

MBS NA Integrated Controller Sequence of Operation

General Information

The MBS NA Integrated Controller is designed as a modular system controlling 2 to 4 condensing boilers and 2 variable speed pumps in duty/standby configuration. All system functions are monitored and controlled by a PLC, (Programmable Logic Controller). System data may be read from or input to the PLC by a 5.7" touch screen display panel (HMI).

Output signals are to the variable frequency drives (VFD), condensing boilers, and to the building automation system (BAS). The following summarizes the range of input/output variables possible for the Integrated Controller:

Possible (maximum) Input/Output (I/O) Variables:

1. 1 digital input (DI) for remote start/stop signal from BAS
2. 4 digital outputs (DO) for alarms: (a) pump/motor/VFD alarm, (b) temperature sensor alarm,
3. (c) boiler alarm, (d) system general alarm for possibility to send to BAS
4. 3 AI's for system hot water supply and return temperatures (NTC type) and for outdoor air temperature (transmitter 4-20 mA configurable range)
5. 4 DO's for up to 4 boiler start/stop run signal
6. 4 DI's for up to 4 boiler run feedback signal
7. 4 DI's for up to 4 boiler alarm status fault signal
8. 4 analog outputs (AO) for boiler capacity modulation signal, 0-10Vdc
9. 1 DI for gas emergency shut off for possibility of connection to external emergency switch
10. 1 serial port for communication with the BAS (standard protocol Modbus)
11. 1 serial port for communication with the VFD's using Modbus protocol (communicate pump speed, alarm, feedback and kW)

Optional Integrated Controller I/O:

1. 1 AI for system HW supply flow measurement
2. 1 AO for 2-way modulating bypass valve
3. Pulse input for optional gas meter
4. 1 DI for gas meter open feedback signal
5. Serial communication to BAS using BACnet/IP, BACnet/Ethernet, BACnet/MSTP, and Lonworks

Processor Generic Logical Features:

1. Standard MBS NA Integrated Controller is supplied with 5.7" Human Machine Interface (HMI) with color touch-screen
2. A schematic of the system is displayed on the HMI showing all variable speed primary pumps variables on the screen
3. System hot water supply & return temperatures shall be displayed. These temperature sensors shall be located on inlet and outlet headers of the MBS NA package
4. Outdoor air temperature shall be displayed
5. Control boilers output temperature (SHWST) by sending modulating signal to maintain system hot water supply temperature set-point, control algorithm in Sequence of Operation section below
6. Monitor boiler(s) minimum and maximum flows (when flow sensor ordered separately) and perform necessary control outside operating flow range. Minimum and maximum pump speeds shall be pre-defined and entered for each MBS Model
7. Re-set system hot water supply temperature based on outdoor air temperature
8. Sequence boiler(s) based on their best efficiency performance curve as required by system demand
9. Monitor System HWRT

10. Compare System hot water return temperature to its set-point
11. SHWRT set-point shall be reset based outdoor air temperature
12. PID control algorithms for pump speed control based on SHWRT and modulating boiler capacity control in PLC based on.
13. Ability to select one of three default hot water system sizes (small, medium, & large) for pump control loop
14. Manual and automatic alternation of primary pumps based on hours of operation, 1 week alternation, adjustable
15. Alarms shall include temperature sensor failure, pump/motor/drive failure, boiler failure, and general system alarm
16. 3 levels of password protection on operator interface
 - a. level 1 is operator level: H-O-A function, display of all parameters
 - b. level 2 is installer level: all parameter setup except for PID variables
 - c. level 3 is factory level: all parameter settings including defaults
17. As options, display system hot water flow and gas consumption on the HMI

Pump Speed Control Algorithm:

Upon start-up the Integrated Controller shall calculate the SHWRT set-point based on outdoor air temperature sensor. The Controller shall compare actual SHWRT with its set-point and display an "error" value which shall control pump speed.

Controller shall vary pump speed in order to maintain SHWRT set-point

Sequence of Operation:

1. When MBS NA Integrated Controller (Controller) is set to "Local" the HW duty pump shall automatically be started at preset minimum speed and **ALL** boilers enabled
2. When Controller is set to "REMOTE", BAS shall sense heat demand called by system
3. BAS shall send signal to controller to start hot water duty pump at preset minimum speed and enable **ALL** boilers
Once enable signal by BAS is received AND the building schedule is satisfied AND OAT drops below 60°F (adjustable) then enable MBS system
4. Once started the Controller calculates the system hot water supply temperature (SHWST) set-point by measuring outside air temperature

Default values are as follows:

Min OAT = 0°F

Max OAT = 60°F

Min SHWST = 100°F

Max SHWST = 150°F

5. ALL boilers shall start once flow has been verified by their own control system (boiler flow switch)
6. If hot water flow has not been verified by Controller within specified time delay then send start signal to HW standby pump at same preset minimum speed and issue HW duty pump alarm on HMI
7. If lag pump does not start shut down, and issue pump and general alarms
8. Controller shall send an analog signal to modulate boilers capacity to maintain the SHWST set-point
9. Controller shall modulate HW duty pump speed to satisfy hot water system demand
10. Controller shall calculate boiler heat output capacity in MBH if optional water flow sensor is selected and installed
11. Display of actual boiler heat output capacity in MBH on HMI



BOILER SEQUENCING ALGORITHM

12. Controller shall run the boilers at best efficiency by sequencing boilers on and off at predetermined optimum efficiency staging points
13. When lead boiler is running at less than its minimum capacity for more than 2 minutes (adjustable), shut down boiler
14. Duty pump still running at pre-determined minimum speed
15. If no heat demand is required while lead boiler is OFF for more than 20 minutes (adjustable), shut OFF HW duty pump
16. Should more heat capacity to building load be required start LEAD boiler provided a time delay has elapsed since LEAD boiler has been OFF
17. HW duty pump will start once LEAD boiler is enabled
18. Any boiler alarm shall be displayed on HMI (touch-screen)
19. Controller shall perform manual and automatic alternation of HW pumps based on hours of operation (1 week alternation adjustable)
20. IF gas emergency shut off signal is connected to Controller, when activated Controller will shut off operation of MBS system, and issue an alarm (general system alarm).
21. First shut down boiler and after 1 minute delay (adjustable) shut down pump.
22. 1st and 2nd stage frost protection shall be provided as standard. This feature is only active when MBS system is disabled by BAS
23. Controller shall monitor SHWST and maintain it above 41°F (adjustable)
24. When SHWST drops below 41°F but above 37°F (adjustable) then start duty pump and run at preset minimum speed
25. If SHWST drops below 37°F then LEAD boiler is signaled to run at minimum capacity with pump running at minimum speed
26. The frost protection shall be enabled even though the MBS is in REMOTE and BAS is commanding OFF

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