device-Specific Commands (HART Interface) (continued)

Command	Definition
140	Read Zero-Mid-Span Drift Check parameters.
141	Write Zero-Mid-Span Drift Check parameters.
142	Read Zero-Mid-Span Drift Check results.
143	Start Zero-Mid-Span Drift Check test.
144	Read diagnostic data.
145	Reset totalizer.
146	Read standard conditions.
147	Write standard conditions.

Command 128 — Read Correction Factor Data

Command 128 reads the field calibration correction factor and the eight sets of variable correction factors (VCF) from the device. The VCF are data pairs that define a reference flow or velocity and the observed/actual flow or velocity. The number of VCF data sets is included in the response data. This value defines the number of VCF sets in use in the process data calculations.

Table 3-9 provides the response data bytes for Command 128. There are no request data bytes.

Table 3-9. Command 128 (Response) — Read Correction Factor Data (HART Interface)

Byte	Format	Description
0	Enum	Correction factor unit code.
1-4	Float	Field calibration correction factor.
5	Unsigned-8	Number of variable correction data factor sets configured for use.
6-9	Float	Data point 1 — reference flow or velocity.
10-13	Float	Data point 1 — observed flow or velocity.
14-17	Float	Data point 2 — reference flow or velocity.
18-21	Float	Data point 2 — observed flow or velocity.
22-25	Float	Data point 3 — reference flow or velocity.
26-29	Float	Data point 3 — observed flow or velocity.
30-33	Float	Data point 4 — reference flow or velocity.
34-37	Float	Data point 4 — observed flow or velocity.
38-41	Float	Data point 5 — reference flow or velocity.
42-45	Float	Data point 5 — observed flow or velocity.
46-49	Float	Data point 6 — reference flow or velocity.
50-53	Float	Data point 6 — observed flow or velocity.
54-57	Float	Data point 7 — reference flow or velocity.
58-61	Float	Data point 7 — observed flow or velocity.
62-65	Float	Data point 8 — reference flow or velocity.
66-69	Float	Data point 8 — observed flow or velocity.
0	Success	No command-specific errors.

Command 129 — Write Correction Factor Data

Command 129 writes the field calibration correction factor and the eight sets of variable correction factors (VCF) from the device.

Table 3-10 provides the request and response data bytes for Command 129.

Table 3-10. Command 129 (Request and Response) — Write Correction Factor Data (HART Interface)

Byte	Format	Description
0	Enum	Correction factor unit code.
1-4	Float	Field calibration correction factor.
5	Unsigned-8	Number of variable correction data factor sets configured for use.
6-9	Float	Data point 1 — reference flow or velocity.
10-13	Float	Data point 1 — observed flow or velocity.
14-17	Float	Data point 2 — reference flow or velocity.
18-21	Float	Data point 2 — observed flow or velocity.
22-25	Float	Data point 3 — reference flow or velocity.
26-29	Float	Data point 3 — observed flow or velocity.
30-33	Float	Data point 4 — reference flow or velocity.
34-37	Float	Data point 4 — observed flow or velocity.
38-41	Float	Data point 5 — reference flow or velocity.
42-45	Float	Data point 5 — observed flow or velocity.
46-49	Float	Data point 6 — reference flow or velocity.
50-53	Float	Data point 6 — observed flow or velocity.
54-57	Float	Data point 7 — reference flow or velocity.
58-61	Float	Data point 7 — observed flow or velocity.
62-65	Float	Data point 8 — reference flow or velocity.
66-69	Float	Data point 8 — observed flow or velocity.

Table 3-11 provides the command-specific response codes for Command 129.

Table 3-11. Command 129 — Command-Specific Response Codes (HART Interface)

Code	Class	Description
0	Success	No command-specific errors.
1-2		Undefined.
3	Error	Parameter too large.
4	Error	Parameter too small.
5	Error	Too few data bytes received.
6		Undefined.
7	Error	In write-protect mode.
8-11		Undefined.
12	Error	Invalid units code.
13-15		Undefined.
16	Error	Access restricted.
17-31		Undefined.
32	Error	Busy.
33-127		Undefined.

Command 130 — Read Current Correction Factor

Command 130 reads the total correction factor from the device.

Table 3-12 provides the response data bytes for Command 130. There are no request data bytes.

Table 3-12. Command 130 (Response) — Read Current Correction Factor (HART Interface)

Byte	Format	Description
0-3	Float	Total correction factor.

Table 3-13 provides the command-specific response codes for Command 130.

