CamCor™
Modbus Protocol Manual

Manual No. 50284150, Rev. 01

Important Safety Information

Symbols and Terms Used in this Manual

WARNING: This symbol identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss.

Important **Indicates actions or procedures which may affect instrument operation or may lead to an instrument response which is not planned.**

Symbols Marked on Equipment

Attention! Refer to manual

Protective (earth) ground

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Section 1—Modbus Protocol

This manual is for use with maintenance board firmware version 3.05.

Introduction

The communications protocol for CamCor CT Series and PRO Series is in accordance with Modicon, Inc. RTU Mode Modbus as described in *Modicon Modbus Protocol Reference Guide*, PI-MBUS-300 Rev. J, June 1996. All registers are implemented as 4X or holding registers. Reading of registers is implemented via Function Code (03H) (Read Holding Registers). Writing to registers is implemented via Function Code 16 (10H) (Preset Multiple Registers).

Communications

CamCor's Modbus communications allow host devices (PC, sequencer, etc.) to connect to slave devices via RS-485 connection. Modbus communication is based on the Master-Slave system, where host devices are designated as "master" and the Coriolis meter(s) is designated as "slave." The system is Modbus-protocol compliant. Contact the host device service provider for assistance with host software.

Caution **If the CamCor meter is installed in a control system, place the control system in manual operating mode before making changes to the CamCor meter configuration. Failure to do so may cause erratic and undesired responses from valves or other devices controlled by the system.**

Consult Table 1.1—Communication Specifications below for CamCor Coriolis meter communication specifications.

Table 1.1—Communication Specifications

Specification	Description
Communication System	RS-485 Multidrop-compliant Master/Slave System
Full-duplex/Half-duplex	Half-duplex
Baud Rate	9600, 19200, 38400 (shipped from Factory at 9600)
Slave Address	1
Data Bits	8
Parity	Odd
Stop Bit	1 Bit
Flow Control	None
Communication Timeout	200 ms
Transmission Length (Maximum)	0.75 miles (1.2 km) (depending on service environment)
Number of Devices on Each Node (Maximum)	32

Optional Modbus Communication Baud Rate Setting

A CamCor meter purchased with the Modbus Communication option is shipped with the baud rate set to 9600. The baud rate is adjustable using the SW3-1 and SW3-2 switches on the maintenance board (Figure 1.1, Page 6) located in the transmitter body. (For more information about maintenance board access and switch locations, see the CamCor Hardware Manual.) See Table 1.2—Baud Rate Switch Settings below to identify baud rate settings based on switch position:

