ModMAG®
M-Series® | B-MAG Electromagnetic Flow Meters

M-Series® M2000

HART® Bi-Directional Communication Protocol Data Access

Badger Meter

User Manual

CONTENTS

ABOUT THIS MANUAL

Definitions

DD   Device Description

HART   Highway Addressable Remote Transducer

HOST   Host System, typically the master (i.e. handheld device)

PV   Primary Variable

SV   Secondary Variable

TV   Tertiary Variable

FV   Fourth Variable

Scope

This document discusses the supported features of HART and how these features are related to the M2000. This document also discusses special considerations and the type of data that is accessible over HART. This document is intended for readers who have a general understanding of the HART protocol. For further information regarding the HART protocol please refer to *www.hartcomm.org*.

The M2000 HART daughterboard supports Universal Command Revision 7.

INTRODUCTION

HART protocol provides the means for sending and receiving digital information across analog wires. HART is a bi-directional communication protocol that provides data access between intelligent field instruments (like the M2000) and host systems (like the Emerson Field Communicator). HART technology is a master/slave protocol, which means that a field device only speaks when spoken to by a master. The M2000 operates as a slave device. In order to connect with the M2000 using the HART protocol, the HART daughterboard is required. As an accessory module to the M-Series M2000, the HART daughterboard allows access to many of the M2000 measurements and configuration data using the analog wires. In addition, the HART daughterboard allows for real-time control and monitoring of the M2000.

The Device Description (DD) files for the M2000 are located on *www.hartcomm.org* under *Product Catalog > All Products > M2000*. These files describe the supported features and functions of the M2000 with respect to HART. The DD includes details of menus and graphic display features to be used by host applications in order to access all parameters and data in the M2000. These files describe what parameters are accessible and should be installed in host systems.

In order to provide access to the M2000 over HART, the daughterboard converts HART protocol commands to MODBUS™ RTU commands.
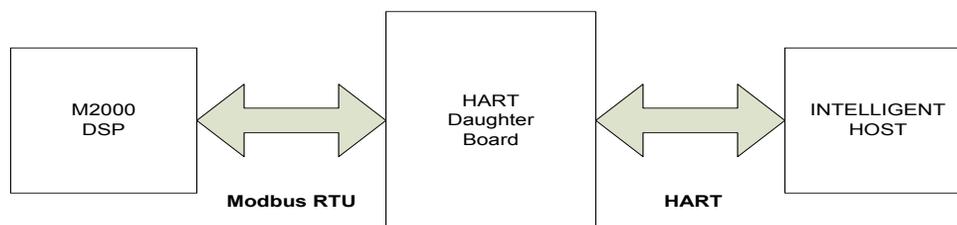
Figure 1: HART-to-MODBUS RTU Commands

INSTALLATION

Prerequisites

Installing a HART daughterboard into an M2000 has two requirements:

- Firmware v1.10 or later.
- M2000 PCB serial number must indicate that the board was manufactured week 19 of Year 2011 or later.

The PCB serial number is listed in the menus at *Main Menu > Info/Help > Serial Number*.
The PCB serial number is of the following format: WWYYSSSS, where WW = Week, YY = Year.
A label on the main board also indicates the week and year.

Figure 2: Main Board Label

Installing the Daughterboard

The daughterboard connects to the 11-pin connector labeled as COMMUNICATION on the main amplifier.

Figure 3: Daughterboard Connection

Follow these steps to install the daughterboard:

1. Prior to installing the daughterboard, verify or configure the M2000 Communication Port B. Access the port settings at *Main Menu > Communications > Port B Settings*.

Parameter	Value	Comments
Port Address	001	—
Extended Port Address	—	Not applicable for HART
Baud Rate	38400	HART Daughterboard auto-bauds, all baud rates supported
Data Bits	8	—
Parity	EVEN	—
Stop Bits	1	—

2. Verify or configure the analog output range at 4…20 mA.
    Access the analog output range at *Main Menu > Inputs/Outputs > Analog Output Range*.

3. Power off the M2000.

⚠CAUTION

DISCONNECT THE INPUT POWER BEFORE ACCESSING THE EQUIPMENT.
This step is important for the M2000 to properly recognize the HART daughterboard and fulfill HART compliance.

