Instruction No. GF-114

AERCO INTERNATIONAL, Inc., Northvale, New Jersey, 07647 USA

# *MODBUS®*

## Communication Manual

## For

# C-More Boiler Controllers and Boiler Management Systems (BMS/BMS II)



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# TABLE OF CONTENTS

# TABLE OF CONTENTS - Continued

# TABLE OF CONTENTS - Continued

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# SECTION 1 INTRODUCTION & GENERAL DESCRIPTION

## 1.1 INTRODUCTION

The information contained in this manual provides general guidelines for implementing a Modbus® communications network utilizing AERCO's Boiler Management System (BMS) Model 168 or Boiler Management System II (BMS II) Model 5R5-384 and C-More Boiler Controllers.

Throughout this document, the following terminology shall be used when referring to BMS Model 168 and BMS II Model 5R5-384:

- BMS: Applies to BMS Model 168 Only
- BMS II: Applies to BMS II Model 5R5-384 Only
- BMS/BMS II: Applies to Both Models (BMS and BMS II)

All Modbus networks are implemented utilizing a Master-Slave technique where only one device, the Master, can initiate a communication sequence. AERCO C-More Controllers can only function as Slave devices in a Modbus network. However, the AERCO BMS can function both as a Master controlling C-More Slaves, or as a Slave controlled by an Energy Management System (EMS) or Building Automation System (BAS) developed by other manufacturers.

## 1.2 AERCO BMS AND C-MORE CONTROLLER MODELS COVERED

To easily determine if your AERCO BMS or C-More Boiler Controller is equipped with Modbus capabilities, check the current software version as follows:

**For BMS:**

- Apply power to the BMS
- The BMS will display: ***INITIALIZING*** followed by ***EPROM REV K***
- If ***REV K*** or higher is displayed, the BMS Controller can support Modbus
- If the *REV* level is lower than **K,** the BMS Controller cannot support Modbus

**For BMS II:**

- All BMS II Controllers support Modbus

**For C-More:**

- Apply external power to the C-More Controller
- Scroll through the Setup Menu and observe the displayed ***Software Version***
- If ***2.00*** or higher is displayed, the C-More Controller can support Modbus
- If a ***Software Version*** lower than ***2.00*** is displayed, the C-More Controller cannot support Modbus

## 1.3 MINIMUM MODBUS SUPPORT REQUIREMENTS

Implementation of a Modbus communication network utilizing the AERCO C-More Controller and BMS/BMS II will be limited to the minimum support requirements listed in Table 1-1 which follows. The remaining paragraphs in this Section provide more detailed descriptions for each of the items listed.

***Table 1-1. Modbus Communication and Support Requirements***

| Characteristic | Requirement |
|---|---|
| Communication Medium: | |
| • EMS Master-To-BMS/BMS II Slave | RS232 (or RS485 With Optional Converter) |
| • BMS/BMS II Master-To-C-More Slave | RS485, 2-Wire Differential Bus With Shield |
| • EMS Master-To- C-More Slave | RS485, 2-Wire Differential Bus With Shield |
| Allowable Cable Lengths | |
| • RS232 | 50 Feet, Maximum |
| • RS485 | 4,000 Feet, Maximum |
| • PWM | 1,000 Feet, Maximum |
| Address Support From Master: | |
| • BMS/BMS II | 128 to 247 (From a Master EMS) |
| • C-More Controller (Slave) | 1 to 127 (From Master BMS/BMS II or EMS) |
| • Broadcast Messages | Address 0 is Reserved for Broadcast Messages |
| Transmission Mode Support | RTU (Remote Terminal Unit) |
| Timing Specifications: | |
| • Baud Rate | Fixed at 9600 For C-More<br>Adjustable For BMS/BMS II: 2400, 4800, 9600, 14.4k, 19.2k<br>Default = 9600 |
| Message Framing | Silent period of at least 3.5 character times Before first character and After last character of message |
| • Character Framing | No more than 1.5 character times of silence between received and transmitted characters |
| • Heartbeat Timeout | Fixed at 10 seconds For C-More<br>Adjustable For BMS/BMS II: 5 to 240 Seconds |

### 1.3.1 Communication Medium

The communication medium for each of the possible Modbus network configurations may vary depending on the Master/Slave scenario being implemented. Detailed installation procedures and wiring diagrams for the configurations described in the following paragraphs are provided in Section 4 of this manual.

#### 1.3.1.1 EMS Master To BMS/BMS II Slave

The Modbus network connections between the EMS and BMS/BMS II will depend on the type of port provide on the EMS Master. If the EMS contains a RS232 port, a direct connection can be made directly to the BMS/BMS II RS232 port. For optimum results the wire length between the EMS and BMS/BMS II RS232 connection should not exceed 50 feet. If the EMS Master contains a RS485 port, a RS485-to-RS232 converter will be required to implement the Modbus network.

#### 1.3.1.2 BMS/BMS II Master To C-More Boiler Controller Slaves

Up to a total of 32 C-More Boiler Controllers can be connected to a BMS/BMS II Master on the Modbus Network. Multi-point drop network connections are made using shielded, twisted-pair wire. In addition to the Modbus Network Boilers, up to 8 additional Legacy Boilers can be connected to the BMS Pulse Width Modulation (PWM) wiring connection. The BMS II does not support PWM. It should be noted that both the BMS and BMS II include a Modbus Pass-Thru feature which, when enabled, permits an EMS to monitor and configure (but not directly control) the boilers.

#### 1.3.1.3 EMS Master To C-More Boiler Controller Slaves

The number of C-More Boiler Controllers which can be connected to a Modbus Network which utilizes a third party EMS Master will depend on the EMS's limitations. Theoretically, the maximum number of Slave devices is limited to 127. If the EMS contains a RS232 port, a RS232-to-RS485 converter will be required to provide the necessary RS485 interfaces and signal levels for the C-More Boiler Controllers. Multi-drop network connections are made using shielded, twisted-pair wire.

### 1.3.2 Address Support

Address support is assigned as follows:

- BMS/BMS II Address Support From EMS Master: 128 – 247 (80 – F7 hex)
- C-More Address Support From BMS/BMS II or EMS Master: 1 – 127 (01 – 7F hex)
- Broadcast Messages: Address 0 is reserved for all Broadcast messages

### 1.3.3 Modbus Transmission Modes

Many Modbus Controllers can be set up to transmit using either the ASCII (American Standard Code for Information Interchange) transmission mode, or the RTU (Remote Terminal Unit) transmission mode. However, since RTU messages can be formatted using far fewer binary bits than the corresponding ASCII message, it is far more efficient. Therefore, all Modbus messages for the AERCO BMS/BMS II and C-More Boiler Controllers use RTU transmission ONLY. If a third-party EMS Master is being used in the Modbus network, ensure that it is set for RTU transmission.

### 1.3.4 Timing Specifications

As Table 1-1 shows, Baud Rate and Heartbeat Timeout will vary depending on the Configurations of the AERCO BMS/BMS II and C-More Boiler Controllers being used in the Modbus Network. Ensure that the Baud Rate used by the controlling Master (BMS/BMS II or EMS) matches the appropriate Baud Rate supported by the Network Slaves (BMS/BMS II or C-More Controllers). Also, ensure that the Modbus Master can refresh the control information to all C-More Slaves before the Heartbeat Timeout period expires.

## 1.4 MODBUS FUNCTION SET SUPPORT

The complete Modbus protocol includes a total of 24 Function Codes. However, for AERCO BMS/BMS II and C-More Boiler Controllers, only the Codes listed in Table 1-2 are supported. The supported Diagnostic Sub-Function Codes associated with Diagnostic Function Code 08 are listed in Table 1-3.

***Table 1-2. Required Function Code Set***

| Function Code | Function Name |
|---|---|
| 03 | Read Holding Register (Read Multiple Registers) |
| 04 | Read Input Registers |
| 06 | Preset (Write) Single Register |
| 08 | Diagnostics<br>(See Table 1-3 for supported Sub-Function Codes) |
| 17 | Report Slave ID |

***Table 1-3. Minimum Diagnostic (Function Code 08) Sub-Function Set***

| Sub-Function Code | Sub-Function Name | Comments |
|---|---|---|
| 00 | Return Query Data | Loop-Back |
| 01 | Restart Communications Options | Resets the Slave. Cancels Listen Only Mode. |
| 02 | Return Diagnostic Register | Not Used |
| 04 | Force Listen Only Mode | Reset by Restart Communications Option |
| 10 | Clear Counters and Diagnostic Register | Also cleared at power up. Clears only the counters |
| 12 | Return Bus Communication Error Count | Slave CRC errors only. |
| 13 | Return Bus Exception Error Count | Slave Exception Response count. |
| 14 | Return Slave Message Count | Number of messages addressed to the slave and successfully processed. Includes broadcast messages. |
| 15 | Return Slave No Response Count | Number of messages addressed to the slave for which no response was returned. |
| 18 | Return Bus Character Overrun Count | Number of overrun and framing errors. |

## 1.5 EXCEPTION RESPONSES

With the exception of Broadcast Messages, queries transmitted by the Master expect a normal response from the addressed Slave on the network. However, if the addressed Slave cannot process or interpret the message, it will respond with one of the Exception Codes listed in Table 1-4.

*Table 1-4. Minimum Exception Code Set*

| Exception Code | Description | Comments |
|---|---|---|
| 01 | Illegal Function | The function code received is not valid or is not supported. |
| 02 | Illegal Data Address | The data address received is invalid or is not accessible due to security setting. |
| 03 | Illegal Data Value | The data value received is not valid |

## 1.6 PHRASES, ABBREVIATIONS & ACRONYMS

The phrases, abbreviations and acronyms used in this manual are listed in Table 1-5.

*Table 1-5. Phrases, Abbreviations and Acronyms*

| Phrase, Abbreviation or Acronym | Meaning |
|---|---|
| ASCII | American Standard Code for Information Interchange |
| BAS | Building Automation System |
| Baud | Bits per Second (bps) |
| BMS (BMS II) | Boiler Management System (Boiler Management System II) |
| C-More Controller (or Control Box) | A control system developed by AERCO International and currently used in all Benchmark and KC Series product lines |
| EMS | Energy Management System |
| FDX | Full-Duplex |
| HDX | Half-Duplex |
| Hex | Hexadecimal Number (0 - 9, A - F) |
| I/O Box | Input/Output (I/O) Box currently used on all Benchmark and KC Series products |
| LSB | Least Significant Byte |
| Modbus® | A serial, half-duplex data transmission protocol developed by AEG Modicon |
| MSB | Most Significant Byte |
| RS232 | A standard for serial, full-duplex (FDX) transmission of data based on the RS232 Standard |
| RS422 | A standard for serial, full-duplex (FDX) transmission of data based on the RS422 Standard |
| RS485 | A standard for serial, half-duplex (HDX) transmission of data based on the RS485 Standard |
| RTU | Remote Terminal Unit |

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# SECTION 2 STANDARD REGISTER ASSIGNMENTS

## 2.1 INTRODUCTION

This Section provides the standard data register addresses assigned to the AERCO and C-More Boiler Controllers and the AERCO Boiler Management System (BMS/BMS II). These data registers consist of Input Registers and Holding Registers. All register addresses provided throughout this manual are expressed as hexadecimal numbers.

### 2.1.1 Input Registers

The Input Registers for the AERCO C-More Boiler Controllers and AERCO BMS/BMS II are intended for information and functions that cannot or should not be controlled remotely. Therefore, unless otherwise specified, ALL Input Register data are READ ONLY.

**IMPORTANT**

All Modbus addresses specified in this manual are written generically in decimal/hexadecimal format. However, many Building Automation Systems utilize another form of addressing where:

40001 is added to the generic address for a Holding Register address.

And

30001 is added to the generic address for an Input Register address.

Be sure to check the addressing scheme being used by the BAS that is being interfaced to the XPC Gateway.

### 2.1.2 Holding Registers

The Holding Registers for the AERCO C-More Boiler Controllers and AERCO BMS/BMS II are intended for information and functions that can be read or written (R/W). Therefore unless otherwise specified, all Holding Register data are R/W.

**CAUTION**

DO NOT write in any Register Addresses marked as “Reserved” in the Input Register and Holding Register Tables which follow. Failure to observe this precaution may result in unstable operation.

## 2.2 C-MORE BOILER CONTROLLER STANDARD REGISTER ASSIGNMENTS

### 2.2.1 C-More Boiler Controller Standard Input Register Assignments

The Read Only Input Register addresses are listed in Table 2-1 which follows:

***Table 2-1. C-More Boiler Controller Standard Input Register Address Mapping***

| Modbus Data Address Decimal (Hex) | Menu Item | Units and Range | Default/Comments |
|---|---|---|---|
| 0 (0x0000) | Default Message Display Code | Enum (1 to 47) | See Appendix A, Table A-1 for listing |
| 1 (0x0001) | Unit Status | Enum (0, 1, 2, 3, 4, 5)<br>0 = Unit Status Disabled<br>1 = Unit Status Standby<br>2 = Unit Status Manual<br>3 = Unit Status Remote<br>4 = Unit Status Auto<br>5 = Unit Status Fault | |
| 2 (0x0002) | Outlet Temp | DEGREES_1 (0 to 1000) | See Appendix A, Tables A-2 and A-3 for Conversions |
| 3 (0x0003) | Inlet Temp | DEGREES_1 (0 to 1000) | See Appendix A, Tables A-2 and A-3 for Conversions |
| 4 (0x0004) | Aux Temp | DEGREES_1 (0 to 1000) | See Appendix A, Tables A-2 and A-3 for Conversions |
| 5 (0x0005) | Outdoor Temp | DEGREES_2 (0 to 1000) | See Appendix A, Tables A-2 and A-3 for Conversions |
| 6(0x0006) | Exhaust Temp | DEGREES_2 (0 to 1000) | See Appendix A, Tables A-2 and A-3 for Conversions |
| 7 (0x0007) | FFWD Temp | DEGREES_1 (0 to 1000) | See Appendix A, Tables A-2 and A-3 for Conversions |
| 8 (0x0008) | Fire Rate Out | % (0 to 100) | |
| 9 (0x0009) | O2 Level | % (0 to 25) | |
| 10 (0x000A) | CO Level | PPM (0 to 500) | |
| 11 (0x000B) | Run Cycles Low (LSB) | int (0 to 65535) | The actual range for run cycles is from 0 to 999,999 |
| 12 (0x000C) | Run Cycles High (MSB) | Int (0 to 15) | |

***Table 2-1. C-More Boiler Controller Standard Input Register Address Mapping - Cont***

| Modbus Data Address Decimal (Hex) | Menu Item | Units and Range | Default/Comments |
|---|---|---|---|
| 13 (0x000D) | Run Hours Low (LSB) | int (0 to 65535) | The actual range for run hours is from 0 to 999,999 |
| 14 (0x000E) | Run Hours High (MSB) | int (0 to 15) | |
| 15 (0x000F) | Flame Strength | % (0 to 100) | |
| 16 (0x0010) | Active Set point | DEGREES_1 (0 to 1000) | See Appendix A, Tables A-2 and A-3 for Conversions |
| 17 (0x0011) | Fire Rate In | % (0 to 100) | |
| 18 (0x0012) | Manual Fire Rate | % (0 to 100) | Only applicable when in the Manual Mode and controlled by the front panel interface |
| 19 (0x0013) | Comm Address | Int (0 to 127) | Default = 0<br>Comm Address 0 disables the Controller's Modbus communications |
| 20 (0x0014) | Software Version | int (0 to 65535) | |
| 21 (0x0015)<br>22 (0x0016) | (Reserved) | | |
| 23 (0x0017) | Fault Log Code | | Fault Log |
| 24 (0x0018) | Fault Log Cycle (LOW) | int (0 to 65535) | The internal variable type for fault log display cycle is long and the range is 0 to 999999 |
| 25 (0x0019) | Fault Log Cycle (HIGH) | Int (0 to 15) | |
| 26 (0x001A) | Fault Log Date | Int (1 to 65535)<br>1 count/day | |
| 27 (0x001B) | Fault Log Time | Int (0 to 1439)<br>1 count/min. | |
| 28 (0x001C) | Sensor Log Active Setpoint | DEGREES_1 (0 to 1000) | See Appendix A, Tables A-2 and A-3 for Conversions |

***Table 2-1. C-More Boiler Controller Standard Input Register Address Mapping - Cont***

| Modbus Data Address Decimal (Hex) | Menu Item | Units and Range | Default/Comments |
|---|---|---|---|
| 29 (0x001D) | Sensor Log<br>Outlet Temp | DEGREES_1 (0 to 1000) | See Appendix A, Tables A-2 and A-3 for Conversions |
| 30 (0x001E) | Sensor Log<br>Inlet Temp | DEGREES_1 (0 to 1000) | See Appendix A, Tables A-2 and A-3 for Conversions |
| 31 (0x001F) | Sensor Log<br>FFWD Temp | DEGREES_1 (0 to 1000) | See Appendix A, Tables A-2 and A-3 for Conversions |
| 32 (0x0020) | Sensor Log<br>Exhaust Temp | DEGREES_3 (0 to 1000) | See Appendix A, Tables A-2 and A-3 for Conversions |
| 33 (0x0021) | Sensor Log<br>Outdoor Temp | DEGREES_2 (0 to 1000) | See Appendix A, Tables A-2 and A-3 for Conversions |
| 34 (0x0022) | Sensor Log<br>Aux Temp | DEGREES_1 (0 to 1000) | See Appendix A, Tables A-2 and A-3 for Conversions |
| 35 (0x0023) | Sensor Log<br>CO xmitter | PPM_UNITS | |
| 36 (0x0024) | Sensor Log<br>O2 xmitter | % (0 to 100) | |
| 37 (0x0025) | Sensor Log<br>Flow Meter | GPM_UNITS | |
| 38 (0x0026) | Time Log<br>Status | 73 (“I”) = Ignition<br>74 (“O”) = Off<br>80 (“P”) = Power Up<br>82 (“R”) = Run | |
| 39 (0x0027) | Time Log<br>Fire Rate | % (0 to 100) | |
| 40 (0x0028) | Time Log<br>Flame Strength | % (0 to 100) | |
| 41 (0x0029) | Time Log<br>Run Length | Int (0 to 65535) | |
| 42 (0x002A) | Time Log<br>Date | Int (0 to 65535)<br>1 count/day | |
| 43 (0x002B) | Time Log<br>Time | Int (0 to 1439)<br>1 count/min. | |

### 2.2.2 C-More Boiler Controller Standard Holding Register Assignments

The Read/Write Input Register address assignments are listed in Table 2-2 which follows. Unless otherwise specified, all Holding Register menu items are Read/Write (R/W)

