Electronic Blending Controller

Smith Meter® miniBlend.net™

Modbus and Modbus/TCP Communications

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GUIDANT

miniBlend.net

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The default or operating values used in this manual and in the program of the Smith Meter® miniBlend.net™ 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.

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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 miniBlend.net acts as a slave device only; an external host must act as the master to query or control the miniBlend.net. Each miniBlend.net must have a unique communication address in the range of 1 to 99. It is recommended that communications ports 2 or 3 on the miniBlend.net be used for Modbus communications. Host messages to address 0 (the Modbus broadcast address) are not currently supported (are ignored) by the miniBlend.net. 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 miniBlend.net. 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 miniBlend.net 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 microLoad 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 miniBlend.net 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
-->Comm Link: Level 3
```

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

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

Implementing Host Status Polling

To implement routine polling loops, the following coils should be periodically read. These coils represent the critical states that a host should monitor.

Coil	State
0	*In Program Mode* – Set when Program mode is accessed, via communications or keypad
1	*Checking Entries* – Active when exiting Program mode, during the validation phase
2	*Program Mode Value Changed*[1] – Active after exiting Program mode when changes made
3	*Power-fail Occurred*[1] – Set on powerup
4	*Printing in Progress* – Set when printing a report (if a port is configured as a Printer)

Coil	State
256	*miniBlend.net Authorized* – All host requirements have been met to deliver
257	*miniBlend.net Released* – The valve has been commanded to open
258	*Transaction in Progress* – This flag is active from Released until Transaction Done
259	*Batch Done*[1] – Active upon completion of a preset amount when proving
260	*Transaction Done*[1] – Active after Print pressed (or host ends transaction) until cleared by host
261	*Reserved*
262	*Reserved*
263	*Reserved*
264	*Alarm Active*[2] – Active when an alarm condition is present
265	*Stop Delay in Effect* – Active when Stop pressed but Delay to Open timer has not yet expired
266	*Proving in Progress* – Active when proving
267	*Product Flowing* – Active when the flow rate is nonzero
268	*Permissive Not Met* – Active when the transaction is in progress but a permissive input is de-asserted

1 – These flags are clearable by writing a 0 to the coil using Modbus Function 5 or 15.

2 – Writing a zero to the Alarm Active coil will effectively clear all active alarms (assuming the condition no longer exists).

Directory: Transaction Data
Data Type: BOOLEAN
Start Address: 256

Implementing Host Run Data Monitoring

During delivery, a host will likely want to monitor the batch progress, including data such as volume, rate, temperature, etc. During delivery, the run data values are accessed primarily via Modbus Function 4 (read status registers).

Single precision I.E.E.E. Floating point values (2 registers each):

0B00 (2816) Load Average Meter Factor
0B02 (2818) Load Average Temperature
0B04 (2820) Load Average Density
0B06 (2822) Load Average Pressure
0B08 (2824) Average CTL
0B0A (2826) Average CPL
0B0C (2828) Preset Amount

Double precision I.E.E.E. Floating point values (4 registers each):

0C00 (3072) Indicated Volume (IV)
0C04 (3076) Gross Volume (GV)
0C08 (3080) Gross @ Std Temp Volume (GST)
0C0C (3084) Gross @ Std Temp & Press (GSV)
0C10 (3088) Mass
0C14 (3092) Remaining Amount
0C18 (3096) Delivered Volume

At transaction end, there are two options for data retrieval... one is to read the same data as read during delivery (run data). The other option is to read the transaction log entry for the completed transaction.

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	N/A
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	N/A
28	N/A
29	Checking Entries
30	Product/Recipe/Additive not Assigned to this Arm
31	Operation Conflicts with Arm Configuration
32	No Key Ever Pressed
33	N/A
34	N/A
35	N/A
36	N/A
37	N/A
38	N/A
39	N/A
40	N/A
91	Communications Buffer Allocation Error
92	Keypad Locked
93	Data Recall Error
94	Not In Program Mode
95	N/A
99	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 miniBlend.net 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 miniBlend.net.

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

Set Batch

In host control mode, remote batch authorization can be controlled using the following registers:

9F02 (40706) *Batch Amount – used when SB is executed (unsigned long integer, 2 registers)*
9E82 (40578)† SB (Set Batch) – trigger register which is used to allow a batch to start; write the recipe number (recipe number of 0 indicates to use digital inputs to select a recipe or use default recipe)

Note: *The communications port Control must be set to Host Control for the Host Authorize functions.*

Start/Stop

8E84 (36484)† Host Start/Stop (SA/SP)

Write the following values to this register to perform the indicated action:

0 – Stop; command valve to close and stop flow
1 – Start; command valve to open (after any programmed valve delay)

Terminate Batch/Transaction/Prompt Sequence etc.

