McCROMETER

MODBUS Protocol User Manual

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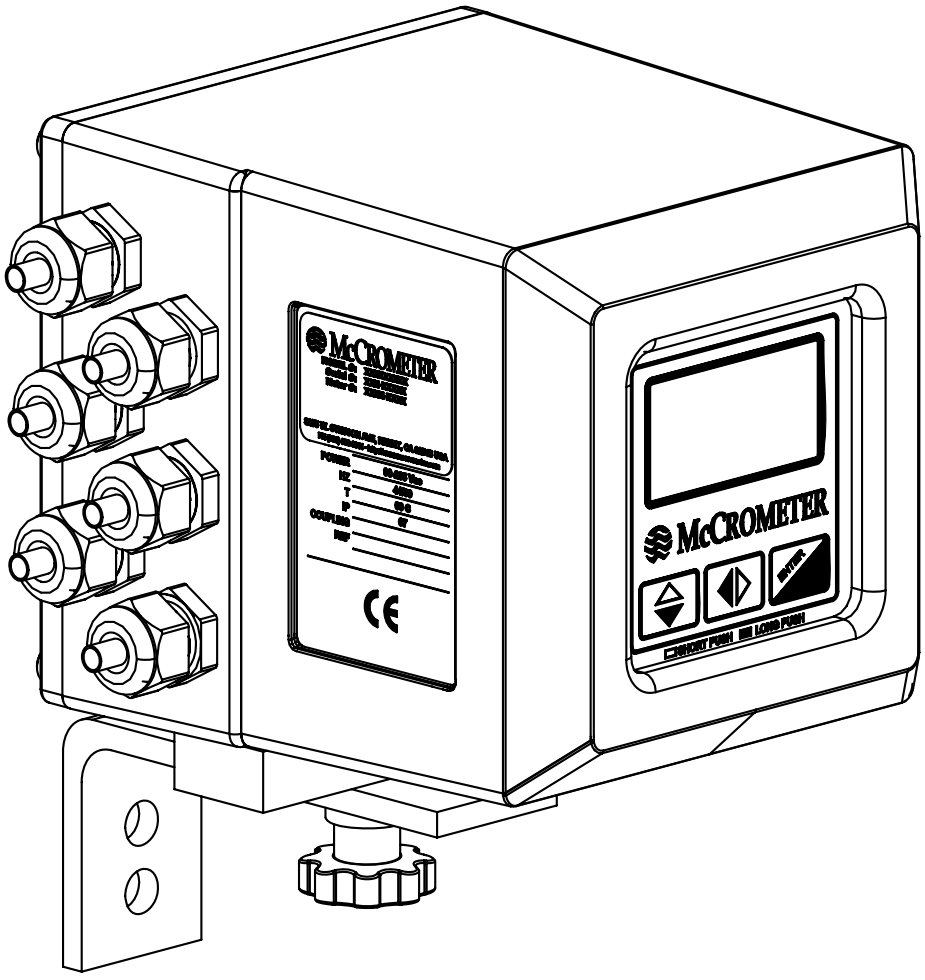

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1.0 INTRODUCTION

MODBUS is an application layer communication protocol for client/server communications between devices connected on different types of buses or networks.

A typical MODBUS network consists of one MASTER and up to 247 SLAVES, each with a unique SLAVE Address from 1 to 247. The Modbus protocol establishes the format of the manner in which the MASTER communicates with the SLAVE, referred to as the MASTER query. The SLAVE responds using the Modbus protocol. For the MODBUS protocol, the converter attached to the McCrometer flow meter has the function of the SLAVE device, and communicates with the MASTER via its RS485 serial port.

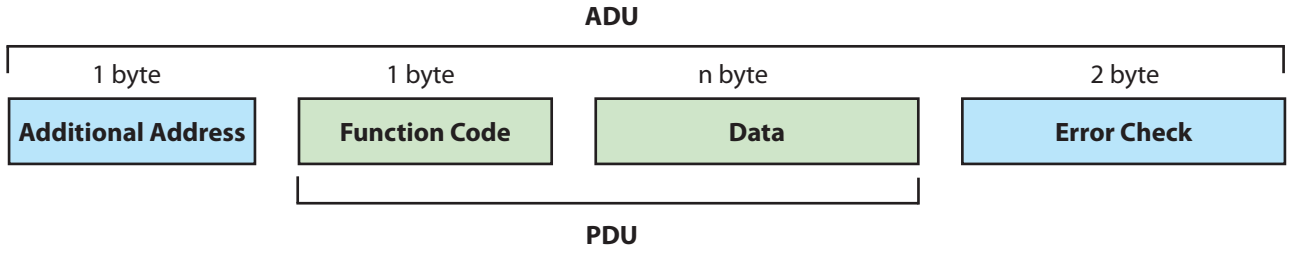
Important Note 1: MODBUS communication is only possible on converters factory configured with MODBUS, unless the converter was ordered with MODBUS installed the converter cannot communicate to the MODBUS network.

Important Note 2: McCrometer provides technical support for its MODBUS converter wired directly to the MODBUS network via an RS485 serial port. For any technical assistance for your MODBUS beyond the McCrometer MODBUS converter or for alternative connection methods such as USD or wireless consult the supplier of that equipment or these additional resources…

- Modbus.org
- Simplymodbus.ca
- Modbustools.com
- Wikipedia/modbus

2.0 PROTOCOL CONVENTIONS

The MODBUS protocol defines a simple Protocol Data Unit (**PDU**), which is independent of the underlying communication layers. The mapping of a MODBUS protocol on specific buses or networks introduces some additional fields in the Application Data Unit (**ADU**).



2.1 A Modbus Query As Part Of The Application Data Unit

- **SLAVE ID:** the address of the SLAVE device to communicate with (0 broadcasts to all devices, 1-247 for individual devices). When the MASTER requests data, the first byte it sends is the SLAVE address. Each SLAVE in a network is assigned a unique unit address from 1 to 247 (excluding 232, which is reserved). This way each SLAVE knows after the first byte whether or not to ignore the message. In the graphic above the SLAVE ID is contained in the additional address. **NOTE:** the converter cannot have the SLAVE ID of 0.

- **FUNCTION CODE:** the instruction to the SLAVE for the type of action to perform, e.g., write coils, read states, read registers, etc. The second byte sent by the MASTER is the Function code. It tells the SLAVE which table to access and whether to read from or write to it. The following table lists the function codes available in McCrometer MODBUS converters.

Function Code	Action
03 (03 hex)	Read the Converter's Process Data, Data Log, or Events Log
05 (05 hex)	Reset the Converter's Totalizer, Data Log, or Events Log
08 (08 hex)	MODBUS Diagnostics (refer to the MODBUS organization for how to use these)
110 (6E hex)	Read/Write ETP Commands

- **DATA:** the additional information relative to the function code, e.g., discrete register addresses, quantity of items handled, etc.

  MODBUS uses a 'big-Endian' representation for addresses and data items. This means that when a numerical quantity larger than a single byte is transmitted, the most significant byte is sent first. For example, if a 16-bit Register (2 bytes) has the value 1234 (hexadecimal) the first byte sent is 12 (hexadecimal) and the second byte sent is 34 (hexadecimal).