***Table 2-2. C-More Controller Standard Holding Register Address Mapping***

| Modbus Data Address Decimal (Hex) | Menu Item | Units and Range | Comments |
|---|---|---|---|
| 0 (0x0000) | Net Remote Set Point | DEGREES_1 (0 to 1000) | See Appendix A, Tables A-2 and A-3 for Conversions. R/W ONLY in Remote Set Point Mode |
| 1 (0x0001) | Net Direct Drive | % (0 to 100) | Normally Read Only. R/W ONLY in Direct Drive Mode. |
| 2 (0x0002) | Modbus Password | int (0 to 65535) | Default = 0 |
| 3 (0x0003) | Password | int (0 to 65535) | Default = 0 |
| 4 (0x0004) | Internal Set Point | DEGREES_1 (0 to 1000) | See Appendix A, Tables A-2 and A-3 for Conversions<br>Default = 130°F |
| 5 (0x0005) | (Reserved) | | |
| 6 (0x0006) | Time | Int (0 to 1439)<br>1count/min | |
| 7 (0x0007) | Date | int (0 to 65535)<br>1count/day | Date count starts with Jan. 1, 2000. For Example: Jan. 1 2001 would equal 365 counts |
| 8 (0x0008) | Unit of Temp | bool (0, 1)<br>0= Degrees Fahrenheit (°F)<br>1=Degrees Celsius (°C) | Default = °F |
| 9 (0x0009) | Baud Rate | enum (0, 1, 2, 3, 4)<br>0 = 2.4k<br>1 = 4.8k<br>2 = 9.6k<br>3 = 19.2k | For C-More RS232 port ONLY<br><br>Default = 2 (9.6k) |
| 10 (0x000A) | Unit Type | bool (0, 1)<br>0 = Boiler<br>1 = Water Heater | Default = Boiler |
| 11 (0x000B) | Unit Size | enum (0, 1, 2, 3, 4, 5)<br>0 = 0.5 MBTU<br>1 = 1 MBTU<br>2 = 1.5 MBTU<br>3 = 2 MBTU<br>4 = 2.5 MBTU<br>5 = 3 MBTU | Default = 1 (1 MBTU) |

***Table 2-2. C-More Controller Standard Holding Register Address Mapping-Cont.***

| Modbus Data Address Decimal (Hex) | Menu Item | Units and Range | Comments |
|---|---|---|---|
| 12 (0x000C) | Boiler Mode | enum (0, 1, 2, 3, 4):<br>0 = Constant Setpt<br>1 = Remote Setpt<br>2 = Direct Drive<br>3 = Combo Unit<br>4 = Outdoor Reset | Default = 0<br>(Constant Setpt) |
| 13 (0x000D) | Remote Signal | enum (0, 1, 2, 3):<br>0 = 4 - 20 mA /1 - 5V<br>1 = 0 -20mA/0 - 5V<br>2 = PWM Input<br>3 = Network | Default = 0<br>(4 - 20 mA/1 - 5V) |
| 14 (0x000E) | Bldg Ref Temp | DEGREES_1 (0 to 1000) | See Appendix A, Tables A-2 and A-3 for Conversions |
| 15 (0x000F) | Reset Ratio | Int (1 to 99 counts)<br>Actual Range = 0.1 to 9.9<br>(Counts = Actual x 10) | Actual Default = 1.2<br>Therefore:<br>1.2 x 10 = 12 counts |
| 16 (0x0010) | Outdoor Sensor Enable | bool (0,1)<br>0 = False<br>1 = True | Default = 0 (False) |
| 17 (0x0011) | System Start Temp | DEGREES_2 (0 to 1000) | See Appendix A, Tables A-2 and A-3 for Conversions<br>Default = 60°F |
| 18 (0x0012) | Set Point Lo Limit | DEGREES_1 (0 to 1000) | See Appendix A, Tables A-2 and A-3 for Conversions<br>Default = 60°F |
| 19 (0x0013) | Set Point Hi Limit | DEGREES_1 (0 to 1000) | See Appendix A, Tables A-2 and A-3 for Conversions<br>Default = 200°F |
| 20 (0x0014) | Temp Hi Limit | DEGREES_1 (0 to 1000) | See Appendix A, Tables A-2 and A-3 for Conversions<br>Default = 210°F |
| 21 (0x0015) | Max Fire Rate | % (40 - 100) | Default = 100% |
| 22 (0x0016) | Pump Delay Timer | MIN_UNITS (0 to 30)<br>1count/min | Default = 0 min. |
| 23 (0x0017) | Aux Start On Delay | SEC_UNITS (0 to 120)<br>1count/sec | Default = 0 sec. |

***Table 2-2. C-More Controller Standard Holding Register Address Mapping-Cont.***

| Modbus Data Address Decimal (Hex) | Menu Item | Units and Range | Comments |
|---|---|---|---|
| 24 (0x0018) | Failsafe Mode | enum (0, 1)<br>0=Shutdown<br>1=Constant Setpoint | Default = 0 (Shutdown) |
| 25 (0x0019) | Low Fire Timer | SEC_UNITS (2 to 60)<br>1count/sec | Default = 2 sec. |
| 26 (0x001A) | Prop Band | ABS_DEG_1 (0 to 1000) | See Appendix A, Tables A-2 and A-3 for Conversions |
| 27 (0x001B) | Integral Gain | 0.00 to 2.00<br>(0.01 increments) | Actual x 100 Counts<br>Defaults:<br>Boiler: 0.10 (10 counts),<br>Heater:1.60 (160 counts) |
| 28 (0x001C) | Derivative Time | MIN_UNITS (0.00 to 2.00)<br>(0.01 min. increments)<br>1count/0.01min | Actual x 100 Counts<br>Defaults:<br>Boiler: 0.00 min.<br>(0 counts)<br>Heater: 0.10 min<br>(10 counts) |
| 29 (0x001D) | Min Load Adjust | ABS_DEG_1 (0 to 1000) | Water Heater ONLY<br>See Appendix A, Tables A-2 and A-3 for Conversions |
| 30 (0x001E) | Max Load Adjust | ABS_DEG_1 (0 to 1000) | Water Heater ONLY<br>See Appendix A, Tables A-2 and A-3 for Conversions |
| 31 (0x001F) | Outlet Feedback | bool (0, 1)<br>0 = Off<br>1 = On | Default = 1 (On)<br>Water Heater ONLY |
| 32 (0x0020) Thru 59 (0x003B) | (Reserved) | | |
| 60 (0x003C) | Set Point Limiting | bool (0, 1)<br>0 = Disabled<br>1 = Enabled | Default = 0 (Disabled) |
| 61 (0x003D) | Set Point Limit Band | ABS_DEG_1 (0 to 1000) | See Appendix A, Tables A-2 and A-3 for Conversions |
| 62 (0x003E) Thru 66 (0x0042) | (Reserved) | | |

***Table 2-2. C-More Controller Standard Holding Register Address Mapping-Cont.***

| Modbus Data Address Decimal (Hex) | Menu Item | Units and Range | Comments |
|---|---|---|---|
| 67 (0x0043) | Sensor Log Interval | Enum (0 to 8)<br>0 = Off<br>1 = 1 Min.<br>2 = 5 Min.<br>3 = 15 Min.<br>4 = 30 Min.<br>5 = 1 Hr.<br>6 = 6 Hrs<br>7 = 12 Hrs.<br>8 = 24 Hrs. | Default = 4 (30 min) |
| 68 (0x0044) | Fault Log Pointer | int 0 - 9 | |
| 69 (0x0045) | Sensor Log Pointer | int 0 - 1199 | |
| 70 (0x0046) | Time Log Pointer | int 0 - 10239 | |
| 71 (0x0047) Thru 65535 (0xFFFF) | (Reserved) | | Available for future expansion. |

## 2.3 BMS/BMS II CONTROLLER STANDARD REGISTER ASSIGNMENTS

### 2.3.1 BMS/BMS II Controller Standard Input Register Assignments

The Read Only Input Register address assignments for the BMS/BMS II are listed in Table 2-3 which follows:

***Table 2-3. BMS/BMS II Standard Input Register Address Mapping***

| Modbus Data Address Decimal (Hex) | Menu Item | Units and Range | Default/Comments |
|---|---|---|---|
| 0 (0x0000) | (Reserved) | | |
| 1 (0x0001) | Header Temperature | 40 to 220°F | |
| 2 0x0002) | Outside Air Temperature | -60 to 120°F | |
| 3 (0x0003) | Indoor Air/Return Temperature | 40 to 220°F | Indoor Air Temp = BMS<br>Return Temp = BMS II |
| 4 (0x0004) | Fire Rate Out | 0 to 100%<br>(out to boilers) | |
| 5 (0x0005) | Header Set Temperature | 40 to 220°F | |
| 6 (0x0006) | Network Address | 128 to 247 | Default = 128<br>(If Address = 0, BMS/ BMS II is Off-Line as a Slave) |
| 7 (0x0007) | Total Boilers Fired | 0 to 40 (for BMS)<br>0 to 32 (for BMS II) | |
| 8 (0x0008) | Total Boilers On Line | 0 to 40 (for BMS)<br>0 to 32 (for BMS II) | |
| 9 (0x0009) | (Reserved) | | |
| 10 (0x000A) | Fault/Message Code | 0 to 65535<br>Bit:<br>0 = Outside Air Sensor<br>1 = Header Sensor Error<br>2 = Interlock 1 Error<br>3 = Interlock 2 Error<br>4 = Indoor Air Sensor Error/ Return Sensor Error<br>5 = 4-20mA Input Error | Interpret Bit 4 as follows:<br><br>Indoor Air Sensor Error applies to BMS.<br><br>Return Sensor Error applies to BMS II. |
| 11 (0x000B) thru 15 (0x000F) | (Reserved) | | |
| 16 (0x0010) | Lead Boiler Number | 1 to 40 (for BMS)<br>1 to 32 (for BMS II) | |

***Table 2-3. BMS/BMS II Standard Input Register Address Mapping-Cont.***

| Modbus Data Address Decimal (Hex) | Menu Item | Units and Range | Comments |
|---|---|---|---|
| 17 (0x0011) | Boiler 1 Status (PWM Boiler 1) | 119 = Not On-Line<br>120 = On-Line But Not Fired<br>1–40 = Fired & Sequence | Boilers 1 - 8 are referred to as the Legacy (PWM) Boilers.(BMS Only) |
| 18 (0x0012) | Boiler 2 Status (PWM Boiler 2) | (Same As Above) | (Same As Above) (BMS Only) |
| 19 (0x0013) | Boiler 3 Status (PWM Boiler 3) | (Same As Above) | (Same As Above) (BMS Only) |
| 20 (0x0014) | Boiler 4 Status (PWM Boiler 4) | (Same As Above) | (Same As Above) (BMS Only) |
| 21 (0x0015) | Boiler 5 Status (PWM Boiler 5) | (Same As Above) | (Same As Above) (BMS Only) |
| 22 (0x0016) | Boiler 6 Status (PWM Boiler 6) | (Same As Above) | (Same As Above) (BMS Only) |
| 23 (0x0017) | Boiler 7 Status (PWM Boiler 7) | (Same As Above) | (Same As Above) (BMS Only) |
| 24 (0x0018) | Boiler 8 Status (PWM Boiler 8) | (Same As Above) | (Same As Above) (BMS Only) |
| 25 (0x0019) | Boiler 9 Status (BMS) (Net Boiler 1) Boiler 1 Status (BMS II) | 119 = Not On-Line<br>120 = On-Line But Not Fired<br>1–40 = Fired & Sequence<br>121 = On-Line But Disabled<br>122 = On-Line But Faulted | Boilers 9 - 32 are the Network Boilers.<br>BMS II has only Network Boilers, therefore Net Boiler 1 = Boiler 1, etc. |
| 26 (0x001A) | Boiler 10 Status (BMS) (Net Boiler 2) Boiler 2 Status (BMS II) | Same As Above | |
| 27 (0x001B) | Boiler 11 Status (BMS) (Net Boiler 3) Boiler 3 Status (BMS II) | Same As Above | |
| 28 (0x001C) | Boiler 12 Status (BMS) (Net Boiler 4) Boiler 4 Status (BMS II) | Same As Above | |
| 29 (0x001D) | Boiler 13 Status (BMS) (Net Boiler 5) Boiler 5 Status (BMS II) | Same As Above | |
| 30 (0x001E) | Boiler 14 Status (BMS) (Net Boiler 6) Boiler 6 Status (BMS II) | Same As Above | |
| 31 (0x001F) | Boiler 15 Status (BMS) (Net Boiler 7) Boiler 7 Status (BMS II) | Same As Above | |
| 32 (0x0020) | Boiler 16 Status (BMS) (Net Boiler 8) Boiler 8 Status (BMS II) | Same As Above | |

***Table 2-3. BMS/BMS II Standard Input Register Address Mapping-Cont.***

| Modbus Data Address Decimal (Hex) | Menu Item | Units and Range | Comments |
|---|---|---|---|
| 33 (0x0021) | Boiler 17 Status (BMS)<br>(Net Boiler 9)<br>Boiler 9 Status (BMS II) | 119 = Not On-Line<br>120 = On-Line But Not Fired<br>1–40 = Fired & Sequence<br>121 = On-Line But Disabled<br>122 = On-Line But Faulted | |
| 34 (0x0022) | Boiler 18 Status (BMS)<br>(Net Boiler 10)<br>Boiler 10 Status (BMS II) | Same As Above | |
| 35 (0x0023) | Boiler 19 Status (BMS)<br>(Net Boiler 11)<br>Boiler 11 Status (BMS II) | Same As Above | |
| 36 (0x0024) | Boiler 20 Status<br>(Net Boiler 12)<br>Boiler 12 Status (BMS II) | Same As Above | |
| 37 (0x0025) | Boiler 21 Status<br>(Net Boiler 13)<br>Boiler 13 Status (BMS II) | Same As Above | |
| 38 (0x0026) | Boiler 22 Status<br>(Net Boiler 14)<br>Boiler 14 Status (BMS II) | Same As Above | |
| 39 (0x0027) | Boiler 23 Status<br>(Net Boiler 15)<br>Boiler 15 Status (BMS II) | Same As Above | |
| 40 (0x0028) | Boiler 24 Status<br>(Net Boiler 16)<br>Boiler 16 Status (BMS II) | Same As Above | |
| 41 (0x0029) | Boiler 25 Status<br>(Net Boiler 17)<br>Boiler 17 Status (BMS II) | Same As Above | |
| 42 (0x002A) | Boiler 26 Status<br>(Net Boiler 18)<br>Boiler 18 Status (BMS II) | Same As Above | |
| 43 (0x002B) | Boiler 27 Status<br>(Net Boiler 19)<br>Boiler 19 Status (BMS II) | Same As Above | |
| 44 (0x002C) | Boiler 28 Status<br>(Net Boiler 20)<br>Boiler 20 Status (BMS II) | Same As Above | |
| 45 (0x002D) | Boiler 29 Status<br>(Net Boiler 21)<br>Boiler 21 Status (BMS II) | Same As Above | |
| 46 (0x002E) | Boiler 30 Status<br>(Net Boiler 22)<br>Boiler 22 Status (BMS II) | Same As Above | |

***Table 2-3. BMS/BMS II Standard Input Register Address Mapping-Cont.***

| Modbus Data Address Decimal (Hex) | Menu Item | Units and Range | Comments |
|---|---|---|---|
| 47 (0x002F) | Boiler 31 Status<br>(Net Boiler 23)<br>Boiler 23 Status (BMS II) | 119 = Not On-Line<br>120 = On-Line But Not Fired<br>1–40 = Fired & Sequence<br>121 = On-Line But Disabled<br>122 = On-Line But Faulted | |
| 48 (0x0030) | Boiler 32 Status<br>(Net Boiler 24)<br>Boiler 24 Status (BMS II) | Same As Above | |
| 49 (0x0031) | Boiler 33 Status<br>(Net Boiler 25)<br>Boiler 25 Status (BMS II) | Same As Above | |
| 50 (0x0032) | Boiler 34 Status<br>(Net Boiler 26)<br>Boiler 26 Status (BMS II) | Same As Above | |
| 51 (0x0033) | Boiler 35 Status<br>(Net Boiler 27)<br>Boiler 27 Status (BMS II) | Same As Above | |
| 52 (0x0034) | Boiler 36 Status<br>(Net Boiler 28)<br>Boiler 28 Status (BMS II) | Same As Above | |
| 53 (0x0035) | Boiler 37 Status<br>(Net Boiler 29)<br>Boiler 29 Status (BMS II) | | |
| 54 (0x0036) | Boiler 38 Status (Net Boiler 30)<br>Boiler 30 Status (BMS II) | Same As Above | |
| 55 (0x0037) | Boiler 39 Status<br>(Net Boiler 31)<br>Boiler 31 Status (BMS II) | Same As Above | |
| 56 (0x0038) | Boiler 40 Status<br>(Net Boiler 32)<br>Boiler 32 Status (BMS II) | Same As Above | |
| 57 (0x0039) | I/O Status | 0 to 255 | Bit map of Input/Output status (BMS II Only)<br>Bit 0 = AUX Relay<br>Bit 1 = Fault Relay<br>Bit 2 = Sys Start Relay<br>Bit 3 = Empty<br>Bit 4 = Setback<br>Bit 5 = Interlock 2<br>Bit 6 = Interlock 1<br>Bit 7 = Empty |
| 58 (0x003A) | Return Sensor Temp | 40 °F to 220°F | BMS II Only |
| 59 (0x003B) thru 65535 (0xFFFF) | (Reserved For Future Expansion) | | |

### 2.3.2 BMS/BMS II Controller Standard Holding Register Assignments

The Holding Register address assignments for the BMS/BMS II are listed in Table 2-4 which follows. Unless otherwise specified, all Holding Register Menu items are Read/Write (R/W).