Table 3-13. Command 130 — Command-Specific Response Code (HART Interface)

Code	Class	Description
0	Success	No command-specific errors.

Command 131 — Read Flow Area

Command 131 reads the flow area from the device.

Table 3-14 provides the response data bytes for Command 131. There are no request data bytes.

Table 3-14. Command 131 (Response) — Read Flow Area (HART Interface)

Byte	Format	Description
0-3	Float	Flow area.
4	Enum	Flow area unit code.

Table 3-15 provides the command-specific response codes for Command 131.

Table 3-15. Command 131 — Command-Specific Response Code (HART Interface)

Code	Class	Description
0	Success	No command-specific errors.

Command 132 — Write Flow Area

Command 132 writes the flow area to the device.

Table 3-16 provides the request and response data bytes for Command 132.

Table 3-16. Command 132 (Request and Response) — Write Flow Area (HART Interface)

Byte	Format	Description
0-3	Float	Flow area.

Table 3-17 provides the command-specific response codes for Command 132.

Table 3-17. Command 132 — Command-Specific Response Code (HART Interface)

Code	Class	Description
0	Success	No command-specific errors.
1-2		Undefined.
3	Error	Parameter too large.
4	Error	Parameter too small.
5	Error	Too few data bytes received.
6		Undefined.
7	Error	In write-protect mode.
8-11		Undefined.
12	Error	Invalid units code.
13-15		Undefined.
16	Error	Access restricted.
17-31		Undefined.
32	Error	Busy.
33-127		Undefined.

Command 133 — Read Last Calibration Date

Command 133 reads the last calibration date from the device.

Table 3-18 provides the response data bytes for Command 133. There are no request data bytes.

Table 3-18. Command 133 (Response) — Read Last Calibration Date (HART Interface)

Byte	Format	Description
0-17	Latin-1	Last calibration date.

Table 3-19 provides the command-specific response codes for Command 133.

Table 3-19. Command 133 — Command-Specific Response Code (HART Interface)

Code	Class	Description
0	Success	No command-specific errors.

Command 137 — Read Purge Parameters

Command 137 reads the purge parameters from the device. The purge parameters include the purge timer, purge assigned digital output, purge width, purge hold time, and purge interval.

Table 3-20 provides the response data bytes for Command 137. There are no request data bytes.

Table 3-20. Command 137 (Response) — Read Purge Parameters (HART Interface)

Byte	Format	Description
0	Unsigned-8	Purge timer — 0 = Off, 1 = On Sets the automatic purge feature on or off. The state of the purge times does not affect the ability to initiate a purge cycle using device-specific Command 139.
1	Unsigned-8	Assigned digital output for the air purge sensor cleaning system. The purge assigned digital output is a fixed assignment and cannot be changed. It is always set as DO2. The data is for informational purposed only
2-3	Unsigned-16	Purge width. The time in milliseconds that the device will hold the purge solenoid open when the purge cycle is initiated.
4-5	Unsigned-16	Purge hold time. The time to allow the sensor to recover following a purge. The purge hold time is the total time for the entire purge. For example, a 2,000 millisecond hold time reflects a 500 millisecond purge time followed by a 1,500 millisecond idle time to allow for sensor recovery.
6-7	Unsigned-32	Purge interval. Sets the frequency in minutes of the purge cycle when the purge timer is on.

Table 3-21 provides the command-specific response codes for Command 137.

Table 3-21. Command 137 — Command-Specific Response Code (HART Interface)

Code	Class	Description
0	Success	No command-specific errors.

Command 138 — Write Purge Parameters

Command 138 writes the purge parameters to the device. The purge parameters in the purge timer, purge assigned digital output, purge width, purge hold time, and purge interval.

Table 3-22 provides the request and response data bytes for Command 138.

Table 3-22. Command 138 (Request and Response) — Write Purge Parameters (HART Interface)

Byte	Format	Description
0	Unsigned-8	Purge timer — 0 = Off, 1 = On Sets the automatic purge feature on or off. The state of the purge timer does not affect the ability to initiate a purge cycle using device-specific Command 139.
1	Unsigned-8	Assigned digital output for the air purge sensor cleaning system. The purge assigned digital output is a fixed assignment and cannot be changed. It is always set as DO2. The data is for informational purposed only
2-3	Unsigned-16	Purge width. The time in milliseconds that the device will hold the purge solenoid open when the purge cycle is initiated.
4-5	Unsigned-16	Purge hold time. The time to allow the sensor to recover following a purge. The purge hold time is the total time for the entire purge. For example, a 2,000 millisecond hold time reflects a 500 millisecond purge time followed by a 1,500 millisecond idle time to allow for sensor recovery.
6-9	Unsigned-32	Purge interval. Sets the frequency in minutes of the purge cycle when the purge timer is on.