8E65 (36485)† Host Terminate Batch/Transaction/Prompt Sequence (ET)

Write the following values to perform the indicated action:

1 – End Transaction

Note: *The communications port Control must be set to Host Control for the Host Authorize functions.*

Read Transaction Log

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

To retrieve transaction data:

Write host transaction select register - 0=current, 1 or greater = number back in storage
Function 6, register 36486† (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 transaction data areas as you would for a current transaction
Example- read transaction 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

COILS – Function 1, 2, 5, 15

Directory: "System Run Data"
Data Type: BOOLEAN
Start Address: 0

DEC	HEX	Description
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: Transaction Data
Data Type: BOOLEAN
Start Address: 256

256	(0100)	miniBlend.net Authorized
257	(0101)	miniBlend.net Released
258	(0102)	Transaction in Progress
259	(0103)	Batch Done
260	(0104)	Transaction Done
261	(0105)	Reserved
262	(0106)	Reserved
263	(0107)	Reserved
264	(0108)	Alarm Active
265	(0109)	Stop Delay in Effect
266	(010A)	Proving in Progress
267	(010B)	Product Flowing
268	(010C)	Permissive Not Met

Directory: Digital I/O Status
Data Type: BOOLEAN
Start Address: 1280

1280	(0500)	Current Digital I/O State

Directory: System Alarms
Data Type: BOOLEAN
Start Address: 2304

2304	(0900)	DA: ROM Bad
2305	(0901)	DA: RAM Bad
2306	(0902)	DA: Flash Memory Error
2307	(0903)	DA: RAM Corrupt on Power-up
2308	(0904)	DA: Flash Corrupt on Power-up
2309	(0905)	DA: Watchdog Alarm
2310	(0906)	DA: Program Error
2311	(0907)	DA: Passcodes Reset
2312	(0908)	PA: Power-fail Alarm
2313	(0909)	U1: User Alarm 1
2314	(090A)	U2: User Alarm 2
2315	(090B)	U3: User Alarm 3
2316	(090C)	U4: User Alarm 4
2317	(090D)	U5: User Alarm 5
2318	(090E)	CM: Communications Alarm
2319	(090F)	CL: Clean Line Alarm
2320	(0910)	OA: Overrun Alarm
2321	(0911)	SP: Shared Printer Alarm
2322	(0912)	PP: PTB Printer Failure

Directory: Meter Alarms
Data Type: BOOLEAN
Start Address: 2816

2816	(0B00)	BL: Blend Low Alarm
2817	(0B01)	BH: Blend High Alarm
2818	(0B02)	OA: Product Overrun Alarm
2819	(0B03)	ZF: Product Zero Flow Alarm
2820	(0B04)	VF: Valve Fault Alarm
2821	(0B05)	BP: Back Pressure Alarm
2822	(0B06)	TP: Temperature Probe Alarm
2823	(0B07)	DR: Density Transducer Failure
2824	(0B08)	PR: Pressure Transducer Fail
2825	(0B09)	HF: High Flow Alarm
2826	(0B0A)	HT: High Temperature Alarm
2827	(0B0B)	HD: High Density Alarm
2828	(0B0C)	HP: High Pressure Alarm
2829	(0B0D)	LF: Low Flow Alarm
2830	(0B0E)	LT: Low Temperature Alarm
2831	(0B0F)	LD: Low Density Alarm
2832	(0B10)	LP: Low Pressure Alarm
2833	(0B11)	PM: Promass Alarm
2834	(0B12)	MF: Mass Meter Comm Alarm
2835	(0B13)	LA: Leakage Alarm

Directory: Digital Output Commands
Data Type: BOOLEAN
Start Address: 3584

3584	(0E00)	Set Digital Output Value

Holding Registers – Function 3, 6, 16

Directory: Digital I/O Configuration
Data Type: UNSIGNED CHAR
Start Address: 3584

DEC	HEX	Description
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 I/O Configuration
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 I/O Configuration
Data Type: UNSIGNED CHAR
Start Address: 5632

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

Directory: System Configuration
Data Type: TEXT
Start Address: 6144

6144 (1800) 101 Date {O}
6160 (1810) 102 Time {O}
6176 (1820) 112 Flow Rate Descriptor
6192 (1830) 114 Volume Descriptor
6208 (1840) 116 Mass Descriptor
6224 (1850) 691 User Alarm 1 Message
6240 (1860) 692 User Alarm 2 Message
6256 (1870) 693 User Alarm 3 Message
6272 (1880) 694 User Alarm 4 Message
6288 (1890) 695 User Alarm 5 Message
6304 (18A0) 103 Unit MAC Address {O}

Directory: System Configuration