***Table 2-4. BMS/BMS II Standard Holding Register Address Mapping***

| Modbus Data Address Decimal (Hex) | Menu Item | Units and Range | Default/Comments |
|---|---|---|---|
| 0 (0x0000) | (Reserved) | | |
| 1 (0x0001) | (Reserved) | | |
| 2 (0x0002) | (Reserved) | | |
| 3 (0x0003) | (Reserved) | | |
| 4 (0x0004) | Net Header Set Temp | 40 to 220°F | Valid when Header Set Mode = Remote Setpt and Remote Signal = Network |
| 5 (0x0005) | System Start Temp | 32 to 120°F | Default = 70°F |
| 6 (0x0006) | System Start Option | 0 or 1<br>0 = Temp Only,<br>1 = Temp and Load | Default = 0 |
| 7 (0x0007) | Manual Hdr Set Temp/Internal Setpt | 40 to 220°F | Default = 160°F |
| 8 (0x0008) | Bldg Ref Temp | 40 to 220°F | Default = 70°F |
| 9 (0x0009) | Indoor Prop Band | 0.0 to 20.0°F/°F<br>(0.5°F/°F increments) | Default = 00.0°F/°F<br>(Value x 10) (BMS Only) |
| 10 (0x000A) | Indoor Setpoint Temp | 50 to 150°F | Default = 70°F<br>(BMS Only) |
| 11 (0x000B) | Reset Ratio | 0.3 to 3.0<br>(0.1 increments), | Default = 1.2<br>(Value x 10) |
| 12 (0x000C) | Max Header Temp | 40 to 220°F | Default = 220°F |
| 13 (0x000D) | Min Header Temp | 40 to 220°F | Default = 40°F |
| 14 (0x000E) | Start Percent | 25 to 100% | Default = 45% (BMS)<br>Default = 20% (BMS II) |
| 15 (0x000F) | Stop Percent | 10 to 45% | Default = 18% (BMS)<br>Default = 16% (BMS II) |
| 16 (0x0010) | Integral Gain | 0.00 to 9.99 Rep/Min<br>(in 0.01 increments | Default = 0.15 Rep/Min<br>(Value x 100) |
| 17 (0x0011) | Header Set Mode | 0, 1, or 2<br>0 = Constant Setpt<br>1 = In/Outdoor Reset<br>2 = Remote Setpt | Default = 0<br>(Constant Setpt)) |

### *Table 2-4. BMS/BMS II Standard Holding Register Address Mapping*

| Modbus Data Address Decimal (Hex) | Menu Item | Units and Range | Default/Comments |
|---|---|---|---|
| 18 (0x0012) | Derivative Gain | -2.00 to 2.00<br>(0.00 increments) | Default = 0.15<br>(Value x 100) |
| 19 0x0013) | Header Temp Bandwidth | 5 to 120°F | Default = 70°F |
| 20 (0x0014) | Aux Relay Open | 0 to 99% | Default = 45% |
| 21 (0x0015) | Aux Relay Mode | 0 or 1<br>0 = 100% Fire Rate<br>1 = 100% Fire Rate and Off | Default = 1<br>(100% Fire Rate & Off) |
| 22 (0x0016) | Temp Sensor Fail Mode/Failsafe Mode | 0 or 1<br>0 = Shutdown<br>1 = Switch Inputs/Constant Setpt | Default = 0<br>(Shutdown) |
| 23 (0x0017) | Fault Alarm Relay Mode | 0, 1, 2, 3<br>0 = All Faults,<br>1 = No Interlock<br>2 = Interlock 1<br>3 = Interlock 2 | Default = 0<br>(All Faults) |
| 24 (0x0018) | Fault Alarm Clear Method | 0 or 1<br>0 = Automatic<br>1 = Manual | Default = 0<br>(Automatic) |
| 25 (0x0019) | Boiler Operation Mode | 0, 1 or 2<br>0 = Parallel<br>1 = Sequential<br>2 = Combination | Default = 1<br>(Sequential) |
| 26 (0x001A) | Number Of Combination Mode Boilers | 0 to 4 | Default = 0 (BMS Only)<br>(Start at Boiler 8 and work back to Boiler 5 to assign Combo Boilers) |
| 27 (0x001B) | (Reserved) | | |
| 28 (0x001C) | (Reserved) | | |
| 29 (0x001D) | (Reserved) | | |
| 30 (0x001E) | Max Power Input | 50 to 100% | Default = 100%<br>(Fire Rate) |
| 31 (0x001F) | Interlock 1 Method (BMS)/Sys Intlk Config (BMSII) | 0 or 1<br>0 = Always Enabled<br>1 = Start Enabled | Default = 1<br>(Start Enabled) |

***Table 2-4. BMS/BMS II Standard Holding Register Address Mapping-Cont.***

| Modbus Data Address Decimal (Hex) | Menu Item | Units and Range | Default/Comments |
|---|---|---|---|
| 32 (0x0020) | Real Time Clock Minutes | 00 to 59 Minutes | Present Time |
| 33 (0x0021) | Real Time Clock Hours | 00 to 23 Hours | Present Time |
| 34 (0x0022) | Real Time Clock Day of Week | 1 to 7 | Present Day |
| 35 (0x0023) | Real Time Clock Year | 00 to 99 | Present Year |
| 36 (0x0024) | Real Time Clock Day of Month | 01 to 31 | Present Day of Month |
| 37 (0x0025) | Real Time Clock Month | 01 to 12 | Present Month |
| 38 (0x0026) | Offset Temp Day 1 | -50 to 50°F | Default = 0°F |
| 39 (0x0027) | Offset Temp Day 2 | -50 to 50°F | Default = 0°F |
| 40 (0x0028) | Offset Temp Day 3 | -50 to 50°F | Default = 0°F |
| 41 (0x0029) | Offset Temp Day 4 | -50 to 50°F | Default = 0°F |
| 42 (0x002A) | Offset Temp Day 5 | -50 to 50°F | Default = 0°F |
| 43 (0x002B) | Offset Temp Day 6 | -50 to 50°F | Default = 0°F |
| 44 (0x002C) | Offset Temp Day 7 | -50 to 50°F | Default = 0°F |
| 45 (0x002D) | Offset On Time Day 1 – Minutes | 00 to 59 Minutes | Default = 0 |
| 46 (0x002E) | Offset On Time Day 2 – Minutes | 00 to 59 Minutes | Default = 0 |
| 47 (0x002F) | Offset On Time Day 3 – Minutes | 00 to 59 Minutes | Default = 0 |
| 48 (0x0030) | Offset On Time Day 4 – Minutes | 00 to 59 Minutes | Default = 0 |
| 49 (0x0031) | Offset On Time Day 5 – Minutes | 00 to 59 Minutes | Default = 0 |
| 50 (0x0032) | Offset On Time Day 6 – Minutes | 00 to 59 Minutes | Default = 0 |
| 51 (0x0033) | Offset On Time Day 7 – Minutes | 00 to 59 Minutes | Default = 0 |

***Table 2-4. BMS/BMS II Standard Holding Register Address Mapping-Cont.***

| Modbus Data Address Decimal (Hex) | Menu Item | Units and Range | Default/Comments |
|---|---|---|---|
| 52 (0x0034) | Offset On Time Day 1 – Hours | 00 to 23 Hours | Default = 0 |
| 53 (0x0035) | Offset On Time Day 2 – Hours | 00 to 23 Hours | Default = 0 |
| 54 (0x0036) | Offset On Time Day 3 – Hours | 00 to 23 Hours | Default = 0 |
| 55 (0x0037) | Offset On Time Day 4 – Hours | 00 to 23 Hours | Default = 0 |
| 56 (0x0038) | Offset On Time Day 5 – Hours | 00 to 23 Hours | Default = 0 |
| 57 (0x0039) | Offset On Time Day 6 – Hours | 00 to 23 Hours | Default = 0 |
| 58 (0x003A) | Offset On Time Day 7 – Hours | 00 to 23 Hours | Default = 0 |
| 59 (0x003B) | Offset Enable | 0 or 1<br>0 = Disabled<br>1 = Enabled | Default = 0<br>(Disabled) |
| 60 (0x003C) | Header Offset | 0 to 5°F | Default = 0°F |
| 61 (0x003D) | System Start Interlock | 1, 2 or 3<br>1 = Either Intlk Opens Start Relay<br>2 = Intlk1 Opens Start Relay<br>3 = Intlk 2 Open Start Relay | Default = 2<br>(Intlk 1) |
| 62 (0x003E) Thru 69 (0x0045) | (Reserved) | | |
| 70 (0x0046) | Offset Off Time Day 1 – Minutes | 0 to 59 Minutes | Default = 0 |
| 71 (0x0047) | Offset Off Time Day 2 – Minutes | 0 to 59 Minutes | Default = 0 |
| 72 (0x0048) | Offset Off Time Day 3– Minutes | 0 to 59 Minutes | Default = 0 |
| 73 (0x0049) | Offset Off Time Day 4– Minutes | 0 to 59 Minutes | Default = 0 |
| 74 (0x004A) | Offset Off Time Day 5 – Minutes | 0 to 59 Minutes | Default = 0 |
| 75 (0x004B) | Offset Off Time Day 6 – Minutes | 0 to 59 Minutes | Default = 0 |

***Table 2-4. BMS/BMS II Standard Holding Register Address Mapping-Cont.***

| Modbus Data Address Decimal (Hex) | Menu Item | Units and Range | Default/Comments |
|---|---|---|---|
| 76 (0x004C) | Offset Off Time Day 7 – Minutes | 0 to 59 Minutes | Default = 0 |
| 77 (0x004D) | Offset Off Time Day 1 – Hours | 0 to 23 Hours | Default = 0 |
| 78 (0x004E) | Offset Off Time Day 2 – Hours | 0 to 23 Hours | Default = 0 |
| 79 (0x004F) | Offset Off Time Day 3 – Hours | 0 to 23 Hours | Default = 0 |
| 80 (0x0050) | Offset Off Time Day 4 – Hours | 0 to 23 Hours | Default = 0 |
| 81 (0x0051) | Offset Off Time Day 5 – Hours | 0 to 23 Hours | Default = 0 |
| 82 (0x0052) | Offset Off Time Day 6 – Hours | 0 to 23 Hours | Default = 0 |
| 83 (0x0053) | Offset Off Time Day 7 – Hours | 0 to 23 Hours | Default = 0 |
| 84 (0x0054) | (Reserved) | | |
| 85 (0x0055) | Indoor Air Input | 0 or 1<br>0 = 4 – 20 Ma<br>1 = Thermistor | Default = 1<br>(Thermistor)<br>BMS Only |
| 86 (0x0056) | Remote Signal | 0 or 1<br>0 = 4 – 20 Ma<br>1 = Network | Default = 0<br>(4 – 20 Ma) |
| 87 (0x0057) | RS232 Mode | 0 or 1<br>0 = Normal<br>1 = Modbus | Default = 0<br>(Normal) |
| 88 (0x0058) | RS232 Baud Rate | 2400, 4800, 9600, 14.4k, 19.2k | Default = 9600 |
| 89 (0x0059) | Number Of Network Boilers | 0 to 32 | Default = 0 (for BMS)<br>Default = 2 (for BMS II) |
| 90 (0x005A) | Min Slave Address | 0 to 127 | Default = 0 |
| 91 (0x005B) | Max Slave Address | 0 to 127, | Default = 0 |
| 92 (0x005C) | Net Boiler 1 Address | Address for Network Boiler 1 | Default = 0 (for BMS)<br>Default = 1 (for BMS II) |
| 93 (0x005D) | Net Boiler 2 Address | Address for Network Boiler 2 | Default = 0 (for BMS)<br>Default = 2 (for BMS II) |

***Table 2-4. BMS/BMS II Standard Holding Register Address Mapping-Cont.***

| Modbus Data Address Decimal (Hex) | Menu Item | Units and Range | Default/Comments |
|---|---|---|---|
| 94 (0x005E) | Net Boiler 3 Address | Address for Network Boiler 3 | Default = 0 |
| 95 (0x005F) | Net Boiler 4 Address | Address for Network Boiler 4 | Default = 0 |
| 96 (0x0060) | Net Boiler 5 Address | Address for Network Boiler 5 | Default = 0 |
| 97 (0x0061) | Net Boiler 6 Address | Address for Network Boiler 6 | Default = 0 |
| 98 (0x0062) | Net Boiler 7 Address | Address for Network Boiler 7 | Default = 0 |
| 99 (0x0063) | Net Boiler 8 Address | Address for Network Boiler 8 | Default = 0 |
| 100 (0x0064) | Net Boiler 9 Address | Address for Network Boiler 9 (same as Boiler #17) | Default = 0 |
| 101 (0x0065) | Net Boiler 10 Address | Address for Network Boiler 10 | Default = 0 |
| 102 (0x0066) | Net Boiler 11address | Address for Network Boiler 11 | Default = 0 |
| 103 (0x0067) | Net Boiler 12 Address | Address for Network Boiler 12 | Default = 0 |
| 104 (0x0068) | Net Boiler 13 Address | Address for Network Boiler 13 | Default = 0 |
| 105 (0x0069) | Net Boiler 14 Address | Address for Network Boiler 14 | Default = 0 |
| 106 (0x006A) | Net Boiler 15 Address | Address for Network Boiler 15 | Default = 0 |
| 107 (0x006B) | Net Boiler 16 Address | Address for Network Boiler 16 | Default = 0 |
| 108 (0x006C) | Net Boiler 17 Address | Address for Network Boiler 17 | Default = 0 |
| 109 (0x006D) | Net Boiler 18 Address | Address for Network Boiler 18 | Default = 0 |
| 110 (0x006E) | Net Boiler 19 Address | Address for Network Boiler 19 | Default = 0 |
| 111 (0x006F) | Net Boiler 20 Address | Address for Network Boiler 20 | Default = 0 |
| 112 (0x0070) | Net Boiler 21 Address | Address for Network Boiler 21 | Default = 0 |
| 113 (0x0071) | Net Boiler 22 Address | Address for Network Boiler 22 | Default = 0 |

***Table 2-4. BMS/BMS II Standard Holding Register Address Mapping-Cont.***

| Modbus Data Address Decimal (Hex) | Menu Item | Units and Range | Default/Comments |
|---|---|---|---|
| 114 (0x0072) | Net Boiler 23 Address | Address for Network Boiler 23 | Default = 0 |
| 115 (0x0073) | Net Boiler 24 Address | Address for Network Boiler 24 | Default = 0 |
| 116 (0x0074) | Net Boiler 25 Address | Address for Network Boiler 25 | Default = 0 |
| 117 (0x0075) | Net Boiler 26 Address | Address for Network Boiler 26 | Default = 0 |
| 118 (0x0076) | Net Boiler 27 Address | Address for Network Boiler 27 | Default = 0 |
| (119 0x0077) | Net Boiler 28 Address | Address for Network Boiler 28 | Default = 0 |
| 120 (0x0078) | Net Boiler 29 Address | Address for Network Boiler 29 | Default = 0 |
| 121 (0x0079) | Net Boiler 30 Address | Address for Network Boiler 30 | Default = 0 |
| 122 (0x007A) | Net Boiler 31 Address | Address for Network Boiler 31 | Default = 0 |
| 123 (0x007B) | Net Boiler 32 Address | Address for Network Boiler 32 | Default = 0 |
| 124 (0x007C) | Network Baud | 0=2400, 1=4800, 2=9600, 3=14.4k, 4=19.2k | Default = 2 (9600) |
| 125 (0x007D) | Network Timeout | 5 to 240 sec | Default = 60 sec. |
| 126 (0x007E) | Password Lo | 0 to 255 (73) | Default = 0 |
| 127 (0x007F) | Password Hi | 0 to 255 (79) | Default = 0 |
| 128 (0x0080) | Modbus Control Type | 0 = Round-Robin<br>1 = Broadcast | Default = 0<br>(Round Robin) |
| 129 (0x0081) | Modbus Pass-Thru | 0 = Disabled<br>1 = Enabled | Default = 0 (Disabled) |
| 130 (0x0082) | Header Dead Band | 1 to 15°F | Default – 5°F (BMS II Only) |
| 131 (0x0083) | Outside Temp Sensor Offset | -10°F to 10°F | |
| 132 (0x0084) | Ramp Up %/MIN | 0 to 300 | Default = 20 (BMS II Only) |
| 133 (0x0085) | Ramp Down %/MIN | 0 to 300 | Default = 200 (BMS II Only) |

***Table 2-4. BMS/BMS II Standard Holding Register Address Mapping-Cont.***

| Modbus Data Address Decimal (Hex) | Menu Item | Units and Range | Default/Comments |
|---|---|---|---|
| 134 (0x0086) | Fault Alarm Boilers | 0 = No Blr Faults,<br>1 = All Blr Faults | Default = 0 |
| 135 (0x0087) | 4 to 20 mA Current Offset | -1.00 to 1.00 mA | Default = 0<br>(BMS II Only) |
| 136 (0x0088) | Return Sensor Offset | -10.0 to 10.0 | Default = 0<br>(BMS II Only) |
| 137 (0x0089) | Load Start Pct | 1 to Blr Start Level | Default =1 (BMS II Only) |
| 138 (0x008A) | Load Stop Pct | 0 to Load Start -1 | Default =0 (BMS II Only) |
| 139 (0x008B) thru 65535 (0xFFFF) | (Reserved For Future Expansion) | Undefined | |

# SECTION 3 STANDARD APPLICATION OPERATIONS

## 3.1 INTRODUCTION

This Section describes the standard application operations for AERCO C-More Boiler Controllers and the AERCO Boiler Management System (BMS/BMS II) and how they are achieved utilizing Modbus. Paragraphs 3.2 through 3.2.7 provide information for the C-More Boiler Controllers which can only function as Slaves in a Modbus Network. Paragraphs 3.3 through 3.3.4 provide similar information for the BMS and BMS II which can function as either a Master or Slave in a Modbus Network.

**NOTE**

Additional information on Modbus hardware and software set up and installation are provided in Section 4 and Section 5 of this manual.

## 3.2 C-MORE CONTROLLER STANDARD APPLICATION OPERATIONS

The information in the following paragraphs apply to C-More Boiler Controllers with the following exceptions:

- C-More Boiler Controllers utilize a Fixed 10 second “Heartbeat” timer.
- C-More Boiler Controllers, require temperature readings to be converted from “counts” to °F or °C.

### 3.2.1 Password Protection for Input and Holding Register Access

Access to the C-More Input Register and Holding Register addresses are protected via security level passwords. Two separate Holding Register addresses (0x0002, 0x0003) are assigned for password entries, one for the Modbus (RS485) Network and one for the RS232 front panel user interface. If desired, separate security passwords can be entered for each interface.

Each C-More Controller menu parameter is assigned a preset security level that controls access from the front panel user interface. If the current communication password of the front-end software does not match the C-More Slave addresses security level, access is denied. When this occurs, an Illegal Data Address Exception Code (02) is generated and the data is not changed. If a Modbus message is received to read multiple Input or Holding Registers (Function Codes 03 or 04) and one or more of the register addresses is not accessible, an Illegal Data Address Exception Code will also be generated and no data is supplied to the Master. It should be noted that Modbus “Write Multiple Registers” command (Function Code 16) is not supported by AERCO C-More Controller Slaves and will cause an Illegal Function Exception Code to be generated.

The Holding Register data can be viewed without a password. However, the data cannot be changed without entering the appropriate password. The communications port security operation will mirror the security operation for viewing and adjusting parameters via the front panel keypad. Refer to C-More Operation Manual GF-112 for additional information on security passwords and menu access.

### 3.2.2 Simultaneous RS232 & RS485 Access to C-More Controller Variables

As previously mentioned, read and write access of the C-More Controller variables are protected from unauthorized access by an internal security level hierarchy. Passwords may be entered in the Slave's Holding Registers using any of the following methods:

- Locally via the front panel keypad and display
- Remotely via the front panel RS232 port
- Remotely via the Modbus (RS485) interface

It is imperative that the user understands that the LAST change made to any menu variable (including passwords) will supersede any previous change, regardless of which of the above methods is used. There is no priority structure assigned to any of the above methods and since they are not interlocked, they may be performed concurrently.

### 3.2.3 Direct Drive Control

In the Direct Drive Mode, the holding register parameter "Net Direct Drive" (address 0x0001) must be written or broadcast periodically from the BMS/BMS II (or EMS Master) to all Slave Controllers on the network. The Modbus message will specify the Fire Rate (0 to 100%) for the addressed Slave(s). If the Net Direct Drive message is broadcast, all enabled network Slaves will be set to the same fire rate percentage. However, if different fire rates are required for specific Slaves, each Slave must be addressed individually. Each time a network Slave successfully receives the Net Direct Drive message, it will reset its Heartbeat Timer which has a fixed 10 second timeout. If this timeout period is exceeded, the C-More Controller Slave will default to "Fail-Safe Mode" (Shutdown or Constant Setpoint) stored in holding register address 0x0018. When this occurs, "Modbus Comm Fault" will be displayed.