Table 1.2—Baud Rate Switch Settings

Baud Rate	SW3-1 Setting	SW3-2 Setting
9600	Off	Off
19200	On	Off
38400	Off	On

Baud Rate	SW3-1 Setting	SW3-2 Setting
Do Not Set	On	On

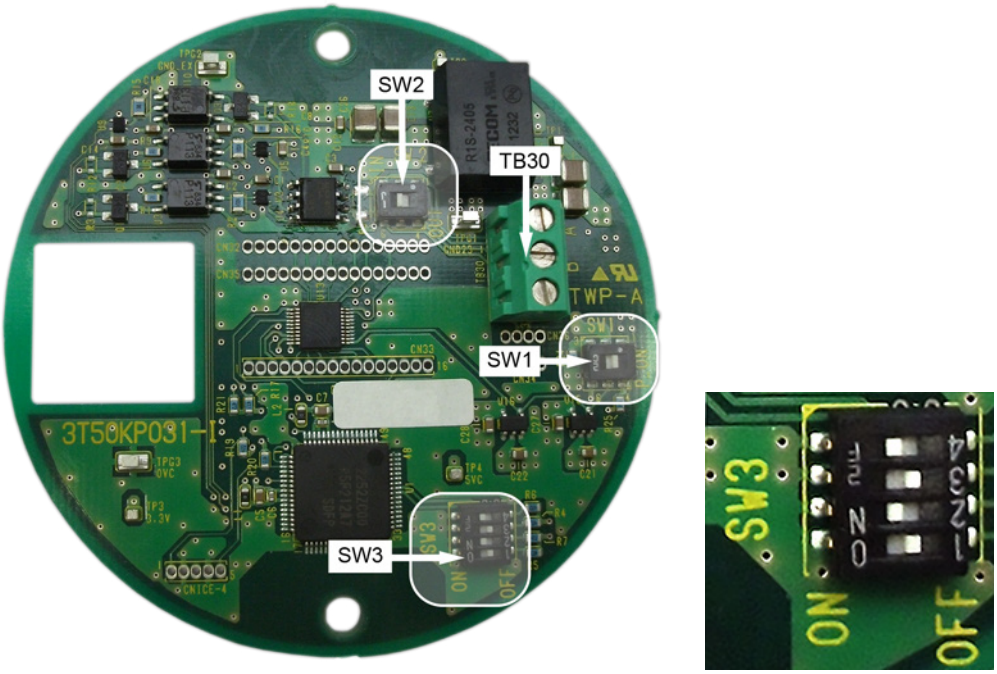

Figure 1.1—Maintenance board switch locations and on/off positions

Standard Modbus Function Codes

The Modbus functions supported by CamCor Coriolis meters are as follows:

Function Code	Description
03 (03H)	Read Holding Registers
16 (10H)	Preset Multiple Registers

Exception Response

If the device receives an unsupported function code in a query message, the device responds with an exception message. For example, if the query message contains Function Code "11," an unrecognized code, the function code on the response message will be changed to the unexpected value code and "0x80," or "0x91" in this case (original Function Code + 80). The data value contains the exception code 0x02.

Slave Addresses

Allowed Slave Addresses

Slave devices are shipped from the factory with a slave address of "1." Typically, each slave device should be assigned a unique slave address. Allowed slave addresses range from 1 to 255. Slave Address "0" broadcasts messages to all slave devices and is only available for Function Code 16. If the broadcast message contains valid data, the device is updated and no response is sent to the host system. For information about invalid message handling, see Exception Response.

Resetting an Unknown Slave Address

If you do not know the slave address of a device to be connected to the CamCor meter, you can reset it using the following procedure:

WARNING **Do not use this query while more than one slave is connected. In a multipoint drop connection setup, all connected slaves share the same address; therefore, resetting the slave address will assign the same address to all slave devices.**

1. Establish a point-to-point connection between the slave device and the CamCor meter.
2. Send the following information:
   - Broadcast slave address 0 (0x00)
   - Function Code 16 (0x10)
   - Register 167 (0x00A7)
   - Data value to be written (in this example, Slave Address 1 = 0x0001)
   - Data validity check—CRC (0xB1FB)

   The entire query string appears as follows:

   0x001000A70001B1FB

Note The “0x” prefix is used only with the first 4-digit character string, and is dropped from the remaining character strings. See Unsigned Short Integer, Page 9 for more information.

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Section 2—Data Types

Data Formats

Various data types are implemented in the CamCor CT Series and PRO Series Coriolis meters. The following table lists the formats and the numbers of bytes and registers associated with each type.

Table 2.1—CamCor Data Formats

Data Format	Data Type	Byte Count	Register Count
16-bit	Floating Point (FP)	4	2
	Unsigned Short Integer (U8)	2	1
	Unsigned Integer (U16)	2	1
	Unsigned Long Integer (U32)	4	2
Packed ASCII	Packed ASCII (PAC)	See Packed ASCII below	

The word ordering for multiple register data types, such as floating-point numbers or long integers, places the most significant word first in the message.

Unsigned Short Integer

The protocol for the CamCor Coriolis meters is based on a 16-bit data format. The value for "U8–Unsigned Short Integer" is appended with 0x00. For example, if the value stored on the device is 125 (0x7D), the Standard Modbus Function Code 3 response is "0x007D."

Packed ASCII

On CamCor meters, Packed ASCII uses three bytes to store four characters. For example, character string "ABCD" is stored as "0x0420C4" in Packed ASCII.

Table 2.2—CamCor Packed ASCII Code

Data Format	Data Appearance			
Byte	0x04	0x20	0xC4	
Bit	0 0 0 0 0 1	0 0 0 0 1 0	0 0 0 0 1 1	0 0 0 1 0 0
Character*	A(1)	B(2)	C(3)	D(4)

**The value inside parentheses is the Packed ASCII Code.*

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Section 3—CamCor Modbus Register Maps

Using CamCor Modbus Maps

Access Types

Each register has an access type as described in the table below:

Access Type	Description
Read Only (RO)	Register can only be read
Read/Write (RW)	Register can be read and written

Note Some RW registers may return a “0” for the read function.