4. Prior to inserting the daughterboard, install the foam insulation pad as shown below. Be sure to align the groove with the two screws attaching the detector or wall mount bracket to the enclosure. The primary purpose of this pad is to ensure the daughterboard is insulated from the enclosure wall. It is important to install this pad flush with the top of the enclosure wall.
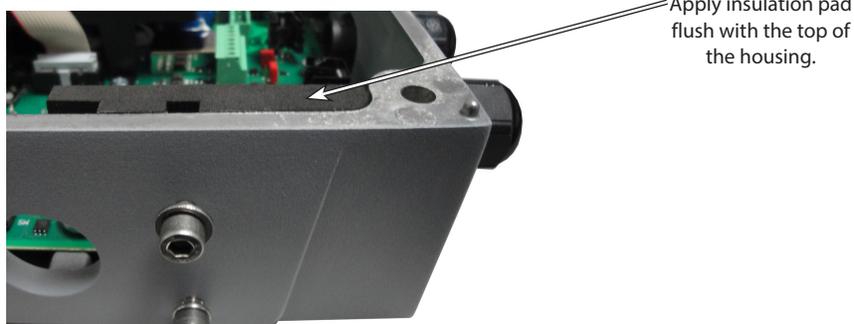

Apply insulation pad flush with the top of the housing.

Figure 4: Installing Foam Insulation Pad

5. Insert the daughterboard into the 11-pin connector.

6. Use the following information to make appropriate wiring of analog wires to the 4-pin customer connector.

Pin Number	Pin Description	Comments
41	Analog Ground	—
42	Analog Signal	Requires minimum loop impedance of 230 Ω for communication
43	Analog Shield	Only for shielded wires
44	Chassis Jumper	Connect to screw in corner

7. Power on the M2000.

8. Allow time for the daughterboard to properly power up and be recognized by the M2000 before navigating the menus. This time is typically 5 seconds. If the HART daughterboard is not recognized, then the M2000 should be power cycled.

9. Verify recognition of the HART daughterboard. Navigate to *Main Menu > Info > Help*. The *Daughterboard Info* field indicates the Daughterboard Type is HART.

M2000 AND HART

HART protocol has three categories of commands: Universal, Device-Specific and Common Practice. The M2000 HART daughterboard supports only some Universal commands and Device-Specific commands. Universal commands supported include:

Command Number	Command Description
0	Read Unique Identifier
1	Read Primary Variable
2	Read Current and Percent of Range
3	Read Current and Four Dynamic Variables
6	Write Polling Address
7	Read Loop Configuration
8	Read Dynamic Variable Class
9	Read Device Variables with Status
11	Read Unique Identifier Associated with Tag
12	Read Message
13	Read Tag, Descriptor, Date
14	Read PV Sensor Information
15	Read Output 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

Typically, these commands are used by advanced users of HART or the usage of these commands is embedded within the DD files. With the use of the HART universal commands, device variables and dynamic variables are accessible. Device and dynamic variables are defined later. For further understanding of the format and function of the HART Universal Commands please refer to HART protocol documentation.

Device-specific commands are mainly for accessing many of the M2000 data parameters, including configuration, identity and diagnostic parameters. Much of the data accessible with device specific commands is accessed through the use of the DD files. The DD files provide all the necessary information for data management within the M2000. Installing and using the DD files in the applications host is the most convenient method for communicating to the M2000 over HART.

Using both the HART universal commands and device-specific commands allows for complete access to the M2000 parameters, including the ability to read or write M2000 parameters. The Data Management section defines the M2000 data and the associated HART command.

Device Variables

There are thirteen device variables as defined in the table below. Device variables can be accessed with universal command #9:

No.	Name	Classification	Units
0	Flow Rate	66	USER UNITS
1	Flow Velocity	67	m/s
2	T1/T+	68	USER UNITS
3	T2/T-	68	USER UNITS
4	T3/Tn	68	USER UNITS
5	Relative Flow Rate	81	%
6	Flow Rate	66	m^3/s
7	T1/T+	68	m^3
8	T2/T-	68	m^3
9	T3/Tn	68	m^3
10	PS	68	m^3
11	PS	68	USER UNITS
12	Power Loss Totalizer	70	Seconds

Dynamic Variables

Four dynamic variables are supported. Dynamic variables can be accessed with universal command #3. The assignment to dynamic variables is fixed and is defined in the table below.

No.	Name	Classification	Units
PV – Primary Variable	Flow Rate	66	USER UNITS
SV – Secondary Variable	T1/T+	68	USER UNITS
TV – Tertiary Variable	T2/T-	68	USER UNITS
FV – Fourth Variable	T3/Tn	68	USER UNITS

Device Status

HART defined device status information is available. Only those bits supported by the M2000 are listed in the table below. All other bits will be set to 0.

Bit	Description	Comments
0	PV Out of Range	Set if the primary variable is exceeding the sensor limits
1	Non PV Out of Range	Not Used
2	PV Output Saturated	Set if the primary variables analog loop current exceeds the limits of 4 mA and 20 mA.
3	PV Output Fixed	Set if the daughterboard is configured for multi-drop mode and the polling address is non-zero. When set current is fixed at 4 mA.
4	More Status Available	Set when alarm or failure is detected. Refer to command #48 for further information.
5	Device Reset	Set at power-up or on reset of the meter
6	Configuration Changed	Indicates when M2000 configuration has been changed. This bit can be cleared by Universal command #38.
7	Field Device Malfunction	Set when there is failure of the M2000 that prevents flow measurement.

