GUIDANT

Electronic Gas Flow Computer System

Smith Meter® microFlow.net™ Gas

Modbus Communications Manual

Bulletin MNFG005 Issue/Rev 0.0 (6/11)

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Caution

The default or operating values used in this manual and in the program of the microFlow.net Gas are for factory testing only and should not be construed as default or operating values for your metering system. Each metering system is unique and each program parameter must be reviewed and programmed for that specific metering system application.

Disclaimer

Guidant hereby disclaims any and all responsibility for damages, including but not limited to consequential damages, arising out of or related to the inputting of incorrect or improper program or default values entered in connection with the microFlow.net Gas.

Proprietary Notice

Introduction

The Modbus protocol was developed by Modicon, Inc. to be a concise method of transferring data to/from programmable logic controllers (PLCs). It has become a de-facto standard in many areas of industrial automation where supervisory control or remote data collection is required. In a Modbus system, a host (master) communicates with one or multiple field devices (slaves). The microFlow.net Gas acts as a slave device only; an external host must act as the master to query or control the microFlow.net Gas. Each microFlow.net Gas must have a unique communication address in the range of 1 to 99. It is recommended that communications ports 2 or 3 on the microFlow.net Gas be used for Modbus communications. Host messages to address 0 (the Modbus broadcast address) are not currently supported (are ignored) by the microFlow.net Gas. For more information regarding Modbus communications specifics, refer to the Modbus Communications primer in the Appendix.

Modbus/TCP

Modbus/TCP is a standard that defines a TCP/IP based version of the Modbus protocol for use over communications links such as Ethernet, etc.

All requests are sent via TCP on registered **port 502**.

Requests are normally sent in half-duplex fashion on a given connection. That is, there is no benefit in sending additional requests on a single connection while a response is outstanding. Devices which wish to obtain high peak transfer rates are instead encouraged to establish multiple TCP connections to the same target, however some existing client devices are known to attempt to 'pipeline' requests. Design techniques which allow a server to accommodate this behavior are described in Appendix A.

The Modbus 'slave address' field is replaced by a single byte 'Unit Identifier' which may be used to communicate via devices such as bridges and gateways which use a single IP address to support multiple independent end units.

The original Modbus protocol request and response are prefixed by six bytes in Modbus/TCP as follows:

byte 0: transaction identifier - copied by server - usually 0
byte 1: transaction identifier - copied by server - usually 0
byte 2: protocol identifier = 0
byte 3: protocol identifier = 0
byte 4: length field (upper byte) = 0 (since all messages are smaller than 256)
byte 5: length field (lower byte) = number of bytes following
byte 6: unit identifier (previously 'slave address')
byte 7: Modbus function code
byte 8 and up: data as needed

So an example transaction 'read 1 register at offset 4 from UI 9' returning a value of 5 would be

request: 00 00 00 00 00 06 09 03 00 04 00 01

response: 00 00 00 00 00 05 09 03 02 00 05

Designers familiar with Modbus should note that the 'CRC-16' or 'LRC' check fields are NOT needed in Modbus/TCP. The TCP/IP and link layer (eg. Ethernet) checksum mechanisms instead are used to verify accurate delivery of the packet.

For detailed specifications on the Modbus protocol refer to the following website: www.modbus.org.

Floating Point Endian Control

Floating-point numbers are not defined in the Modbus specification; there are nearly as many variations of how it is supported as there are vendors. Most often, Modbus registers are combined sequentially to make up an IEEE single precision or double precision floating point number; this is the case in the microFlow.net Gas. Two registers are needed for single precision and four for double precision numbers. There are, however, several ways to map floating point values to Modbus registers. To assure compatibility with off-the-shelf drivers, three popular variations of byte ordering for floating point numbers are supported (see system program code 727).

Communications Control Selections

This program code defines the level of control the associated communications port commands. Poll and Program, and Host Control are valid with host communications options. XON/XOFF is valid with printer options. Selections are as follows:

None – No communications control on this port.

Poll & Program – For use with demonstration/microMate ports. Allows full program access but does not affect transaction control (acts like a standalone unit).

Host Control – Full programming and prompting control. plus transaction control (requiring authorization from host). Allows use of AU or AP (Authorize, Authorize to Preset) or SB (Set Batch) to enter the preset remotely.

Xon/Xoff – For printer ports only. Xon/Xoff flow control.

PTB-FX – For printer ports only. Security level designed to support PTB compliant printers.

PTB-LQ – For printer ports only. Security level designed to support PTB compliant printers.

Critical: Comm port not configured for host communications.

Critical: Comm port not configured for printer.

Note: *No entry if corresponding function = Not Used.*

Help: Select the degree of control for this communications port.

Configuring the microFlow.net Gas for Modbus Communications Via Serial Port

- Press <Enter> at the Ready screen to access the Main Menu
- From the Main Menu, select Program Mode Menu and press <Enter>
- Enter the Access Code when prompted and press <Enter>
- From the Program Mode, select Comm Directory and press <Enter>
- Select Comm Port Config and press <Enter>
- From the Comm Port Config menu, select the desired port
- From the chosen communications port, set up the following items:

  Baud Rate – the rate at which the Modbus device is sending data.

  Data Parity – typical or standard setting is 8/None.

  Control – can be Host Control, but standard is Poll and Program due to access being granted at the microFLow.net Gas to start/stop batches (refer to Comm. Control Settings in previous section).

  Timeout – dependent on Modbus host polling rate and number of slave devices in the loop.

  Mode – dependent on EIA 232/EIA 485 wiring configuration. Must match the master device.
- Return to the Main Menu by pressing the <Clear> key.

Configuring the microFlow.net Gas for Modbus Communications via TCP/IP (Ethernet or SLIP)

- Press <Enter> at the Ready screen to access the Main Menu
- From the Main Menu, select Program Mode Menu and press <Enter>
- Enter the Access Code when prompted and press <Enter>
- From the Program Mode menu, select Comm. Directory and Press <Enter>
- Select Host Interface and press <Enter>
- From the Host interface Menu set the following items:

Host Interface
IP Address: 192.168.0.1
Net mask: 255.255.255.0
Gateway: 192.168.0.10
Ethernet Control: Poll and Program
--> Com Link: Level 3

- Return to the Main Menu using the <Clear> key

To access Modbus/TCP on the microFlow.net Gas – connect to the standard Modbus/TCP port 502 via the Ethernet port or a serial port configured for SLIP.

Supervisory System Polling Example

During normal operation the supervisory system usually monitors the health and status of the flow computer as well as the current line conditions. The following paragraphs describe a basic polling loop example.

Step 1 – Monitor alarm flag and process variables
Step 2 – Check batch done flag, if not set return to step 1 else continue to step 3
Step 3 – Read totals and averages from the just completed batch
Step 4 – Reset the batch done flag, continue to step 1

Step 1 Registers

Coil (modbus function code = 1 read coil)

Register	Contents
259	Alarm active flag

Single precision process value – 2 registers each (function code = 4)

Register	Contents
2818	Current temperature
2820	Current pressure
2826	Energy forward flowrate
2912 - 2952	Current Mole % gas composition

Double precision process value – 4 registers each (function code = 4)

Register	Contents
3084	Current forward standard volume batch total
3092	Current forward energy batch total
3156	Current base density

Step 2 Registers

Coil (modbus function code = 1 read coil)

258	Batch done flag

Step 3 Registers

Registers	Contents
36484	Select previous batch by number back command – write 1 to select previous batch
3587	Read command result register to verify the previous batch data has been retrieved without error. (good result is 254). Then read totals etc. for previous batch from the same registers used in step number 1.
36484	When finished reading previous batch data, write a zero to select the current batch data. Then return to the basic polling loop at step 1.

Note: *Section III contains a complete listing of the modbus registers and the contents. There are many more process variables available in addition to the ones shown in this example.*

Implementing Host Control (Automation) Interface via Modbus

Special Modbus registers for Host Control

Certain registers are 'trigger' registers that invoke a host automation command such as a prompting function or a remote authorization function. These registers are listed here. Note that some of these 'trigger' registers require other registers have valid argument values prior to invoking the command trigger.

Registers that are 'trigger' registers will be designated with the superscript symbol † in the appendix. Registers that act as arguments for a trigger register are in italics.