During operation in the Direct Drive Mode, only the Net Direct Drive variable in the Slave's Holding Register can be remotely adjusted. If desired, manual control via the C-More Controller front panel can be invoked by pressing the AUTO/MAN switch on the front panel.

### 3.2.4 Remote Setpoint Control

In the Remote Setpoint Mode, the holding register parameter "Net Remote Setpoint" (address 0x0000) must be written or broadcast periodically from the BMS/BMS II (or EMS Master) to all Slave Controllers on the network. The Modbus message will specify the Setpoint Temperature for the addressed Slave(s). If the Net Remote Setpoint message is broadcast, all enabled network Slaves will be set to the same setpoint temperature. However, if different setpoint temperatures are required for specific Slaves, each Slave must be addressed individually. Each time a network Slave successfully receives the Net Remote Setpoint message, it will reset its "Heartbeat". For C-More Controllers, the "Heartbeat" timeout is fixed at 10 seconds. If this timeout period is exceeded, the C-More Controller Slave will default to "Fail-Safe Mode" and display a "Modbus Comm Fault".

During operation in the Remote Setpoint Mode, only the "Net Remote Setpt" variable in the Slave's Holding Register can be remotely adjusted. If desired, manual control via the C-More Controller front panel can be invoked by pressing the AUTO/MAN switch on the front panel.

### 3.2.5 Combination Control (BMS Only)

At the present time, the Combination Control Mode is not implemented via the Modbus network.

### 3.2.6 Physical Slave Address Zero

Normally, each Modbus Network Slave Controller will be assigned its own unique Comm. Address (Input Register Address 0x0013). Valid entries are from 1 to 127. However, if the default address of 0 is assigned, the C-More Slave, will not respond or process any Modbus Network messages. This effectively disables the Slave's Modbus communication link.

## 3.3 BMS/BMS II STANDARD APPLICATION OPERATIONS

For an AERCO BMS (only) Controller, the first eight Boilers are reserved for Legacy Boilers. These Legacy Boilers are wired to the J2 connector terminals and are controlled utilizing Pulse Width Modulation (PWM) signals, just as with earlier BMS Models, prior to implementation of Modbus. Therefore, Boiler No. 9 will be the first Modbus Network Boiler, Boiler No. 10 will be the second and so on. Up to 32 Network Boilers can be connected on a Modbus Network, in addition to the 8 Legacy Boilers. The BMS will operate the Network Boilers and the Legacy Boilers as one complete System.

The BMS II does not utilize PWM signals and will not operate a Legacy Boiler Controller that does not have Modbus capability. The BMS II will operate up to 32 Network Boilers.

### 3.3.1 Password Protection for BMS/BMS II Input and Holding Register Access

Access to BMS/BMS II register addresses are protected by a password in virtually the same manner as the C-More Controllers. For the BMS/BMS II, a communications security code holding register "Password Lo" and "Password Hi" (addresses 0x007E, 0x007F) must be written with the proper password for writing data in the BMS/BMS II through the RS232 communications port. If an attempt is made to write data to a single holding register using an incorrect password, write access is denied. If this occurs, an Illegal Data Address Exception Code (02) is generated and the data is not changed. Reading data is allowed, even if the password is incorrect. If a Modbus message is received to read multiple Input or Holding Registers and one or more of the addresses is not accessible, an Illegal Data Address Exception Code will be sent to the EMS Master and no data is affected.

Only the network control variable "Net Header Set Temp" (address 0x0004) can be written without a password and only if the BMS/BMS II is programmed for Remote Setpoint Control by an EMS Master.

### 3.3.2 Remote Setpoint Control of BMS/BMS II Slave By EMS Master

All Modbus communication between a BMS/BMS II Slave and an EMS Master is accomplished via the RS232 port. If the EMS Master also contains a RS232 port, it can be directly connected to the BMS/BMS II. However, if the EMS Master contains only a RS485 port, a RS232-to-RS485 Converter is required.

To enable the Remote Setpoint Mode, the parameters "Remote Signal" and "RS232 Mode" must be set to "Network" and "Modbus" respectively. These parameter are stored in Standard Holding Register addresses 0x0056 and 0x0057 respectively. Also, ensure that the RS232 Baud Rate setting (address 0x0058) matches the EMS Baud Rate being used.

In the Remote Setpoint Mode, the holding register parameter "Net Header Set Temp" (Holding Register address 0x0004) must be transmitted periodically from the EMS Master to the BMS/BMS II Slave. A "Heartbeat" Timer with a timeout period defined by the variable "Network Timeout" (Holding Register address 0x007D), is reset each time the signal is successfully received. If the timeout period is exceeded, the BMS/BMS II will default to its "Fail-Safe" mode and display a Network Comm Fault.

### 3.3.3 BMS/BMS II Master Control of C-More Slaves Via Network

The BMS/BMS II can also communicate with the up to 32 Network C-MORE Boiler Control Slaves via the BMS RS485 port. Parallel and Sequential control can be selected as before. See BMS Manual GF-108M or BMS II Manual GF-124 for additional information.

The "Number Of Network Boilers" must be entered at location 0x0059 in the Standard Holding Registers. The C-More Slave communication addresses ("Net Boiler 1 Address" To "Net Boiler 32 Address") can either be manually entered in a pre-defined order in the BMS, or they can be detected from the network and operated in the order they are detected. To manually enter Network Boiler communication addresses, leave the "Min Slave Address" and "Max Slave Address" set to their default values of 0. To allow the BMS to automatically detect the Network Boilers, enter the respective "Min Slave Address" and "Max Slave Address" in their proper location in the Standard Holding Registers (0x005A, 0X005B). The Max Slave Address must be no more than 31 above the Min Slave Address.

The fire rate information will be transmitted periodically from the BMS/BMS II to the C-MORE boiler controls. A "heartbeat" timer will be reset in the slave each time the control information is successfully received from the BMS. If a timeout occurs, the slave will default to its "Fail-Safe Mode" and display "Modbus Comm Fault".

### 3.3.4 BMS Combination Mode Boiler Control of C-More Slaves (BMS Only)

At the current time, only Legacy (PWM) Boilers 5 through 8 can be selected as Combination Boilers. These Boilers are connected to the BLR 5 - BLR 8 PWM terminal connections (J2). None of the Network -Controlled Boilers (1 - 32) should be assigned as a Combination Boiler. An AERCO Combination Control Panel (CCP) is necessary to configure this type of setup. It should be noted that the assigned PWM Combination Boilers can be monitored and configured on the Modbus Network by assigning a Comm Address between 1 and 127. However, the Combination Boilers cannot be controlled via Modbus. Refer to BMS Manual GF-108M for additional information on installation and setup.

**NOTE**

The C-More Demand Delay function can only be used on C-More Controllers with software version 2.01 or higher.

# SECTION 4 MODBUS NETWORK HARDWARE SETUP & INSTALLATION

## 4.1 INTRODUCTION

This Section provides basic information on planning and setup of a Modbus Communication Network utilizing AERCO C-More Boiler Controllers and Boiler Management Systems (BMS/ BMS II). It also provides basic information on Modbus Network setup utilizing AERCO BMS/ BMS II or C-More Slaves with a Master EMS (or BAS) provided by other manufacturers.

## 4.2 PHYSICAL MODBUS RS485 NETWORK WIRING CONNECTIONS

Modbus RS485 devices should be wired in a "Daisy-Chain" configuration similar to the example shown Figure 4-1. DO NOT wire the units in a "Star" configuration where all devices are connected to a central point (node).

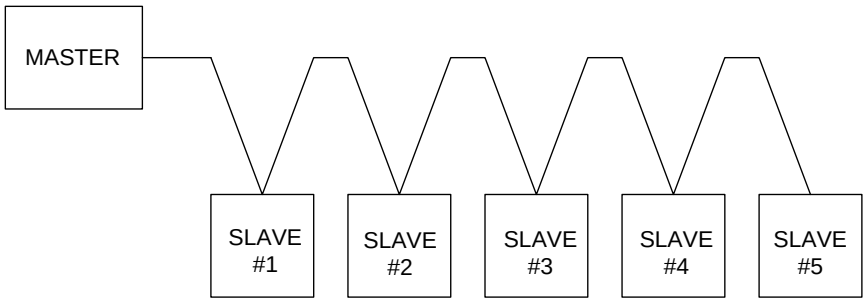



***Figure 4-1. Typical Daisy-Chain Modbus/RS485 Network***

The physical wiring connections for a Modbus Network utilizing an AERCO BMS/BMS II and C-More Boiler Controllers should be made using shielded twisted-pair wire, from 18 to 24 AWG. Examples of suitable wire are: Belden #9841, #8761, #3105A, or equivalent.

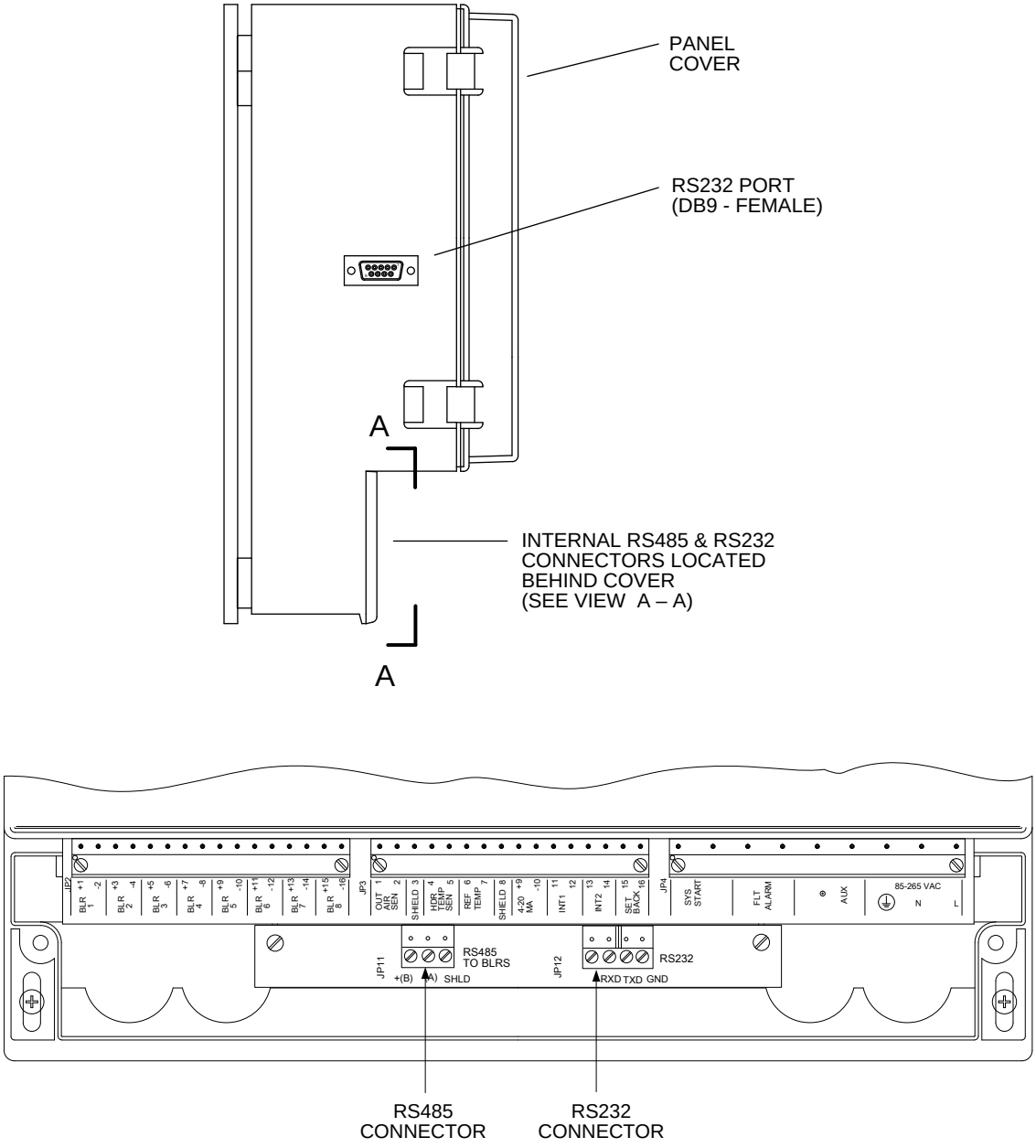
The actual locations of the wiring connectors necessary for Modbus Network implementation utilizing the AERCO BMS or BMS II and C-More Boiler Controllers are provided in paragraphs 4.2.1 and 4.2.2 respectively. Where necessary, connector pin-out information is also provided.

### 4.2.1 BMS Slave To EMS Master Wiring Connections

Wiring connections between an EMS Master and an AERCO BMS Slave can be made at either the RS232 (DB9) port on the left side of the BMS, or at the internal RS232 connector located on the terminal board behind the connection cover on the BMS. These connections are shown in Figure 4-2. The internal RS232 connections are used when interfacing with an EMS Master via a conduit connection at the bottom edge of the BMS enclosure. If the internal RS232 connections are used, it is recommended that nothing be connected to the external RS232 (DB9) port.

If the EMS Master being used contains only an RS485 port (2-wire or 4-wire), an RS485-to-RS232 Converter is required. A BMS option is available with a built-in RS485-to-RS232 Converter to permit a conduit connection between the EMS and BMS. If the external RS232 port on the left side of the BMS is used, a separate external converter is required.

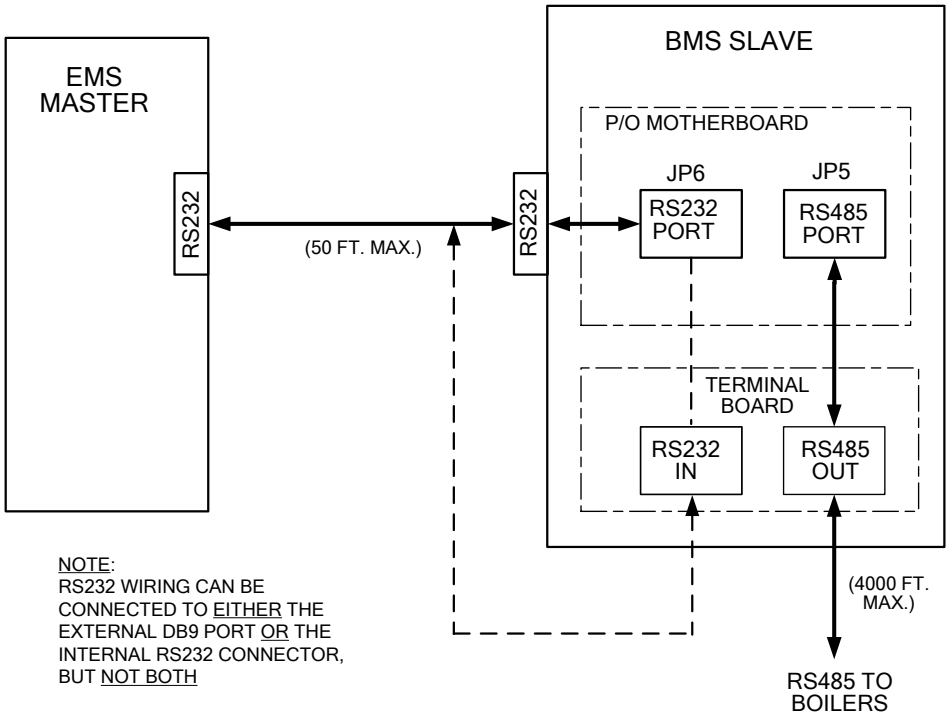
Simplified block diagrams showing the internal and external connection options between the BMS and EMS are shown in Figure 4-3. Connector pinouts for the external RS232 (DB9-Female) and internal RS232 connector are shown in Figure 4-4. In addition, Figure 4-4 shows the pin assignments for the internal RS485 connector mounted on the BMS terminal board. This connector is used to interface the boilers to the Modbus network.



