



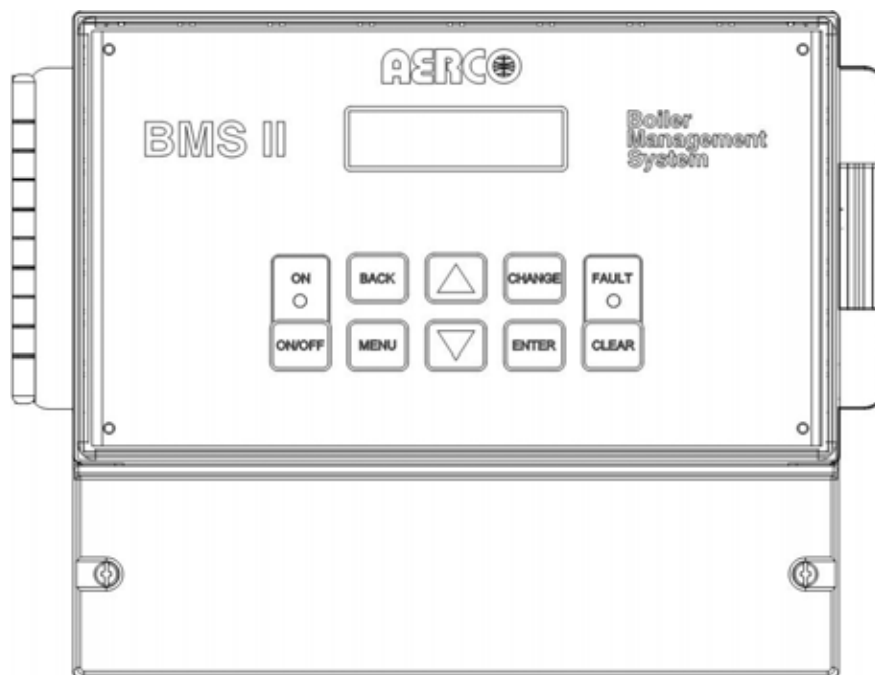
Instruction
No.

GF-124

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

Installation, Operation & Maintenance Instructions

BMS II BOILER MANAGEMENT SYSTEM



JANUARY, 2009

Telephone Support

Direct to AERCO Technical Support
(8 to 5 pm EST, Monday through Friday):

1-800-526-0288



AERCO International, Inc.
159 Paris Avenue
Northvale, NJ 07647-0128

www.aerco.com

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Foreword

The Model 5R5-384 Boiler Management System II (BMS II) is the latest model of AERCO's BMS line of flexible boiler plant controllers. The system can control a boiler plant comprised of AERCO Benchmark Series, Modulex Series or KC1000 Boilers. The BMS II can stage and coordinate the operation of up to 32 AERCO Boilers with maximized efficiency. With individual boilers with turn-down ratios as high as 20:1, a 5-boiler plant can deliver a system turn-down ratio of 100:1 when the boilers are staged to operate sequentially.

The BMS II is fully compatible with a wide array of Building Automation Systems (BAS) or Energy Management Systems (EMS) utilizing Modbus Protocol. The BAS or EMS communicates with the BMS II utilizing a RS232 interface. If the BAS or EMS does not contain a RS232 port, the BMS II can be ordered with a RS485-to-RS232 Converter which can be easily installed within the BMS II' wiring compartment.

PHRASES, ABBREVIATIONS & ACRONYMS

The phrases, abbreviations and acronyms used in this document are listed in the following table

Phrases, Abbreviations and Acronyms

Phrase, Abbreviation or Acronym	Meaning
A (Amp)	Ampere
ADDR	Address
ALRM	Alarm
AUX	Auxiliary
BAS	Building Automation System, often used interchangeably with EMS (see below)
Baud Rate	Symbol rate, or simply the number of distinct symbol changes (signaling events) transmitted per second. It is not equal to bits per second, unless each symbol is 1 bit long.
BCM	Boiler Control Module used with AERCO Modulex Series Boilers
BLR	Boiler
BMS II	AERCO Boiler Management System, Second Generation
BND	Band
Bias Resistors	A pair of resistors used to force the communication line to a definite logic state so that noise is not picked up as invalid data during communication.
BLDG (Bldg)	Building
C-More Controller (or Control Box)	A control system developed by AERCO and currently used in all Benchmark and KC1000 Series product lines.
CNTL	Control
DIP	Dual In-Line Package
DYN	Dynamic
EMS	Energy Management System; often used interchangeably with BAS
Ethernet	A computer networking technology for Local Area Networks (LANs)
FDX	Full-Duplex
FLT	Fault
GND	Ground
HDR	Header
HDX	Half-Duplex

FOREWORD

Phrases, Abbreviations and Acronyms - Continued

Phrase, Abbreviation or Acronym	Meaning
Hex	Hexadecimal Number (0 - 9, A - F)
Hz	Hertz (Cycles Per Second)
INTLK	Interlock
I/O	Input/Output
I/O Box	Input/Output (I/O) Box currently used on all Benchmark and KC Series products
IP	Internet Protocol
ISO	Isolated
LSB	Least Significant Byte
LSD	Least Significant Digit
MA (mA)	Milliampere
MAX (Max)	Maximum
MIN (Min)	Minimum
Modbus®	A serial, half-duplex data transmission protocol developed by AEG Modicon
MSB	Most Significant Byte
MSD	Most Significant Digit
MS/TP	Master-Slave/Token-Passing (usually over RS485 networks)
OFFS	Offset
OUTD	Outdoor
PTP	Point-to-Point (usually over RS232 networks)
REF (Ref)	Reference
Response Time	The maximum amount of time allowed to receive a response to a request
RS232 (or EIA-232)	A standard for serial, full-duplex (FDX) transmission of data based on the RS232 Standard
RS422 (or EIA-422)	A standard for serial, full-duplex (FDX) transmission of data based on the RS422 Standard
RS485 (or EIA-485)	A standard for serial, half-duplex (HDX) transmission of data based on the RS485 Standard
RTN	Return
RTU	Remote Terminal Unit
SEN	Sensor
SETPT (Setpt)	Setpoint Temperature
SHLD (Shld)	Shield
SLTA	Serial LonTalk Adapter
SYS	System
TEMP (Temp)	Temperature
Terminating Resistor	A resistor placed at each end of a daisy-chain or multi-drop network in order to prevent reflections that may cause invalid data in the communication
VAC	Volts, Alternating Current
VDC	Volts, Direct Current
VFD	Vacuum Fluorescent Display

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CHAPTER 1 - GENERAL INFORMATION

1.1 SAFETY PRECAUTIONS & WARNINGS

The Warnings and Cautions appearing throughout this manual should be reviewed and thoroughly understood prior to attempting to install, operate, troubleshoot or repair the BMS II.

1.2 INTRODUCTION

This manual provides installation, operation and troubleshooting instructions for the AERCO Boiler Management System, Model 5R5-384. Since this Model is the second generation of AERCO's Boiler Management System (BMS) line, this Model is referred to as the BMS II throughout this document.

1.3 BMS II GENERAL DESCRIPTION

The BMS II (Figure 1-1) is a rugged, flexible controller designed to stage and coordinate the operation of up to 32 AERCO Benchmark Series, Modulex Series or KC1000 Boilers while maximizing operational efficiency. Under normal load conditions, the BMS II can precisely regulate the header temperature of the boiler plant within $\pm 2^{\circ}\text{F}$.

Boiler plant control is accomplished via a RS485 network utilizing Modbus protocol. For facilities that have taken a building-wide approach to energy efficiency, the BMS II can be easily integrated with an Energy Management System (EMS) or Building Automation System (BAS) utilizing Modbus protocol. Physical connection to the remote EMS or BAS is accomplished via an RS232 interface. EMS/BAS integration will also permit utilization of the pass-thru function incorporated in the BMS II. The pass-thru function permits the remote system to monitor up to 35 operating parameters from each boiler in the plant.

The BMS II is housed in a NEMA 13 enclosure. A hinged clear-plastic cover over the unit's panel controls protects against incidental contact of control settings and provides a degree of protection against airborne debris and the spraying or splashing of water. The physical dimensions, weight and electrical power requirements for the BMS II are as follows:

Dimensions	9.50" W x 7.25" H x 4.00" D
Weight	3 lbs.
Power Requirements	85-to-265 VAC, Single-Phase, 50-60 Hz @ 1A

Each BMS II shipment includes a Header Sensor Kit, Part No. GM-122790 which is required for all modes of operation. Other available options which can be ordered with your shipment include:

Outdoor Air Sensor Kit, Part No. GM-122781	Required for Outdoor Reset Mode Operation
Return Sensor Kit, Part No. 122790 (Same as Header Sensor Kit)	Used for external monitoring of boiler water return temperature
RS485-to-RS232 Converter, Part No 124943	For use with EMS or BAS equipment that do not include a RS232 Port

GENERAL INFORMATION

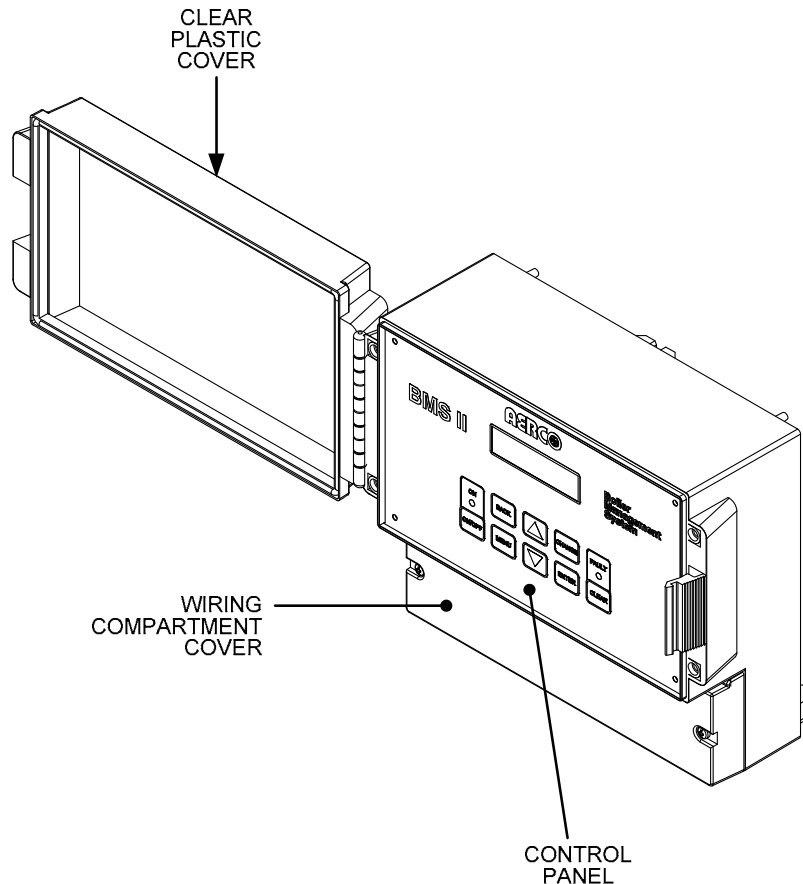


Figure 1-1. Boiler Management System II (BMS)

1.4 BMS II FEATURES

The following paragraphs briefly describe some of the unique features incorporated in the BMS II.

Simplified Installation and Set-Up

The BMS II system operates on single-phase input power ranging from 85 to 265 VAC, 50-60 Hz. Connections to the boiler plant are accomplished utilizing a 2-wire RS485 network connected in a daisy-chain configuration. When an EMS or BAS is used with the BMS II, connections are made via the RS232 port terminals. In the event that the EMS or BAS is not equipped with a RS232 port, the BMS II can be ordered with a RS485 to RS232 Converter which can be easily installed within the wiring compartment of the BMS II. With the exception of AC power, interlock and setback inputs and relay outputs, BMS II connections are accomplished using twisted-shielded pair cable.

User-Friendly Control System Interface

The unit incorporates a menu-driven architecture which is comprised of 9 primary menus. The user interface to these menus is accomplished via the BMS II control panel and a Vacuum Fluorescent Display (VFD). The display is capable of displaying two lines with 16 characters per line. Virtually all of the control panel keys are identical to the C-More Control System currently used on AERCO Benchmark Series and KC1000 Boilers. This commonality will help simplify the time required for system setup of the BMS II.

GENERAL INFORMATION

Retention of Menu Option Settings

By using non-volatile memory, the BMS II retains program and menu settings during shut-down or when input AC power is interrupted. Settings can be retained for more than 2 years.

Application Flexibility

Four different configuration options can be selected to match the needs of any closed-loop system. These configurations are: Outdoor Reset, Constant Setpoint, Remote Setpoint via a 4-20 Ma input and Remote Setpoint via Modbus.

Sequential or Parallel Operation

Boilers can be programmed for either sequential or parallel operation using the BMS II keypad controls. When set for sequential operation, the boilers are brought on-line one at a time as needed. When set for parallel operation, the boilers are all brought on-line together at the same firing rate.

Accuracy

Using PID (Proportional Integral Derivative) and Ramp-Up/Ramp-Down Modulation Control Algorithms, the BMS II provides dynamic responses to all changes in boiler plant operation. Header temperatures, as well as percentages of boiler input are precisely controlled with virtually no over-shoot or short-cycling of boiler units. A header temperature accuracy of $\pm 2^{\circ}\text{F}$ is virtually assured during continuous plant operation.

Bumpless Transfer

When operated sequentially, The BMS II stages boilers on and off at selectable firing rate percentages. The result is a seamless transition with undetectable room temperature changes. In addition, when in sequential mode, the BMS II sequences boilers using a first-on, first-off basis, thereby equalizing the accumulated run time of all boilers in the plant.

The BMS II also continuously monitors the number of Boilers that are available for operation. In the event of a boiler malfunction, or required servicing, the BMS II automatically compensates for a lack of response from any unit and brings on the next available boiler to satisfy the demand. This feature operates in both sequential and parallel modes.

Fault Alarm Surveillance

If an EMS or BAS is not used with the BMS II to monitor faults, a Fault Alarm Relay can be activated thereby notifying facility managers of faults associated with the BMS II.

BMS II Programming Via RS232 Port.

If desired, the BMS II can be programmed by connecting a Laptop Computer or other terminal emulation device to the RS232 Port terminals on the BMS II. Detailed set-up instructions and available command listings are provided in Appendix G. Most settings are also programmable using Modbus.

CHAPTER 2 - INSTALLATION

2.1 INTRODUCTION

This Chapter provides the descriptions and procedures necessary to mount the BMS II and connect all boiler plant units and applicable sensors. Guidelines are also provided for connection of an EMS or BAS being used with the system. Refer to the wiring diagram provided in Appendix E when making all wiring connections to the BMS II.

2.2 SITE SELECTION AND MOUNTING

Ensure that the site selected for installation of the BMS II provides the following:

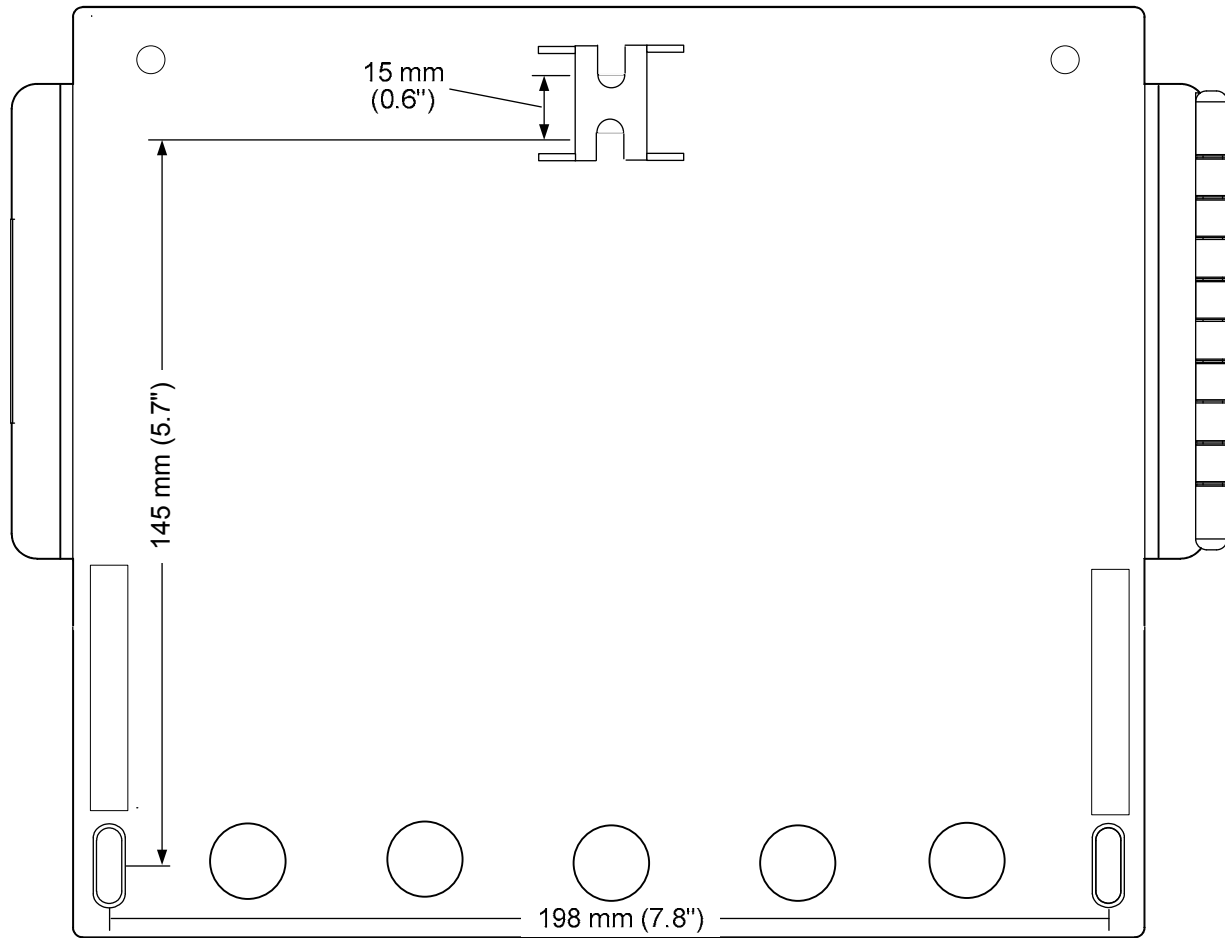
- Access to single-phase AC power from 110 to 240 VAC, 60 Hz nominal
- Sufficient clearances to permit maintenance and setup/operational tasks on the BMS II.

Mounting the BMS

AERCO recommends that the BMS II be wall-mounted using a sheet of plywood or other suitable material. For easy viewing, the BMS II controls and display should be at eye level. Mounting is accomplished using three screws (not provided). The spacing for the three screws are indicated on the rear of the BMS II in millimeters. Figure 2-1 shows the rear of the panel enclosure and also indicates the required spacing for the three mounting screws in inches. Proceed as follows to mount the unit:

1. First install a screw on the mounting surface at the top center location shown in Figure 2-1. Leave a space of approximately 1/8 inch between the mounting surface and the head of the screw.
2. Remove the wiring compartment cover from the front of the BMS II (see Figure 1-1) to provide access to the slots for the two lower mounting screw locations.
3. Hang the BMS II on the installed top screw. Position the unit so it is level.
4. Mark the locations for the two lower screws.
5. Remove the BMS II and drill two pilot holes for the lower screws.
6. Replace the BMS II on the installed top-center screw.
7. Secure the BMS II to the wall by installing the two lower screws. DO NOT over-tighten the screws.

INSTALLATION



REAR VIEW

Figure 2-1. BMS II Mounting Provisions

2.3 GENERAL WIRING REQUIREMENTS

All wiring connections to the BMS II are made at the terminals located behind the wiring compartment cover as shown in Figure 2-2. Run all wiring through the knock-outs provided on the bottom surface of the unit. Shielded, twisted-pair cable should be used for sensor and communication wiring. This wiring should be 18 to 24 AWG. Examples of suitable sensor and communication wire are: Belden 9841, 8761, 3105A or equivalent. AC power wiring should be 14 to 18 AWG. The BMS II wiring diagram is provided in Appendix E. Once mounting is complete and the BMS is secured in place, loosen the two captive screws on the wiring compartment cover using a Phillips screwdriver. Feed all wiring through the knock-outs provided on the bottom of the panel.

NOTE


Refer to the wiring diagram provided in Appendix E when making all wiring connections to the BMS II.

WARNING

THE BMS II CAN BE POWERED BY SINGLE-PHASE AC VOLTAGES RANGING FROM 85 TO 265 VAC. THEREFORE, EXERCISE EXTREME CARE WHEN CONNECTING POWER WIRING TO THE UNIT. ENSURE THAT THE EXTERNAL CIRCUIT BREAKER SUPPLYING LINE VOLTAGE TO THE BMS II IS TURNED OFF TO AVOID SEVERE ELECTRICAL SHOCK.

2.4 POWER WIRING

Use 14 to 18 AWG wire for AC power connections and proceed as follows:

1. Feed the power wiring through the right-most knock-out in the bottom of the panel enclosure (Figure 2-2).
2. Connect the Line (black), Neutral (white) and Ground (green) wire leads to the L, N and  (GND) terminals. The terminal blocks can be detached from the BMS II headers if necessary to simplify field wiring connections.
3. Following completion of power wiring, turn on the external circuit breaker or switch and apply power to the unit. The BMS II display will momentarily show:

**AERCO BMSII
REV X.XX**

(Where: X.XX represents the revision level of the installed BMS II software)

4. Next, since the Header Sensor is not yet installed, the display will then show:

**HEADER TEMP
SENSOR ERROR**

The red FAULT LED indicator will also light and a fault message will alternately be displayed as follows:

**HEADER SENSOR
ERROR**

5. Press the ON-OFF key on the keypad. The green ON LED indicator will light and the BMS II display will continue to show the above message.
6. After verifying proper power connections, press the ON-OFF key. The ON LED will turn off.
7. Turn off the external power switch and/or circuit breaker. The BMS II display will go blank.
8. DO NOT apply power to the BMS II until all of the required external connections described in paragraphs 2.5 through 2.11 have been completed.