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) 146 Auto Preset
6918 (1B06) 162 Reference Temperature

Directory: System Configuration
Data Type: UNSIGNED CHAR
Start Address: 7680

7680 (1E00) 101 Pulse Output Function
7681 (1E01) 103 Pulse Output Units
7682 (1E02) 111 Flow Rate Units
7683 (1E03) 113 Volume Units
7684 (1E04) 115 Mass Units
7685 (1E05) 123 Run Display Options
7686 (1E06) 124 Display Resolution
7687 (1E07) 125 Decimal/Comma Select
7688 (1E08) 126 Default/Translated Literals
7689 (1E09) 131 Dynamic Display Timeout
7690 (1E0A) 141 Recipes per Transaction
7691 (1E0B) 142 Start Key Disable
7692 (1E0C) 143 Stop Key Disable
7693 (1E0D) 145 Transaction Termination
7694 (1E0E) 253 Auto Prove
7695 (1E0F) 161 Temperature Units
7696 (1E10) 163 Density Units
7697 (1E11) 171 Pressure Units
7698 (1E12) 601 Driver Alarm Clearing
7699 (1E13) 602 Powerfail Alarm
7700 (1E14) 725 Comm Link Programming
7701 (1E15) 724 Ethernet Host Control
7702 (1E16) 727 Modbus Endian Select
7703 (1E17) 206 Blend Amount Type
7704 (1E18) 144 Transaction Start
7705 (1E19) 148 Transaction Reset Start Hour
7706 (1E1A) 149 Pulse In Type
7707 (1E1B) 603 Alarm 1 Polarity
7708 (1E1C) 604 Alarm 2 Polarity
7709 (1E1D) 105 Pulse Out Prd

Directory: System Configuration
Data Type: UNSIGNED INTEGER
Start Address: 7808

7808 (1E80) 207 Clean Line Amount
7809 (1E81) 223 Clean Alarm Limit
7810 (1E82) 147 Trans Reset Time

Directory: System Configuration
Data Type: UNSIGNED LONG
Start Address: 7936

7936 (1F00) 721 IP Address
7938 (1F02) 722 Netmask
7940 (1F04) 723 Gateway

Directory: Security Configuration
Data Type: UNSIGNED INTEGER
Start Address: 9856

9856 (2680) 191 Level 1 Access Code
9857 (2681) 192 Level 2 Access Code
9858 (2682) 193 Level 3 Access Code
9859 (2683) 194 Level for Security Input
9860 (2684) 195 Level for Diagnostics Dir.

Directory: Alarm Configuration
Data Type: UNSIGNED CHAR
Start Address: 11776

11776 (2E00) 611 Communications Alarm
11777 (2E01) 612 Clean Line Alarm
11778 (2E02) 613 Overrun Alarm
11779 (2E03) 631 Promass Meter Alarm
11780 (2E04) 632 Prd Overrun Alarm
11781 (2E05) 633 High Flow Alarm
11782 (2E06) 634 Low Flow Alarm
11783 (2E07) 635 Back Pressure Alarm
11784 (2E08) 636 Valve Fault Alarm
11785 (2E09) 637 Zero Flow Alarm
11786 (2E0A) 638 High Temperature Alarm
11787 (2E0B) 639 Low Temperature Alarm
11788 (2E0C) 640 Temp Transducer Alarm

11789 (2E0D) 641 High Density Alarm
11790 (2E0E) 642 Low Density Alarm
11791 (2E0F) 643 Density Transducer Alarm
11792 (2E10) 644 High Pressure Alarm
11793 (2E11) 645 Low Pressure Alarm
11794 (2E12) 646 Pres Transducer Alarm
11795 (2E13) 647 Leakage Alarm
11796 (2E14) 648 Blend High Alarm
11797 (2E15) 649 Blend Low Alarm
11798 (2E16) 650 Mass Mtr Comm Alarm
11799 (2E17) 615 Shared Printer Failure
11800 (2E18) 614 PTB Printer Failure

Directory: User Alarm Configuration
Data Type: UNSIGNED CHAR
Start Address: 13824

13824 (3600) 681 User Alarm 1
13825 (3601) 682 User Alarm 2
13826 (3602) 683 User Alarm 3
13827 (3603) 684 User Alarm 4
13828 (3604) 685 User Alarm 5

Directory: Communications Configuration
Data Type: UNSIGNED CHAR
Start Address: 15872

15872 (3E00) 701 Comm 1 Function
15873 (3E01) 707 Comm 2 Function
15874 (3E02) 713 Comm 3 Function
15875 (3E03) 702 Comm 1 Baud Rate
15876 (3E04) 708 Comm 2 Baud Rate
15877 (3E05) 714 Comm 3 Baud Rate
15878 (3E06) 703 Comm 1 Data/Parity
15879 (3E07) 709 Comm 2 Data/Parity
15880 (3E08) 715 Comm 3 Data/Parity
15881 (3E09) 704 Comm 1 Control
15882 (3E0A) 710 Comm 2 Control
15883 (3E0B) 716 Comm 3 Control
15884 (3E0C) 706 Comm 1 Mode
15885 (3E0D) 712 Comm 2 Mode
15886 (3E0E) 718 Comm 3 Mode

Directory: Communications Configuration
Data Type: UNSIGNED INTEGER
Start Address: 16000

16000 (3E80) 705 Comm 1 Timeout
16001 (3E81) 711 Comm 2 Timeout