CamCor-Specific Modbus Protocol Constraints

Modbus protocol, as applied to CamCor Coriolis meters, has the following constraints:

- Maximum data length for any message (read or write) is 64 bytes (32 register counts)
- Maximum of 18 parameters can be updated/reset in 1 second
- Parameters with several register types (U32, PAC, FP) must be updated using a single Function Code 16 message
- A minimum 2.5 second wait time between sending Function Code 16 commands is required

Note Attempting to update individual register types separately will return a “normal” response, but will not update the value displayed on the device.

Updating Intervals

CamCor meters are synchronized to update Modbus readings every 1080 ms. Sending a read query of less than 1080 ms may result in stale data, since the reading will not be updated before the query is sent. Therefore, establish a read query time of greater than 1080 ms to ensure updated information is returned.

Modbus Registers

Note Register numbers in the tables do not necessarily appear in consecutive numerical order. Non-consecutive numbers in the same table are denoted by a darkened line between the non-consecutive registers (decimal).

Device and System Information

Register (Decimal)	Register (Hex)	Description	Default	Data Type	Data Range	Access
Device Information						
0–7		Reserved				
Firmware Versions						
174	00AE	Main CPU Firmware Version		U16		RO
175	00AF	LCD Board Firmware Version				
176	00B0	I/O Board Firmware Version				
177	00B1	Maintenance Board Firmware Version				

Alarm Status Information

Register (Decimal)	Register (Hex)	Description	Default	Data Type	Data Range	Access
128	0080	Output Saturation Alarm Status		U8	0 = Off 1 = On	RO
129	0081	Sensor Failure Alarm Status				
130	0082	Transmitter Failure Alarm Status				
131	0083	Parameter Error Alarm Status				
132	0084	Calibration Failure Alarm Status				
133	0085	Slug Flow Alarm Status				
134	0086	Transmitter Alarm Status				
135	0087	Output Override Status				
136	0088	Calibration in Progress				
326	0146	Left Pickoff (LPO) Connect Status		U8	0 = Not Found 1 = Found	RO
327	0147	Right Pickoff (RPO) Connect Status				
328	0148	Resistance 1 Connection Status				
329	0149	Resistance 2 Connection Status				
330	014A	Resistance 3 Connection Status				
331	014B	Sensor Connect Status				
332	014C	Maintenance Status		U8	0 = Normal Operation 1 = Maintenace Mode	RO
333	014D	Resistance Connection		U8	0 = 2 wires (PRO Series) 1 = 3 wires (CT Series)	RO
334	014E	Digital Signal Processing (DSP) Parameter Error		U8	0 = Normal 1 = Error	RO
335	014F	Internal Communication: Short Span Error		U8	0 = Normal 1 = Communication Error	RO
336	0150	LPO Overflow Status		U8	0 = Normal 1 = Overflow	RO
337	0151	RPO Overflow Status				
338	0152	CPU Reset Status		U8	0 = More than 10 seconds after reset 1 = Within 10 seconds of reset	RO
339	0153	DSP Reset Status				
340	0154	Internal Communication: Long Span Error		U8	0 = Normal 1 = Communication Error	RO
341	0155	Internal Communication Overrun Error				
342		Reserved				

Communications Alarm Counter

Register (Decimal)	Register (Hex)	Description	Default	Data Type	Data Range	Access
181	00B5	Slave Address Mismatch Counter		U16		RO
182	00B6	Undefined Function Counter	0	U16		RO
183	00B7	Improper Usage of Broadcast Counter				
184	00B8	Data Count Overflow Counter				
185–187		Reserved				

Register (Decimal)	Register (Hex)	Description	Default	Data Type	Data Range	Access
188	00BC	CRC Mismatch Counter	0	U16		RO
189	00BD	Invalid Data Write Counter				
190	00BE	Communication Timeout Counter				
191	00BF	Internal Communication Error Counter				
192–196		Reserved				