  The MASTER of the MODBUS network sees the Converter as a set of registers of 1 bit or 16 bit. Information is stored in the SLAVE device in four different tables. Two tables store on/off discrete values (coils) and two store numerical values (registers). The coils and registers each have a read-only table and read-write table. Each table has 9999 values.

  Single precision floating point data is stored and communicated following the IEEE-754 standard format.

2.2 Error Check

An error-check value calculated by the sending and the receiving devices from all the bits in the query.

The MASTER builds the message to send to the serial port and then adds two bytes (the Cyclic Redundancy Check, or CRC) to the end of every Modbus message for error detection. Every byte in the message is used to calculate the CRC using the standard CRC16 algorithm (*see Figure 2*).

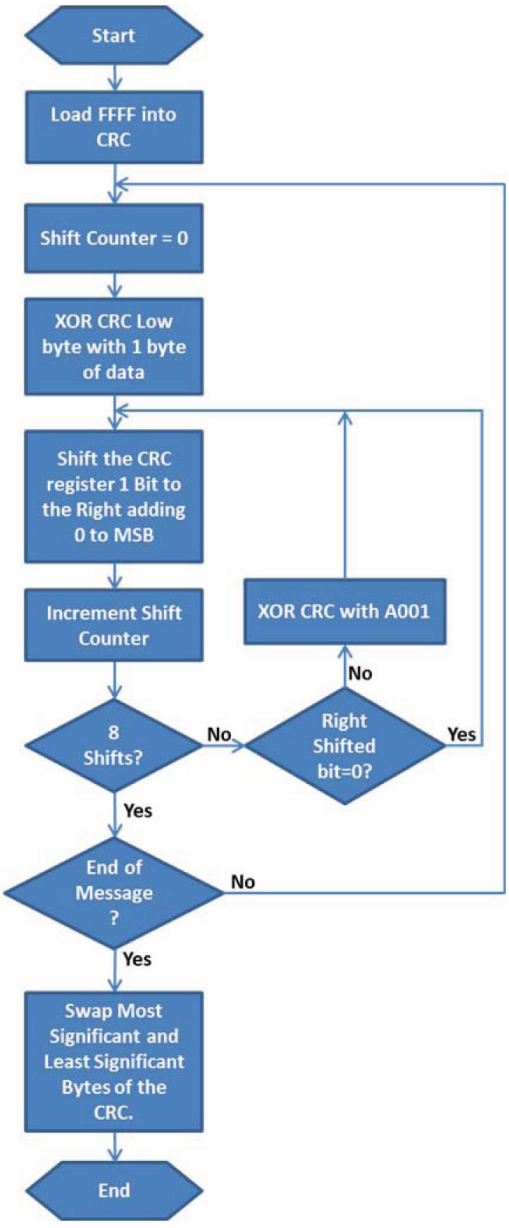


Figure 2: CRC

In normal operation the MASTER makes a request or sends a command to the SLAVE. The SLAVE then responds so that the response function code equals the request function code, e.g., address, function code, data, CRC, etc. *See Figure 3.*

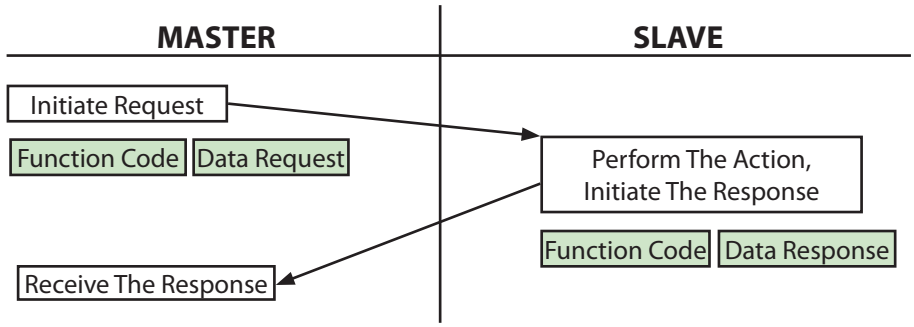


Figure 3: Example Of An Error Free MODBUS Transaction

If an error is detected in the transmission an exception code is created to indicate the reason of the error. The exception function code is the sum of the request function code added to 80 (hexadecimal). In other words, the server returns a code equivalent to the original function code from the request PDU with its most significant bit set to logic 1.

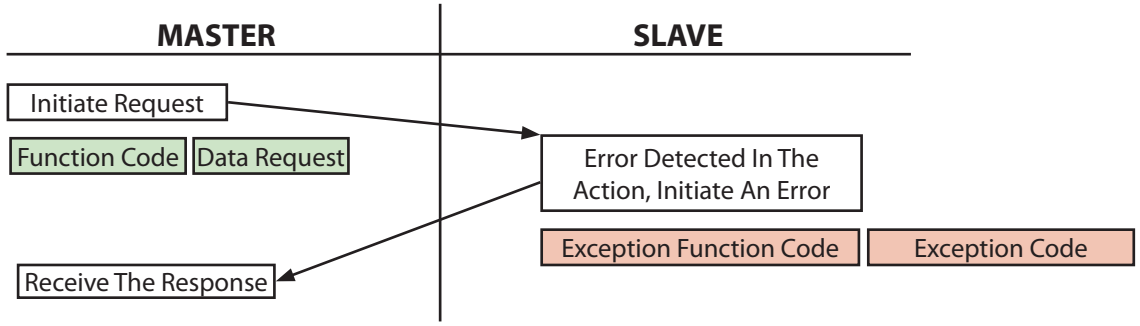


Figure 4: Example Of A MODBUS Transaction With An Error

2.2.1 Example Of A Mater Query Containing An Error

If the MASTER sends a request in the following form: "`buff tx: [01][03][AB][CD][00][02][75][D0]`"

MASTER query elements:

```
SlaveID    = [01]
Function   = [03]
Start addr = [AB][CD]
Num. reg.  = [00][02]
Crc 16     = [75][D0]
```

Assuming there is an error in the MASTER Query, the SLAVE will return the following response containing the modified function code with the appropriate error code (refer to the attached table for an explanation of error codes).

```
buff rx:[01][83][02][C0][F1]
```

SLAVE response elements:

```
SlaveID   =[01]
Function  =[83]
Err. code =[02]  --------> Exception Code: Illegal Address
Crc 16    =[C0][F1]
```

MODBUS Exception Codes	
Code	**Name**
1	Illegal Function
2	Illegal Address
3	Illegal Data Value
4	Server Device Failure
5	Acknowledge Error
6	Server Device Busy
7	Memory parity Error

3.0 CONNECTING THE RS485 CABLE TO THE CONVERTER

The RS485 serial interface is used to connect the converter to a network of several instruments. The converter adopts the MASTER-SLAVE type format for communication. Up to 32 devices can be connected with this interface in a single network covering a length of up to 4000 feet with only two wires. It has excellent immunity to electrical disturbance. The RS485 port is suitable for even long distance and network connections because it is galvanically insulated from all other circuits.