16002 (3E82) 717 Comm 3 Timeout
16003 (3E83) 726 Ethernet Host Timeout

Directory: Load Arm Configuration
Data Type: TEXT
Start Address: 16384

16384 (4000) 121 Position ID
16400 (4010) 122 Ready Message
16416 (4020) 737 Summary Report Print Time

Directory: Load Arm Configuration
Data Type: FLOATING POINT
Start Address: 17152

17152 (4300) 251 Low Flow Start Rate
17154 (4302) 182 Overrun Alarm Limit
17156 (4304) 181 Leakage Alarm Limit
17158 (4306) 203 Blend Correct Amount
17160 (4308) 202 Blend Tolerance Amount
17162 (430A) 201 Blend Tolerance Percentage
17164 (430C) 252 Low Flow Start Amount

Directory: Load Arm Configuration
Data Type: UNSIGNED CHAR
Start Address: 17920

17920 (4600) 231 Valve Delay to Open
17921 (4601) 233 Pump Delay to Off
17922 (4602) 731 Report Select
17923 (4603) 732 Report Total Resolution
17924 (4604) 205 Blend Error Reset
17925 (4605) 206 Maintain Minimum Flow {B}

Directory: Load Arm Configuration
Data Type: UNSIGNED INTEGER
Start Address: 18048

18048 (4680) 232 Start after Stop Delay
18049 (4681) 738 Summary Report Interval
18050 (4682) 204 Blend Correct Time
18051 (4683) 221 Blend Alarm Timeout
18052 (4684) 222 Blend Alarm Min Amount
18053 (4685) 207 Valve Minimum Close Time {B}

Directory: Meter Configuration
Data Type: FLOATING POINT
Start Address: 19200

19200 (4B00) 301 K Factor
19202 (4B02) 203 Flow Adjust Tolerance {B}
19204 (4B04) 223 Overrun Alarm

Directory: Meter Configuration
Data Type: UNSIGNED CHAR
Start Address: 19968

19968 (4E00) 302 Pulse Period Sample Count
19969 (4E01) 331 Mass Meter Type
19970 (4E02) 303 Pulse Multiplier
19971 (4E03) 208 Meter Plumbing {B}
19972 (4E04) 304 Pulse Input {W}
19973 (4E05) 404 Shared Temp In
19974 (4E06) 411 Shared Density In
19975 (4E07) 505 Shared Pressure In

Directory: Meter Configuration
Data Type: UNSIGNED LONG
Start Address: 20224

20224 (4F00) 332 Mass Meter Sequence Number

Directory: Product Configuration
Data Type: TEXT
Start Address: 20480

20480 (5000) 102 HM Class Part 1
20496 (5010) 103 HM Class Part 2
20513 (5020) 104 HM Class Part 3
20528 (5030) 105 HM Class Part 4
20544 (5040) 101 Product ID

Directory: Product Configuration
Data Type: FLOATING POINT
Start Address: 21248

21248 (5300) 205 Minimum Flow Rate {B}
21250 (5302) 209 High Flow Rate {B}
21252 (5304) 201 Flow Tolerance %{ B}
21254 (5306) 202 Flow Tolerance Rate {B}
21256 (5308) 210 1st Trip Amount {B}
21258 (530A) 211 2nd Trip Amount {B}
21260 (530C) 222 Low Flow Alarm Limit
21262 (530E) 311 Meter Factor 1
21264 (5310) 312 Flow Rate 1
21266 (5312) 313 Meter Factor 2
21268 (5314) 314 Flow Rate 2
21270 (5316) 315 Meter Factor 3
21272 (5318) 316 Flow Rate 3
21274 (531A) 317 Meter Factor 4
21276 (531C) 318 Flow Rate 4
21278 (531E) 319 Master Meter Factor
21280 (5320) 320 Linear Factor Deviation
21282 (5322) 352 Mtr Factor % Change per Degree
21284 (5324) 353 Mtr Factor Variation Ref Temp
21286 (5326) 401 Maintenance Temperature
21288 (5328) 402 High Temperature Alarm
21290 (532A) 403 Low Temperature Alarm
21292 (532C) 406 Reference Density
21294 (532E) 407 High Density Alarm
21296 (5330) 408 Low Density Alarm
21298 (5332) 501 Maintenance Pressure
21300 (5334) 502 Pressure Coefficient
21302 (5336) 503 High Pressure Alarm Limit
21304 (5338) 504 Low Pressure Alarm Limit
21306 (533A) 512 BP Percent Reduction {B}
21308 (533C) 513 Min BP Flow Rate {B}
21310 (533E) 515 Differential Pressure {B}
21312 (5340) 516 BP Flow Recovery Pressure {B}
21314 (5342) 522 Vapor Pressure 1
21316 (5344) 523 Vapor Press Temp 1
21318 (5346) 524 Vapor Pressure 2
21320 (5348) 525 Vapor Press Temp 2
21322 (534A) 526 Vapor Pressure 3
21324 (534C) 527 Vapor Press Temp 3
21326 (534E) 409 Reference Density's Temperature
21328 (5350) 410 Reference Density for C Tables
21330 (5352) 204 Flow Adjust Time {B}

Directory: Product Configuration