Host Command Result Status Register

For each write to a trigger register that implements a host command, the result of the operation will be left in the Host Result register (Function 4, register 3594). If the command was executed successfully the value in this register will be 254. Otherwise the value in the register will be set to one of the following error codes indicating the operation was not completed for the reason described below:

01 In Program Mode
02 Released
03 Value Rejected
04 Flow Active
05 No Transaction Ever Done
06 Operation Not Allowed
07 Wrong Control Mode
08 Transaction In Progress
09 Alarm Condition
10 Storage Full
11 Operation out of Sequence
12 Power Failed During Transaction
13 Already Authorized
14 Program Code Not Used
15 Display/Keypad in Remote mode
16 Ticket Not In Printer
17 No Keypad Data Pending
18 No Transaction In Progress
19 Option Not Installed/Enabled
20 Start After Stop Delay in Effect
21 Permissive Not Met
22 Print Request Pending
23 No Meter Enabled
24 Must be In Program Mode
25 Ticket Alarm During Transaction
26 Volume Type Not Available
27 Exactly One Recipe Must Be Enabled
28 Batch Limit Reached
29 Checking Entries
30 Product/Recipe/Additive not Assigned to this Arm
31 Operation Conflicts with Arm Configuration
32 No Key Ever Pressed
33 Active Arm Limit Already Met
34 Transaction Not Standby
35 Swing Arm Out of Position
36 Card-In Required
37 Data Not Available
38 Too Many Shared Additives
39 No Current Batch on This Arm
40 Must Use Minicomputer Protocol For This Operation
91 Communications Buffer Allocation Error
92 Keypad Locked
93 Data Recall Error

94 Not In Program Mode
95 Security Access Not Available
96 Internal Error

Program Mode Interface – Entering Program Mode via Modbus

Entry to Program mode via Modbus is done by simply writing a value to a configuration register in the map (assuming all security requirements are met). Each write to the configuration restarts the auto-logout timer. If three seconds transpire with no additional updates (writes), it is assumed by the microFlow.net Gas that the host has completed the Program Mode session and the changes will be accepted and used (if all were valid). See the Operator Reference manual for detailed descriptions of the various Program Codes available for configuration of the microFlow.net Gas.

Program Mode Interface – Explicit Logout command

Register: 40577 (Function 6/16 – Write Holding Register) – word data

If it is not desired to wait for the three second period to expire, it is possible to force the unit to exit program mode immediately by writing to the above register. If the value 1 is written, the preceding changes will be accepted and used. If the value 2 is written, any changes made will be abandoned and the original values prior to entry into Program mode by the Modbus host will continue to be used.

Note: *this immediate logout functionality is also assumed implicitly when host commands like Allocate Recipes or Set Batch are issued when in Program mode via Modbus.*

Set Time/Date

To set the date and time via Modbus, write the following holding registers (Function 3):

7688 (30344) *Time Set – Year, 4 digit*
7689 (30345) *Time Set - Month*
768A (30346) *Time Set - Day*
768B (30347) *Time Set - Hour*
768C (30348) *Time Set - Minute*
768D (30349) *Time Set - Seconds*
768E (30350)† Time Set (0=MIL,1=AM,2=PM)

Alarm Clearing

Force the Alarm Status coil Off (Write a 0 to coil 264 using Modbus Function 5/15) to clear all active alarms.

Other Host clearable flags (Program Change, Power Fail, Transaction/Batch Done, etc.)

Force the status flag Off (Write a 0 to coil using Modbus Function 5/15) to clear the flag.

Coil #	Status Flag Cleared on Write of 0
2	Program Mode Value Changed
3	Power-fail Occurred
259	Batch Done
260	Transaction Done

Read Batch Log

The batch data is read from the same Modbus locations for both current and historical batches. Hence, historical batch data should only be requested during idle periods. Also, to read current data the Batch Select register MUST BE SET TO 0. After reading historic batch log data, be sure to set the host batch select register back to 0 to be able to read current run data.

To retrieve batch data:

Write host batch select register - 0=current, 1 or greater = number back in storage
Function 6, register 40587† (unsigned integer)

Read Modbus host command result to assure the retrieval was successful

Function 4, register 3594 (254 on success, an error code from 1-99 otherwise)

Read the batch data areas as you would for a current batch
Example- read batch header info – end time text, start time text
Function 4, registers 2432-2447 (text)
Function 4, registers 2448-2463 (text)

Example 2 - read unsigned character batch run data – recipe number
Function 4, register 5632 (unsigned integer)

Read Event Log

To read historical events from the event log, the following steps are used. The most recent event log entry's sequence number is available via Function 4, registers 1792-1793 (unsigned long integer).

To read an entry:

- Write desired event's sequence number to request register (Function 16; registers 30464-30465)†
- Read text for event from Event/Audit Log Text registers (Function 4, registers 48-96, Text)

If an error occurs (such as invalid seq #, etc.) the Host Result Register will be set to a value other than 254 indicating the error. On success, the Host Result Register will contain the value 254.

Read Audit Log

Reading from the Audit Log uses the same procedure as reading from the Event Log. Replace the register numbers for the most recent entry and the request with the Audit Log equivalents; the entry itself is read from the same location for both the Event and Audit logs: The most recent Audit Log entry's sequence number can be read via Function 4, registers 1794-1795 (unsigned long integer).

To read an entry:

- Write desired entry sequence number to request register (Function 16; registers 30466-30467)†
- Read text for event from Event/Audit Log Text registers (Function 4, registers 48-96, Text)

If an error occurs (such as invalid seq #, etc.) the Host Result Register will be set to a value other than 254 indicating the error. On success, the Host Result Register will contain the value 254.

Modbus Register Reference

INPUT (STATUS) COILS – Function 2

Dec. Hex. Description

Directory: SYS_RUN_DATA

Data Type: BOOLEAN

Start Address: 0

0 (0000) In Program Mode
1 (0001) Checking Entries
2 (0002) Program Mode Value Changed
3 (0003) Power-fail Occurred
4 (0004) Printing in Progress

Directory: BATCH_RUN_DATA

Data Type: BOOLEAN

Start Address: 256

256 (0100) microFlow Released
257 (0101) Batch in Progress
258 (0102) Batch Done
259 (0103) Alarm Active
260 (0104) Product Flowing
261 (0105) Permissive Not Met

Directory: BATCH_RUN_DATA

Data Type: UNSIGNED INTEGER

Start Address: 3712

3712 (0E80) Batch Number
3713 (0E81) Batch start year
3714 (0E82) Batch start month
3715 (0E83) Batch start day
3716 (0E84) Batch start week day
3717 (0E85) Batch start seconds
3718 (0E86) Batch start minutes
3719 (0E87) Batch start hour
3720 (0E88) Batch end year
3721 (0E89) Batch end month
3722 (0E8A) Batch end day
3723 (0E8B) Batch end week day
3724 (0E8C) Batch end seconds
3725 (0E8D) Batch end minutes
3726 (0E8E) Batch end hour

Directory: DIG_RUN_DATA

Data Type: BOOLEAN

Start Address: 512

512 (0200) Current Digital I/O State

Directory: SYSTEMS_ALARMS

Data Type: BOOLEAN

Start Address: 1280

1280 (0500) DA: ROM Bad
1281 (0501) DA: RAM Bad
1282 (0502) DA: Flash Memory Error
1283 (0503) DA: RAM Corrupt on Power-Up
1284 (0504) DA: Flash Corrupt on Power-Up
1285 (0505) DA: Watchdog Alarm
1286 (0506) DA: Program Error
1287 (0507) DA: Passcodes Reset
1288 (0508) PA: Power-fail Alarm
1289 (0509) U1: User Alarm 1
1290 (050A) U2: User Alarm 2
1291 (050B) U3: User Alarm 3
1292 (050C) U4: User Alarm 4
1293 (050D) U5: User Alarm 5
1294 (050E) CM: Communications Alarm
1295 (050F) PS: Pulse Security Alarm
1296 (0510) TP: Temperature Probe Alarm
1297 (0511) DR: Density Transducer Failure
1298 (0512) PR: Pressure Transducer Alarm
1299 (0513) HF: High Flow Alarm
1300 (0514) HT: High Temperature Alarm
1301 (0515) HD: High Density Alarm
1302 (0516) HP: High Pressure Alarm
1303 (0517) LF: Low Flow Alarm
1304 (0518) LT: Low Temperature Alarm
1305 (0519) LD: Low Density Alarm
1306 (051A) LP: Low Pressure Alarm
1307 (051B) MF: Mass Meter Comm Fail
1308 (051C) MO: Mass Meter Overdrive
1309 (051D) MT: Mass Meter Tube Fail
1310 (051E) PP: PTB Printer Failure
1311 (051F) SP: Shared Printer Failure
1312 (0520) SA: Sampler Error
1313 (0521) UC: Ultrasonic Comm Fail
1314 (0522) UM: Ultrasonic Meter Fail
1315 (0523) GC: GC Comm Fail
1316 (0524) GF: GC Failure

OUTPUT COILS – Function 1/5/15

Directory: DIGITAL_CMDS

Data Type: BOOLEAN

Start Address: 2560

2560 (0A00) Set Digital Output Value

Program Configuration, etc. – HOLDING REGISTERS - Function 3, 6, 16 Table:

Dec. Hex. Parameter # and Description

Directory: DIGITAL_CMDS
Data Type: UNSIGNED CHAR
Start Address: 3584

3584 (0E00) 201 Input 1 (DC)
3585 (0E01) 202 Input 2 (DC)
3586 (0E02) 203 Input 3 (DC)
3587 (0E03) 301 Output 1 (DC)
3588 (0E04) 302 Output 2 (DC)
3589 (0E05) 303 Output 3 (AC)
3590 (0E06) 304 Output 4 (AC)
3591 (0E07) 305 Output 5 (AC)
3592 (0E08) 306 Output 6 (AC)

Directory: ANALOG_DIR
Data Type: FLOATING POINT
Start Address: 4864

4864 (1300) 402 Analog I/O 1 RTD Offset
4866 (1302) 412 Analog I/O 2 (4-20ma) Low Value
4868 (1304) 413 Analog I/O 2 (4-20ma) High Value

