IVS Sensorless Series

ARMSTRONG

Product shown with guards removed to show external mechanical seal detail

Intelligent Variable Speed Pumps

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Meeting your Sustainability Objectives for New and Existing Buildings.

▶ Sustainable Building Challenges

Sustainable buildings, whether new or existing, are a higher priority than ever before. The need for better energy performance in buildings is driven not only by individual concerns for the environment but also by increasing pressure from legislation such as Part L of the building regulations and the EU Energy Performance of Buildings Directive. The challenges that face building services professionals include the need to achieve good Energy Performance Certificate (see Figure 1 for an example) and BREEAM ratings while designing heating and cooling systems that meet occupancy comfort needs.

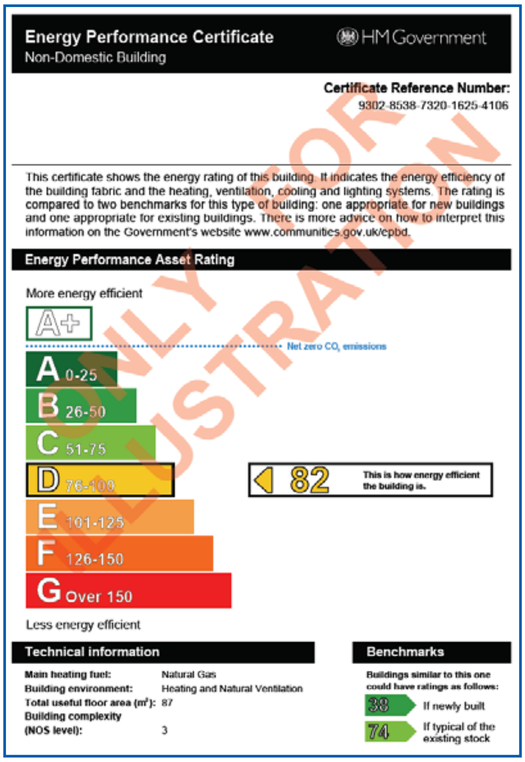
▶ The Implications of Poor Building Performance

Designing and operating buildings using practices and technologies of the past will have major implications for your business, regardless of whether you are a system designer, contractor, end user or any other profession involved with building services systems. Poorly designed and performing buildings lead not only to higher utility bills but also to tenant complaints and higher maintenance costs. Low building energy ratings will likely impact the sale or rentable value of the building. For organisations with highly visible CSR (Corporate Social Responsibility) programs, this can have a negative impact on brand image as well as customer retention and acquisition.

▶ Improved Performance in Heating and Cooling Systems

Traditional heating and cooling systems were designed such that under part load conditions, where heating or cooling demand is reduced, control valves would divert the flow of water around the heating or cooling load, leaving the system pump to continue producing full design flow even though the system didn't require it. This design of system, incorporating constant speed pumps, results in significant energy wastage. Life cycle cost analysis identifies that typically 95% of the lifetime cost of the pump is energy cost.

In recent years the reduced cost and improved reliability of variable speed drives (VSD) has led to changes in design approach where the pump speed is adjusted in response to changes in demand and this in turn leads to significant energy savings. Energy savings are dependant upon a number of factors, including the control strategy of the VSD and the location for the pressure feedback signal. Other design and installation considerations include space availability, VSD to pump optimisation and electrical interference issues. Armstrong IVS Sensorless pumps make variable speed pumping easy through complete integration of pump and controls.


Energy Performance Certificate
Non-Domestic Building
HM Government

Certificate Reference Number:
9302-8538-7320-1625-4106

This certificate shows the energy rating of this building. It indicates the energy efficiency of the building fabric and the heating, ventilation, cooling and lighting systems. The rating is compared to two benchmarks for this type of building: one appropriate for new buildings and one appropriate for existing buildings. There is more advice on how to interpret this information on the Government's website www.communities.gov.uk/epbd.