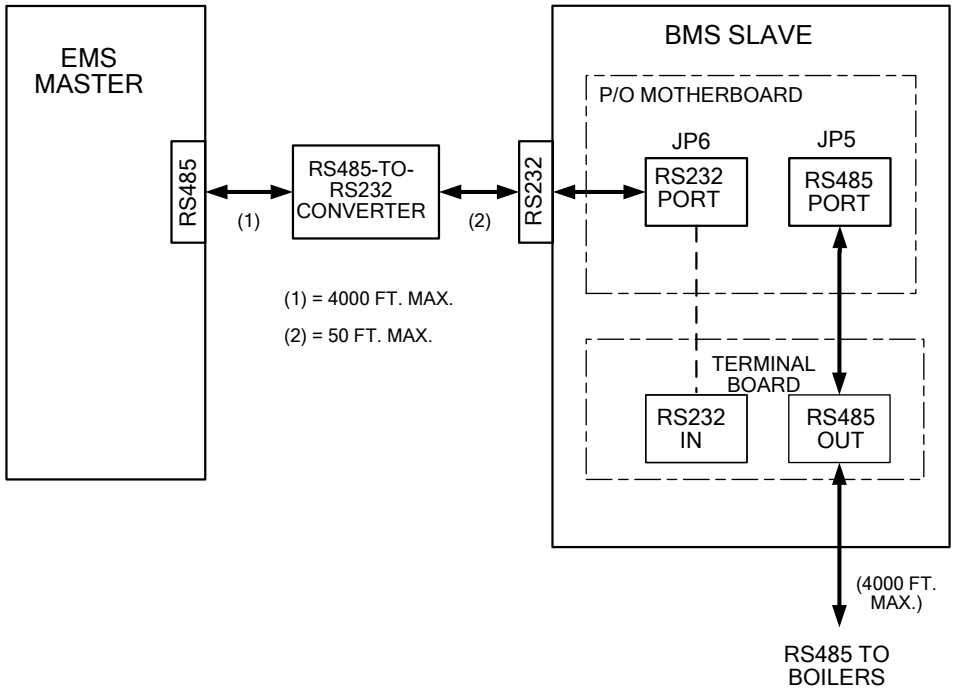

VIEW A – A

(PARTIAL FRONT VIEW WITH COVER REMOVED)

***Figure 4-2. BMS Left Side View***

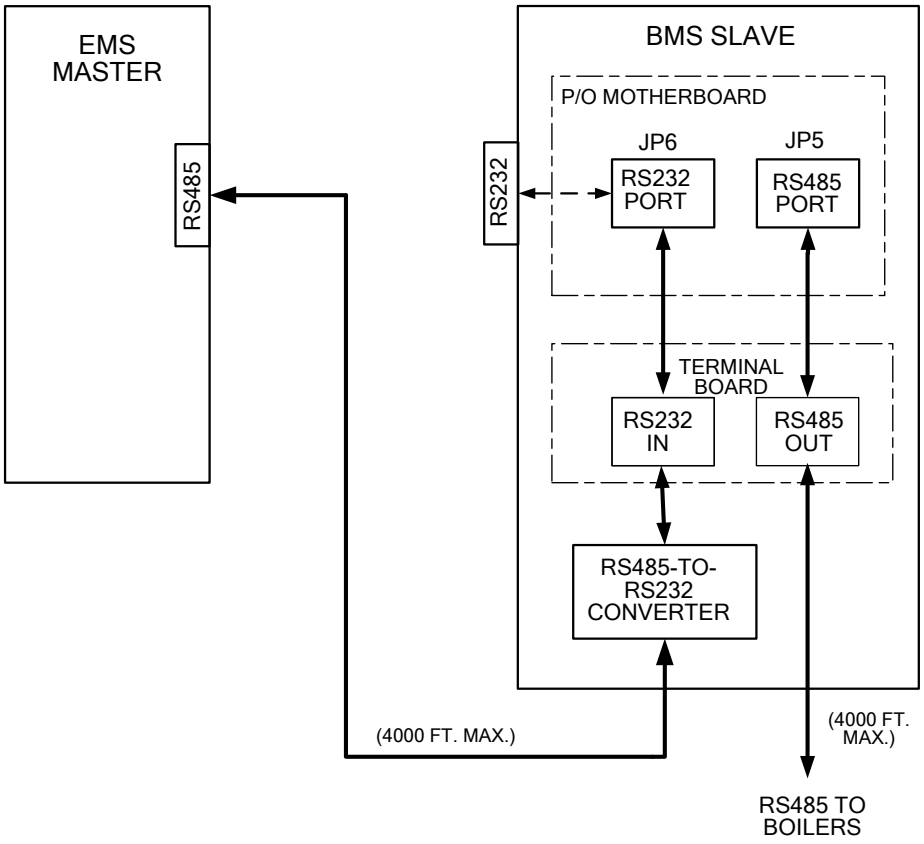



EMS RS232 PORT TO BMS RS232 PORT




EMS RS485 PORT TO BMS RS232 PORT USING EXTERNAL CONVERTER

***Figure 4-3. EMS Master-To-BMS Slave Connection Diagrams (Sheet 1 of 2)***




EMS RS485 PORT TO BMS RS232 PORT USING INTERNAL CONVERTER

***Figure 4-3. EMS Master-To-BMS Slave Connection Diagrams (Sheet 2 of 2)***

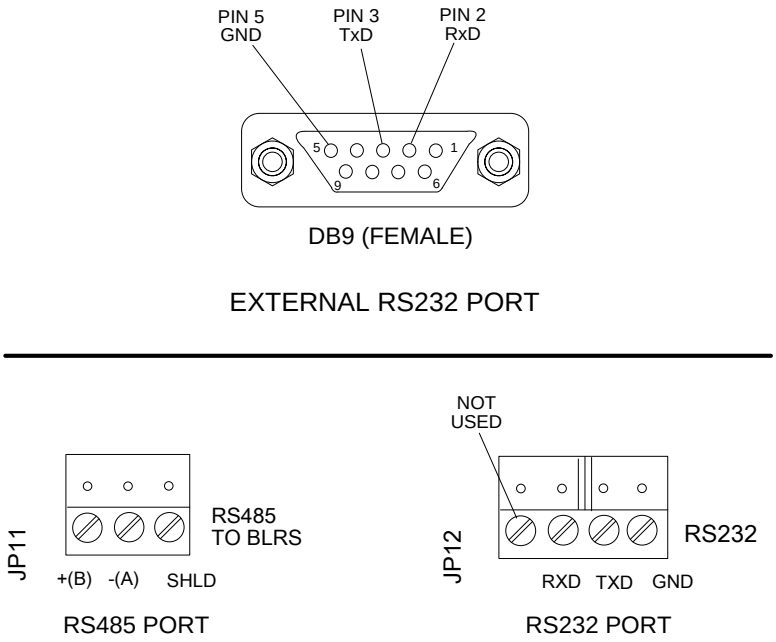



***Figure 4-4. BMS RS232 & RS485 Connectors***

### 4.2.2 BMS II Slave To EMS Master Wiring Connections

Wiring connections between an EMS Master and an AERCO BMS II Slave are made at the internal RS232 port terminals behind the wiring compartment cover of the BMS II. These connections are shown in Figure 4-5. These terminals are labeled RXD, TXD and 232 ISO GND. In addition, Figure 4-5 shows the internal RS485 terminals used to interface the boilers to the Modbus Network.

If the EMS Master being used contains only an RS485 port (2-wire or 4-wire), an RS485-to-RS232 Converter is required. A BMS II option is available with a built-in RS485-to-RS232 Converter to simplify connection between the EMS and BMS II. A separate external converter can also be used if desired.

Simplified block diagrams showing the internal and external connection options between the BMS II and EMS are shown in Figure 4-6.

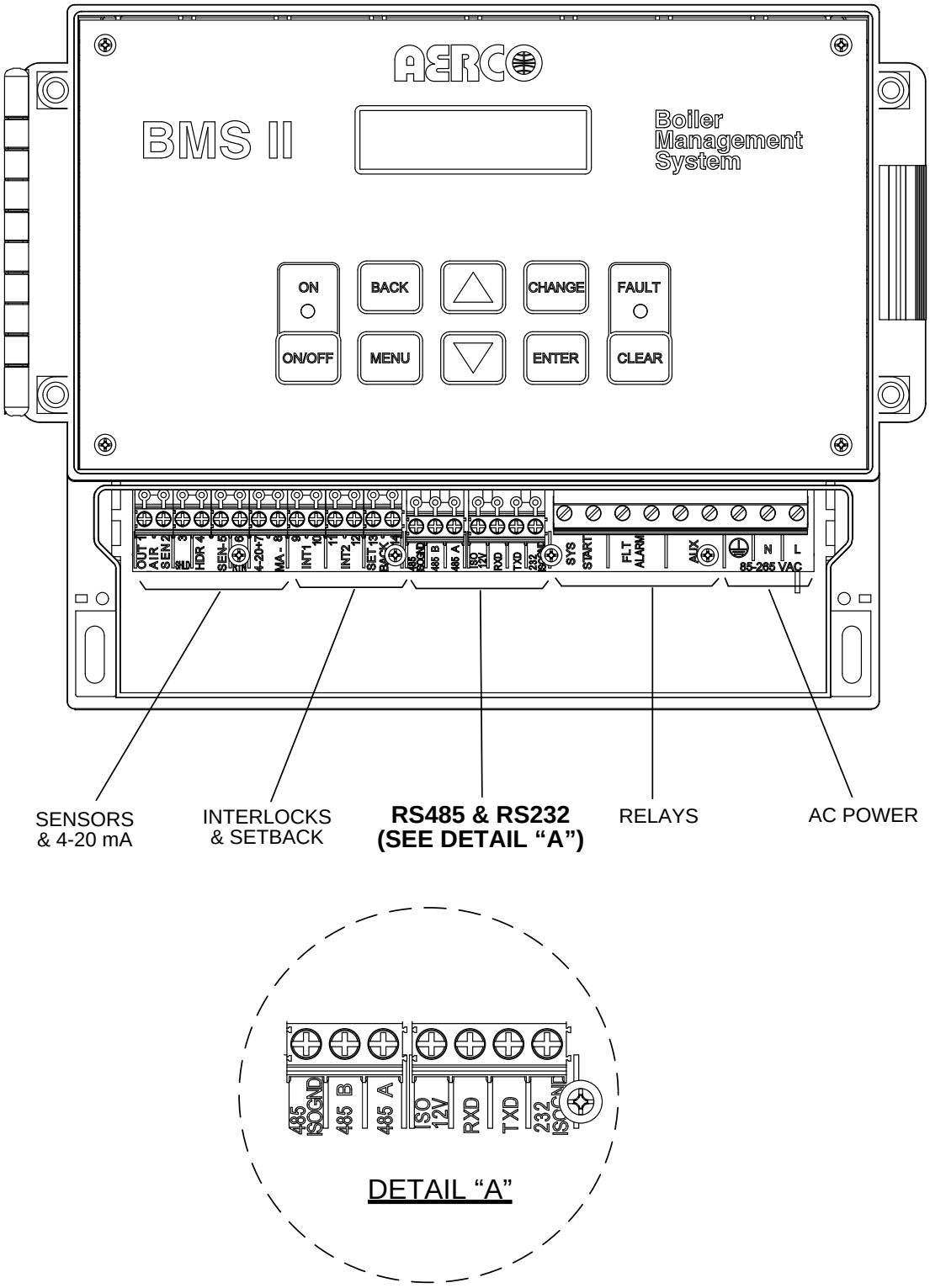
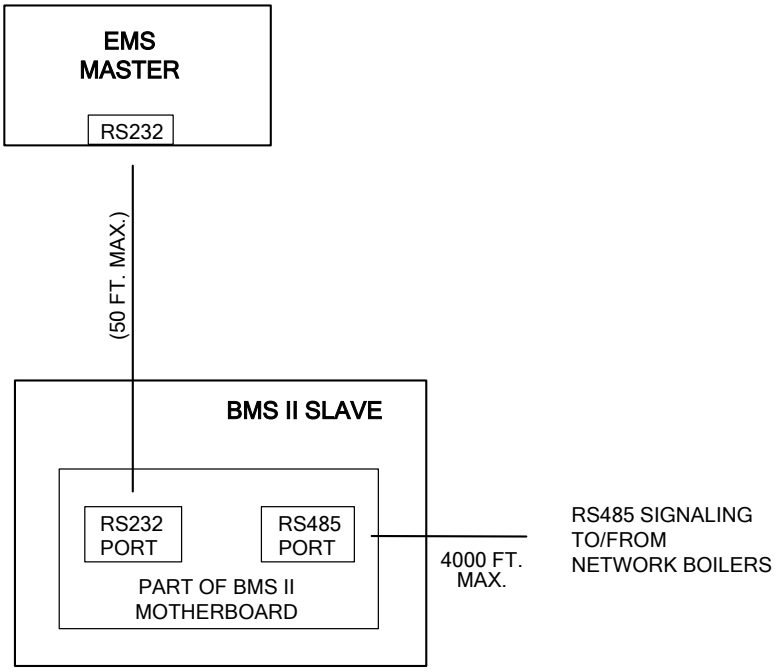
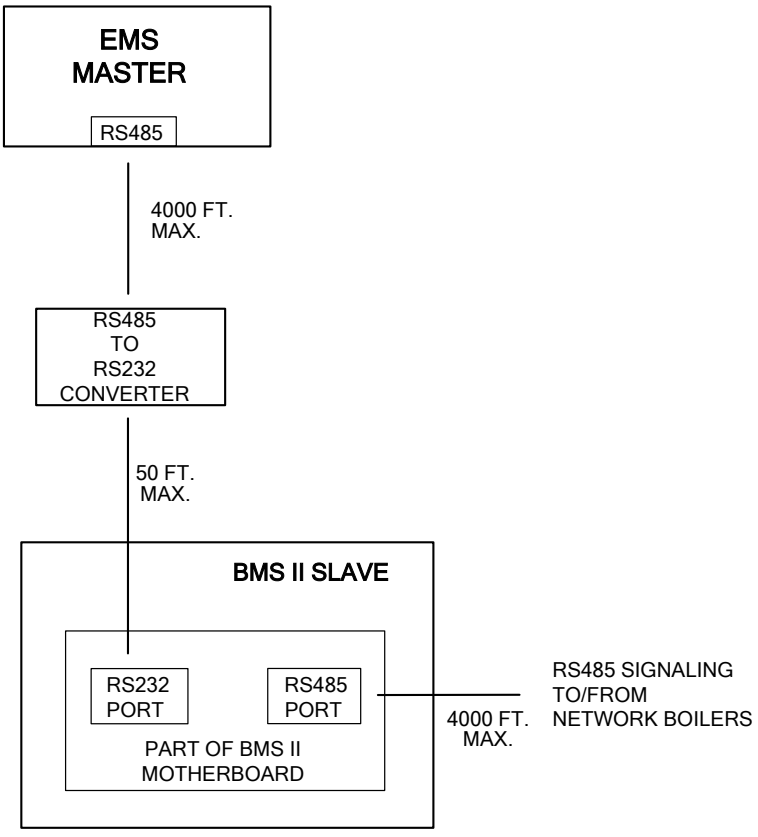



***Figure 4-5. BMS II With Wiring Compartment Cover Removed***

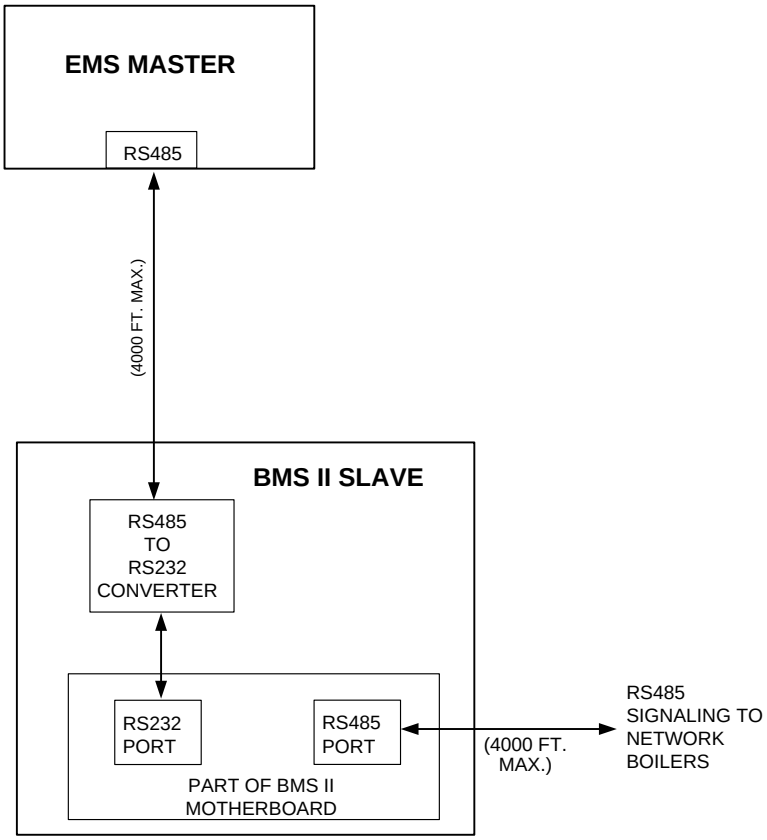



EMS RS232 PORT TO BMS RS232 PORT




EMS RS485 PORT TO BMS RS232 PORT USING EXTERNAL CONVERTER

***Figure 4-6. EMS Master To BMS II Slave Connection Diagrams (Sheet 1 of 2)***




EMS TO BMS II WITH INTERNAL RS485-TO-RS232 CONVERTER

***Figure 4-6. EMS Master To BMS II Slave Connection Diagrams (Sheet 2 of 2)***

### 4.2.3 BMS/BMS II Master To C-More Boiler Controller Slaves

Wiring connections for Modbus operation between a BMS/BMS II Master and C-More Boiler Controller Slaves are made between the BMS/BMS II internal RS485 Port terminals and the I/O Box for the associated C-More Boiler Controller. The RS485 Port terminals for the BMS and BMS II are shown in Figure 4-4 and 4-5 respectively. The RS485 COMM connections at each Boiler's I/O Box are shown in Figure 4-7. Identical I/O Boxes are used for both Benchmark and KC1000 Boilers.

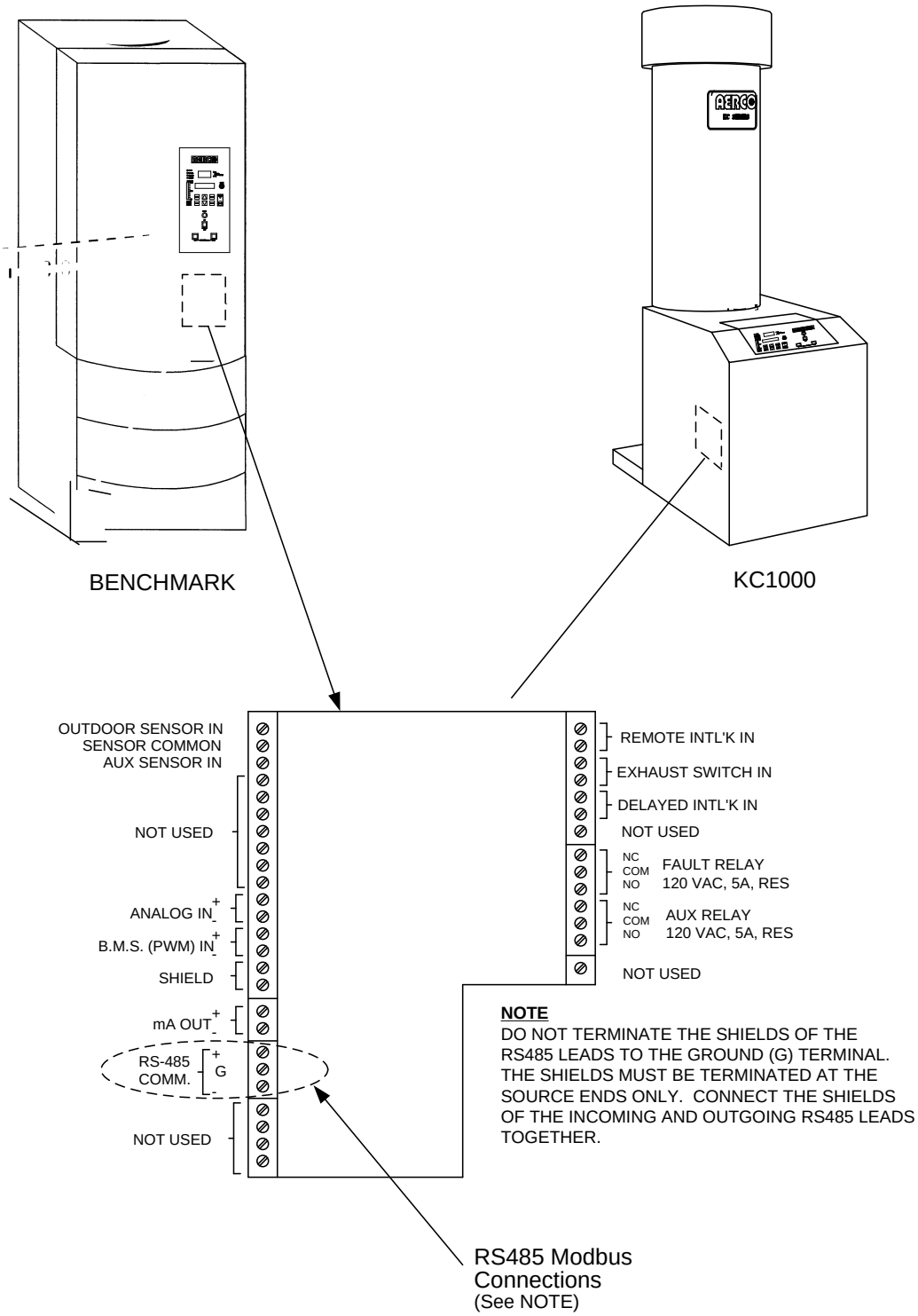



***Figure 4-7. I/O Box RS485 COMM Terminal Connections***

### 4.2.4 C-More Slaves To BMS/BMS II or EMS Master

Wiring connections between a BMS/BMS II Master and up to 32 Network C-More Boiler Controller Slaves are made directly between the BMS/BMS II internal RS485 terminals (Figure 4-4 or 4-5) and the RS485 COMM terminals in each Boiler's I/O Box (Figure 4-7).