Data Type: UNSIGNED CHAR
Start Address: 22016

22016 (5600) 351 Meter Factor Variation Select
22017 (5601) 405 API Table
22018 (5602) 511 Min BP Flow Timer {B}
22019 (5603) 514 BP Flow Recovery Timer {B}
22020 (5604) 521 Vapor Pressure Calc Method
22021 (5605) 231 High Flow Alarm Timeout
22022 (5606) 232 Low Flow Alarm Timeout
22023 (5607) 233 Zero Flow Timer
22024 (5608) 234 Valve Fault Timeout

Directory: Product Configuration
Data Type: UNSIGNED LONG
Start Address: 22272

22272 (5700) 221 Excess High Flow Rate

Directory: Recipe Configuration
Data Type: TEXT
Start Address: 22528

22528 (5800) 002 Recipe Name

Directory: Recipe Configuration
Data Type: FLOATING POINT
Start Address: 23296

23296 (5B00) 004 Blend Percent

Directory: Recipe Configuration
Data Type: UNSIGNED CHAR
Start Address: 24064

24064 (5E00) 001 Recipe Used
24065 (5E01) 003 HM Class

Directory: System Commands
Data Type: UNSIGNED CHAR
Start Address: 26112

26112 (6600) Set User Alarm

Directory: System Commands
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 Commands
Data Type: UNSIGNED LONG
Start Address: 26368

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

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

29440 (7300) User Float Register

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

30208 (7600) User Boolean Register

Directory: User 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 Commands
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 Commands
Data Type: UNSIGNED INTEGER
Start Address: 36480

36480 (8E80) PP - Print to Printer
36481 (8E81) LO - Program Mode Logout
36482 (8E82) SB - Start Batch
36483 (8E83) NR - New Recipe
36484 (8E84) SA/SP - Host Start/Stop
36485 (8E85) ET - Host Terminate Transaction
36486 (8E86) RT - Retrieve Transaction - Number Back (0=current)
36487 (8E87) Recipe Index to Read/Write (1-12)
36488 (8E88) Product Index to Read/Write (1-2)

Directory: Arm Commands
Data Type: UNSIGNED LONG
Start Address: 36608

36610 (8F02) Reserved – future

Status Registers – Function 4

DEC HEX Description

Directory: System Run Data
Data Type: TEXT
Start Address: 0

0000 (0000) Time of Last Power Fail
0016 (0010) Requested Audit/Event Log Entry Pt 1
0032 (0020) Requested Audit/Event Log Entry Pt 2
0048 (0030) Requested Audit/Event Log Entry Pt 3

Directory: System Run Data
Data Type: UNSIGNED CHAR
Start Address: 1536

1536 (0600) Current time type (Mil, AM, PM)
1537 (0601) Last Key Pressed

Directory: System Run Data
Data Type: UNSIGNED INTEGER
Start Address: 1664

1664 (0680) Current year
1665 (0681) Current month
1666 (0682) Current day
1667 (0683) Current week day
1668 (0684) Current seconds
1669 (0685) Current minutes
1670 (0686) Current hour

Directory: System Run Data
Data Type: UNSIGNED LONG
Start Address: 1792

1792 (0700) Most Recent Event Sequence Number
1794 (0702) Most Recent Audit Trail Sequence Number

Directory: Transaction Data
Data Type: TEXT
Start Address: 2048

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

Directory: Transaction Data
Data Type: FLOATING POINT
Start Address: 2816

2816 (0B00) Average Meter Factor
2818 (0B02) Average Temperature
2820 (0B04) Average Density
2822 (0B06) Average Pressure
2824 (0B08) Average CTL
2826 (0B0A) Average CPL
2828 (0B0C) Preset Amount
2830 (0B0E) Prover Coefficient of Expansion
2862 (0B10) Prove New Meter Factor
2834 (0B12) Prove Old Meter Factor
2836 (0B14) Prove Meter Factor Flow Rate
2838 (0B16) Archived User Float Register 46
2840 (0B18) Archived User Float Register 47
2842 (0B1A) Archived User Float Register 48
2844 (0B1C) Archived User Float Register 49
2846 (0B1E) Archived User Float Register 50

Directory: Transaction Data
Data Type: DOUBLE PRECISION
Start Address: 3072

3072 (0C00) Indicated Volume (IV)
3076 (0C04) Gross Volume (GV)