Connect the RS485 cable to the terminal block in the converter as shown in Figure #. Pin 11 is data-, pin 12 is data+, and pin 13 is ground, see Figure #.

Note: The terminal block numbering is the same for the panel mount converters.

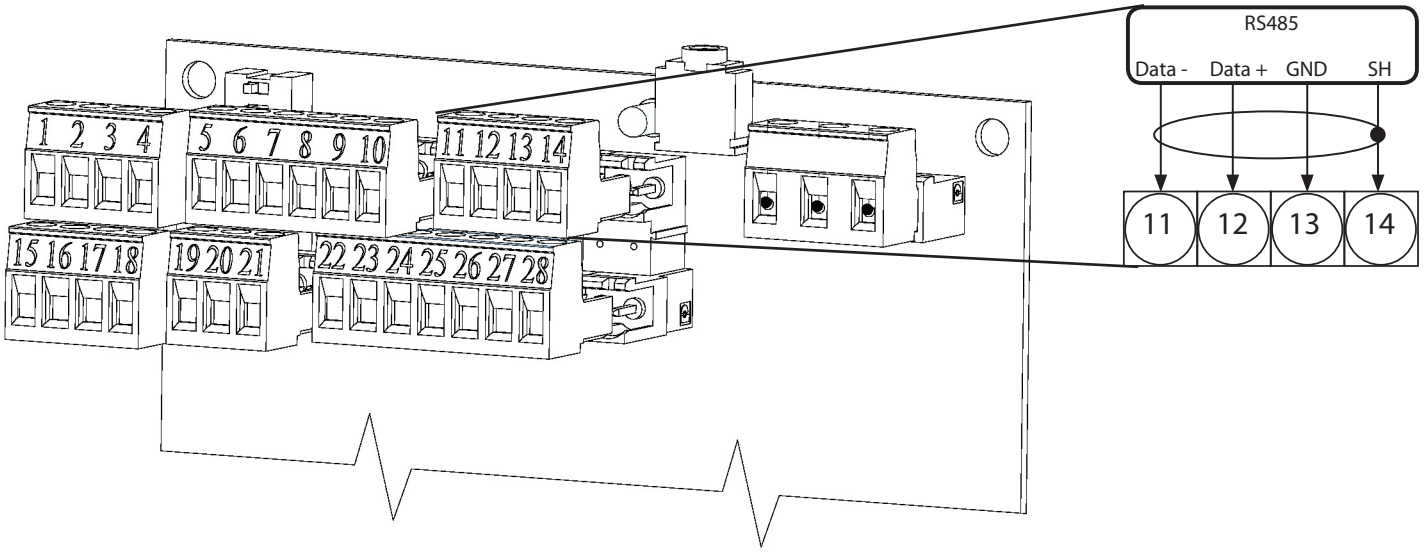


Figure 5: RS485 Data Cable Wiring Diagram For The Flow Meter Converter

4.0 ESTABLISHING COMMUNICATION

4.1 Data Word Format

The data bytes travelling in serial form on the communication line are enclosed in words which have a fixed length of 10 bits: 1 START BIT, 8 DATA BITS (1 BYTE), and 1 STOP BIT. NOTE: a byte commonly consists of 8 bits.

Each word contains one byte of data plus additional bits which serve to synchronize communication and make it safer. These extra bits are added automatically in the transmission phase by the transmitter integrated circuit. In the reception phase, the reverse operation is executed by the receiver integrated circuit: the eight data bits are extracted and the others are eliminated. These operations are executed entirely on a hardware level. Note that the 8 data bits must be serialized, starting from bit 0 (the least significant bit). **NOTE**: communication Flow Control is set to none; no control lines or XON/XOFF characters are used.

4.2 Converter Parameter Settings

The settings indicated below must be entered in the Communications (7) menu of the converter to establish serial communication after the serial port is wired. Refer to the M-Series Electromagnetic Flow Meter Installation, Operation and Maintenance manual for complete instructions (*McCrometer literature number 30120-47*). *See Figure 6, below.*

Figure 6: M-Series Converter Communications Screen

- **Protocol Type [RS485 pr.=]:** establishes communication protocol. Options are MODBUS (0) or DPP (1). Set to MODBUS (0).
- **Communication Speed [RS485 bps=]:** establishes serial line communication speed. Options are 4800Hz (0), 9600Hx (1), 19200Hz (2), and 38400Hz (3). Set this to match the communication speed of the MODBUS network's MASTER device.
- **Answer Delay [A.delay=ms]:** establishes converter delay (how long it will wait to answer the MODBUS network's MASTER). Options, in milliseconds, are 0 (0), 20 (1), 4 (2), 60 (3), 80 (4), 100 (5), 120 (6) and 140 (7). Typically, set to 0.
- **MODBUS Parity [Parity=]:** establishes parity for the byte frame in MODBUS communication. Options are EVEN (0), NONE (1), and ODD (2). Set to match the parity of the MODBUS network's MASTER device.
- **Device Address [Address]:** establishes the address of the converter in the MODBUS network. Options are 1 through 247 (excluding 232, which is reserved).

Important Notes Regarding RS485 Networks: an RS485 network is comprised of a certain number of devices, each one identified by a unique address number. Each of these devices is designated a SLAVE with one device in the network, the network "referee", designated the MASTER. The MASTER interrogates all of the other instruments connected to the network (the SLAVES) in turn. The maximum number of devices that can be connected to the network is 32. Information requests sent from the MASTER are received simultaneously by all the SLAVES, but only the one addressed in the communication replies. For this reason, it is absolutely necessary that each SLAVE has a different address. As the MASTER establishes the time scheduling by which the information must transit the network, there must be only one MASTER in the network; two MASTERs would create conflicts in the communication, making the entire system unusable. MASTER devices can be PCs, PLCs, or other terminals that collect measurement data from the instruments. The converter is always a SLAVE. When more than 32 instruments must be networked, the network must be divided into separate groups of a maximum of 32 devices. Each group connects to the next through a repeater which has the task of regenerating the necessary electric signals. In any case, given that the converter sets a maximum number of addresses that can be assigned to 247, networks with more than 246 elements cannot be created (note that address 232 is reserved).

5.0 TRANSMITTING/RECEIVING COMMANDS/DATA VIA MODBUS

As described earlier, in the MODBUS protocol the converter functions as a SLAVE device. The MASTER of the network sees the converter as a set of registers of 1 bit or 16 bit. These registers are addressed and grouped in tables with different length. The data in these registers are accessed specific function calls.

A transmission from the MASTER to a SLAVE on the MODBUS network has the form as shown in the table below.

	SLAVE ID	Function	Address from which to Start Reading		Number of Registers to Read		CRC16 Error Check Number (*see above*)	
Byte:	1	2	3	4	5	6	7	8
	[01]	[03]	[00]	[00]	[00]	[02]	[C4]	[0B]
Transmission example, buff tx:	Device 1	Function 3	Start at address 0000 (hexadecimal)		Read 2 Registers		CRC16: C40B (hexadecimal)	

A transmission from the SLAVE to a MASTER on the MODBUS network has the form as shown in the table below.