If a third-party EMS Master is used in place of the BMS/BMS II, the Modbus Network connections will depend on the available communication port(s) on the EMS. Many EMS Models contain only a RS232 (DB9) port, while others contain either a 2-Wire or 4-Wire RS485 port. Some EMS models contain both a RS232 and a RS485 port. If the EMS is equipped with only a RS232 port, a RS232-to-RS485 converter will be required (such as a B&B Electronics, Model 485SD9TB).

## 4.3 RS485 LOOP TERMINATING RESISTORS AND BIAS

A terminating resistor (120 ohms) on each end of the RS485 loop is designed to match the electrical impedance characteristic of the twisted-pair loop and prevent echoes or cross-talk from corrupting data on the line.

Bias may be necessary on the RS485 loop to minimize noise on the circuit. Loop bias is accomplished by activating pull-up/pull-down resistors on the last C-More Boiler Controller in the chain. Do not activate the bias DIP switches on the BMS II when the C-More bias is used

AERCO requires that both terminating resistors and bias be implemented on the RS485 circuit as described in paragraphs 4.3.1 and 4.3.2 which follow.

### 4.3.1 BMS Terminating Resistor

Each BMS/BMS II is equipped with a built-in terminating resistor (120 ohms) on the RS485 port. Therefore, only one additional terminating resistor will be required at the other end of the RS485 loop. Ensure that the last C-More Boiler Controller Slave on the loop has its terminating resistor activated as described in paragraph 4.3.2.

### 4.3.2 C-More Boiler Controller Terminating Resistor and Bias

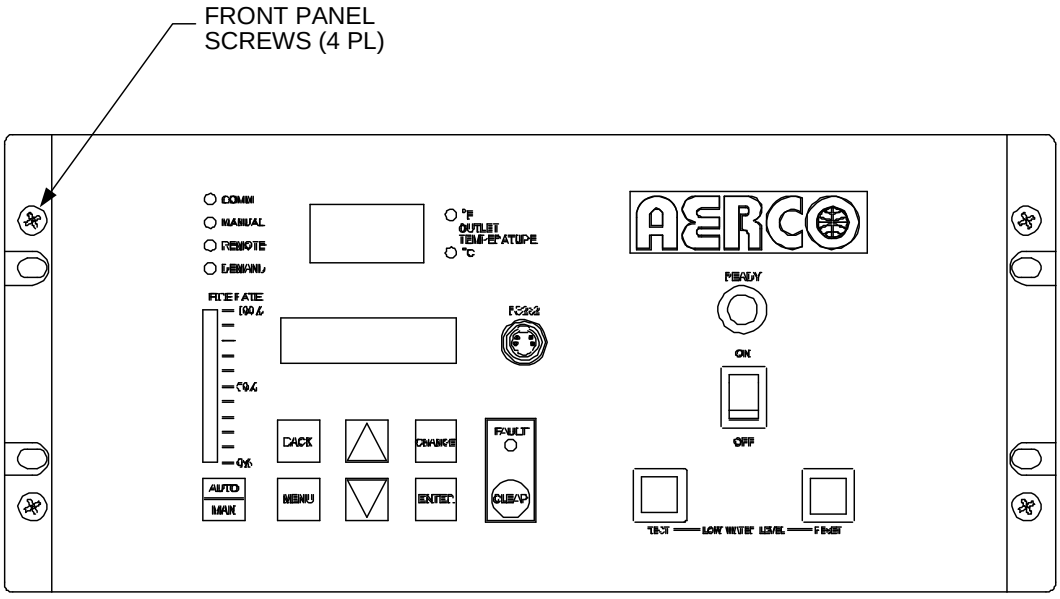
C-More Boiler Controllers can function only as Slave devices on a Modbus Network. Since the Slaves are connected in a "Daisy-Chain" configuration, the terminating resistor must be enabled only in the last C-More Boiler Controller in the chain. In addition, bias must also be implemented only in the last C-More Boiler Controller. This is accomplished by setting a DIP switches on the Primary Micro-Controller (PMC) Board contained in the applicable C-More Boiler Controller. The last unit in the chain must be energized (even if disabled) to enable bias. To activate the DIP switches, proceed as follows:

1. Remove power from the last C-More Boiler Controller in the RS485 loop.
2. Loosen and remove the four (4) screws securing the front panel assembly to the chassis as shown in Figure 4-8.
3. Carefully separate the panel from the chassis. Use care to avoid applying undue stress to the ribbon cable connected between the back of the panel and the chassis-mounted printed circuit boards.

**CAUTION**

The C-More Boiler Controller Printed Circuit Boards contain electronic components that are sensitive to electrostatic discharge (ESD). Prior to performing the following steps, put on an anti-static wrist strap and connect the clip lead to earth ground. Failure to observe this precaution may result in permanent damage to on-board ESD-sensitive components.

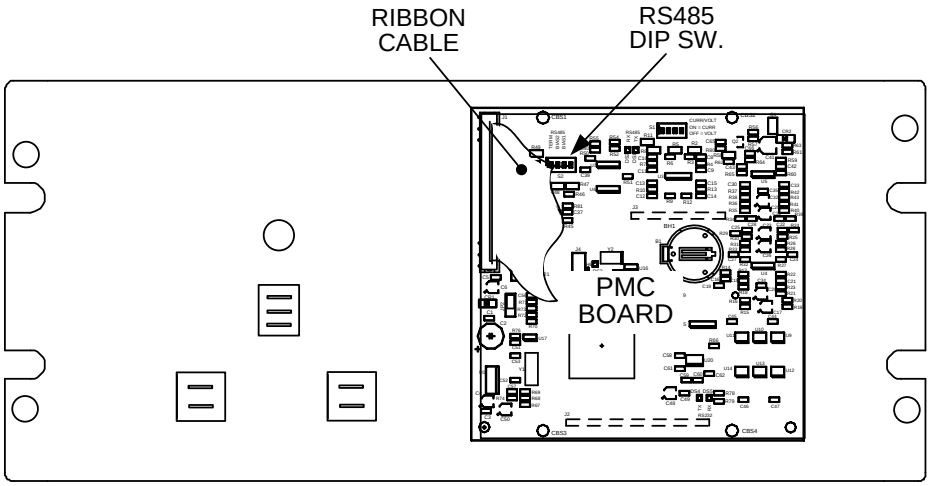
4. Put on an anti-static wrist strap and attach the clip lead to earth ground.
5. From the back of the Panel Assembly (Figure 4-9), locate the RS485 DIP switches on the PMC Board.
6. Refer to Figure 4-10 and set the “TERM” switch to the ON (Up) position.
7. Set the BIAS2 and BIAS1 switches to the ON (Up) position.
8. After the DIP switches have been set, reposition the Front Panel Assembly on the chassis and secure it in place with the four screws.



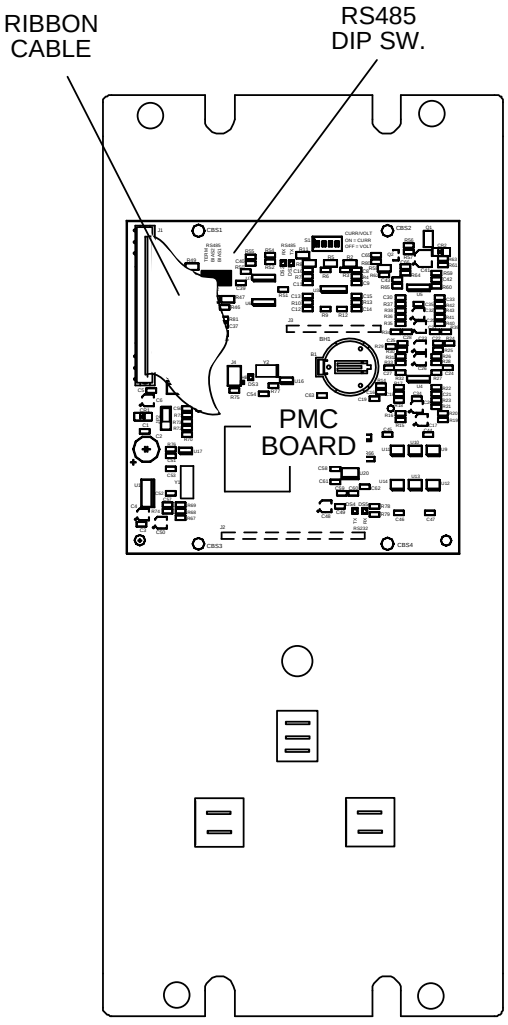

NOTE:

THE C-MORE CONTROLLER MODEL SHOWN WITH A HORIZONTAL PANEL CONTROL LAYOUT IS USED ON KC1000 BOILERS.
BENCHMARK BOILERS UTILIZE C-MORE CONTROLLERS WITH A VERTICAL PANEL CONTROL LAYOUT.

***Figure 4-8. C-More Control Panel - Front View***

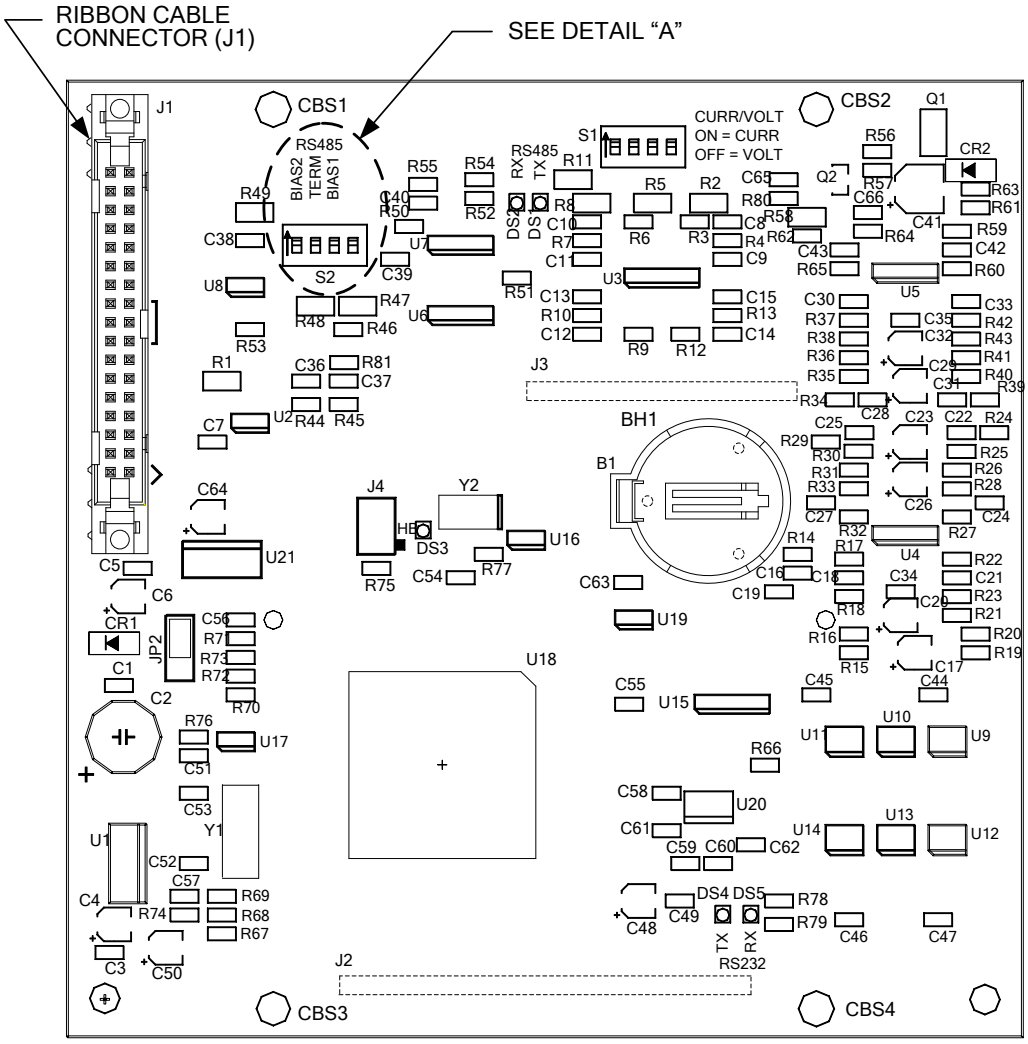



CONTROL PANEL REAR VIEW – KC1000

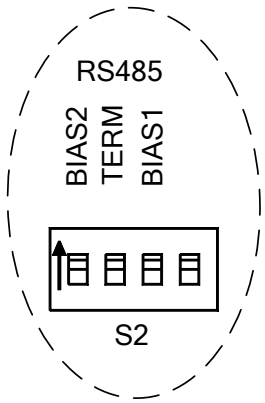



CONTROL PANEL REAR VIEW – BENCHMARK

***Figure 4-9. C-More Control Panel - Rear Views***




PMC BOARD




SET THE BIAS2, TERM & BIAS1 DIP SWITCHES TO THE ON (UP) POSITION TO ACTIVATE EACH FUNCTION

DETAIL "A"

***Figure 4-10. C-More Control Panel PMC Board***

## 4.4 MODBUS NETWORK WIRING DIAGRAMS

Sample Modbus Network wiring diagrams for the basic circuit configurations are provided in paragraphs 4.4.1 through 4.4.3. It should be noted that these diagrams are only intended as a guide and do not include all possible scenarios. If a third-party EMS is being utilized, refer to the manufacturer's manual prior to attempting any network wiring connections.

**CAUTION**

It is imperative that polarity be maintained between all Modbus Network connections. The Network will not operate if the proper polarity is not maintained. Also, twisted-pair wiring shield should only be terminated at the controlling Master Controller for the Modbus Network.

### 4.4.1 Wiring Diagrams for Master EMS Controlling BMS Slaves With Legacy (PWM) Boilers

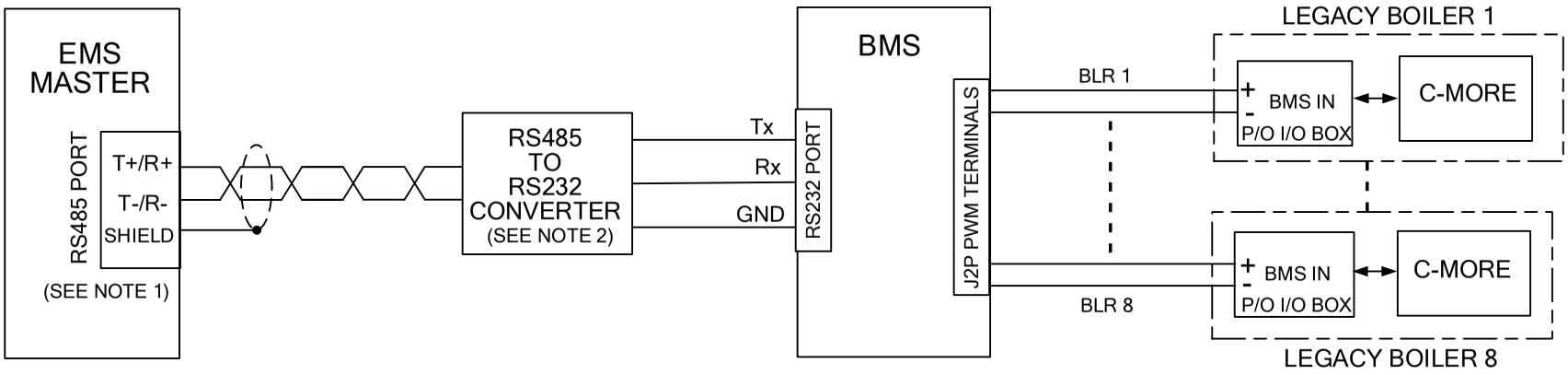
Figure 4-11 provides a sample wiring diagram for a BMS (Model 168) being controlled by an EMS Master equipped with a RS485 port.

### 4.4.2 Wiring Diagram for Master BMS Controlling Networked C-More Slaves

Wiring connections for the "Network" Boilers are made at the BMS/BMS II RS485 port as shown in Figure 4-12. In addition, for a BMS (only) up to 8 "Legacy" Boilers can be wired to the PWM terminal strip to allow control of up to 40 Boilers by one BMS. The BMS PWM terminal connections can also be used to connect AERCO Boilers which utilize older types of control systems, such as Modular Control Boxes, or C-More Controllers equipped with software version 1.61 or lower. Refer to BMS Manual GF-108M for additional setup details for the PWM "Legacy" Boilers. BMS II units do not support PWM, therefore disregard the PWM terminal connections shown in Figure 4-12. BMS II units can only operate networked boilers with C-More control systems.

### 4.4.3 Wiring Diagram For EMS Master Controlling C-More Controller Slaves

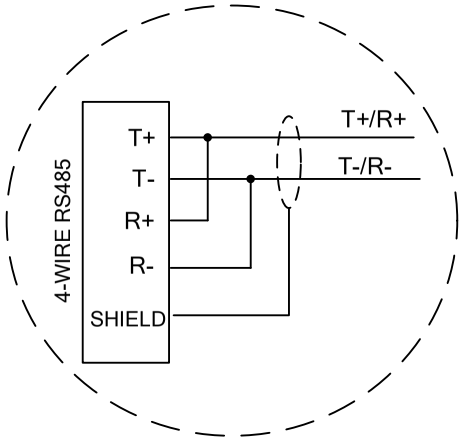
Figure 4-13 provides a sample wiring diagram for an EMS equipped with a RS485 port. If the EMS contains a 4-wire RS485 port, refer to Figure 4-11, Detail "A" for additional wiring details.