Device, Sensor and Slave Address Configuration

Register (Decimal)	Register (Hex)	Description	Default	Data Type	Data Range	Access
Device						
8	0008	Device Identification Number		U32	0 – 1677215	RW
10	000A	Message		PAC	24 bytes (32 characters)	RW
22	0016	Tag Number		PAC	6 bytes (8 characters)	RW
25	0019	Description		PAC	12 bytes (16 characters)	RW
31	001F	Day (DD)		U8	1 – 31	RW
32	0020	Month (MM)		U8	1 – 12	RW
33	0021	Year (YY)		U8	00 – 99	RW
34	0022	Sensor Serial Number		U32	0 – 1677215	RW
36	0024	Manufacture Number				
Sensor						
92	005C	Flange Type	see Table 4.2—Flange Types and Sensor Materials	U8		RO
93	005D	Sensor Type <Character String>		PAC	6 bytes (8 characters)	RW
96	0060	Sensor Material	see Table 4.2—Flange Types and Sensor Materials	U8		RW
127	007F	Sensor Type		U8	0x00 = CT Series 0x01 = Pro Series	RO
Slave Address						
167	00A7	Slave Address	1	U8	1 – 255	RW

Damping Time Configuration

Register (Decimal)	Register (Hex)	Description	Default	Data Type	Data Range	Access
62	003E	Mass Flow Rate Damping Time (sec.)		FP	0.0 – 200.0	RW
64	0040	Density Damping Time (sec.)				
66	0042	Temperature Damping Time (sec.)				
68	0044	Analog Output 1 Damping Time (sec.)				
70	0046	Analog Output 2 Damping Time (sec.)				

Output Configuration

Caution **If the CamCor meter is installed in a control system, place the control system in manual operating mode before making changes to the CamCor meter configuration. Failure to do so may cause erratic and undesired responses from valves or other devices controlled by the system.**

Register (Decimal)	Register (Hex)	Description	Default	Data Type	Data Range	Access
Analog Outputs						
42	002A	Analog Output 1 Configuration	4	U8	0 = Mass Flow 1 = Temperature 3 = Density 4 = Volume Flow 6 = Drive Output	RW
43	002B	Analog Output 2 Configuration	3			
46	002E	Analog Output Maximum Mass Flow Rate	see Table 3.1—Configured Units, page 16, then see Table 4.1—Units, page 23	FP	-9999999 to 9999999	RW
48	0030	Analog Output Minimum Mass Flow Rate				RO
50	0032	Analog Output Maximum Volume Flow Rate				RW
52	0034	Analog Output Minimum Volume Flow Rate				RO
54	0036	Analog Output Maximum Density				RW
56	0038	Analog Output Minimum Density				RW
58	003A	Analog Output Maximum Temperature				RW
60	003C	Analog Output Minimum Temperature				RW
80	0050	Analog Output 1 Override Value Setting (mA)		FP	2.40 – 21.60	RW
82	0052	Analog Output 2 Override Value Setting (mA)				
84	0054	Analog Output 1 Adjustment Value for 4 mA (Reading Value) (mA)		FP	2.40 – 5.60	RW
86	0056	Analog Output 2 Adjustment Value for 4 mA (Reading Value) (mA)				
88	0058	Analog Output 1 Adjustment Value for 20 mA (Reading Value) (mA)		FP	18.40 – 21.60	RW
90	005A	Analog Output 2 Adjustment Value for 20 mA (Reading Value) (mA)				
159	009F	Analog Output 1 Low Cutoff (%)		FP	0.0 – 10.0%	RW
161	00A1	Analog Output 2 Low Cutoff (%)				