INSTALLATION

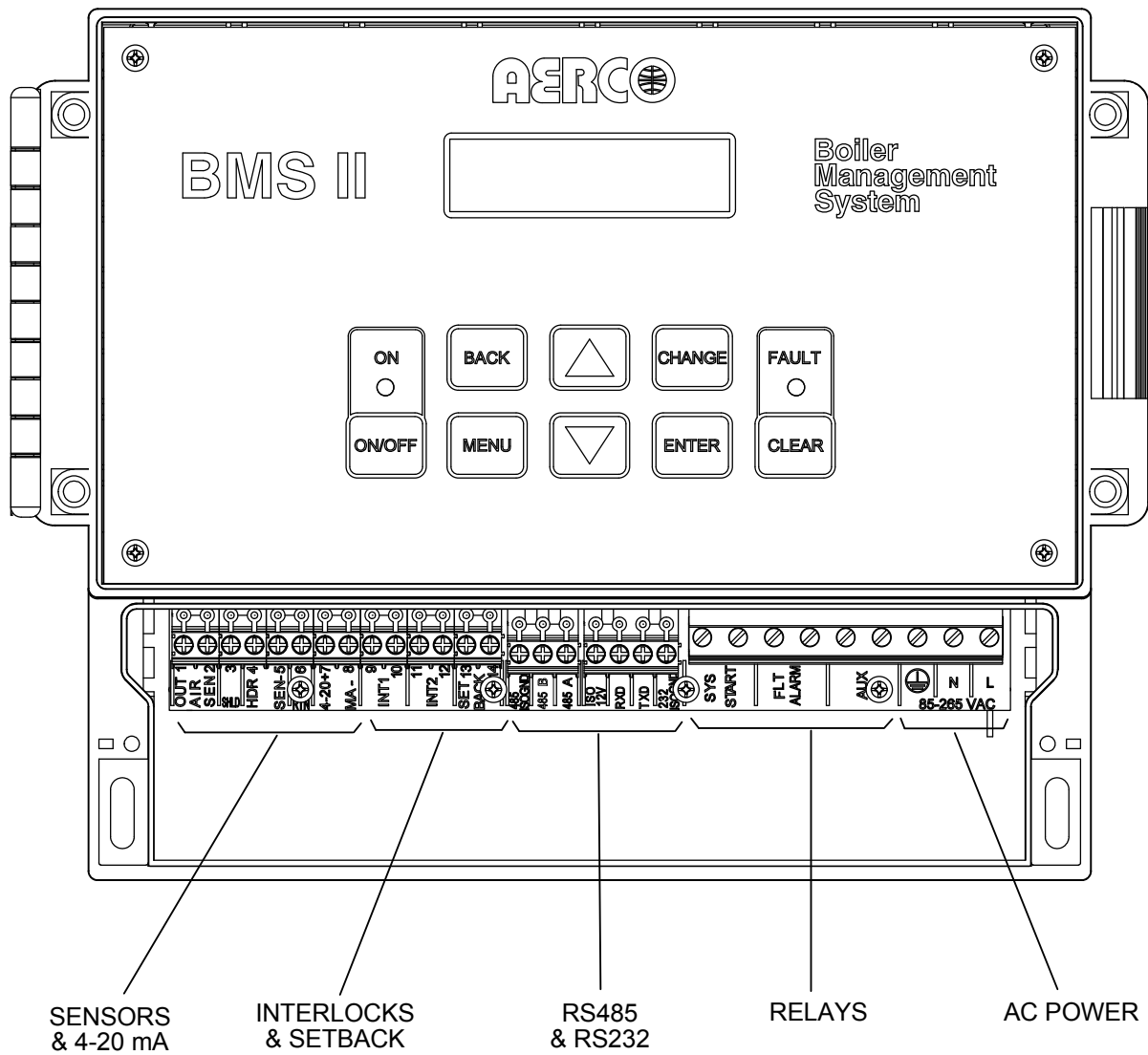


Figure 2-2. BMS II With Wiring Compartment Cover Removed

2.5 SENSOR INSTALLATION AND WIRING

There are two types of sensors that can be installed: a Header Sensor and an Outside Air Sensor. If desired, an optional Return Sensor can also be installed. The Return Sensor is the same type and part number as the Header Sensor, however it is only used for external monitoring purposes. The Header Sensor is required for all modes of operation. The Outdoor Air Sensor is required for operation in the Outdoor Reset Mode.

All Sensor wiring should be run separately from power wiring to avoid inducing electrical noise on the sensor wiring.

Header Sensor

A Header Sensor Kit, (part no. 122790) is provided with the BMS II. This Kit contains the Header Sensor (64038), a Thermowell (122758) and some heat conductive grease which **MUST** be used with the Sensor. When installing the Sensor, use a 1/2 inch NPT tapped coupling or a 4 x 4 x 1/2 inch Tee fitting. Shielded pair, 18 AWG cable (Belden # 8760 or equiv.) is recommended for Header Sensor wiring. The Header Sensor must be installed between 2 and 10 feet downstream of the LAST boiler in the boiler plant's supply water header. Install the Header Sensor as follows:

NOTE

The Header Sensor is a thermistor type sensor. The Resistance vs. Temperature Chart for this sensor is provided in Appendix D. The length of the Header Sensor wire leads should not exceed 600 feet.

1. Refer to Figure 2-3 for the Header Sensor installation details.
2. Install the Header Sensor and Thermowell into the 1/2 inch NPT tapped coupling or a 4 x 4 x 1/2 inch Tee fitting using heat-conductive grease provided. This will aid in its response.
3. For proper response, ensure that the Header Sensor probe is inserted at least 2 inches into the water flow.
4. Using shielded pair cable (Belden #8760 or equiv.) connect the Header Sensor leads to HDR SEN terminals 4 and 5 on the BMS II. There is no polarity to observe when making these connections.
5. Terminate the cable shield at SHLD terminal 3 of the BMS II. **DO NOT** terminate the shield at the Sensor end of the cable.

Return Sensor

As mentioned in paragraph 2.5, the Return Sensor is identical to the Header Sensor. Therefore, if a Return Sensor is being installed, another Header Sensor Kit (part no. 122790) is required. The Return Sensor should be installed in the boiler water return line within 3 feet of the first boiler in the boiler plant's return water line. The installation details shown in Figure 2-3 for the Header Sensor also apply to the Return Sensor. If used, install the Return Sensor as follows:

1. Refer to Figure 2-3 and install the Return Sensor and Thermowell into the 1/2 inch tapped coupling or Tee fitting using heat conductive grease.
2. Using shielded pair cable (Belden #8760 or equiv.) connect the Return Sensor leads to terminals 6 and 5 on the BMS II. There is no polarity to observe when making these connections.
3. Terminate the cable shield at SHLD terminal 3 of the BMS II. **DO NOT** terminate the shield at the Sensor end of the cable.

INSTALLATION

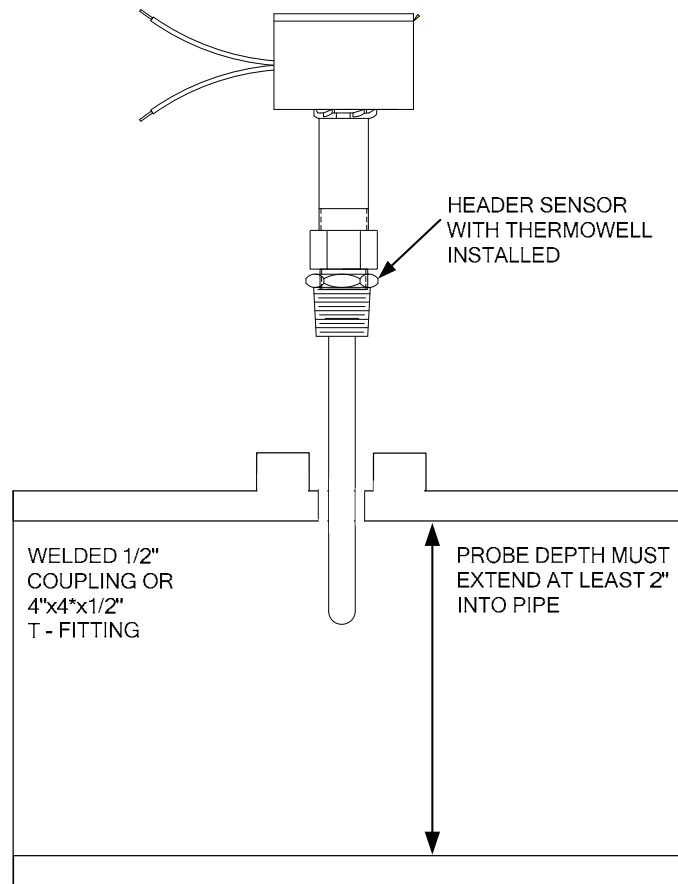


Figure 2-3. Header Sensor Installation Details

Outdoor Air Sensor

The Outdoor Air Temperature Sensor (part no. GP-122662) is required when operating in the BMS II in the Outdoor Reset Mode (paragraph 4.2). An Outdoor Air Sensor Kit (part no. GM-122781) is also available. This kit contains the Sensor (GP-122662) and a Mounting Bracket for wall mounting. The Outdoor Air Sensor should be mounted on the North side of the building, shielded from direct sunlight, and away from air intakes or outlets from the building. Shielded pair 18 AWG cable (Belden # 8760 or equiv.) is recommended for sensor wiring. The Outdoor Air Sensor can be mounted up to 600 feet from the BMS II.

NOTE

The Outdoor Air Sensor is a thermistor type sensor. The Resistance vs. Temperature Chart for this type of sensor is provided in Appendix E. The length of the Header Sensor wire leads should not exceed 600 feet.

1. Refer to Figure 2-4 for a typical Outdoor Air Sensor installation.
2. Attach the sensor to the mounting bracket and secure the bracket in a suitable location on the North side of the building.
3. Using shielded pair cable (Belden #8760 or equiv.), connect the two Sensor leads to terminals 1 and 2 on the BMS II. There is no polarity to observe when connecting the sensor.

INSTALLATION

4. Terminate the cable shield at SHLD terminal 3 of the BMS II. DO NOT terminate the shield at the Sensor end of the cable.

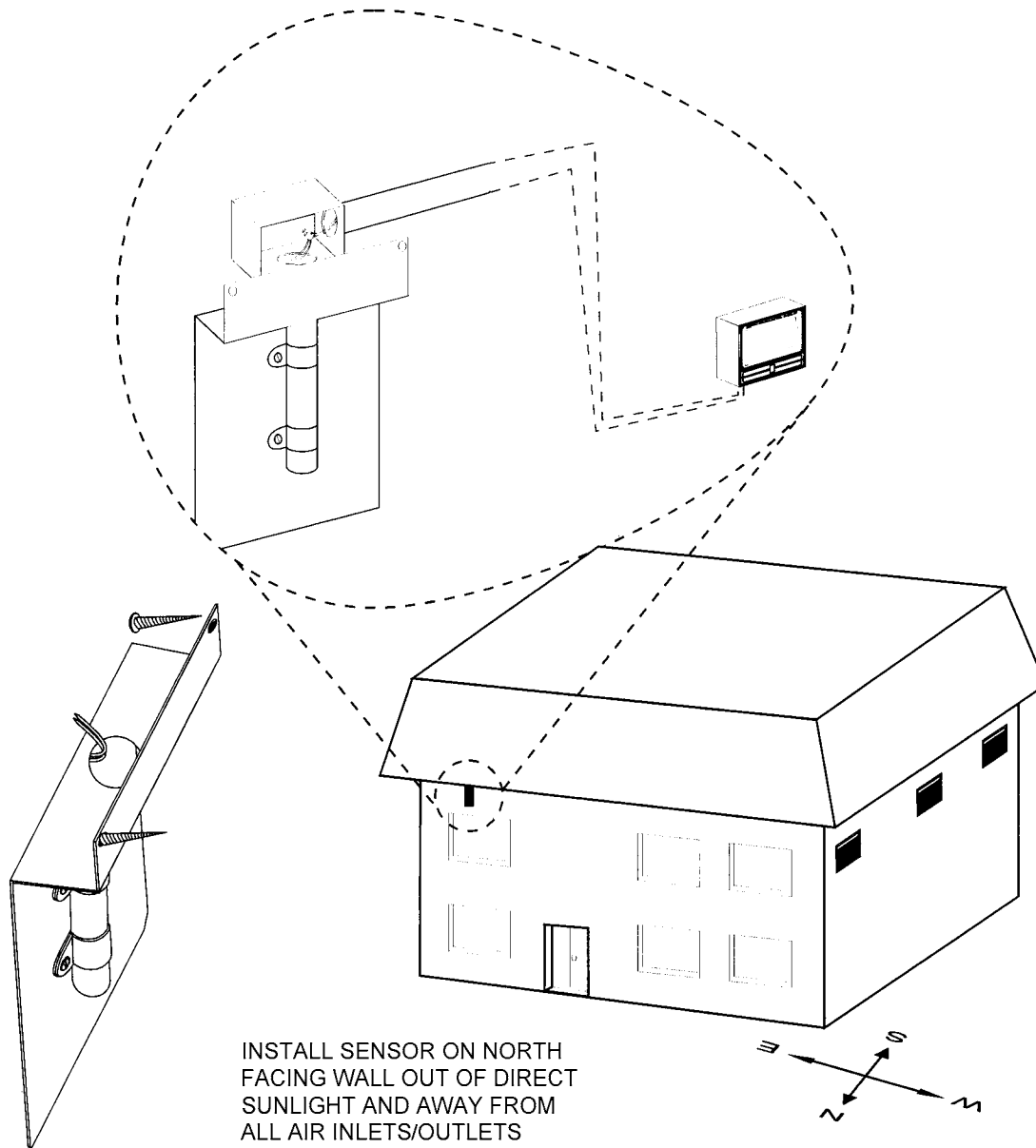


Figure 2-4. Outdoor Air Sensor Installation

INSTALLATION

2.6 RS485 (MODBUS) WIRING AT THE BMS II

The BMS II communicates with the AERCO Boilers over a RS485 network using Modbus protocol. All Modbus networks are implemented utilizing a Master/Slave scenario where only one device, the Master, can initiate a communication sequence. AERCO Boilers equipped with C-More or E8/BCM (Modulex) control systems can only function as Slaves on a Modbus network. However, the BMS II can function as a Master controlling C-More or E8/BCM Boiler Slaves, or as a Slave controlled by an Energy Management System (EMS) developed by other manufacturers. Additional information on implementing Modbus networks is provided in AERCO Modbus Communication Manual GF-114.

RS485 (Modbus) networks are wired in a “daisy chain” configuration similar to the example shown in Figure 2-5. Shielded twisted-pair, 18 – 24 AWG cable (Belden #98421, #3105A, #8760 or equiv.) is recommended for RS485 wiring connections.

At the BMS II, wiring connections are made at the terminals labeled 485 B+ and 485 A-.

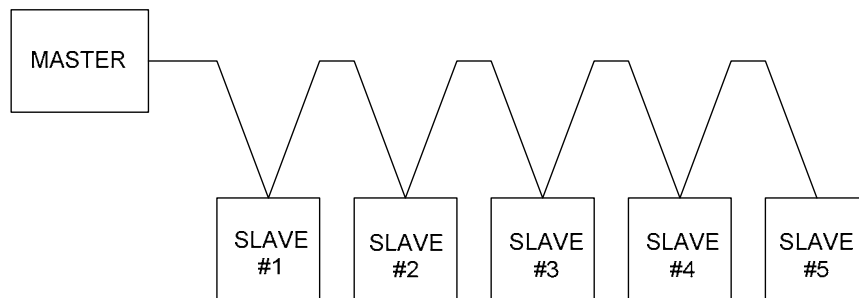


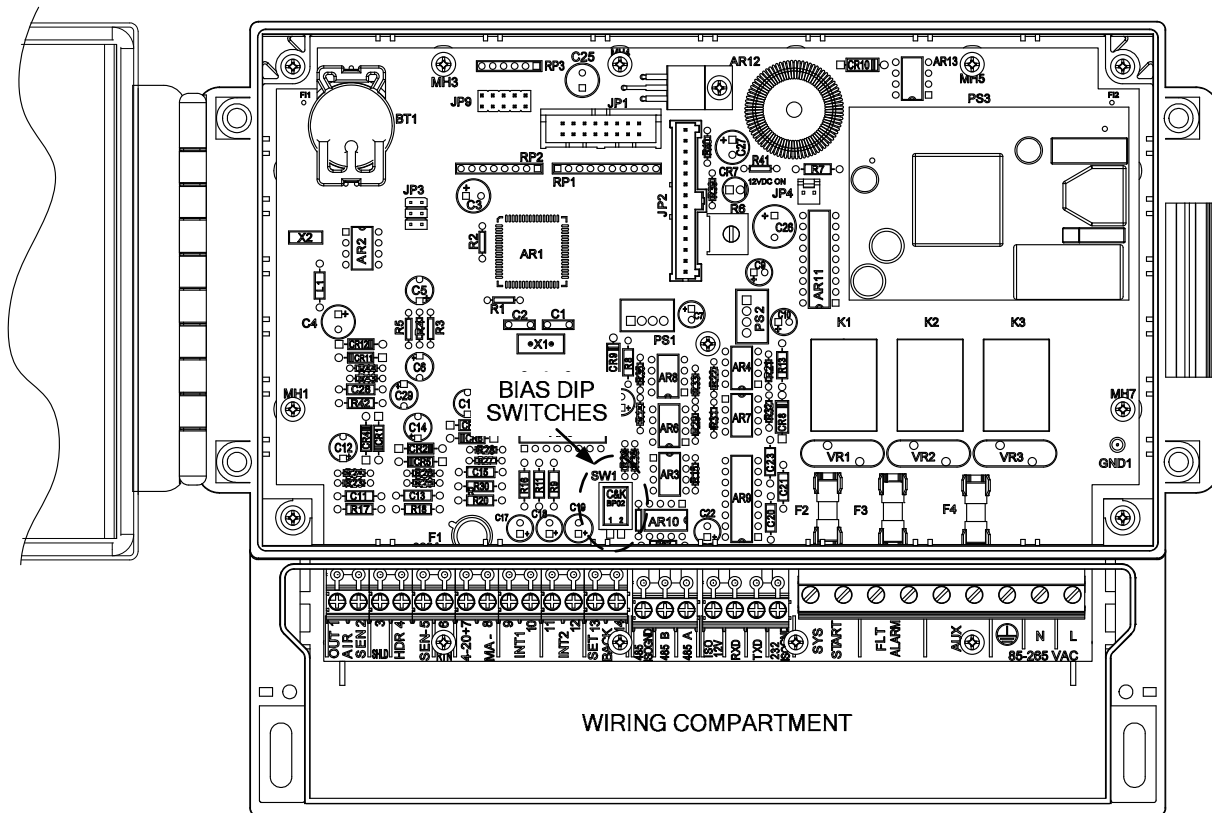
Figure 2-5. Typical Daisy-Chain Modbus/RS485 Network

At the BMS II, RS485 (Modbus) wiring connections are made at the wiring terminals labeled **485 B+** and **485 A-**. The cable shield is terminated at the **SHLD** terminal (3) of the BMS II.

BMS II Bias Switches

The BMS II contains two bias DIP switches which are mounted on the lower portion of the motherboard (Figure 2-6). These switches are used to activate or deactivate bias voltage on the RS485 network and should be positioned as follows:

1. When wiring to BCMs controlling Modulex Boilers, the BMS II bias switches must be turned on (down).
2. When wiring to C-More control systems (Benchmark & KC1000 Boilers), the BMS II bias switches must be turned off (up). Bias on the network is provided by activating switches in the last C-More Controller on the daisy-chain loop.



NOTE:
THE BIAS DIP SWITCHES CAN BE ACCESSED
FROM THE WIRING COMPARTMENT WITHOUT
REMOVING THE FRONT PANEL FROM THE UNIT.

Figure 2-6. Location of BMS II DIP Switches

2.7 RS485 (MODBUS) WIRING AT THE AERCO BOILERS

The RS485 wiring connections at the AERCO Boilers will depend on the type of AERCO Boilers and Control Systems being used on the Modbus Network. Benchmark Series and KC1000 Boilers currently utilize C-More Control Systems. Modulex Series Boilers utilize Boiler Control Modules (BCMs) with E8 Controllers.

RS485 Wiring for Benchmark Series and KC1000 Boilers

RS485 wiring connections are made at the RS485 COMM terminals of each boiler's I/O Box as shown in Figures 2-7 (Benchmark) and Figure 2-8 (KC1000). Connect the wiring as follows:

1. Connect the positive lead to the + terminal
2. Connect the negative lead to the - terminal

INSTALLATION

3. DO NOT terminate the shields to the Ground (**G**) terminal at the Boiler end of the RS485 loop. Connect the shields of the incoming and outgoing leads together. The RS485 loop shield should only be terminated at terminal 3 of the BMS II.
4. Activate the BIAS1, BIAS2 and TERM switches on the last boiler in the daisy-chain loop.
5. DO NOT activate the bias switches on the BMS II.

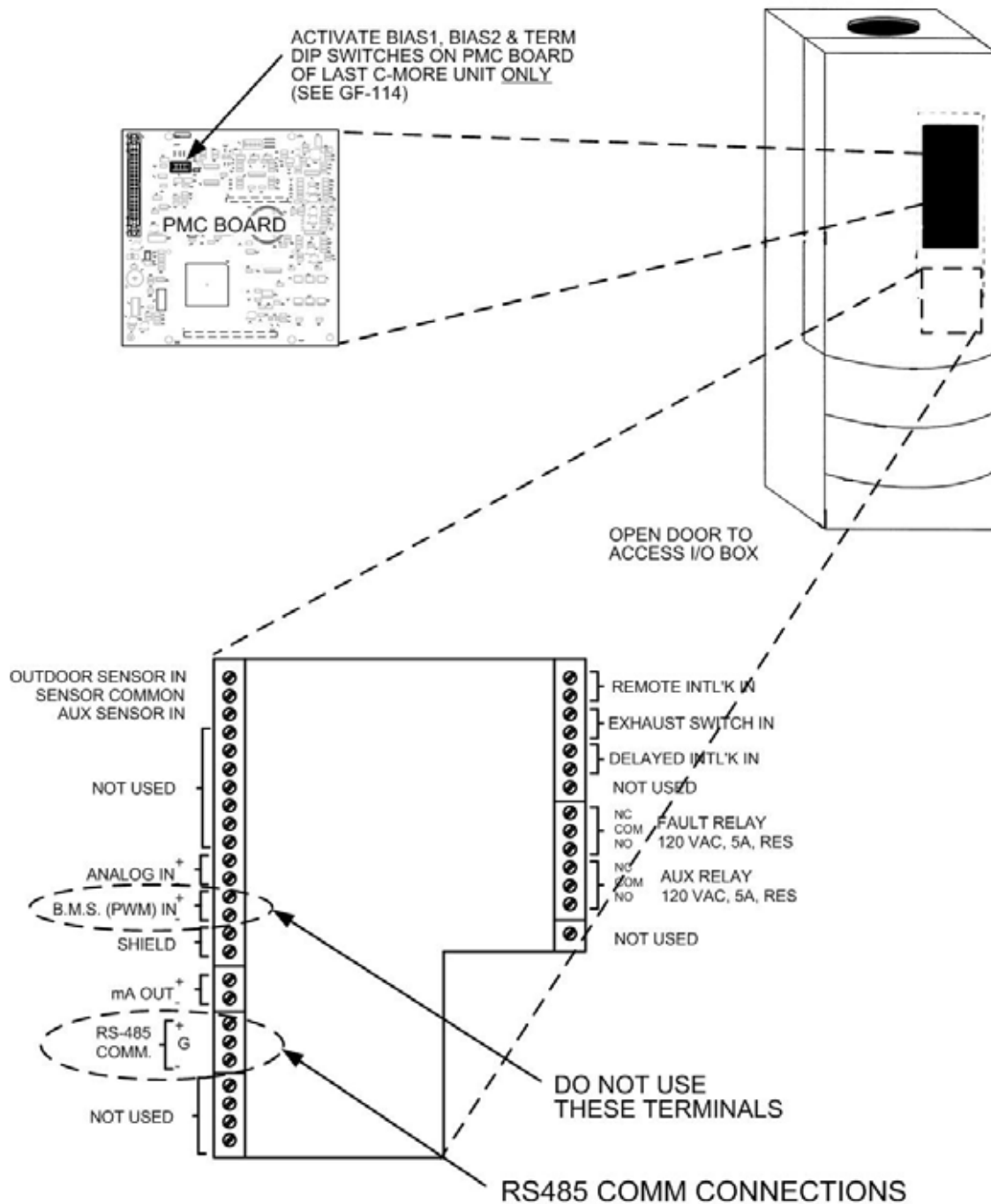


Figure 2-7. RS485 (Modbus) Wiring For Benchmark Series Boilers

INSTALLATION

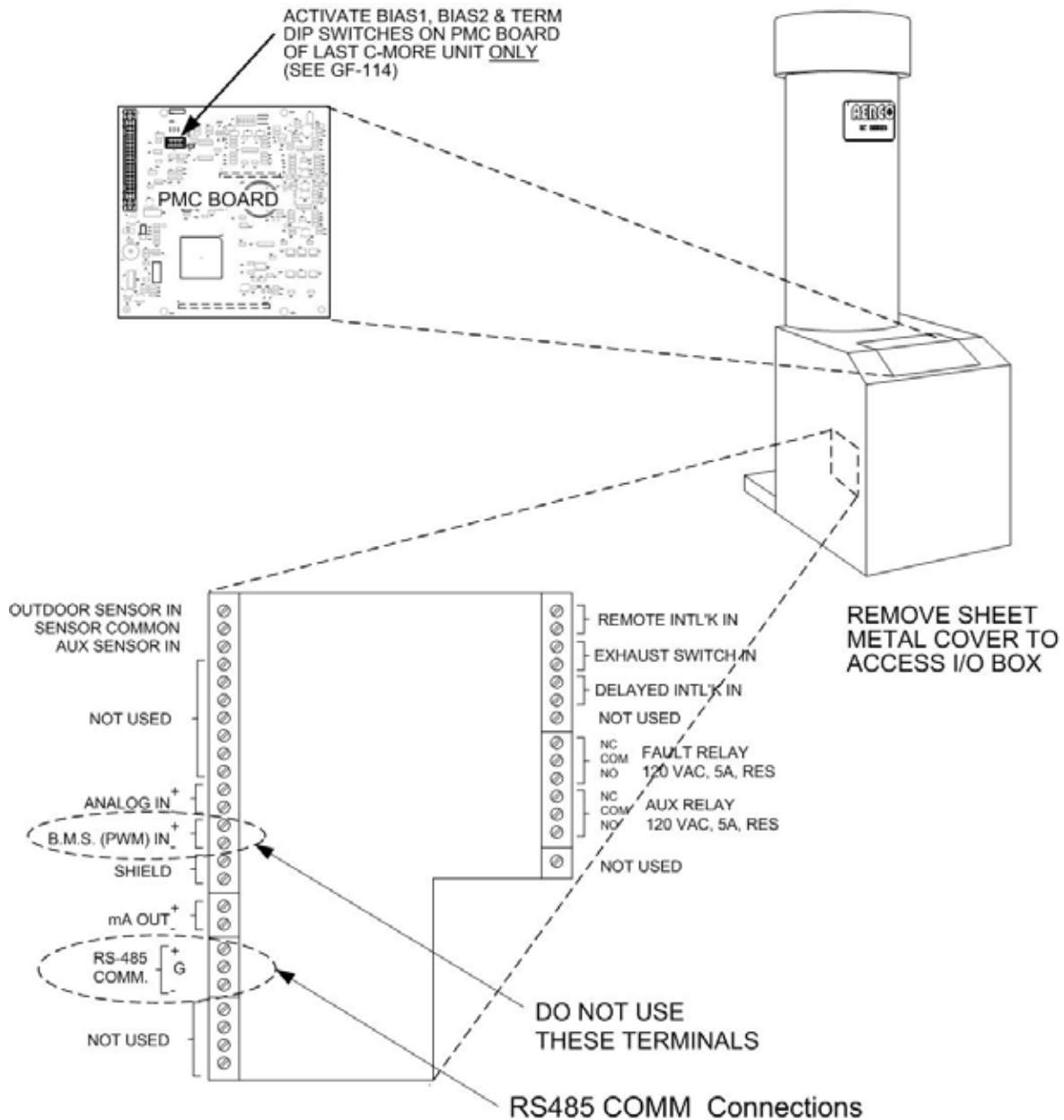


Figure 2-8. RS485 (Modbus) Wiring For KC1000 Boilers

RS485 Wiring for Modulex Series Boilers

RS485 wiring connections are made at the MODBUS terminals of each Boiler's BCM Module as shown in Figure 2-9. Connect the wiring as follows:

INSTALLATION

1. Connect the positive lead to terminal **1** (MODBUS B +) of connector Y2.
2. Connect the negative lead to terminal **2** (MODBUS A -) of connector Y2.
3. DO NOT terminate the shields at the Boiler end of the RS485 loop. Connect the shields of the incoming and outgoing leads together. The RS485 loop shield should only be terminated at the BMS II.
4. The last BCM in the daisy-chain must have the termination jumper engaged as shown in Figure 2-9.
5. The BMS II bias switches must be activated.

