ARMSTRONG

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SEQUENCE OF OPERATION
IPS Controller 9100

General Information

The IPS Controller 9100 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 9100” project Submittal sheet. Output signals are to the variable frequency drives (VFD), any by-pass, and optionally to the building management system (BMS). The following summarizes the range of input variable possible for each of the IPS Controller 9100 variants:

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

- ☐ IPS CONTROLLER 9101 (with up to 6 pumps in parallel and 6 zones)
- ☐ IPS CONTROLLER 9102 (with up to 6 pumps in parallel and 12 zones)
- ☐ IPS CONTROLLER 9103 (with up to 6 pumps in parallel and 18 zones)

1. 1 analogue input per zone DP transmitter 4-20 mA
2. 1 analogue input for DP transmitter or flow sensor 4-20 mA of run-out protection
3. 1 analogue input for kW sensor
4. 2 analogue inputs for supply and return temperatures
5. 1 digital input per DP switch (1 DP switch per pump)
6. 1 digital input for remote connection for start/stop
7. 1 digital input per VFD run feedback signal
8. 1 digital input per VFD for fault signal
9. 1 digital input per VFD bypass feedback signal
10. 1 digital input for alarm silencer
11. 1 analogue output per VFD for speed signal
12. 1 digital output per pump run signal
13. 1 digital output per VFD auto bypass
14. 1 digital output for pump/motor/VFD alarm
15. 1 digital output for DP transmitter alarm
16. 1 digital output for general system alarm
17. 1 digital output for low and high chilled water temperature alarm (optional)
18. 1 serial connection for BMS communication (optional)
19. 1 serial connection for VFD communication (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 9103)

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Processor Generic Logical Features:

1. Standard IPS Controller 9100 is supplied with 10.4" Human Machine Interface (HMI) or touch-screen
2. A schematic of the system is displayed on the HMI with all variables showing 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 9100
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 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 secondary pumps based on hours of operation (1 week alternation)
13. Alarms shall include transmitters failure, pump/motor/drive failure, and general system failure
14. Run-out protection on variable speed pumps based DP or flow sensor
15. 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 pumps, 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 pumps can also be started using the virtual H-O-A switch in the Hand or Auto position
5. In stand-by configuration the control panel shall be capable of alternating the lead and lag pumps manually, and automatically based on hours of operation
6. DP switches across pumps to prove differential pressure developed by pump (pump running)
7. The IPS Controller 9100 controller shall automatically start lag pump and its VFD upon failure of lead pump, an alarm will be displayed showing pump/drive fault
8. Lag pump shall run for a minimum of 15 minutes (adjustable) once started
9. Upon failure of both drives the controller will send a system failure alarm and either pump can be started manually across the line (constant speed)
10. Pump operation can be switched manually to bypass the drive using the VFD-OFF-Bypass switch of each pump
11. The transmitter signal shall be analogue 4-20 mA to the controller
12. Each zone shall have its own field adjustable differential pressure set point in the controller
13. Each zone DP transmitter shall have its own field adjustable differential pressure range in the controller
14. 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
15. 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
16. IPS Controller 9100 controller shall stage on lag pump and start a timed sequence of events once DP set-point cannot be met by lead pump
17. The controller will maintain pump minimum speed of 30% (adjustable)
18. 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
19. VFD automatic bypass feedback to IPS Controller confirming VFD bypass operation
20. An alarm shall be displayed on the operator's interface indicating VFD failure
21. IPS Controller shall be capable of staging and de-staging secondary pumps when running on bypass
22. In case there is an overload trip on that pump across the line, automatically alternate to start the stand-by pump on VFD mode
23. 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)

24. The controller shall scan and analyze the remaining transmitters if available
25. Motor speed shall be switched to manual at speed set by the operator if all transmitters failed
26. IPS Controller 9100 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
27. IPS Controller 9100 controller shall be capable of receiving up to eighteen (18) analogue signals from zone differential pressure transmitters
28. The IPS Controller 9100 controller shall be capable of controlling up to four (6) variable speed secondary pumps
29. The IPS Controller 9100 shall be capable of displaying wire-water efficiency (requires DP, flow and kW sensors)
30. As an option, the controller shall be capable of staging and de-staging pumps based on the best wire-to-water efficiency of the system
31. Staging and de-staging speeds shall be programmed in the controller and adjusted on site through the HMI if required
32. 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

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