Meter Status Register

Meter status is a status variable accessible over MODBUS that identifies the error state of the M2000. The HART daughterboard shall query this MODBUS register and report status through the usage of Universal Command #9 and #48. Below is a table that defines the meter status register. Unused bits are not listed in the table and are always set to 0.

Bit	Description
0	Detector Error
1	Empty Pipe Error
2	Full Scale Flow Error
3	Totalizer Rollover Error
4	Totalizer Rollover Status
5	Flow Simulation Status
6	Reserved
7	ADC Interrupt Error
8	ADC Range Error

Universal Command #0 – Read Unique Identifier

Command #0 has particular status information that requires definition. Below is a table that defines byte 16 of the response, Extended Field Device Status.

Bit	Description
0	Maintenance Required - Set when Meter Status bits 0, 1, 3, 4, 7, or 8 are set
1	Alert State - Set when Meter Status bits 2,5,or 6 are set

Universal Command #9 – Read Device Variables with Status

Command #9 has particular status information that requires definition. Below is a table that defines the device variable status byte coding. Only those defined in the table below can be observed.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Description
Process Data Status		Limit Status		Reserved – Always 0				
1	1	X	X	0	0	0	0	Good Data – M2000 is without error and all measurements are proper
0	0	X	X	0	0	0	0	Bad Data – M2000 is with error and measurements are not relating to actual flow

Bad data is considered when "additional device status" indicates an error condition. Refer to Universal Command #48. Warning conditions are considered good data.

Universal Command #48 – Read Additional Device Status

Command #48 returns 8 bytes of data that is specific to the M2000 HART daughterboard. The following table defines the status information for the reply to this command. Unused bits are not listed in the table and are always set to 0. Some of these bits influence the device status bits shown in the Device Status Bits Set column:

Byte	Bit	Description	Class	Device Status Bits Set
0	0	Detector Error	Error	4, 7
	1	Empty Pipe Error	Error	4, 7
	2	Full Scale Flow Error	Warning	0, 4
	3	Totalizer Rollover Error	Error	4, 7
	4	Totalizer Rollover Status	Warning	4
	5	Flow Simulation Status	Warning	4
	6	Pulse Synchronization Warning	Warning	4
	7	ADC Interrupt Error	Error	4, 7
1	0	ADC Range Error	Error	4, 7
4	0	Internal Communication Failure	Error	4, 7
	1	Configuration Error	Warning	4

The "internal communication failure" status bit, byte 4 bit 0, is set when MODBUS communication between the meter and the daughterboard have failed. Verify that the diagnostic, bi-color LED on the daughterboard is blinking both status indicators (red and green). If both colors are not observed, then power cycle the meter.

The "Configuration Error" status bit, byte 4 bit 1, is set when a mismatch between the meter's configuration and that reported over the HART protocol. Generally, this implies the intended value for the parameter was invalid. Below are some examples for how this bit could be set.

Example #1: Intended value is invalid

If the configured function for output #1 is set to 24V DC supply, the output type has to be normally open. If the intended value for the output type is normally closed, the configuration error flag will be set indicating the intended value was invalid due to its dependency on the function of the output.

Example #2: Writing to a secured meter

If connected to a secured meter, and you try to change a parameter after the login timer has expired, the "Configuration Error" indicates that the parameter image between HART and the M2000 is not equal.

ADDITIONAL FEATURES

Security

The M2000 Security feature, when enabled, also applies to remote access (that is, HART). Refer to the M2000 IOM for information on how to configure security.

Remote reads are always allowed regardless of security rights. Remote writes using the HART protocol are not allowed unless the user has remotely logged into the meter with the appropriate access level. The remote login pins are the same as the login pins that are used on the M2000 display.

Remote writes are not allowed if a user is actively navigating the menus at the display. Remote login expires five minutes after the last remote write. To remotely logout more quickly, do one of the following:

- Write an invalid pin to the Remote Login parameter.

- Send a remote logoff action request to the Service parameter.

Access levels for writable parameters are defined in the Data Management section.