	SLAVE ID	Function	Number of Bytes (n)	Data from the first Register Queried (1)		...	Data from the Last Register Queried (1)		CRC16 Error Check Number (*see above*)	
Byte:	1	2	3	4	5		n+4	n+5	n+6	n+7
	[01]	[03]	[04]	[42]	[47]		[FF]	[CF]	[5F]	[FA]
Reply example, buff tx:	Device 1	Function 3	4 Bytes	Data in first register: 4247 (hexadecimal)			Data in Last Register: FFCF Hexadecimal		CRC16: 5FFA (hexadecimal)	

6.0 CONVERTER DATA MAP

Process data, data logger data, and data logger events are contained in the converter's memory at specific addresses or registers and can be accessed by the MODBUS function codes. Following are the maps for process data, data logger data, and data logger events.

6.1 Process Data (0000-0025 hexadecimal)

Address (hexadecimal)	**Data**															
0000-0001	Flow rate in % (float)															
0002-0003	Flow rate in technical unit (float)															
0004-0005	Totalizer for total volume positive (long)															
0006-0007	Totalizer for partial volume positive (long)															
0008-0009	Totalizer for total volume negative (long)															
000A-000B	Totalizer for partial volume negative (long)															
000C-0021	n/a															
0022 Bit:	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Process Flags	The excitation is too fast for the sensor connected	The max alarm is active	The min alarm is active	The flow rate exceeds the scale range, overflow	There are too many impulses to emit correctly	The measurement signal is disturbed or the sensor is disconnected	The pipe is empty	The coils are not working or the sensor is disconnected	The second measurement scale is active	The flow rate is below the low flow cutoff threshold	The flow rate is negative	A new measurement value is available for the display	The counter block signal is active	A batch is in progress	The calibration cycle is in progress	Flow rate simulation is in progress
0023-0025	n/a															

6.2 Data-Logger Data (0064-0077 Hexadecimal)

Note that there are 32 log entries in the data-logger data log and the address range referenced above (and in the breakdown listed below) refers to the first record in the log. To acquire subsequent records 2-32 add the product of 0014 (hexadecimal) multiplied by the record sought (2-32) less 1 to the address.

For example, to get the first address of the 6th record in the data-logger data log add 0014 (hexadecimal) multiplied by record number 06 (hexadecimal) less 1 to the address for the first address of 0064 (hexadecimal). *See the example below*.

(0014 x (06-1)) + 0064 = 00C8 (hexadecimal)

Figure 7: Example Of Calculating A Data-logger Data Log Address

Address (hexadecimal)	Data
0064-0065	Date and time of the record in seconds (long)
0066-0067	Totalizer value positive (long)
0068-0069	Totalizer value negative (long)
006A-006B	Flow rate in technical unit (float)
006C-0077	n/a

6.3 Data-Logger Events (03E8-04E7 Hexadecimal)

Note that there are 64 log entries in the data-logger events log and the address range referenced above (and in the breakdown listed below) refers to the first record in the log. To acquire subsequent records 2-64 add the product of 0004 (hexadecimal) multiplied by the record sought (2-64) less 1 to the address.

For example, to get the first address of the 10th record in the data logger events log add 0004 (hexadecimal) multiplied by record number 0A (hexadecimal) less 1 to the address for the first address of 03E8 (hexadecimal). *See the example below.*

(0004 x (0A-1)) + 03E8 = 040C (hexadecimal)

Figure 8: Example Of Calculating A Data-logger Events Log Address

IMPORTANT NOTE: when the value of the single long-integer variable, which contains the event flags, is 000300FF (hexadecimal) it means the converter has restarted and the individual bits are not, in themselves, significant.

Address (hexadecimal		Data														
03E8-03E9		Date and time of the record in seconds (long)														
03EA	Bit:	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Event Flags		n/a	There was a maximum flow rate alarm	There was a minimum flow rate alarm	There was a scale range value overflow	Impulses saturated the output	There was an input measurement error	The pipe was empty	The excitation of the coils was interrupted	n/a							
03EB	Bit:	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Event Flags		The current loop 4-20 mA was interrupted	There was a power supply error	n/a													

7.0 MODBUS FUNCTION CODES

Function 03: retrieve process data, data logger data, and data logger events from the converter.

This command returns 16 bit variables that are linked to form floating-point (float) or 32 bit long-integer (long) variables type. The high side of the word (MSW) is on even address, the low side of the word (LSW) is in the immediately following address. The addresses are in HEX format. Refer to Converter Data Map for the addresses and the data they contain.

IMPORTANT NOTE: When the request is for data from the data logger or the event logger that is invalid (data not collected), the returned value is FFFFFFFF (hex).

Example 1: Read flow rate in %, which is mapped to addresses 0000-0001. Use function 03, starting at address 0000 to read two registers (16 bits) by putting the following byte sequence on the RS-485 serial port transmission buffer:

buff tx:[01][03][00][00][00][02][C4][0B], where

```
SlaveID   =[01]
Function  =[03]
Start addr=[00][00]
Num. reg. =[00][02]
Crc 16    =[C4][0B]
```

The converter replies with the following byte sequence on the serial port buffer:

buff rx:[01][03][04]**[42][47][FF][CF]**[5F][FA], where

```
SlaveID  =[01]
Function =[03]
Num.bytes=[04]
Reg[0000]=[42][47]
Reg[0001]=[FF][CF]
Crc 16   =[5F][FA]
```

Converting Reg[0000] and Reg[0001] to a float turns the sequence [42][47][FF][CF]into the floating point value **49.99981**.

Example 2: Read flow rate in technical unit, which is mapped to addresses 0002-0003. Use function 03, starting at address 0002 to read two registers (16 bits) by putting the following byte sequence on the RS-485 serial port transmission buffer:

buff tx:[01][03][00][02][00][02][65][CB], where

```
SlaveID   =[01]
Function  =[03]
Start addr=[00][02]
Num. reg. =[00][02]
Crc 16    =[65][CB]
```

The converter replies with the following byte sequence on the serial port buffer:

buff rx:[01][03][04]**[42][9F][FF][DA]**[1E][0E], where

```
SlaveID  =[01]
Function =[03]
Num.bytes=[04]
Reg[0000]=[42][9F]
Reg[0001]=[FF][DA]
Crc 16   =[1E][0E]
```

Converting Reg[0000] and Reg[0001] to a float turns the sequence [42][9F][FF][DA] into the floating point value **79.99971**.

Example 3: read totalizer for total volume, positive direction, which is mapped to addresses 0004-0005. Use function 03, starting at address 0004 to read two registers (16 bits) by putting the following byte sequence on the RS-485 serial port transmission buffer:

buff tx:[01][03][00][04][00][02][85][CA], where

```
SlaveID   =[01]
Function  =[03]
Start addr=[00][04]
Num. reg. =[00][02]
Crc 16    =[85][CA]
```

The converter replies with the following byte sequence on the serial port buffer:

buff rx:[01][03][04]**[00][04][CF][23]**[AF][DB], where

```
SlaveID  =[01]
Function =[03]
Num.bytes=[04]
Reg[0000]=[00][04]
Reg[0001]=[CF][23]
Crc 16   =[AF][DB]
```

Converting Reg[0000] and Reg[0001] to a float turns the sequence [00][04][CF][23] into the long value **315171**.