3080 (0C08) Gross @ STD Temp Volume (GST)
3084 (0C0C) Gross @ STD Temp & Press (GSV)
3088 (0C10) Mass
3092 (0C14) Remaining Amount
3096 (0C18) Delivered Volume

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

3584 (0E00) ROM Major Version #
3585 (0E01) ROM Minor Version #
3586 (0E02) Batch Status
3587 (0E03) Pump Status
3588 (0E04) Prove Meter Factor #
3589 (0E05) Prove # Batches Used
3590 (0E06) Prove Meter Factor Stored
3591 (0E07) Current Batch Index
3592 (0E08) Current Recipe Index
3593 (0E09) Batch Presetting in Progress
3594 (0E0A) Result of last Host Command
3595 (0E0B) Archived User Boolean Register 46
3596 (0E0C) Archived User Boolean Register 47
3597 (0E0D) Archived User Boolean Register 48
3598 (0E0E) Archived User Boolean Register 49
3599 (0E0F) Archived User Boolean Register 50

Directory: Transaction Data
Data Type: UNSIGNED INTEGER
Start Address: 3712

3712 (0E80) Transaction Number
3713 (0E81) Total Number of Batches
3714 (0E82) Transaction start year
3715 (0E83) Transaction start month
3716 (0E84) Transaction start day
3717 (0E85) Transaction start week day
3718 (0E86) Transaction start seconds
3719 (0E87) Transaction start minutes
3720 (0E88) Transaction start hour
3721 (0E89) Transaction end year
3722 (0E8A) Transaction end month
3723 (0E8B) Transaction end day
3724 (0E8C) Transaction end week day
3725 (0E8D) Transaction end seconds
3726 (0E8E) Transaction end minutes
3727 (0E8F) Transaction end hour

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

3840 (0F00) ROM CRC

Directory: Batch Data
Data Type: TEXT
Start Address: 4096

4096 (1000) 1st Alarm in Batch
4112 (1010) 2nd Alarm in Batch
4128 (1020) 3rd Alarm in Batch
4144 (1030) 4th Alarm in Batch
4160 (1040) 5th Alarm in Batch
4176 (1050) 6th Alarm in Batch
4192 (1060) 7th Alarm in Batch
4208 (1070) 8th Alarm in Batch
4224 (1080) 9th Alarm in Batch
4240 (1090) 10th Alarm in Batch

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

4864 (1300) Average Flow Rate
4866 (1302) Load Average Meter Factor
4868 (1304) Load Average Temperature
4870 (1306) Load Average Density
4872 (1308) Load Average Pressure
4874 (130A) Average CTL
4876 (130C) Average CPL
4878 (130E) Prover CTSP
4880 (1310) Prover CTLP
4882 (1312) Prove CTLM
4884 (1314) Prover IV
4886 (1316) Prove Meter IV
4888 (1318) Prover Temperature
4890 (131A) Prove Meter Temperature
4892 (131C) Prove New Meter Factor
4894 (131E) Prove Average Flow Rate
4896 (1320) Prove Average Density

Directory: Batch Data
Data Type: DOUBLE PRECISION
Start Address: 5120

5120 (1400) Total Pulses
5124 (1404) Indicated Volume (IV)
5128 (1408) Gross Volume (GV)
5132 (140C) Gross Volume @ STD Temp (GST)
5136 (1410) Gross @ Std Temp & Press (GSV)
5140 (1414) Mass Total

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

5632 (1600) Recipe Number
5633 (1601) Batch #
5634 (1602) Prove Batch Accepted

Directory: Product Run Data
Data Type: FLOATING POINT
Start Address: 6912

6912 (1B00) Current Product Flow Rate
6914 (1B02) Current Product Flow Rate per Hour
6916 (1B04) Current Product Flow Rate per Min
6918 (1B06) Current Product Meter Factor
6920 (1B08) Current Product Temperature
6922 (1B0A) Current Product Density
6924 (1B0C) Current Product Pressure
6926 (1B0E) Current Product Vapor Pressure
6928 (1B10) Current Product Blend Ratio
6930 (1B12) Current Product Instant Blend Ratio

Directory: Product Run Data
Data Type: DOUBLE PRECISION
Start Address: 7168

7168 (1C00) Prd Indicated Non-resettable Volume
7172 (1C04) Prd Gross Non-resettable Volume
7167 (1C08) Prd GST Non-resettable Volume
7180 (1C0C) Prd GSV Non-resettable Volume
7184 (1C10) Prd Mass Non-resettable Total
7188 (1C14) Prd Start Non-resettable IV
7192 (1C18) Prd Start Non-resettable GV
7196 (1C1C) Prd Start Non-resettable GST
