Low Charge Product Family

Document LC101c:

Introduction

Hansen's new Low Charge Product Family is an innovative solution that enables many refrigeration systems to operate with a reduced refrigerant charge, helping address several challenges facing the refrigeration industry. Typically sold as a package, the Hansen Low Charge Product Family includes:

- A Vapor Quality Sensor (HXS) to measure vapor percentage leaving the evaporator
- An adjustable-capacity pulse-width modulated solenoid valve (PWV20) in the liquid feed line (Hansen MCV product line can also be used as an alternate)
- A standalone controller (PXVC2) with communication capabilities

This product family can reduce and control circulation rates in pumped overfeed systems—minimizing required refrigerant—or improve the efficiency of direct expansion (DX) systems by enabling zero or near-zero superheat operation. In some DX applications, efficiency with this system may approach or exceed traditional pumped overfeed systems. Guidance on DX applications will be available soon. The Hansen Low Charge Product Family is suitable for use with ammonia and approved freon / fluorinated refrigerants. For optimal compatibility and control performance, Hansen recommends using the HXS, PWV20, and PXVC2 together as a complete system.

This bulletin covers overall system considerations and each component—HXS, PWV20, and PXVC2—within a single document.

Hansen Low Charge: Potential Benefits

- Smaller equipment and reduced installation costs
- Lower refrigerant charge and reduced global warming potential
- Enhanced safety due to minimized refrigerant quantities

- Reduced regulatory burden
- Higher operational efficiency through:
    - Lower pressure drops in evaporator return lines
    - Lower pressure drops in evaporator coils
    - Improved evaporator heat transfer performance
    - Elimination or reduction of superheat inefficiencies in DX systems

System Overview: Low Circulation Ratio Pumped Overfeed Control

Pumped liquid overfeed has long been a standard in industrial refrigeration, with typical recirculation ratios ranging from 2 to 7. However, high circulation rates result in greater pressure drops, oversized piping and equipment, and unnecessary refrigerant charge. These issues are amplified during partial load conditions, reducing overall system efficiency.

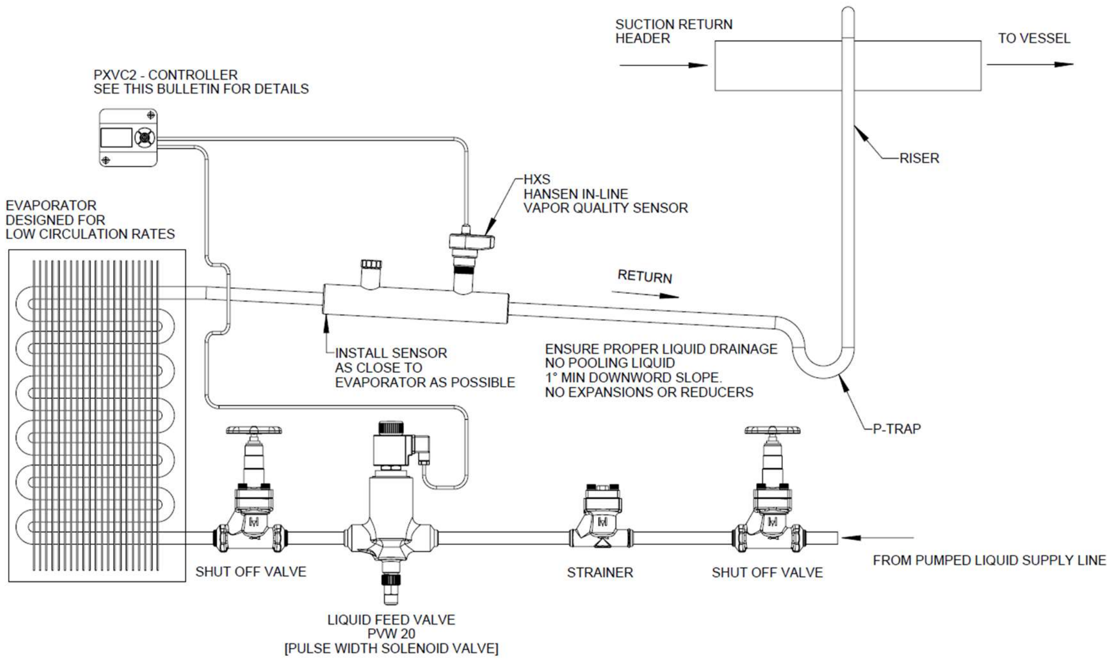
To address these drawbacks, Hansen developed the Low Charge Controlled Circulation Ratio system, which enables active monitoring and control of circulation ratios significantly lower than traditional designs. Some industry research indicates that lower circulation rates may actually improve evaporator heat transfer coefficients in some cases.

Proper implementation requires not only the Hansen Low Charge components but also a system-wide approach to low charge design, affecting:

- Refrigerant inventory and vessel sizing
- Piping and riser design
- Valve selection
- Oil and liquid drainage
- Evaporator choice and design

New systems using these methodologies may operate effectively at a circulation ratio of ~1.2, while retrofit systems with traditional evaporators may perform better at ratios of 1.5 or higher to ensure adequate liquid distribution and heat transfer.

In some cases, existing systems may be unsuitable for low circulation without substantial redesign. However, even in such systems, Hansen's Low Charge system can help maintain optimal circulation ratios over time—especially under part-load or after operational drift from original balancing.



Typical Low Circulation Pumped Overfeed System

(Note: Some required system components not shown for simplicity)

The HXS sensor monitors vapor quality—defined as the mass percentage of vapor in a two-phase mixture—in the suction line and outputs a 4–20 mA signal. For accurate, stable readings, oil and liquid drainage must be properly managed to prevent liquid backup or accumulation in the sensor. Additionally, correct vertical riser sizing is critical to minimize suction line pressure drop and avoid flow reversal (see HXS section).

The PXVC2 controller interprets the HXS signal and modulates the PWV20 or MCV valve to maintain the target circulation ratio (Circulation Ratio = 1 / Vapor Quality). During defrost or pump-out cycles, the controller shuts off the feed valve. After defrost, it initiates a short, adjustable "blow out" phase—temporarily ignoring the HXS signal—to clear any liquid accumulation. While this may cause a brief overshooting of the circulation ratio, most systems tolerate it without issue.

The PWV20, a pulse-width modulated solenoid valve with an integral hand expansion function, offers a cost-effective alternative to motorized valves like the MCV. Its built-in hand expansion feature typically eliminates the need for a separate hand expansion valve.

Controlled Circulation Ratio (CCR) System Best Practices:

Successful operation of controlled circulation ratio (CCR) refrigeration systems requires proper system design, component selection, installation, commissioning, and controller tuning. Low-charge refrigeration systems often operate differently than traditional pumped overfeed systems and therefore require careful review of Hansen product bulletins and applicable industry design practices.

Improper application of low-charge components can result in unstable circulation rates, excessive pressure drop, poor evaporator performance, liquid hammer, inaccurate vapor quality readings, or flood-starve cycling.

The most common causes of unstable system operation are:

- Improper suction riser sizing or liquid drainage
- Oversized liquid feed valves
- Large process dead time combined with aggressive controller tuning
- Improper vapor quality sensor location
- Flash gas or unstable liquid feed conditions

System Suitability

Not all existing pumped overfeed systems are suitable for very low circulation ratio operation without modification. Traditional evaporators, piping systems, and risers may have been designed assuming significantly higher circulation ratios.

Retrofit systems may therefore require:

- Higher minimum circulation ratios
- Revised riser sizing
- Double risers

- Improved liquid drainage provisions
- Feed valve resizing or adjustment

Some systems may require substantial redesign before stable low circulation operation can be achieved.

Suction Line Design and Riser Sizing

Suction line design is critical to proper operation of low-charge refrigeration systems and vapor quality sensors. Suction piping must be designed to promote proper liquid and oil drainage while minimizing pressure drop.

Horizontal suction lines should generally be sloped downward in the direction of flow to prevent liquid accumulation and oil trapping.

Vertical risers require special consideration because low circulation systems frequently operate at reduced vapor velocities during minimum load conditions. If vapor velocity becomes too low, flow reversal may occur, where vapor continues upward while liquid accumulates or falls back down the riser. Flow reversal can cause:

- Excessive riser pressure drop
- Liquid floodback
- Erratic vapor quality sensor readings
- Unstable circulation ratio control

Riser sizing should therefore be evaluated at both maximum and minimum evaporator load conditions. Oversized risers are strongly discouraged because they may increase the likelihood of flow reversal during low-load operation.

Hansen recommends use of established two-phase riser sizing methodologies, such as those described in the IIAR Refrigeration Piping Handbook and IIAR Riser Tool.

Vapor Quality Sensor (HXS) Installation

The HXS sensor should be installed in a horizontal suction line section immediately downstream of the evaporator outlet and at least 200mm upstream of the P-trap at the base of the riser.

The sensor should not be installed:

- In vertical piping
- Directly adjacent to the P-trap
- In areas where liquid can accumulate
- In pipe sections with abrupt diameter changes

Improper sensor location may result in false vapor quality readings and unstable system control.

The HXS fitting size should match the pipe diameter of the section in which it is installed.

HXS Sensor Configuration

HXS sensor dry calibration and span scaling values must be configured appropriately for the refrigerant, pipe size, and application type. Incorrect configuration values can result in inaccurate vapor quality measurements and unstable control performance.

Refer to the HXS calibration tables and setup procedures included in this bulletin.

Liquid Feed Valve Sizing and Adjustment

Proper sizing and adjustment of the liquid feed valve is one of the most important factors affecting system stability.

Oversized liquid feed valves are a common cause of flood-starve cycling and unstable circulation ratio control. Excessive valve capacity increases process gain, causing small output changes to produce disproportionately large changes in evaporator feed rate and vapor quality.

Controller tuning alone cannot compensate for severe valve oversizing.

The PWV20 valve and internal hand expansion adjustment should be selected such that the valve operates near approximately 75–80% pulse on-time at maximum evaporator load.

Selection should consider:

- Available pressure drop across the valve: Do not assume that the valve operates at only the minimum pressure differential required for opening. The internal hand expansion stem contributes a significant portion of the total pressure drop through the piping. Estimating the actual operating pressure drop will generally produce more accurate valve sizing.

- Minimum operating pressure differential
- Maximum and minimum evaporator load conditions
- Liquid line velocity limitations
- Potential flash gas formation

System Tuning

Controlled circulation ratio systems typically exhibit significant process dead time because changes in liquid feed rate may require several minutes to propagate through the evaporator and suction piping before reaching the HXS sensor.

As a result, aggressive controller tuning often causes oscillation or flood-starve cycling.

Most systems require:

- Relatively large proportional bands
- Long integral times
- Slow controller response

In many cases, evaporator thermal mass and time constants allow slower control response without negatively affecting system performance.

If unstable operation is encountered:

1. Verify proper riser sizing and liquid drainage
2. Verify proper sensor location & settings
3. Verify liquid feed valve sizing and hand expansion adjustment
4. Reduce controller aggressiveness only after hardware and piping issues have been addressed

For additional guidance, refer to the PXVC2 tuning section.