Energy Performance Asset Rating

More energy efficient
A+
Net zero CO_2 emissions
A 0-25
B 26-50
C 51-75
D 76-100
E 101-125
F 126-150
G Over 150
Less energy efficient

82 This is how energy efficient the building is.

ONLY FOR ILLUSTRATION

Technical information

Main heating fuel:	Natural Gas
Building environment:	Heating and Natural Ventilation
Total useful floor area (m^2):	87
Building complexity (NOS level):	3

Benchmarks

Buildings similar to this one could have ratings as follows:
38 If newly built
74 If typical of the existing stock

Figure 1 - Energy Performance Certificate

Intelligent Variable Speed Pumps

▶ Reduced Capital and Installation Costs

- ▶ Reduced capital cost—no differential pressure sensor to procure
- ▶ Reduced installation cost—no mounting of variable speed drive (VSD), reduced wiring and no system feedback sensor installation
- ▶ Reduced commissioning cost—no sensor positioning issues or installation errors to slow the process
- ▶ Reduced plant room space cost—controls are generally within the footprint of the pump

▶ Increased Energy Savings

- ▶ All the savings of variable speed pumping at a reduced installed cost
- ▶ Controls are optimised to motor in factory, ensuring perfect integration and peak performance
- ▶ Control curve optimisation eliminates the energy lost due to incorrect sensor placement

▶ Primary/Secondary Chilled Water Systems

Figure 2 (page 4) shows a typical heating or chilled water system with constant speed primary pumps and variable speed secondary pumps in a duty/standby arrangement. The secondary pumps in a primary/secondary chilled water system distribute the chilled water from the primary production loop to the loads that satisfy the cooling requirements of the building.

Referring to Figure 3 (page 4), the VSD is programmed to maintain a pressure at the location of the differential pressure feedback sensor, typically installed across a remote cooling load and two-port control valve. As demand for cooling decreases, the two-port valves start to close and the differential pressure across the valve increases. The variable speed drive then slows the pump to maintain the set value. Because of the position of the sensor, the head/flow characteristic will follow a control curve (see Figure 2, page 4) between minimum and maximum flow.

The installation shown in Figure 3 has variable speed drives remote from the pumps that will occupy valuable plant-room space and incur mounting and wiring costs. Two pressure sensors are shown so that if one sensor should fail the standby sensor will take over the duty. Again, wiring and mounting costs are incurred and the sensors may require periodic calibration.

▶ Sensorless Technology

Sensorless control is an innovative concept for circulating pumps. Pump performance and characteristic curves for ten different speeds are embedded in the memory of the speed controller during manufacture. This data includes power, pressure and flow across the flow range of the pump. During operation, the power and speed of the pump are monitored, enabling the controller to establish the hydraulic performance and position in the pumps head-flow characteristic.

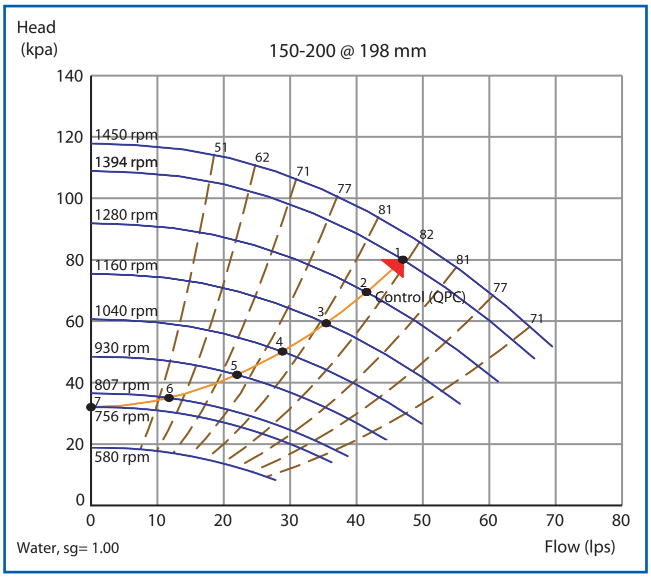


Figure 2 - System Control Curve

These measurements enable the pump to continuously identify the head and flow at any point in time, giving accurate pressure control without the need for external feedback signals. Patented software technology within the controller ensures trouble-free operation in all conditions.

Incorporating the pump's hydraulic data into the controller and removing sensors results in true integration of all components and removes the risk of sensor failure.