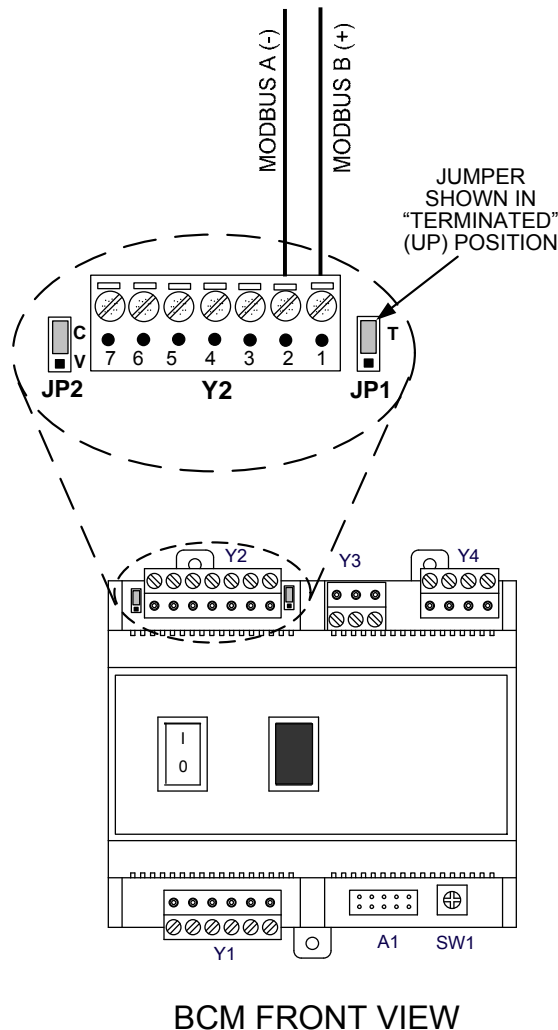


Figure 2-9. RS485 (Modbus) Wiring For Modulex Series Boilers

2.8 SAMPLE RS485 (MODBUS) NETWORK DIAGRAMS

Figure 2-10 shows a sample RS485 (Modbus) Network diagram with the BMS II connected to KC1000 or Benchmark Series Boilers equipped with C-More Control Systems. Figure 2-11 shows a similar sample diagram with the BMS II connected to Modulex Series Boilers equipped with BCMs and E8 Controllers.

INSTALLATION

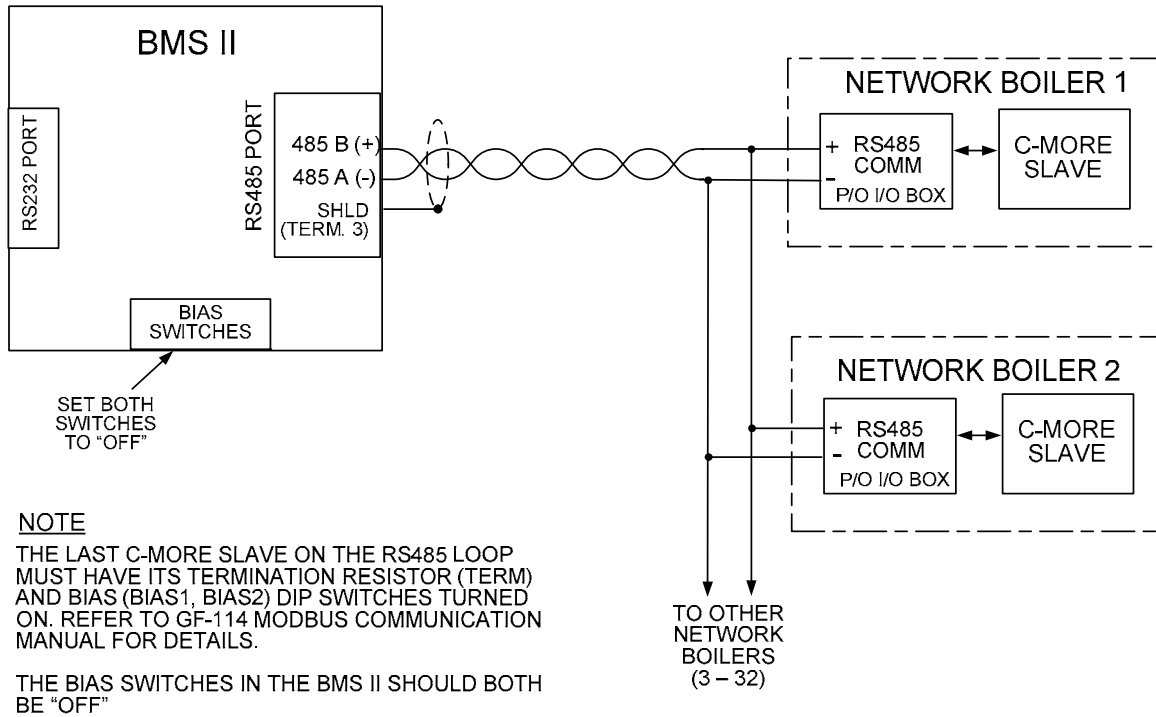


Figure 2-10. Sample RS485 (Modbus) Network For Benchmark or KC1000 Boilers

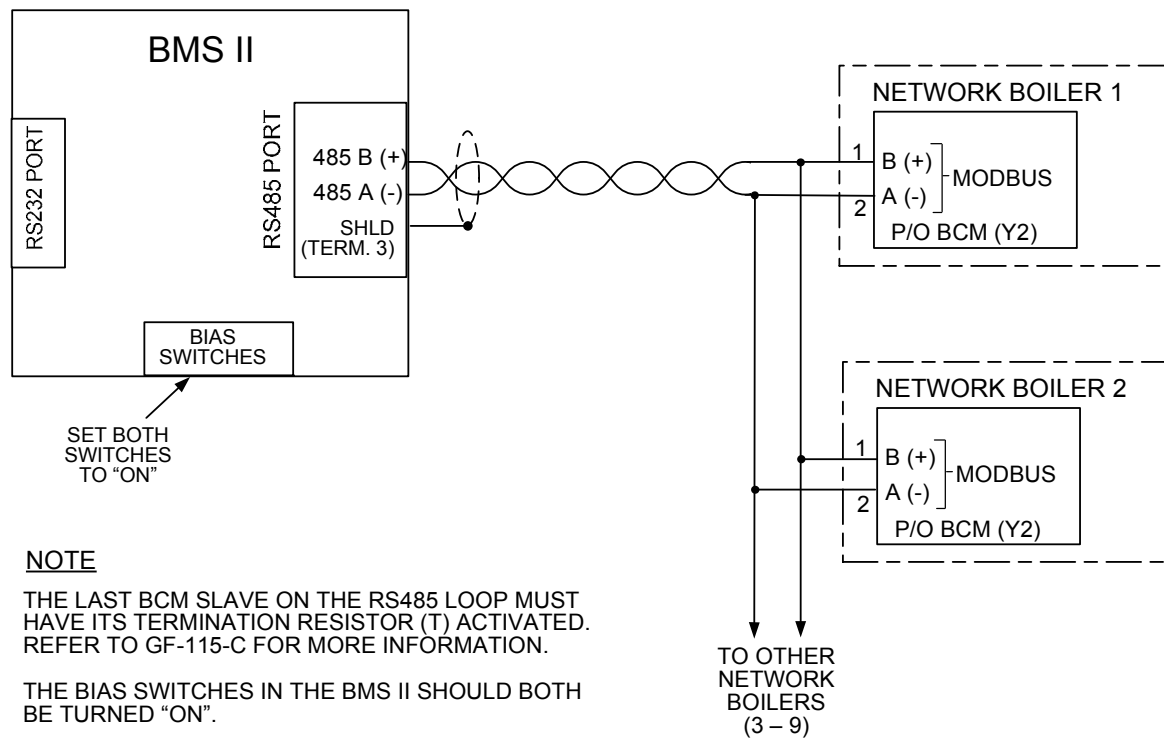
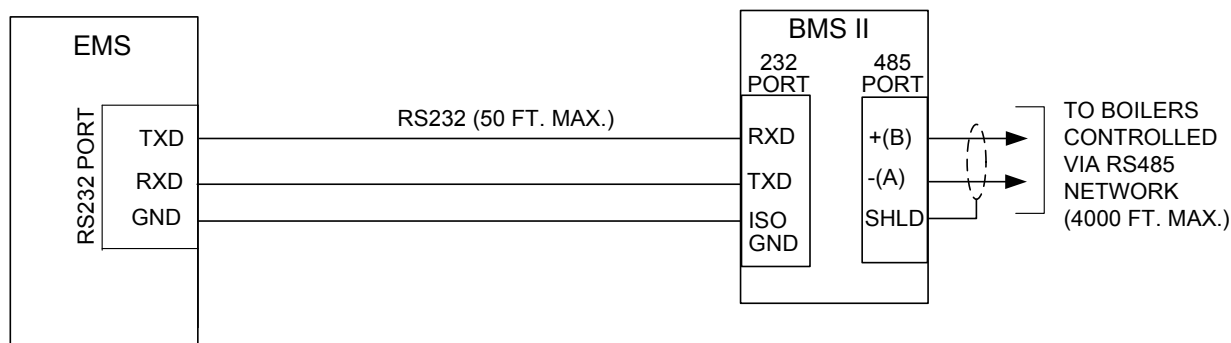


Figure 2-11. Sample RS485 (Modbus) Network For Modulex Series Boilers

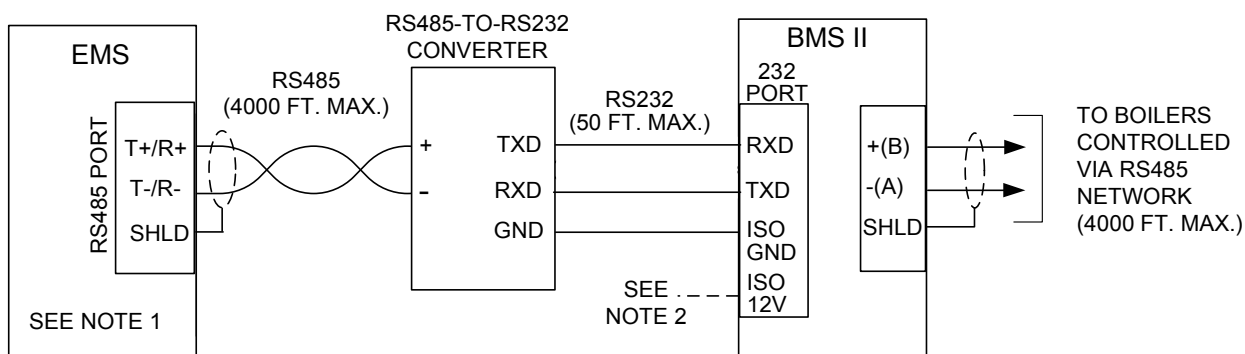
INSTALLATION

2.9 RS232 WIRING AT THE BMS II

The BMS II communicates with an external Energy Management System (EMS) or Building Automation System (BAS) utilizing the wiring terminals labeled **RXD** (Receive Data), **TXD** (Transmit Data) and **232 ISO GND** (Isolated Ground). If the EMS does not contain an RS232 port, a RS485-to-RS232 Converter (AERCO Part No. 124943) is required to communicate with the BMS II. If a Converter is required, it can be installed inside the wiring compartment of the BMS II, or installed externally. The BMS II provides an isolated 12 VDC output terminal (**ISO 12V**) which can be used to power AERCO's RS485-to-RS232 Converter if needed. Refer to Figure 2-12 for sample network layouts.

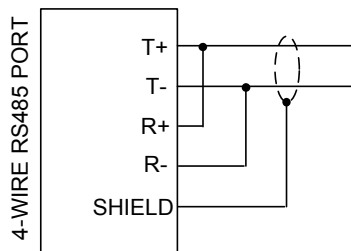


EMS WITH RS232 PORT



NOTES:

1. IF THE EMS CONTAINS A 4-WIRE RS485 PORT, SEE DETAIL "A".
2. THE BMS II PROVIDES A 12V OUTPUT IF NEEDED TO POWER THE RS485-TO-RS232 CONVERTER.



DETAIL "A"

EMS WITH ONLY RS485 PORT

Figure 2-12. Sample Network Connections To EMS

2.10 INTERLOCK WIRING

The BMS II is equipped with two interlocks designated Interlock 1 (INT 1) and Interlock 2 (INT 2). Since both interlocks must be closed for the BMS to operate the boiler plant, the associated wiring terminals are jumpered, prior to shipment. If desired, proving device switches can be connected to either interlock in place of the jumper. If used, interlock wiring connections are made as described in the following paragraphs.

CAUTION

DO NOT remove the factory-installed jumpers for INT1 or INT2 unless the respective Interlock is being connected to an external proving device. The boiler plant WILL NOT operate if one or both Interlocks remain open.

NOTE

If necessary, Interlock 1, Interlock 2 or both can be programmed to operate the boilers only when the outdoor air temperature falls below the system start temperature. The selection is made with "SYS START INTLK" in the Relay Menu. The default is set to Interlock 1. See paragraph 3.11 for details.

Interlock 1 (INT 1) Wiring

Interlock 1 is often used with auxiliary equipment, such as air dampers or flow switches. It can also be used as a general purpose interlock. If used, connect the end proving switch to INT 1 terminals 9 and 10 as shown in the wiring diagram in Appendix E.

Interlock 2 (INT 2) Wiring

Similar to Interlock 1, Interlock 2 is a general purpose interlock which can be used with a variety of devices or equipment or conditions that must be "proved" prior to enabling the boiler plant. If used, connect the end proving switch to INT 2 terminals 11 and 12 as shown in the wiring diagram in Appendix E.

2.11 SET BACK WIRING

The **SET BACK** terminals, shown in the wiring diagram in Appendix E, are used only when implementing a manually-controlled header temperature offset. If used, connect a dry contact switch across **SET BACK** terminals 13 and 14. See the sub-section entitled Manual Offset included in paragraph 3.8 (Field Adjust Menu),

2.12 RELAY WIRING

The BMS contains a System Start (SYS START) Relay, a Fault Alarm (FLT ALARM) Relay and an Auxiliary (AUX) Relay which can be connected to external monitoring or control devices. The contacts for each of these relays are rated at 120 VAC, 5A and are fused internally at 5A with replaceable fuses. The contact terminals for these relays are shown in the wiring diagram in Appendix E.

INSTALLATION

NOTE

The state of the SYS START, FLT ALARM and AUX Relays are controlled by options contained in the Relay Menu described in Chapter 3, paragraph 3.11.

System Start Relay

The state of the System Start (SYS START) relay contacts are controlled by the value set for the SYS START TEMP and SYS START OPTION in the Relay Menu. The contacts are closed either when the outdoor air temperature is less than the System Start Temperature (SYS START TEMP) or when there is a load, or both. The default value for this temperature setting is 70°F. See paragraph 4.5 for additional information.

Fault Alarm Relay

The state of the Fault Alarm (FLT ALARM) relay contacts are controlled by the option selected for the FAULT ALRM RELAY, FAULT ALARM BLR and FAULT ALRM CLEAR in the Relay Menu. Contact closure can be set to: ALL FAULTS, NO INTERLOCK, INTERLOCK 2 or INTERLOCK 1. The default for this option is ALL FAULTS.

Auxiliary Relay

The state of the Auxiliary (AUX) relay contacts are controlled by the AUX RELAY CLOSE and AUX RELAY OPEN options selected in the Relay Menu. Contact closure can be set to occur either when all available boilers are at the 100% Fire Rate or for either when all boilers are at 100% Fire Rate or no boilers are available (all boilers faulted or turned off).

2.13 4 – 20 MA WIRING

The BMS II can accept a remote 4 – 20 mA current signal representing a setpoint. This input is fused internally at 0.63A. Connect the signal leads to the 4-20 + and 4-20 – terminals. Refer to Chapter 4, paragraph 4.3 for Remote Setpoint programming using a 4 -20 mA input.

CHAPTER 3 - OPERATION

3.1 INTRODUCTION

The information in this Chapter provides a guide to the operation of the BMS II using the controls and display mounted on the front panel of the unit. This Chapter describes the basic procedure to navigate through the extensive array of menus and options incorporated in the BMS II design. Descriptions for all menus and options are also provided.

3.2 FRONT PANEL OPERATING CONTROLS AND DISPLAYS

The front panel of the BMS II contains an vacuum fluorescent display (VFD) and an 8-key touch-pad. The display and controls are illustrated and described in Figure 3-1 and Table 3-1 respectively.

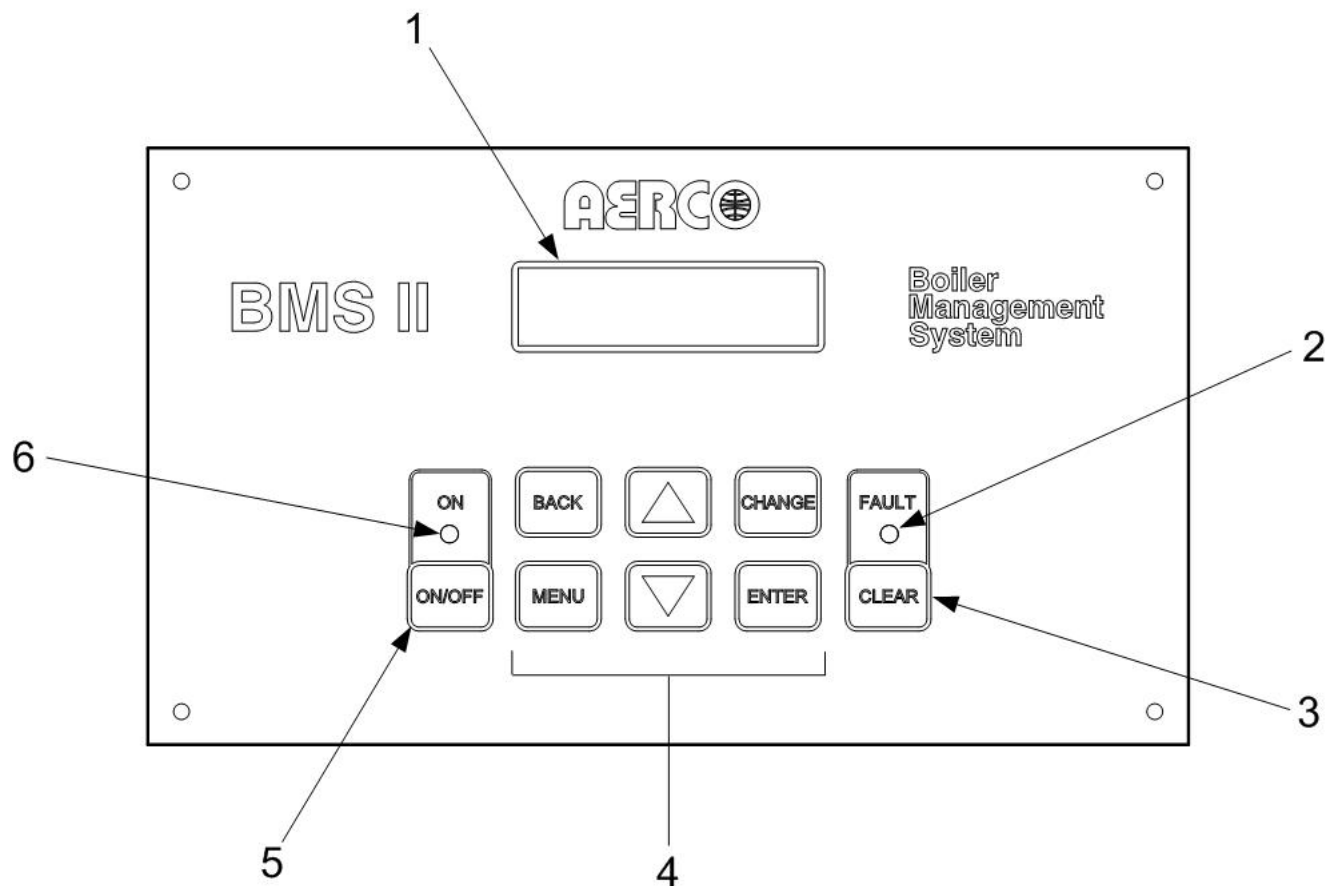


Figure 3-1. BMS II Front Panel Controls and Displays

OPERATION

Table 3-1. BMS II Front Panel Controls and Displays

ITEM NO.	CONTROL, INDICATOR OR DISPLAY	FUNCTION
1	VFD Display	The Vacuum Fluorescent Display (VFD) display consists of 2 lines each capable of displaying up to 16 alphanumeric characters. The information displayed includes: <ul style="list-style-type: none"> • Startup Messages • Alarm Messages • Operating Status Messages • Menu Selections
2	FAULT Indicator	Red FAULT LED indicator lights when a BMS II alarm condition occurs. An alarm message will also appear in the VFD display.
3	CLEAR Key	Turns off the FAULT indicator and relay if FAULT ALRM CLEAR is set to Manual and the fault is still active or no longer active. If FAULT ALRM CLEAR is set to Automatic and the fault is still active, this will also turn off the fault relay and indicator. In both cases the alarm message will remain until the alarm is no longer valid.
4	<u>MENU Keypad</u> MENU BACK	Consists of 6 keys which provide the following functions for the BMS II menus: Steps through the main menu categories shown in Figure 2-1. The Menu categories wrap around in the order shown. Allows you to go back to the previous menu level without changing any information. Continuously pressing this key will bring you back to the default status display in the Operating Menu. Also, this key allows you to go back to the top of a main menu category.
	▲ (Up) Arrow	When in one of the main menu categories, pressing this key will move you forward through the displayed menu category. If the CHANGE key was pressed and the menu item is flashing, press the ▲ arrow key increment the setting.
	▼ (Down) Arrow	When in one of the main menu categories, pressing this key will select the displayed menu category. If the CHANGE key was pressed and the menu item is flashing, pressing the ▼ (Down) arrow key will decrement the selected setting.
	CHANGE	Permits a setting to be changed (edited). A valid password must be entered before changing most menu items. When the CHANGE key is pressed, the displayed menu item will alternate in color with the background (reverse video). Pressing the ▲ or ▼ arrow key when this occurs will increment or decrement the displayed setting.
	ENTER	Saves the modified menu information in memory. The display will return to the normal state.
5	ON/OFF Key	Enables and disables BMS II operation.
6	ON Indicator	Green ON LED lights when the BMS II is enabled.