System Overview: DX Control (Wet / Zero Superheat DX) In Development – Contact Factory for Details

Traditional DX systems rely on superheat control, which reduces efficiency in two ways:

1. Part of the evaporator remains dry, decreasing heat transfer
2. Superheated vapor requires more energy to compress than saturated vapor

Historically, superheat control of 8-12°F superheat was necessary due to the lack of precise measurement tools that could prevent liquid carryover to the compressor. Hansen's Low Charge DX system solves this by combining:

- A vapor quality sensor
- A superheat sensor (optional for some systems)
- A pulse-width modulated feed valve
- The PXVC2 controller

Together, these components maintain near-zero superheat conditions, improving performance while managing small, controlled levels of liquid floodback—requiring protection like surge drums. DX-rated evaporators and proper oil drainage management are also essential. DX Control is limited to ammonia and R507 refrigeration systems.

Further product selection and installation guidance for DX will be provided soon.

Hansen X Sensor (HXS)

Vapor Quality Sensor for Refrigerants

Introduction:

Efficient operation of pump-circulated refrigeration systems depends heavily on maintaining an optimal circulation ratio. Hansen’s Vapor Quality Sensor (HXS) can be used to monitor and control liquid return from the evaporator to improve the coefficient of performance (COP). The sensor enables real-time measurement and feedback control of the liquid feed, supporting system operation at minimal yet stable circulation ratios. The HXS is designed to detect the presence of liquid phase in a predominantly gaseous flow. The sensor provides continuous, real-time measurement of the volumetric liquid content within a two-phase flow system and outputs the data as an analog signal. A key feature of the sensor is its adjustable sensitivity, which enables optimization for a range of system configurations. High sensitivity settings are suitable for direct expansion (DX) systems while lower sensitivity settings are more appropriate for pump-circulated systems, where transient liquid presence is less critical. Further information on DX systems and compressor protection will be available soon. For any questions on these applications, contact the factory.

In refrigeration and process systems, accurate detection of vapor quality is critical for system efficiency and component protection. The HXS offers a reliable method for detecting both minor and substantial amounts of entrained liquid within a vapor stream.

The sensor operates by continuously monitoring the volumetric percentage of liquid in a gas-liquid mixture. The analog output signal is proportional to the liquid content, allowing real-time integration with control systems for monitoring or safety intervention.

To accommodate a range of application requirements, the sensor features a configurable sensitivity setting via the Hansen Tool. When configured for high sensitivity, the sensor is capable of detecting small quantities of liquid, making it ideal for DX systems and critical components such as compressors. Conversely, in pump-circulated systems, where liquid carryover is less detrimental, the sensitivity can be reduced to prevent unnecessary alerts or signal fluctuations.

The Vapor Quality Sensor provides a versatile solution for monitoring liquid content in gas streams. Its continuous measurement capability and adjustable sensitivity make it suitable for diverse system architectures, from highly sensitive compressor protection setups to robust pump-circulated systems.

HXS Material Specifications:

Pressure Bearing Components: 304 Stainless Steel

Internal Components:

304 Stainless Steel, PTFE, PEEK

Safe working pressure:

400 PSIG

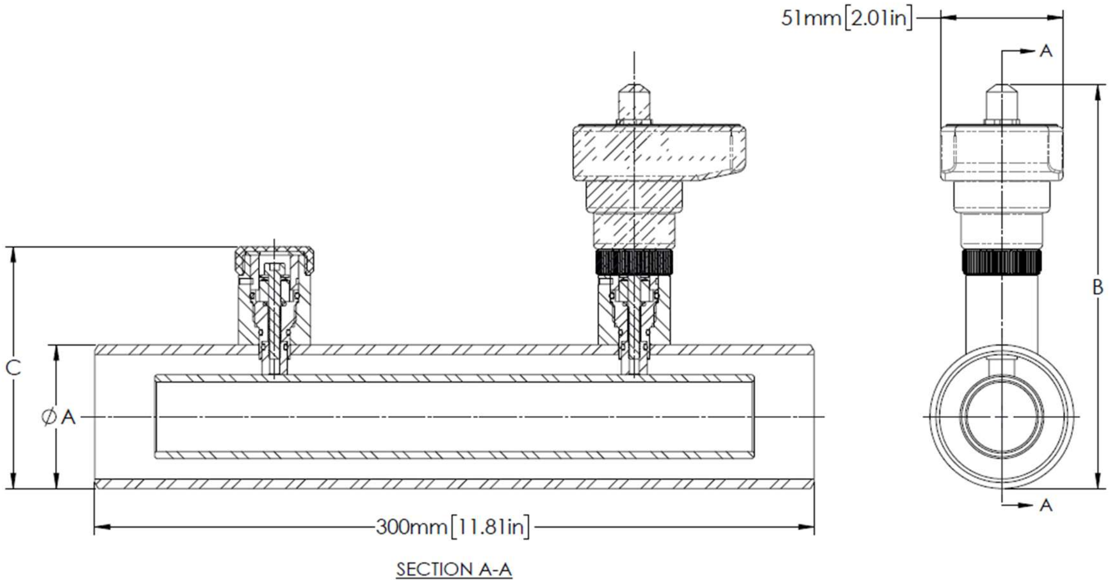
Refrigerant Temperature:

-60°F to +240°F (-50°C to +115°C)

Refrigerants:

Ammonia (R717) & R507. For others, contact factory.

Installation Dimensions:



X-SENSOR INSTALLATION DIMENSIONS				
SIZE	**ØA**	**B**	**C**	**ESTIMATED WEIGHT**
DN 25 [1"]	**Ø34 [1.34]**	**142.1 [5.59]**	**75 [2.95]**	**1.29 KG [2.85 LBS]**
DN 32 [1.25"]	**Ø42 [1.65]**	**150.1 [5.91]**	**83 [3.27]**	**1.55 KG [3.41 LBS]**
DN 40 [1.5"]	**Ø48 [1.89]**	**156.1 [6.15]**	**89 [3.50]**	**1.75 KG [3.87 LBS]**
DN 50 [2"]	**Ø60 [2.36]**	**168.1 [6.62]**	**101 [3.98]**	**2.70 KG [5.95 LBS]**
DN 65 [2.5"]	**Ø76 [2.99]**	**184.1 [7.25]**	**117 [4.61]**	**3.48 KG [7.68 LBS]**
DN 80 [3"]	**Ø89 [3.50]**	**197.1 [7.76]**	**130 [5.12]**	**4.14 KG [9.12 LBS]**
DN 100 [4"]	**Ø114 [4.49]**	**222.1 [8.74]**	**155 [6.10]**	**6.19 KG [13.64 LBS]**

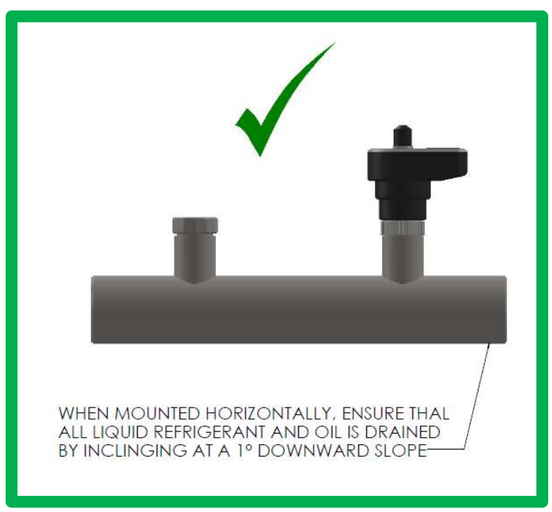
Considerations Prior to Installation

Where to Install

The HXS sensor should be installed on the outlet side of an evaporator in the suction return line as close as practical to the evaporator. Due to the capacitive sensing nature of the sensor, any liquid that is not part of the overall fluid flow stream that is stuck or held up in the sensor will be sensed and cause a falsely low vapor quality reading. Proper piping sizing and design, including consideration for two-phase flow regime, liquid drainage, and oil fouling, are critical for the proper operation of the vapor quality sensor and for operating a low charge refrigeration system in general. A good working knowledge of where the liquid in the piping is located is needed to prevent improper liquid accumulation or slugging, which will cause sensor accuracy and control issues.

The Vapor quality sensor should be installed at least 8” (200mm) away from the P-trap at the bottom of the vertical riser to prevent liquid flood back. The pipe run in which the sensor is installed should not have any expansions or reductions, and there should be a minimum of 1° downward slope to prevent liquid holdup or drainage issues.

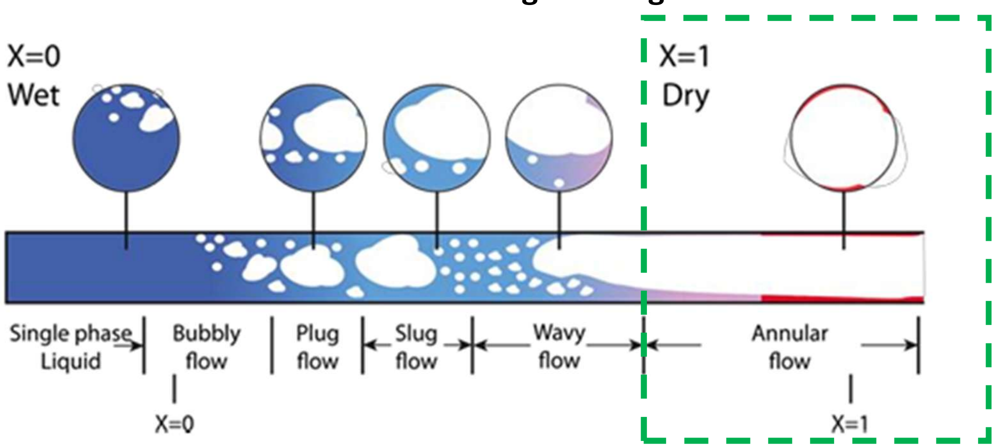
Acceptable HXS Mounting Orientations



Unacceptable HXS Mounting Orientations

To ensure optimal performance, maintain annular flow in the pipe where the HXS is installed. Annular flow typically occurs at high vapor qualities and velocities, forming a ring of liquid along the pipe wall. This flow pattern offers stable, easily detectable liquid flow and helps minimize pressure drop. In contrast, irregular flow regimes such as wavy or slug flow can lead to control and accuracy issues. Refer to the *Riser Design* section for guidance on maintaining annular flow and preventing flow reversal in vertical risers. Unless flow analysis is conducted for the horizontal section, the horizontal return line diameter should match the vertical riser diameter.

Two-Phase-Flow Regime Diagram



Riser Design

One of the key benefits of using a low-charge system with a controlled, low overfeed ratio is the potential to significantly reduce pressure drop in the wet return line—an important factor in maximizing overall system efficiency. When a vertical riser is incorporated into this return line, proper sizing is essential to ensure optimal system performance.

Designing risers for use with Hansen Low-Charge systems requires special consideration. Conventional pipe sizing software is generally not applicable for vertical two-phase flow. Instead, specialized methodologies—such as those outlined in the IIAR Refrigeration Piping Handbook and applied through the IIAR Riser Tool—should be used to accurately evaluate flow characteristics and pressure drops across all expected evaporator loads.