Function 05: reset the converter's totalizer, data logger, or events logger.

The two 16 bit words that follow the function in this command indicate the function type (address) and action (on or off); note that the "off" action has no practical effect on the converter. The code number for "on" is FF00 (hexadecimal), for "off" is 0000 (hexadecimal). Others values produce the "Illegal Data Value" exception (3).

Address (hexadecimal)	Data
0000-0001	n/a
0002	Reset totalizers
0003	Reset data logger
0004	Reset events logger

Example: Reset totalizers, which is mapped to address 0002. Use function 05 and set address 0002 to ON (FF00, hexadecimal) by putting the following byte sequence on the RS-485 serial port transmission buffer:

buff tx:[01][05][00][02][FF][00][2D][FA], where

```
SlaveID   =[01]
Function  =[05]
Start addr=[00][02]
Num. reg. =[FF][00]
Crc 16    =[2D][FA]
```

The converter replies with the following byte sequence on the serial port buffer:

buff rx:[01][05][00][02][FF][00][2D][FA], where

```
SlaveID  =[01]
Function =[05]
          [00][02]
          [FF][00]
Crc 16   =[2D][FA]
```

The reply has the same bytes sent in transmission from a MASTER to SLAVE; this means that there is no error.

Function 08: Perform the standard MODBUS diagnostic functions. These are not typically used in normal operation of the meter. Consult the MODBUS organization at www.modbus.org if there is a need to access the standard MODBUS diagnostic functions.

Function 110: Sends ETP protocol formatted commands to the converter.

With this function a text string up to 251 characters long in the ETP protocol format can be sent to the converter (the ETP command is embedded in the MODBUS standard protocol format). The converter then returns string up to 251 characters long embedded in the same format. With ETP commands it is possible to set and to return the value of every parameter in the converter. See below for the complete list of the ETP commands that can be transmitted to the converter.

Note: each ETP is five characters long with a suffix. For each command, unless otherwise indicated, the suffixes are:

Suffix	Command	Action Taken
?	read	Reads the value currently in the specified parameter, e.g. PDIMV? returns the current setting for the pipe diameter in the converter. The read command can also return the following message: • 1:CMD ERR, the parameter is not currently enabled • 5: ACCESS ERR, the current access level is insufficient to access the parameter
=n	set	Sets the currently specified field to value of n (here n is not literally the character n, but a numeric value within the range that the currently specified field will accept), e.g. PDIMV=100 sets the pipe diameter in the converter to 100mm. The set command can also return the following message: • 0:OK, the value entered for the parameter is acceptable • 1:CMD ERR, the parameter is not currently enabled • 2:PARAM ERR, the value entered for the parameter is out of range • 5: ACCESS ERR, the current access level is insufficient to access the parameter
=?	help	Displays the acceptable set or range of values than can be entered in the currently specified field, e.g. PDIMV=? returns the range of acceptable pipe diameters that can be entered into the converter, 0 to 10000mm. The help command can also return the following message: • 1:CMD ERR, the parameter is not currently enabled • 5: ACCESS ERR, the current access level is insufficient to access the parameter

A transmission from the MASTER to a SLAVE is modified from the standard form for ETP commands as follows…

	SLAVE ID	Function	EPT Command (n bytes long)	Carriage Return	CRC16 Error Check Number (see above)	
Byte:	1	2	3 to n+2	n+3	n+4	n+5
	[01]	[6E]	[50] [44] [49] [4D] [56] [3D] [31] [30]	[0D]	[A0]	[61]
Transmission example, buff tx:	device 1	function 110	PDIMV=10	character 13	CRC16: A061 (hexadecimal)	

A reply from the SLAVE to a MASTER is modified from the standard form for ETP commands as follows:

	SLAVE ID	Function	EPT Command Reply/ Acknowledgement (n bytes long)	Carriage Return	Line Feed	CRC16 Error Check Number (see above)	
Byte:	1	2	3 to n+2	n+3	n+4	n+5	n+6
Reply example, buff tx:	[01]	[6E]	[30] [3A] [4F] [4B]	[0D]	[0A]	[31]	[A1]
	Device 1	Function 110	0:OK	Character 13	Character 10	CRC16: 31A1 (hexadecimal)	

Example: Send the command "MODSV?" via the ETP protocol. Use function 110 and send the test string "MODSV?" to the converter by putting the following byte sequence on the RS-485 serial port transmission buffer:

buff tx:[01][6E][4D][4F][44][53][56][3F][0D][C2][91], where

```
SlaveID   =[01]
Function  =[6E]
-ch(00)'M'=[4D]
-ch(01)'O'=[4F]
-ch(02)'D'=[44]
-ch(03)'S'=[53]
-ch(04)'V'=[56]
-ch(05)'?'=[3F]
CR        =[0D]
Crc 16    =[C2][91]
```

The converter replies with the following byte sequence on the serial port buffer:

buff rx:**[01][6E]**[4D][63][4D][41][47][31][20][56][45][52][2E][33][2E]
[30][31][2E][30][35][30][30][20][4E][6F][76][20][20][33][20][32][30]
[31][34][20][31][33][3A][33][38][3A][35][34][0D][0A]**[EB][0C]**, where

SlaveID =[01]
Function =[6E]
-ch(00)'M'=[4D]
-ch(01)'c'=[63]
-ch(02)'M'=[4D]
-ch(03)'A'=[41]
-ch(04)'G'=[47]
-ch(05)'1'=[31]
-ch(06)''=[20]
-ch(07)'V'=[56]
-ch(08)'E'=[45]
-ch(09)'R'=[52]
-ch(10)'.'=[2E]
-ch(11)'3'=[33]
-ch(12)'.'=[2E]
-ch(13)'0'=[30]
-ch(14)'1'=[31]
-ch(15)'.'=[2E]
-ch(16)'0'=[30]
-ch(17)'5'=[35]
-ch(18)'0'=[30]
-ch(19)'0'=[30]
-ch(20)''=[20]
-ch(21)'N'=[4E]
-ch(22)'o'=[6F]
-ch(23)'v'=[76]
-ch(24)''=[20]
-ch(25)''=[20]
-ch(26)'3'=[33]
-ch(27)''=[20]
-ch(28)'2'=[32]
-ch(29)'0'=[30]
-ch(30)'1'=[31]
-ch(31)'4'=[34]
-ch(32)''=[20]
-ch(33)'1'=[31]
-ch(34)'3'=[33]
-ch(35)':'=[3A]
-ch(36)'3'=[33]
-ch(37)'8'=[38]
-ch(38)':'=[3A]
-ch(39)'5'=[35]
-ch(40)'4'=[34]
CR =[0D]
LF =[0A]
Crc 16 =[EB][0C]