3.3 **BMS II MENU STRUCTURE**

The BMS II incorporates an extensive menu structure which permits the operator to set up, and configure the unit. The menu structure consists of nine major menu categories as shown in Figure 3-2. Each of the menus shown, contain options which permit operating parameters to be viewed or changed. The menus are protected by two different password levels to prevent unauthorized use. These passwords provide access as follows:

- Password Level 1 (159) allows viewing of all menu categories. In addition, this Password Level allows all Menu options to be changed, except for Calibration Menu options.
- Password Level 2 (6817) allows viewing and changing of the options contained in the Calibration Menu. In addition, it allows all Level 1 menu categories to be viewed or changed. The Calibration Menu should only be used by factory-trained personnel.

Prior to entering the correct password, the options contained in all of the Menu categories (except the Calibration Menu) can be viewed. However, except for Internal Setpoint Temperature (Field Adjust Menu), none of the viewable menu options can be changed.

Once the valid Level 1 (159) or Level 2 (6817) password is entered, the options listed in the available menus can be viewed and changed, if desired.

Menu Processing Procedure

Accessing each menu and option is accomplished using the Menu Keys shown in Figure 3-1. Therefore, it is imperative that you be thoroughly familiar with the following basic steps before attempting to perform specific menu processing procedures.

1. The BMS II will normally be in the Operating Menu and the VFD will display the current unit status. Pressing the ▲ or ▼ arrow key will display the other available data in the Operating Menu.
2. Press the **MENU** key. The display will show the Setup Menu which is the next menu category shown in Figure 3-2. This menu contains the Password option which must be entered if other menu options will be changed.
3. Continue pressing the **MENU** key until the desired menu is displayed.
4. With the desired menu displayed, press the ▲ arrow key. The first option in the selected menu will be displayed.
5. Continue pressing the ▲ or ▼ arrow key until the desired menu option is displayed. Pressing the ▲ arrow key will display the available menu options in the Top-Down sequence. Pressing the ▼ arrow key will display the options in the Bottom-Up sequence. The menu options will stop when the last option is reached, going forward, or the first option is reached, going backwards. They do not wrap-around after the first or last available option.
6. To change the value or setting of a displayed menu option, press the **CHANGE** key. The displayed option will appear in reverse video. Press the ▲ or ▼ arrow key to scroll through the available menu option choices for the option to be changed. The menu option choices do not wrap around.
7. To select and store a changed menu option, press the **ENTER** key.

OPERATION

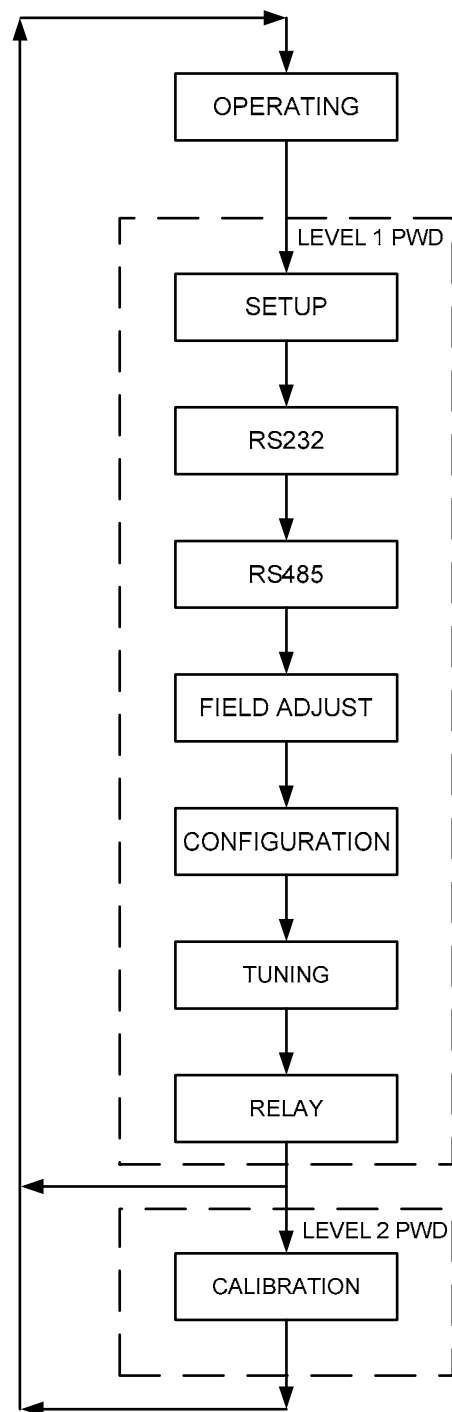


Figure 3-2. BMS II Menu Structure

NOTE

Paragraphs 3.4 through 3.12 provide detailed descriptions of the options contained in each of the menus shown in Figure 3-2. The menu options appear in the first line of the VFD display and the corresponding value or setting for the displayed option will appear in the second line of the display.

Refer to Appendix A for tabular summaries of all menu options showing the allowable entry ranges and default values,

3.4 OPERATING MENU

The Operating Menu displays a number of key operating parameters for the BMS II: These parameters include:

HEADER TEMP, HEADER SETPOINT, OUTSIDE AIR TEMP, PERCENT OF LOAD, I/O STATUS and RETURN TEMP.

All of the items in this menu are “Read-Only” and do not allow personnel to change or adjust any of the displayed parameters. Since this menu is “Read Only”, it can be viewed at any time without entering a password. The Operating Menu options are described in the paragraphs which follow.

HEADER TEMP and PERCENT OF LOAD

The *HEADER TEMP* menu option displays the actual water temperature (°F) measured by the Header Sensor connected to HDR SEN terminals 4 and 5 of the BMS II. If the Header Sensor is not installed, *HDR SENS ERROR* will appear in the first line of the display. The red **FAULT** indicator will also light. The Header Sensor **MUST** be installed for the BMS II to operate properly.

The *PERCENT OF LOAD* option shows the percent level going from the BMS II to each boiler in the boiler plant. It also shows the number of boiler units that are operating.

HEADER SETPOINT

This menu option is the setpoint temperature to which the control is set when operating in the Constant Setpoint, Remote Setpoint or Outdoor Reset Mode. When in the Constant Setpoint Mode, this value is equal to the Internal Setpoint setting in the Configuration Menu. When in the Remote Setpoint Mode, this value is the setpoint equivalent to the remote analog signal or Modbus value supplied to the unit. When in the Outdoor Reset Mode, this is the derived value from the charts in Appendix D.

OUTSIDE AIR TEMP

The *OUTSIDE AIR TEMP* option shows the outdoor air temperature (°F) measured by the Outdoor Air Sensor. This sensor is connected to OUT AIR SENS terminals 1 and 2 of the BMS II. If the Sensor is not connected, the second line of the display will show *NOT CONNECTED*. The Outdoor Air Sensor **MUST** be connected when operating in the Outdoor Reset Mode.

OPERATION

I/O STATUS

I/O (Input/Output) *STATUS* is displayed as a hexadecimal number. The meaning of each bit is as indicated below. The higher 4 bits, or most significant digit (MSD), indicate which inputs are activated. The lower 4 bits, or least significant digit (LSD), indicate which relay outputs are activated.

MSD: Bit 7 =(empty)
Bit 6 = Interlock 1
Bit 5 = Interlock 2
Bit 4 = Setback
LSD: Bit 3 = (empty)
Bit 2 = Sys Start Relay
Bit 1 = Fault Relay
Bit 0 = Aux Relay

RETURN TEMP

The *RETURN TEMP* (°F) option is displayed only if an optional Return Sensor is installed in the boiler water return line. When installed, it is connected to terminals 5 and 6 on the BMS II. This optional sensor is used for external monitoring purposes **ONLY**.

3.5 SETUP MENU

The **SETUP MENU** permits the operator to set the unit password which is required to change any of the menu options. To prevent unauthorized use, a previously entered password entry will time-out after 1 hour. Therefore, the password must be reentered when required. In addition to permitting password entries, the Setup Menu is also used to enter the date and time. Descriptions of the Setup Menu options follow.

ENTER PASSWORD

The *ENTER PASSWORD* option allows the Level 1 (159) or Level 2 (6817) to be entered.

Once the valid Level 1 password (159) is entered, options in all Menus, except the Calibration Menu, can be changed.

The Level 2 password (6817) must be entered to view or change options in the Calibration Menu. Only factory trained personnel should use this Menu.

Date and Time Menu Options

The Setup Menu options associated with date and time are as follows:

- *SET MONTH* 01 -12
- *SET DATE* 01 – 31
- *SET YEAR* 00 – 99
- *SET HOUR* 00 -23
- *SET MINUTE* 00 – 59
- *SET DAY OF WEEK* SUNDAY TO SATURDAY

3.6 **RS232 MENU**

The *RS232 MENU* options permit the BMS II to communicate with an external Energy Management System (EMS) or Computer via the RS232 Port wiring terminals labeled RXD, TXD, ISOGND on the BMS II. The RS232 Menu options are used to select the RS232 Mode, Baud Rate, Modbus Address, Network Timeout period and Modbus Pass-Thru feature for the BMS II.

RS232 MODE

The RS232 MODE option allows the selection of the type of communication desired at the RS232 port: NORMAL (dumb terminal) or MODBUS SLAVE (Modbus Protocol). When the BMS II is being controlled by an external Energy Management System (EMS), via Modbus Protocol, set this option to MODBUS SLAVE (default). If the EMS being used contains only a RS485 port, a RS485-to-RS232 Converter is required.

RS232 BAUD RATE

The RS232 BAUDRATE option sets the communication Baud Rate between the BMS II and the EMS. Available settings include 2400, 4800, 9600 (default), or 19200. Both the BMS II and EMS MUST be set to the same baud rate to enable the communication link.

MODBUS ADDRESS

The *MODBUS ADDRESS* option sets the BMS II address when operating as a Slave on a Modbus Network. The address can be set from 128 (default) to 247.

NETWORK TIMEOUT

When the BMS II is operating in the Remote Setpt mode via Modbus, the *NETWORK TIMEOUT* option defines the maximum time (seconds) allowed before re-sending the setpoint information. If the information is not re-sent within this time period, the BMS will default to its Failsafe mode of operation set in the Configuration Menu. The network timeout period is selectable from 005 to 240 seconds (Default = 060).

MODBUS PASS THRU

When enabled, the MODBUS PASS THRU option allows an EMS or computer, communicating from the RS232 port, to access information from the boilers connected on the RS485 port of the BMS II. When enabled, it allows boiler monitoring and setup but not direct control of the boilers.

3.7 **RS485 MENU**

The BMS II communicates with the connected AERCO network boilers via its RS485 (Modbus) Port (485 B+ and 485 A-). Therefore, the RS485 Menu contains the options necessary to enable communication between the BMS II and the connected network boiler slaves. Each network boiler on the Modbus network must be assigned a unique address to enable communication.

The RS485 Menu options are used to select the RS232 Baud Rate, Min./Max. Range of Slave Addresses, Total Number of Networked Boilers, Type of Modbus Control and the Unique Address for each Networked Boiler. Descriptions of these options follow.

The BMS II can automatically detect boilers within the “Min Slave Addr” and “Max Slave Addr” range, or you can program the boiler addresses in the order desired. AERCO recommends programming the addresses in the desired order. When programming the boiler addresses, set the “Min Slave Addr” and “Max Slave Addr” to zero.

OPERATION

RS485 BAUD RATE

The *RS485 BAUDRATE* option Sets the communication baud rate for the Modbus network between the BMS II and the Boilers connected to the RS485 terminals [B(+), A(-)]. Available settings are 2400, 4800, 9600 (default), or 19200.

MIN SLAVE ADDR

The *MIN SLAVE ADDR* sets the Minimum Slave Address for the Boilers being controlled on the RS485 (Modbus) Network when automatic boiler detection is desired; otherwise, leave set to zero. Allowable entry range is 000 to 127 (default = 000).

MAX SLAVE ADDR

The *MAX SLAVE ADDR* Sets the Maximum Slave Address for the Boilers being controlled on the RS485 (Modbus) Network when automatic boiler detection is desired; otherwise, leave set to zero. Allowable entry range is 000 to 127 (default = 000).

NUMBER NETWK BLRS

This menu option sets the Number of Network Boilers connected to the BMS II RS485 (Modbus) terminals. Up to 32 Boilers can be connected to the Network (default = 02).

MODBUS CNTL TYPE

This menu option sets the Modbus Control Type to *ROUND ROBIN* or *BROADCAST*. Only *ROUND ROBIN* can be used at this time. When set to *ROUND ROBIN*, each networked boiler is addressed individually in sequence. *BROADCAST* is currently not used for the BMS II.

NETW BOILER Xx ADDRESS= Yyy (Where Xx = 01 – 32; Yyy = 001 – 127)

Up to 32 Network Boilers can be accommodated on the Modbus Network. Each Boiler must be assigned a unique address on the network ranging from 001 to 127. No addresses should be entered if automatic boiler detection is desired. Simply set the *MIN SLAVE ADDR* and *MAX SLAVE ADDR* to the minimum and maximum address range of the boilers. To program boiler addresses in the order you desire, enter them here and set the *MIN SLAVE ADDR* and *MAX SLAVE ADDR* to zero.

3.8 FIELD ADJUST MENU.

The *FIELD ADJUST MENU* contains the most extensive list of options compared to the other 8 Menu categories. The options in this menu allow you to adjust important parameters to suit the specific needs of your BMS II installation. Included are options to select the Header Mode and Temperature Limits, Internal Setpoint, Building Reference Temperature, Reset Ratio and Remote Signal. In addition, the Field Adjust Menu contains a series of options which can be used to set up a Header Setpoint Offset Schedule for an entire week. Descriptions of the Field Adjust Menu options:

HEADER SET MODE

The *HEADER SET MODE* option sets the Header Setpoint selection method for the BMS II. Allowable selections are: *CONSTANT SETPT*, *OUTDOOR RESET* or *REMOTE SETPT*. (Default = *CONSTANT SETPT*).

HDR HIGH LIMIT

The *HDR HIGH LIMIT* option sets the maximum temperature setting allowed for the Header Setpoint. This setting also defines the 20 mA temperature equivalent when operating in the Remote Setpoint Mode using a 4 – 20 mA signal. The allowable setting range is from the *HDR LOW LIMIT* to 220°F. (Default = 200°F).

HDR LOW LIMIT

The *HDR LOW LIMIT* menu option sets the minimum temperature setting allowed for the Header Setpt. This setting also defines the 4 mA temperature equivalent when operating in the Remote Setpoint Mode using a 4 – 20 mA signal. The setting range is from 40°F to the *HDR HIGH LIMIT*. (Default = 40°F).

INTERNAL SETPT

The *INTERNAL SETPT* temperature is the *HEADER SETPT* used when *CONSTANT SETPT* is selected for the *HEADER SET MODE* or when the BMS II operates in the Failsafe Mode and *CONSTANT SETPT* is selected as the FAIL SAFE MODE setting in the Configuration Menu.

RESET RATIO

This menu option is displayed only if the *HEADER SET MODE* is set to *OUTDOOR RESET*. The *RESET RATIO* option setting defines the ratio of the increase in Header temperature with respect to each degree decrease in Outdoor temperature starting from the Building Reference Temperature (*BLDG REF TEMP*).

The Reset Ratio is adjustable from 0.1 to 9.9. (Default = 1.2). The Reset Ratio Charts provided in Appendix D are suitable for most applications. However, if a special reset schedule is desired, the calculation method described in Appendix D must be used.

BLDG REF TEMP

The *BLDG REF TEMP* menu option is only displayed when the *HEADER SET MODE* is set to *OUTDOOR RESET*. This option is used to set the Building Reference Temperature (*BLDG REF TEMP*) to the desired value from 40°F to 220°F. (Default = 70°F).

REMOTE SIGNAL

The *REMOTE SIGNAL* menu option is only displayed when the *HEADER SET MODE* is set to *REMOTE SETPT*. When displayed, this option is used to select the controlling remote signal: to 4 – 20 mA or MODBUS. (Default = 4-20 mA)

OFFSET ENABLE

The *OFFSET ENABLE* menu option is used to turn ON, or turn OFF the Setpoint Temperature Offset feature. (Default = OFF)

Offset Menu Options

The Field Adjust Menu contains a series of menu options which permit an offset schedule to be set up for a 7-day period (Sunday through Saturday). For each day (Sunday – Saturday), these options include:

- *OFFS TEMP* [Setpoint Offset Temperature (-50°F to +50°F)]
- *ON HOUR* (00 to 23)
- *ON MINUTE* (00 to 59)
- *OFF HOUR* (00 to 23)
- *OFF MINUTE* (00 to 59)

Normally, if an Offset Schedule is used, it is controlled automatically using the set-up procedures described in the paragraph titled “Setting Up An Offset Reset Schedule” However, if desired, the header offset can be controlled manually by connecting a switch across the SET BACK wiring terminals 13 and 14 as shown in the wiring diagram in Appendix E. If a manual offset is used, refer to the paragraph titled “Manual Offset”.

OPERATION

Setting Up An Offset Schedule

The basic steps involved in setting up an automatic reset schedule consist first selecting the temperature offset and then entering the start and stop times for which the offset will be in effect. Keep in mind that the BMS II uses a 24-hour clock (00:00 to 23:59). The steps are outlined below. In this example, the setpoint temperature is being offset -15°F on Sunday from 12:01 AM (00:01) to 8:00 AM (08 hrs)

1. Scroll through the *FIELD ADJUST MENU* and select *OFFSET ENABLE*. Set this option to *ON*.
2. Next, scroll to *SUN OFFS TEMP* and set the Offset Temperature to -15°F.
3. Press the ▲ arrow key. *SUN ON HOUR* will be displayed. Set the *HOUR* to 00.
4. Press the ▲ arrow key again. *SUN ON MINUTE* will be displayed. Set the *MINUTE* to 01.
5. Press the ▲ arrow key again. *SUN OFF HOUR* will be displayed. Set the *HOUR* to 08.
6. Press the ▲ arrow key again. *SUN OFF MINUTE* will be displayed. Set the *MINUTE* to 00.
7. Repeat steps 2 through 6 to set offset schedules for the remaining days of the week. Different offset temperatures and ON/OFF times can be set for each day if desired.

Manual Offset

If a switch is connected across terminals 13 and 14 on the BMS II, the offset temperature can be controlled manually. To set up a manual offset schedule, proceed as follows:

1. Scroll through the *FIELD ADJUST MENU* and select *OFFSET ENABLE*. Set this option to *ON*.
2. Next, scroll to *SUN OFFS TEMP* and set the desired Offset Temperature. A different Offset Temperature can be set for each day if desired.
3. Scroll through the remaining days of the week and set the desired offset temperature for each day.

Once programmed as described above, closing the SET BACK switch will enable the programmed *OFFS TEMP* for that day. Opening the SET BACK switch will disable the *OFFSET* and the Header Setpoint will return the selected *INTERNAL SETPT* temperature.

3.9 CONFIGURATION MENU

The Configuration Menu contains options which set the Boiler operating modes start/stop levels and maximum allowable power input. In addition, it contains a Fail Safe Mode feature which is used to select the default mode when the controlling input source is lost.

BOILER OP MODE

The *BOILER OP MODE* menu option sets the control operation method for the BMS II. to either *SEQUENTIAL* or *PARALLEL MODE*.

Parallel Mode

When *PARALLEL MODE* is selected, all boilers are simultaneously started by the BMS II. The *BLR START LEVEL* and *BLR STOP LEVEL* set in the Configuration Menu (see below) have no effect when in this mode. Regardless of the number of Boilers in the plant, the turn-down ratio in the Parallel Mode is fixed at 20:1 for KC1000 Series Boilers (except 11:1 for KC Low NOx). For Benchmark Series Boilers, the turn-down ratio is fixed at 20:1 for BMK2.0, 2.0LN, and 1.5LN Boilers. However, for BMK3.0LN Boilers the turn-down ratio is fixed at 15:1.

Sequential

When *SEQUENTIAL MODE* is selected it provides a greater turn-down ratio than the *PARALLEL MODE*. This is due to the fact that the turn-down ratio in the Sequential Mode is equal to the number of Boilers multiplied by the 20 for KC1000 Series and Benchmark Series units.

In Sequential Mode, each boiler is started one at a time based on the load and start/stop levels programmed in the BMS. The BMS will start a single Modulex boiler when there is a load demand or a Benchmark or KC1000 boiler when the boiler start level is reached. Once the first boiler reaches twice the start level, a second boiler will be started and the load will be distributed evenly between the two boilers.

For instance, if a start level of 25% is chosen, when the first boiler reaches 50% a second boiler will start (after a 30 second delay), and the BMS will distribute the load 25% for each boiler. If the firing rate of both boilers reach a combined value equal to 3 times the start level, a third boiler is started by the BMS (after a 30 second delay), and the load will be distributed across all three boilers. This sequence will continue based on load demand and the number of boilers connected to the BMS.

SYS INTLK CONFIG

This option selects when the System Start Interlock takes effect. The available choices are *START ENABLED* (default) and *ALWAYS ENABLED*. If *START ENABLED* is selected, the BMS II will wait 30 seconds after the System Start Relay is activated before looking for a closure across the System Start Interlock selected. (See *SYS START INTLK* in the RELAY MENU). If no closure is seen after 30 seconds, the BMS II will stop the boilers and display a fault message and activate the fault relay. *ALWAYS ENABLED* will cause a fault whenever the interlocks are opened.

NOTE:

The *BLR START LEVEL* and *BLR STOP LEVEL* must be programmed in the BMS II by the user. Refer to Appendix I for additional information on *START/STOP LEVELS*.

BLR START LEVEL

The Boiler Start Level (*BLR START LEVEL*) sets the percentage level at which the Boilers connected to the BMS II will start. The allowable entry range is from 1% to 100% (default = 20%).

BLR STOP LEVEL

The Boiler Stop Level (*BLR STOP LEVEL*) menu option set the percentage level below which the Boilers connected to the BMS II will stop. The allowable entry range is from 1% to 40% (default = 16%).

MAX POWER INPUT

The Maximum Power Input (*MAX POWER INPUT*) sets the maximum Percent Level that the BMS II can ramp up the boilers to. This may be useful in an over-sized boiler plant. The allowable entry range is from 50 % to 100% (default = 100%).

FAIL SAFE MODE

Selects the desired operating mode of the BMS II if it loses its Outdoor Air Sensor when operating in the Outdoor Reset mode, or loses its Remote Signal when operating in the Remote Setpoint mode. If *CONSTANT SETPT* is selected as the *FAIL SAFE MODE*, the BMS II will operate the boilers to achieve a Header Setpt equal to the programmed Internal Setpt. If *SHUTDOWN* is selected, it will shut down all the boilers.

NOTE:

If the Header Sensor is lost, the BMS II will shut down all the boilers.