This approach uses empirical correlations to calculate both frictional and static pressure losses, which together form the total pressure drop in the riser. As illustrated in the screenshot below, plotting pressure drop versus cooling load often reveals a minimum point. Interestingly, unlike in most piping systems, increasing the pipe diameter beyond a certain point may not lead to lower pressure drops in two-phase risers.

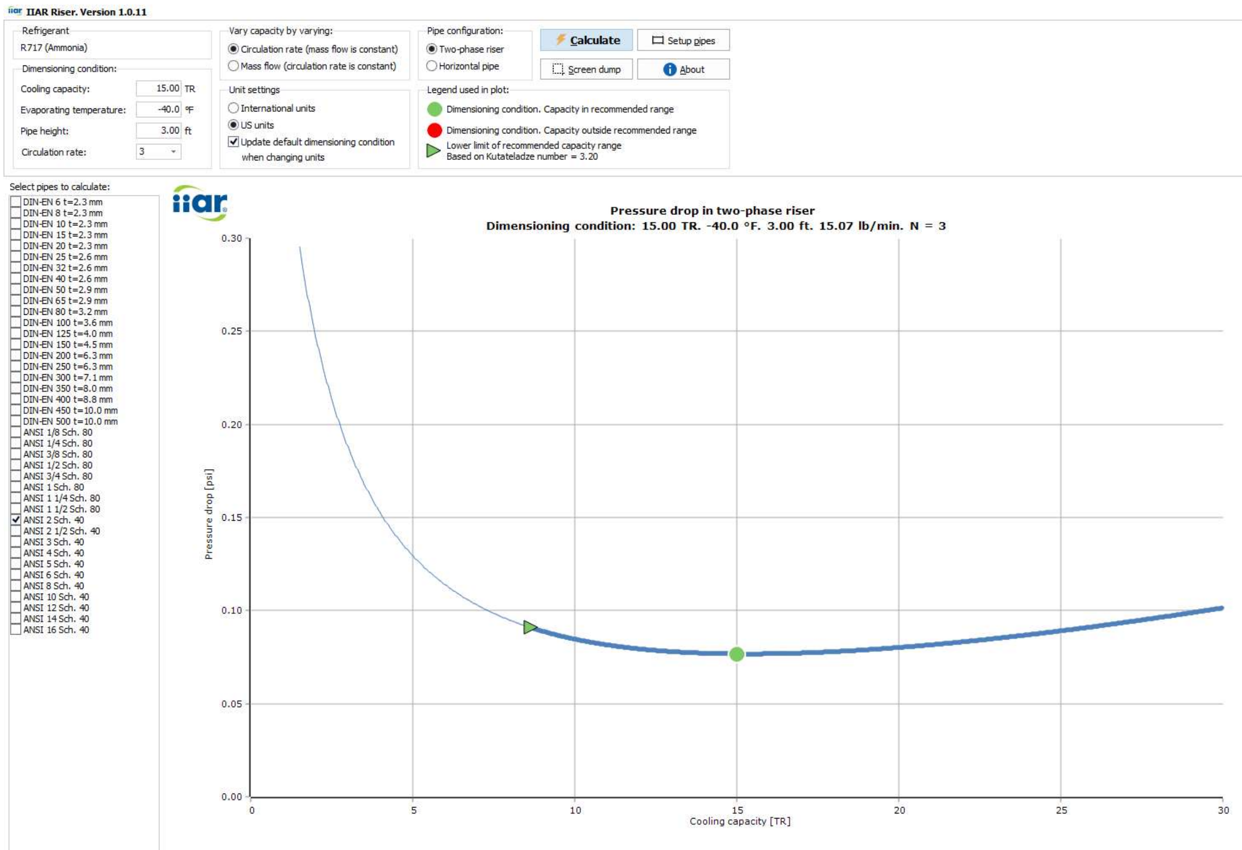
The triangle on the graph marks the condition where the Kutateladze number (Ku) equals 3.2 — a threshold below which flow reversal can occur. In this phenomenon, vapor continues to rise while liquid stagnates or even descends, leading to severe system instability and steep pressure loss increases (as shown to the left of the triangle). Flow reversal can also cause liquid flood back and erratic readings from vapor quality sensors, resulting in poor control and system performance.

To avoid this, all potential load scenarios should be assessed to ensure that Ku remains above 3.2 at the minimum cooling load. When vapor quality or overfeed ratio is uncertain, a conservative approach should be taken by assuming the lowest plausible vapor quality. Oversizing vertical risers is **NOT** recommended. For systems experiencing wide load swings, special configurations such as double risers may be necessary.

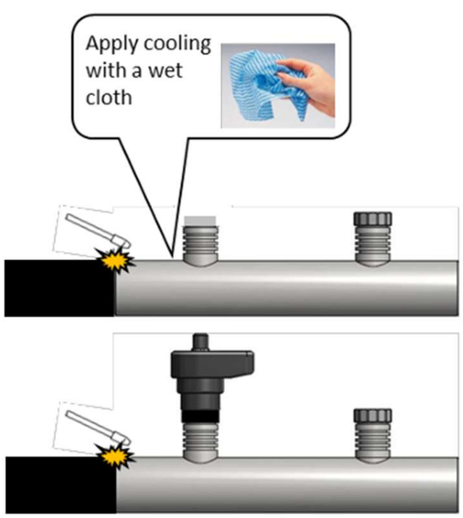
Sources: IIAR Refrigeration Piping Handbook; IIAR Riser Sizing Tool

Disclaimer: This information is intended for general guidance on using Hansen products within low-charge refrigeration systems. System designers and installers are responsible for confirming the suitability of their specific designs and for following proper safety procedures, engineering best practices, and all applicable regulations.

Figure 2: Sample Screenshot from IIAR Riser Tool



Welding



When the sensor is welded or braced into the plant the electronic unit has to be removed in order to protect it from the heat. The pipe and studs have to be cooled during welding as they include O-rings which does not tolerate temperature beyond 100°C (212°F). A wet cloth is normally sufficient to cool the studs.
Don't try to remove the sealing by loosening the small hex screw. This can lead to leakage and the inner pipe can drop down without any possibility to get it back in position

Remove electronic unit before welding or soldering and cool the studs ex. with a wet cloth.
Don't loosen the hex screws

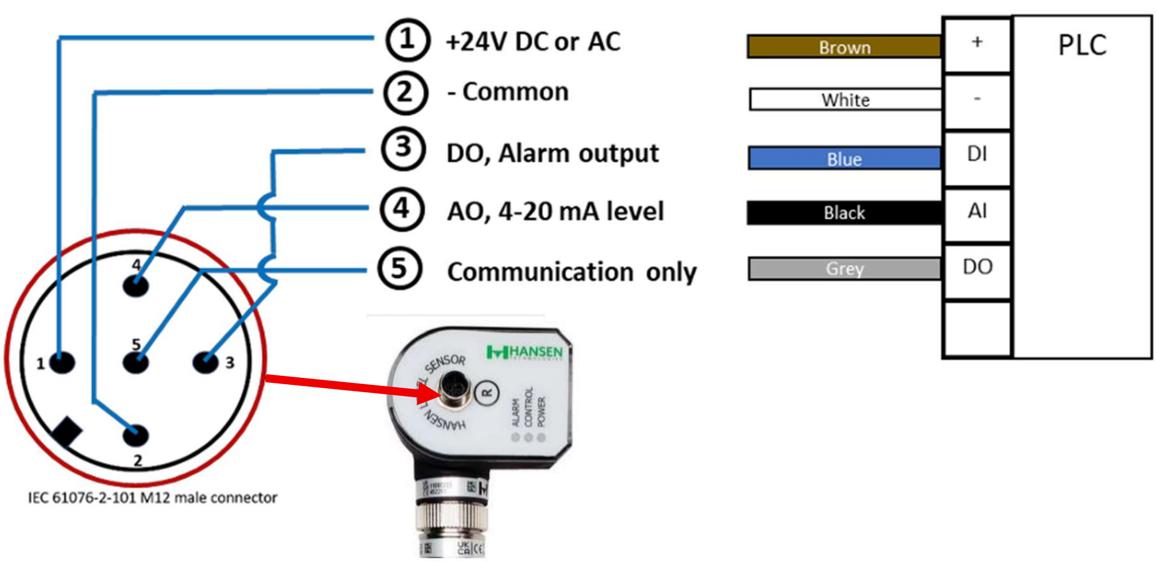
Sensor Installation Recommendations

- Protect the interior of the HXS sensor from dirt and metal particles before and during installation
- Extra care must be taken to remove any dirt and metal shavings from pipe cutting or weld preparation
- Be sure to remove dirt and debris and not push it further into the upstream piping
- Before final installation and welding, conduct a post cleaning inspection to verify all debris has been removed
- Consult your SOP for cleaning techniques and cleanliness standards
- Horizontal HXS installations must be sloped (1° minimum) to allow oil and refrigerant to fully drain

Wiring Diagrams

For wiring with the PXVC2 controller, see the PXVC2 section of this bulletin.

Electrical connections for standard sensors without direct valve control.