Directory: ANALOG_DIR
Data Type: UNSIGNED CHAR
Start Address: 5632

5632 (1600) 401 RTD
5633 (1601) 411 4-20 ma Function

Directory: SYSTEM_DIR
Data Type: TEXT
Start Address: 6144

6144 (1800) 101 Date {O}
6160 (1810) 102 Time {O}
6176 (1820) 691 User Alarm 1 Message
6192 (1830) 692 User Alarm 2 Message
6208 (1840) 693 User Alarm 3 Message
6224 (1850) 694 User Alarm 4 Message
6240 (1860) 695 User Alarm 5 Message

Directory: SYSTEM_DIR
Data Type: FLOATING POINT
Start Address: 6912

6912 (1B00) 102 Pulse Out 1 Pulses/Amount
6914 (1B02) 104 Pulse Out 1 Max Frequency
6916 (1B04) 402 Reference Temperature
6918 (1B06) 415 Density of Air
6920 (1B08) 502 Reference Pressure

Directory: SYSTEM_DIR
Data Type: UNSIGNED CHAR
Start Address: 7680

7680 (1E00) 101 Pulse Output Function
7681 (1E01) 103 Pulse Output Units
7682 (1E02) 111 Flow Rate Time
7683 (1E03) 112 Volume Units
7684 (1E04) 113 Mass Units
7685 (1E05) 114 Energy Units
7686 (1E06) 115 Velocity Units
7687 (1E07) 122 Default Run Time Screen
7688 (1E08) 123 Display Resolution
7689 (1E09) 124 Decimal/Comma Select
7690 (1E0A) 125 Default/Translated Literals
7691 (1E0B) 131 Dynamic Display Timeout
7692 (1E0C) 132 Auto Reset Time
7693 (1E0D) 141 Batch Reset
7694 (1E0E) 142 Sampler Type
7695 (1E0F) 143 Sampler Pace
7696 (1E10) 144 Sampler Pulse Width
7697 (1E11) 145 Sampler Disable
7698 (1E12) 312 Pulse In Type
7699 (1E13) 313 Channel Select
7700 (1E14) 401 Temperature Units
7701 (1E15) 411 Density Units
7702 (1E16) 501 Pressure Units
7703 (1E17) 601 User Alarm Clearing
7704 (1E18) 602 Powerfail Alarm
7705 (1E19) 724 Ethernet Host Control
7706 (1E1A) 725 Comm Link Programming
7707 (1E1B) 727 Modbus Endian Select
7708 (1E1C) 735 User Text Archived
7709 (1E1D) 406 Combustion Temperature

Directory: SYSTEM_DIR
Data Type: UNSIGNED LONG
Start Address: 7936

7936 (1F00) 721 IP Address
7938 (1F02) 722 Netmask
7940 (1F04) 723 Gateway
7942 (1F06) 335 Ultrasonic IP Address
7944 (1F08) 382 GC IP Address

Directory: SYSTEM_DIR
Data Type: UNSIGNED INTEGER
Start Address: 9856

9856 (2680) 161 Level 1 Access Code
9857 (2681) 162 Level 2 Access Code
9858 (2682) 163 Level 3 Access Code
9859 (2683) 164 Level for Security Input
9860 (2684) 165 Level for Diagnostics Dir.

Directory: ANA_RUN_DATA
Data Type: FLOATING POINT
Start Address: 6912

6912 (1B00) Analog Counts
6914 (1B02) Analog Raw Value (mA or volts)
3916 (1B04) Analog Engineering Value

Directory: PROMPT_DIR
Data Type: TEXT
Start Address: 10240

10240 (2800) 763 Prompt 1 Message
10256 (2810) 766 Prompt 2 Message
10272 (2820) 769 Prompt 3 Message
10288 (2830) 772 Prompt 4 Message
10304 (2840(775 Prompt 5 Message

Directory: PROMPT_DIR
Data Type: UNSIGNED CHAR
Start Address: 11776

11776 (2E00) 761 Prompts Used
11777 (2E01) 762 Prompt Timeout
11778 (2E02) 764 Prompt 1 Input Type
11779 (2E03) 765 Prompt 1 Length
11780 (2E04) 767 Prompt 2 Input Type
11781 (2E05) 768 Prompt 2 Length
11782 (2E06) 770 Prompt 3 Input Type
11783 (2E07) 771 Prompt 3 Length
11784 (2E08) 773 Prompt 4 Input Type
11785 (2E09) 774 Prompt 4 Length
11786 (2E0A) 776 Prompt 5 Input Type
11787 (2E0B) 777 Prompt 5 Length

Directory: ALARM_DIR
Data Type: UNSIGNED CHAR
Start Address: 13824

13824 (3600) 611 Communications Alarm
13825 (3601) 621 High Flow Alarm
13826 (3602) 622 Low Flow Alarm
13827 (3603) 635 High Temperature Alarm
13828 (3604) 636 Low Temperature Alarm
13829 (3605) 637 Temp Transducer Alarm
13830 (3606) 638 High Density Alarm
13831 (3607) 639 Low Density Alarm
13832 (3608) 640 Density Transducer Alarm
13833 (3609) 641 High Pressure Alarm
13834 (360A) 642 Low Pressure Alarm
13835 (360B) 643 Pres Transducer Alarm
13836 (360C) 651 Pulse Security Alarm
13837 (360D) 652 Mass Mtr Comm Alarm
13838 (360E) 653 Mass Mtr Overdrive Alarm
13839 (360F) 654 Mass Mtr Tube Alarm
13840 (3610) 612 PTB Printer Failure
13841 (3611) 613 Shared Printer Failure
13842 (3612) 614 Sampler Failure
13843 (3613) 655 Ultrasonic Comm Alarm
13844 (3614) 656 Ultrasonic Meter Alarm
13845 (3615) 657 GC Comm Alarm
13846 (3616) 658 GC Alarm

Directory: USER_ALARM_DIR
Data Type: UNSIGNED CHAR
Start Address: 15872

15872 (3E00) 681 User Alarm 1
15873 (3E01) 682 User Alarm 2
15874 (3E02) 683 User Alarm 3
15875 (3E03) 684 User Alarm 4
15876 (3E04) 685 User Alarm 5

Directory: COMM_PORT_DIR
Data Type: UNSIGNED CHAR
Start Address: 17920

17920 (4600) 701 Comm 1 Function
17921 (4601) 707 Comm 2 Function
17922 (4602) 713 Comm 3 Function
17923 (4603) 702 Comm 1 Baud Rate
17924 (4604) 708 Comm 2 Baud Rate
17925 (4605) 714 Comm 3 Baud Rate
17926 (4606) 703 Comm 1 Data/Parity
17927 (4607) 709 Comm 2 Data/Parity
17928 (4608) 715 Comm 3 Data/Parity
17929 (4609) 704 Comm 1 Control
17930 (460A) 710 Comm 2 Control
17931 (460B) 716 Comm 3 Control
17932 (460C) 706 Comm 1 Mode
17933 (460D) 712 Comm 2 Mode
17934 (460E) 718 Comm 3 Mode

Directory: COMM_PORT_DIR
Data Type: UNSIGNED INTEGER
Start Address: 18048

18048 (4680) 705 Comm 1 Timeout
18049 (4681) 711 Comm 2 Timeout
18050 (4682) 717 Comm 3 Timeout
18051 (4683) 726 Ethernet Host Timeout

Directory: LOAD_ARM_DIR
Data Type: TEXT
Start Address: 18432

18432 (4800) 121 Flow Computer ID
18448 (4810) 152 Permissive 1 Message
18464 (4820) 154 Permissive 2 Message
18480 (4830) 733 Report Print Time

Directory: LOAD_ARM_DIR
Data Type: UNSIGNED CHAR
Start Address: 19968

19968 (4E00) 151 Permissive 1 Sense
19969 (4E01) 153 Permissive 2 Sense
19970 (4E02) 731 Report Select
19971 (4E03) 732 Report Total Resolution
19972 (4E04) 734 Report Interval