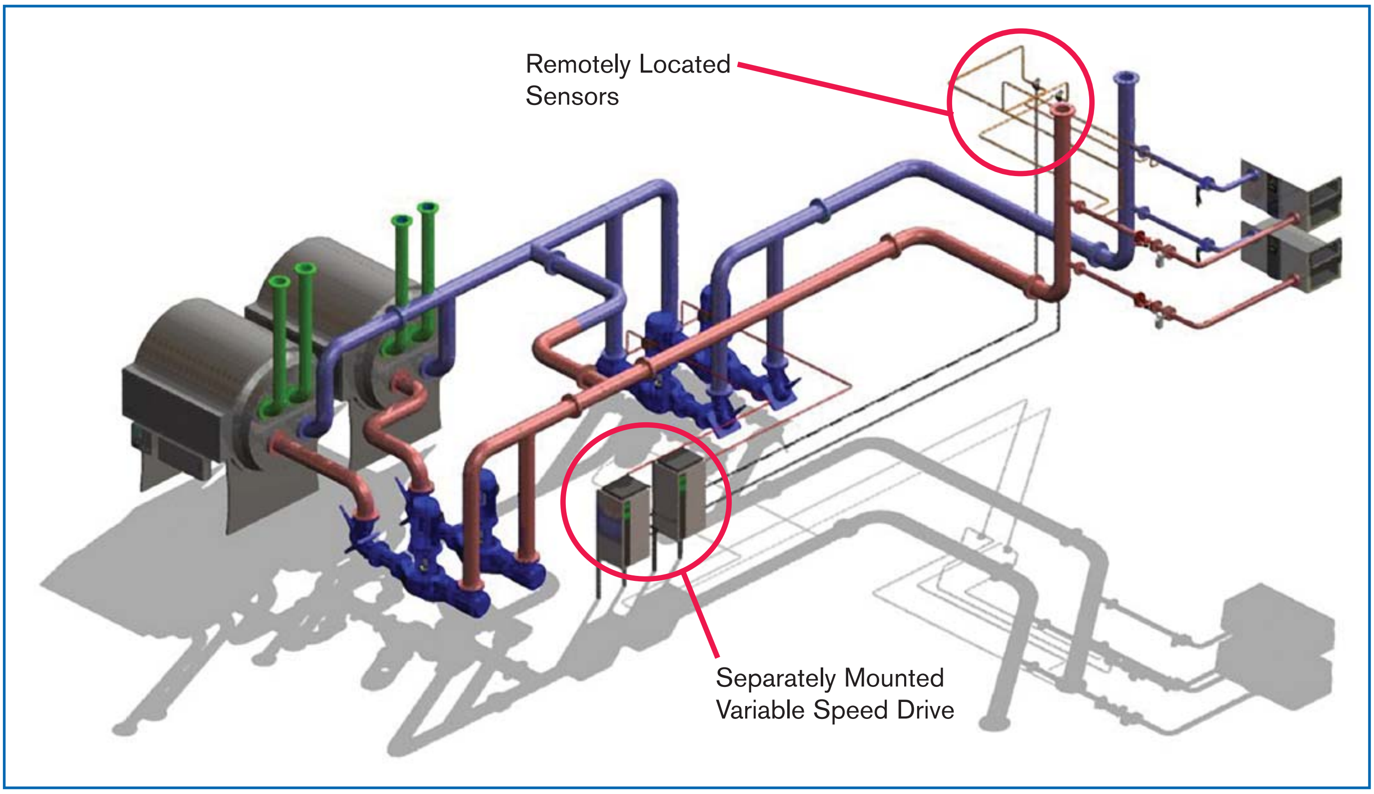


Figure 3 - Typical Primary/Secondary Chilled or Heating Water System Incorporating Variable Speed Drives

▶ The Sensorless Solution

In Figure 4 the pumps and remote variable speed drives have now been replaced by Vertical In-Line IVS Sensorless pumps. The pressure sensors are no longer required as the IVS Sensorless pump is preprogrammed to follow a control curve (Figure 2) between the head point at design duty and the head required at minimum flow. The control curve is fully site adjustable and gives the installer the flexibility to replicate sensor positions at varying distances from the pump. This feature removes the problems associated with incorrect sensor placement and allows optimum energy savings to be realised.