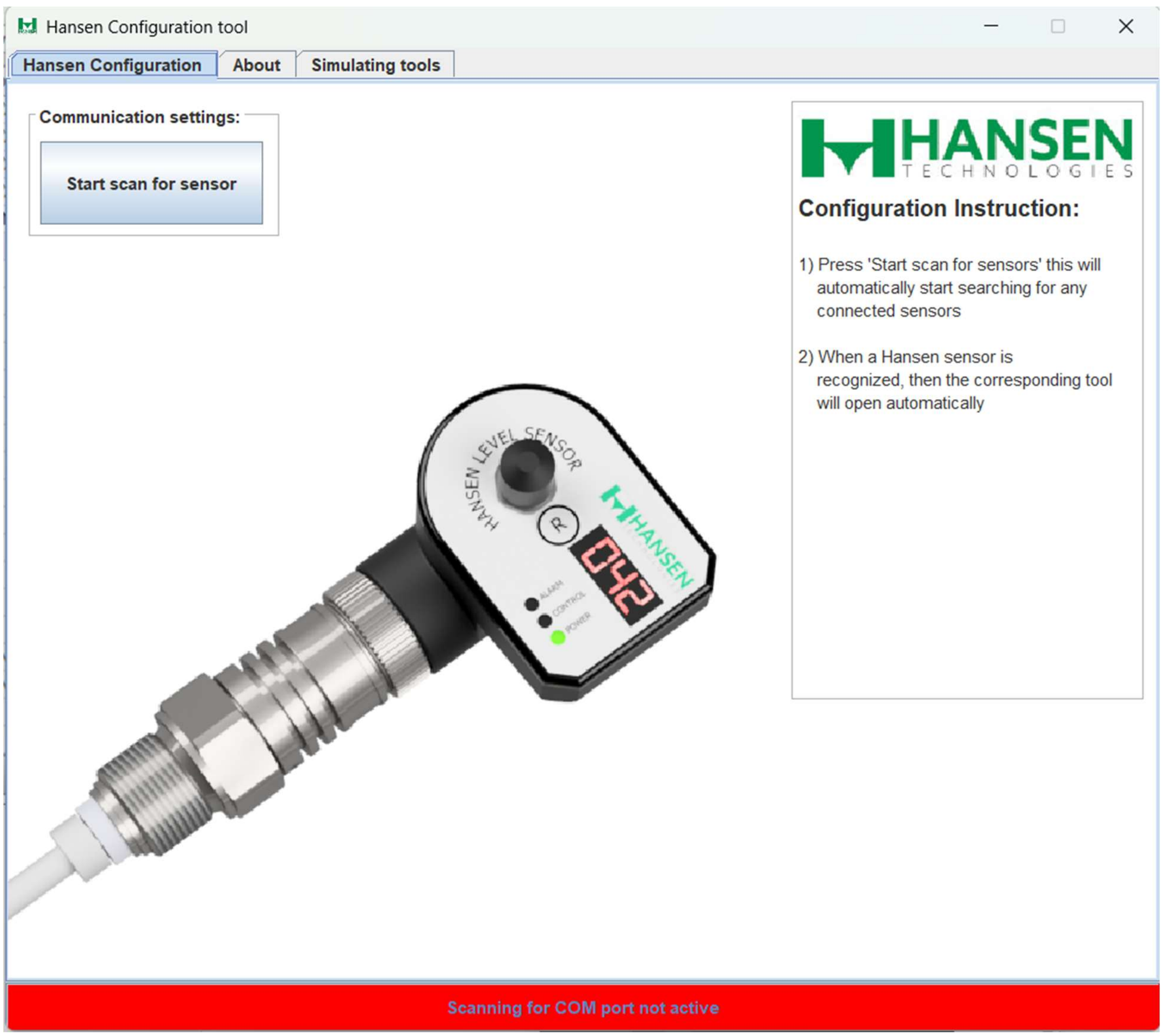


Calibration/ Set up Tool

The HXS sensor can be used off the shelf and field calibrated for a variety of refrigerants, temperatures, and applications (DX, controlled circulation rate). The settings of the sensor need to be adjusted for each application by using the Hansen Tool.

The HXS can be connected to a PC to view sensor readings, adjust settings and alarms, and recalibrate the sensor. Using the USB/M12 connector, connect to a PC and download the Hansen Tool from the Hansen Technologies website.

The Hansen tool will scan for sensors and load the appropriate tool automatically.



The calibration tab is the dashboard. The dashboard shows calibration, current measurement, vapor quality (X), and controller output. Clicking dry sensor calibration will recalibrate the sensor, setting its current environment as dry. The sensor must be in dry conditions before calibrating.

By clicking Enable manual calibration , the dry calibration, span, and measuring scale can be manually input. The table below shows the values that should be input into the X measuring scale and Span sections of the Hansen tool calibration tab.

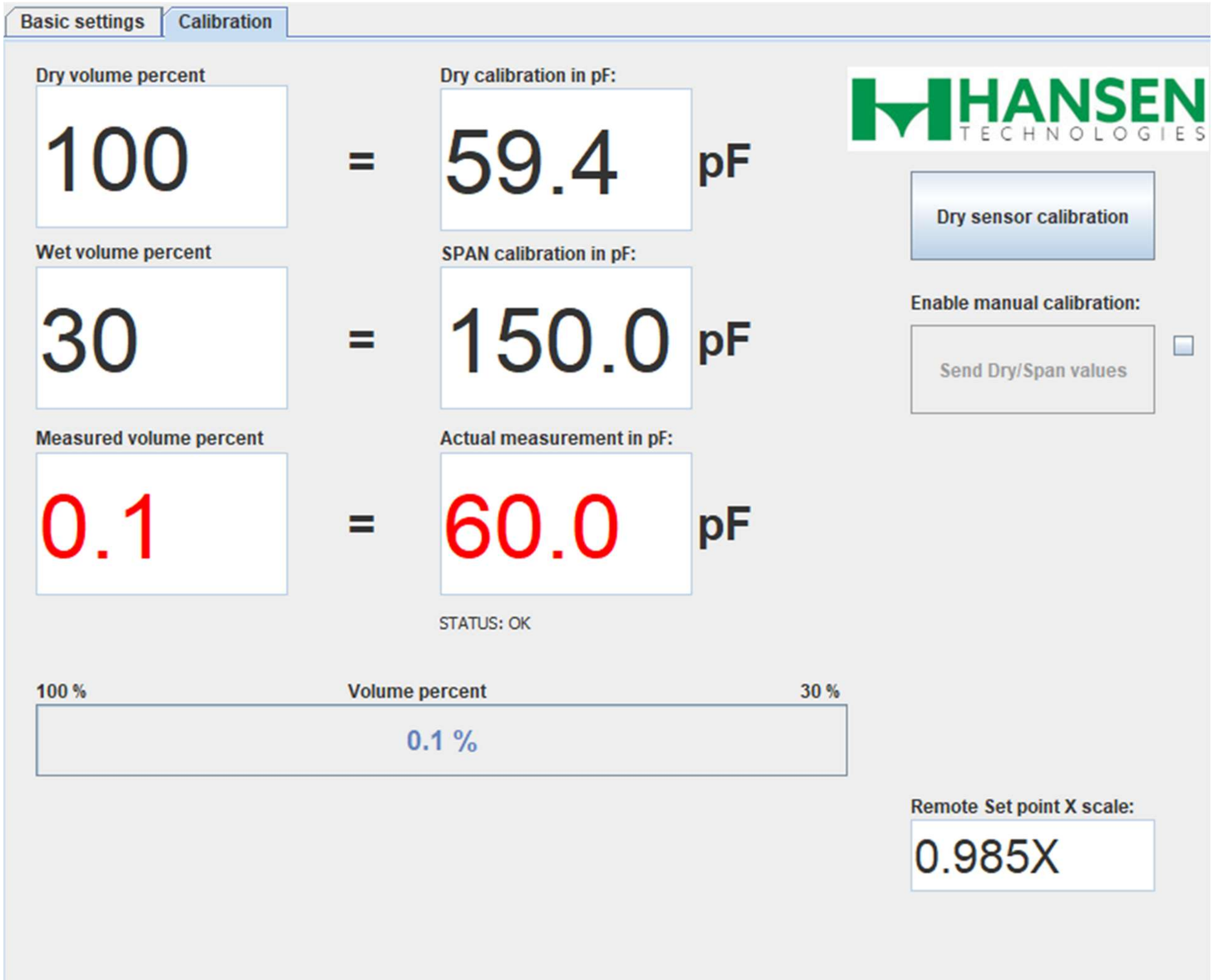
Refrigerant		**NH3**	**NH3**	**NH3**	**R507**	**R507**	**R507**	**DX**
Temperature (°C)		-50	-25	0	-50	-25	0	
Application		CCR	CCR	CCR	CCR	CCR	CCR	
X Range		.3 to 1.0	.3 to 1.0	.3 to 1.0	.3 to 1.0	.3 to 1.0	.3 to 1.0	In Development Contact Factory
Wet Volume Percent		30	30	30	30	30	30	
Span (pF)	**DN25**	55.3	57.5	62.7	15.8	18.7	24.9	
	DN32	67.4	70.0	76.5	19.2	22.6	30.2	
	DN40	93.5	97.1	106	27.5	32.4	43.2	
	DN50	97.2	101	110	28.5	33.6	44.8	
	DN65	169	175	191	50.7	59.9	80	
	DN80	417	433	473	130	153	204	
	DN100	358	372	406	110	130	173	

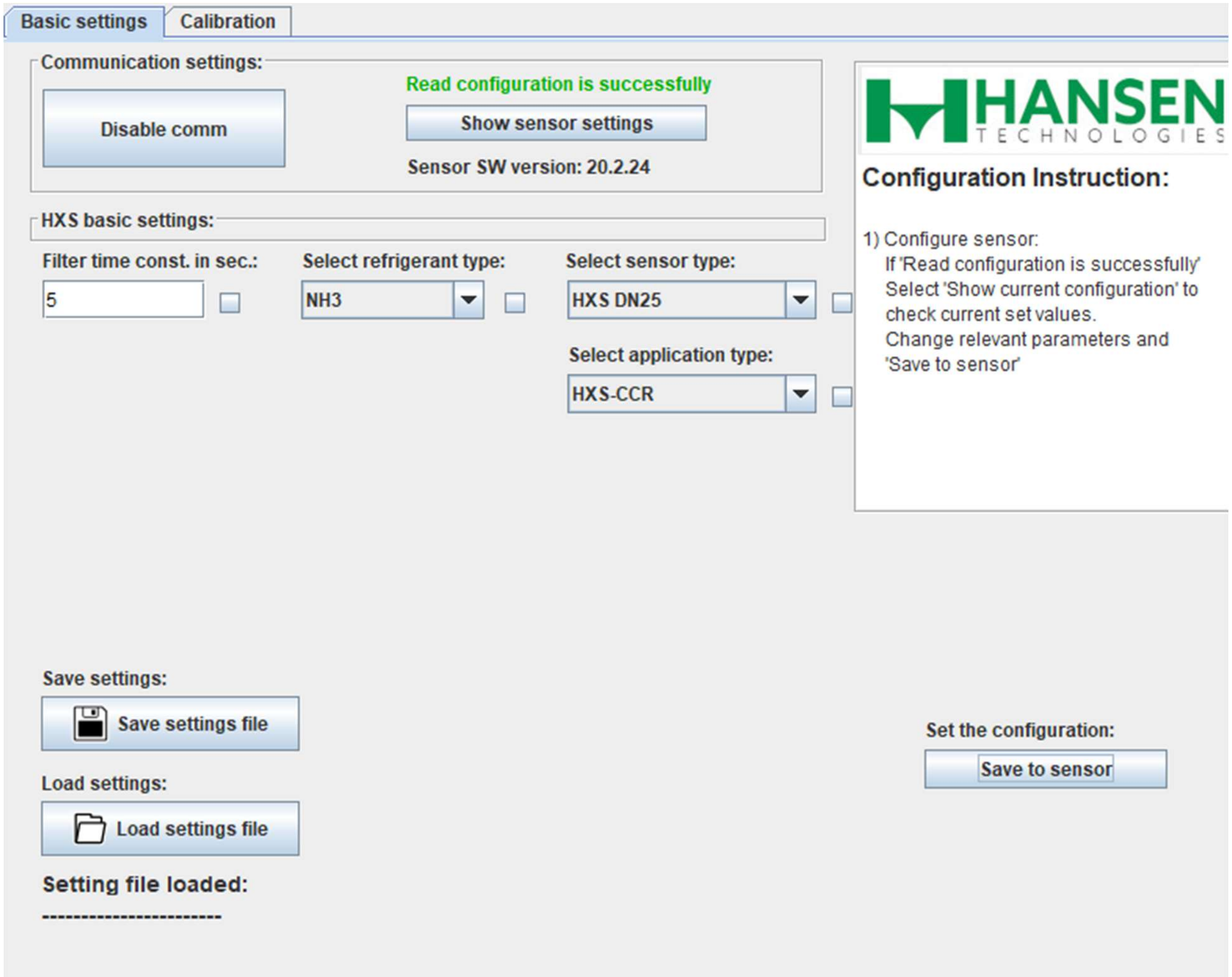
With an X measuring scale of 0.30, the Hansen X sensor will output a 4-20 mA signal where 20 mA equals a vapor quality of 0.30, and a 4 mA signal equals a vapor quality of 1.00 (dry gas). The intermediate values relate linearly such that:

$$mA = \left(\frac{16}{.7}\right) * (1 - X) + 4$$

Hansen recommends the sensor be used in conjunction with the PXVC2 controller. See the PXVC2 controller section of this bulletin for further instructions on how to integrate system control

Note: Adjustments to the settings can affect the performance of the sensor. Ensure that any changes being made are fully understood and performed by qualified personnel.