7200 (1C20) Prd Start Non-resettable GSV
7204 (1C24) Prd Start Non-resettable Mass
7208 (1C28) Prd Blend Deviation Count

Directory: Product Run Data
Data Type: UNSIGNED LONG
Start Address: 7936

7936 (1F00) Product Current Pulse Count

Directory: Product Run Data for Batch
Data Type: FLOATING POINT
Start Address: 8960

8960 (2300) P1 Average Flow Rate
8962 (2302) P2 Average Flow Rate
8964 (2304) P1 Average Meter Factor
8966 (2306) P2 Average Meter Factor
8968 (2308) P1 Average Temperature
8970 (230A) P2 Average Temperature
8972 (230C) P1 Average Density
8974 (230E) P2 Average Density
8976 (2310) P1 Average Pressure
8978 (2312) P2 Average Pressure
8980 (2314) P1 Average CTPL
8982 (2316) P2 Average CTPL
8984 (2318) P1 Average CTL
8986 (231A) P2 Average CTL
8988 (231C) P1 Average CPL
8990 (231E) P2 Average CPL
8992 (2320) P1 CCF
8994 (2322) P2 CCF
8996 (2324) P1 Average Reference Density
8998 (2326) P2 Average Reference Density
9000 (2328) P1 Average Relative Density
9002 (232A) P2 Average Relative Density
9004 (232C) P1 Average API @ Ref Temp
9006 (232E) P2 Average API @ Ref Temp
9008 (2330) P1 Average Vapor Pressure

9010 (2332) P2 Average Vapor Pressure
9012 (2334) P1 Avg Reference Density @ Ref Dens Temp
9014 (2336) P2 Avg Reference Density @ Ref Dens Temp
9016 (2338) P1 Avg Rel Dens@60F &Prs (E Tables CPL Only)
9018 (233A) P2 Avg Rel Dens@60F &Prs (E Tables CPL Only)

Directory: Product Run Data for Batch
Data Type: DOUBLE PRECISION
Start Address: 9216

9216 (2400) Batch P1 Total Pulses
9220 (2404) Batch P2 Total Pulses
9224 (2408) Batch P1 Indicated Volume (IV)
9228 (240C) Batch P2 Indicated Volume (IV)
9232 (2410) Batch P1 Gross Volume (GV)
9236 (2414) Batch P2 Gross Volume (GV)
9240 (2418) Batch P1 Gross @ Std Temp (GST)
9244 (241C) Batch P2 Gross @ Std Temp (GST)
9248 (2420) Batch P1 Gross @ Std Temp & Press (GSV)
9252 (2424) Batch P2 Gross @ Std Temp & Press (GSV)
9256 (2428) Batch P1 Mass Total
9260 (242C) Batch P2 Mass Total

Directory: Analog I/O Values
Data Type: FLOATING POINT
Start Address: 13056

13056 (3300) Analog Counts
13058 (3302) Analog Raw Value (mA or volts)
13060 (3304) Analog Engineering Value

Directory: Recipe Run Data
Data Type: DOUBLE PRECISION
Start Address: 15360

15360 (3C00) Recipe Indicated Non-resettable Volume
15364 (3C04) Recipe Gross Non-resettable Volume
15368 (3C08) Recipe GST Non-resettable Volume
15372 (3C0C) Recipe GSV Non-resettable Volume
15376 (3C10) Recipe Mass Non-resettable Total

Directory: Meter Run Data
Data Type: UNSIGNED CHAR
Start Address: 17920

17920 (4600) Valve Status

Modbus Communications Primer

The miniBlend.net 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 miniBlend.net 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 register(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 validate 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 miniBlend.net 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 miniBlend.net receives the first field (the address field), it decodes it to determine if it is the miniBlend.net 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 miniBlend.net 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 miniBlend.net 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 starting 3.5 character time for the next message (there is no need for the ‘master’ to delay twice between messages as long as the duration exceeds the specified delay).

How Characters are Transmitted Serially

When messages are transmitted on standard Modbus 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 miniBlend.net.

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 miniBlend.net 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 miniBlend.net by sending messages containing function codes. Function codes indicate the actions the miniBlend.net is to perform.

