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SEQUENCE OF OPERATION
IPS Controller 9500 (NO Chiller Sequencing)

General Information

The IPS Controller 9500 is designed to control the variable primary pumps and chillers or boilers in a hydronic distribution system and can be configured for a variety of process variables (inputs), and output signals. The details of the IPS Controller hardware configuration are detailed on the "IPS Controller 9500" project Submittal sheet. Output signals are to the variable frequency drives (VFD), VFD by-pass (if applicable), chillers or boilers, and optionally to the building management system (BMS). The following summarizes the range of input variable possible for each of the IPS Controller 9500 variants:

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

1. 18 analog inputs (AI) for zone differential pressure (DP) transmitter signals 4-20 mA
2. 1 AI for DP transmitter for primary pump run-out protection (if selected)
3. 6 digital inputs (DI) for up to 6 primary pump DP switches
4. 5 DI's for primary pump remote start/stop signals from up to 5 chillers
5. 6 DI's for VFD fault signals on up to 6 primary pumps
6. 1 digital output (DO) for alarm horn (buzzer)
7. 1 DI for alarm silencer
8. 6 analog outputs (AO) for VFD speed signals on up to 6 primary pumps
9. 6 DO's for up to 6 primary pump run signals
10. 4 DO's for alarms:
    a. Pump/motor/VFD alarm,
    b. DP transmitter alarm,
    c. General system alarm,
    d. Primary pump fatal alarm
11. 6 DO's for up to 6 VFD automatic bypass run signals on primary pumps
12. 6 AI's for primary motor temperatures selectable between NTC or PT1000
13. 6 DI's for VFD run feedback signals on primary pumps
14. 6 DI's for VFD Bypass run feedback signals on primary pumps
15. 5 AO's for primary and distribution flow measurement, kW, supply and return temperature sensors
16. 1 AO for bypass 2-way modulating valve
17. 1 serial port for communication with the BMS
18. 1 serial port for communication with the VFD's

☐ IPS CONTROLLER 9501 (with up to 6 primary pumps and 6 zones)

☐ IPS CONTROLLER 9502 (with up to 6 primary pumps and 12 zones)

☐ IPS CONTROLLER 9503 (with up to 6 primary pumps and 18 zones)

Optional Controller I/O*:

1. BMS communications serial port
2. VFD automatic bypass: In the event of a system failure due to VFD fault, the PLC shall automatically start the pump across the line. An alarm shall be displayed on the operator's interface indicating VFD failure. In case there is an overload trip on that pump across the line, automatically alternate to start the stand-by pump on VFD mode
3. 18 zones DP transmitters max (IPS CONTROLLER 9503)

*The details of the IPS Controller hardware configuration are detailed on the "IPS Controller 9500" project Submittal sheet.

Processor Generic Logical Features:

1. Standard IPS Controller 9500 is supplied with 10.4" Human Machine Interface (HMI) or touch-screen
2. A schematic of the system is displayed on the HMI showing all variable speed primary pumps variables on the screen
3. Zone DP, system flow, kW input (consumption) and supply & return temperatures shall be displayed if applicable and when connected to the IPS Controller 9500
4. Monitor single zone differential pressure transmitter (up to 18 transmitters as an option remotely installed by contractor)

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5. Compare each value to its set point. The zone that has deviated the most from its set-point shall be set as the controlling zone (see detailed specifications for multi-zone control)
6. PID control algorithm for pump speed control in PLC
7. Independent PID control loop for each remote signal
8. Monitor chiller(s)/boiler(s) minimum and maximum flows and control automatic modulating bypass valve
9. Stage primary pumps upon increase of system demands based on either maximum pump speed, pump BEP or wire-to-water efficiency program
10. Automatically disable any zone differential pressure signals that are not within limits and alert the operator of a possible transmitter failure
11. Motor speed would be switched to manual at speed set by the operator if all transmitters failed
12. Manual VFD bypass
13. Manual and automatic alternation of primary pumps based on hours of operation (1 week alternation)
14. Alarms shall include transmitters failure, pump/motor/drive failure, primary pump fatal alarms, and general system failure
15. Run-out protection on variable speed primary pumps based on DP or flow sensor (if selected)
16. 3 levels of password protection on operator interface

Active Zone Selection (Multi-zone) Logic:

The multi-zone controller will select a "control signal" from one of up to eighteen (18) signals (signal is the differential pressure, e.g. 40 KPa). Each signal is compared to its set point to calculate the "error from set point" (e.g. The set point might be 30 KPa, giving 40 – 30 = +10 KPa error from set point).