▶ Available Pump Models

For units fitted with motors up to and including 7.5kW the integrated IVS Sensorless control is available with the following pumps:

- ▶ 4300 Split Coupled Vertical In-line
- ▶ 4280 Close Coupled End Suction
- ▶ 4302 DualArm Split Coupled Vertical In-line Twin
- ▶ 4030 Long Coupled End Suction
- ▶ 4380 Close Coupled Vertical In-line
- ▶ 4392 Close Coupled Vertical In-line Twin
- ▶ 4382 DualArm Close Coupled Vertical In-line Twin

For pumps fitted with larger motors, it is necessary to consider the pump maintenance challenges of integrated variable speed solutions. Conventional pump designs have an internal mechanical seal which can only be accessed for maintenance by removing the motor and rotating assembly. This labour intensive and costly process can be exacerbated by the need to remove a large VSD from the pump assembly. Armstrong's revolutionary split-coupled pump designs feature an external mechanical seal that can be replaced without the need for removing the motor, VSD and rotating assembly. This feature makes large, integrated variable speed pumps a viable proposition in terms of maintenance, reliability, reduced system downtime and cost.

Therefore pumps fitted with motors from 11.0kW to 250.0kW are available with the integrated IVS Sensorless control on the following pump types:

- ▶ 4300 Split Coupled Vertical In-Line
- ▶ 4302 DualArm Split Coupled Vertical In-Line Twin

Note that all Armstrong IVS Sensorless Vertical In-Line pumps are designed for pipeline mounting, thereby removing the need for inertia base, anti-vibration mounts and flexible pump connections. This feature can reduce installed cost by 30–40% and save significant amounts of plant room space.