19973 (4E05) 736 Batch Reset on Report

Directory: METER_DIR
Data Type: FLOATING POINT
Start Address: 20480

20480 (5000) 302 Meter ID
20496 (5010) 303 Meter S/N

Directory: METER_DIR
Data Type: FLOATING POINT
Start Address: 21248

21248 (5300) 202 Minimum Flow Rate
21250 (5301) 203 High Flow Rate
21252 (5302) 204 Flow Tolerance %
21254 (5304) 205 Flow Tolerance Rate
21256 (5306) 221 Excess High Flow Rate
21258 (5308) 222 Low Flow Alarm Limit
21260 (530A) 316 Dual Pulse Flow Rate Cutoff
21262 (530C) 341 Meter Factor 1
21264 (5310) 342 Flow Rate 1
21266 (5312) 343 Meter Factor 2
21268 (5314) 344 Flow Rate 2
21270 (5316) 345 Meter Factor 3
21272 (5318) 346 Flow Rate 3
21274 (531A) 347 Meter Factor 4
21276 (531C) 348 Flow Rate 4
21278 (531E) 349 Meter Factor 5
21280 (5320) 350 Flow Rate 5
21282 (5322) 351 Meter Factor 6
21284 (5324) 352 Flow Rate 6
21286 (5326) 353 Meter Factor 7
21288 (5328) 354 Flow Rate 7
21290 (532A) 355 Meter Factor 8
21292 (532C) 356 Flow Rate 8
21294 (532E) 357 Meter Factor 9
21296 (5330) 358 Flow Rate 9
21298 (5332) 359 Meter Factor 10
21300 (5334) 360 Flow Rate 10
21302 (5336) 361 Master Meter Factor
21304 (5338) 362 Linear Factor Deviation
21306 (533A) 364 Mtr Factor % Change Per Degree
21308 (533C) 365 Mtr Factor Variation Ref Temp
21310 (533E) 373 SMASS Coefficient Ka
21312 (5340) 374 SMASS Coefficient Kb
21314 (5342) 375 SMASS Coefficient Kc
21316 (5344) 403 Maintenance Temperature
21318 (5346) 404 High Temperature Alarm
21320 (5348) 405 Low Temperature Alarm
21322 (534A) 412 Maintenance Line Density
21324 (534C) 413 High Density Alarm
21326 (534E) 414 Low Density Alarm
21328 (5350) 503 Maintenance Pressure
21330 (5352) 504 High Pressure Alarm Limit
21332 (5354) 505 Low Pressure Alarm Limit
21334 (5356) 383 GC C6 Percent
21336 (5358) 384 GC C7 Percent
21338 (535A) 385 GC C8 Percent

Directory: METER_DIR
Data Type: DOUBLE
Start Address: 21504

21504 (5400) 311 K Factor

Directory: METER_DIR
Data Type: UNSIGNED CHAR
Start Address: 22016

22016 (5600) 201 Valve Type
22017 (5601) 301 Meter Type
22018 (5602) 315 Dual Pulse Error Reset
22019 (5603) 317 Pulse Period Sample Count
22020 (5604) 331 Ultrasonic Meter Type
22021 (5605) 332 Ultrasonic Meter Config
22022 (5606) 333 Share Temp. w/Meter
22023 (5607) 334 Share Press. w/Meter
22024 (5608) 363 Meter Factor Variation Select
22025 (5609) 371 Mass Meter Type
22026 (560A) 377 Mass Meter Pulse Multiplier
22027 (560B) 378 Mass Meter Low Flow Cutoff
22028 (560C) 379 Mass Meter Tube Material
22029 (560D) 380 Mass Meter Model

Directory: METER_DIR
Data Type: UNSIGNED CHAR
Start Address: 22144

22144 (5680) 314 Dual Pulse Error Count
22145 (5681) 376 SMASS Density Factor
22146 (5682) 381 GC Update Timeout

Directory: METER_DIR
Data Type: UNSIGNED CHAR
Start Address: 22272

22272 (5700) 372 Mass Meter Sequence Number

Directory: PRODUCT_DIR
Data Type: TEXT
Start Address: 22528

22528 (5800) 002 Product Name

Directory: PRODUCT_DIR
Data Type: FLOATING POINT
Start Address: 23296

23296 (5B00) 041 Maintenance Reference Density
23298 (5B02) 042 Maintenance Heat Value
23300 (5B04) 043 Maintenance Viscosity
23302 (5B06) 044 Maintenance Isentropic Exponent

Directory: PRODUCT_DIR
Data Type: UNSIGNED CHAR
Start Address: 23552

23552 (5C00) 011 Mole % Methane (C1)
23556 (5C04) 012 Mole % Nitrogen (N2)
23560 (5C08) 013 Mole % Carbon Dioxide (CO2)
23564 (5C0C) 014 Mole % Ethane (C2)
23568 (5C10) 015 Mole % Propane (C3)
23572 (5C14) 016 Mole % Water (H2O)
23576 (5C18) 017 Mole % Hydrogen Sulfide (H2S)
23580 (5C1C) 018 Mole % Hydrogen (H2)
23584 (5C20) 019 Mole % Carbon Monoxide (CO)
23588 (5C24) 020 Mole % Oxygen (O2)
23592 (5C28) 021 Mole % i-Butane (iC4)
23596 (5C2C) 022 Mole % n-Butane (nC4)
23600 (5C30) 023 Mole % i-Pentane (iC5)
23604 (5C34) 024 Mole % n-Pentane (nC5)
23608 (5C38) 025 Mole % n-Hexane (nC6)
23612 (5C3C) 026 Mole % n-Heptane (nC7)
23616 (5C40) 027 Mole % n-Octane (nC8)
23620 (5C44) 028 Mole % n-Nonane (nC9)
23624 (5C48) 029 Mole % n-Decane (nC10)
23628 (5C4C) 030 Mole % Helium (He)
23632 (5C50) 031 Mole % Argon (Ar)

Directory: PRODUCT_DIR
Data Type: UNSIGNED CHAR
Start Address: 24064

24064 (5E00) 003 Heat Value Calculation Method

Directory: SYSTEM_CMDS
Data Type: UNSIGNED CHAR
Start Address: 26112

26112 (6600) Set User Alarm

Directory: SYSTEM_CMDS
Data Type: UNSIGNED INTEGER
Start Address: 26240

26240 (6680) Tenth Second Timer Set
26241 (6681) Tenth Second Timer Set
26242 (6682) One Second Timer Set
26243 (6683) One Second Timer Set
26244 (6684) One Minute Timer Set
26245 (6685) One Minute Timer Set
26246 (6686) One Hour Timer Set
26247 (6687) One Hour Timer Set
26248 (6688) Time Set – Year
26249 (6689) Time Set – Month
26250 (668A) Time Set – Day
26251 (668B) Time Set – Hour
26252 (668C) Time Set – Minute
26253 (668D) Time Set – Seconds
26254 (668E) Time Set – 0=MIL, 1=AM, 2=PM

Directory: SYSTEM_CMDS
Data Type: UNSIGNED LONG
Start Address: 26368

26368 (6700) Request Event Log Entry
26370 (6702) Request Audit Log Entry

Directory: ALGEBOOL_DATA
Data Type: FLOATING POINT
Start Address: 29440

29440 (7300) User Float Register

Directory: ALGEBOOL_DATA
Data Type: UNSIGNED CHAR
Start Address: 30208

30208 (7600) User Boolean Register

Directory: ALGEBOOL_DATA
Data Type: UNSIGNED INTEGER
Start Address: 30336

30336 (7680) 1/10 Second Timer 1 Value
30337 (7681) 1/10 Second Timer 2 Value
30338 (7682) 1 Second Timer 1 Value
30339 (7683) 1 Second Timer 2 Value
30340 (7684) 1 Minute Timer 1 Value
30341 (7685) 1 Minute Timer 2 Value
30342 (7686) 1 Hour Timer 1 Value
30343 (7687) 1 Hour Timer 2 Value

Directory: ARM_CMDS
Data Type: TEXT
Start Address: 34816

34816 (8800) BR S/BW S – User Text 1
34832 (8810) BR S/BW S – User Text 2
34848 (8820) BR S/BW S – User Text 3
34864 (8830) BR S/BW S – User Text 4
34880 (8840) BR S/BW S – User Text 5
34896 (8850) BR S/BW S – User Text 6
34912 (8860) BR S/BW S – User Text 7
34928 (8870) BR S/BW S – User Text 8

Directory: ARM_CMDS
Data Type: UNSIGNED INTEGER
Start Address: 36480

36480 (8E80) PP – Print to Printer
36481 (8E81) LO – Program Mode Logout
36482 (8E82) SB – Reset Batch
36483 (8E83) SA/ST/SP – Host Start/Stop
36484 (8E84) Archived Transaction Retrieval – Number Back (0=current)

*******Start of Function 4***** – STATUS REGISTERS - Function 4 Table:**

Dec. Hex. Description

Directory: SYS_RUN_DATA

Data Type: TEXT

Start Address: 0

0 (0000) Time of Last Power Fail
16 (0010) Requested Audit/Event Log Entry Pt 1
32 (0020) Requested Audit/Event Log Entry Pt 2
48 (0030) Requested Audit/Event Log Entry Pt 3

Directory: SYS_RUN_DATA

Data Type: UNSIGNED CHAR

Start Address: 1536

1536 (0600) ROM Major Version #
1537 (0601) ROM Minor Version #
1538 (0602) Current Time Type (Mil, AM, PM)
1539 (0603) Last Key Pressed

Directory: SYS_RUN_DATA

Data Type: UNSIGNED INTEGER

Start Address: 1664

1536 (0680) Current year
1537 (0681) Current month
1538 (0682) Current day
1539 (0683) Current week day
1537 (0684) Current seconds
1538 (0685) Current minutes
1539 (0686) Current hour

Directory: SYS_RUN_DATA

Data Type: UNSIGNED LONG

Start Address: 1792

1792 (0700) ROM CRC
1794 (0702) Most Recent Event Sequence Number
1796 (0704) Most Recent Audit Trail Sequence Number