No zone shall have a –ve error. The eighteen "errors from set-point" would be compared to select which error would be used to determine the input to the speed control algorithm. The following logic would be used to select the zone signal error:
   i. The controller will look constantly at all 18 error signals. If all errors are –ve then the zone with the highest negative error will be the controlling signal
   ii. If all 18 errors are +ve then the controlling signal shall be the zone with the smallest positive error
   iii. At the end of every 60 seconds the controller will switch to the active zone that has deviated the most from its set-point

Generic Process Sequence of Operation:

1. When IPS Controller 9500 is set to "Remote", BMS or chillers send signal to controller to start lead primary pump
2. When in "Remote" the H-O-A switch must be on A position for the lead pump to start
3. The controller shall start the primary lead pump
4. Once flow through pump has been proven and isolation valve proven fully open, the lead chiller shall be turned ON (by others)
5. If lead primary pump fails to start, the lag primary pump and its VFD shall automatically start and an alarm will be displayed showing pump/drive fault and shall be sent to the BMS
6. The run signals shall operate the variable primary pumps available for the primary circuit whether they are dedicated or headered to the chillers
7. In stand-by configuration the control panel shall be capable of alternating the lead and lag variable primary pumps manually, and automatically based on hours of operation
8. DP switches across primary pumps shall prove differential pressure developed by primary pump (pump running)
9. Lag pump shall run for a minimum of 15 minutes (adjustable) once started
10. Upon failure of all drives the controller will send a system failure alarm and each pump can be started manually across the line (constant speed)
11. Variable primary pump operation can be switched manually to bypass the drive using the VFD-OFF-Bypass switch of each primary pump/VFD
12. The zone DP transmitter signal shall be analogue 4-20 mA to the IPS Controller 9500
13. Each zone shall have its own field adjustable differential pressure set point in the controller
14. Each zone DP transmitter shall have its own field adjustable differential pressure range in the controller
15. The IPS Controller 9500 shall analyze the signals and select the zone that has deviated the most from its set point to be the controlling signal to the VFD
16. Upon increase in system demands, the IPS Controller 9500 controller shall stage on primary lag pump and start a timed sequence of events once DP set-point cannot be met by lead primary pump
17. The lead and lag primary pumps will both run at the optimum speed to satisfy demand and to maintain the optimal wire-to-water efficiency of the hydronic system

18. When the controlling zone set point has been satisfied the IPS Controller shall maintain the speed the primary pump VFD is running at. If the controlling zone becomes less loaded the controller shall reduce the primary pump speed to conserve energy while satisfying all remote zone DP set-points
19. The IPS Controller shall maintain primary pump minimum speed of 30% (adjustable)
20. Once the operating chiller minimum recommended flow has been approached (30% of chiller design flow, adjustable), the controller shall start to modulate the 2-way bypass valve open to maintain the minimum required flow through the operating chiller
21. The flow shall be monitored by flow sensor in the chiller supply header. The set-point on the flow sensor shall be the required minimum flow rate through operating chiller(s)
22. VFD automatic bypass as an option (**if selected**): In the event of a system failure due to VFD fault, the PLC shall automatically start the pump across the line. In the event that the controlling zone is not satisfied with one pump across the line the second pump will be started DOL
23. VFD automatic bypass feedback to IPS Controller confirming VFD bypass operation
24. An alarm shall be displayed on the operator's interface indicating VFD failure
25. In case there is an overload trip on that primary pump across the line, automatically stage ON next primary pump in sequence and set all primary pumps to run on bypass mode
26. Automatically disable any zone differential pressure signals that are not within limits and alert the operator of a possible transmitter failure. Should a zone DP sensor fail the minimum speed will be increased to 95% FS (adjustable)
27. The controller shall scan and analyze the remaining transmitters if available
28. Motor speed shall be switched to manual at speed set by the operator if all transmitters failed
29. IPS Controller 9500 shall have run out protection of the variable primary pumps using either a DP sensor as the standard method or using a flow sensor as an option
30. IPS Controller 9500 controller shall be capable of receiving up to eighteen (18) analogue signals from zone differential pressure transmitters
31. The IPS Controller 9500 controller shall be capable of controlling up to six (6) primary pumps
32. The IPS Controller 9500 shall be capable of staging and de-staging primary based on either maximum pump speed, pump BEP or wire-to-water efficiency program as an option
33. The IPS Controller 9500 shall be capable of displaying wire-water efficiency (requires DP, flow and kW sensors)
34. Staging and de-staging speeds shall be programmed in the controller and adjusted on site through the HMI if required
35. Pump BEP optimization can be also achieved by staging and de-staging the pumps by inputting the % speed to start and stop the pumps using the HMI
36. The IPS Controller 9500 shall be capable of both hard-wired and serial communications with the BMS using Modbus, LonWorks, Trend and Metasys as standard protocols. The IPS controller shall offer the option of a gateway to communicate using BACnet or TCP/IP protocols.