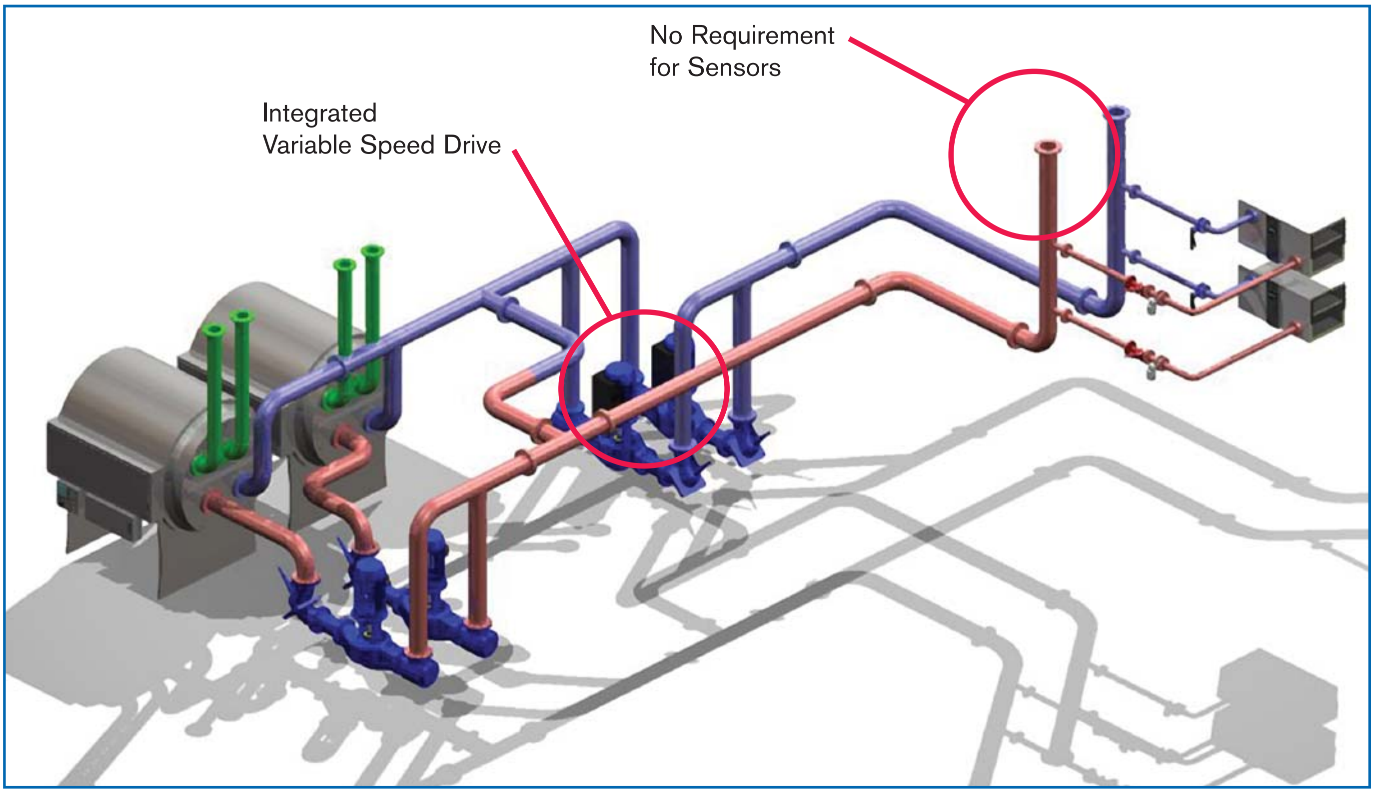


Figure 4 - Primary/Secondary Chilled or Heating Water System Incorporating Armstrong IVS Sensorless Pumps

▶ Product Features

- Fast and easy installation - no pressure sensors required
- IP55 Enclosure rating
- Graphical user interface (units with motors above 7.5kW only)
- Supplied with customers' design pre-sets
- Compact space-saving design - as compact as a standard pump
- BMS compatible - analogue / digital I/O and RS485 port with Modbus RTU
- Interchangeable with standard pumps
- Multiple control modes
- Bypass frequency selection to eliminate system noise and vibration problems
- Programmable motor pre-heat function to prevent condensation problems
- Built in RFI filter for EMC Directive compliance
- Built in DC link chokes to reduce mains borne harmonics

▶ Product Options

- Quick connection keypad and cable for programming and monitoring - one required per site (units above 7.5kW have an integrated graphical interface fitted as standard)
- LonWorks BMS protocol (units with motors above 7.5kW only)
- BACnet BMS protocol (units with motors above 7.5kW only)
- Integral mains isolator (units with motors above 7.5kW only)
- EFF1 Premium efficiency motor (units with motors above 7.5kW only*)

*Variable speed motors 7.5kW and below are high efficiency designs as standard, however the level of integration between motor and VSD means that they are exempt from the CEMEP efficiency labelling scheme and therefore cannot be rated under the EFF system.

▶ Environmental Ratings

- Temperature: 0 - 40°C
- Maximum Relative Humidity: 93% +2%, -3%

▶ Sensorless Control Modes

The default mode of operation for IVS Sensorless pumps is to follow a system control curve similar to that shown in Figure 2 (page 4). This mode of control is also known as 'Quadratic Pressure Control' as the control curve is a quadratic curve between two operating points H_{MAX} and H_{MIN}. H_{MAX} is the design duty head of the pump and H_{MIN} is the head at minimum flow which is set to a factory default of 40% of H_{MAX}. Other control modes possible include proportional pressure control and constant pressure control. All settings are easily adjusted in the field for as-built system conditions.

▶ Constant Curve Control

Where a Building Management System (BMS) or a remote feedback sensor is directly used to control the speed of the pump (using a 0 - 10V signal), the sensorless control can be switched off. The pump speed will now vary according to the BMS reference signal. The graphic keypad can also be used to vary the speed reference signal allowing manual speed control of IVS Sensorless pumps in primary or secondary systems.

The Constant Curve Control mode (Figure 5) is used, along with an Armstrong IPS Controller with multiple sensors, for multiple pump control and/or for complicated systems where a single sensor or Sensorless control would not be suitable.