The security status of the meter is accessible using device specific command #243. The response data is defined in the following table:

Bit	Definition
0	If set indicates meter is secured
1	If set indicates menu access level is NONE
2	If set indicates menu access level is USER
3	If set indicates menu access level is SERVICE
4	If set indicates menu access level is ADMIN
5	If set indicates menu access level is FACTORY
6	Not Defined
7	Not Defined
8	If set indicates remote access level is NONE
9	If set indicates remote access level is USER
10	If set indicates remote access level is SERVICE
11	If set indicates remote access level is ADMIN
12	If set indicates remote access level is FACTORY
13	Not Defined
14	Not Defined
15	Not Defined

Fixed Current Mode (Multi-Drop)

The M2000 provides an active analog output. This means it is the source of the analog signal. When placing the meter into fixed current mode, the M2000 shall fix the output current to 4 mA regardless of the primary variables value (that is, Flow Rate). During this condition the device status bit 3 (PV Analog Channel Fixed) is set.

To place the meter into fixed current mode, the polling address must be non-zero. This is a HART specific parameter. The polling address is not accessible within the M2000 menu structure. Changing this value when the meter is secured is not prevented. With reference to the HART DD, this parameter is located at *Configuration > Hart > Hart Output > Poll Addr*.

Each meter to be commissioned for multi-drop should exercise the following procedure. The default polling address for all HART daughterboards is 0.

1. Turn off power to all meters to be commissioned for HART multi-drop mode.

   IMPORTANT
   As a result of the M2000 having an active analog output, only five M2000s can be configured for multi-drop mode within the same network.

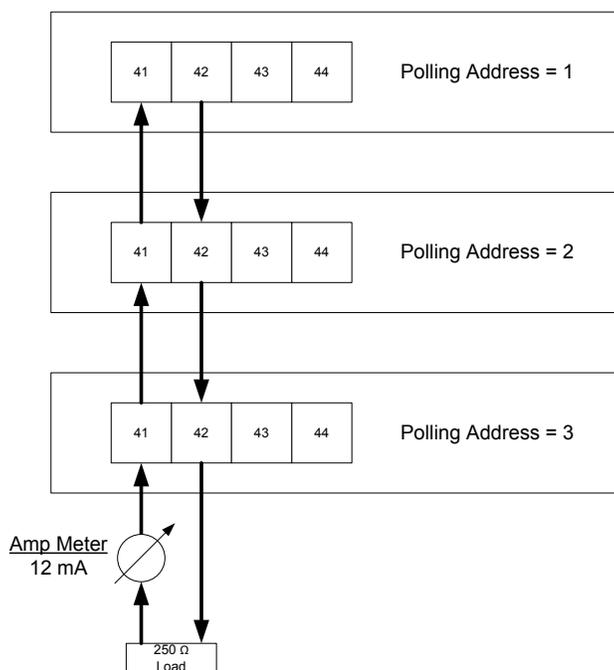2. Wire the meters in parallel as shown in *Figure 5*:

Figure 5: Wiring Meters in Parallel

3. Turn on power to one of the meters.
4. Change the polling address to desired address. As a suggestion, it may be desirable to change the installation data while changing the polling address. Installation data can provide additional means for identifying the meter on the HART network.
5. Repeat this procedure until all nodes on the HART multi-drop network are configured with a non-zero and unique polling address.

IMPORTANT

The analog output alarm mode has no effect while the meter is configured for multi-drop mode.

Command Action Request

There are several remote actions that can be requested of the meter over HART. Below is a table that defines the remote actions that can be taken including the level of security required if the meter is secured.

To issue an action to the meter, access the command action parameter at *Configuration > M2000 > Advanced > Miscellaneous > Service*.

Value	Security	Description
6	NONE	Save Totalizers to EEPROM
7	SERVICE	Clear T1 or T+
8	SERVICE	Clear T2 or T-
9	SERVICE	Clear T3 or Tn
10	SERVICE	Clear All Totalizers
11	SERVICE	Clear Port A Diagnostics
12	SERVICE	Clear Port B Diagnostics
13	SERVICE	Clear All Error Counts
21	SERVICE	Clear Power Off Totalizer
23	SERVICE	Remote Reset (power cycle)
27	SERVICE	Reset Batch Amount
28	NONE	Logoff Remote
—	—	No Action

Empty Pipe Calibration

Empty Pipe Calibration is an application embedded within the DD file that allows for remote calibration of empty pipe. Navigate to *Configuration > M2000 > Advanced > Empty Pipe* and select **Empty Pipe Calib** to start the application. Follow the on-screen instructions for further details.

- It may take up to 30 seconds for each pipe condition's reading to stabilize. During this time, the following message displays, "Wait while reading stabilizes."

- Executing the empty pipe calibration application will leave Empty Pipe enabled regardless of the state prior to execution.

Analog Output Calibration

Analog Output Calibration is an application embedded within the DD file that allows for remote configuration of the analog output. Navigate to *Configuration > M2000 > Advanced > Analog Output* and select **D/A Trim**. Follow the on-screen instructions for further details.