OPERATION

3.10 TUNING MENU

The *TUNING MENU* options are used to select PID (Proportional Integral Derivative) control functions incorporated in the BMS II. These functions govern temperature control and response of the 'BMS II to the boiler system. Since each system is different, these PID controls can tune the BMS II to the characteristics of your specific installation. The factory defaults preset by AERCO work well for most applications. In instances when there is a large error between the setpoint and the actual supply water temperature, the BMS II may appear to require PID tuning. However, it is best to observe BMS II operation over a period of time prior to making any PID changes. Contact AERCO, or an AERCO representative, prior to making any PID setting changes.

The *TUNING MENU* options include Proportional Bandwidth, Integral Gain, Derivative Gain and Header Temperature Deadband.

PROPORTIONAL BND

The Proportional Bandwidth (degrees) represents the immediate response to a setpoint error. This value is the temperature deviation from setpoint for which a 100% output change is desired. This is a part of the PID output calculation in the BMS II.

For instance, proportional band of 50°F is chosen. The header temperature setpoint is 180°F and the actual incoming supply water temperature is 130°F. This is a 50° error and the following is true:

$$\frac{\text{Temp. Error}}{\text{Prop Bandwidth}} \times 100 = \text{Firing Rate in \%}$$

Therefore:

$$\frac{50}{50} \times 100\% = \text{Firing Rate}$$

$$1 \times 100 = 100 \% \text{ Firing Rate}$$

With an error of 30° and a bandwidth of 50, the following would be true:

$$30/50 \times 100 = .6 \times 100 = 60\% \text{ Firing Rate.}$$

INTEGRAL GAIN

The Integral Gain (repeats/min) responds to the setpoint error over time. Integral references the proportional band error signal and sums itself with respect to the period of time the error exists. Based on the previous example, if the integral gain is 0.15 repeats/minute at a firing rate of 60% and a temperature error exists for one minute, then the following is true:

$$(0.15 \text{ reps/min.}) \times (60\% \text{ firing rate}) = 9\% \text{ actual firing rate}$$

$$60\% \text{ firing rate} + 9\% \text{ firing rate} = 69\% \text{ firing rate}$$

If the error continues and is present for another minute, another 9% correction factor will be added:

$$69\% \text{ firing rate} + 9\% \text{ firing rate} = 78\% \text{ firing rate}$$

If, after a load change, the supply water temperature stabilizes at a temperature above or below the setpoint, the integral gain should be increased. If, after a load change, the supply water temperature overshoots and oscillates excessively, integral gain should be reduced.

DERIVATIVE GAIN

Derivative Gain is a function of time. It senses and responds to the rate of change of the setpoint error. A slow rate of change will yield a small amount of derivative gain. Conversely, a fast rate of change will yield a large derivative gain. Too high a derivative gain setting will produce a large output for a short time. This can result in overshoot of the setpoint. Too low a derivative gain setting will have the opposite effect, producing a small output for a longer period, and may result in slow system response or the system undershooting the setpoint.

HDR TEMP DEADBND

This is the temperature deviation allowed from setpoint within which the Percent Level output will remain constant. The default value is 5°F.

3.11 RELAY MENU

As the name implies, the *RELAY MENU* contains the options necessary to select the actions performed by the System Start (SYS START), Fault Alarm (FLT ALARM) and Auxiliary (AUX) Relays in the BMS II.

SYS START TEMP

If an Outdoor Air Sensor is installed, this menu option is used to select the Outdoor Temperature below which the System Start Relay is allowed to activate (close), provided that the SYS START OPTION conditions specified below are satisfied. The percent level will always remain at 0% until the System Start Relay is activated. The System Start Relay will open if the Outdoor temperature is above the value set for this option.

SYS START OPTION

The *SYS START OPTION* can be set to *TEMP ONLY* or *TEMP AND LOAD*. Selecting *TEMP ONLY* means the System Start Relay will be active whenever the Outdoor Temperature falls below the System Start Temperature (SYS START TEMP).

Selecting *TEMP AND LOAD* will cause the System Start Relay to activate if the Outdoor Temperature falls below the System Start Temperature and the Percent of Load (Operating Menu) is at or above the *LOAD START PCT* (Calibration Menu). It will deactivate (open) the System Start Relay when the Percent of Load goes below the *LOAD START PCT*.

SYS START INTLK

The *SYS START INTLK* selects the Interlock associated with the System Start Relay activation when *SYS INTLK CONFIG* is set for *START ENABLED*. Available settings include, *INTERLOCK 1 (default)*, *INTERLOCK 2*, or *INTERLOCK 1&2*.

AUX RELAY OPEN

The *AUX RELAY OPEN* setting is the Percent Level output below which the AUX Relay will open if it was closed due to the conditions described by the *AUX RELAY CLOSE* setting.

AUX RELAY CLOSE

This determines the condition for which the AUX relay will close. If 100% FIRE RATE is selected, the AUX relay will close when all available boilers are firing at 100%. If 100% AND OFF (default) is selected, it will close when all available boilers are firing at 100% as well as when no boilers are available and the boiler plant is below setpoint. This relay can trigger emergency heat in the latter case.

OPERATION

FAULT ALARM RELAY

This setting tells the BMS II which faults should activate the fault alarm relay. The default is *ALL FAULTS*. If *NO INTERLOCK* is selected, the Fault Alarm Relay will not activate when the interlocks are opened, however the BMS II will still shut down all boilers. If *INTERLOCK 2* is selected, the Fault Alarm Relay will only activate when Interlock 2 is opened and not when Interlock 1 is opened. Similarly, when *INTERLOCK 1* is selected, the fault alarm relay will only activate when Interlock 1 is opened and not when Interlock 2 is opened.

FAULT ALARM BLRS

This selection tells the BMS II whether to activate the fault alarm relay if a boiler connected to it is faulted.

FAULT ALARM CLEAR

Selecting *MANUAL* will latch the fault alarm relay if a fault condition occurs and goes away. The *CLEAR* key must be pushed to deactivate the relay. If set to *AUTOMATIC*, the fault relay will open when the fault condition goes away.

3.12 CALIBRATION MENU

NOTE

The Level 2 Password (6817) must be entered in order to view or change options in the Calibration Menu.

The options contained in this Menu should only be used by factory-trained personnel, since it contains options that could adversely affect system operation if incorrectly set.

HDR SENS OFFSET

This option sets the offset temperature value that is added to the displayed Header Sensor temperature in the event that it is different from a trusted reference Header temperature reading and needs calibration. Be sure the Header Sensor is properly installed before adjusting this offset value. The allowable offset range is $\pm 10^{\circ}\text{F}$.

OUTD SENS OFFSET

This offset value is added to the Outdoor Sensor temperature displayed in case it is different from a trusted reference outdoor temperature reading and needs calibration. Be sure the Outdoor sensor is properly installed before adjusting this value. The allowable offset range is $\pm 10^{\circ}\text{F}$.

4 - 20 MA OFFSET

This offset value is added to the 4 – 20 mA Remote signal input to the BMS II in the event that calibration is needed. The allowable offset range is ± 1.0 mA.

RETN SENS OFFSET

This offset value is added to the Return Sensor temperature displayed in case it is different from a trusted reference return temperature reading and needs calibration. Be sure the Return Sensor is properly installed before adjusting this value. The allowable offset range is $\pm 10^{\circ}\text{F}$.

RAMP UP %/MIN

This sets the maximum Percent Level ramp up rate for the BMS II. The Percent Level output will follow the PID output if it is slower than this rate. The default setting is 20% per minute.

RAMP DOWN %/MIN

This sets the maximum Percent Level ramp down rate for the BMS II. The Percent Level output will follow the PID output if it is slower than this rate. The default setting is 200% per minute.

LOAD START PCT

When the *SYS START OPTION* is set to *TEMP AND LOAD*, this parameter determines the percent of load value at or above which the “load” portion of the parameter is true. This value cannot exceed the *BLR START LEVEL* set in the Configuration Menu. The default setting is 1%.

LOAD STOP PCT

When the *SYS START OPTION* is set to *TEMP AND LOAD*, this parameter determines the percent of load value at or below which the “load” portion of the parameter is false. This value cannot exceed the *BLR STOP LEVEL* set in the Configuration Menu nor the *LOAD START PCT*. The default is 0%.

RESET DEFAULTS

This option is used to set the BMS II to its factory default values. Make sure that you want to reset all options before activating.

3.13 BMS II QUICK-START GUIDE

NOTE

The “Quick Start” procedures in paragraph 3.13 assume that the user fully understands the BMS II menu structure and is able to navigate through these menus to display and change menu options. Refer to paragraph 3.3 for menus and menu processing procedures.

The following procedure assumes that you are programming a new BMS II that has the “Factory Default” settings currently stored in memory.

If you wish to restore a “Field-Programmed” BMS II to the “Factory Default” values, go to the CALIBRATION MENU and select the *RESET DEFAULTS* option. ALL SETTINGS, EXCEPT TIME AND DATE, WILL RETURN TO THEIR FACTOR DEFAULTS.

This paragraph provides the instructions to quickly start up and operate the BMS II in some of the most commonly used modes. The ranges and default values of the Menu Options used in the following instructions are summarized in Appendix A.

OPERATION

CONSTANT SETPT MODE (Default)

MENU & OPTION

ACTION

1. SETUP MENU



ENTER PASSWORD

Enter 159



2. RS485 MENU

Enter this menu if there are more than 2 boilers (default), otherwise go to step 3



NUMBER NETW BOILERS

This setting is preset to 2. If more than 2 Boilers (default), enter number (03, 04, etc)



NETW BOILER 01
ADDRESS= 001

Address 001 and 002 are preset. Enter other Network Addresses if required (003, 004, 005, etc.)



3. FIELD ADJUST MENU

If Setpt is other than 160°F (default), enter this menu; otherwise go to step 4



INTERNAL SETPT

Enter Setpoint temperature



4. CONFIGURATION MENU

If BLR START LEVEL=20% & BLR STOP LEVEL=16%, skip this menu.



BLR START LEVEL

Enter Boiler Start Level Percent (default = 20%). See Appendix I.



BLR STOP LEVEL

Enter Boiler Stop Level Percent (default = 16%). See Appendix I.

REMOTE SETPT MODE

Perform the procedure described for the CONSTANT SETPT MODE and then continue with the steps described below:

MENU & OPTION

ACTION

1. FIELD ADJUST MENU



HEADER SET MODE

Set to REMOTE SETPT



HDR HIGH LIMIT

Enter the maximum temperature for the Remote Setpoint input (this will be the temperature equivalent to a 20 mA input) Default = 200°F



HDR LOW LIMIT

Enter the minimum temperature for the Remote Setpoint input (this will be the temperature equivalent to a 4 mA input) Default = 40°F



REMOTE SIGNAL

Select 4-20 Ma (default) or MODBUS



2. CONFIGURATION MENU



FAIL SAFE MODE

Set to CONSTANT SETPT if you want to maintain a Constant Setpoint temperature in the event that the Remote signal is lost. (Default = SHUTDOWN)

OUTDOOR RESET MODE

Perform the procedure described for the CONSTANT SETPT MODE and then continue with the steps described below:

MENU & OPTION

ACTION

1. FIELDADJUST MENU



HEADER SET MODE

Set to *OUTDOOR RESET*



RESET RATIO

Enter a different value, if required (default = 1.2). Refer to Appendix C.



BLDG REF TEMP

Enter the desired Building Reference Temperature. Default = 70°F (Refer to Appendix C).



2. CONFIGURATION MENU



FAIL SAFE MODE

Set to *CONSTANT SETPT* if you want to maintain a Constant Setpoint temperature in the event that the Outdoor Sensor signal is lost. (Default = *SHUTDOWN*)



3. RELAY MENU



SYS START TEMP

Enter the outdoor temperature below which the system will be activated.

After completing the “Quick Start” procedure for any of the modes described above, check to ensure that the “ON” LED is lit. If it is not, press the **ON/OFF** key to activate the BMS II.

For further programming details, refer to Chapter 4.

CHAPTER 4 - PROGRAMMING BMS II OPERATING MODES

4.1 INTRODUCTION

Prior to programming, the BMS-II must be mounted and all required wiring completed. In addition, all connections should be checked for accuracy. Once these items are completed, the BMS-II is ready to be programmed for the desired mode of operation for the boiler plant. The steps for programming will vary somewhat, depending on whether the Outdoor Reset, Remote Setpoint or Constant Setpoint operating mode is selected.

NOTE

The Level 1 Password (159) must be entered prior to programming the BMS II for operation in any of the modes described in paragraphs 4.2 through 4.4. Refer to Chapter 3 for instructions on password entry and basic menu processing procedures.

4.2 OUTDOOR RESET MODE

The Outdoor Reset mode operates based on outside air temperature. In this mode, the header supply water temperature will vary up or down in accordance with outside air temperature. Therefore, in order to set up and operate in this mode, an outdoor air sensor **MUST** be installed. This mode requires entries to be made in the Field Adjust Menu and Relay Menu for the following options:

- FIELD ADJUST MENU
 - HEADER SET MODE
 - RESET RATIO
 - BLDG REF TEMP
- CONFIGURATION MENU
 - BOILER OPERATING MODE
- RELAY MENU
 - SYSTEM START RELAY TEMP

The programming set-up instructions for the above menu options are provided in paragraphs which follow.

Selecting Outdoor Reset Mode

The Outdoor Reset Mode is selected using the Header Set Mode option in the Field Adjust Menu as follows:

1. Using the keypad on the BMS II, press the **MENU** key, until *FIELD ADJUST MENU* appears in the display.
2. Using the ▲ or ▼ arrow key on the keypad, scroll through the menu until *HEADER SET MODE* is displayed in the first line of the VFD display. The second line of the display will show the currently selected Header Set Mode (*CONSTANT SETPOINT*, *OUTDOOR RESET* or *REMOTE SETPOINT*).
3. If *OUTDOOR RESET* is not displayed in the second line of the display, press the **CHANGE** key. The VFD display will switch to a reverse video format indicating that a change is in process.

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4. Using the ▲ or ▼ arrow key, select *OUTDOOR RESET*.
5. Press the **ENTER** key to store the change. The reverse video display will revert to the normal display format indicating that the change has been store in memory. While still in the Field Adjust Menu, proceed to the next paragraph and continue the set-up procedure.

Determining Reset Schedule

There are two variables that must be considered when determining Reset Schedule: Reset Ratio and Building Reference Temperature. There are two methods for determining the Reset Ratio. The first method utilizes the Reset Ratio Charts provided in Appendix C. This method is suitable for most installations. However, if a special Reset Schedule is desired for reheat or other purposes, the calculation method must be used. When using this method, both Reset Ratio and Building reference Temperature must be calculated. Refer to Appendix C for further instructions concerning both of these methods.

Once the Reset Ratio and Building Reference Temperature have been determined, proceed to the next paragraph and enter these options.

Entering Reset Ratio And Building Reference Temperature

The Reset Ratio and Building Reference Temperature (*BLDG REF TEMP*) are also entered using options contained in the Field Adjust Menu. These parameters are entered as follows:

1. To enter the required Reset Ratio, scroll through the Field Adjust Menu and select *RESET RATIO*.
2. If the desired ratio is not displayed, press the **CHANGE** key. The display will switch to a reverse video format indicating that a change is in process.
3. Select the required Reset Ratio using the ▲ or ▼ arrow key.
4. Press the **ENTER** key to store the change. The reverse video display will revert to the normal display format indicating that the change has been store in memory.
5. Next, scroll through the Field Adjust Menu and select *BLDG REF TEMP*.
6. If the desired *BLDG REF TEMP* is not displayed, press the **CHANGE** key. The display will switch to a reverse video format.
7. Select the required *BLDG REF TEMP* using the ▲ or ▼ arrow key.
8. Press the **ENTER** key to store the change. The reverse video display will revert to the normal VFD display format.
9. This completes the required entries in the Field Adjust Menu. Proceed to the next paragraph and select the Boiler Operating Mode.

Selecting Boiler Operating Mode

The Boiler Plant can be set for either Parallel or Sequential Mode operation. The Boiler Operating Mode is selected in the Configuration Menu as follows:

1. Using the keypad on the BMS II, press the **MENU** key, until *CONFIGURATION MENU* appears in the display.
2. On the keypad, press the ▲ arrow key once. *BOILER OP MODE* will be displayed in the first line of the VFD display. The second line of the display will show the currently selected Boiler Operating Mode. (*SEQUENTIAL MODE* or *PARALLEL MODE*). The default setting is *SEQUENTIAL MODE*.
3. If the desired Operating Mode is not displayed in the second line of the display, press the **CHANGE** key. The VFD display will switch to a reverse video format indicating that a change is in process.
4. Using the ▲ or ▼ arrow key, toggle the display to the desired setting.
5. Press the **ENTER** key to store the change. The reverse video display will revert to the normal display format indicating that the change has been stored in memory.

Entering System Start Temperature

In order to complete the required set-up procedures for the Outdoor Reset Mode, the System Start Temperature must be entered. The System Start Temperature is the outside air temperature at which the boiler plant begins to operate. The factory default value for the System Start Temperature (*SYS START TEMP*) is 70°F. However, temperatures from 32°F to 120°F can be selected using the ▲ and ▼ arrow keys on the BMS II keypad. Proceed as follows:

1. Press the **MENU** key until *RELAY MENU* appears in the display.
2. Press the ▲ arrow key once. *SYS START TEMP* will be displayed along with the current setting for the System Start Temperature.
3. Press the **CHANGE** key to change the displayed temperature. The display will switch to a reverse video format.
4. Select the desired System Start temperature using the ▲ or ▼ arrow key.
5. Press the **ENTER** key to store the changed temperature. The reverse video display will revert to the normal VFD display format.
6. The BMS II is now programmed for operation in the Outdoor Reset Mode.

4.3 REMOTE SETPOINT MODE

In order to set up the BMS II to operate in this mode, a Modbus communication line or a 4-to-20 mA input line with a floating ground from an Energy Management System (EMS) is required. In addition, a BMS header sensor is required. This mode may be used with or without an outdoor air temperature sensor installed. Entries in this mode are required for the following items:

- FIELD ADJUST MENU
 - HEADER SET MODE
 - HEADER HIGH LIMIT
 - HEADER LOW LIMIT
 - REMOTE SIGNAL
- CONFIGURATION MENU
 - BOILER OPERATING MODE

Selecting Remote Setpoint Mode

The Remote Setpoint Mode is selected using the Header Set Mode option in the Field Adjust Menu as follows:

1. Using the keypad on the BMS II, press the **MENU** key, until *FIELD ADJUST MENU* appears in the display.
2. Using the ▲ or ▼ arrow key on the keypad, scroll through the menu until *HEADER SET MODE* is displayed in the first line of the VFD display. The second line of the display will show the currently selected Header Set Mode (*CONSTANT SETPOINT*, *OUTDOOR RESET* or *REMOTE SETPOINT*).
3. If *REMOTE SETPOINT* is not displayed in the second line of the display, press the **CHANGE** key. The VFD display will switch to a reverse video format indicating that a change is in process.
4. Using the ▲ or ▼ arrow key, select *REMOTE SETPOINT*.

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5. Press the **ENTER** key to store the change. The reverse video display will revert to the normal display format indicating that the change has been store in memory. With the BMS II still in the *FIELD ADJUST MENU*, proceed to the next paragraph and continue the set-up procedure.

Entering Header High Limit And Low Limit Temperatures

The Header High Limit and Header Low Limit are also selected using options in the *Field Adjust Menu* as follows:

1. Using the ▲ or ▼ arrow key on the keypad, scroll through the menu until *HDR HIGH LIMIT* is displayed in the first line of the VFD display. The second line of the display will show the currently selected Header High Limit temperature (default = 200°F).
2. If the required *HDR HIGH LIMIT* is not displayed in the second line of the display, press the **CHANGE** key. The VFD display will switch to a reverse video format indicating that a change is in process.
3. Using the ▲ or ▼ arrow key, select required *HDR HIGH LIMIT* temperature.
4. Press the **ENTER** key to store the change. The reverse video display will revert to the normal display format indicating that the change has been store in memory.
5. Next, scroll through the *FIELD ADJUST MENU* until *HDR LOW LIMIT* is displayed in the first line of the VFD display. The second line of the display will show the currently selected Header Low Limit temperature (default = 040°F).
6. If the required *HDR LOW LIMIT* is not displayed, press the **CHANGE** key.
7. Using the ▲ or ▼ arrow key, select required *HDR LOW LIMIT* temperature. Press the **ENTER** key to store the change.
8. With the BMS II still in the *FIELD ADJUST MENU*, proceed to the next paragraph and continue the set-up procedure.

NOTE

If the Remote Signal is set to 4 – 20 mA, the *HDR HIGH LIMIT* temperature defines the 20 mA value and the *HDR LOW LIMIT* temperature defines the 4 mA value.

Selecting Remote Signal Type

The boilers connected to the BMS II can be controlled by either a 4-to-20 mA signal or a Modbus signal from an Energy Management System (EMS). The Remote Signal type is selected in the Field Adjust Menu as follows:

1. Using the ▲ or ▼ arrow key on the keypad, scroll through the menu until *REMOTE SIGNAL* is displayed in the first line of the VFD display. The second line of the display will show the currently selected Remote Signal (*4-20 mA* or *MODBUS*). The default is *4-20 mA*.
2. If the required *REMOTE SIGNAL* is not displayed in the second line of the display, press the **CHANGE** key. The VFD display will switch to a reverse video format indicating that a change is in process.
3. Using the ▲ or ▼ arrow key, toggle the display to the required signal type.
4. Press the **ENTER** key to store the change. The reverse video display will revert to the normal display format indicating that the change has been store in memory.
5. This completes all required entries in the Field Adjust Menu. To complete Remote Setpoint Mode setup, select the Boiler Operating Mode option as described below.

Selecting Boiler Operating Mode

The Boiler Plant can be set for either Parallel or Sequential Mode operation. The Boiler Operating Mode is selected in the Configuration Menu as follows:

1. Using the keypad on the BMS II, press the **MENU** key, until *CONFIGURATION MENU* appears in the display.
2. On the keypad, press the **▲** arrow key once. *BOILER OP MODE* will be displayed in the first line of the VFD display. The second line of the display will show the currently selected Boiler Operating Mode. (*SEQUENTIAL MODE* or *PARALLEL MODE*). The default setting is *SEQUENTIAL MODE*.
3. If the desired Operating Mode is not displayed in the second line of the display, press the **CHANGE** key. The VFD display will switch to a reverse video format indicating that a change is in process.
4. Using the **▲** or **▼** arrow key, toggle the display to the desired setting.
5. Press the **ENTER** key to store the change. The reverse video display will revert to the normal display format indicating that the change has been store in memory.
6. The BMS II is now programmed for operation in the Remote Setpoint Mode.

4.4 CONSTANT SETPOINT MODE

In the Constant Setpoint Mode of operation, only a header sensor is required. Entries in this mode are required for the following items:

- FIELD ADJUST MENU
 - HEADER SET MODE
 - INTERNAL SETPOINT
- CONFIGURATION MENU
 - BOILER OPERATING MODE

Selecting Constant Setpoint Mode

The Constant Setpoint Mode is selected using the Header Set Mode option in the Field Adjust Menu as follows:

1. Using the keypad on the BMS II, press the **MENU** key, until *FIELD ADJUST MENU* appears in the display.
2. Using the **▲** or **▼** arrow key on the keypad, scroll through the menu until *HEADER SET MODE* is displayed in the first line of the VFD display. The second line of the display will show the currently selected Header Set Mode (*CONSTANT SETPOINT*, *OUTDOOR RESET* or *REMOTE SETPOINT*).
3. If *CONSTANT SETPOINT* is not displayed in the second line of the display, press the **CHANGE** key. The VFD display will switch to a reverse video format indicating that a change is in process.
4. Using the **▲** or **▼** arrow key, select *CONSTANT SETPOINT*.
5. Press the **ENTER** key to store the change. The reverse video display will revert to the normal display format indicating that the change has been store in memory. With the BMS II still in the *FIELD ADJUST MENU*, proceed to next paragraph to select the Internal Setpoint Temperature.

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Selecting Internal Setpoint Temperature

The Internal Setpoint Temperature is selected using in the Field Adjust Menu as follows:

1. Using the ▲ or ▼ arrow key on the keypad, scroll through the menu until *INTERNAL SETPT* is displayed in the first line of the VFD display. The second line of the display will show the currently selected Internal Setpoint temperature (default = 160°F). If the required *INTERNAL SETPT* is not displayed in the second line of the display, press the **CHANGE** key. The VFD display will switch to a reverse video format indicating that a change is in process.
2. Using the ▲ or ▼ arrow key, select required *INTERNAL SETPT* temperature.
3. Press the **ENTER** key to store the change. The reverse video display will revert to the normal display format indicating that the change has been store in memory.
4. This completes the required entries in the Field Adjust Menu. To complete the Constant Setpoint Mode set-up, select the Boiler Operating Mode as described below.