Directory: BATCH_RUN_DATA

Data Type: TEXT

Start Address: 2048

2048 (0800) 1st Alarm in Batch
2064 (0810) 2nd Alarm in Batch
2080 (0820) 3rd Alarm in Batch
2096 (0830) 4th Alarm in Batch
2112 (0840) 5th Alarm in Batch
2128 (0850) 6th Alarm in Batch
2144 (0860) 7th Alarm in Batch
2160 (0870) 8th Alarm in Batch
2176 (0880) 9th Alarm in Batch
2192 (0890) 10th Alarm in Batch
2208 (08A0) 11th Alarm in Batch
2224 (08B0) 12th Alarm in Batch
2240 (08C0) 13th Alarm in Batch
2256 (08D0) 14th Alarm in Batch
2272 (08E0) 15th Alarm in Batch
2288 (08F0) 16th Alarm in Batch
2304 (0900) 17th Alarm in Batch
2320 (0910) 18th Alarm in Batch
2336 (0920) 19th Alarm in Batch
2352 (0930) 20th Alarm in Batch
2368 (0940) Batch Start Time
2384 (0950) Batch End Time
2400 (0960) Alphanumeric Prompt Response 1
2416 (0970) Alphanumeric Prompt Response 2
2432 (0980) Alphanumeric Prompt Response 3
2448 (0990) Alphanumeric Prompt Response 4
2464 (09A0) Alphanumeric Prompt Response 5
2480 (09B0) User Text 1 (Archived)
2496 (09C0) User Text 2 (Archived)
2512 (09D0) User Text 3 (Archived)
2528 (09E0) User Text 4 (Archived)
2544 (09F0) User Text 5 (Archived)
2560 (0A00) User Text 6 (Archived)
2576 (0A10) User Text 7 (Archived)
2592 (0A20) User Text 8 (Archived)

Directory: BATCH_RUN_DATA

Data Type: FLOATING POINT

Start Address: 2816

2816 (0B00) Current Meter Factor
2818 (0B02) Current Temperature
2820 (0B04) Current Pressure
2822 (0B06) Average (Fwd) Line Volume Flow Rate
2824 (0B08) Average (Fwd) GSV Flow Rate
2826 (0B0A) Average (Fwd) Energy Flow Rate
2828 (0B0C) Average (Fwd) Mass Flow Rate
2830 (0B0E) Average (Rev) Line Volume Flow Rate
2832 (0B10) Average (Rev) GSV Flow Rate
2834 (0B12) Average (Rev) Energy Flow Rate
2836 (0B14) Average (Rev) Mass Flow Rate
2838 (0B16) Average Meter Factor
2840 (0B18) Average Temperature
2842 (0B1A) Average Pressure
2844 (0B1C) Average Line Density
2846 (0B1E) Average Reference Density
2848 (0B20) Average Relative Density
2850 (0B22) Avg Line Compressibility Factor
2852 (0B24) Avg Ref Compressibility Factor
2854 (0B26) Avg Compressibility Factor Ratio
2856 (0B28) Avg Wobbe Index
2858 (0B2A) Average Heating Value
2860 (0B2C) Avg Mole % Methane (C1)
2862 (0B2E) Avg Mole % Nitrogen (N2)
2864 (0B30) Avg Mole % Carbon Dioxide (CO2)
2866 (0B32) Avg Mole % Ethane (C2)
2868 (0B34) Avg Mole % Propane (C3)
2870 (0B36) Avg Mole % Water (H2O)

2872	(0B38)	Avg Mole % Hydrogen Sulfide (H2S)
2874	(0B3A)	Avg Mole % Hydrogen (H2)
2876	(0B3C)	Avg Mole % Carbon Monoxide (CO)
2878	(0B3E)	Avg Mole % Oxygen (O2)
2880	(0B40)	Avg Mole % i-Butane (iC4)
2882	(0B42)	Avg Mole % n-Butane (nC4)
2884	(0B44)	Avg Mole % i-Pentane (iC5)
2886	(0B46)	Avg Mole % n-Pentane (nC5)
2888	(0B48)	Avg Mole % n-Hexane (nC6)
2890	(0B4A)	Avg Mole % n-Heptane (nC7)
2892	(0B4C)	Avg Mole % n-Octane (nC8)
2894	(0B4E)	Avg Mole % n-Nonane (nC9)
2896	(0B50)	Avg Mole % n-Decane (nC10)
2898	(0B52)	Avg Mole % Helium (He)
2900	(0B54)	Avg Mole % Argon (Ar)
2902	(0B56)	Archived User Float Register 46
2904	(0B58)	Archived User Float Register 47
2906	(0B5A)	Archived User Float Register 48
2908	(0B5C)	Archived User Float Register 49
2910	(0B5E)	Archived User Float Register 50
2912	(0B60)	Cur Mole % Methane (C1)
2914	(0B62)	Cur Mole % Nitrogen (N2)
2916	(0B64)	Cur Mole % Carbon Dioxide (CO2)
2918	(0B66)	Cur Mole % Ethane (C2)
2920	(0B68)	Cur Mole % Propane (C3)
2922	(0B6A)	Cur Mole % Water (H2O)
2924	(0B6C)	Cur Mole % Hydrogen Sulfide (H2S)
2926	(0B6E)	Cur Mole % Hydrogen (H2)
2928	(0B70)	Cur Mole % Carbon Monoxide (CO)
2930	(0B72)	Cur Mole % Oxygen (O2)
2932	(0B74)	Cur Mole % i-Butane (iC4)
2934	(0B76)	Cur Mole % n-Butane (nC4)
2936	(0B78)	Cur Mole % i-Pentane (iC5)
2938	(0B7A)	Cur Mole % n-Pentane (nC5)
2940	(0B7C)	Cur Mole % n-Hexane (nC6)
2942	(0B7E)	Cur Mole % n-Heptane (nC7)
2944	(0B80)	Cur Mole % n-Octane (nC8)
2946	(0B82)	Cur Mole % n-Nonane (nC9)
2948	(0B84)	Cur Mole % n-Decane (nC10)
2950	(0B86)	Cur Mole % Helium (He)
2952	(0B88)	Cur Mole % Argon (Ar)

Directory: BATCH_RUN_DATA

Data Type: DOUBLE

Start Address: 3072

3072	(0C00)	(Fwd) Total Pulses
3073	(0C04)	(Fwd) Indicated Volume (IV)
3080	(0C08)	(Fwd) Gross Volume (GV)
3084	(0C0C)	(Fwd) Gross @ Std Temp & Press (GSV)
3088	(0C10)	(Fwd) Mass Total
3092	(0C14)	(Fwd) Energy Total
3096	(0C18)	(Rev) Total Pulses
3100	(0C1C)	(Rev) Indicated Volume (IV)
3104	(0C20)	(Rev) Gross Volume (GV)
3108	(0C24)	(Rev) Gross @ Std Temp & Press (GSV)
3112	(0C28)	(Rev) Mass Total
3116	(0C2C)	(Rev) Energy Total
3120	(0C30)	Current (Fwd) Line Volume Flow Rate
3124	(0C34)	Current (Fwd) GSV Flow Rate
3128	(0C38)	Current (Fwd) Energy Flow Rate
3132	(0C3C)	Current (Fwd) Mass Flow Rate
3136	(0C40)	Current (Rev) Line Volume Flow Rate
3140	(0C44)	Current (Rev) GSV Flow Rate
3144	(0C48)	Current (Rev) Energy Flow Rate
3148	(0C4C)	Current (Rev) Mass Flow Rate
3152	(0C50)	Current Line Density
3156	(0C54)	Current Reference Density
3160	(0C58)	Current Relative Density
3164	(0C5C)	Cur Line Compressibility Factor
3168	(0C60)	Cur Ref Compressibility Factor
3172	(0C64)	Current Compressibility Ratio
3176	(0C68)	Current Wobbe Index
3180	(0C6C)	Current Heating Value
3184	(0C70)	Start (Fwd) IV Non-resettable
3188	(0C74)	Start (Fwd) GV Non-resettable
3192	(0C78)	Start (Fwd) GSV Non-resettable
3196	(0C7C)	Start (Fwd) Mass Non-resettable
3200	(0C80)	Start (Fwd) Energy Non-resettable
3204	(0C84)	Start (Rev) IV Non-resettable
3208	(0C88)	Start (Rev) GV Non-resettable
3212	(0C8C)	Start (Rev) GSV Non-resettable
3216	(0C90)	Start (Rev) Mass Non-resettable
3220	(0C94)	Start (Rev) Energy Non-resettable
3224	(0C98)	End (Fwd) IV Non-resettable
3228	(0C9C)	End (Fwd) GV Non-resettable
3232	(0CA0)	End (Fwd) GSV Non-resettable
3236	(0CA4)	End (Fwd) Mass Non-resettable
3240	(0CA8)	End (Fwd) Energy Non-resettable
3244	(0CAC)	End (Rev) IV Non-resettable
3248	(0CB0)	End (Rev) GV Non-resettable
3252	(0CB4)	End (Rev) GSV Non-resettable
3256	(0CB8)	End (Rev) Mass Non-resettable
3260	(0CBC)	End (Fwd) Energy Non-resettable

Directory: BATCH_RUN_DATA

Data Type: UNSIGNED CHAR

Start Address: 3584

3584	(0E00)	Number of Batch Alarms
3585	(0E01)	Batch Status
3586	(0E02)	Pump Status
3587	(0E03)	Result of last Host Command
3588	(0E04)	Archived User Boolean Register 46
3589	(0E05)	Archived User Boolean Register 47
3590	(0E06)	Archived User Boolean Register 48
3591	(0E07)	Archived User Boolean Register 49
3592	(0E08)	Archived User Boolean Register 50