Do not exercise the D/A Trim application if meter is configured in multi-drop mode. The output current is fixed in multi-drop mode (that is, Polling address is non-zero).

This application uses the custom offsets. The deviation from 4 mA and 20 mA must be entered in terms of milliamperes. Recalibration will take effect once all offsets are configured and the application has completed.

Figure 6 is an example of a diagram for a setup intended to assist in calibrating the analog output.
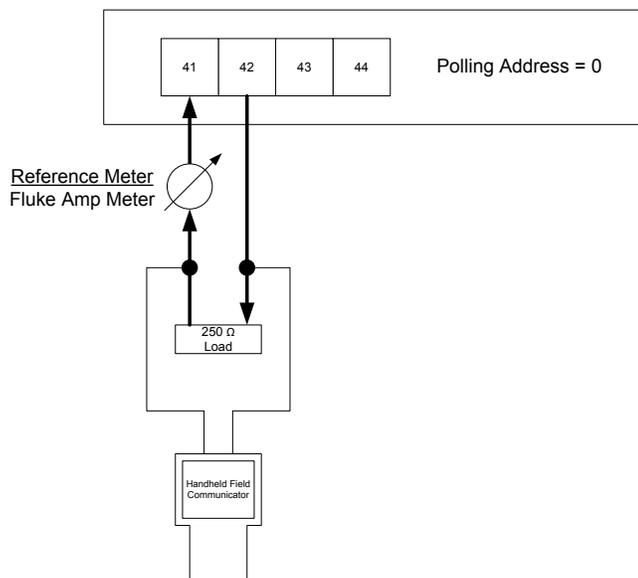

Figure 6: Setup to Assist in Calibrating Analog Output

DATA MANAGEMENT

Below is a table identifying all M2000 specific data that is accessible over HART. This table lists the HART Protocol commands used to access the data. This table also lists the security privileges and data types of the data. Typically the DD files handle all data access. Refer to the DD files for further information.

No.:	Write Security	Register Name	Register Type	HART Command Support (DS = Device Specific UN = Universal)
		Product Identification		
1	FIRMWARE	Product Code	UINT16	DS 130 (Read)
2	FIRMWARE	Product Name	UCHAR16[8]	DS 131 (Read)
3	FIRMWARE	Firmware Name	UCHAR16[16]	DS 132 (Read)
4	FACTORY	Application Version	UCHAR16[10]	DS 133 (Read)
5	FIRMWARE	Compile Date [MM:DD:YYYY]	UCHAR16[16]	DS 134 (Read)
6	FIRMWARE	Compile Time [HH:MM:SS]	UCHAR16[16]	DS 134 (Read)
7	FACTORY	PCB Serial Number	UCHAR16[5]	DS 141 (Read)
8	FIRMWARE	OTP Boot Checksum	UCHAR16[3]	DS 135 (Read)
9	FIRMWARE	Flash OS Checksum	UCHAR16[3]	DS 136 (Read)
10	FIRMWARE	Boot Version	UCHAR16[5]	DS 137 (Read)
11	FIRMWARE	Os Version	UCHAR16[4]	DS 138 (Read)
12	NONE	Daughterboard Product Type	UINT16	DS 139 (Read)
13	NONE	Daughterboard Major Version	UINT16	DS 140 (Read)
14	NONE	Daughterboard Minor Version	UINT16	DS 140 (Read)
15	NONE	Meter Tag Name	UCHAR16[17]	UN 20/22 (Read/Write)

No.:	Write Security	Register Name	Register Type	HART Command Support (DS = Device Specific UN = Universal)
		Meter Calibration		
16	ADMIN	Detector Diameter	UINT16	DS 150 (Read)
17	ADMIN	Detector Diameter Other [mm]	UINT16	DS 152 (Read)
18	ADMIN	Detector Factor	FLOAT32	DS 154 (Read)
19	ADMIN	Detector Offset [m/s]	FLOAT32	DS 156 (Read)
20	ADMIN	Amplifier Factor	FLOAT32	DS 158 (Read)
21	ADMIN	Detector Current [mA]	FLOAT32	DS 160 (Read)
22	SERVICE	Power Line Frequency [Hz]	UINT16	DS 162/163 (Read/Write)
23	ADMIN	Excitation Frequency [Hz]	UINT16	DS 164/165 (Read/Write)
24	SERVICE	Scale Factor [%]	FLOAT32	DS 166/167 (Read/Write)

