ARMSTRONG

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SEQUENCE OF OPERATION
IPS Controller 9200

General Information

The IPS Controller 9200 is designed to control both the constant primary and variable secondary pumps 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 9200" project Submittal sheet. Output signals are to the variable frequency drives (VFD), VFD by-pass (if applicable), constant speed starter panel, and optionally to the building management system (BMS). The following summarizes the range of input variable possible for each of the IPS Controller 9200 variants:

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

- ☐ IPS CONTROLLER 9201 (with up to 6 pumps total (primary & secondary) and 6 zones)
- ☐ IPS CONTROLLER 9202 (with up to 6 pumps total (primary & secondary) and 12 zones)
- ☐ IPS CONTROLLER 9203 (with up to 6 pumps total (primary & secondary) and 18 zones)

1. 18 analog inputs (AI) for zone differential pressure (DP) transmitter signals 4-20 mA
1. 1 AI for DP transmitter for secondary pump run-out protection
2. 6 digital inputs total (DI) for pump DP switches (primary and secondary pump fault signals)
3. 1 DI for remote connection for start/stop
4. 4 DI's total for primary pump remote start/stop signals from
5. up to 4 chillers
6. 4 DI's total for VFD fault signals on secondary pumps
7. 1 DI for alarm horn (buzzer)
8. 1 DI for alarm silencer
9. 4 analog outputs (AO) for VFD speed signals on secondary pumps
10. 6 digital outputs total (DO) for primary and secondary pumps run signals
11. 5 DO's for alarms:
    a. Pump/motor/VFD alarm,
    b. DP transmitter alarm,
    c. General system alarm,
    d. Primary pump fatal alarm and
    e. Secondary pump fatal alarm
12. 4 DO's total for VFD automatic bypass run signals on secondary pumps
13. 6 AI's total for primary and secondary motor temperatures selectable between NTC or PT1000
14. 4 DI's total for VFD run feedback signals on secondary pumps
15. 4 DI's total for VFD Bypass run feedback signals on secondary pumps
16. 4 DI's total for primary pump motor run feedback signals
17. 5 AO's for primary and secondary flow, kW, supply and return temperature sensors
18. 1 serial port for communication with the BMS (optional)
19. 1 serial port for communication with the VFD's (optional)

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 9203)

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Processor Generic Logical Features:

1. Standard IPS Controller 9200 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 primary and secondary 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 9200

4. Monitor single zone differential pressure transmitter (up to 18 transmitters as an option remotely installed by contractor)
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. Stage secondary pumps upon increase of system demands based on either maximum pump speed, pump BEP or wire-to-water efficiency program
9. Automatically disable any zone differential pressure signals that are not within limits and alert the operator of a possible transmitter failure
10. Motor speed would be switched to manual at speed set by the operator if all transmitters failed
11. Manual VFD bypass
12. Manual and automatic alternation of primary and secondary pumps based on hours of operation (1 week alternation)
13. Alarms shall include transmitters failure, pump/motor/drive failure, primary and secondary pump fatal alarms, and general system failure
14. Run-out protection on variable speed pumps based on DP or flow sensor (if selected)
15. 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. The IPS Controller 9200, when in the REMOTE mode, shall be started by receiving a signal from the customer’s contact or BMS
2. For remote start of the pumps the H-O-A switch should be in the Auto position
3. The pumps shall not start manually if controller is on REMOTE mode
4. When in the LOCAL mode the IPS Controller 9200 can also be started using the virtual ON/OFF switch in the HMI
5. When secondary pumps are placed in Auto mode using the virtual H-O-A switch, the lead secondary pump shall start to maintain system demand
6. The constant speed primary pumps shall receive a start/stop signal from up to 4 operating chillers in parallel
7. The IPS Controller 9200 shall send a run signal to the primary lead pump
8. The run signals shall operate the primary pumps available for the primary circuit whether they are dedicated or headered to the chillers.
9. In the headered configuration the controller shall, through a signal from the lead chiller or BMS, start the lag primary pump in case the lead primary pump has failed.
10. In stand-by configuration the control panel shall be capable of alternating the lead and lag primary and secondary pumps manually, and automatically based on hours of operation
11. DP switches across primary and secondary pumps to prove differential pressure developed by pump (pump running)
12. The IPS Controller 9200 controller shall automatically start secondary lag pump and its VFD upon failure of lead pump, an alarm will be displayed showing pump/drive fault
13. Lag pump shall run for a minimum of 15 minutes (adjustable) once started
14. 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)
15. Secondary pump operation can be switched manually to bypass the drive using the VFD-OFF-Bypass switch of each pump

16. The transmitter signal shall be analogue 4-20 mA to the controller
17. Each zone shall have its own field adjustable differential pressure set point in the controller
18. Each zone DP transmitter shall have its own field adjustable differential pressure range in the controller
19. The controller 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
20. When the controlling zone set point has been satisfied the VFD shall maintain the speed it is running at. If the controlling zone becomes less loaded the controller shall reduce the pump speed to conserve energy while satisfying all remote zone DP set-points
21. IPS Controller 9200 controller shall stage on secondary lag pump and start a timed sequence of events once DP set-point cannot be met by lead pump
22. The controller will maintain secondary pump minimum speed of 30% (adjustable)
23. 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
24. VFD automatic bypass feedback to IPS Controller confirming VFD bypass operation
25. An alarm shall be displayed on the operator's interface indicating VFD failure
26. Primary pump run feedback to IPS Controller confirming primary pump operation
27. IPS Controller shall be capable of staging and de-staging secondary pumps when running on bypass
28. In case there is an overload trip on that pump across the line, automatically alternate to start the stand-by pump on VFD mode
29. 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)
30. The controller shall scan and analyze the remaining transmitters if available
31. Motor speed shall be switched to manual at speed set by the operator if all transmitters failed
32. IPS Controller 9200 shall have run out protection of the pumps using either a DP sensor as the standard method or using a flow sensor as an option
33. IPS Controller 9200 controller shall be capable of receiving up to eighteen (18) analogue signals from zone differential pressure transmitters
34. The IPS Controller 9200 controller shall be capable of controlling up to six (6) constant primary and variable secondary pumps total (maximum of either 4 primary or secondary pumps in parallel)
35. The IPS Controller 9200 shall be capable of staging and de-staging secondary pumps upon increase of system demands based on either maximum pump speed, pump BEP or wire-to-water efficiency program as an option
36. The IPS Controller 9200 shall be capable of displaying wire-water efficiency (requires DP, flow and kW sensors)
37. Staging and de-staging speeds shall be programmed in the controller and adjusted on site through the HMI if required
38. 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
39. The IPS Controller 9200 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.

Armstrong Integrated Limited
Wenlock Way
Manchester
United Kingdom, M12 5JL
T: +44 (0) 8444 145 145
F: +44 (0) 8444 145 146

S. A. Armstrong Limited
23 Bertrand Avenue
Toronto, Ontario
Canada, M1L 2P3
T: (416) 755-2291
F (Main): (416) 759-9101