Or, in more standard form: McMag1 Ver. 3.01.0500 Nov. 3, 2014 13:38:54

ETP Commands For Use With Function 110

Sensor Commands

ETP	Description	Range	Notes
PDIMV	NOMINAL DIAMETER	0 to 10000 mm	0 here forces the sensor to report process fluid velocity in m/s rather than volumetric flow.
SCALN	CABLE LENGTH	0 to 500 meters	
EPDEN	EMPTY PIPE DETECT ENABLE	0:OFF/1:ON	The sensitivity of the empty pipe detection may change with liquid conductivity and ground connections. Larger values decreases empty pipe sensitivity. Be aware that disabling empty pipe detection may cause phantom flows.
EPDTH	EMPTY PIPE DETECT THRESHOLD	20 to 250	

Scales Commands

ETP	Description	Range	Notes
FRMUT	FLOW RATE UOM TYPE	0: volumetric-metric, 1: mass-metric (n/a), 2: volumetric-English, 3: mass-English (n/a)	This indicates to the sensor and equipment the maximum volumetric flow (note that the full scale in the specified units of measure cannot be higher than would be generated by a stable 10m/s in the specified meter). The converter accepts any combination of listed units of measure provided the full scale is less than or equal to 99999 and represents a value greater than 0.4 m/s.
FRMUV	FLOW RATE UOM VALUE	see UOM table*	
FRFS1	PRIMARY FULL SCALE FLOW RATE	0 to 99999	
FRFS2	ALTERNATE FULL SCALE FLOW RATE		This is available only if ARNGE = 1 (auto-range enabled). This must be less than FRFS1.
VTMUT	TOTALIZER UOM TYPE	0: volumetric-metric, 1: mass-metric (n/a), 2: volumetric-English, 3: mass-English (n/a)	
VTMUV	TOTALIZER UOM	see UOM table*	
VTDPP	TOTALIZER DECIMAL POINT POSITION	0: 00001 1: 001.0 2: 01.00 3: 1.000	
CH1PV	PULSE VALUE, CHANNEL 1	0 to 99999	This is available only if OUT1F (or 2, 3, or 4) = 1, 2, or 3 (pulse channel 1 enabled) for channel 1 or if OUT1F (or 2, 3, or 4) = 4, 5, or 6 (pulse channel 2 enabled) for channel 2. This allows the user to set the volume of fluid passing through the meter which one pulse represents as well as the duration of that pulse when it is triggered. The pulse duration must be compatible with the external device processing the pulse. If the pulse is too long the coils may burn out, while, if the pulse is too short, the counter may not be able to function and possibly cause damage to the output.
CH2PV	PULSE VALUE, CHANNEL 2		
CH1PT	PULSE DURATION, CHANNEL 1	0.4 to 9999.99 milliseconds	
CH2PT	PULSE DURATION, CHANNEL 2		
CH1FF	OUTPUT FREQ., CHANNEL 1, AT FS	0.1 to 1000.0 Hertz	This is available only if OUT1F (or 2, 3, or 4) = 7, 8, or 9 (frequency channel 1 enabled).
CH2FF	OUTPUT FREQ., CHANNEL 2, AT FS		This is available only if OUT1F (or 2, 3, or 4) = 10, 11, or 12 (frequency channel 2 enabled).

Measure Commands

ETP	Description	Range	Notes
MFWAT	AC FILTER	0: OFF 1: 0.1s (ready measure) 2: 0.2s (liquid noise filter) 3: 0.5s (strong noise filter)	This adjusts main line filtering (AC noise from buildings, pour grounding, and electrical noise in the liquid). A high setting will slow response. For typical McCrometer applications the setting should be high.
MFDMP	DAMPENING	0: OFF 1: smart 1 2: smart 2 3: smart 4 4: 0.2s 5: 0.5s 6: 1.0s 7: 2.0s 8: 5.0s 9: 10s 10: 20s 11: 50s 12: 100s 13: 200s 14: 500s 15: 1000s	The Dampening filter determines the amount of hydraulic noise the converter removes from the flow indication. It ensures the proper response of the meter to the measured flow rate. With the dampening turned off the converter responds immediately to any change in flow and can result in a noisy output. With the dampening set between 0.2 and 1000 seconds the converter buffers and averages flow data over the period of time specified. Larger values give quieter and more stable output but respond sluggishly to changes or transitions in flow rate. A typical FPI, SPI, or UltraMag setting is 10 seconds, but it can be changed to make the meter more or less responsive and/or stable depending on the application's requirements. Note also that there are also some specialized settings, SMART 1, SMART 2, and SMART 4, which dampen small variations but respond quickly to large changes in flow; these are not typically used with the FPI, SPI, or UltraMag flow meters.
MFCUT	CUTOFF POINT	0.0 to 25.0	This is where the converter no longer reports flow, expressed as a percentage of the full scale value.
ACALE	AUTO CALIBRATION ENABLED	0:OFF/1:ON	Auto Calibration should be left off unless the application's temperate range is high (-20C to +60C for instance). Note that, when the converter is turned on, it will make this calibration automatically as well as conduct a self-test.
ARNGE	AUTO RANGING ENABLED	0:OFF/1:ON	This enables the automatic changing between two pre-set flow range scales (FS1 and FS2), useful where process conditions are highly variable process (typically one scale is sufficient). If enabled, when the flow rate increases and reaches the 100% of FS1 the meter automatically switches to scale 2. When the flow rate decreases again reaching a value on scale 2 equal to the 90% of FS1 scale 1 becomes again. Note that the autorange disables the range change external command.
MDCVT	MAXIMUM DC VARIATION THRESHOLD	0.0 to 25.0	This filters DC noise in the signal (like impacts on the electrodes or noise in the wiring). The value is a percent of the full scale DC voltage. Zero means the filter off. A setting of 2.5 or 3.0 filters most noise. The filter works by truncating (ignoring) values with a DC variation greater than the threshold value. If it is set too low if the reading will freeze, ignoring most or all the values and leaving nothing from which to average and update. If it is set too high (or off) the reading will be noisy.
MRFCE	REVERSE FLOW CHANNEL ENABLE	0:OFF/1:ON	This enables reverse on a Forward/Reverse meter
MRFGE	REVERSE FLOW GROUND ENABLE	0:OFF/1:ON	On a Forward/Reverse FPI, this makes the "inactive" electrodes reference or floating. Typically, leaving this off (floating) gives the most satisfactory performance.

Alarm Commands

ETP	Description	Range	Notes
FRAXP	FLOW RATE ALARM MAX, POSITIVE	0 to 125%	This triggers when the flow exceeds the setting. The function is disabled when set to 0.
FRAXN	FLOW RATE ALARM MAX, NEGATIVE		
FRANP	FLOW RATE ALARM MIN, POSITIVE		
FRANN	FLOW RATE ALARM MIN, NEGATIVE		
ATHYS	ALARM THRESHOLD HYSTERESIS	0 to 25%	
OCACV	CURRENT OUTPUT VALUE IN CASE OF FAILURE	0 to 120	This is the output current signal (A) the converter outputs in case of empty pipe, coils interrupted, or ADC error. It can be set as a percentage (0 to 120%) of the 4 (or 0)-20mA current. 120% = 24mA. NAMUR NE43 recommends the alarm signalling value for the current output be lower than 3.6mA (<18%) or bigger than 21mA (>105%). Typical settings would be: A<2mA -5%, line interrupted, power supply failure or faulty converter; 2mA -5% *A* 2mA +5%, hardware alarm; 4mA *A* 20mA, normal working range; 20mA <A* 22mA, out of range, measure above 100%.
OFACV	FREQUENCY OUTPUT VALUE IN CASE OF FAILURE	0 to 125	If OUT1F (or 2, 3, or 4) = 7-12 (frequency channel 1 or 2 enabled) this is the frequency value (f) assigned to the on/off output in the following failure cases: empty pipe; coils interrupted; ADC error. The allowable range is from 0 to 125% of the frequency full scale value. Typical settings would be: 0% Hz ≤ f ≤ 100% f.s., normal working range; 100% f.s. < f ≤ 110% f.s., overflow, measure above 100% of the f.s.; 115% f.s. ≤ f ≤ 125% f.s., hardware alarm condition.