Meter Measurement Settings				
No.:	**Write Security**	**Register Name**	**Register Type**	**HART Command Support (DS = Device Specific UN = Universal)**
25	USER	Flow Unit	UINT16	DS 175/176 (Read/Write)
26	USER	Volume Unit	UINT16	DS 177/178 (Read/Write)
27	USER	Unit Multiplier	UINT16	DS 179/180 (Read/Write)
28	USER	Full Scale Velocity [m/s]	FLOAT32	DS 181/182 (Read/Write)
29	USER	Full Scale Flow [User Units]	FLOAT32	DS 173/174 (Read/Write)
30	USER	Low Flow Cutoff [%]	FLOAT32	DS 183/184 (Read/Write)
31	USER	Flow Direction	UINT16	DS 185/186 (Read/Write)
32	USER	Damping Factor [s]	UINT16	DS 187/188 (Read/Write)

Digital Input				
No.:	**Write Security**	**Register Name**	**Register Type**	**HART Command Support (DS = Device Specific UN = Universal)**
33	SERVICE	Digital Input: Input Operation	UINT16	DS 190/191 (Read/Write)
34	FIRMWARE	Digital Input: Status	UINT16	DS 192 (Read)

Analog Output				
No.:	**Write Security**	**Register Name**	**Register Type**	**HART Command Support (DS = Device Specific UN = Universal)**
35	SERVICE	Analog Customer Offset 4 MA [A]	FLOAT32	DS 193/194 (Read/Write)
36	SERVICE	Analog Customer Offset 20 MA [A]	FLOAT32	DS 195/196 (Read/Write)
37	FIRMWARE	Analog Output Current [A]	FLOAT32	UN 2/3 - (Read /Read)
38	SERVICE	Alarm Mode	UINT16	DS 197 (Write)
39	NONE	Fixed Current Mode	FLOAT32	UN 6/7 (Read/Write)

Output #1				
No.:	**Write Security**	**Register Name**	**Register Type**	**HART Command Support (DS = Device Specific UN = Universal)**
40	SERVICE	Output #1: Pulses Per Unit [User Units]	FLOAT32	DS 200/201) Read/Write)
41	SERVICE	Output #1: Pulse Width [ms]	UINT16	DS 202/203 (Read/Write)
42	SERVICE	Output #1: Flow Alarm Minimum [%]	UINT16	DS 204/205 (Read/Write)
43	SERVICE	Output #1: Flow Alarm Maximum [%]	UINT16	DS 206/207 (Read/Write)
44	SERVICE	Output #1: Output Mode	UINT16	DS 208/209 (Read/Write)
45	SERVICE	Output #1: Output Operation	UINT16	DS 210/211 (Read/Write)

Output #2				
No.:	**Write Security**	**Register Name**	**Register Type**	**HART Command Support (DS = Device Specific UN = Universal)**
46	SERVICE	Output #2: Pulses Per Unit [User Units]	FLOAT32	DS 200/201 (Read/Write)
47	SERVICE	Output #2: Pulse Width [ms]	UINT16	DS 202/203 (Read/Write)
48	SERVICE	Output #2: Flow Alarm Minimum [%]	UINT16	DS 204/205 (Read/Write)
49	SERVICE	Output #2: Flow Alarm Maximum [%]	UINT16	DS 206/207 (Read/Write)
50	SERVICE	Output #2: Output Mode	UINT16	DS 208/209 (Read/Write)
51	SERVICE	Output #2: Output Operation	UINT16	DS 210/211 (Read/Write)

Output #3				
No.:	**Write Security**	**Register Name**	**Register Type**	**HART Command Support (DS = Device Specific UN = Universal)**
52	SERVICE	Output #3:Full Scale Frequency [Hz]	UINT16	DS 212/213 (Read/Write)
53	SERVICE	Output #3: Flow Alarm Minimum [%]	UINT16	DS 204/205 (Read/Write)
54	SERVICE	Output #3: Flow Alarm Maximum [%]	UINT16	DS 206/207 (Read/Write)
55	SERVICE	Output #3: Output Mode	UINT16	DS 208/209 (Read/Write)
56	SERVICE	Output #3: Hardware Select	UINT16	DS 214/215 (Read/Write)
57	SERVICE	Output #3: Output Operation	UINT16	DS 210/211 (Read/Write)

Output #4				
No.:	**Write Security**	**Register Name**	**Register Type**	**HART Command Support (DS = Device Specific UN = Universal)**
58	SERVICE	Output #4: Flow Alarm Minimum [%]	UINT16	DS 204/205 (Read/Write)
59	SERVICE	Output #4: Flow Alarm Maximum [%]	UINT16	DS 206/207 (Read/Write)
60	SERVICE	Output #4: Output Mode	UINT16	DS 208/209 Read/Write)
61	SERVICE	Output #4: Hardware Select	UINT16	DS 214/215 Read/Write)
62	SERVICE	Output #4: Output Operation	UINT16	DS 210/211 Read/Write)