Selecting Boiler Operating Mode

The Boiler Plant can be set for either Parallel or Sequential Mode operation. The Boiler Operating Mode is selected in the Configuration Menu as follows:

1. Using the keypad on the BMS II, press the **MENU** key, until *CONFIGURATION MENU* appears in the display.
2. On the keypad, press the ▲ arrow key once. *BOILER OP MODE* will be displayed in the first line of the VFD display. The second line of the display will show the currently selected Boiler Operating Mode. (*SEQUENTIAL MODE* or *PARALLEL MODE*). The default setting is *SEQUENTIAL MODE*.
3. If the desired Operating Mode is not displayed in the second line of the display, press the **CHANGE** key. The VFD display will switch to a reverse video format indicating that a change is in process.
4. Using the ▲ or ▼ arrow key, toggle the display to the desired setting.
5. Press the **ENTER** key to store the change. The reverse video display will revert to the normal display format indicating that the change has been store in memory.
6. The BMS II is now programmed for operation in the Constant Setpoint Mode.

4.5 “TEMP AND LOAD” OPTION

The boiler plant, and the System Start Relay, can be programmed to start based on either, or both, an outdoor temperature and/or load demand criteria. When the *SYS START OPTION* is set to *TEMP ONLY*, the outdoor temperature is the only criteria used to activate the system. In this case the system, and the System Start Relay, will activate when the outdoor temperature falls below the *SYS START TEMP* setting. If no outdoor sensor is installed, the system (and the System Start Relay) will always be activated in this case. The system will shut down and the System Start Relay deactivated when the outdoor temperature rises above the *SYS START TEMP* setting.

If the *SYS START OPTION* is set to *TEMP AND LOAD*, the system (and the System Start Relay) will start when the outdoor temperature is below the *SYS START TEMP* setting and the load demand (*PERCENT OF LOAD*) is at or above the *LOAD START PCT* (in Calibration Menu). The *PERCENT OF LOAD* display in the Operating Menu will show 0% until both of these criteria are satisfied. The system will shut down and the System Start Relay deactivated if either the outdoor temperature rises above the *SYS START TEMP* or the *PERCENT OF LOAD* falls below the *LOAD STOP PCT*. If no outdoor sensor is installed, the system (and the System Start Relay) will activate when the *PERCENT OF LOAD* is at or above the *LOAD START PCT*. The system will shut down when the *PERCENT OF LOAD* falls below the *LOAD STOP PCT*.

4.6 “START ENABLED” OPTION

The BMS II can be used to turn on and prove a device such as a fresh air damper, gas booster or the flow of a local pump before ramping up the output. With *SYS INTLK CONFIG* (Configuration Menu) set to *START ENABLED*, the BMS II will allow 30 seconds after it activates the System Start Relay before proving the selected interlock (such as *SYS START INTLK*) and ramping up the output. The System Start Relay can activate the device and the dry-contact proving switch of the device, or devices can be wired to one or both interlocks.

4.7 SYSTEM INITIALIZATION AND POLLING

In order for the BMS II to recognize the boilers connected to the RS485 Network, Initialization and polling must be accomplished by performing the following steps:

1. Set the **ON/OFF** switch on each boiler control panel to **ON**.
2. Turn on the BMS II by pressing the **ON** key. The BMS will automatically poll (recognize) each boiler at prescribed intervals.
3. Check the yellow **REMOTE (REM)** LED on each boiler control panel to ensure it is ON. This indicates that the boiler is now being controlled by the BMS II.
4. If any of the boiler **REMOTE** LEDs are off, check to ensure that:
 - (a) Boiler AC power is not turned off
 - (b) Boiler is not shut down due to a fault.
 - (c) The RS485 Network connection is not broken.

The BMS will continuously poll the boilers at prescribed intervals. Therefore, if a boiler is placed off-line and then placed back on-line, it will again be recognized by the BMS during the next polling cycle.

4.8 TESTING THE SYSTEM

The following procedure places a load on the system and will begin firing the boilers. At this point it is very important to make sure the system pumps are running.

After system has been initialized as described in paragraph 4.5, proceed as follows:

IMPORTANT

Prior to performing these tests, view and record the **PRESENT** settings stored in the BMS II for *HEADER SET MODE* and *INTERNAL SETPT*. These settings are located in the Field Adjust Menu and **MUST** be restored to these values upon completion of the following tests.

1. Turn off the BMS II by pressing the **ON/OFF** key. The **ON** LED will turn off.
2. Using the **MENU** key, select the *FIELD ADJUST MENU* and scroll to the *HEADER SET MODE* option. The second line of the display will show the current setting stored in memory (*CONSTANT SETPT*, *OUTDOOR RESET*, or *REMOTE SETPT*).
3. If *CONSTANT SETPT* is not currently selected, press the **CHANGE** key. Select the *CONSTANT SETPT* mode using the **▲** or **▼** arrow key. When selected, store the change by pressing the **ENTER** key.

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4. Next, scroll to the *INTERNAL SETPT* menu option. The second line of the display will show the current Internal Setpoint temperature (°F) stored in memory.
5. Press the **CHANGE** key. Set the *INTERNAL SETPT* temperature to 180°F using the ▲ and ▼ arrow keys. When set, store the change by pressing the **ENTER** key.
6. Turn on the BMS II by pressing the **ON/OFF** key. The ON indicator will light and the boiler plant will start to operate.
7. Using the **MENU** key on the BMS II, scroll to the OPERATING MENU. The first line of the display will show the Header Temperature. The second line of the display will show the Firing Rate % and the number of Units (boilers) firing.
8. When all boilers have reached at least a 55% firing rate, any boilers that have not started have not been identified by the BMS II.
9. Remember that in the Sequential mode, the BMS II turns boilers on in 30-second intervals. Therefore, in a 6-boiler plant, with five boilers operating at 55% capacity, a boiler that has not started after 3 minutes has not been recognized. In parallel mode, all boilers will start at the same time.
10. This completes the System Test. Return the *HEADER SET MODE* and *INTERNAL SETPT* settings to their previously stored values.
11. If the System Test is not completed successfully, refer to the troubleshooting procedures in this manual (Chapter 5) and the applicable O & M Manuals for the boilers included in the boiler plant. If the problem can still not be resolved, contact AERCO at 1-800-526-0288.

CAUTION

Monitor the HDR TEMP reading to ensure it is not ramping up too high. If it is, press the ON/OFF key of the BMS II to shut down the boilers. Remember that the boiler outlet temperature may be higher than the BMS II header temperature.

CHAPTER 5 - TROUBLESHOOTING

5.1 FAULT MESSAGES & COMMON PROBLEMS

When a fault occurs in the boiler plant, the BMS II flashes fault messages at 2-second intervals and the Fault Alarm (FLT ALARM) relay contacts are closed. The red **FAULT** indicator on the front panel will also light. To cancel the alarm (open relay contacts), press the **CLEAR** key on the BMS II keypad. The **FAULT** indicator will turn off, however the fault message will continue to be displayed.

The fault messages shown in Table 5-1 can appear when the BMS II is operating in any of the three basic modes (Constant Setpoint, Outdoor Reset, or Remote Setpoint).

Table 5-2 lists some common problems that may occur during BMS II operation and provide Probable Causes and Corrective Action for each listed Probable Cause.

Table 5-1. Fault Messages

Fault Message	Description & Possible cause
OUTSIDE AIR TEMP NOT CONNECTED	<ul style="list-style-type: none"> Open outside air temp. sensor: resistance greater than 240K ohms (less than -40°F) Shorted outside air temp. sensor: resistance less than 1K ohms (greater than 200°F) No sensor connected <p>Note: Displays only in Remote Setpt and Constant Setpoint modes. I</p>
OUTSIDE AIR TEMP SENSOR ERROR	When in Outdoor Reset Mode, the outside air temperature sensor is either open, shorted, or not connected.
HEADER SENSOR ERROR	<ul style="list-style-type: none"> Open header sensor: resistance greater than 240K ohms (less than -40°F) Shorted header sensor: resistance less than 240 ohms (over 300°F) Sensor not installed
INTERLOCK 1 ERROR	Interlock 1 is open
INTERLOCK 2 ERROR	Interlock 2 is open

TROUBLESHOOTING

Table 5-1. Fault Messages – Continued

Fault Message	Description & Possible cause
CURRENT LOOP ERROR	The 4-to-20-mA remote input signal has dropped below 3 mA, or the signal is not present at the BMS II.
FAIL SAFE MODE ACTIVATED	This message indicates that the BMS II is operating in the Fail Safe (Constant Setpoint) mode.due to sensor loss or signal loss.
MODBUS TIMEOUT ERROR	Displayed during Modbus Remote Setpoint operation when the BMS II is functioning as a Slave to an EMS Master. Error indicates that the Network Timeout has expired.
NETWORK DISABLED MODBUS LISTEN	Displayed during Modbus operation when the “FORCE LISTEN ONLY” Modbus diagnostic command is sent to the BMS II Slave by the controlling Master, thereby disabling normal Modbus Network communication. It indicates that the BMS II is listening for the “RESTART COMMUNICATIONS OPTIONS” diagnostic command required to restart normal Modbus communication. The BMS II will operate in the Fail Safe mode during this period.

Table 5-2 Common Problems

Problem	Possible Causes	Solution
Boiler plant not started by BMS II	<ul style="list-style-type: none"> • BMS II not turned ON. • Outside air temperature higher than system's start temperature • Configuration not correct. • System must be initialized • Wiring between boilers and BMS II not correct 	<ul style="list-style-type: none"> • Press ON/OFF button and ensure that the LED lights • Check outside air temperature and system start temperature. System start temperature should be higher than outside air temperature for boilers to run. Check <i>SYS START TEMP</i> setting in RELAY MENU (paragraph 3.11). • Check <i>SYS START OPTION</i> in RELAY MENU. Load <i>START PCT</i> and <i>STOP PCT</i> in CALIBRATION MENU paragraphs 3.11, 3.12). • Initialize and test system (para. 4.7 and 4.8). • Check wiring. (See Chapter 2 & Appendix E)
BMK or KC Boiler with C-More Control Box not being recognized by BMS II.	<ul style="list-style-type: none"> • C-More Box not configured correctly. • C-More Box not enabled. Front panel switch is off. • Incorrect wiring between BMS II and Boiler. • Alarm condition present on C-More Control Box. 	<ul style="list-style-type: none"> • Ensure that the C-More Boiler is configured for Direct Drive (see Chapter 5 of correct BMK or KC1000 O & M Manual for required menu settings). • Check ON/OFF switch. • See Chapter 2 for correct wiring connections • Clear alarm condition.
Modulex Boiler with BCM Control not being recognized by BMS II.	<ul style="list-style-type: none"> • BCM not configured correctly. • 3-position switch on boiler not in correct position. • BCM Control is in alarm. • Incorrect wiring between BMS II and BCM Control. 	<ul style="list-style-type: none"> • Ensure that last boiler has termination activated (see GF-114, GF-115-C). • Ensure that the 3-position switch is in the 0 (zero) position. • Clear alarm condition. • Refer to Chapter 2 for correct wiring connections.
BMS II controlling boilers. EMS can see BMS II, but cannot see boilers.	<ul style="list-style-type: none"> • <i>MODBUS PASS THRU</i> not enabled in BMS II. • EMS communication response time too short. 	<ul style="list-style-type: none"> • See RS232 MENU (paragraph 3.6). • Allow at least 2 seconds to receive boiler information.

TROUBLESHOOTING

Table 5-2 Common Problems - Continued

Problem	Possible Causes	Solution
EMS cannot see BMSII	<ul style="list-style-type: none"> • Incorrect address • Incorrect Baud Rate • Faulty wiring between EMS and BMS II. 	<ul style="list-style-type: none"> • See RS232 MENU (paragraph 3.6). • See RS232 MENU (paragraph 3.6). • See Chapter 2. Check wiring polarity and connections.
Boiler <i>RAMP UP</i> or <i>RAMP DOWN</i> too slow or too fast	<ul style="list-style-type: none"> • <i>RAMP UP</i> or <i>RAMP DOWN</i> time needs adjustment. • PID requires adjustment. 	<ul style="list-style-type: none"> • Refer to CALIBRATION MENU (paragraph 3.12) and check the <i>RAMP UP %/MIN</i> or <i>RAMP DOWN %/MIN</i> • Refer to TUNING MENU (para. 3.10).
<i>HEADER TEMPERATURE</i> not reaching Setpoint	<ul style="list-style-type: none"> • Deadband requires adjustment • PID requires adjustment 	<ul style="list-style-type: none"> • Check <i>HDR TEMP DEADBND</i> in TUNING MENU (paragraph 3.10). Default = 5°. • See TUNING MENU (paragraph 3.10).
Need to restore Factory Default Settings.	<ul style="list-style-type: none"> • Too many setting changes. 	<ul style="list-style-type: none"> • Go to <i>RESET DEFAULTS</i> option in CALIBRATION MENU (paragraph 3.12)
Boilers over-shooting setpoint or tripping aquastat	<ul style="list-style-type: none"> • Header sensor not installed correctly • PID setting require adjustment • Adjustable aquastat set too low • System pumps are shut down and not controlled by or interlocked with the BMS II 	<ul style="list-style-type: none"> • Check header sensor connections and installation. • Adjust PID settings in TUNING MENU (paragraph 3.10). • If aquastat is set lower than 200°F, reset it to 220°F. • If system pumps are shut down, check start and stop temperatures on energy management system. They should correspond to those set in the BMS II. In addition, interlock wiring can be run between the BMS II and energy management system to disable the BMS II pumps when pumps are not running.
Modbus Network faults encountered. Boiler plant not operating	<ul style="list-style-type: none"> • BMS II or boilers not properly configured for Modbus communication. • Bias and/or termination not activated. 	<ul style="list-style-type: none"> • Refer to Modbus Communication Manual GF-114 for C-More control or GF-115-C for BCM control on Modulux boilers. Check all wiring connections and software menu settings. • Activate termination in last boiler. Activate bias on BMS II for BCM control or in last C-More control.

APPENDIX A

BMS II MENUS

	AVAILABLE CHOICES OR LIMITS		
MENU LEVEL & OPTION	MINIMUM	MAXIMUM	DEFAULT
<u>OPERATING MENU</u>			
HEADER TEMP	40	280	N/A
HEADER SET TEMP	40	220	N/A
OUTSIDE AIR TEMP	-60	180	N/A
PERCENT OF LOAD	0	100	N/A
I/O STATUS	Bit 0 = AUX Relay Bit 1 = Fault Relay Bit 2 = Sys Start Relay Bit 3 = Empty Bit 4 = Setback Bit 5 = Interlock 2 Bit 6 = Interlock 1 Bit 7 = Empty		
RETURN TEMP	40	280	N/A
<u>SETUP MENU</u>			
ENTER PASSWORD (Level 1 = 159) (Level 2 = 6817)	0	32000	0
SET MONTH	01	12	
SET DATE	01	31	
SET YEAR	00	99	
SET HOUR	00	23	
SET MINUTE	00	59	
SET DAY OF WEEK	SUNDAY TO SATURDAY		
<u>RS232 MENU</u>			
RS232 MODE	MODBUS SLAVE, NORMAL		MODBUS SLAVE
RS232 BAUDRATE	2400, 4800, 9600, 19200		9600
MODBUS ADDRESS	128	247	128
NETWORK TIMEOUT (Seconds)	005	240	060
MODBUS PASS THRU	DISABLED, ENABLED		DISABLED

APPENDIX A

APPENDIX A

BMS II MENUS - Continued

MENU LEVEL & OPTION	AVAILABLE CHOICES OR LIMITS		DEFAULT
	MINIMUM	MAXIMUM	
<u>RS485 MENU</u>			
RS485 BAUDRATE	2400, 4800, 9600, 19200		9600
MIN SLAVE ADDR	000	127	000
MIN SLAVE ADDR	000	127	000
NUMBER NETW BLRS	00	32	02
MODBUS CNTL TYPE	ROUND ROBIN, BROADCAST		ROUND ROBIN
NETW BOILER 01 ADDRESS =	000	127	001
NETW BOILER 02 ADDRESS =	000	127	002
NETW BOILER 03 ADDRESS =	000	127	000
Etc., Up To:			
NETW BOILER 32 ADDRESS =	000	127	000
<u>FIELD ADJUST MENU</u>			
HEADER SET MODE	CONSTANT SETPOINT, OUTDOOR RESET, REMOTE SETPOINT		CONSTANT SETPOINT
HDR HIGH LIMIT	040°F	220°F	200°F
HDR LOW LIMIT	040°F	220°F	040°F
INTERNAL SETPT	040°F	220°F	160°F
RESET RATIO (Displayed Only if HDR SET MODE = OUTDOOR RESET)	0.3	3.0	1.2
BLDG REF TEMP (Displayed Only If HDR SET MODE = OUTDOOR RESET)	40°F	220°F	70°F
REMOTE SIGNAL (Displayed Only If HDR SET MODE = REMOTE SETPT)	4 – 20 mA, MODBUS		4 - 20 mA

APPENDIX A

BMS II MENUS - Continued

MENU LEVEL & OPTION	AVAILABLE CHOICES OR LIMITS		DEFAULT
	MINIMUM	MAXIMUM	
<u>FIELD ADJUST MENU</u> – Cont.			
OFFSET ENABLE	OFF, ON		OFF
SUN OFFS TEMP	-50.0°F	50.0°F	00.0
SUN ON HOUR	00	23	00
SUN ON MINUTE	00	59	00
SUN OFF HOUR	00	23	00
SUN OFF MINUTE	00	59	00
Etc., Up To:			
SAT OFF MINUTE	00	59	00
<u>CONFIGURATION MENU</u>			
BOILER OP MODE	SEQUENTIAL MODE, PARALLEL MODE		SEQUENTIAL MODE
SYS INTLK CONFIG	START ENABLED, ALWAYS ENABLED		START ENABLED
BLR START LEVEL	001%	100%	020%
BLR STOP LEVEL	001%	040%	016%
MAX POWER INPUT	050%	100%	100%
FAIL SAFE MODE	SHUTDOWN, CONSTANT SETPOINT		SHUTDOWN
<u>TUNING MENU</u>			
PROPORTIONAL BND	005°F	120°F	070°F
INTEGRAL GAIN	0.00 REP/MIN	9.99 REP/MIN	0.15 REP/MIN
DERIVATIVE GAIN	-2.00 MIN.	2.00 MIN.	0.15 MIN.
HDR TEMP DEADBND	001°F	015°F	005°F

APPENDIX A

APPENDIX A

BMS II MENUS - Continued

MENU LEVEL & OPTION	AVAILABLE CHOICES OR LIMITS		DEFAULT
	MINIMUM	MAXIMUM	
<u>RELAY MENU</u>			
SYS START TEMP	032°F	120°F	070°F
SYS START OPTION	TEMP ONLY, TEMP AND LOAD		TEMP ONLY
SYS START INTLK	DISABLED INTERLOCK 1 INTERLOCK 2 INTERELOCK 1&2		INTERLOCK 1
AUX RELAY OPEN	000%	099%	045%
AUX RELAY CLOSE	100% FIRE RATE, 100% AND OFF		100% AND OFF
FAULT ALRM RELAY	ALL FAULTS, NO INTERLOCK, INTERLOCK 2, INTERLOCK 1		ALL FAULTS
FAULT ALARM BLRS	NO BLR FAULTS, ALL BLR FAULTS		NO BLR FAULTS
FAULT ALRM CLEAR	AUTOMATIC, MANUAL RESET		AUTOMATIC
<u>CALIBRATION MENU</u>			
HDR SENS OFFSET	-10.0°	10.0°	00.0°
OUTD SENS OFFSET	-10.0°	10.0°	00.0°
4 – 20 MA OFFSET	-10.0	10.0	00.0
RET SENS OFFSET	-10.0°	10.0°	00.0
RAMP UP %/MIN	000	300	020
RAMP DOWN %/MIN	000	300	200
LOAD START PCT	000	100	1
LOAD STOP PCT	000	100	0
RESET DEFAULTS	NO, YES (DONE If Selected)		NO

APPENDIX B

STATUS AND FAULT MESSAGES

DISPLAY MESSAGES	DESCRIPTION
STATUS MESSAGES:	
FAIL SAFE MODE ACTIVATED	The system is running in the Constant Setpt mode due to loss of the Remote signal or Outdoor Air sensor input.
NETWORK DISABLED MODBUS LISTEN	“Forced Listen Only Mode” has been activated. All Modbus commands except “restart Communications Options” will be ignored. The BMS II will operate in the Fail Safe Mode.
OUTSIDE AIR TEMP NOT CONNECTED	The Outdoor Air Temperature Sensor is not installed and connected.
RETURN TEMP NOT INSTALLED	The Boiler Return Temperature Sensor is not installed.
FAULT MESSAGES	
OUTDOOR SENSOR ERROR	The Outdoor Air Temperature Sensor signal is out of range.
HEADER SENSOR ERROR	The Header Temperature Sensor signal is out of range or disconnected.
RETURN SENSOR ERROR	The Return Temperature Sensor signal is out of range.
INTERLOCK 1 ERROR	Interlock 1 input is open.
INTERLOCK 2 ERROR	Interlock 2 input is open.
4 – 20 mA INPUT ERROR	The 4 – 20 mA Remote Input signal is lost.
MODBUS TIMEOUT ERROR	The Modbus remote input information was not received within the network timeout period.

APPENDIX C

METHODS FOR DETERMINING RESET SCHEDULE AND OUTDOOR RESET RATIO CHARTS

Using the Charts to Determine Reset Schedule

Each table in this appendix provides data for a specific building reference temperature. On the vertical axis of each table are degree day temperatures. These are the average lowest temperatures likely to be encountered. The engineer of your system should have this number for your area. The reset ratio is shown across the top. The data in the tables is header temperature. To determine the reset ratio for your installation, follow these steps:

- On the vertical axis, find the degree day for your area.
- Select the temperature that should be maintained in the header to maintain the building at the desired temperature. The system engineer should have this information.
- The proper reset ratio is the value found above the two selected points. For example, for a degree day of 15°F and a header temperature of 125°F, the reset ratio is 1.4.

Determining Reset Schedule By Formula

There are two steps required to determine reset schedule with this method. The first is to determine the reset ratio by dividing the range of outside temperatures by the range of header temperatures:

$$T_{\text{header}}/T_{\text{outside}} = \text{Reset Ratio.}$$

for example, If T_{outside} varies from -10 to +95°F (105° range), and

T_{header} varies from 125 to 200°F (75° range), then the reset ratio equals

$$75^{\circ}\text{F}/105^{\circ}\text{F} = 0.714.$$

Once the reset ratio is determined, this number and the lowest or highest header temperature and corresponding lowest or highest air temperature, are input to the following equation to yield the building reference temperature:

$$T_{\text{header}} - \text{RR} (T_{\text{R}} - T_{\text{O}}) + T_{\text{R}}, \text{ where:}$$

RR is the reset ratio

T_{R} is the building reference temperature

T_{O} is the minimum outside temperature, and

T_{header} is the maximum heating system

Temperature desired at the minimum outside air temperature.

So in this example:

$$T_{\text{header}} = 200^{\circ}\text{F}$$

$$200^{\circ}\text{F} = 0.714 [T_{\text{R}} - (-10^{\circ}\text{F})] + T_{\text{R}}$$

$$200^{\circ}\text{F} = 1.714T_{\text{R}} + 7.14^{\circ}\text{F}$$

Solving for T_{R} :

$$T_{\text{R}} = (200^{\circ}\text{F} - 7.14^{\circ}\text{F})/1.714$$

$$T_{\text{R}} = 192.86^{\circ}\text{F}/1.714$$

$$T_{\text{R}} = 112.5^{\circ}\text{F}$$

Therefore, use a reset ratio of 0.7 (closest to 0.714) and a building reference temperature of 113 (closest to 112.5).