Directory: BATCH_RUN_DATA

Data Type: UNSIGNED INTEGER

Start Address: 3712

3712	(0E80)	Batch Number
3713	(0E81)	Batch start year
3714	(0E82)	Batch start month
3715	(0E83)	Batch start day
3716	(0E84)	Batch start week day

3717 (0E85) Batch start seconds
3718 (0E86) Batch start minutes
3719 (0E87) Batch start hour
3720 (0E88) Batch end year
3721 (0E89) Batch end month
3722 (0E8A) Batch end day
3723 (0E8B) Batch end week day
3724 (0E8C) Batch end seconds
3725 (0E8D) Batch end minutes
3726 (0E8E) Batch end hour

Directory: BATCH_RUN_DATA
Data Type: UNSIGNED LONG
Start Address: 3840

3840 (0F00) Prompt Response Data 1
3842 (0F02) Prompt Response Data 2
3844 (0F04) Prompt Response Data 3
3846 (0F06) Prompt Response Data 4
3848 (0F08) Prompt Response Data 5
3850 (0F0A) Current Prompt Response Data 1
3852 (0F0C) Current Prompt Response Data 2
3854 (0F0E) Current Prompt Response Data 3
3856 (0F10) Current Prompt Response Data 4
3858 (0F12) Current Prompt Response Data 5

Directory: METER_RUN_DATA
Data Type: FLOATING POINT
Start Address: 8960

8960 (2300) Ultrasonic Meter Log Count
8962 (2302) Ultrasonic Meter Alarm Status
8964 (2304) Ultrasonic Meter Flow Velocity
8966 (2306) Ultrasonic Meter VOS

Directory: METER_RUN_DATA
Data Type: UNSIGNED CHAR
Start Address: 9728

9728 (2600) Valve Status

Modbus Communications Primer

The microFlow.net Gas Modbus interface is designed to conform to a subset of the "Modicon Modbus Protocol Reference Guide" PI-MBUS-300 Rev. D (Modicon, Inc., Industrial Automation Systems). Modbus can be implemented on various transmission mediums (such as RS-232 or RS-485 communication ports). Transmission of data is serial and asynchronous. It is recommended that communications ports 2 or 3 on the microFlow.net Gas be used for Modbus communications.

The Host Message: The host transmits a message on the communications line that represents a specific query or command. The address specifies which slave device is to act on the message. The function in the query tells the addressed slave device what kind of action to perform. The register word specifies what particular internal state/value of the slave is of interest to the host. The data bytes contain any additional information that the slave will need to perform the function. For example, function code 03 will query the slave to read holding registers and respond with their contents. The register field must contain information telling the slave which reg-ister(s) to read and the data field specifies how many registers to read. The error check or CRC (cyclical redundancy check) field enables the slave to vali-date the integrity of the message contents.

The Response: If the slave makes a normal response, the function byte in the response is an echo of the function in the query. The data bytes contain the data collected by the slave, such as register values or status. If an error occurs, the function code is modified to indicate that the response is an error response, and the data bytes contain a code that describes the error. The error check field allows the master to confirm that the message contents are valid.

RTU Framing

Every Modbus message begins with a silent interval of at least 3.5 character times. Multiply the character times by the current network baud rate to determine the length of the silent interval (see T1-T2-T3-T4 in the figure below). Next, the microFlow.net Gas address field is transmitted.

Characters for all fields are transmitted as binary bytes. In this manual, characters are represented by hexadecimal 0-9, A-F. All networked devices constantly monitor the network bus. This monitoring occurs even during silent intervals. As each microFlow.net Gas receives the first field (the address field), it decodes it to determine if it is the microFlow.net Gas being addressed.

A second silent interval of at least 3.5 character times follows the last transmitted character of each message, after which a new message can begin. The new message must be transmitted as a continuous stream, with no silent interval in excess of 3.5 character times. If an excessively long silent interval occurs before completion of the frame, the receiving microFlow.net Gas will disregard the entire incomplete message and wait for the address field of the next new message.

If a silent interval is less than 3.5 character times, the receiving microFlow.net Gas will be unable to recognize it as the start of a new message and will attempt to read it as a part of the prior message. These combined messages will result in an invalid value in the final CRC field, and an error will result. A typical message frame is shown below.

3.5 char. time delay	ADDRESS	FUNCTION	REGISTER	DATA	CRC	3.5 char. time delay
	1 byte	1 byte	2 bytes	n bytes	2 bytes	

The starting 3.5 character-time ending delay for one message may be the same actual delay as the start-ing 3.5 character time for the next message (there is no need for the master to delay twice between mes-sages as long as the duration exceeds the specified delay).

How Characters are Transmitted Serially

When messages are transmitted on standard Mod-bus serial networks, each character or byte is sent in this order (left to right):

With Parity Checking (8 bit word, 1 stop)

Start	1	2	3	4	5	6	7	8	Par	Stop

Without Parity Checking (8 bit word, 2 stop)

Start	1	2	3	4	5	6	7	8	Stop	Stop

Data Addresses in Modbus Messages

All data addresses in Modbus messages are referenced to zero; the first occurrence of a data item is addressed as item number zero.

Modbus Functions

The following Modbus functions have been implemented in the microFlow.net Gas.

Code	Function	Description
01	Read Relay Status	Reads the binary data from the (read/write) set of variables.
02	Read Input Status	Reads the binary data from the "inputs" (read only) set of variables.
03	Read Integer Registers (Read/Write Register Set)	Retrieves the current data from the requested registers.
04	Read Integer Registers (Read Only Register Set)	Retrieves the current data from the requested registers.
05	Force Single Relay	Changes the state of a binary (read/write).
06	Write (Preset) Single Register	Places a specific value into a (read/write) register.
08	Loop Back Diagnostic Text	Diagnostic test message sent to the microFlow.net Gas to evaluate communications processing. ***Note:*** *Only the return Query Data diagnostic code is supported.*
15	Force Multiple Relays	Changes the state of multiple binary (read/write).
16	Write (Preset) Multiple Registers	Places specific values into a series of consecutive (read/write) registers.

Master/Slave Communications

The master communicates with the microFlow.net Gas by sending messages containing function codes. Function codes indicate the actions the microFlow.net Gas is to perform.

The microFlow.net Gas' response to the master uses the function code field to report on the status of the task it was assigned. The two possible reports are (1) a normal, error-free response or (2) an exception response, indicating an error. A normal response repeats the original function code. An exception response returns a code that corresponds to the original function code, with its most-significant bit set to a logic 1.

For example, a master directs a microFlow.net Gas to read a group of holding registers by sending the following function code:

0000 0011 (Hexadecimal 03)

If the microFlow.net Gas completes the action without error, its response echoes the original command. If an error occurs, the microFlow.net Gas returns the following message:

1000 0011 (Hexadecimal 83)

The microFlow.net Gas augments its exception response by adding a code in the data field that indicates what type of error occurred. The exception response is handled according to the parameters of the application program controlling the master device.

For example, if the relay address is absent in the microFlow.net Gas device, the microFlow.net Gas will return the exception response with the exception code shown (02). This response indicates an invalid data address for the microFlow.net Gas.

A listing of the exception codes appears below.

Code	Name	Meaning
01	Illegal Function	The function code received in the query is not an allowable action for the slave. If a Poll Program Complete command was issued, this code indicates that no program function preceded it.
02	Illegal Data Address	The data address received in the query is not an allowable value for the microFlow.net Gas.
03	Illegal Data Value	A value contained in the query data field is not an allowable value for the microFlow.net Gas.
04	Command Error	An unrecoverable error occurred while the microFlow.net Gas was attempting to perform the requested action.

Contents of the Data Field

The data field consists of sets of two hexadecimal digits, in the range of 00 to FF hexadecimal.

The microFlow.net Gas reads the data field sent by the master to perform the actions indicated by the function code. The data field contains information such as discrete and register addresses, the number of items to be handled, and the count of actual data bytes in the field.

If, for example, the master directs an microFlow.net Gas to read a group of holding registers (function code 03), the data field sent by the master must also indicate the starting register and the number of registers to be read. If the master writes to a group of registers in the slave (function code 10 hexadecimal), the data field sent by the master must also indicate the starting register, the number of registers to be writ-ten, the count of data bytes to follow in the data field, and the data to be written into the registers.

Assuming that no error in communication interferes, the data field of a response from a slave to a master contains the requested data. If an error does occur, the field contains an exception code that the application controlling the master can use to determine the next action to be taken.

Beginning Register

This register identifies the beginning register from which the master is requesting information. This two-byte field lists the most significant digit first and the least significant digit last.

Number of Requested Registers

This field identifies the number of consecutive registers from which the master is requesting information. This two-byte field lists the most significant digit first and the least significant digit last. The response is limited to 250 bytes of information.

Error Check (CRC16)

This field allows the microFlow.net Gas and the supervisory system to check for errors in the transmission of commands and responses. Electrical noise or other interference may cause changes in transmitted data. The capacity to check for errors prevents the receiving device from responding to a message that has changed.