Port A Diagnostic Counters				
No.:	**Write Security**	**Register Name**	**Register Type**	**HART Command Support (DS = Device Specific UN = Universal)**
63	FIRMWARE	Port A: Packets Processed	UINT16	DS 220 (Read)
64	FIRMWARE	Port A: Broadcast Packets	UINT16	DS 220 (Read)
65	FIRMWARE	Port A: CRC Errors	UINT16	DS 220 (Read)
66	FIRMWARE	Port A: Packets Received	UINT16	DS 220 (Read)
67	FIRMWARE	Port A: Packets Sent	UINT16	DS 220 (Read)
68	FIRMWARE	Port A: Parity Errors	UINT16	DS 220 (Read)
69	FIRMWARE	Port A: Framing Errors	UINT16	DS 220 (Read)
70	FIRMWARE	Port A: Overrun Errors	UINT16	DS 220 (Read)
71	FIRMWARE	Port A: Break Detects	UINT16	DS 220 (Read)

Port B Diagnostic Counters				
No.:	**Write Security**	**Register Name**	**Register Type**	**HART Command Support (DS = Device Specific UN = Universal)**
72	FIRMWARE	Port B: Packets Processed	UINT16	DS 221 (Read)
73	FIRMWARE	Port B: Broadcast Packets	UINT16	DS 221 (Read)
74	FIRMWARE	Port B: CRC Errors	UINT16	DS 221 (Read)
75	FIRMWARE	Port B: Packets Received	UINT16	DS 221 (Read)
76	FIRMWARE	Port B: Packets Sent	UINT16	DS 221 (Read)
77	FIRMWARE	Port B: Parity Errors	UINT16	DS 221 (Read)
78	FIRMWARE	Port B: Framing Errors	UINT16	DS 221 (Read)
79	FIRMWARE	Port B: Overrun Errors	UINT16	DS 221 (Read)
80	FIRMWARE	Port B: Break Detects	UINT16	DS 221 (Read)

Measurements				
No.:	Write Security	Register Name	Register Type	HART Command Support (DS = Device Specific UN = Universal)
81	FIRMWARE	T1 / T+ [m^3]	FLOAT32	UN 9 (Read)
82	FIRMWARE	T1 / T+ [User Units]	FLOAT32	UN 3/9 (Read)
83	FIRMWARE	T2 / T- [m^3]	FLOAT32	UN 9 (Read)
84	FIRMWARE	T2 / T- [User Units]	FLOAT32	UN 3/9 (Read)
85	FIRMWARE	T3 / TN [m^3]	FLOAT32	UN 9 (Read)
86	FIRMWARE	T3 / TN [User Units]	FLOAT32	UN 3/9 (Read)
87	FIRMWARE	T1 / T+ Rollover Counter	UINT16	DS 239 (Read)
88	FIRMWARE	T2 / T- Rollover Counter	UINT16	DS 239 (Read)
89	FIRMWARE	Flow Velocity [m/s]	FLOAT32	UN 9 (Read)
90	FIRMWARE	Flow Rate [m^3/s]	FLOAT32	UN 9 (Read)
91	FIRMWARE	Flow Rate [User Units]	FLOAT32	UN 1/3/9 (Read)
92	FIRMWARE	Relative Flow Rate [%]	FLOAT32	UN 2/9 (Read)
93	FIRMWARE	Preset Batch Totalizer [m^3]	FLOAT32	UN 9 (Read)
94	FIRMWARE	Preset Batch Totalizer [User Units]	FLOAT32	UN 9 (Read)
95	FIRMWARE	Flow Direction	UINT16	DS 239 (Read)

Meter Diagnostic Counters				
No.:	Write Security	Register Name	Register Type	HART Command Support (DS = Device Specific UN = Universal)
96	FIRMWARE	Power Up Counter	UINT16	DS 222 (Read)
97	FIRMWARE	Detector Error Counter	UINT16	DS 222 (Read)
98	FIRMWARE	Empty Pipe Counter	UINT16	DS 222 (Read)
99	FIRMWARE	Full Scale Counter	UINT16	DS 222 (Read)
100	FIRMWARE	Totalizer Overflow Counter	UINT16	DS 222 (Read)
101	FIRMWARE	Pulse Sync Counter	UINT16	DS 222 (Read)
102	FIRMWARE	ADC Interrupt Counter	UINT16	DS 222 (Read)
103	FIRMWARE	ADC Range Counter	UINT16	DS 222 (Read)
104	FIRMWARE	WDT Resets Counter	UINT16	DS 222 (Read)
105	FIRMWARE	WDT Location	UINT16	DS 222 (Read)
106	FIRMWARE	System Error #	UINT16	DS 222 (Read)
107	FIRMWARE	Meter Status	UINT16	UN 48 (Read)
108	FIRMWARE	Action Request Overflows	UINT16	DS 222 (Read)
109	FIRMWARE	Measurement Overflows	UINT16	DS 222 (Read)
110	FIRMWARE	Remote Resets	UINT16	DS 222 (Read)