Table 3-23 provides the command-specific response codes for Command 138.

Table 3-23. Command 138 — Command-Specific Response Code (HART Interface)

Code	Class	Description
0	Success	No command-specific errors.
1-2		Undefined.
3	Error	Parameter too large.
4	Error	Parameter too small.
5	Error	Too few data bytes received.
6		Undefined.
7	Error	In write-protect mode.
8-11		Undefined.
12	Error	Invalid units code.
13-15		Undefined.
16	Error	Access restricted.
17-31		Undefined.
32	Error	Busy.
33-127		Undefined.

Command 139 — Start Purge Cycle

Command 139 sends a request to the device to start a purge cycle. The device must be configured with the optional Air Purge Cleaning System and digital output #2 must be assigned to this function.

Note The command does not confirm that the optional purge feature is configured on the device and will provide a successful response.

There are no request or response data bytes for Command 139.

Table 3-24 provides the command-specific response codes for Command 139.

Table 3-24. Command 139 — Command-Specific Response Code (HART Interface)

Code	Class	Description
0	Success	No command-specific errors.

Command 140 — Read Zero-Mid-Span Drift Check Parameters

Command 140 reads the Zero-Mid-Span Drift Check parameters from the device. The drift check parameters include the on/off state of the auto drift check, the time interval of the drift check, and the percent of full-scale voltage and duration for each drift check.

Table 3-25 provides the response data bytes for Command 140. There are no request data bytes.

Table 3-25. Command 140 (Response) — Read Zero-Mid-Span Drift Check Parameters (HART Interface)

Byte	Format	Description
0	Unsigned-8	Auto drift check on/off — 0 = Off, 1 = On Sets the auto drift check feature on or off. The state of the auto drift check does not affect the ability to initiate a drift check using device-specific Command 143.
1-2	Unsigned-16	Auto drift check time interval. Defines the periodic interval in hours when the drift test check is initiated.
3-6	Float	Zero drift check % full scale. Defines the amplitude of the output signal that is applied to the test. The amplitude is given as a percent of full of the independent voltage source (3.3V). For example, if 10.0% is used, then 0.33V are applied to the 4-20 mA output.
7-8	Unsigned-16	Zero drift check duration. Defines the duration of the output signal that is applied to the test.
9-12	Float	Mid drift check % full scale. Defines the amplitude of the output signal that is applied to the test. The amplitude is given as a percent of full of the independent voltage source (3.3V). For example, if 10.0% is used, then 0.33V are applied to the 4-20 mA output.
13-14	Unsigned-16	Mid drift check duration. Defines the duration of the output signal that is applied to the test.
15-18	Float	Span drift check full scale. Defines the amplitude of the output signal that is applied to the test. The amplitude is given 100% percent of full of the independent voltage source (3.3V).
19-20	Unsigned-16	Span drift check duration. Defines the duration of the output signal that is applied to the test.

Table 3-26 provides the command-specific response codes for Command 140.

Table 3-26. Command 140 — Command-Specific Response Code (HART Interface)

Code	Class	Description
0	Success	No command-specific errors.
1-2		Undefined.
3	Error	Parameter too large.
4	Error	Parameter too small.
5	Error	Too few data bytes received.
6		Undefined.
7	Error	In write-protect mode.
8-11		Undefined.
12	Error	Invalid units code.
13-15		Undefined.
16	Error	Access restricted.
17-31		Undefined.
32	Error	Busy.
33-127		Undefined.

Command 141 — Write Zero-Mid-Span Drift Check Parameters

Command 141 writes the Zero-Mid-Span Drift Check parameters to the device.

Table 3-27 provides the request and response data bytes for Command 141.