Inputs Commands

ETP	Description	Range	Notes
VTTPE	VOLUME TOTALIZER TOTAL POSSITIVE RESET ENABLE	0:OFF/1:ON	This allows for the positive or negative total totalizers to be reset through the input.
VTTNE	VOLUME TOTALIZER TOTAL NEGATIVE RESET ENABLE		
PORIE	PULSE OUTPUT RESET INPUT ENABLE	0:OFF/1:ON	This allows for the totalized pulses to be reset through the input.
TCLIE	TOTALIZERS COUNT LOCK INPUT ENABLE	0:OFF/1:ON	This allows for the totalizers to be locked (frozen) when the input is tripped.
CALIE	CALIBRATION INPUT ENABLE	0:OFF/1:ON	When enabled, applying a voltage on the on/off input terminal initiates an autozero calibration. If the pulse is less than 1 second, the meter performs a calibration cycle to compensate for possible thermal drifts. If the pulse is more than 1 second, the meter performs a zero calibration measure. Note that this enables/disables the automatic zero calibration of the system. When performing the calibration it is absolutely necessary the sensor be full of liquid and that the liquid stays perfectly still. Even very small movement of the liquid may affect the result of the calibration, and, consequently, the accuracy of the system.

Output Commands

ETP	Description	Range	Notes
OUT1F (to 4F)	OUTPUT 1 (thru 4) FUNCTION	see Output table*	see Output table*
CO1FS (and 2)	CURRENT OUTPUT 1 (& 2) FULL SCALE	0:20mA/1:22mA	This sets the full scale value for the analog output.
CO1SS (and 2)	CURRENT OUTPUT 1 (& 2) START SCALE	0:0mA/1:4mA	This sets the zero flow point for the analog output.
CO1FM (and 2)	CURRENT OUTPUT 1 (& 2) FUNCTION	0: -0+ (+flow & -flow); 1: +, (+flow only); 2: -, (-flow only); 3: <sp>, (+flow & -flow)	This sets the analog output's response to flow. Note that for the -0+ setting the converter responds to negative flow on the low to middle range (e.g. 4-12mA) and to positive flow on the middle to high range (e.g. 12-20 mA).

Communication Commands

ETP	Description	Range	Notes
485PT	RS485 PROTOCOL TYPE	0: MODBUS 1: DPP	This reads or sets the protocol type and baud rate for the RS485 port. This is valid only if the RS485 port is installed and enabled.
485SP	RS485 OUTPUT SPEED	0: 4800 Hz 1: 9600 Hz 2: 19200 Hz 3: 38400 Hz	
ANSDL	INSTRUMENT ANSWER DELAY	0: 0, 1: 20, 2: 40, 3: 60, 4: 80, 5: 100, 6: 120, or 7: 140	This sets the answer delay in microseconds.
MODBP	RS485 PARITY	0: EVEN 1: NONE 2: ODD	This sets the parity of the MODBUS communication
DVADR	DEVICE ADDRESS	1 to 247 (ex. 232)	This sets the address of the SLAVE device for RS485 communication.

Display Commands

ETP	Description	Range	Notes
LLANG	LANGUAGE	0: English, 1: Italian, 2: French), 3: Spanish, or 4: German	This sets the converter language.
DISRF	DISPLAY REFRESH FREQUENCY	0: 1Hz, 1: 2Hz, 2: 5Hz, or 3: 10Hz	This sets the frequency at which the display is updated.
DISCV	DISPLAY CONTRAST VALUE	1 to 15	This sets the contrast intensity for the display. Be aware that the contrast can change with room temperature. The entered value only goes into effect when leaving the function itself. **WARNING: a setting >10 is a dark screen and obscures the writing on the display.**
DATDE	DATE AND TIME DISPLAY ENABLE	0:OFF/1:ON	
TTNVE	TOTALIZER NET VALUE ENABLE	0:OFF/1:ON	This enables the display of the net totalizer.
VTTPR	TOTALIZER RESET, POSITIVE FLOW	1	This resets the forward or reverse flow totalizer. Note that the read function is not supported here.
VTTNR	TOTALIZER RESET, NEGATIVE FLOW		

Data-Logger Commands

ETP	Description	Range	Notes
DTIME	DATE AND TIME	YYYY/MM/DD HH:MM:SS	This sets the date and time in the converter.
DLOGE	DATA-LOGGER ENABLE	0:OFF/1:ON	This enables data-logging. The following commands are only available if the DLOGE is enabled.
DLGSI	DATA-LOGGING INTERVAL	0: 1hr, 1: 2hr, 2: 3hr, 3: 6hr, 4: 8hr, 5: 12hr, 6: 24hr, or 7: 48hr	This sets the data-logging interval.
DLDRD	DISPLAY DATA-LOGGER DATA	1 to 32	The read function reports the number of records in the converter's data-logger. The set function reads the record specified, in csv format, from the data-logger. There are 32 possible cells for data. Enter a number from 1 to 32 to display the information in the cell indexed by that number.
DLERD	DISPLAY EVENTS (ALARMS) IN DATA-LOGGER	1 to 64	This displays the 64 most recent alarms and/or events recorded by the converter. Enter a number from 1 to 64 to display the information in the cell indexed by that number.
DLMRD	DISPLAY MIN/MAX DATA		This displays the minimum and maximum values for flow rate since the minimum and maximum was last reset. This can only be read and does not support the set or help commands.
DLDRE	CLEAR DATA-LOGGER	1	This clears and reinitializes the data-logger data or stored alarms. Note that the read function is not supported here
DLERE	CLEAR EVENTS (ALARMS)	1	

Diagnostic Commands

ETP	Description	Range	Notes
CALIC	CALIBRATE CONVERTER	1	This initiates the calibration of the converter. During the calibration process a "C" is displayed in the upper left corner of the display.
ATSIC	AUTO (SELF) TEST THE CONVERTER	1	This stops the normal meter functions and tests the measure input circuits and excitation generator. The result of the test is shown on the display. Afterward, the converter will revert to normal operation (performed automatically when switching on the device). This can only be read and does not support the set or help commands.
MSIEM	MEASUREMENT SIMULATION	0:OFF/1:ON	This enables flow rate simulation. With this function it is possible to generate an internal signal that simulates the flow rate, allowing the outputs and all the connected instruments to be tested. Enter the rate of flow to simulate as a percentage of the full scale setting in the converter. After enabling it, an "S" appears in the top left of the screen. Entering a 0 disables flow rate simulation.