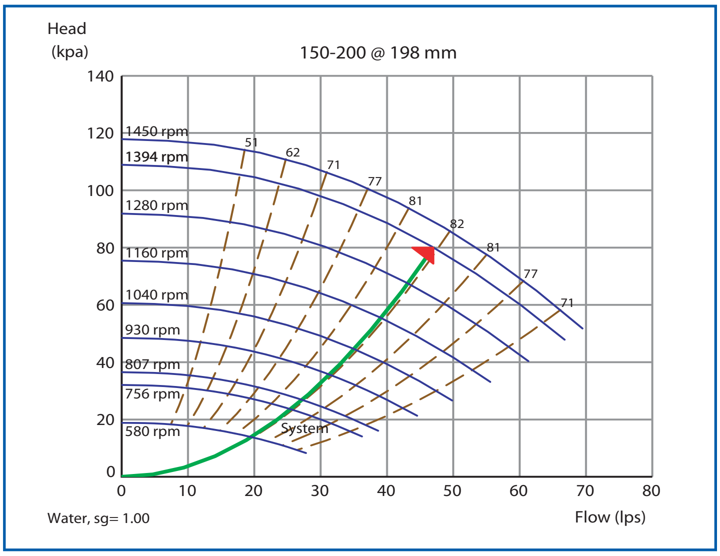


Figure 5 - Constant Curve Control

▶ Duty/Standby Operation

Duty/standby operation is available, where pumps will alternate at pre-set intervals and the standby unit will start automatically, should the duty pump fail. Alarms can also be sent to BMS on duty pump failure. Series 4302 IVS dualARM, fitted with 11.0kW or larger motors, can be supplied pre-wired for duty/standby operation. Series 4300 IVS units, fitted with 11.0kW or larger motors, may be wired on-site for duty/standby operation per the supplied installation instructions. Armstrong IPS controllers can also be used to control duty/standby units or multiple units with best efficiency staging control.

▶ Variable Speed Drives for Larger Pumps and Other Pump Types

Variable speed drives are available for most Armstrong commercial pump designs. Controls are typically supplied separately as 'stand-alone' units for pump types other than those specified here. Armstrong IVS102 variable speed drives are suitable for mounting in plant rooms adjacent to the pumping units. Standalone controls can be supplied in an IP20/21 enclosure or an IP55 (IP54 on some larger sizes) enclosure.

▶ Multi-pump, Multi-zone Controls

For complex systems with a requirement for individual zone control, Armstrong offers a range of IPS controllers that can control as many as six pumps in parallel with up to eighteen remote system load sensors. IPS controllers can be used in conjunction with both IVS integrated VFD pumps or pumps connected to IVS102 standalone VFDs.

Typical Specification

Provide Armstrong Series ______IVS Sensorless pump to Armstrong Series _____pump typical specification with motor and control specification as per the following:

The driving motor shall be of squirrel cage induction type incorporating an integrated variable speed drive (VSD), vertical solid shaft with IP55 enclosure.

The integrated VSD shall be of the VVC-PWM type providing near unity displacement power factor (cos phi) without the need for external power factor correction capacitors at all loads and speeds. The VSD shall incorporate DC link chokes for the reduction of mains borne harmonic currents to aid in compliance with the Electricity Council's Engineering Recommendation G5/4 Stage 2 and to reduce the DC link ripple current. The product shall be CE marked showing compliance with both the EMC Directive 89/336/EEC and the Low Voltage Directive 72/23/EEC. RFI filters shall be fitted as standard to ensure the VSD meets the emission and immunity requirements of EN61800-3.

VSD and motor protection shall include: motor phase to phase fault, motor phase to earth fault, loss of supply phase, over voltage, under voltage, motor over temperature, inverter overload, over current.

Sensorless control software shall be embedded in the integrated VFD to provide automatic speed control in variable volume systems without the need for pump mounted (internal/external) or remote differential pressure sensor. The default operating mode under Sensorless control shall be 'quadratic pressure control' whereby head reduction as the flow is reduced will be calculated according to a quadratic control curve, the head at minimum flow being 40% of the design duty head. Control mode setting and minimum/maximum head setpoints shall be user adjustable via an integrated or optional programming interface.

The VFD shall have the following additional features: Sensorless override for BMS/manual pump control or closed loop PID control, programmable skip frequencies and adjustable switching frequency for noise/vibration control, auto alarm reset, motor pre-heat function, a minimum four programmable digital inputs, two analogue inputs, one programmable analogue/digital output, one volt-free contact and one RS485 port with Modbus RTU for serial communications to building management systems.

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