NOTES:

1. IF EMS MASTER CONTAINS 4-WIRE RS485 PORT, TIE THE TWO POSITIVE (+) AND NEGATIVE (-) LEADS TOGETHER AS SHOWN IN DETAIL "A"

2. RS485-TO-RS232 CONVERTER NOT REQUIRED IF EMS MASTER CONTAINS RS232 PORT. EMS CAN BE DIRECTLY CONNECTED TO BMS.




DETAIL "A"

Figure 4-11. EMS Master Controlling BMS Slave

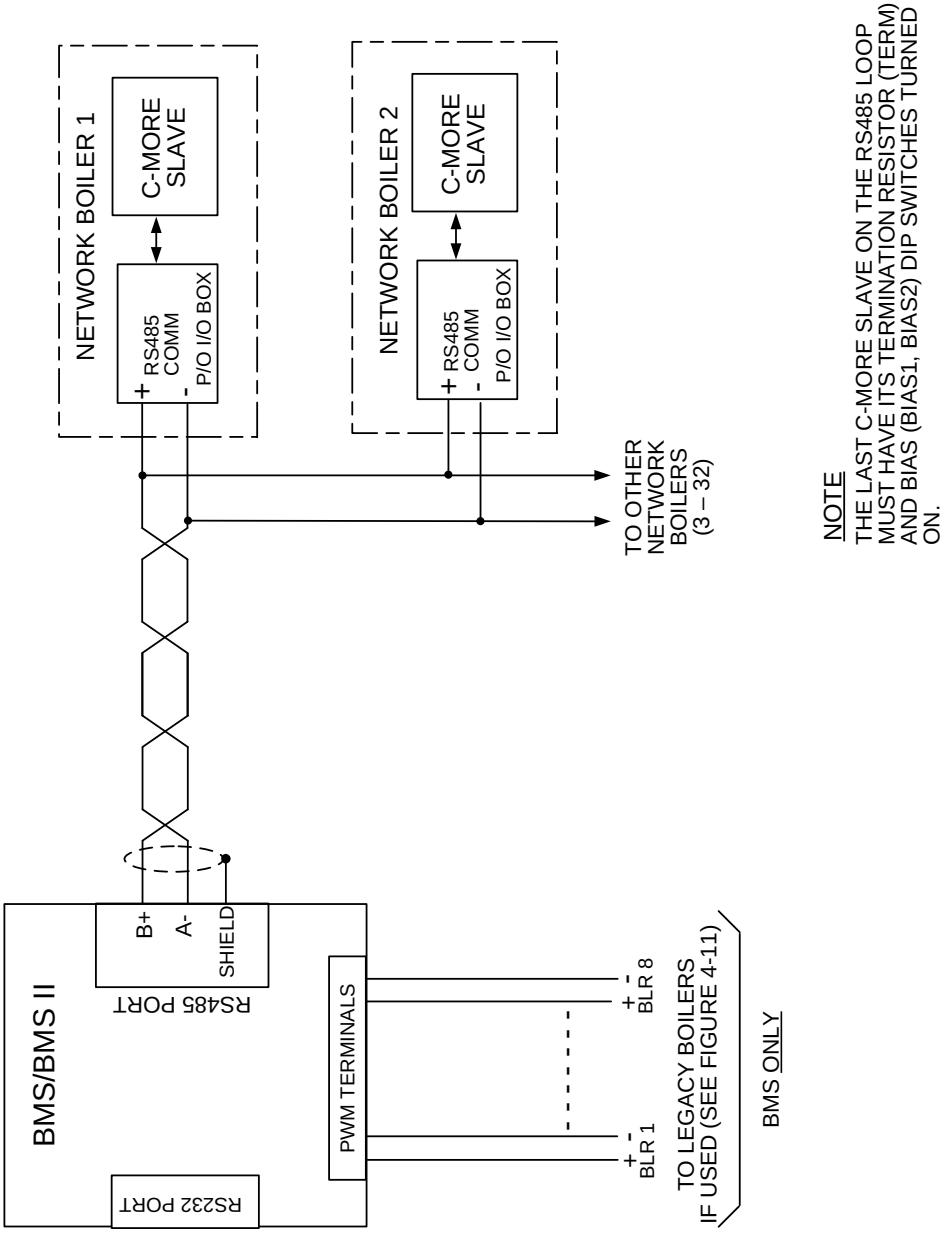
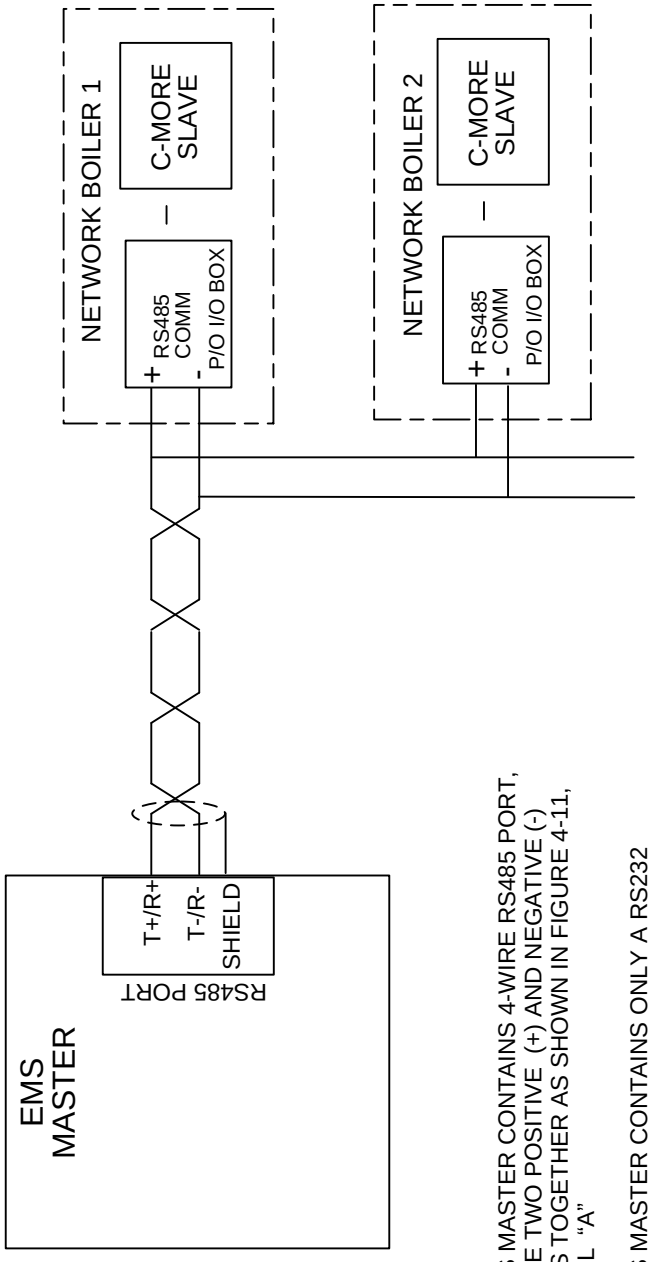



Figure 4-12. BMS Master Controlling C-More Slaves




NOTES:

1. IF EMS MASTER CONTAINS 4-WIRE RS485 PORT, TIE THE TWO POSITIVE (+) AND NEGATIVE (-) LEADS TOGETHER AS SHOWN IN FIGURE 4-11, DETAIL "A"
2. IF EMS MASTER CONTAINS ONLY A RS232 PORT, A RS232-TO-RS485 CONVERTER WILL BE REQUIRED.
3. THE LAST C-MORE SLAVE ON THE RS485 LOOP MUST HAVE ITS TERMINATION RESISTOR (TERM) TURNED ON. ALSO, BIAS (BIAS1, BIAS2) MAY BE REQUIRED. CHECK WITH THE EMS MANUFACTURER.

Figure 4-13. EMS Master Controlling C-More Slaves

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# SECTION 5 MODBUS SOFTWARE SETUP

**NOTE**

Section 5 provides Modbus Software Setup information for BMS (Model 168) units only. Refer to Section 6 for Modbus Software Setup information for BMS II Model 5R5-384 units.

**NOTE**

The BMS includes a Modbus Pass-Thru function which permits an EMS to monitor and configure the boilers on the Modbus network. However, it does not permit the EMS to directly control the boilers. This Modbus Pass-Thru feature is enabled in the BMS Field Adjust Menu using the AIR TEMP key. Refer to BMS Manual GF-108M, paragraph 4.3.2 and Appendix D for details.

## 5.1 INTRODUCTION

This Section provides the information necessary to configure the AERCO C-More Boiler Controllers and a Boiler Management System (BMS) for operation on a Modbus Network. It also provides the basic setup procedures to operate the C-More Boiler Controller and BMS in each available Modbus Mode.

## 5.2 C-MORE BOILER CONTROLLER SETUP FOR MODBUS OPERATION

The C-More Boiler Controller can be set up for three types of Modbus operating modes. These modes are as follows:

- Monitoring and Configuration Only
- Modbus Direct Drive Control and Monitoring
- Modbus Remote Setpoint Control and Monitoring

The following paragraphs provide the procedures necessary to set up the C-More Boiler Controllers for each of the above modes of operation. These procedures assume that the required wiring connections for Modbus operation have already been accomplished as described in Section 4.

**NOTE**

The appropriate password must be entered in the Setup Menu of the C-More Boiler Controller, prior to changing any of the current settings. For detailed information on menu items, refer to the appropriate Operation and Maintenance Manual for the Benchmark Series or KC1000 Series units being used.

### 5.2.1 Monitoring and Configuration Control

In order for the C-More Boiler Controller to be recognized by the Modbus Master, a valid Network Comm Address must be entered in the Setup Menu as follows:

**NOTE**

A C-More Boiler Controller can be monitored or configured on the Modbus Network regardless of its mode of control.

1. Scroll through the Setup Menu until *Comm Address* is displayed.
2. With *Comm Address* displayed, press the **CHANGE** key.
3. Using the ▲ or ▼ arrow key, enter the appropriate *Comm Address* from 1 to 127.
4. Press the **ENTER** key to store the *Comm Address* in memory.

Once the *Comm Address* has been entered, the C-More Boiler Controller can be accessed by the Modbus Network Master (BMS or EMS).

### 5.2.2 Modbus Direct Drive Control and Monitoring

Modbus Direct Drive Control of the C-More Boiler Controller is set up as follows:

1. Enter and store a valid Comm Address using the procedures in paragraph 5.2.1.
2. Scroll through the Configuration Menu and change the following menu options to the settings shown:
3. 

| MENU OPTION | SETTING |
|---|---|
| Boiler Mode | Direct Drive |
| Remote Signal | Network |

4. The C-More Controller is now set for Direct Drive operation via the Modbus Network.
5. AERCO recommends that the *Setpoint Limiting* feature in the Configuration Menu be enabled. Also, ensure that the *Failsafe Mode* setting is set to the desired setting (*Shutdown* or *Constant Setpoint*) in the event that the Modbus Network signal is lost.

### 5.2.3 Modbus Remote Setpoint Control

Modbus Remote Setpoint Control of the C-More Boiler Controller is set up as follows:

1. Enter and store a valid Comm Address using the procedures in paragraph 5.2.1.
2. Scroll through the Configuration Menu and change the following menu options to the settings shown:

| MENU OPTION | SETTING |
|---|---|
| Boiler Mode | Remote Setpoint |
| Remote Signal | Network |

3. The C-More Controller is now set for Remote Setpoint operation via the Modbus Network.
4. AERCO recommends that the *Setpoint Limiting* feature in the Configuration Menu be enabled. Also, ensure that the *Failsafe Mode* setting is set to the desired setting (*Shutdown* or *Constant Setpoint*) in the event that the Modbus Network signal is lost.

**NOTE**

The AERCO BMS can function as either a Slave or a Master on a Modbus Network. Paragraph 5.3 provides the programming setup procedures when the BMS is a Slave to an EMS (or BAS). Paragraph 5.4 provides the programming setup procedures when the BMS is the controlling Master for C-More Boiler Controllers.

## 5.3 BMS SETUP FOR OPERATION AS A SLAVE TO AN EMS MASTER

The BMS can be programmed as a Slave to an EMS Master on the Modbus Network in two ways:

- Monitoring and Configuration Only
- Modbus Remote Setpoint Control and Monitoring

The setup procedures for the above operating configurations are provided in paragraphs 5.3.1 and 5.3.2 which follow.

### 5.3.1 BMS Monitoring and Configuration By An EMS Master

To set up the BMS to be monitored or configured on the Modbus Network, proceed as follows:

1. Press the **FIELD ADJ** key on the BMS front panel to enter the Field Adjust Mode. The yellow LED on the key should be lit.
2. Press the **AIR TEMP** key until *RS232 MODE* is shown on the top line of the display. If necessary, press the ▲ or ▼ arrow key until *MODBUS SLAVE* appears in the second line of the display.
3. Press the **AIR TEMP** key again until *RS232 BAUDRATE* is shown on the top line of the display. Press the ▲ or ▼ arrow key to select the appropriate baud rate.
4. Press the **AIR TEMP** key again until *MODBUS ADDRESS* is shown on the top line of the display. Press the ▲ or ▼ arrow key to set the desired address for the BMS on the Modbus Network.
5. Press the **FIELD ADJ** key to exit the Field Adjust Mode. The yellow LED on the key should go off.

The BMS is now set up to be monitored or configured on the Modbus Network. Remember that the configuration can only be changed on the Modbus Network by first entering a valid password for PASSWORD LO and PASSWORD HI.

### 5.3.2 BMS Modbus Remote Setpoint Control By An EMS Master

To configure the BMS for Remote Setpoint Control from an EMS Master, proceed as follows:

1. Press the **FIELD ADJ** key on the BMS front panel to enter the Field Adjust Mode. The yellow LED on the key should be lit.
2. Press the **AIR TEMP** key until *RS232 MODE* is shown on the top line of the display. If necessary, press the ▲ or ▼ arrow key until *MODBUS SLAVE* appears in the second line of the display.
3. Press the **AIR TEMP** key again until *RS232 BAUDRATE* is shown on the top line of the display. Press the ▲ or ▼ arrow key to select the appropriate baud rate.
4. Press the **AIR TEMP** key again until *MODBUS ADDRESS* is shown on the top line of the display. Press the ▲ and ▼ arrow keys to set the required address for the BMS on the Modbus Network.
5. Press the **AIR TEMP** key again until *NETWORK TIMEOUT* is shown in the top line of the display. Press the ▲ and ▼ arrow keys to select the maximum allowable time (in seconds) for the EMS (or BAS) to refresh the Remote Setpoint information being sent to the BMS. AERCO recommends that a time be selected that is at least 3 times the normal refresh rate. This will allow for the loss of 1 or 2 transmissions without timing out.
6. Press the **AIR TEMP** key again until *REMOTE SIGNAL* is shown in the top line of the display. Press the ▲ or ▼ arrow key to select *MODBUS.*
7. Press the **FIELD ADJ** key to exit the Field Adjust Mode. The yellow LED on the key should go off.
8. To set the BMS for Remote Operation, press the **CONFIG SYS** key to enter the System Configuration Mode. The red LED on the key will light.
9. Press the **FIELD ADJ** key until *HDR SET MODE* is shown in the top line of the display. Press the ▲ and ▼ arrow keys to select *REMOTE SET TEMP.*
10. *Press the* **CONFIG SYS** key to exit the System Configuration Mode. The red LED on the key will go off.

The BMS is now programmed for Remote Setpoint Operation from an EMS Master. In the event of a Modbus signal interruption, AERCO recommends that the *TEMP FAIL MODE* setting be set to *Switch Inputs* if you want the BMS to continue running the Boilers in the CONSTANT SET TEMP Mode. In this case, ensure that the *REF TEMP* is set to the desired setpoint temperature.

## 5.4 BMS SETUP AS MASTER TO C-MORE BOILER CONTROLLERS

To set up the BMS as a Master to Control C-More Boiler Slaves, proceed as follows:

1. Press the **FIELD ADJ** key on the BMS front panel to enter the Field Adjust Mode. The yellow LED on the key should be lit.
2. Press the **HDR TEMP** key until *RS485 BAUDRATE* is shown on the top line of the display. Press the ▲ and ▼ arrow keys if necessary to set the baud rate to 9600.
3. Press the **HDR TEMP** key again until *MIN SLAVE ADDR* is shown in the display. Use the ▲ and ▼ arrow keys to set the address to zero.
4. Press the **HDR TEMP** key again until *MAX SLAVE ADDR* is shown in the display. Use the ▲ and ▼ arrow keys to set the address to zero.
5. Press the **HDR TEMP** key until *NUMBER NETW BLRS* is shown on the top line of the display. Using the ▲ and ▼ arrow keys, set the number to the maximum number of C-More Boilers that will be controlled on this Modbus Network.

**NOTE**

DO NOT count the C-More Boilers or Water Heaters that will only be monitored on the Modbus Network. Only count the Boilers that will be controlled by the BMS using the Modbus connection.

6. Press the **HDR TEMP** key until *MODBUS CNTL TYPE* is shown on the top line of the display. Using the ▲ or ▼ arrow key, if necessary, set it to *ROUND ROBIN*.
7. Press the **HDR TEMP** key until *NETW BOILER 1* is shown on the top line of the display. Use the ▲ and ▼ arrow keys to set the address of the first Boiler being controlled on the BMS RS485 loop. (This address must be the same as the Comm Address setting in the C-More Boiler Controller).
8. Press the **HDR TEMP** key again until *NETW BOILER 2* is shown on the top line of the display. Use the ▲ and ▼ arrow keys to set the address of the second Boiler being controlled on the BMS RS485 loop. (This address must be the same as the Comm Address setting in the C-More Boiler Controller).
9. Repeat step 8 for each additional C-More Boiler being controlled on the BMS RS485 loop.
10. This completes programming for the BMS RS485 Network. Press the **FIELD ADJ** key to exit the Field Adjust Mode. The yellow LED on the key should go off.

**IMPORTANT**

Boilers #1 thru #8 are reserved for the Legacy Boilers connected to the Pulse Width Modulation (PWM) connections on the BMS. Therefore, *NETW BOILER 1* is the same as Boiler #9. *NETW BOILER 2* is the same as Boiler #10 and so on.

The BMS is now programmed to control the Networked Boilers, as well as any Legacy Boilers connected to it. The BMS will automatically detect any C-More Boiler that is programmed for Network Control as follows:

- Boiler Mode = Direct Drive
- Remote Signal = Network
- Comm Address = Matches one of the *NETW BOILER* addresses stored in the BMS

# SECTION 6 MODBUS SOFTWARE SETUP

**NOTE**

Section 6 provides Modbus Software Setup information for BMS II (Model 5R5-384) units only. Refer to Section 5 for Modbus Software Setup information for BMS (Model 168) units.

**NOTE**

The BMS II includes a Modbus Pass-Thru function which permits an EMS to monitor and configure the boilers on the Modbus network. However, it does not permit the EMS to directly control the boilers. This Modbus Pass-Thru feature is enabled in the BMS II RS232 Menu. Refer to BMS II Manual GF-124, paragraph 3.6 and Appendix A for details.

## 6.1 INTRODUCTION

This Section provides the information necessary to configure the AERCO C-More Boiler Controllers and a Boiler Management System II (BMS II) for operation on a Modbus Network. It also provides the basic setup procedures to operate the C-More Boiler Controller and BMS II in each available Modbus Mode.

## 6.2 C-MORE BOILER CONTROLLER SETUP FOR MODBUS OPERATION

The C-More Boiler Controller can be set up for three types of Modbus operating modes. These modes are as follows:

- Monitoring and Configuration Only
- Modbus Direct Drive Control and Monitoring
- Modbus Remote Setpoint Control and Monitoring

The following paragraphs provide the procedures necessary to set up the C-More Boiler Controllers for each of the above modes of operation. These procedures assume that the required wiring connections for Modbus operation have already been accomplished as described in Section 4.