Register (Decimal)	Register (Hex)	Description	Default	Data Type	Data Range	Access
Pulse Outputs						
203	00CB	Pulse Operation Mode	0	U8	0 = Weight (Scaling) 1 = Frequency	RW
44	002C	Pulse Output 1 Assignment	1	U8	0 = Mass Flow 1 = Volume Flow	RW
45	002D	Pulse Output 2 Assignment				
104	0068	Pulse Output 1 Frequency Rate Factor Unit	see Table 4.1—Units, page 23	U8		RO
105	0069	Pulse Output 1 Frequency Factor (Hz)		FP	0.10 – 10000.00	RW
107	006B	Pulse Output 1 Flow Rate Factor	see Table 4.1—Units, page 23	FP		RW
109	006D	Volume Flow Rate Compensation Coefficient		FP	–999999 to 999999	RW
111	006F	Pulse Output 2 Frequency Rate Factor Unit	see Table 4.1—Units, page 23	U8		RO
112	0070	Pulse Output 2 Frequency Factor (Hz)		FP	0.10 – 10000.00	RW
114	0072	Pulse Output 2 Flow Rate Factor	see Table 4.1—Units, page 23	FP		RW
116	0074	Pulse Output 1 Override Frequency Setting (Hz)	10000	FP	0.1 – 11000.0	RW
118	0076	Pulse Output 1 Pulse Count	0	FP	0 – 99999999	RW
120	0078	Pulse Output 2 Override Frequency Setting (Hz)	10000	FP	0.1 – 11000.0	RW
122	007A	Pulse Output 2 Output Pulse Count	0	FP	0 – 99999999	RW
124	007C	Flow 1 Total Control		U8	1 = Start 2 = Stop 3 = Reset	RW
125	007D	Flow 2 Total Control				
126	007E	Status Output Override		U8	0 = N.C. 1 = N.O. 3 = Stop	RW
163	00A3	Pulse Output 1 Low Cutoff (%)		FP	0.0 – 10.0%	
165	00A5	Pulse Output 2 Low Cutoff (%)				
197	00C5	Pulse Output 1 Scaling Factor Unit	see Table 3.1—Configured Units, page 16, then see Table 4.1—Units, page 23	U8		RO
198	00C6	Pulse Output 1 Scaling Factor		FP		RW
200	00C8	Pulse Output 2 Scaling Factor Unit		U8		RO
201	00C9	Pulse Output 2 Scaling Factor		FP		RW
343	0157	Double Pulse Mode Option*	0	U8	0 = Off 1 = Double Pulse with 90° 2 = Double Pulse with -90° 3 = Double Pulse with 180°	RW

** When the Double Pulse Mode (Decimal Register 343) is enabled [in any mode other than "0 (Off)"], the Pulse Output 2 Setting (Decimal Register 45) cannot be changed. To change the Pulse Output 2 Setting, you must change the Double Pulse Mode to "0 (Off)" and then change the Pulse Output 2 Setting.*

Table 3.1—Configured Units

Register (Decimal)	Register (Hex)	Description	Units	Data Type	Data Range	Access
38	0026	Mass Flow Rate Unit	see Table 4.1—Units, page 23	U8		RW
39	0027	Volume Flow Rate Unit				
40	0028	Density Unit				
41	0029	Temperature Unit				

Density Configuration

Register (Decimal)	Register (Hex)	Description	Default	Data Type	Data Range	Access
154	009A	Density Override Setting		U8	0 = Disable 1 = Enable	RW
155	009B	Density Override Value (g/ml)		FP	0.0000 – 5.0000	RW
168	00A8	Density Compensation	0	U8	0 = Disable 1 = Enable	RW
169	00A9	Base Temperature (°C)		FP	–999.99 to 999.99	RW
171	00AB	ExpASMEon Factor	0.00024	FP	–999999 to 999999	RW

Alarm/Status Configuration

Register (Decimal)	Register (Hex)	Description	Default	Data Type	Data Range	Access
137	0089	Analog Output Error Setting	1	U8	0 = Upscale 1 = Downscale 2 = Hold 3 = Zero (4 mA)	RW
138	008A	Pulse Output Error Setting	3	U8	0 = Upscale 2 = Hold 3 = Zero (0 Hz)	RW
139	008B	High/Low Alarm Check Setting	0	U8	0 = High Alarm Check 1 = Low Alarm Check 2 = High and Low Alarm Check	RW
140	008C	High/Low Alarm Unit	see Table 4.1—Units, page 23	U8		RO
141	008D	High Alarm Set Point		FP	–999999 to 999999	RW
143	008F	Low Alarm Set Point				
145	0091	High/Low Alarm Deadband				
147	0093	Status Input Function Setting	250	U8	0 = 0% Signal Lock 1 = Auto Zero Adjust 2 = Reset All Flow Totals 3 = Reset Flow Total 1 4 = Reset Flow Total 2 250 = No Function	RW
148	0094	Status Output Function Setting	250	U8	0 = Error Status 1 = Bidirectional 2 = High/Low Alarm Setting 3 = Drive Out Alarm 250 = No Function	RW