Basic settings
Calibration
Dry volume percent
100
=
Dry calibration in pF:
59.4
pF
HANSEN
TECHNOLOGIES
Dry sensor calibration
Wet volume percent
30
=
SPAN calibration in pF:
150.0
pF
Enable manual calibration:
Send Dry/Span values
Measured volume percent
0.1
=
Actual measurement in pF:
60.0
pF
STATUS: OK
100 %
Volume percent
30 %
0.1 %
Remote Set point X scale:
0.985X


Basic settings
Calibration
Communication settings:
Disable comm
Read configuration is successfully
Show sensor settings
Sensor SW version: 20.2.24
HANSEN TECHNOLOGIES
Configuration Instruction:
1) Configure sensor:
If 'Read configuration is successfully'
Select 'Show current configuration' to
check current set values.
Change relevant parameters and
'Save to sensor'
HXS basic settings:
Filter time const. in sec.:
5
Select refrigerant type:
NH3
Select sensor type:
HXS DN25
Select application type:
HXS-CCR
Save settings:
Save settings file
Load settings:
Load settings file
Setting file loaded:

Set the configuration:
Save to sensor

PULSE WIDTH VALVE (PWV)

Pulse-Width Modulated Liquid Feed

Solenoid Valve for Refrigerants

Document P480a:

Introduction:

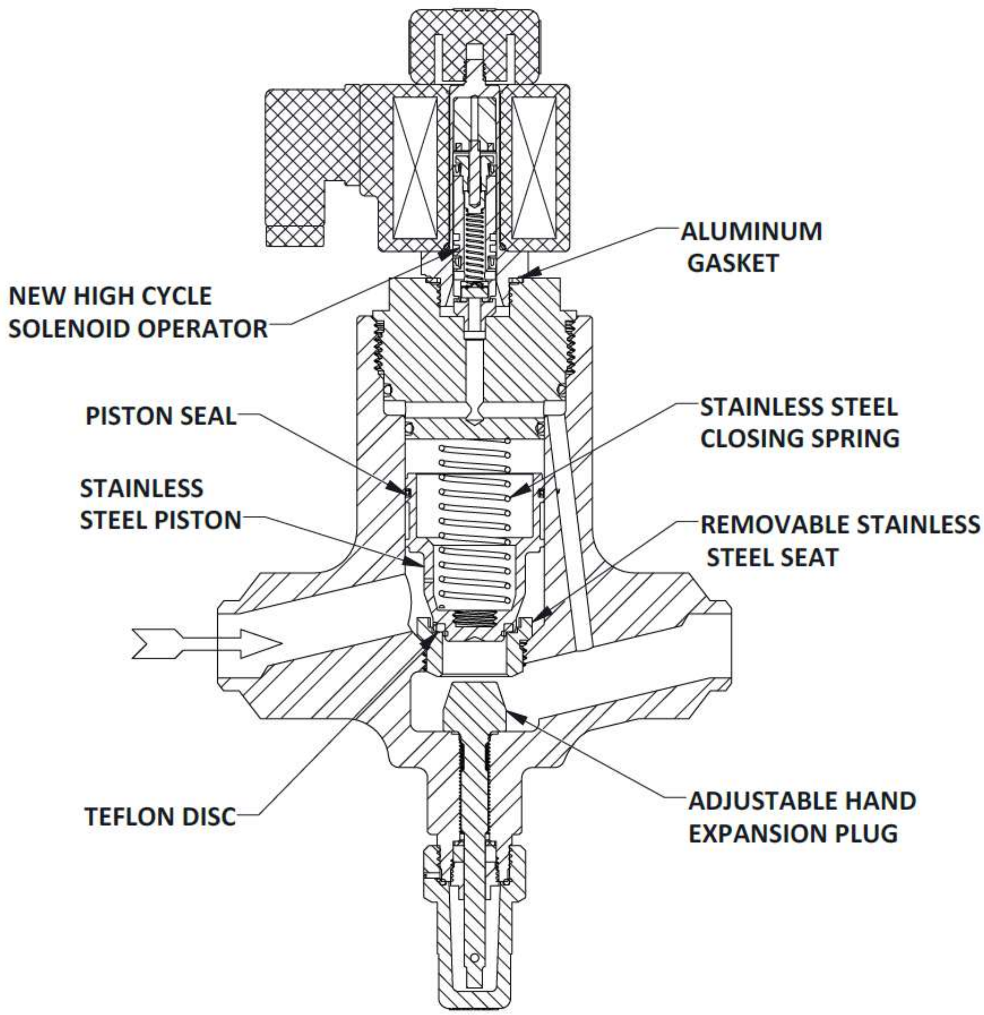
The Pulse Width Valve (PWV) is a specially designed, high-cycle, long-life, high-capacity solenoid valve. The PWV pulses open and closed to control the liquid feed of refrigerant to evaporators, which allows for control of the circulation ratio or vapor quality at the outlet of the evaporator. When electrically energized, a slight pressure difference across the valve causes it to open to its adjustable flow rate setting; when de-energized, a spring promptly closes the main Teflon seat to stop all flow in the arrow direction of the valve body. The PWV is a lower cost alternative to other modulating valves. The PWV is a component of the Hansen Low Charge Product family along with a line of pulse width controllers (Hansen PXVC2) and Vapor Quality Sensors (HXS), which work as a system to precisely control the circulation ratio of an evaporator.

Applications:

The PWV is ideal for modulating control of the liquid feed of refrigerant to evaporators or chillers. It is recommended to use on pumped overfeed evaporator systems where the circulation ratio can be controlled with pulse width modulation, even with varying evaporator loads. The PWV is also suitable for some large capacity direct expansion systems (DX option is still under development – contact factory). These functions often can allow for a system design that requires a lower refrigerant charge while also operating at increased efficiency and lower first costs compared to traditional pumped overfeed systems. This product is intended to work as part of a set within the Hansen Low Charge Product family and is currently not recommended to be used in other applications.

Key Features:

The PWV features an adjustable, integral hand-expansion plug to regulate the max flow or Cv settings, which in most circumstances can eliminate the need for a hand expansion or balancing valve downstream of the solenoid valve. The integral hand expansion plug is double sealed to allow for packing replacement and also allows for the solenoid to be manually opened when turned all the way in to allow for system pump down. The piston seal helps to slow the valve piston close to minimize inlet liquid shock to piping and other system components. The throttling stem, seat ring, piston, and spring are all stainless steel construction and are removable for servicing or replacement. The PWV is offered in a weld-in line steel body. This valve also features a redesigned long life solenoid pilot cartridge that is sealed to the cartridge with a reliable aluminum gasket. Operates with 115V, 220V, or 24V AC or 24V DC coil.



Material Specifications:

Body:

Weld-In Line: Forged Steel (Q355)

Seat Disc: Teflon

Removable Valve Seat: Stainless Steel

Safe working pressure:

Weld-In Line: 754 psig (52 bar)

MOPD: 225 psig

Refrigerant Temperature: -60°F to +240°F (-50°C to +115°C)

Refrigerants: Ammonia, R22, R404, R507, R134a. For CO_2, contact the factory.

SIZING:

Proper valve sizing is important for smooth operation and long, trouble-free life of the valve. Therefore, capacity at both the maximum and minimum flow and pressure drop should be analyzed. The PVW valve has an adjustable, integral hand expansion plug that allows the maximum Cv of the valve to be adjusted from Cv of 7 to 0.8. It is recommended that the valve and expansion plug settings should be sized based on an approximate 75% pulse on time at maximum valve demand, while the capacity tables below show the 100% pulse on time. Ideally, the valve should operate and be sized to operate at between 25% and 75% capacity for optimum trouble free operation. To reduce the risk of liquid hammer, the PWV20 may require approximately 2 seconds to close under certain operating conditions. As a result, turn-down capability is typically limited to approximately 25% of full load when using a standard 10-second PWM cycle. Additionally, the PVW requires a 8 psid minimum drop across the valve for proper opening. In most circumstances, the PWV20 valve should be the main liquid line restriction in the system. Other restrictions, orifices, or hand expansion valves can cause issues to maintain proper differential across the valve to open. It should be noted that the sizing of liquid feed valves for low charge operation will likely be smaller than for typical liquid overfeed operation due to a much smaller amount of liquid that needs to be circulated through the system. Oversizing the valve or leaving the internal hand expansion plug too open is not recommended, as this can lead to short cycling of the solenoid valve and a flood / starve cycle or inability to control to set point.

The liquid line to the inlet of the pulse-width valve (PWV) should be sized for a maximum liquid refrigerant velocity of 7 feet/second for ammonia or 5 feet/second for R22. Liquid line velocity should be limited to 5 ft/s for R507. Liquid lines must be appropriately anchored, as is required with any liquid solenoid valve. Also, liquid lines should be free of vapor. Following these installation guidelines will help minimize liquid velocity shock (liquid hammer) in the pipe. Additionally, a riser with a gas space may be installed in the piping before the PWV to further minimize liquid hammer.

For DX systems, proper considerations must be made to ensure that any subcooling provided can overcome pressure drops in piping or dynamic pressure loss to avoid the creation of flash gas prior to the internal hand expansion plug, as this will greatly reduce system performance. Consult relevant industry best practices guidelines like those published in The Refrigeration Piping Handbook. DX applications are still under development – contact factory for availability.