The miniBlend.net’s 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 an miniBlend.net to read a group of holding registers by sending the following function code:

0000 0011 (Hexadecimal 03)

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

1000 0011 (Hexadecimal 83)

The miniBlend.net 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 miniBlend.net device, the miniBlend.net will return the exception response with the exception code shown (02). This response indicates an invalid data address for the miniBlend.net.

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 miniBlend.net.
03	Illegal Data Value	A value contained in the query data field is not an allowable value for the miniBlend.net.
04	Command Error	An unrecoverable error occurred while the miniBlend.net 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 miniBlend.net 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 a miniBlend.net 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 written, 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 miniBlend.net 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 miniBlend.net address 06. The miniBlend.net 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 miniBlend.net first echoes the function code sent by the 'master.' The miniBlend.net then transmits the byte count field, indicating the number of 8-bit data items being returned. Finally, the miniBlend.net 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 miniBlend.net response example illustrates a typical byte count field in a normal response.

Master Query		
Field Name	**Example (Hex)**	**RTU 8-Bit Field**
Header		None
miniBlend.net 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

miniBlend.net Response		
Field Name	**Example (Hex)**	**RTU 8-Bit Field**
Header		None
miniBlend.net 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 miniBlend.net monitors the amount of time between the receipt of characters. If three and one-half character times elapse without the miniBlend.net 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 miniBlend.net, it will respond. If the address is not for that miniBlend.net, 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 miniBlend.net ('slave') that is to receive the message that is sent via the supervisory system ('master'). Each miniBlend.net 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 miniBlend.net when data is requested. By returning the address as part of the response, the 'master' can tell which of the miniBlend.nets 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 miniBlend.net 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 miniBlend.net. 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 miniBlend.net to the 'master' is 256 bytes. The data lengths for the data types currently used by the miniBlend.net 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 miniBlend.net. The maximum number of "coils" per response is 256 in the miniBlend.net.

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 miniBlend.net device 17:

Query	
Field Name	**Example (Hex)**
miniBlend.net 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)**
miniBlend.net 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 miniBlend.net. The maximum number of parameters supported by miniBlend.net 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 miniBlend.net 17 is shown below:

Query	
Field Name	**Example (Hex)**
miniBlend.net 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)**
miniBlend.net 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 miniBlend.net 17 is shown below.

Query	
Field Name	**Example (Hex)**
miniBlend.net 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)**
miniBlend.net 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 miniBlend.net. 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 miniBlend.net 17 appears below.

Query	
Field Name	**Example (Hex)**
miniBlend.net 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)**
miniBlend.net 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 miniBlend.net 17 appears below. (Reset User Alarm #9)

Query	
Field Name	**Example (Hex)**
miniBlend.net 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)**
miniBlend.net 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 miniBlend.net 17 appears below.

Query	
Field Name	**Example (Hex)**
miniBlend.net 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)**
miniBlend.net 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 miniBlend.net 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 miniBlend.net 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 corresponding 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)**
miniBlend.net 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)**
miniBlend.net 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 miniBlend.net 17, appears below.

Query	
Field Name	**Example (Hex)**
miniBlend.net 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)**
miniBlend.net 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 miniBlend.net device, there are three possible outcomes:

1. The miniBlend.net receives the query with no communication errors, handles the query normally, and returns a normal response.
2. A communication error bars the miniBlend.net from receiving the query, so no response is returned. The 'master' program eventually processes a timeout condition for the query.
3. The miniBlend.net 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: An miniBlend.net 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 miniBlend.net condition that caused the exception.

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

Query		
Byte	**Contents**	**Example**
1	miniBlend.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	miniBlend.net Address	0A
2	Function	81
3	Exception Code	02
4	CRC	--

Here, the 'master' addresses a query to miniBlend.net 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.

How to Access 64-bit information using Modbus when Modbus will only read 32-bit information

64-bit information is referring to double precision data which is the data type of most volumes as well as a lot of other data stored in the preset. 32-bit information is referring to single precision data.

The answer to this problem is to save each double precision register to a user float register using an equation. The preset device will handle the conversion, however, be aware that some precision is lost when converted to single precision due to the fact that there are less Mantissa Bits in a 32-bit value.

Here is an example of an equation written in the mate software:

USERFLOAT1 = ARM1 TRANSACTION DATA INDICATED VOLUME(IV)

There are 100 userfloat registers that are 32-bit single precision registers (capable of being read using Modbus). Registers #96-100 get archived with transaction data for use after the transaction has ended. Userfloat registers #1-95 do NOT get archived and will be lost when the transaction is ended.

Indicated volume, as we know, is a double precision (64-bit) value that cannot be read directly using modbus. Using the equation above will enable the value to be read from the Userfloat1 register.

Related Publications

Revisions included in MNMB005 Issue/Rev. 0.1 (9/13):
Page 5: Revised Coils 261-269 to have the same State Titles as 261-268 on page 10.

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