Miscellaneous				
No.:	Write Security	Register Name	Register Type	HART Command Support (DS = Device Specific UN = Universal)
111	FIRMWARE	Power Loss Totalizer [seconds]	UINT32	UN 9 (Read)
112	USER	Display Backlight Mode	UINT16	DS 225/226 (Read/Write)
113	SERVICE	Preset Batch Amount [m^3]	FLOAT32	DS 227/228 (Read/Write)
114	USER	Menu Language Setting	UINT16	DS 229/230 (Read/Write)
115	NONE	Port B Extended Address	UINT16	UN 6/7 (Read/Write)

No.:	Write Security	Register Name	Register Type	HART Command Support (DS = Device Specific UN = Universal)
		Empty Pipe		
116	ADMIN	Empty Pipe Calibration [Volts]	FLOAT32	DS 233/234 (Read/Write)
117	FIRMWARE	Empty Pipe Measure Value [Volts]	FLOAT32	DS 237 (Read)
118	ADMIN	Full Pipe Calibration [Volts]	FLOAT32	DS 235/236 (Read/Write)
119	SERVICE	Empty Pipe Mode	UINT16	DS 231/232 (Read/Write)

No.:	Write Security	Register Name	Register Type	HART Command Support (DS = Device Specific UN = Universal)
		Control Commands		
120	NONE	Command Action Request	UINT16	DS 244 (Write)
121	SERVICE	Flow Simulation	SINT16	DS 240/241 (Read/Write)

No.:	Write Security	Register Name	Register Type	HART Command Support (DS = Device Specific UN = Universal)
		Security		
122	FIRMWARE	Security Status	UINT16	DS 243 (Read)
123	FIRMWARE	Random Value	UINT32	DS 247 (Read)
124	NONE	Remote Login	UINT32	DS 242 (Write)

DEVICE DESCRIPTION

The device descriptions, located on *www.hartcomm.org* under *Product Catalog > All Products > M2000*, can be installed into host systems such as the Emerson 475 Field Communicator.

Periodically, the device description monitors the attached device for non-zero status codes (universal command #48). These codes inform the user of the status of the M2000. If the status of the M2000 does not clear, these informational dialogs will continue to be presented. To reduce the amount of dialogs, correct the state of the meter or configure the host to ignore these non-zero status codes.

In addition, performing changes to the meter's configuration generates a "configuration changed" status dialog. This bit must be manually cleared to prevent future display of this dialog. This can be done within the DD file by navigating to *M2000>Advanced>Miscellaneous>Service>Reset Config Change* or separately issuing universal command #38.

TROUBLESHOOTING

Symptom	Solution
Using DD files, not able to change values with the handheld	—
Unable to communicate with the meter over HART	Check the wiring. Verify load is above minimum required resistance of 230 Ohms. Verify installation requirements are met (firmware v1.10 or later, PCB serial number 1911xxxx or later). Verify the loop current is within range, especially if configured for multi-drop.
Unable to find the calibration methods for empty pipe or the analog output	These methods only are visible when the meter is unsecured or when properly logged into a secured meter. For secured meters, these methods require SERVICE level authorization.
The configuration error flag is set	To eliminate this condition and any concerns regarding this condition, it is advisable to reset the M2000. This can be done by issuing the RESET command in the *Advanced>Miscellaneous>Service* menu. Shortly thereafter the M2000 resets and the daughterboard image updates to match the M2000 image. Then re-verify all configuration data is as desired.
My analog current is always 4 mA	Verify the meter is not configured for multi-drop mode. A meter configured for multi-drop mode will have a non-zero polling address. Set the polling address to zero. Verify flow rate is non-zero. Flow rate is directly proportional to the analog current.

COMPLIANCE

HART REGISTERED

Certificate of Registration
HCF Verified

Badger Meter Europe	M2000
Manufacturer	Product Name / Model Number
0000BD	BD02
Manufacturer ID (Hex)	Expanded Device Type (Hex)
7	01
HART Protocol Revision	Device Revision
01	0E
Hardware Revision	Software Revision
10/30/2011	HCF
Test Date	Verification Method

The above product has successfully completed the validation process and meets the requirements to be "HART REGISTERED"

Registration Number: L2-06-1000-130   Registration Issue Date: Nov. 30, 2011   HCF QA Approval:

HART
COMMUNICATION FOUNDATION

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