CAPACITY:

PUMPED OVERFEED CAPACITY

Turns In (Clockwise)	Cv	Capacity NH3		Capacity R507	
		Tons	kW	Tons	kW
0 (Fully Retracted)	7	443	1560	82	289
1	6	380	1337	70	248
2	4.9	310	1092	57	202
3	4.1	260	914	48	169
4	3.6	228	802	42	149
5	3.1	196	691	36	128
6	2.7	171	602	32	112
7	2.2	139	490	26	91
8	1.7	108	379	20	70
9	1.2	76	267	14	50
10	0.8	51	178	9	33
11-15	**Manually open**				
16 (Fully In)					

Above capacities are based on a 1:1 recirculation ratio, and -20F evaporator temperature, 10 psi drop

DIRECT EXPANSION CAPACITY (Not Released – Contact Factory)

Turns In (Clockwise)	Cv	Capacity NH3		Capacity R507	
		Tons	kW	Tons	kW
0 (Fully Retracted)	7	NOT RECOMMENDED		NOT RECOMMENDED	
1	6				
2	4.9				
3	4.1				
4	3.6				
5	3.1				
6	2.7	338	1191		
7	2.2	276	970	30	106
8	1.7	213	750	23	82
9	1.2	150	529	17	58
10	0.8	100	353	11	39
11-15	Manually open				
16 (Fully In)					

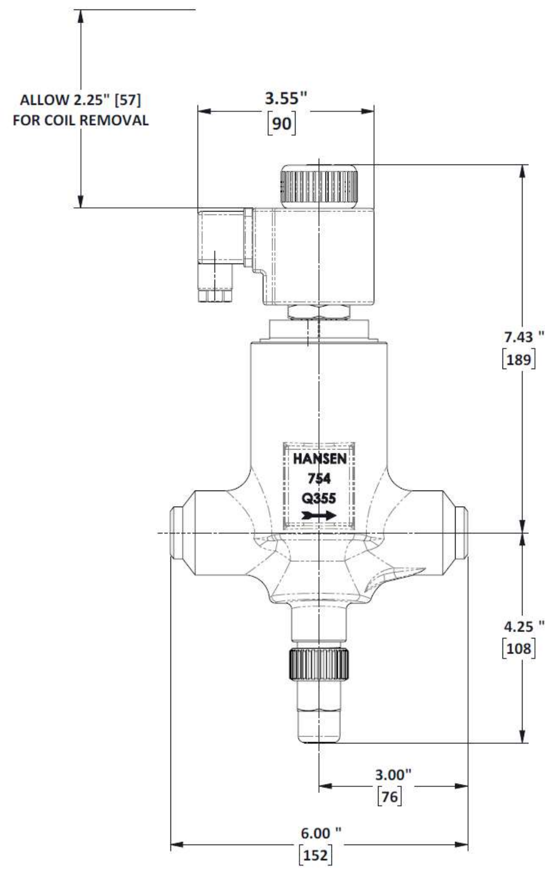
Capacities are based on 85°F condensing pressure and 0°F evaporator temperature. Areas marked "Not Recommended" indicate that the inlet liquid velocity exceeds 7 ft/s for ammonia or 5 ft/s for R507, assuming a maximum upstream liquid line size of 1-1/4" reduced to the valve inlet connection. Alternate piping arrangements should be evaluated to ensure acceptable liquid velocities are maintained.

For other operating conditions, consult the Hansen Quoting and Sizing software located on the Hansen Technologies Website. For smaller capacity pulse width valves, see Hansen's PXV5, PXV15, and PXVW60 product offerings. For larger capacity applications, see Hansen's MCV and MCR product lines.

Installation:

Protect the interior of the valve from dirt during installation; use an upstream inlet strainer. Allow 2.25" (57mm) above the valve for coil removal, 3" (76 mm) below the strainer for screen removal. Match the arrow on the body with the system flow direction. If a pressure reversal can occur, during hot gas defrost with liquid recirculation, use a check valve on the outlet side of the PWV. For proper flange gasket sealing, care must be taken when threading or welding to ensure flanges are parallel to each other and perpendicular to the pipe. Also, gaskets should be lightly oiled, and all bolts must be tightened evenly.

Installation Dimensions:

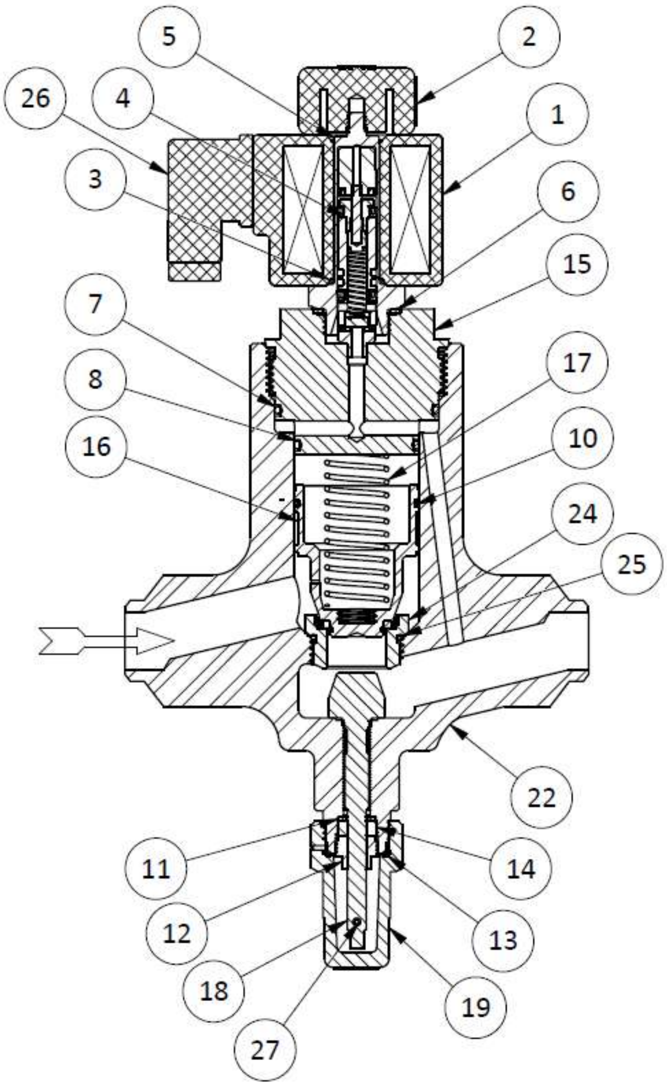


WELD-IN-LINE

Electrical:

The coil draws 16 watts and will operate properly between 85% and 110% of rated voltage (24V coil draws 19 watts). Standard coil connection is a DIN plug. All coils are totally encapsulated and meet NEMA 3R (rainproof) and NEMA 4 (splashproof, approx. IP65) requirements. The coil should only be energized while on the solenoid tube. Otherwise, immediate coil burnout may occur. To avoid bending the solenoid tube, remove the coil from the valve before connecting any electrical conduit. Pilot lights are available.

Parts List:



ITEM	DESCRIPTION	QTY.	KIT NO
1	**Kit (208/230V)DIN Coil**	**1**	**70-1168**
	Coil Kit (Other Voltages / Connections)		**FACTORY**
	Above kit consists of:		
1	Bare Coil	1	
2	Coil Knob	1	
3	Coil O-Ring	1	
26	DIN Connector and Gasket	1	
	Long Life Solenoid Tube/Plunger Kit	**1**	**70-1183**
	Above kit consists of:		
4	Plunger	1	
5	Solenoid Tube	1	
6	Solenoid Tube Gasket	1	
2	Coil Knob	1	
3	Coil O-Ring	1	
	Gasket Kit	**1**	**70-1184**
	Above kits consist of		
7	Upper Body O-Ring	1	
8	Lower Body O-Ring	1	
9	Flange Gasket	2	
11	Stem Washer	1	
12	Packing Nut	1	
14	Stem Packing	1	
13	Seal Cap O-Ring	1	
25	Seat O-Ring	1	
	Bonnet Cartridge Kit	**1**	**70-1185**
	Above kits consist of		
15	Cartridge Assembly	1	
	Gasket Kit	1	
	Solenoid Tube/Plunger Kit	1	
	Piston Assembly Kit	**1**	**70-1186**
	Above kits consist of		
16a	Piston Assembly	1	
17	Closing Spring	1	
7	Upper Body O-Ring	1	
8	Lower Body O-Ring	1	
10	Piston Seal	1	
	Hand Expansion Stem Kit	**1**	**70-1187**
	Above kits consist of		
18	Hand Expansion Stem	1	
27	Stem Pin		
	Gasket Kit	1	
	Seat Ring Kit	1	**70-1188**
	Above kits consist of		
24	Seat Ring		
	Gasket Kit		
	Seal Cap Kit	**1**	**70-1023**
	Above kits consist of		
19	Seal Cap	1	
13	Seal Cap O-Ring	1	
	Bolt and Nut Kit -Flanged Valve Only (Not Pictured)		
	For valve less Strainer (a)		**70-1024**
	For valve with Strainer (b)		**70-1025**
	Above kits consist of		
20	Nut	4	
21a	Bolt (less Strainer) 2.75"	4	
21b	Bolt (with Strainer) 2.75"	2	
21b	*Bolt (with Strainer) 6.5"*	2	
22	Body	1	
23	Flanges (Not Pictured)	2	

SERVICE AND MAINTENANCE

Failure to open: wrong voltage coil; low line voltage; controlling switch or thermostat not contacting; coil is burned-out; inlet/outlet pressure differential too high; less than 8 psi (0.55 bar) pressure drop across valve; piston or plunger is jammed closed with dirt.

Failure to close: controller not opening contacts; throttling stem / manual opening stem is turned in;

piston or plunger is jammed upward by dirt; damage or dirt at main valve seat or pilot valve seat.

Basic Maintenance Procedure: Before opening the valve for service, be sure it is isolated from the system and all refrigerant is removed. Disconnect electrical power from coil. Remove the coil by unscrewing the coil knob. Use a large wrench to unscrew the bonnet-cartridge, proceeding cautiously to avoid any refrigerant still remaining inside the valve. Remove closing spring and piston. A 7/16-14 bolt may be screwed into the bottom of the inside of the piston to aid in the removal. Check for dirt on piston, seat, or piston seal. Polish with fine emery cloth and replace or else install new parts. Check and replace bonnet-cartridge O-rings if necessary, using refrigerant oil or grease. Effective late 2025, Hansen will discontinue the sale of solenoid tubes and plunger kits for long life plunger modules, as well as other service kits for the old solenoid operator. Instead, Hansen recommends a full cartridge replacement when service parts are needed for the old module or to convert to the new module version. Please note that for a PWV that only a long life plunger or cartridge replacement should be used and not a standard solenoid plunger. Check face of Teflon seat in plunger, plunger spring, gasket mating surfaces, and seat orifice in body. Clean, polish, or replace parts as necessary. Always replace the solenoid tube when replacing the plunger. The seat orifice in the solenoid pilot cartridge is integral with the body. When replacing the aluminum gasket, it is common for the aluminum gasket to stick to the base or tube during removal. In this case, take care to not scratch or damage the mating parts of the body or tube when removing. Reassemble the solenoid tube to the body by torquing the hex tube to the body. Factory torque is 75 ft-lbs (102 Nm). Take care not to over-torque the tube. Reassemble bonnet-cartridge to valve body, using 75 foot-pounds torque to tighten secondary, metal, knife edge seal. Carefully check the valve for leaks before restoring to service.

CAUTION

Hansen valves are only for refrigeration systems. These instructions must be completely read and understood before selecting, using or servicing Hansen valves. Only knowledgeable, trained refrigeration mechanics should install, operate, or service these valves. Stated temperature and pressure limits should not be exceeded. Bonnets, solenoid tubes, etc. should not be removed from valves unless system has been evacuated to zero pressure. Must also see Safety Precautions in current List Price Bulletin and Safety Precautions Sheet supplied with product.

WARRANTY: All Hansen products, except electronics, are guaranteed against defective materials or workmanship for one year F.O.B. factory. Electronics are guaranteed against defective materials or workmanship for 90 days F.O.B. factory. No consequential damages or field labor is included.