APPENDIX C

Table C-1. Header Temperature for a Building Reference Temperature of 50°F

Air Temp	RESET RATIO									
	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
50°F	50°F	50°F	50°F	50°F	50°F	50°F	50°F	50°F	50°F	50°F
45°F	53°F	54°F	55°F	56°F	57°F	58°F	59°F	60°F	60°F	62°F
40°F	56°F	58°F	60°F	62°F	64°F	66°F	68°F	70°F	72°F	74°F
35°F	59°F	62°F	65°F	68°F	71°F	74°F	77°F	80°F	83°F	86°F
30°F	62°F	66°F	70°F	74°F	78°F	82°F	86°F	90°F	94°F	98°F
25°F	65°F	70°F	75°F	80°F	85°F	90°F	95°F	100°F	105°F	110°F
20°F	68°F	74°F	80°F	86°F	92°F	98°F	104°F	110°F	116°F	122°F
15°F	71°F	78°F	85°F	92°F	99°F	106°F	113°F	120°F	127°F	134°F
10°F	74°F	82°F	90°F	98°F	106°F	114°F	122°F	130°F	138°F	146°F
5°F	77°F	86°F	95°F	104°F	113°F	122°F	131°F	140°F	149°F	158°F
0°F	80°F	90°F	100°F	110°F	120°F	130°F	140°F	150°F	160°F	170°F
-5°F	83°F	94°F	105°F	116°F	127°F	138°F	149°F	160°F	171°F	182°F
-10°F	86°F	98°F	110°F	122°F	134°F	146°F	158°F	170°F	182°F	194°F
-15°F	89°F	102°F	115°F	128°F	141°F	154°F	167°F	180°F	193°F	206°F
-20°F	92°F	106°F	120°F	134°F	148°F	162°F	176°F	190°F	204°F	218°F

Table C-2. Header Temperature for a Building Reference Temperature of 60°F

Air Temp	RESET RATIO									
	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
60°F	60°F	60°F	60°F	60°F	60°F	60°F	60°F	60°F	60°F	60°F
55°F	63°F	64°F	65°F	66°F	67°F	68°F	69°F	70°F	71°F	72°F
50°F	66°F	68°F	70°F	72°F	74°F	76°F	78°F	80°F	82°F	84°F
45°F	69°F	72°F	75°F	78°F	81°F	84°F	87°F	90°F	93°F	96°F
40°F	72°F	76°F	80°F	84°F	88°F	92°F	96°F	100°F	104°F	108°F
35°F	75°F	80°F	85°F	90°F	95°F	100°F	105°F	110°F	115°F	120°F
30°F	78°F	84°F	90°F	96°F	102°F	108°F	114°F	120°F	126°F	132°F
25°F	81°F	88°F	95°F	102°F	109°F	116°F	123°F	130°F	137°F	144°F
20°F	84°F	92°F	100°F	108°F	116°F	124°F	132°F	140°F	148°F	156°F
15°F	87°F	96°F	105°F	114°F	123°F	132°F	141°F	150°F	159°F	168°F
10°F	90°F	100°F	110°F	120°F	130°F	140°F	150°F	160°F	170°F	180°F
5°F	93°F	104°F	115°F	126°F	137°F	148°F	159°F	170°F	181°F	192°F
0°F	96°F	108°F	120°F	132°F	144°F	156°F	168°F	180°F	192°F	204°F
-5°F	99°F	112°F	125°F	138°F	151°F	164°F	177°F	190°F	203°F	216°F
-10°F	102°F	116°F	130°F	144°F	158°F	172°F	186°F	200°F	214°F	
-15°F	105°F	120°F	135°F	150°F	165°F	180°F	195°F	210°F		
-20°F	108°F	124°F	140°F	156°F	172°F	188°F	204°F			

APPENDIX C

Table C-3. Header Temperature for a Building Reference Temperature of 65°F

Air Temp	RESET RATIO									
	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
65°F	65°F	65°F	65°F	65°F	65°F	65°F	65°F	65°F	65°F	65°F
60°F	68°F	69°F	70°F	71°F	72°F	73°F	74°F	75°F	76°F	77°F
55°F	71°F	73°F	75°F	77°F	79°F	81°F	83°F	85°F	87°F	89°F
50°F	74°F	77°F	80°F	83°F	86°F	89°F	92°F	95°F	98°F	101°F
45°F	77°F	81°F	85°F	89°F	93°F	97°F	101°F	105°F	109°F	113°F
40°F	80°F	85°F	90°F	95°F	100°F	105°F	110°F	115°F	120°F	125°F
35°F	83°F	89°F	95°F	101°F	107°F	113°F	119°F	125°F	131°F	137°F
30°F	86°F	93°F	100°F	107°F	114°F	121°F	128°F	135°F	142°F	149°F
25°F	89°F	97°F	105°F	113°F	121°F	129°F	137°F	145°F	153°F	161°F
20°F	92°F	101°F	110°F	119°F	128°F	137°F	146°F	155°F	164°F	173°F
15°F	95°F	105°F	115°F	125°F	135°F	145°F	155°F	165°F	175°F	185°F
10°F	98°F	109°F	120°F	131°F	142°F	153°F	164°F	175°F	186°F	197°F
5°F	101°F	113°F	125°F	137°F	149°F	161°F	173°F	185°F	197°F	209°F
0°F	104°F	117°F	130°F	143°F	156°F	169°F	182°F	195°F	208°F	
-5°F	107°F	121°F	135°F	149°F	163°F	177°F	191°F	205°F	219°F	
-10°F	110°F	125°F	140°F	155°F	170°F	185°F	200°F	215°F		
-15°F	113°F	129°F	145°F	161°F	177°F	193°F	209°F			
-20°F	116°F	133°F	150°F	167°F	201°F	218°F				

Table C-4. Header Temperature for a Building Reference Temperature of 70°F

Air Temp	RESET RATIO									
	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
70°F	70°F	70°F	70°F	70°F	70°F	70°F	70°F	70°F	70°F	70°F
65°F	73°F	74°F	75°F	76°F	77°F	78°F	79°F	80°F	81°F	82°F
60°F	76°F	78°F	80°F	82°F	84°F	86°F	88°F	90°F	92°F	94°F
55°F	79°F	82°F	85°F	88°F	91°F	94°F	97°F	100°F	103°F	106°F
50°F	82°F	86°F	90°F	94°F	98°F	102°F	106°F	110°F	114°F	118°F
45°F	85°F	90°F	95°F	100°F	105°F	110°F	115°F	120°F	125°F	130°F
40°F	88°F	94°F	100°F	106°F	112°F	118°F	124°F	130°F	136°F	142°F
35°F	91°F	98°F	105°F	112°F	119°F	126°F	133°F	140°F	147°F	154°F
30°F	94°F	102°F	110°F	118°F	126°F	134°F	142°F	150°F	158°F	166°F
25°F	97°F	106°F	115°F	124°F	133°F	142°F	151°F	160°F	169°F	178°F
20°F	100°F	110°F	120°F	130°F	140°F	150°F	160°F	170°F	180°F	190°F
15°F	103°F	114°F	125°F	136°F	147°F	158°F	169°F	180°F	191°F	202°F
10°F	106°F	118°F	130°F	142°F	154°F	166°F	178°F	190°F	202°F	214°F
5°F	109°F	122°F	135°F	148°F	161°F	174°F	187°F	200°F	213°F	
0°F	112°F	126°F	140°F	154°F	168°F	182°F	196°F	210°F		
-5°F	115°F	130°F	145°F	160°F	175°F	190°F	205°F			
-10°F	118°F	134°F	150°F	166°F	182°F	198°F	214°F			
-15°F	121°F	138°F	155°F	172°F	189°F	206°F				
-20°F	124°F	142°F	160°F	178°F	196°F	214°F				

APPENDIX C

Table C-5. Header Temperature for a Building Reference Temperature of 75°F

Air Temp	RESET RATIO									
	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
75°F	75°F	75°F	75°F	75°F	75°F	75°F	75°F	75°F	75°F	75°F
70°F	78°F	79°F	80°F	81°F	82°F	83°F	84°F	85°F	86°F	87°F
65°F	81°F	83°F	85°F	87°F	89°F	91°F	93°F	95°F	97°F	99°F
60°F	84°F	87°F	90°F	93°F	96°F	99°F	102°F	105°F	108°F	111°F
55°F	87°F	91°F	95°F	99°F	103°F	107°F	111°F	115°F	119°F	123°F
50°F	90°F	95°F	100°F	105°F	110°F	115°F	120°F	125°F	130°F	135°F
45°F	93°F	99°F	105°F	111°F	117°F	123°F	129°F	135°F	141°F	147°F
40°F	96°F	103°F	110°F	117°F	124°F	131°F	138°F	145°F	152°F	159°F
35°F	99°F	107°F	115°F	123°F	131°F	139°F	147°F	155°F	163°F	171°F
30°F	102°F	111°F	120°F	129°F	138°F	147°F	156°F	165°F	174°F	183°F
25°F	105°F	115°F	125°F	135°F	145°F	155°F	165°F	175°F	185°F	195°F
20°F	108°F	119°F	130°F	141°F	152°F	163°F	174°F	185°F	196°F	207°F
15°F	111°F	123°F	135°F	147°F	159°F	171°F	183°F	195°F	207°F	219°F
10°F	114°F	127°F	140°F	153°F	166°F	179°F	192°F	205°F	218°F	
5°F	117°F	131°F	145°F	159°F	173°F	187°F	201°F	215°F		
0°F	120°F	135°F	150°F	165°F	180°F	195°F	210°F			
-5°F	123°F	139°F	155°F	171°F	187°F	203°F	219°F			
-10°F	126°F	143°F	160°F	177°F	194°F	211°F				
-15°F	129°F	147°F	165°F	183°F	201°F	219°F				

Table C-6. Header Temperature for a Building Reference Temperature of 80°F

Air Temp	RESET RATIO									
	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
80°F	80°F	80°F	80°F	80°F	80°F	80°F	80°F	80°F	80°F	80°F
75°F	83°F	84°F	85°F	86°F	87°F	88°F	89°F	90°F	91°F	92°F
70°F	86°F	88°F	90°F	92°F	94°F	96°F	98°F	100°F	102°F	104°F
65°F	89°F	92°F	95°F	98°F	101°F	104°F	107°F	110°F	113°F	116°F
60°F	92°F	96°F	100°F	104°F	108°F	112°F	116°F	120°F	124°F	128°F
55°F	95°F	100°F	105°F	110°F	115°F	120°F	125°F	130°F	135°F	140°F
50°F	98°F	104°F	110°F	116°F	122°F	128°F	134°F	140°F	146°F	152°F
45°F	101°F	108°F	115°F	122°F	129°F	136°F	143°F	150°F	157°F	164°F
40°F	104°F	112°F	120°F	128°F	136°F	144°F	152°F	160°F	168°F	176°F
35°F	107°F	116°F	125°F	134°F	143°F	152°F	161°F	170°F	179°F	188°F
30°F	110°F	120°F	130°F	140°F	150°F	160°F	170°F	180°F	190°F	200°F
25°F	113°F	124°F	135°F	146°F	157°F	168°F	174°F	190°F	201°F	212°F
20°F	116°F	128°F	140°F	152°F	164°F	176°F	188°F	200°F	212°F	
15°F	119°F	132°F	145°F	158°F	171°F	184°F	197°F	210°F		
10°F	122°F	136°F	150°F	164°F	178°F	192°F	206°F			
5°F	125°F	140°F	155°F	170°F	185°F	200°F	215°F			
0°F	128°F	144°F	160°F	176°F	192°F	208°F				
-5°F	131°F	148°F	165°F	182°F	199°F	216°F				
-10°F	134°F	152°F	170°F	188°F	206°F					

APPENDIX C

Table C-7. Header Temperature for a Building Reference Temperature of 90°F

Air Temp	RESET RATIO									
	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
90°F	90°F	90°F	90°F	90°F	90°F	90°F	90°F	90°F	90°F	90°F
85°F	93°F	94°F	95°F	96°F	97°F	98°F	99°F	100°F	101°F	102°F
80°F	96°F	98°F	100°F	102°F	104°F	106°F	108°F	110°F	112°F	114°F
75°F	99°F	102°F	105°F	108°F	111°F	114°F	117°F	120°F	123°F	126°F
70°F	102°F	106°F	110°F	114°F	118°F	122°F	126°F	130°F	134°F	138°F
65°F	105°F	110°F	115°F	120°F	125°F	130°F	135°F	140°F	145°F	150°F
60°F	108°F	114°F	120°F	126°F	132°F	138°F	144°F	150°F	156°F	162°F
55°F	111°F	118°F	125°F	132°F	139°F	146°F	153°F	160°F	167°F	174°F
50°F	114°F	122°F	130°F	138°F	146°F	154°F	162°F	170°F	178°F	186°F
45°F	117°F	126°F	135°F	144°F	153°F	162°F	171°F	180°F	189°F	198°F
40°F	120°F	130°F	140°F	150°F	160°F	170°F	180°F	190°F	200°F	210°F
35°F	123°F	134°F	145°F	156°F	167°F	178°F	189°F	200°F		
30°F	126°F	138°F	150°F	162°F	174°F	186°F	198°F	210°F		
25°F	129°F	142°F	155°F	168°F	181°F	194°F	207°F			
20°F	132°F	146°F	160°F	174°F	188°F	202°F	216°F			
15°F	135°F	150°F	165°F	180°F	195°F	210°F				
10°F	138°F	154°F	170°F	186°F	202°F	218°F				
5°F	141°F	158°F	175°F	192°F	209°F					
0°F	144°F	162°F	180°F	198°F	216°F					

APPENDIX D

NTC Temperature Sensor Resistance Chart

Temperature (°F)	Resistance (ohms)	Temperature (°F)	Resistance (ohms)
-40	239,571	180	1,362
-30	173,530	190	1,155
-20	127,088	200	984
-10	94,059	210	842
0	70,314	220	723
10	53,068	230	623
20	40,418	240	539
30	31,053	250	468
40	24,057	260	408
50	18,787	270	357
60	14,783	280	313
70	11,717	290	276
80	9,353	300	243
90	7,516	310	
100	6,078	320	
110	4,946	330	
120	4,049	340	
130	3,333	350	
140	2,759	360	
150	2,296	370	
160	1,920	380	
170	1,613	390	

NOTE

This Temperature Chart is applicable to Header Sensor (and Return Sensor), Part No. 64038 and Outside Air Sensor, Part No. GP-122662.

TERMINALS PROVIDE 12 VDC @ 15 mA

RELAYS RATED AT 120 VAC, 5A & FUSED INTERNALLY AT 5A

POWER INPUT, 16 AWG 120 VAC, 60 Hz, 1A FUSED INTERNALLY AT 1A

CONTACT CLOSING LOGIC:

- CONTACT CLOSING ON OUTSIDE AIR TEMP
- CONTACT CLOSING ON BMS FAULT CONDITION
- CONTACT CLOSING WHEN HEATING PLANT IS AT MAX. POWER INPUT

RS232 FROM EMS (NOTE 3)

RS485 TO BOILERS (TERM. 3) TO SHLD (TERM. 3)

INTERLOCKS & SETBACK WIRING (NOTE 2)

SENSOR WIRING (NOTE 1)

NOTES:

1. AERCO RECOMMENDS USING TWO-CONDUCTOR, TWISTED, SHIELDED PAIR, 22 AWG CABLE (BELDEN 9841 OR EQUIV.)

- TERMINATE SHIELDS AT BMS SHIELD (SHLD) TERMINAL ONLY.
- DO NOT CONNECT SHIELDS AT SENSOR ENDS.
- DO NOT RUN SENSOR WIRING WITH POWER WIRING.

2. CONTACTS PROVIDED BY OTHERS. USE CONTACTS RATED FOR LOW SIGNAL LEVELS.

JUMPER INTERLOCKS (INT1, INT2) IF EXTERNAL CONTACTS ARE NOT USED.

3. IF THE EMS BEING USED CONTAINS ONLY A RS485 PORT, A RS485-TO-RS232 CONVERTER IS REQUIRED. IF NECESSARY, A 12 VDC OUTPUT IS PROVIDED BY THE BMS II TO POWER THE RS485-TO-RS232 CONVERTER,

APPENDIX F

BMS II PARTS AND ACCESSORIES

PART NUMBER	DESCRIPTION	COMMENTS
64053	Boiler Management System II (BMS II)	Complete BMS II
GP-123043	12 VAC, 5A, 2AG Subminiature, Fast-Acting Fuse (Littlefuse 225005)	For System-Start, Fault Alarm, and Auxiliary Relays
69091	4 – 20 mA Fuse	63 microamp fuse for current loop
GP-122662	Outside Air Temperature Sensor	Sensor Only
GM-122781	Outside Air Temperature Sensor Kit	Includes Sensor (GP-122662) and Mounting Bracket
64038	Header Temperature Sensor	Sensor Only
GP-122758	Thermowell for Header Temperature Sensor	Thermowell Only
GM-122790	Header Temperature Sensor Kit	Includes 64038 and GP-122758
GM-122791	Outdoor Reset Kit	Includes GM-122781 and GM-122790
62017	Low Voltage Terminal Block (14 pin)	
62018	High Voltage Terminal Block (9 pin)	
62019	RS485 Terminal Block (3 pin)	
62020	RS232 Terminal Block (4 pin)	

APPENDIX G

PROGRAMMING THE BMS II USING RS-232 COMMUNICATION

Introduction

The RS-232 port located in the wiring compartment area of the BMS II can be used to program the BMS II using a laptop computer or other suitable terminal. Connection to a laptop or other terminal device is made by wiring to the RXD, TXD and GND connections (see paragraph 2.9 and Figure 2-12 for pinout information when wiring from a DB9 connector).. Communication can be accomplished using any “Dumb Terminal” emulation, such as Hyper Terminal which is included with Microsoft Windows. The RS-232 communication feature allows the BMS to be easily programmed to your installation requirements using a listing of entry commands.

Set-Up

Regardless of the terminal emulation utilized, the following guidelines must be adhered to when interfacing the BMS to the Terminal device:

1. Connect cable leads to the RS-232 connector in the wiring area of the BMS II.
2. Connect the free end of the cable to the COM 1 or COM 2 port on your laptop, or other suitable terminal device.
3. Set up the emulator communication link as follows:
 - (d) Set the baud rate to 9600.
 - (e) Set the data format to 8 bits, 1 stop bit, no parity and either Xon/Xoff or No Flow Control.
4. Turn on the BMS II by pressing the **ON/OFF** key. Verify that the **ON** LED lights.
5. Press the **MENU** key. Go to the SETUP MENU and enter a valid PASSWORD.
6. Press the **MENU** key and go to the RS232 MENU.
7. Press the **▲** arrow key to display the *RS232 MODE* option.
8. Press the **▲** or **▼** arrow key to display *NORMAL*. Press the **ENTER** key to store the *NORMAL* selection
9. Start the emulator software program.
10. At the command prompt, enter the password EXACTLY as follows (case-sensitive):

P=gobms
11. Press Return (<Rtn>) on your terminal.
12. The setup is now complete. You are ready to begin viewing or changing BMS functions.

APPENDIX G

APPENDIX G (cont.)

Programming Procedure

BMS II functions which can be viewed or changed are listed in Table J-1 along with their corresponding command numbers. Functions which can only be viewed (such as actual sensor readings) are marked "Read Only". Viewing or changing function values is accomplished as follows:

1. Select the number of the desired command from Table J-1.
2. To view a parameter, type ?, followed by the command number and then press return (<Rtn>). For example, to view command no. 00 (HEADER TEMPERATURE), enter:

?00<Rtn>

The header temperature reading will be displayed. All temperature readings are in °F.

3. To program (set) a BMS parameter, type @, followed by the command number, an equal sign, the parameter value and a trailing zero. For example, to set command 05 (SYSTEM OUTSIDE AIR START TEMPERATURE) to 65°F, enter:

@05=650<Rtn>

Use the above steps to view and/or program the desired BMS II functions listed in Table G-1.

APPENDIX G (cont.)

Table G-1. BMS II COMMANDS

No.	COMMAND	ENTRY RANGE	FACTORY DEFAULT
00	Header Temperature (°F)	40 to 220	Read Only
01	Outside Air Temperature (°F)	-60 to 80	Read Only
02	Return Sensor (°F)	40 to 160	Read Only
03	Percent of Load (%)	0 to 100	Read Only
04	Header Set Temperature (°F)	40 to 220	Read Only
05	System Start Temperature (°F)	32 to 120	70
06	System Start Mode	0 = Temp Only 1 = Temp and Load	0 = Temp Only
07	Internal Setpt (°F)	40 to 220	160
08	Bldg Reference Temperature (°F)	40 to 220	70°F
09	Not Used		
10	Not Used		
11	Reset Ratio	0.3 to 3.0 (0.1 increments)	1.2
12	Maximum Header Temperature (°F)	40 to 220	220
13	Minimum Header Temperature (°F)	40 to 220	40
14	Boiler Start Percent	25 to 100	20
15	Boiler Stop Percent	10 to 45	16
16	Integral Gain (Rep./Min)	0.00 to 9.99 (0.01 increments)	0.15
17	Header Set Mode	0 = Constant Setpt 1 = Indr/Outdr Reset 2 = Remote Settemp	0 = Constant Setpt
18	Derivative Gain	-2.00 to 2.00 (0.01 increments)	0.15
19	Proportional Band (°F)	5 to 100	70
20	Aux Relay Open	0 to 99	45
21	Aux Relay Close	0 = 100% Fire Rate 1 = 100% and OFF	1 = 100% AND OFF
22	Failsafe Mode	0 = Shutdown 1 = Switch Inputs	0 = Shutdown
23	Fault Relay Mode	0 = All Faults 1 = No Interlock 2 = Interlock 2 3 = Interlock 1	0 = All Faults
24	Alarm Clear Method	0 = Automatic 1 = Manual	0 = Automatic
25	Boiler Operation Mode	0 = Parallel 1 = Sequential 2 = Combination	1 = Sequential

APPENDIX G

APPENDIX G (cont.)

Table G-1. BMS II COMMANDS

No.	COMMAND	ENTRY RANGE	FACTORY DEFAULT
26	Not Used		
27 28 29	Reserved		
30	Maximum Power Input	50 to 100	100
31	System Interlock Configuration	0 = Always Enabled 1 = Start Enabled	1 = Start Enabled
32	Real Time Clock - Minutes	00 to 59	Present Time
33	Real Time Clock - Hours	00 to 23	Present Time
34	Real Time Clock - Day Of Week	1 to 7	Present Day
35	Real Time Clock - Year	00 to 99	Present Year
36	Real Time Clock - Day Of Month	00 to 31	Present Day
37	Real Time Clock - Month	00 to 12	Present Month
38 Thru 44	(Day 1 – Sun.) Offset Temperatures (Day 1-7) (Day 7 – Sat.)	-50 to +50°F	All Set To 0°F
45 Thru 51	(Sun.) Offset ON Time – Minutes (Sun.-Sat.) (Sat.)	00 to 59	All Set to Zero
52 Thru 58	(Sun.) Offset ON Time – Hours (Sun.-Sat.) (Sat.)	00 to 23	All Set To Zero
59	Offset Enable	0 = Disabled 1 = Enabled	0 = Disabled
60	Header Temp Offset (°F)	-10°F to 10°F	0
61	System Start Interlock	1 = Intlk 1 Opens Start Relay 2 = Intlk 2 Opens Start Relay 3 = Either Intlk Opens Start Relay	1 = Intlk 1
70 Thru 76	(Sun.) Offset OFF Time – Minutes (Sun.-Sat.) Sat.)	00 to 59	All Set To Zero
77 Thru 83	(Day 1) Offset OFF Time – Hours (Day 1-7) (Day 7)	0 to 23	All Set To Zero
84	(Reserved)		
85	Not Used	0 or 1	

APPENDIX G (cont.)