Error-checking in RTU mode is built on the Cyclical Redundancy Check (CRC) method. The entire message is subject to scrutiny by the CRC field, and the CRC is applied regardless of any other parity check method that might be in effect.

The CRC consists of a two-byte field containing a 16-bit binary value. The transmitting device calculates the CRC value and adds the CRC to the message. The receiving device then recalculates the CRC when the message is received, and compares the first value with the second. An error results when the two message values are unequal.

The CRC is initiated by pre-loading a 16-bit register to all 1's. Successive 8-bit bytes of the message are then applied to the current contents of the register. The CRC is generated only by the eight bits of data in each character. Start and stop bits, and the parity bit if one is used, are not taken into account.

When the CRC is generated, each 8-bit character is exclusive ORed with the register contents. The result is then shifted toward the least significant bit (LSB), and a zero added to the most significant bit (MSB) position. The LSB is extracted and examined. Assuming the LSB was a 1, the register is then exclusive ORed with a preset, fixed value. If the LSB was a 0, there will be no exclusive OR.

The process consists of eight shifts. After the eighth and final shift, the next 8-bit byte is exclusive ORed with the register's current value. The process is then repeated for an additional eight shifts. The final content of the register, after all the bytes of the message have been applied, is the CRC value.

Placing the CRC into the Message

When the 16-bit CRC (2 8-bit bytes) is transmitted in the message, the low-order byte will be transmitted first, followed by the high-order byte. For example, if the CRC value is 1241 hex (0001 0010 0100 0001):

Addr	Func	Data Count	Data	Data	Data	Data	CRC Lo	CRC Hi
							41	12

Field Contents in Modbus Messages

Examples of a Modbus query message and normal response are shown in the tables on the following page. The field contents in both examples are displayed in hexadecimal.

In this example, the master sends a Read Holding Registers request to microFlow.net Gas address 06. The microFlow.net Gas is specifically directed to return data from three holding registers, starting with address 0107 (006B hex).

As is the case in any normal response, the microFlow.net Gas first echoes the function code sent by the master. The microFlow.net Gas then transmits the byte count field, indicating the number of 8-bit data items being returned. Finally, the microFlow.net Gas returns the 8-bit bytes containing the requested data.

How to Use the Byte Count Field: When constructing responses in buffers, use a byte count value that equals the count of 8-bit bytes in the message data. The value is exclusive of all other field contents, including the byte count field. The microFlow.net Gas response example illustrates a typical byte count field in a normal response.

Master Query		
Field Name	Example (Hex)	RTU 8-Bit Field
Header		None
microFlow.net Gas Address	06	0000 0110
Function	03	0000 0011
Starting Address Hi	00	0000 0000
Starting Address Lo	6B	0110 1011
No. of Registers Hi	00	0000 0000
No. of Registers Lo	03	0000 0011
Error Check		CRC (16 bits)
	Total Bytes:	8

microFlow.net Gas Response		
Field Name	Example (Hex)	RTU 8-Bit Field
Header		None
microFlow.net Gas Address	06	0000 0110
Function	03	0000 0011
Byte Count	06	0000 0110
Data Hi	02	0000 0010
Data Lo	2B	0010 1011
Data Hi	00	0000 0000
Data Lo	00	0000 0000
Data Hi	00	0000 0000
Data Lo	63	0110 0011
Error Check		CRC (16 bits)
	Total Bytes:	11

The microFlow.net Gas monitors the amount of time between the receipt of characters. If three and one-half character times elapse without the microFlow.net Gas seeing a new character or the end of a frame, the message is flushed and the next characters received will be viewed as an address. If the address is for that microFlow.net Gas, it will respond. If the address is not for that microFlow.net Gas, the message will be flushed and it will look for the next message.

Address

The address is the first field in the frame and consists of one byte (eight bits) of information. The address is the unique identification of the microFlow.net Gas (slave) that is to receive the message that is sent via the supervisory system (master). Each microFlow.net Gas address must be unique so that only the addressed 'slave' will respond to a query. The address is also part of the response message sent back to the master from the microFlow.net Gas when data is requested. By returning the address as part of the response, the 'master' can tell which of the microFlow.net Gas the data is coming from.

Query Responses

The first two fields of the response to the read only message are identical to the command. The microFlow.net Gas returns the address and the function code that was transmitted to the unit. The next field is the byte count.

Byte Count

The byte count is sent to the master (supervisory system) indicating how much data is being sent from the microFlow.net Gas. In the example shown, the command requested data from these registers and each register contains two bytes of data.

Data Register

Each of the data registers of unsigned characters contains two bytes of data. The response message returns the data with the most significant byte of data first and the least significant byte second. Data can be requested and returned from a number of registers with a single interrogation message. The limit on the amount of data returned from the microFlow.net Gas to the 'master' is 256 bytes. The data lengths for the data types currently used by the microFlow.net Gas are as follows:

Data Length	
Type	Binary
Double	8 bytes
Integer	2 bytes
Long Integer	4 bytes
Text String	variable length
Character	2 bytes (high order byte set to zero)
CRC-16	2 bytes
Float	4 bytes
Unsigned Integer	2 bytes
Unsigned Long	4 bytes
Unsigned Character	2 bytes (high order byte set to zero)

The error-checking sequence is the same as described in the paragraph under Read Only Message.

01 Read Relay Status

Description

Reads the ON/OFF status of discrete variables in the microFlow.net Gas. The maximum number of "coils" per response is 256 in the microFlow.net Gas.

Query

The query message specifies the starting register and quantity of registers to be read.

There are now no variables to read from this group. If there were, this is an example of a request to read variables 20 through 56 from microFlow.net Gas device 17:

Query	
Field Name	Example (Hex)
microFlow.net Gas Address	0x11
Function	0x01
Starting Address Hi	0x00
Starting Address Lo	0x13
No. of Points Hi	0x00
No. of Points Lo	0x25
Error Check (CRC)	(calculated)

Response

A response message consists of a relay status packed as one relay per bit of the data field. Status is indicated by means of the following code: 0 = OFF; 1 = ON. The first data byte is contained in the LSB, and specifies the relay addressed in the query. All other relays follow from "low order to high order" in subsequent bytes.

The returned relay quantity must be a multiple of eight; otherwise, it will be padded with zeros toward the high order end of the byte. The assembled bytes of data are specified in the byte count field.

An example of a response to the preceding query appears below.

Response	
Field Name	Example (Hex)
microFlow.net Gas Address	0x11
Function	0x01
Byte Count	0x05
Data (Relays 27-20)	0xCD
Data (Relays 35-28)	0x6B
Data (Relays 43-36)	0xB2
Data (Relays 51-44)	0x0E
Data (Relays 56-52)	0x1B
Error Check (CRC)	(calculated)

The status of relays 27 through 20 is shown as the byte value CD hex, or binary 1100 1101. Relay 27 is the MSB of the byte, and relay 20 is the LSB. The status of relays 27 through 20 is expressed from left to right as ON-ON-OFF-OFF-ON-ON-OFF-ON.

Bits within a byte are shown with the MSB to the left and the LSB to the right; therefore, the relays in the first byte are “27 through 20,” from left to right. Relays “35 through 28" are contained in the next byte, again from left to right. As the bits are transmitted serially, they flow from LSB to MSB (i.e., 20 through 27, 28 through 35, and so on).

In the last data byte, the status of relays 56 through 52 is shown as the byte value 1B hex, or binary 0001 1011. Relay 56 is in the fourth bit position from the left, and relay 52 is the LSB of this byte. The status of relays 56 through 52 is expressed as ON-ON-OFF-ON-ON. The three remaining bits toward the high order end are padded with zeros.

02 Read Input Status

Description

Reads the ON/OFF status of discrete "inputs" (read only binary references) in the microFlow.net Gas. The maximum number of parameters supported by microFlow.net Gas is limited to 256 per query.

Query

The query message specifies the starting "input" and quantity of "inputs" to be read. "Inputs" are addressed starting at zero: inputs 1 through 16 are addressed as 0 through 15.

An example of a request to read the states of inputs 1024 to 1033 from microFlow.net Gas 17 is shown below:

Query	
Field Name	Example (Hex)
microFlow.net Gas Address	0x11
Function	0x02
Starting Address Hi	0x00
Starting Address Lo	0xC4
No. of Points Hi	0x00
No. of Points Lo	0xOA
Error Check (CRC)	(calculated)

Response

The input status is packed in the response message as one input per bit of the data field. Status is indicated as 0 = OFF; 1 = ON. The input addressed in the query appears in the LSB of the first data byte. The other inputs follow toward the high order end of this byte, and from low order to high order in all subsequent bytes.

The returned input quantity must be a multiple of eight; otherwise, the remaining bits in the final data byte will be padded with zeros toward the high order end of the byte. The quantity of complete bytes of data is indicated in the byte count field.

An example of a response to the preceding query appears below.

Response	
Field Name	Example (Hex)
microFlow.net Gas Address	0x11
Function	0x02
Byte Count	0x02
Data (Inputs 1031-1024)	0xAC
Data (Inputs 1033-1032)	0x01
Error Check (CRC)	(calculated)

The status of inputs 1031 through 1024 is shown as the byte value AC hex, or binary 1010 1100. Input 1031 is the MSB of this byte and input 1024 is the LSB. The status of inputs 1031 through 1024 is expressed as ON-OFF-ON-OFF-ON-ON-OFF-OFF, from left to right.