Register (Decimal)	Register (Hex)	Description	Default	Data Type	Data Range	Access
149	0095	High/Low Alarm Source	0	U8	0 = Mass Flow 1 = Volume Flow 2 = Density 3 = Temperature 232 = Net Total 1 231 = Net Total 2	RW
150	0096	Status Input Active Level Setting	0	U8	0 = Closed Active 1 = Open Active	RW
151	0097	Status Output Active Level Setting				
152	0098	Slug Flow Detection Delay (sec.)	0	FP	0 – 60	RW

Flow Configuration

Register (Decimal)	Register (Hex)	Description	Default	Data Type	Data Range	Access
97	0061	Flow Direction	0	U8	0 = Positive 1 = Reverse	RW
98	0062	Maximum Density (Slug Flow) (g/ml)		FP	0.000 – 10.000	RW
100	0064	Minimum Density (Slug Flow) (g/ml)				
102	0066	Flow Rate Low Cutoff (%)		FP	0.000 – 5.000	RW

Maintenance Configuration

Register (Decimal)	Register (Hex)	Description	Default	Data Type	Data Range	Access
206	00CE	Maintenance Mode	Disabled	U8		RW
207	00CF	Maintenance Mass Flow Rate Unit		U8		RO
208	00D0	Maintenance Mass Flow Rate		FP	-9999999 to 9999999	RW
210	00D2	Maintenance Density	see Table 3.1—Configured Units, page 16, then see Table 4.1—Units, page 23	FP	-9999999 to 9999999	RW
212	00D4	Maintenance Inner Temperature				
214	00D6	Maintenance Outer Temperature				
216	00D8	Maintenance Volume Flow Rate Unit		U8		RO
217	00D9	Maintenance Volume Flow Rate		FP	-9999999 to 9999999	RW
344	0158	Drive Output Threshold (%)		U32	0.0 to 100.0	RW

Security Configuration

Register (Decimal)	Register (Hex)	Description	Default	Data Type	Data Range	Access
173	00AD	Front Panel Control Lock Setting	0	U8	0 = Unlock 1 = Lock	RW
226	00E2	Write Protect Configuration	0	U8	0 = Disable 1 = Enable	RO

Calibration and Testing

Register (Decimal)	Register (Hex)	Description	Default	Data Type	Data Range	Access
157	009D	Zero Offset	0	FP	– 999999 to 999999	RW
178	00B2	Trigger Self Diagnosis		U8	0 = Self Diag. Mode 1 1 = Self Diag. Mode 2 2 = Self Diag. Mode 3 3 = Self Diag. Mode 4 4 = Self Diag. Mode 5	RW
179	00B3	LCD Test		U8	1 = Backlight Test 2 = LED Test 3 = LCD Test	RW
180	00B4	Trigger Auto Zero Offset		U8	Any data will start auto zero offset	RW
204	00CC	Trigger for High-Density Calibration		U32		RW

Holding Registers

Register (Decimal)	Register (Hex)	Description	Default	Data Type	Data Range	Access
227	00E3	Mass Flow Rate Unit	see Table 4.1—Units, page 23	U8		RO
228	00E4	Mass Flow Rate Reading		FP		
230	00E6	Volume Flow Rate Unit		U8		
231	00E7	Volume Flow Rate Reading		FP		
233	00E9	Density Unit		U8		
234	00EA	Density Reading		FP		
236	00EC	Internal Temperature Unit		U8		
237	00ED	Internal Temperature Reading		FP		
239	00EF	Output Saturation Alarm	see Table 3.2—Transmitter Status Data, page 20	U8		RO
240	00F0	Sensor Failure Alarm				
241	00F1	Transmitter Failure Alarm				
242	00F2	Parameter Error Alarm				
243	00F3	Calibration Failure Alarm				
244	00F4	Slug Flow Alarm				
245	00F5	Transmitter Alarm				
246	00F6	Output Override Status				
247	00F7	Calibration in Progress				
248	00F8	High/Low Alarm				
249	00F9	Maintenance in Progress				
250	00FA	Transmitter Operation				
251–255		Reserved				
256	0100	Analog Output 1 Output (%)		FP		RO
258	0102	Analog Output 2 Output (%)				
260	0104	Status Input Status		U8		RO
261-267		Reserved				