Table 3-27. Command 141 (Request and Response) — Write Zero-Mid-Span Drift Check Parameters (HART Interface)

Byte	Format	Description
0	Unsigned-8	Auto drift check on/off — 0 = Off, 1 = On Sets the auto drift check feature on or off. The state of the auto drift check does not affect the ability to initiate a drift check using device-specific Command 143.
1-2	Unsigned-16	Auto drift check time interval. Defines the periodic interval in hours when the drift test check is initiated.
3-6	Float	Zero drift check % full scale. Defines the amplitude of the output signal that is applied to the test. The amplitude is given as a percent of full of the independent voltage source (3.3V). For example, if 10.0% is used, then 0.33V are applied to the 4-20 mA output.
7-8	Unsigned-16	Zero drift check duration. Defines the duration of the output signal that is applied to the test.
9-12	Float	Mid drift check % full scale. Defines the amplitude of the output signal that is applied to the test. The amplitude is given as a percent of full of the independent voltage source (3.3V). For example, if 10.0% is used, then 0.33V are applied to the 4-20 mA output.
13-14	Unsigned-16	Mid drift check duration. Defines the duration of the output signal that is applied to the test.
15-18	Float	Span drift check full scale. Defines the amplitude of the output signal that is applied to the test. The amplitude is given 100% percent of full of the independent voltage source (3.3V).
19-20	Unsigned-16	Span drift check duration. Defines the duration of the output signal that is applied to the test.

Table 3-28 provides the command-specific response codes for Command 141.

Table 3-28. Command 141 — Command-Specific Response Code (HART Interface)

Code	Class	Description
0	Success	No command-specific errors.
1-2		Undefined.
3	Error	Parameter too large.
4	Error	Parameter too small.
5	Error	Too few data bytes received.
6		Undefined.
7	Error	In write-protect mode.
8-11		Undefined.
12	Error	Invalid units code.
13-15		Undefined.
16	Error	Access restricted.
17-31		Undefined.
32	Error	Busy.
33-127		Undefined.

Command 142 — Read Zero-Mid-Span Drift Check Results

Command 142 reads the Zero-Mid-Span Drift Check results of the last test. The drift check results include the VCal input, the corresponding output of the auto drift check, and the percent difference between the two values.

Table 3-29 provides the response data bytes for Command 142. There are no request data bytes.

Table 3-29. Command 142 (Response) — Read Zero-Mid-Span Drift Check Results (HART Interface)

Byte	Format	Description
0-3	Float	VCal input used for the Zero Drift Check test.
4-7	Float	VCal output used for the Zero Drift Check test.
8-11	Float	Percent difference between VCal In and VCal Out for the Zero Drift Check test.
12-15	Float	VCal input used for the Mid Drift Check test.
16-19	Float	VCal output used for the Mid Drift Check test.
20-23	Float	Percent difference between VCal In and VCal Out for the Mid Drift Check test.
24-27	Float	VCal input used for the Span Drift Check test.
28-31	Float	VCal output used for the Span Drift Check test.
32-35	Float	Percent difference between VCal In and VCal Out for the Span Drift Check test.

Table 3-30 provides the command-specific response codes for Command 142.

Table 3-30. Command 142 — Command-Specific Response Code (HART Interface)

Code	Class	Description
0	Success	No command-specific errors.

Command 143 — Start Zero-Mid-Span Drift Check Test

Command 143 starts the Zero-Mid-Span Drift Check test. The command includes a Drift Check command code specifier that defines each Drift Check test:

- 0x01 — Zero Drift Check test
- 0x02 — Mid Drift Check test
- 0x04 — Span Drift Check test
- 0x08 — All Drift Check tests

Table 3-31 provides the request and response data bytes for Command 143.

Table 3-31. Command 143 (Request and Response) — Start Zero-Mid-Span Drift Check Test (HART Interface)

Byte	Format	Description
0	Unsigned-8	Drift check command code

Table 3-32 provides the command-specific response codes for Command 143.

Table 3-32. Command 143 — Command-Specific Response Code (HART Interface)

Code	Class	Description
0	Success	No command-specific errors.

Command 144 — Read Diagnostic Data

Command 144 reads the diagnostic data from the device. The diagnostic data includes input voltages, sensor outputs, and sensor control data.

Table 3-33 provides the response data bytes for Command 144. There are no request data bytes.

Table 3-33. Command 144 (Response) — Read Diagnostic Data (HART Interface)

Byte	Format	Description
0-3	Float	VPs
4-7	Float	VIph
8-11	Float	VRtch
12-15	Float	VRtcl
16-19	Float	VLeakSense
20-23	Float	VExtIn
24-27	Float	VTemp
28-31	Float	VCal
32-35	Float	Irp
36-39	Float	Prp
40-43	Float	Rp
44-47	Float	Rtc
48-51	Float	Resistance of the sensor wire.
52-55	Float	Sensor leakage resistance.
56-59	Float	Electronics temperature.
60-63	Unsigned-32	Device runtime counter.
64-67	Float	VLl

Table 3-34 provides the command-specific response codes for Command 144.