Auxiliary Commands

ETP	Description	Range	Notes
MODSV	MODEL/SOFTWARE VERSION		This displays the converter models and software version. This can only be read and does not support the set or help commands.

Internal Data Commands

ETP	Description	Range	Notes
L2ACD	LEVEL 2 ACCESS CODE	0 to 999999	This sets the level 2 access code. **WARNING: this code governs access to many of the converter functions. If the code is lost, so will access to those converter functions.**
LFDIC	LOAD FACTOR DEFAULTS	1	This overrides the converter's exiting settings with the factory defaults. **WARNING: executing this command will cause all parameters modified by the user to be lost.** Note that the read function is not supported here.
LUDIC	LOAD USER DATA	1	This overrides the converter's exiting settings with those previously saved by the SUDIC command. **WARNING: executing this command will cause all parameters modified by the user to be lost.** Note that the read function is not supported here.
SUDIC	SAVE USER DATA	1	This saves the converter's existing settings for recall later with the LUDIC command. Note that the read function is not supported here.
SRNUM	SERIAL NUMBER	0 to 999999	This displays the converter's 6-digit serial number. This can only be read and does not support the set or help commands.
TONTM	TOTAL ON TIME	0 to 999999	This displays the total time the converter has been on. This can only be read and does not support the set or help commands.
ICALE	IGNORE CALIBRATION ERRORS	0:OFF/1:ON	This instructs the converter to ignore any calibration errors during the "switch on" test.
CFFKS	KS COEFFICIENT	-99.9999 to +99.9999	This sets the Field adjustment coefficient.
CFFKZ	KZ COEFFICIENT	-999999 to +999999	This sets the Zero adjustment coefficient.

Process Data Commands

ETP	Description	Range	Notes
FRVPC	FLOW RATE VALUE PERCENTAGE	-125% to +125%	This displays (or sets, in simulation mode) the flow rate as a percent of full scale
FRVPX	FLOW RATE VALUE PERCENTAGE w/o CUTOFF		This displays (or sets, in simulation mode) the flow rate as a percent of full scale regardless of the low flow cutoff setting.
FRVTU	FLOW RATE VALUE TECHNICAL UNIT		This displays the flow rate in the technical units specified. This can only be read and does not support the set or help commands.
FRVTX	FLOW RATE VALUE TECHNICAL UNIT w/o CUTOFF		This displays the flow rate in the technical units specified regardless of the low flow cutoff setting. This can only be read and does not support the set or help commands.
VTPNV	TOTALIZER PARTIAL NEGATIVE VALUE		This displays the value for the various totalizers (partial and total, positive and negative). This can only be read and does not support the set or help commands.
VTPPV	TOTALIZER PARTIAL POSITIVE VALUE		
VTTNV	TOTALIZER NEGATIVE VALUE		
VTTPV	TOTALIZER POSITIVE VALUE		
ALARM	ALARM STATUS		This displays the status of the alarms. This can only be read and does not support the set or help commands.
INSRD	INPUT STATUS READ		This displays the status of the input. This can only be read and does not support the set or help commands.

Units Of Measure*

Volumetric unit per time	Abbreviation xxx/y → ↓	Days	Hours	Minutes	Seconds	Volumetric Totalizer Unit
		d	h	m	s	
		Converter Numeric Value				
When FRMUT = 2 (English units of measure)						
Cubic inches	in3	**0**	**1**	**2**	**3**	**0**
Gallons	gal	**4**	**5**	**6**	**7**	**1**
Imperial Gallons	IG	**8**	**9**	**10**	**11**	**2**
Cubic Feet	ft3	**12**	**13**	**14**	**15**	**3**
Barrels (=42 gallons)	bbl	**16**	**17**	**18**	**19**	**4**
Barrels (=55 gallons)	BBL	**20**	**21**	**22**	**23**	**5**
Hundreds Of Cubic Feet	hf3	**24**	**25**	**26**	**27**	**6**
Thousands Of Gallons	KGL	**28**	**29**	**30**	**31**	**7**
Thousand Imperial Gallons	IKG	**32**	**33**	**34**	**35**	**8**
Thousands Of Cubic Feet	kf3	**36**	**37**	**38**	**39**	**9**
Tens Of Thousands Of Gallons	ttG	**40**	**41**	**42**	**43**	**10**
Acre Inches	Ain	**44**	**45**	**46**	**47**	**11**
Acre Feet	Aft	**48**	**49**	**50**	**51**	**12**
Millions Of Gallons	MGL	**52**	**53**	**54**	**55**	**13**
When FRMUT = 0 (metric units of measure)						
Milliliters	ml	**0**	**1**	**2**	**3**	**0**
Cubic Centimeters	cm3	**4**	**5**	**6**	**7**	**1**
Liters	l	**8**	**9**	**10**	**11**	**2**
Cubic Decimeters	dm3	**12**	**13**	**14**	**15**	**3**
Dekaliters	dal	**16**	**17**	**18**	**19**	**4**
Hectoliters	hl	**20**	**21**	**22**	**23**	**5**
Cubic Meters	m3	**24**	**25**	**26**	**27**	**6**
Mega Liters	Ml	**28**	**29**	**30**	**31**	**7**

***** Note that the sensor does not support the mass units of measure.

Output*

Setting (enable) of the function of the indicated output to report (operate as):	Converter Numeric Value	Setting	Converter Numeric Value	Setting	Converter Numeric Value	Setting
Disable the indicated output	**0**	OFF				
Flow as pulses on channel 1	**1**	#1 IMP+ (+flow only)	**2**	#1 IMP- (-flow only)	**3**	#1 IMP (+/-flow)
Flow as pulses on channel 2	**4**	#2 IMP+ (+flow only)	**5**	#2 IMP- (-flow only)	**6**	#2 IMP (+/-flow)
Flow as frequency on channel 1	**7**	#1 FREQ+ (+flow only)	**8**	#1 FREQ- (-flow only)	**9**	#1 FREQ (+/-flow)
Flow as frequency on channel 1	**10**	#2 FREQ+ (+flow only)	**11**	#2 FREQ- (-flow only)	**12**	#2 FREQ (+/-flow)
Flow direction indication (off = + / on = -)	**13**	SIGN				
Flow scale indication (on = scale 2)	**14**	RANGE				
Maximum flow alarm	**15**	MAX AL.+ (+flow only)	**16**	MAX AL.- (-flow only)	**17**	MAX AL. (+/-flow)
Minimum flow alarm	**18**	MIN AL.+ (+flow only)	**19**	MIN AL.- (-flow only)	**20**	MIN AL. (+/-flow)
Maximum or minimum flow alarm	**21**	MAX + MIN				
Empty pipe alarm	**22**	P.EMPTY				
Out of range alarm	**23**	OVERFLOW				
Cumulative (any) alarm	**24**	HARDW AL.				

***** Note that the sensor does not support the batching functions, codes 25-29.

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