Register (Decimal)	Register (Hex)	Description	Default	Data Type	Data Range	Access
269	010D	Positive Flow Total 1	see Table 3.1—Configured Units, page 16, then see Table 4.1—Units, page 23	FP	0 – 99999999	RO
271	010F	Positive Flow Total 2				
273	0111	Reverse Flow Total 1				
275	0113	Reverse Flow Total 2				
277	0115	Net Flow Total 1 (Positive - Reverse)		FP	± 99999999	RO
279	0117	Net Flow Total 2 (Positive - Reverse)				
281	0119	Net Flow Rate 1 Unit	see Table 4.1—Units, page 23	U8		RO
282	011A	Net Flow Rate 1		FP	± 99999999	
284	011C	Net Flow Rate 2 Unit		U8		
285	011D	Net Flow Rate 2		FP	± 99999999	
287	011F	Self-Diagnosis Result: DSP Voltage		U8		RO
288	0120	Self-Diagnosis Result: Input Frequency		U8		RO
289	0121	Self-Diagnosis Result: Input Phase Difference		U8	0 = OK 1 = Fail	RO
290	0122	Self-Diagnosis Result: Input Amplitude		U8		RO
291	0123	Self-Diagnosis Result: Input Temperature		U8		RO
292	0124	Self-Diagnosis Result: Resistance Value		U8		RO
293	0125	Self-Diagnosis Result: Static Installation Test		U8	0 = Best 1 = Good 2 = Fair 3 = Poor	RO
294	0126	Self-Diagnosis Result: Dynamic Installation Test		U8	0 = Stable Flow 1 = Fairly Stable Flow 2 = Unstable Flow	RO
295		Reserved				
296	0128	DSP Maintenance Remaining Time		U8	30 to 0 countdown	RO
297	0129	LCD Test Mode		U8	0 = Off 1 = Backlight 2 = LED 3 = LCD	RO
298		Reserved				
299	012B	LPO Amplitude Unit	see Table 4.1—Units, page 23	U8		RO
300	012C	LPO Amplitude Reading		FP		
302	012E	RPO Amplitude Unit		U8		
303	012F	RPO Amplitude Reading		FP		
305	0131	Drive Frequency Unit		U8		
306	0132	Drive Frequency (Hz)		FP		
308	0134	Drive Phase Unit		U8		
309	0135	Drive Phase (urad)		FP		
311	0137	Drive Output Unit		U8		
312	0138	Drive Output (V)		FP		
314	013A	Phase Difference Unit		U8		
315	013B	Phase Difference (urad)		FP		
317	013D	Inner Temperature Unit		U16		

Register (Decimal)	Register (Hex)	Description	Default	Data Type	Data Range	Access
318	013E	Inner Temperature	see Table 4.1—Units, page 23	FP		RO
320	0140	Outer Temperature Unit		U16		
321	0141	Outer Temperature		FP		
323	0143	Temperature Difference Unit		U16		
324	0144	Temperature Difference		FP		

Table 3.2—Transmitter Status Data

Enabled when Bit Value = 1

Register	Transmitter Status	Bit Position	Status Description
239	Output Saturation Alarm	0	Analog Output 1 Saturated
		1	Analog Output 2 Saturated
		2	Pulse Output 1 Saturated
		3	Pulse Output 2 Saturated
		4–7	Reserved
240	Sensor Failure Alarm	0	Drive Input Out of Range
		1	Scale Over
		2	Temperature Out of Range
		3	Density Outside Limits
		4	P.O Signal Error
		5	Temp Connect Error
		6	P.O Connect Error
		7	Reserved
241	Transmitter Failure Alarm	0	EEPROM Checksum Error
		1	Data Update Error
		2	Transmitter Interface Failure 0
		3	Transmitter Interface Failure 1
		4	Transmitter Interface Failure 2
		5	Transmitter Interface Failure 3
		6	Transmitter Interface Failure 4
		7	Reserved
242	Parameter Error Alarm	0	Analog 1 Set Alarm
		1	Analog 2 Set Alarm
		2	H/L Alarm Point Set Alarm
		3–7	Reserved
243	Calibration Failure Alarm	0	Auto Zero Failed
		1	Stability Check Failed
		2–7	Reserved
244	Slug Flow Alarm	0	Slug Flow
		1–7	Reserved