Table 3-34. Command 144 — Command-Specific Response Code (HART Interface)

Code	Class	Description
0	Success	No command-specific errors.

Command 145 — Reset Totalizer

Command 145 resets the flow totalizer accumulation. The value of the flow totalizer is mapped to the QV dynamic variable.

There are no request or response data bytes.

Table 3-35 provides the command-specific response codes for Command 145.

Table 3-35. Command 145 — Command-Specific Response Code (HART Interface)

Code	Class	Description
0	Success	No command-specific errors.

Command 146 — Read Standard Conditions

Command 146 reads the user's standard temperature and pressure parameters from the device.

Table 3-36 provides the response data bytes for Command 146. There are no request data bytes.

Table 3-36. Command 146 (Response) — Read Standard Conditions (HART Interface)

Byte	Format	Description
0	Enum	Standard temperature unit code.
1	Enum	Standard pressure unit code.
2-5	Float	Standard temperature value.
6-9	Float	Standard pressure value.

Table 3-37 provides the command-specific response codes for Command 146.

Table 3-37. Command 146 — Command-Specific Response Code (HART Interface)

Code	Class	Description
0	Success	No command-specific errors.

Command 147 — Write Standard Conditions

Command 147 writes the user’s standard temperature and pressure parameters to the device.

Table 3-38 provides the request and response data bytes for Command 147.

Table 3-38. Command 147 (Request and Response) — Write Standard Conditions (HART Interface)

Byte	Format	Description
0	Enum	Standard temperature unit code.
1	Enum	Standard pressure unit code.
2-5	Float	Standard temperature value.
6-9	Float	Standard pressure value.

Table 3-39 provides the command-specific response codes for Command 147.

Table 3-39. Command 147 — Command-Specific Response Code (HART Interface)

Code	Class	Description
0	Success	No command-specific errors.
1-2		Undefined.
3	Error	Parameter too large.
4	Error	Parameter too small.
5	Error	Too few data bytes received.
6		Undefined.
7	Error	In write-protect mode.
8-11		Undefined.
12	Error	Invalid units code.
13-15		Undefined.
16	Error	Access restricted.
17-31		Undefined.
32	Error	Busy.
33-127		Undefined.

Correction Factor Unit Codes

Table 3-40 provides the correction factor unit codes.

Table 3-40. Correction Factor Unit Codes (HART Interface)

Unit Code	Units
15	Cubic feet per minute.
19	Cubic meters per hour.
20	Meters per second.
21	Feet per minute.

B-Series FaultIndex Bit Definitions

Table 3-41 provides the FaultIndex definitions for B-Series flow meters.

Table 3-41. B-Series FaultIndex Bit Definitions (HART Interface)

Bit	Definition
0	RP resistance above high limit.
1	RP resistance below low limit.
2	RTC resistance above high limit.
3	RTC resistance below low limit.
4	Wire resistance above high limit.
5	Sensor RPS lead open circuit.
6	High sensor or wire leakage current. S-GND below 100k ohms.
7	Flow rate above design limit.
8	Undefined.
9	Undefined.
10	ADC failed to convert data.
11	Sensor control stop responding.
12	Sensor control crowbar engaged.
13	Sensor type does not match configuration.

Table 3-41. B-Series FaultIndex Bit Definitions (HART Interface) (continued)

Bit	Definition
14	Abnormal sensor node voltages.
15	Unable to write new configuration file.
16	Sensor type does not match board.
17-27	Undefined.
28	HART warning: subsystem fail.
29	Sensor leak warning S-GND below 100k ohms.
30	Power was applied (momentary).
31	Change made to the configuration (momentary).

B-Series OperationStatus Bit Definition

Table 3-39 provides the OperationStatus definitions for B-Series flow meters.

Table 3-42. Command 147 — Command-Specific Response Code (HART Interface)

Bit	Definition	Condition To Set Bit
0 (0x01)	Device in diagnostic mode.	SensorTestFlag is set
1 (0x02)	Device in current loop mode.	HART LoopCurrentMode& 0x80 cHartCurrentControlFlag = 1
2 (0x04)	Device fault.	Any bit in FaultIndex is set except POWER_ON (Bit#30) or CONFIG_CHANGE (Bit#31)
3 (0x08)	4-20 mA output is saturated.	4-20 mA signal is set to low/high saturation value

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