Table G-1. BMS COMMANDS – (Continued)

No.	COMMAND	ENTRY RANGE	FACTORY DEFAULT
86	Remote Signal	0 or 1 0 = 4 - 20 mA 1 = Modbus	0 = 4 - 20 mA
87	RS232 Mode	0 or 1 0 = Normal 1 = Modbus	1 = Modbus
88	RS232 Baud Rate	0=2400, 1=4800, 2=9600, 3=14400, 4=19200	2 = 9600
89	Number Of Network Boilers	0 to 32	2
90	Min Slave Address	0 to 127	0
91	Max Slave Address	0 to 127	0
92	Net Boiler 1 Address	Address for Network Boiler 1	001
93	Net Boiler 2 Address	Address for Network Boiler 2	002
94	Net Boiler 3 Address	Address for Network Boiler 3	000
95	Net Boiler 4 Address	Address for Network Boiler 4	000
96	Net Boiler 5 Address	Address for Network Boiler 5	000
97	Net Boiler 6 Address	Address for Network Boiler 6	000
98	Net Boiler 7 Address	Address for Network Boiler 7	000
99	Net Boiler 8 Address	Address for Network Boiler 8	000
100	Net Boiler 9 Address	Address for Network Boiler 9	000
101	Net Boiler 10 Address	Address for Network Boiler 10	000
102	Net Boiler 11 Address	Address for Network Boiler 11	000
103	Net Boiler 12 Address	Address for Network Boiler 12	000
104	Net Boiler 13 Address	Address for Network Boiler 13	000
105	Net Boiler 14 Address	Address for Network Boiler 14	000
106	Net Boiler 15 Address	Address for Network Boiler 15	000

APPENDIX G (cont.)

Table G-1. BMS II COMMANDS – (Continued)

No.	COMMAND	ENTRY RANGE	FACTORY DEFAULT
107	Net Boiler 16 Address	Address for Network Boiler 16	000
108	Net Boiler 17 Address	Address for Network Boiler 17	000
109	Net Boiler 18 Address	Address for Network Boiler 18	000
110	Net Boiler 19 Address	Address for Network Boiler 19	000
111	Net Boiler 20 Address	Address for Network Boiler 20	000
112	Net Boiler 21 Address	Address for Network Boiler 21	000
113	Net Boiler 22 Address	Address for Network Boiler 22	000
114	Net Boiler 23 Address	Address for Network Boiler 23	000
115	Net Boiler 24 Address	Address for Network Boiler 24	000
116	Net Boiler 25 Address	Address for Network Boiler 25	000
117	Net Boiler 26 Address	Address for Network Boiler 26	000
118	Net Boiler 27 Address	Address for Network Boiler 27	000
119	Net Boiler 28 Address	Address for Network Boiler 28	000
120	Net Boiler 29 Address	Address for Network Boiler 29	000
121	Net Boiler 30 Address	Address for Network Boiler 30	000
122	Net Boiler 31 Address	Address for Network Boiler 31	000
123	Net Boiler 32 Address	Address for Network Boiler 32	000
124	Network Baud	0=2400, 1=4800, 2=9600, 3=14400, 4=19200	2 = 9600
125	Network Timeout	5 to 240 sec	60 sec.
126	Password Lo	0 to 255	0
127	Password Hi	0 to 255	0
128	Modbus Control Type	0 = Round-Robin 1 = Broadcast	0 = Round Robin

APPENDIX G (cont.)

Table G-1. BMS II COMMANDS – (Continued)

No.	COMMAND	ENTRY RANGE	FACTORY DEFAULT
129	Modbus Pass-Thru	0 = Disabled 1 = Enabled	0 = Disabled
130	Header Temp Deadband	01 to 15°F	05°F
131	Outside Temp Sensor Offset	-10.0°F to 10.0°F	0.0°F
132	Ramp Up %/Min	000 to 300	20
133	Ramp Down %/Min	000 to 300	200
134	Fault Alarm Boilers	No Blr Faults All Blr faults	No Blr Faults
135	4-20 mA Offset	-1.00 to 1.00 mA	0.0 mA
136	Return Sensor Offset	-10.0 to 10.0°F	0.0°F
137	Load Start Pct	000 to 100	1
138	Load Stop Pct	000 to 100	0
150	I/O Status	00 to 255	Bit 0 = AUX Relay Bit 1 = Fault Relay Bit 2 = Sys Start Relay Bit 3 = Empty Bit 4 = Setback Bit 5 = Interlock 2 Bit 6 = Interlock 1 Bit 7 = Empty
151 & Up	(Reserved For Future Expansion)	Undefined	

APPENDIX H

BMS II MODBUS ADDRESS ASSIGNMENTS

H-1 BMS II STANDARD INPUT REGISTER ASSIGNMENTS

The Read Only Input Register assignments for the BMS II are listed in Table H-1 which follows:

Table H-1. BMS II Standard Input Register Address Mapping

Modbus Data Address (Hex)	Menu Item	Units and Range	Default/Comments
0x0000	(Reserved)		
0x0001	Header Temperature	40 to 220°F	
0x0002	Outside Air Temperature	-60 to 120°F	
0x0003	Indoor Air/Return Temperature	40 to 220°F	
0x0004	Fire Rate Out	0 to 100% (out to boilers)	
0x0005	Header Set Temperature	40 to 220°F	
0x0006	Network Address	128 to 247	Default = 128
0x0007	Total Boilers Fired	0 to 32 (for BMS II)	
0x0008	Total Boilers On Line	0 to 32	
0x0009	(Reserved)		
0x000A	Fault/Message Code	0 to 65535 <u>Bit:</u> 0 = Outside Air Sensor 1 = Header Sensor Error 2 = Interlock 1 Error 3 = Interlock 2 Error 4 = Indoor Air Sensor Error/ Return Sensor Error 5 = 4-20mA Input Error	
0x000B thru 0x000F	(Reserved)		
0x0010	Lead Boiler Number	1 to 32	

APPENDIX H

APPENDIX H (cont.)

Table H-1. BMS II Standard Input Register Address Mapping-Cont.

Modbus Data Address (Hex)	Menu Item	Units and Range	Comments
0x0011 Thru 0x0018	Not Applicable		Used for 8 BMS Legacy (PWM) Boilers Only
0x0019	Boiler 1 Status (Net Boiler 1)	119 = Not On-Line 120 = On-Line But Not Fired 1–40 = Fired & Sequence 121 = On-Line But Disabled 122 = On-Line But Faulted	BMS II has only Network Boilers so Net Boiler 1 = Boiler 1, etc.
0x001A	Boiler 2 Status (Net Boiler 2)	Same As Above	
0x001B	Boiler 3 Status (Net Boiler 3)	Same As Above	
0x001C	Boiler 4 Status (Net Boiler 4)	Same As Above	
0x001D	Boiler 5 Status (Net Boiler 5)	Same As Above	
0x001E	Boiler 6 Status (Net Boiler 6)	Same As Above	
0x001F	Boiler 7 Status (Net Boiler 7)	Same As Above	
0x0020	Boiler 8 Status (Net Boiler 8)	Same As Above	
0x0021	Boiler 9 Status (Net Boiler 9)	Same As Above	
0x0022	Boiler 10 Status (Net Boiler 10)	Same As Above	
0x0023	Boiler 11 Status (Net Boiler 11)	Same As Above	
0x0024	Boiler 12 Status (Net Boiler 12)	Same As Above	
0x0025	Boiler 13 Status (Net Boiler 13)	Same As Above	
0x0026	Boiler 14 Status (Net Boiler 14)	Same As Above	

APPENDIX H (cont.)

Table H-1. BMS II Standard Input Register Address Mapping-Cont.

Modbus Data Address (Hex)	Menu Item	Units and Range	Comments
0x0027	Boiler 15 Status (Net Boiler 15)	119 = Not On-Line 120 = On-Line But Not Fired 1–40 = Fired & Sequence 121 = On-Line But Disabled 122 = On-Line But Faulted	
0x0028	Boiler 16 Status (Net Boiler 16)	Same As Above	
0x0029	Boiler 17 Status (Net Boiler 17)	Same As Above	
0x002A	Boiler 18 Status (Net Boiler 18)	Same As Above	
0x002B	Boiler 19 Status (Net Boiler 19)	Same As Above	
0x002C	Boiler 20 Status (Net Boiler 20)	Same As Above	
0x002D	Boiler 21 Status (Net Boiler 21)	Same As Above	
0x002E	Boiler 22 Status (Net Boiler 22)	Same As Above	
0x002F	Boiler 23 Status (Net Boiler 23)	Same As Above	
0x0030	Boiler 24 Status (Net Boiler 24)	Same As Above	
0x0031	Boiler 25 Status (Net Boiler 25)	Same As Above	
0x0032	Boiler 26 Status (Net Boiler 26)	Same As Above	
0x0033	Boiler 27 Status (Net Boiler 27)	Same As Above	
0x0034	Boiler 28 Status (Net Boiler 28)	Same As Above	
0x0035	Boiler 29 Status (Net Boiler 29)	Same As Above	
0x0036	Boiler 30 Status (Net Boiler 30)	Same As Above	

APPENDIX H

APPENDIX H (cont.)

Table H-1. BMS II Standard Input Register Address Mapping-Cont.

Modbus Data Address (Hex)	Menu Item	Units and Range	Comments
0x0037	Boiler 31 Status (Net Boiler 31)	119 = Not On-Line 120 = On-Line But Not Fired 1–40 = Fired & Sequence 121 = On-Line But Disabled 122 = On-Line But Faulted	
0x0038	Boiler 32 Status (Net Boiler 32)	Same As Above	
0x0039	I/O Status	00 to 255	Bit map of Input/Output Status: Bit 0 = AUX Relay Bit 1 = Fault Relay Bit 2 = Sys Start Relay Bit 3 = Empty Bit 4 = Setback Bt 5 = Interlock 2 Bit 6 = Interlock 1 Bit 7 = Empty
0x003A	Return Sensor Temp	40°F to 220°F	
0x003B Thru 0xFFFF			

APPENDIX H (cont.)

H-2. BMS II Controller Standard Holding Register Assignments

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

Table H-2. BMS II Standard Holding Register Address Mapping

Modbus Data Address (Hex)	Menu Item	Units and Range	Default/Comments
0x0000 thru 0x0003	(Reserved)		
0x0004	Net Header Set Temp	40 to 220°F	Valid when Hdr Set Mode=Remote Setpt and Remote Signal = Network
0x0005	System Start Temp	32 to 120°F	Default = 70°F
0x0006	System Start Option	0 or 1 0 = Temp Only, 1 = Temp and Load	Default = 0
0x0007	Manual Hdr Set Temp/Internal Setpt	40 to 220°F	Default = 160°F
0x0008	Bldg Ref Temp	40 to 220°F	Default = 70°F
0x0009	Not Applicable		
0x000A	Not Applicable		
0x000B	Reset Ratio	0.3 to 3.0 (0.1 increments),	Default = 1.2 (Value x 10)
0x000C	Max Header Temp	40 to 220°F	Default = 200°F
0x000D	Min Header Temp	40 to 220°F	Default = 40°F
0x000E	Start Percent	25 to 100%	Default = 20%
0x000F	Stop Percent	10 to 45%	Default = 16%
0x0010	Integral Gain	0.00 to 9.99 Rep/Min (in 0.01 increments)	Default = 0.15 Rep/Min (Value x 100)
0x0011	Header Set Mode	0, 1, or 2 0 = Constant Setpt 1 = In/Outdoor Reset 2 = Remote Setpt	Default = 0 (Constant Setpt))

APPENDIX H

APPENDIX H (cont.)

Table H-2. BMS II Standard Holding Register Address Mapping

Modbus Data Address (Hex)	Menu Item	Units and Range	Default/Comments
0x0012	Derivative Gain	-2.00 to 2.00 (0.00 increments)	Default = 0.15 (Value x 100)
0x0013	Header Temp Bandwidth	5 to 120°F	Default = 70°F
0x0014	Aux Relay Open	0 to 99%	Default = 45%
0x0015	Aux Relay Mode	0 or 1 0 = 100% Fire Rate 1 = 100% Fire Rate and Off	Default = 1 (100% Fire Rate & Off)
0x0016	Failsafe Mode	0 or 1 0 = Shutdown 1 = Constant Setpt	Default = 0 (Shutdown)
0x0017	Fault Alarm Relay Mode	0, 1, 2, 3 0 = All Faults, 1 = No Interlock 2 = Interlock 1 3 = Interlock 2	Default = 0 (All Faults)
0x0018	Fault Alarm Clear Method	0 or 1 0 = Automatic 1 = Manual	Default = 0 (Automatic)
0x0019	Boiler Operation Mode	0, 1 or 2 0 = Parallel 1 = Sequential 2 = Combination	Default = 1 (Sequential)
0x001A	Not Applicable		
0x001B	(Reserved)		
0x001C	(Reserved)		
0x001D	(Reserved)		
0x001E	Max Power Input	50 to 100%	Default = 100% (Fire Rate)
0x001F	Sys Intlk Config	0 or 1 0 = Always Enabled 1 = Start Enabled	Default = 1 (Start Enabled)
0x0020	Real Time Clock Minutes	00 to 59	Present Time

APPENDIX H (cont.)

Table H-2. BMS II Standard Holding Register Address Mapping

Modbus Data Address (Hex)	Menu Item	Units and Range	Default/Comments
0x0020	Real Time Clock Minutes	00 to 59	Present Time
0x0021	Real Time Clock Hours	00 to 23 Hours	Present Time
0x0022	Real Time Clock Day of Week	1 to 7	Present Day
0x0023	Real Time Clock Year	00 to 99	Present Year
0x0024	Real Time Clock Day of Month	01 to 31	Present Day of Month
0x0025	Real Time Clock Month	01 to 12	Present Month
0x0026	Offset Temp Sun.	-50 to 50°F	Default = 0°F
0x0027	Offset Temp Mon.	-50 to 50°F	Default = 0°F
0x0028	Offset Temp Tue.	-50 to 50°F	Default = 0°F
0x0029	Offset Temp Wed.	-50 to 50°F	Default = 0°F
0x002A	Offset Temp Thu.	-50 to 50°F	Default = 0°F
0x002B	Offset Temp Fri.	-50 to 50°F	Default = 0°F
0x002C	Offset Temp Sat.	-50 to 50°F	Default = 0°F
0x002D	Offset On Time Day 1 – Minutes	00 to 59 Minutes	Default = 0
0x002E	Offset On Time Day 2 – Minutes	00 to 59 Minutes	Default = 0
0x002F	Offset On Time Day 3 – Minutes	00 to 59 Minutes	Default = 0
0x0030	Offset On Time Day 4 – Minutes	00 to 59 Minutes	Default = 0
0x0031	Offset On Time Day 5 – Minutes	00 to 59 Minutes	Default = 0
0x0032	Offset On Time Day 6 – Minutes	00 to 59 Minutes	Default = 0
0x0033	Offset On Time Day 7 – Minutes	00 to 59 Minutes	Default = 0

APPENDIX H

APPENDIX H (cont.)

Table H-2. BMS II Standard Holding Register Address Mapping

Modbus Data Address (Hex)	Menu Item	Units and Range	Default/Comments
0x0034	Offset On Time Day 1 – Hours	00 to 23 Hours	Default = 0
0x0035	Offset On Time Day 2 – Hours	00 to 23 Hours	Default = 0
0x0036	Offset On Time Day 3 – Hours	00 to 23 Hours	Default = 0
0x0037	Offset On Time Day 4 – Hours	00 to 23 Hours	Default = 0
0x0038	Offset On Time Day 5 – Hours	00 to 23 Hours	Default = 0
0x0039	Offset On Time Day 6 – Hours	00 to 23 Hours	Default = 0
0x003A	Offset On Time Day 7 – Hours	00 to 23 Hours	Default = 0
0x003B	Offset Enable	0 or 1 0 = Disabled 1 = Enabled	Default = 0 (Disabled)
0x003C	Header Temp Offset	-10 to 10°F	Default = 0°F
0x003D	System Start Interlock	1, 2 or 3 1 = Intlk1 Opens Start Relay 2 = Intlk2 Opens Start Relay 3 = Either Intlk Opens Start Relay	Default = 1 (Intlk 1)
0x003E Thru 0x0045	(Reserved)		
0x0046	Offset Off Time Sun. – Minutes	0 to 59 Minutes	Default = 0
0x0047	Offset Off Time Mon. – Minutes	0 to 59 Minutes	Default = 0
0x0048	Offset Off Time Tue.– Minutes	0 to 59 Minutes	Default = 0
0x0049	Offset Off Time Wed.– Minutes	0 to 59 Minutes	Default = 0
0x004A	Offset Off Time Thu – Minutes	0 to 59 Minutes	Default = 0
0x004B	Offset Off Time Fri. – Minutes	0 to 59 Minutes	Default = 0

APPENDIX H (cont.)

Table H-2. BMS II Standard Holding Register Address Mapping

Modbus Data Address (Hex)	Menu Item	Units and Range	Default/Comments
0x004C	Offset Off Time Sat. – Minutes	0 to 59 Minutes	Default = 0
0x004D	Offset Off Time Sun. – Hours	0 to 23 Hours	Default = 0
0x004E	Offset Off Time Mon. – Hours	0 to 23 Hours	Default = 0
0x004F	Offset Off Time Tue. – Hours	0 to 23 Hours	Default = 0
0x0050	Offset Off Time Wed. – Hours	0 to 23 Hours	Default = 0
0x0051	Offset Off Time Thu. – Hours	0 to 23 Hours	Default = 0
0x0052	Offset Off Time Fri. – Hours	0 to 23 Hours	Default = 0
0x0053	Offset Off Time Sat. – Hours	0 to 23 Hours	Default = 0
0x0054	(Reserved)		
0x0055	Not Applicable		
0x0056	Remote Signal	0 or 1 0 = 4 – 20 Ma 1 = Network	Default = 0 (4 – 20 Ma)
0x0057	RS232 Mode	0 or 1 0 = Normal 1 = Modbus	Default = 1 (Modbus)
0x0058	RS232 Baud Rate	0=2400, 1=4800, 2=9600, 3=14400, 4=19200	2 = 9600
0x0059	Number Of Network Boilers	0 to 32	Default = 2
0x005A	Min Slave Address	0 to 127	Default = 0
**0x005B	Max Slave Address	0 to 127,	Default = 0
**0x005C	Net Boiler 1 Address	Address for Network Boiler 1	Default = 1
**0x005D	Net Boiler 2 Address	Address for Network Boiler 2	Default = 2

APPENDIX H

APPENDIX H (cont.)

Table H-2. BMS II Standard Holding Register Address Mapping

Modbus Data Address (Hex)	Menu Item	Units and Range	Default/Comments
0x005E	Net Boiler 3 Address	Address for Network Boiler 3	Default = 0
0x005F	Net Boiler 4 Address	Address for Network Boiler 4	Default = 0
0x0060	Net Boiler 5 Address	Address for Network Boiler 5	Default = 0
0x0061	Net Boiler 6 Address	Address for Network Boiler 6	Default = 0
0x0062	Net Boiler 7 Address	Address for Network Boiler 7	Default = 0
0x0063	Net Boiler 8 Address	Address for Network Boiler 8	Default = 0
0x0064	Net Boiler 9 Address	Address for Network Boiler 9	Default = 0
*0x0065	Net Boiler 10 Address	Address for Network Boiler 10	Default = 0
0x0066	Net Boiler 11address	Address for Network Boiler 11	Default = 0
0x0067	Net Boiler 12 Address	Address for Network Boiler 12	Default = 0
0x0068	Net Boiler 13 Address	Address for Network Boiler 13	Default = 0
**0x0069	Net Boiler 14 Address	Address for Network Boiler 14	Default = 0
0x006A	Net Boiler 15 Address	Address for Network Boiler 15	Default = 0
0x006B	Net Boiler 16 Address	Address for Network Boiler 16	Default = 0
0x006C	Net Boiler 17 Address	Address for Network Boiler 17	Default = 0
0x006D	Net Boiler 18 Address	Address for Network Boiler 18	Default = 0
0x006E	Net Boiler 19 Address	Address for Network Boiler 19	Default = 0
0x006F	Net Boiler 20 Address	Address for Network Boiler 20	Default = 0

APPENDIX H (cont.)

Table H-2. BMS II Standard Holding Register Address Mapping

Modbus Data Address (Hex)	Menu Item	Units and Range	Default/Comments
0x0070	Net Boiler 21 Address	Address for Network Boiler 21	Default = 0
0x0071	Net Boiler 22 Address	Address for Network Boiler 22	Default = 0
0x0072	Net Boiler 23 Address	Address for Network Boiler 23	Default = 0
0x0073	Net Boiler 24 Address	Address for Network Boiler 24	Default = 0
0x0074	Net Boiler 25 Address	Address for Network Boiler 25	Default = 0
0x0075	Net Boiler 26 Address	Address for Network Boiler 26	Default = 0
0x0076	Net Boiler 27 Address	Address for Network Boiler 27	Default = 0
0x0077	Net Boiler 28 Address	Address for Network Boiler 28	Default = 0
0x0078	Net Boiler 29 Address	Address for Network Boiler 29	Default = 0
0x0079	Net Boiler 30 Address	Address for Network Boiler 30	Default = 0
0x007A	Net Boiler 31 Address	Address for Network Boiler 31	Default = 0
**0x007B	Net Boiler 32 Address	Address for Network Boiler 32	Default = 0
0x007C	Network Baud	0=2400, 1=4800, 2=9600, 3=14400, 4=19200	2 = 9600
0x007D	Network Timeout	5 to 240 sec	Default = 60 sec.
0x007E	Password Lo	0 to 255 (73)	Default = 0
0x007F	Password Hi	0 to 255 (79)	Default = 0
0x0080	Modbus Control Type	0 = Round-Robin 1 = Broadcast	Default = 0 (Round Robin)
0x0081	Modbus Pass-Thru	0 = Disabled 1 = Enabled	Default = 0 (Disabled)
0x0082	Header Dead Band	1 to 15°F	Default = 5°F

APPENDIX H

APPENDIX H (cont.)

Table H-2. BMS II Standard Holding Register Address Mapping

Modbus Data Address (Hex)	Menu Item	Units and Range	Default/Comments
0x0083	Outside Temp Sensor Offset	-50 to +50°F	Default = 0
0x0084	Dyn Up	0 to 300	Default = 20
0x0085	Dyn Down	0 to 300	Default = 200
0x0086	Fault Alarm Boilers	0 = No Blr Faults 1 = All Blr Faults	Default = 0
0x0087	4 to 20 mA Current Offset	-1.00 mA to 1.00 mA	Default = 0
0x0088	Return Sensor Offset	-10.0°F to 10.0°F	Default = 0
0x0089	Load Start Pct	1 to Blr Start Level	Default = 1
0x008A	Load Stop Pct	0 to Load Start -1	Default = 0
0x008B Thru 0xFFFF	(Reserved For Future Expansion)	Undefined	

APPENDIX I

BOILER START AND BOILER STOP LEVELS

The BMS II Configuration Menu contains options for the Boiler (BLR) Start and Boiler Stop Levels. The default settings for these options are as follows:

- Boiler Start Level: 20%
- Boiler Stop Level: 16%

In order for the BMS II to properly control the boilers in the Boiler Plant, the corresponding Start and Stop levels must be entered in the BMS II Configuration Menu for the type of AERCO boilers being controlled.

For C-More controlled Benchmark or KC1000 Boilers, the Required Start and Stop Levels are listed at the end of Chapter 3 in the appropriate Boiler O & M Manual. If the correct O & M Manuals are not available at the installation site, the correct values can be verified by accessing the Calibration Menu in the C-More Boiler Controllers.

For Modulex Boilers, the corresponding Start and Stop Levels for each Boiler Model are listed in the following Table.

MODULEX BOILER START/STOP LEVELS

MODULEX MODEL	NUMBER OF MODULES	START LEVEL	STOP LEVEL
MLX-303	2	17%	15%
MLX-454	3	12%	10%
MLX-606	4	9%	7%
MLX-757	5	7%	5%
MLX-909	6	6%	4%
MLX-1060	7	5%	3%

When the Boiler Plant being controlled by the BMS II is comprised of a combination of AERCO Boiler types and sizes, the following guidelines should be used:

- **Modulex Boilers:** For different sizes of Modulex Boilers, use the Lowest Start/Stop levels for the Modulex Boilers included in the plant.
- **C-More Controlled Boiler:** For different sizes of C-More controlled Boilers, use the highest Start/Stop levels for the Boilers included in the plant.
- **Modulex & C-More Controlled Boilers:** When a mix of Modulex and C-More Boilers is included in the heating plant, use the C-More controlled Boiler Start/Stop levels.