Enabled when Bit Value = 1

Register	Transmitter Status	Bit Position	Status Description
245	Transmitter Alarm	0	Transmitter Temperature Alarm
		1–7	Reserved
246	Output Override Status	0	Analog Output 1 Fixed
		1	Analog Output 2 Fixed
		2	Pulse Output 1 Fixed
		3	Pulse Output 2 Fixed
		4	Status Output Fixed
		5	0% Sig Lock
		6–7	Reserved
247	Calibration in Progress	0	Calibration in Progress
		1	Stability Check in Progress
		2–7	Reserved
248	High/Low Alarm	0	H/L Alarm Triggered
		1–7	Reserved
249	Maintenance in Progress	0	Key Volume Set in Progress
		1	Self-Diagnosis
		2	Installation
		3	Maintenance Test
		4	Factory Data Operating
		5–7	Reserved
250	Transmitter Operation	0	Transmitter Operating-Time Over
		1	Transmitter Warm Up
		2	Transmitter Power OK
		3–7	Reserved

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Section 4—Reference Tables

Table 4.1—Units

Mass Flow Rate

CODE	UNIT
70	g/sec
71	g/min
72	g/hr
73	kg/sec
74	kg/min
75	kg/hr
76	kg/day
77	metric ton/min
78	metric ton/hr
79	metric ton/day
80	lb/sec
81	lb/min
82	lb/hr
83	lb/day
84	U.S. short ton/min
85	short ton/hr
86	short ton/day
249	Special

Temperature

CODE	UNIT
32	°C
33	°F
34	°R
35	K

Volume Flow Rate

CODE	UNIT
15	ft^3/min
16	metric gal/min
17	L/min
18	gal/min
19	m^3/hr
22	metric gal/sec
24	L/sec
26	ft^3/sec
28	m^3/sec
29	m^3/day
30	gal/hr
31	gal/day
130	ft^3/hr
131	m^3/min
132	bbl/sec
133	bbl/min
134	bbl/hr
135	bbl/day
138	L/hr
139	ml/sec
140	ml/min
141	ml/hr
240	L/day
249	Special

Mass Flow Total

CODE	UNIT
60	g
61	kg
62	metric ton
63	lb
64	short ton
249	Special

Volume Flow Total

CODE	UNIT
40	gal
41	L
42	Imperial gal
43	m^3
46	bbl
112	ft^3
114	ml
249	Special

Density

CODE	UNIT
90	SG
91	g/cc
92	kg/m^3
93	lb/gal
94	lb/ft^3
95	g/ml
96	kg/L

Table 4.2—Flange Types and Sensor Materials

Flange Type

CODE	DESCRIPTION
0	ASME 150
1	ASME 300
2	ASME 600
5	DIN (PN) 40
6	DIN (PN) 100
10	Sanitary Clamp Fitting
249	Special

Sensor Material

CODE	DESCRIPTION
3	Alloy C
19	SUS316L

Table 4.3—Packed ASCII Code List

PA = Packed ASCII Code

ASC = ASCII Code

CHR = Character

PA	ASC	CHR
0	64	@
1	65	A
2	66	B
3	67	C
4	68	D
5	69	E
6	70	F
7	71	G
8	72	H
9	73	I
10	74	J
11	75	K
12	76	L
13	77	M
14	78	N
15	79	O

PA	ASC	CHR
16	80	P
17	81	Q
18	82	R
19	83	S
20	84	T
21	85	U
22	86	V
23	87	W
24	88	X
25	89	Y
26	90	Z
27	91	[
28	92	\
29	93	]
30	94	^
31	95	_

PA	ASC	CHR
32	32	SPC
33	33	!
34	34	“
68	68	#
36	36	$
37	37	%
38	38	&
39	39	‘
40	40	(
41	41	)
42	42	*
43	43	+
44	44	,
45	45	-
46	46	.
47	47	/

PA	ASC	CHR
48	48	0
49	49	1
50	50	2
51	51	3
52	52	4
53	53	5
54	54	6
55	55	7
56	56	8
57	57	9
58	58	:
59	59	;
60	60	<
61	61	=
62	62	>
63	63	?

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