ORDERING INFORMATION

Connection Style & Sizes Inches (mm)		
Size	**PN**	**Weld-In-Line Style**
3/4" (20)	PWVW20	ANSI / ASME SCH 80 BW
1" (25)	PWVW25	

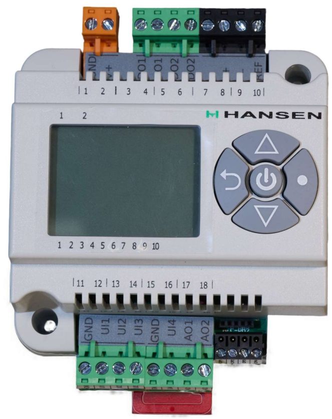
Coils with DIN plug are sold separately; please specify when ordering

*Note: PWV valves are typically sold as a set as part of a Hansen's Low Charge Product Family along with the Hansen Vapor Quality Sensor (HXS) and next generation Pulse Width

PXVC2 Universal Controller Bulletin

Low Circulation Rate/DX Controller

Document PXVC2:



INTRODUCTION

Hansen PXVC2 controller offers a flexible line of controllers to meet a variety of application needs. Primarily, the PXVC2 is an intelligent dual-loop PI controller designed for use with Hansen Motorized Control Valves and Pulse Width Valves. The PXVC2 is an upgraded version of the PXVC (bulletin PXVC), which incorporates the X2 operating system. This operating system features more parameters and alarm settings, more inputs and outputs, remote communication via Modbus RTU or TCP, and compatibility with EasySet software. The PXVC2 is ordered pre-configured for the following application:

- PXVC2-CCR evaporator circulation rate control
- (DX option is still under development – contact factory)

KEY FEATURES

Pre-configured alarms

Compatible with EasySet software with features such as easier parameter setup, ability to program controllers remotely, and live graphing

Displays output signal in 10% incremental resolution

Up to 8 possible inputs, 2 digital outputs, 2 analog outputs, and 2 control loops

Remote communication with Modbus RTU or TCP

ADVANTAGES

1. AC or DC power rated

2. Digital, pulse or analog output

3. User-friendly interface

    A. Intuitive, easy-to-navigate menu buttons

    B. Compatibility with EasySet software

        I. Incorporates X2 Operating System

        II. Ability to read/write programs to controllers via serial connection

        III. The user interface allows for easy parameter adjustment

    C. Easy-to-read multi-character display

        I. Ability to monitor set point and sensor values

        II. Visual alarm notification

4. Optional remote interlock

5. Plug-style terminal block connectors allow for quick connections

6. Versatile configuration options

APPLICATIONS

1. Evaporator Circulation Rate Control (CCR)

Inputs

1. HXS sensor
2. Interlock
    a. Universal input configured based on Application
    b. Remote interlock

Outputs

1. Two digital (Pulse width or Binary)
2. Two analog (4-20mA, 0-20mA, 2-10V or 0-10V) outputs

Selection of Control Valves

1. PWV20 / PXV
2. Motorized Control Valve

TECHNICAL SPECIFICATIONS

1. Connections
    a. Power Supply Requirements 24VDC 3A or 24VAC 3A
    b. Signal Inputs
        i. Analog - 0…20mA, 0…10 VDC
        ii. Digital Input
        iii. Passive – NTC (10kΩ@25^{0}C: -40^{0}C…100^{0}C), PT1000 (-50^{0}C…205^{0}C)
    c. Output
        i. Digital Output 1(Pulse Width / Alarm) – 24-250VAC 3A Max
        ii. Digital Output 2 (Pulse Width / Alarm) – 24- 250VAC 3A Max
        iii. Analog – 0…20mA, 0…10VDC
            1. Maximum load: Voltage ≥ 1kΩ, Current: ≤250Ω
2. General
    a. Ambient Environment (IEC 721-3-3 class 3K5) :
        i. Operating temperature range 0 C to 50 C (32°F to 122°F)
        ii. <85% RH (noncondensing)
    b. Degree of Protection: IP30
    c. Material: Fireproof ABS plastic (UL94 class V-D)
3. Modbus Remote Communication
    a. Hardware interface: RS485, Shielded Twisted Pair cable
    b. Recommended maximum chain length: 1200 m
    c. Default Setting:
        i. Baud rate: 19200
        ii. Stop bit: 1, Parity bit: 1
        iii. RTU 8 data bits

INSTALLATION

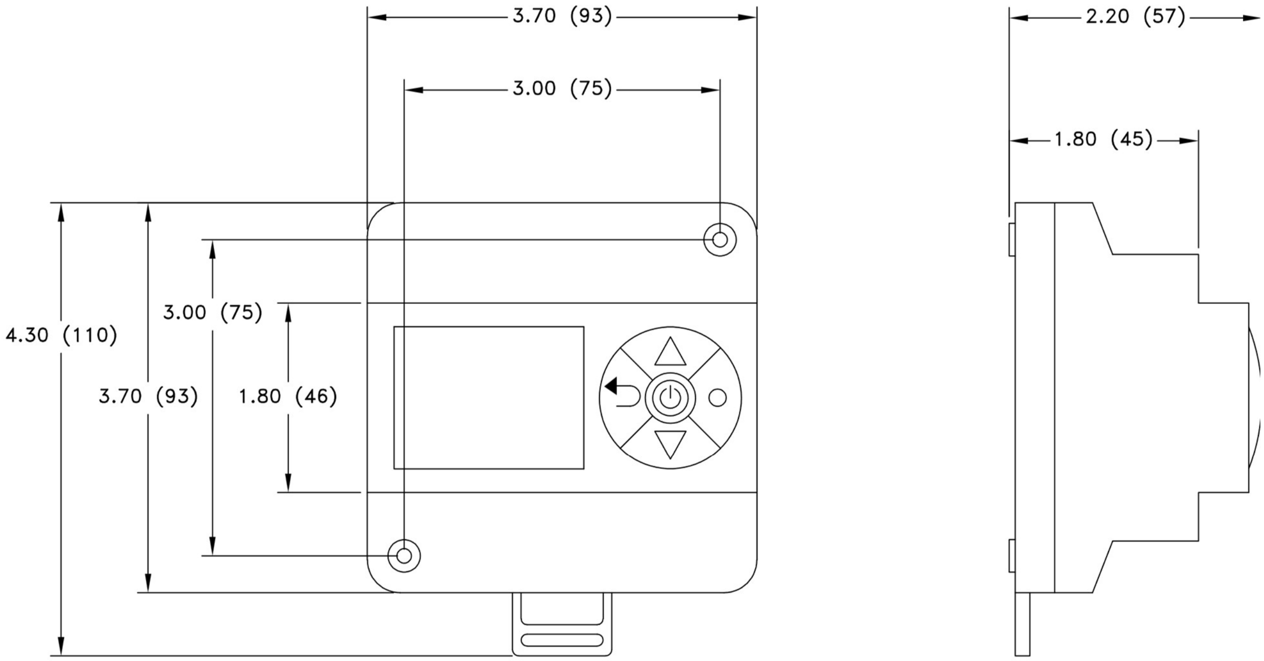


Figure 1. Controller Dimensions

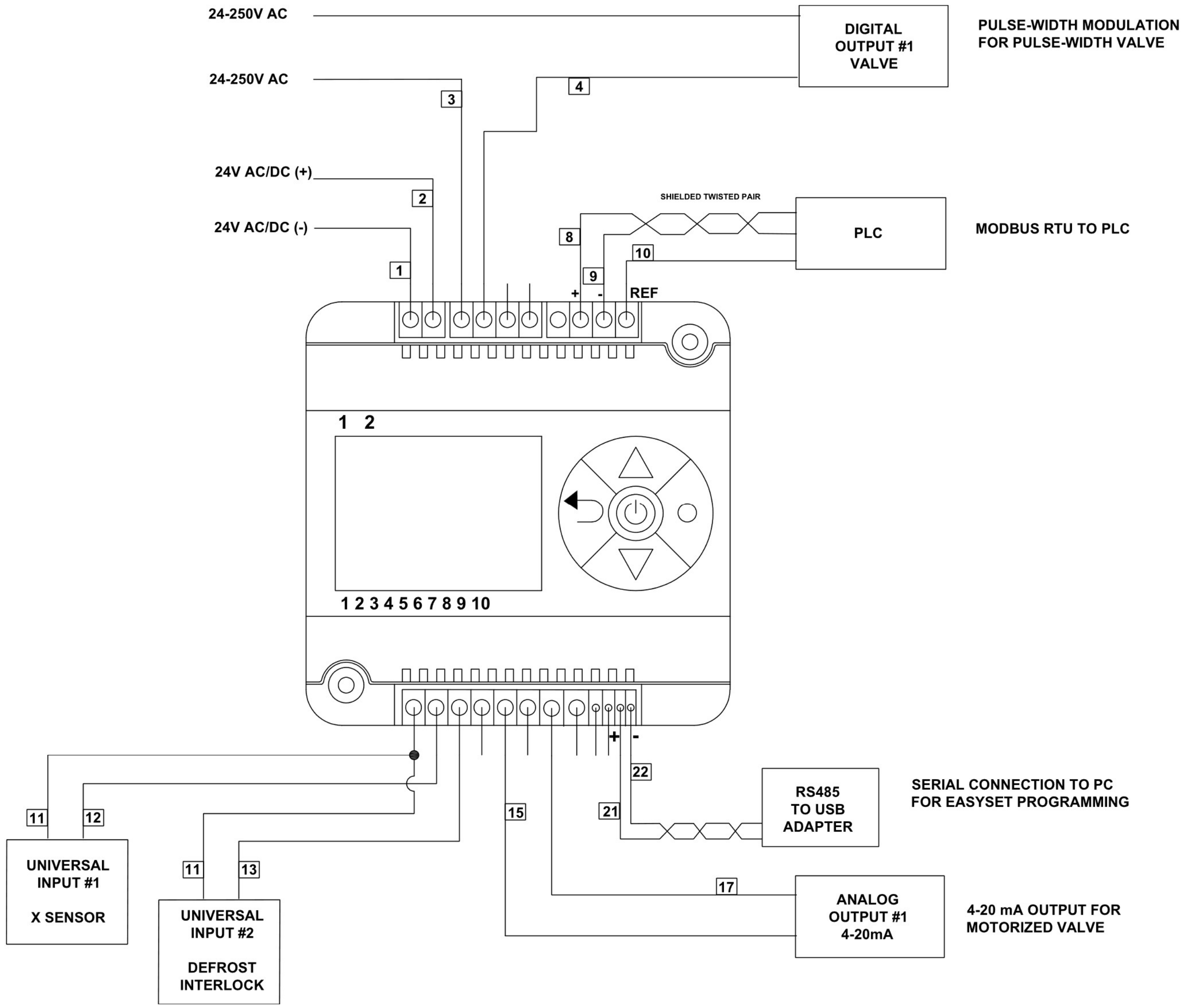


Figure 2. Controller terminal diagram

The PXVC model controllers require careful attention to the wiring diagrams based on the application to prevent damage to the equipment. Failure to follow the diagrams as presented may result in damage to the controller and voidance of product warranty.

Review the controller-specific applications and select the application based on your controller and application needs. For additional applications, contact the factory. **WIRING NOTES** (refer to controller-specific applications for detailed diagrams):

The controller power pins 1 and 2 accept 24 volts DC or AC. Refer to Figure 5.

INPUTS / OUTPUTS

Digital Output #1 is set up for pulse width operation and requires a 24- 250VAC 3A power source. The TRIAC output acts as a switch, stopping and starting the valve (pins 3 and 4)

Digital Output #2 monitors the start-up condition of the controller (See section X)

Analog Output #1 is set up for Motorized Control valve operation. This output will produce a 4-20mA signal (pins 15 and 17).