**NOTE**

The appropriate password must be entered in the Setup Menu of the C-More Boiler Controller, prior to changing any of the current settings. For detailed information on menu items, refer to the appropriate Operation and Maintenance Manual for the Benchmark Series or KC1000 Series units being used.

### 6.2.1 Monitoring and Configuration Control

In order for the C-More Boiler Controller to be recognized by the Modbus Master, a valid Network Comm Address must be entered in the Setup Menu as follows:

**NOTE**

A C-More Boiler Controller can be monitored or configured on the Modbus Network regardless of its mode of control.

1. Scroll through the Setup Menu until *Comm Address* is displayed.
2. With *Comm Address* displayed, press the **CHANGE** key.
3. Using the ▲ or ▼ arrow key, enter the appropriate *Comm Address* from 1 to 127.
4. Press the **ENTER** key to store the *Comm Address* in memory.

Once the *Comm Address* has been entered, the C-More Boiler Controller can be accessed by the Modbus Network Master (BMS II or EMS).

### 6.2.2 Modbus Direct Drive Control and Monitoring

Modbus Direct Drive Control of the C-More Boiler Controller is set up as follows:

1. Enter and store a valid Comm Address using the procedures in paragraph 6.2.1.
2. Scroll through the Configuration Menu and change the following menu options to the settings shown:
3. 

| MENU OPTION | SETTING |
|---|---|
| Boiler Mode | Direct Drive |
| Remote Signal | Network |

4. The C-More Controller is now set for Direct Drive operation via the Modbus Network.
5. AERCO recommends that the *Setpoint Limiting* feature in the Configuration Menu be enabled. Also, ensure that the *Failsafe Mode* setting is set to the desired setting (*Shutdown* or *Constant Setpoint*) in the event that the Modbus Network signal is lost.

### 6.2.3 Modbus Remote Setpoint Control

Modbus Remote Setpoint Control of the C-More Boiler Controller is set up as follows:

1. Enter and store a valid Comm Address using the procedures in paragraph 6.2.1.
2. Scroll through the Configuration Menu and change the following menu options to the settings shown:

| MENU OPTION | SETTING |
|---|---|
| Boiler Mode | Remote Setpoint |
| Remote Signal | Network |

3. The C-More Controller is now set for Remote Setpoint operation via the Modbus Network.
4. AERCO recommends that the *Setpoint Limiting* feature in the Configuration Menu be enabled. Also, ensure that the *Failsafe Mode* setting is set to the desired setting (*Shutdown* or *Constant Setpoint*) in the event that the Modbus Network signal is lost.

**NOTE**

The AERCO BMS II can function as either a Slave or a Master on a Modbus Network. Paragraph 6.3 provides the programming setup procedures when the BMS II is a Slave to an EMS (or BAS). Paragraph 6.4 provides the programming setup procedures when the BMS II is the controlling Master for C-More Boiler Controllers.

The appropriate password must be entered in the Setup Menu of the BMS II prior to changing any of the current settings. For detailed information on menu items or change procedures, refer to the BMS II operating instructions provided in GF-124.

## 6.3 BMS II SETUP FOR OPERATION AS A SLAVE TO AN EMS MASTER

The BMS II can be programmed as a Slave to an EMS Master on the Modbus Network in two ways:

- Monitoring and Configuration Only
- Modbus Remote Setpoint Control and Monitoring

The setup procedures for the above operating configurations are provided in paragraphs 6.3.1 and 6.3.2 which follow.

### 6.3.1 BMS II Monitoring and Configuration By An EMS Master

To set up the BMS II to be monitored or configured on the Modbus Network, entries must be made in the RS232 Menu as follows:

1. Using the **MENU** key on the BMS II front panel, select the RS232 MENU.
2. Scroll through the RS232 Menu and select the *RS232 MODE* option. The second line of the display will show the currently selected RS232 Mode (*MODBUS SLAVE* or *NORMAL*).
3. If *MODBUS SLAVE* is not displayed, press the **CHANGE** key and toggle the display to *MODBUS SLAVE.*
4. Press the **ENTER** key to store the *MODBUS SLAVE* setting in memory.

5. While still in the RS232 MENU, scroll to the *RS232 BAUDRATE* option. Using the **CHANGE** key and ▲ or ▼ arrow keys, select the appropriate baud rate being used on the Modbus Network. Press the **ENTER** key to store the selected baud rate.

6. Next, scroll to the *MODBUS ADDRESS* option. Using the **CHANGE** key**,** and the ▲ or▼ arrow keys, select the desired address for the BMS II on the Modbus Network.

7. When the address is selected, press the **ENTER** key to store the address in memory.

The BMS II is now set up to be monitored or configured on the Modbus Network.

### 6.3.2 BMS II Modbus Remote Setpoint Control By An EMS Master

To configure the BMS II for Remote Setpoint Control from an EMS Master, options must be set in the RS232 Menu and Field Adjust Menu as follows:

1. Using the **MENU** key on the BMS II front panel, select the RS232 MENU.

2. Scroll through the RS232 Menu and select the *RS232 MODE* option. The second line of the display will show the currently selected RS232 Mode (*MODBUS SLAVE* or *NORMAL*).

3. If *MODBUS SLAVE* is not displayed, press the **CHANGE** key and toggle the display to *MODBUS SLAVE.*

4. Press the **ENTER** key to store the *MODBUS SLAVE* setting in memory.

5. While still in the RS232 MENU, scroll to the *RS232 BAUDRATE* option. Using the **CHANGE,** ▲ and ▼ arrow keys, select the appropriate baud rate being used on the Modbus Network. Press the **ENTER** key to store the selected baud rate.

6. Scroll to the *MODBUS ADDRESS* option in the RS232 MENU. Using the **CHANGE** key**,** and the ▲ and ▼ arrow keys, select the desired address for the BMS II on the Modbus Network. When the address is selected, press the **ENTER** key to store the address in memory.

7. Next, scroll to the *NETWORK TIMEOUT* option in the RS232 MENU. Press the **CHANGE** key and then select the maximum allowable time (in seconds) for the EMS (or BAS) to refresh the Remote Setpoint information being sent to the BMS II. AERCO recommends that a time be selected that is at least 3 times the normal refresh rate. This will allow for the loss of 1 or 2 transmissions without timing out. This completes the required entries in the RS232 MENU.

8. Press the **MENU** key and enter the FIELD ADJUST MENU.

9. Using the ▲ and ▼ arrow keys, scroll through the FIELD ADJUST MENU until the *HDR SET MODE* option is displayed.

10. If *REMOTE SETPT* is not shown in the second line of the display, press the **CHANGE** key and toggle the display to *REMOTE SETPT.*

11. Press the **ENTER** key to store the *REMOTE SETPT* setting.

12. While still in the FIELD ADJUST MENU, scroll to the *REMOTE SIGNAL* option.

13. If *MODBUS* is not shown in the second line of the display, press the **CHANGE** key and toggle the display to *MODBUS.*

14. Press the **ENTER** key to store the setting.

15. This completes all required menu entries for this mode.

The BMS II is now programmed for Remote Setpoint Operation from an EMS Master. In the event of a Modbus signal interruption, AERCO recommends that the *FAIL SAFE MODE* setting in the (CONFIGURATION MENU) be set to *CONSTANT SETPT* if you want the BMS II to continue running the Boilers in the CONSTANT SETPT Mode. In this case, ensure that the INTERNAL SETPT (Field Adjust Menu) is set to the desired setpoint temperature.

## 6.4 BMS II SETUP AS MASTER TO C-MORE BOILER CONTROLLERS

To set up the BMS II as a Master to control C-More Boiler Slaves, options must be set in the RS485 Menu as follows:

1. Using the **MENU** key on the BMS II front panel, select the RS485 MENU.
2. Scroll through the RS485 Menu and select the *RS485 BAUDRATE option*. The second line of the display will show the currently selected RS232 Baud Rate (*2400, 4800, 9600 or 19200).*
3. If *9600* is not displayed, press the **CHANGE** key.
4. Using the ▲ and ▼ arrow keys, scroll through the menu option choices until *9600* is displayed.
5. With a RS485 Baud Rate of *9600* displayed, press the **ENTER** key to store the setting in memory.
6. Continue scrolling through the RS485 MENU until *MIN SLAVE ADDR* is shown in the display.
7. If 000 is not displayed in the second line of the display, press the **CHANGE** key. Use the ▼ arrow key to set the *MIN SLAVE ADDR* to *000.*
8. Press the **ENTER** key to store the *000* address in memory.
9. Scroll through the RS485 MENU until *MAX SLAVE ADDR* is shown in the display.
10. If *000* is not displayed in the second line of the display, press the **CHANGE** key. Use the ▼ arrow key to set the *MAX SLAVE ADDR* to *000.*
11. Press the **ENTER** key to store the *000* address in memory.
12. Next, scroll to the *NUMBER OF NETW BLRS* option. The second line of the display will show the current number of Network Boilers currently stored in memory.
13. Press the **CHANGE** key and set the correct number of *NETW BOILERS.*
14. Press ENTER to store the number of Boilers on the Network.
15. Scroll to the *MODBUS CNTL TYPE* and ensure it is set to *ROUND ROBIN* (default). The only other setting available for this option is *BROADCAST* which is not available at this time.

**NOTE**

The remaining steps in this setup procedure involve assigning separate and distinct addresses for each Boiler on the Modbus Network. The valid address range is from 001 through 127.

16. While still in the RS485 MENU, scroll to *NETW BOILER 01*. The second line of the display will show *ADDRESS = 001* which is the default address for Network Boiler 1. If desired, this address can be changed to any other value within the valid range (*001* to *127).*
17. Repeat step 16 for each additional C-More Boiler being controlled on the BMS II RS485 loop. Do Not count Boilers or Water Heaters that will only be monitored on the Modbus Network. Only count Boilers that will be controlled by the BMS II using the Modbus connection.
18. This completes programming for the BMSII RS485 Network.

The BMS II is now programmed to control the Networked Boilers  The BMS II will automatically detect any C-More Boiler that is programmed for Network Control as follows:

- Boiler Mode = Direct Drive
- Remote Signal = Network
- Comm Address = Matches one of the *NETW BOILER* addresses stored in the BMS II.

# APPENDIX A

## C-MORE BOILER CONTROLLER

## STATUS & FAULT MESSAGES
## AND
## CONVERSION EQUATIONS

### *Table A-1. Status and Fault Messages*

| Code | MESSAGE | DESCRIPTION |
|---|---|---|
| 1 | DISABLED<br>HH:MM pm MM/DD/YY | Displayed if ON/OFF switch is set to OFF. The display also shows the time and date that the unit was disabled. |
| 2 | STANDBY | Displayed when ON/OFF switch is in the ON position, but there is no demand for heat. The time and date are also displayed. |
| 3 | DEMAND DELAY<br>XX sec | Displayed if Demand Delay is active. |
| 4 | PURGING<br>XX sec | Displayed during the purge cycle during startup. The duration of the purge cycle counts up in seconds. |
| 5 | IGNITION TRIAL<br>XX sec | Displayed during ignition trial of startup sequence. The duration of cycle counts up in seconds. |
| 6 | FLAME PROVEN | Displayed after flame has been detected for a period of 2 seconds. Initially, the flame strength is shown in %. After 5 seconds has elapsed, the time and date are shown in place of flame strength. |
| 7 | WARMUP<br>XX sec | Displayed for 2 minutes during the initial warm-up only. |
| 8 | HIGH WATER TEMP<br>SWITCH OPEN | The High Water Temperature Limit Switch is open. |
| 9 | LOW WATER<br>LEVEL | The Water Level Control board is indicating low water level. |
| 10 | LOW GAS<br>PRESSURE | The Low Gas Pressure Limit Switch is open. |
| 11 | HIGH GAS<br>PRESSURE | The High Gas Pressure Limit Switch is open. |
| 12 | INTERLOCK<br>OPEN | The Remote Interlock is open. |
| 13 | DELAYED<br>INTERLOCK OPEN | The Delayed Interlock is open. |
| 14 | AIRFLOW FAULT<br>DURING PURGE | The Blower Proof Switch opened during purge. |
| 15 | SSOV FAULT<br>DURING PURGE | The SSOV switch opened during purge. |
| 16 | PRG SWTCH OPEN<br>DURING PURGE | The Purge Position Limit switch on the Air/Fuel valve opened during purge. |

***Table A-1. Status and Fault Messages –Cont.***

| Code | MESSAGE | DESCRIPTION |
|---|---|---|
| 17 | IGN SWTCH OPEN DURING IGNITION | The Ignition Position Limit switch on the Air/Fuel valve opened during ignition. |
| 18 | AIRFLOW FAULT DURING IGN | The Blower Proof Switch opened during ignition. |
| 19 | AIRFLOW FAULT DURING RUN | The Blower Proof Switch opened during run. |
| 20 | SSOV FAULT DURING IGN | The SSOV switch closed or failed to open during ignition. |
| 21 | SSOV FAULT DURING RUN | The SSOV switch closed for more than 15 seconds during run. |
| 22 | FLAME LOSS DURING IGN | The Flame signal was not seen during ignition or lost within 5 seconds after ignition. |
| 23 | FLAME LOSS DURING RUN | The Flame signal was lost during run. |
| 24 | HIGH EXHAUST TEMPERATURE | The High Exhaust Temperature Limit Switch is closed. |
| 25 | LOSS OF POWER | A power loss occurred. The time and date when power was restored is displayed. |
| 26 | LOSS OF SENSOR | Not Currently Used |
| 27 | LOSS OF SIGNAL | Not Currently Used |
| 28 | HIGH O2 LEVEL | Not Currently Used |
| 29 | LOW O2 LEVEL | Not Currently Used |
| 30 | HIGH CO LEVEL | Not Currently Used |
| 31 | SSOV RELAY FAILURE | A failure has been detected in one of the relays that control the SSOV. |
| 32 | RESIDUAL FLAME | The Flame signal was seen for more than 60 seconds during standby. |
| 33 | HEAT DEMAND FAILURE | The Heat Demand Relays on the Ignition board failed to activate when commanded. |
| 34 | IGN SWTCH CLOSED DURING PURGE | The Ignition Position Limit switch on the Air/Fuel valve closed during purge. |
| 35 | PRG SWTCH CLOSED DURING IGNITION | The Purge Position Limit switch on the Air/Fuel valve closed during ignition. |
| 36 | SSOV SWITCH OPEN | The SSOV switch opened during standby. |
| 37 | IGNITION BOARD COMM FAULT | Communication fault between the Ignition board and the CPU board. |
| 38 | WAIT | Prompts the operator to wait. |

***Table A-1. Status and Fault Messages –Cont.***

| Code | MESSAGE | DESCRIPTION |
|---|---|---|
| 39 | DIRECT DRIVE SIGNAL FAULT | The direct drive signal is not present or is out of range. |
| 40 | REMOTE SETPT SIGNAL FAULT | The remote setpoint signal is not present or is out of range. |
| 41 | OUTDOOR TEMP SENSOR FAULT | The temperature measured by the Outdoor Air Sensor is out of range. |
| 42 | OUTLET TEMP SENSOR FAULT | The temperature measured by the Outlet Sensor is out of range. |
| 43 | FFWD TEMP SENSOR FAULT | The temperature measured by the FFWD Sensor is out of range. |
| 44 | HIGH WATER TEMPERATURE | The temperature measured by the Outlet Sensor exceeded the Temp Hi Limit setting. |
| 45 | LINE VOLTAGE OUT OF PHASE | The High AC voltage is out of phase from the low AC voltage. |
| 46 | STEPPER MOTOR FAILURE | The stepper motor failed to move the valve to the desired position. |
| 47 | SETPT LIMITING ACTIVE | Setpoint temperature has exceeded the maximum allowable setting. |
| 48 | MODBUS COMM FAULT | The RS485 (Modbus) network information is not present or is corrupted. |

***Table A-2. Conversion Equations for Temperature Variables – Variable Counts to Temp***

| Register Variable Type | Degrees Fahrenheit (°F) | Degrees Celsius (°C) |
|---|---|---|
| DEGREES_1 | $\text{Temp(F)} = \left[\frac{(\text{RegVar}) * (230) + 500}{1000}\right] + 20$ | $\text{Temp(C)} = \left[\frac{(\text{RegVar}) * (128) + 500}{1000}\right] - 7$ |
| DEGREES_2 | $\text{Temp(F)} = \left[\frac{(\text{RegVar}) * (220) + 500}{1000}\right] - 80$ | $\text{Temp(C)} = \left[\frac{(\text{RegVar}) * (183) + 500}{1000}\right] - 62$ |
| DEGREES_3 | $\text{Temp(F)} = \left[\frac{(\text{RegVar}) * (520) + 500}{1000}\right] + 40$ | $\text{Temp(C)} = \left[\frac{(\text{RegVar}) * (289) + 500}{1000}\right] - 4$ |
| ABS_DEG_1 | For (RegVar≥0): $\text{Temp(F)} = \left[\frac{(\text{RegVar}) * (230) + 500}{1000}\right]$ For (RegVar<0): $\text{Temp(F)} = \left[\frac{(\text{RegVar}) * (230) - 500}{1000}\right]$ | For (RegVar≥ 0): $\text{Temp(C)} = \left[\frac{(\text{RegVar}) * (128) + 500}{1000}\right]$ For (RegVar< 0): $\text{Temp(C)} = \left[\frac{(\text{RegVar}) * (128) - 500}{1000}\right]$ |

***Table A-3. Conversion Equations for Temperature Variables – Temp to Variable Counts***

| Register Variable Type | Degrees Fahrenheit | Degrees Celsius |
|---|---|---|
| DEGREES_1 | $\text{RegVar} = \left[\frac{(\text{degF} - 20) * (1000) + 115}{230}\right]$ | $\text{RegVar} = \left[\frac{(\text{degC} + 7) * (1000) + 64}{128}\right]$ |
| DEGREES_2 | $\text{RegVar} = \left[\frac{(\text{degF} - 80) * (1000) + 110}{220}\right]$ | $\text{RegVar} = \left[\frac{(\text{degC} + 62) * (1000) + 91.5}{183}\right]$ |
| DEGREES_3 | $\text{RegVar} = \left[\frac{(\text{degF} + 40) * (1000) + 300}{600}\right]$ | $\text{RegVar} = \left[\frac{(\text{degC} - 4) * (1000) + 144.5}{289}\right]$ |
| ABS_DEG_1 | For (degF≥0): $\text{RegVar} = \left[\frac{(\text{degF}) * (1000) + 115}{230}\right]$ For (degF<0): $\text{RegVar} = \left[\frac{(\text{degF}) * (1000) - 115}{230}\right]$ | For (degC≥ 0): $\text{RegVar} = \left[\frac{(\text{degC}) * (1000) - 115}{128}\right]$ For (degC<0): $\text{RegVar} = \left[\frac{(\text{degC}) * (1000) - 64}{128}\right]$ |