The status of inputs 1033 through 1032 are shown as the byte value 01 hex, or binary 0000 0001. Input 1033 is in the seventh bit position from the left and input 1032 is the LSB. The status of inputs 1033 through 1032 is OFF-ON. The six remaining bits toward the high order end are padded with zeros, since the returned input quantity must be a multiple of eight.

03 Read Holding Registers

Description

Reads the binary contents of holding registers (read/write registers).

Query

The query message specifies the starting register and quantity of registers to be read. Registers are addressed starting at zero.

An example of a request to read registers 107 through 109 from microFlow.net Gas 17 is shown below.

Query	
Field Name	Example (Hex)
microFlow.net Gas Address	0x11
Function	0x03
Starting Address Hi	0x00
Starting Address Lo	0x6B
No. of Points Hi	0x00
No. of Points Lo	0x03
Error Check (CRC)	(calculated)

Response

Each register data in the response message contains two bytes. The binary contents are right justified within each byte. Within each register, the first byte contains the high order bits and the second byte contains the low order bits.

An example of a response to the preceding query is shown below.

Response	
Field Name	Example (Hex)
microFlow.net Gas Address	11
Function	03
Byte Count	06
Data Hi (Register 107)	02
Data Lo (Register 107)	2B
Data Hi (Register 108)	00
Data Lo (Register 108)	00
Data Hi (Register 109)	00
Data Lo (Register 109)	64
Error Check (CRC)	--

04 Read Input Registers

Description

This function reads the binary contents of "input registers" in the microFlow.net Gas. These are "read-only" values; they cannot be written.

Query

The query message specifies the starting register and quantity of registers to be read. Registers are addressed starting at zero.

An example of a request to read register 8 from microFlow.net Gas 17 appears below.

Query	
Field Name	Example (Hex)
microFlow.net Gas Address	11
Function	04
Starting Address Hi	00
Starting Address Lo	08
No. of Points Hi	00
No. of Points Lo	01
Error Check (CRC)	--

Response

Each register data in the response message contains two bytes. The binary contents are right justified within each byte. Within each register, the first byte contains the high order bits and the Second byte contains the low order bits.

An example of a response to the preceding query appears below.

Response	
Field Name	Example (Hex)
microFlow.net Gas Address	11
Function	04
Byte Count	02
Data Hi (Register 30009)	00
Data Lo (Register 30009)	0A
Error Check (CRC)	--

05 Force Single Relay

Description

Forces a single relay either ON or OFF.

Query

The query message specifies the relay reference to be forced. Relays are addressed starting at zero.

A constant in the query data field indicates the required ON/OFF state. A value of FF 00 hex directs the relay to be ON. A value of 00 00 directs the relay to be OFF. No other value is valid, nor will it affect the relay.

An example of a request to force relay 150 ON in microFlow.net Gas 17 appears below. (Reset User Alarm #9)

Query	
Field Name	Example (Hex)
microFlow.net Gas Address	11
Function	05
Relay Address Hi	00
Relay Address Lo	96
Force Data Hi	FF
Force Data Lo	00
Error Check (CRC)	--

Response

An echo of the query, returned after the relay status has been forced, indicates a normal response.

An example of a response to the preceding query appears below.

Response	
Field Name	Example (Hex)
microFlow.net Gas Address	11
Function	05
Relay Address Hi	00
Relay Address Lo	96
Force Data Hi	FF
Force Data Lo	00
Error Check (CRC)	--

06 Preset Single Register

Description

Presets a value into a single holding register.

Query

The query message specifies the register reference to be preset. Registers are addressed starting at zero. The requested preset value is specified in the query data field.

An example of a request to preset register 1 to 0x0003 (hex) in microFlow.net Gas 17 appears below.

Query	
Field Name	Example (Hex)
microFlow.net Gas Address	11
Function	06
Register Address Hi	00
Register Address Lo	01
Preset Data Hi	00
Preset Data Lo	03
Error Check (CRC)	--

Response

An echo of the query, returned after the register contents have been preset, is a normal response.

An example of a response to the preceding query appears below.

Response	
Field Name	Example (Hex)
microFlow.net Gas Address	11
Function	06
Register Address Hi	00
Register Address Lo	01
Preset Data Hi	00
Preset Data Lo	03
Error Check (CRC)	--

15 (0F Hex) Force Multiple Relays

Description

Forces each relay in a sequence of relays to either ON or OFF. The maximum number of parameters by microFlow.net Gas is limited to 256 per query.

Query

The query message specifies the relay references to be forced. Relays are addressed starting at zero; thus, relay 1 is addressed as 0.

The contents of the query data field specify whether a state is ON or OFF. A logical “1” in a bit position of the field requests the corresponding relay to be ON. A logical “0” requests that the relay be OFF.

An example of a request to force a series of ten relays starting at address 15, or OF hex in microFlow.net Gas 17, appears below.

The query data content consists of two bytes: CD 01 hex (1100 1101 0000 0001 binary). The binary bits correspond to the relays as shown below.

Bit:	1	1	0	0	1	1	0	1		0	0	0	0	0	0	0	1
Relay:	22	21	20	19	18	17	16	15		-	-	-	-	-	-	24	23

The first byte transmitted (CD hex) addresses relays 22 through 15, with the least significant bit corre-sponding to the lowest relay (15) in this set.

The next byte transmitted (01 hex) addresses relays 24 to 23, with the least significant bit corresponding to the lowest relay (23) in this set. Unused bits in the last data byte are padded with zeros.

Query	
Field Name	Example (Hex)
microFlow.net Gas Address	11
Function	0F
Relay Address Hi	00
Relay Address Lo	0F
Quantity of Relays Hi	00
Quantity of Relays Lo	0A
Byte Count	02
Force Data Hi (Relays 27-20)	CD
Force Data Hi (Relays 29-28)	01
Error Check (CRC)	--

Response

The normal response consists of the slave address, function code, starting address, and number of relays forced.

An example of a response to the preceding query appears below.

Response	
Field Name	Example (Hex)
microFlow.net Gas Address	11
Function	0F
Relay Address Hi	00
Relay Address Lo	01
Quantity of Relays Hi	00
Quantity of Relays Lo	0A
Error Check (CRC)	--

16 (10 Hex) Preset Multiple Registers

Description

Presets values into a sequence of holding registers.

Query

The query message specifies the register references to be preset. Registers are addressed beginning with zero.

An example of a request to preset two registers starting at 1 to 0x000A and 0x0102 (hex), in microFlow.net Gas 17, appears below.

Query	
Field Name	Example (Hex)
microFlow.net Gas Address	11
Function	10
Starting Address Hi	00
Starting Address Lo	01
No. of Registers Hi	00
No. of Registers Lo	02
Byte Count	04
Data Hi	00
Data Lo	0A
Data Hi	01
Data Lo	02
Error Check (CRC)	--

Response

A normal response consists of the slave address, function code, starting address, and quantity of registers preset.

An example of a response to the preceding query appears below.

Response	
Field Name	Example (Hex)
microFlow.net Gas Address	11
Function	10
Starting Address Hi	00
Starting Address Lo	01
No. of Registers Hi	00
No. of Registers Lo	02
Error Check (CRC)	--

Exception Responses

When a master device sends a query to an microFlow.net Gas device, there are three possible outcomes:

1. The microFlow.net Gas receives the query with no com-munication errors, handles the query normally, and returns a normal response.
2. A communication error bars the microFlow.net Gas from receiving the query, so no response is returned. The master program eventually processes a timeout condition for the query.
3. The microFlow.net Gas receives the query without error, but returns no response. The master program eventually processes a timeout condition for the query.

Two fields in the exception response message differentiate it from a normal response:

Function Code Field: A microFlow.net Gas normally echoes the function code of the original query in the function code field of the response. Because the values of all function codes are below 80 hexadecimal, all function codes have a most-significant bit (MSB) of 0. In an exception response, however, the slave sets the MSB of the function code to 1. The value of the function code in an exception response is therefore 0x80 (hex) higher than the value for a normal response.

Accordingly, the application program controlling the master can quickly recognize the exception response and derive the exception code from the data field.

Data Field: A normal response consists of any data or statistics in the data field requested by the query. An exception response consists of an exception code in the data field. The code indicates the microFlow.net Gas condition that caused the exception.

An example of a master query and microFlow.net Gas exception response is shown in the table below. The field examples are given in hexadecimal.

Query		
Byte	Contents	Example
1	microFlow.net Address	0A
2	Function	01
3	Starting Address Hi	28
4	Starting Address Lo	0A
5	No. of Relays Hi	00
6	No. of Relays Lo	01
7	CRC	--
Exception Response		
Byte	Contents	Example
1	microFlow.net Address	0A
2	Function	81
3	Exception Code	02
4	CRC	--

Here, the master addresses a query to microFlow.net Gas 10. The function code (01) is for a Read Relay Status operation that requests the status of the relay at address 10250 (0x280A hex). The number of relays field (0001) specifies that only one relay is to be read.

Related Publications

Technical Support

Contact Information:
Field Service Response Center
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