Universal Input #1 is used for the HXS sensor analog (4- 20mA) input; a 24VDC power source must be applied to the sensor as indicated in the diagrams (pins 11 and 12).

Universal Input #2 must be a continuous circuit (switch closed) to operate as remote interlock pins (11 and 13). This is used to turn off the controller and outputs when the system is defrosting. If the system does not require defrosting, a jumper wire should be assembled on this input.

SENSOR INSTALLATION:

HXS Sensor – Refer to the HXS sensor product bulletin.

SETTING UP THE CONTROLLER

1. Verify jumpers on the back of the controller are set as follows:

		AO1		UI2			UI1		
PXVC2-CCR		**0…10V**	**0…20mA**	**0…10V**	**0…20mA**	**RT / DI**	**0…10V**	**0…20mA**	**RT / DI**
			■			■		■	

Figure 3. Controller Jumper Configurations

2. Connect sensors and power.
3. (Optional) Configure the user's desired alarms.
4. (Optional) Connect the defrost signal remote interlock. Interlock is active when the switch is open and deactivated when the switch is closed. When the interlock is active, the controller is off, and the valve output is disabled.

5. Best practice is to test the function of the unit, verifying the output matches expectations, using a process calibrator (4- 20mA by default), and measuring the analog signal output.
6. Switch off the power
7. Connect outputs to valves and place them into service

Contact Hansen if errors are encountered.

MOUNTING CONSIDERATIONS:

Ensure the controller has an adequate protective enclosure for the environment. An enclosure is required for wet or condensation-prone environments. Ensure the controller has adequate heating if the environment is below 32°F (0°C). The controller may be surface-mounted with two #4 screws, or the controller may be mounted to a DIN rail.

USER MENUS FIGURE

CHANGING PARAMETERS VIA EASYSET SOFTWARE

The EasySet software simplifies the parameter configuration process and allows for controller program files to be loaded to the PXVC2. Contact Hansen for more information.

Uploading Program File to Controller

1. Connect two serial wires to A+ and B- on the controller's operation terminal. Connect the two wires to an RS-485 to USB adapter. Connect the adapter to the PC. See Figure 2.
2. Go to the Load & Save screen in the EasySet software and locate the *Controller Connection section*.
3. Select "Wired Serial Connection" and the PC's COM port from the drop-down menus. Press "Connect."
    a. A dialog box will pop up when the controller is connected.
    b. If the controller does not connect, make sure the wiring to the operation terminal is correct. Make sure the correct COM port is chosen. Ensure that the controller is powered on.
4. Once the controller is connected, locate the *Controller Transfer* section.
5. Press "Write" to write the loaded and saved program to the controller.

CHANGING PARAMETERS WITH PXVC2 DEVICE BUTTONS:

1. Press the UP/DOWN buttons simultaneously for three seconds. The display will show the firmware version and hardware revision number. Press the OPTION button to start the login.
2. CODE is shown in small digits display.
3. Select the relevant Parameter Access Code using UP/ DOWN (refer to controller subsections with parameter listings)
4. Press the OPTION button after selecting the correct code.
5. Select the parameter required with the UP/DOWN buttons. Change a parameter value by pressing the OPTION button. Three arrows are displayed to indicate that the parameter may be modified. Use the UP/DOWN buttons to adjust the value.
6. Upon completion, press the OPTION button to save the new value and return to menu selections (three arrows should disappear). Pressing the POWER button will discard changes without saving. Pressing the ESC button will return to the next highest-level menu
7. The POWER button may be used to exit the menu as well; otherwise, the unit will return to the default screen when no button has been pressed for longer than 5 minutes.
8. **It is recommended that only personnel experienced in control loops adjust control settings.** There are sets of control parameters (P and I values) for direct-acting and reverse-acting controllers. When adjusting the control parameters, ensure you select the correct parameter
    a. PXVC2-CCR is a reverse-acting controller, meaning the output is inversely related to the input level (liquid % increases and valve closes)

MODEL SPECIFIC CONTROLLER DETAILS:

PXVC2-CCR

The PXVC2-CCR controller controls the circulation rate of the refrigerant feed to the evaporator by measuring the refrigerant quality at the exit of the evaporator. The controller provides proportional control with integral error correction to digital and analog outputs; the controller can be used with Hansen Motorized Control Valves and Pulse Width Valves. This controller has one input, the HXS sensor, to measure the circulation rate. The following equation can be used to find the circulation rate of the evaporator: $CR = \frac{1}{X}$, where X is the vapor quality of the refrigerant. The PXVC2 allows monitoring of the refrigerant quality using the display screen. The refrigerant quality is measured in percentage, where 0% represents a dry sensor (4mA) and 100% represents the full range of the sensor (dryness of 0.3, 20mA).

Table 1 lists several circulation rates and their associated set points. Follow the startup instructions as written in the startup section.

Table 1. Controller set points for the desired Circulation Rate

Set Point	Circulation Rate	Approximate mA output from X sensor
24%	1.2	7.8 mA
47.5%	1.5	11.6 mA
53.5%	1.6	12.6 mA
58.5%	1.7	13.4 mA
63.5%	1.8	14.2 mA
71.5%	2.0	15.4 mA
85.5%	2.5	17.7 mA
95.5%	3.0	19.2 mA

System design considerations – Defrost Control

The defrost interlock / remote relay (pins 11 and 13) must be connected to the system's defrost control circuit. This interlock is a critical safety feature and should be configured to open during defrost and close once defrost is complete. When the interlock is open, the controller is disabled, and its output to the valve is turned off. This prevents liquid refrigerant from feeding into the evaporator during defrost, which could otherwise cause liquid hammer, valve damage, or ineffective defrosting. If needed, this logic can be reversed by setting parameter **2u00** to **5**, where the interlock should close when the system enters defrost mode. Proper configuration of the defrost control and interlock is essential for system safety and performance.

Upon completion of the defrost cycle, the controller will open the valve to 100% until the X sensor reads 10%. After the X sensor reads 10%, the controller will keep the valve open for an additional 2 minutes. This post-defrost or start-up period is intended to flood the evaporator with liquid refrigerant before transitioning to normal control mode. The duration must be sufficient for the liquid to reach the HXS sensor. After the evaporator completes its first defrost cycle, monitor the system and observe the signal from the X sensor. The signal should either reach within 10% of the control setpoint or exceed the setpoint. If this does not occur, the evaporator may not be adequately flooded. In such cases, increase the default post-defrost duration to ensure reliable operation. For additional guidance on proper HXS sensor placement and system riser design, refer to the Hansen Low Charge System Design Bulletin.

System design considerations – System Tuning

The system should be tuned when encountering consistently unstable control. Typical causes of instability include oversized liquid feed valves and significant process dead time due to liquid travel between the evaporator and suction piping before reaching the HXS sensor. If instability is encountered, Hansen recommends that the system be tuned to find the optimal control parameters. In general, low-circulation-rate systems require a non-aggressive P-band and a large measuring interval. General guidelines are provided below for simple mitigation techniques. If instability is encountered after trying the recommendations below, then the system may require more precise tuning. See the advanced system tuning section.

General Guidelines for Unstable Systems:

- Set Ti parameter (**1L 15**) to be twice the measured dead time (amount of time between liquid entering the valve and X sensor reading a change in liquid)
- Increase the P-band to be **3X** the set point
- Increase P-band to **100%**; this is the least aggressive proportional gain
- Integral only control by setting parameter **1L 11** to 0

Advanced System Tuning – Low Circulation Rate

The following should be conducted by personnel experienced in control loops.

Pre-tuning Checks:

1. Verify sensor span matches the values provided in the *HXS Calibration Values* table
2. Confirm the X sensor filter time is reasonable. 10 seconds is recommended starting point.

Manual Stepping Phase:

1. Change controller output to manual mode by changing parameters **1A 00** to **6** (MCV) or **1d 01** to **6** (PWV). The output can now be controlled via the arrows on the PXVC2. Navigate to the desired output by pressing the dot or arrow key. See Figure 4.

Figure 4. PXVC2 Manual Analog Output Screen

2. Set the output to 30% and allow the X sensor reading to stabilize.
    a. If the liquid does not reach the X sensor within 5 minutes, increase the valve's manual output by 10% until the X sensor has a reading.
3. Once stabilized, increase the output by 10%. Document the 3 key parameters:
    a. **Dead time (θ):** Time from output step to first measurable process response.
    b. **Time constant (τ):** Time to reach 63% of the total process variable change.
    c. **Process gain (Kp):** Kp = ΔX / ΔOutput (change in PV divided by change in output).
4. Repeat at 2–3 operating points to detect gain variation across the range.

Hardware Sizing Check:

1. At full load conditions, the valve should be approximately 80% open. This indicates proper sizing.

2. A valve that is fully open — or nearly so — at less than full load indicates the valve is undersized. In this case, the valve should be increased in size or flow should be less restricted (turn PVW stem out more) to bring it within the appropriate operating range.

3. A $K_p > 3$ indicates that the valve is oversized.

Initial PI Values

1. Start with a P-band = 100%

2. Start with integral time: $T_i = 2 * \theta$
    a. Note that the PXVC2 measuring interval is limited to a maximum of 255 seconds. For systems requiring a longer measuring interval, use the reset time parameter (Tn) instead.
    b. Calculate the initial integral time in seconds using the formula provided: $T_n = T_i * (\frac{1084}{K_i * X_p})$, in seconds.
    c. Use Ki = 1 as the starting value for this calculation.

Fine Tuning:

1. Adjust one parameter at a time.
2. Allow adequate settling time between adjustments
3. Define clear pass/fail criteria for the system (e.g., no more than one overshoot, peak deviation within X%, settle within a certain number of dead time intervals)

Acceptance test:

1. Perform a set point change test and a small disturbance test
2. Confirm stability margins are acceptable under test conditions
3. Document all final parameter values and test results.

Other Considerations – Integral Only Control

As a diagnostic tool, integral-only mode confirms whether proportional action is driving oscillation. If I-only is markedly more stable than the Xp = 100% result, the proportional term is amplifying the delayed error.

As a long-term operating mode, integral-only is more viable for dead-time-dominated processes. With I-only, the expected oscillation period stretches to approximately 4 × θ — for a 3-minute dead time, that is 12–14 minutes rather than the 1–2 minutes typically observed with PI on this class of system.

Whether this trade is acceptable depends on the process requirements. For slow-acting, constant load systems, it is often acceptable. Integral-only should be considered a workaround rather than a permanent solution until valve sizing is corrected.

Table 2. System Tuning Quick Reference Table

Topic	Recommendation	Notes
Valve sizing	80% on-time at full load	Prerequisite — correct before tuning
Initial Xp	100%	Minimum aggressive P without firmware change
Initial Ti	360–480 s (for 3-min dead time)	Start at 2 × θ; increase if unstable
Sensor filter	≤ 1/10 of dead time (~10 s)	Reduce before step testing
Sensor span (testing)	Widen to prevent saturation	Re-verify tuning after narrowing
I-only (Xp = 0)	Diagnostic or temporary workaround	Oscillation ~4 × θ; stable but slow
Autotuning	Prefer manual step test	Relay-based autotuners struggle with long dead time

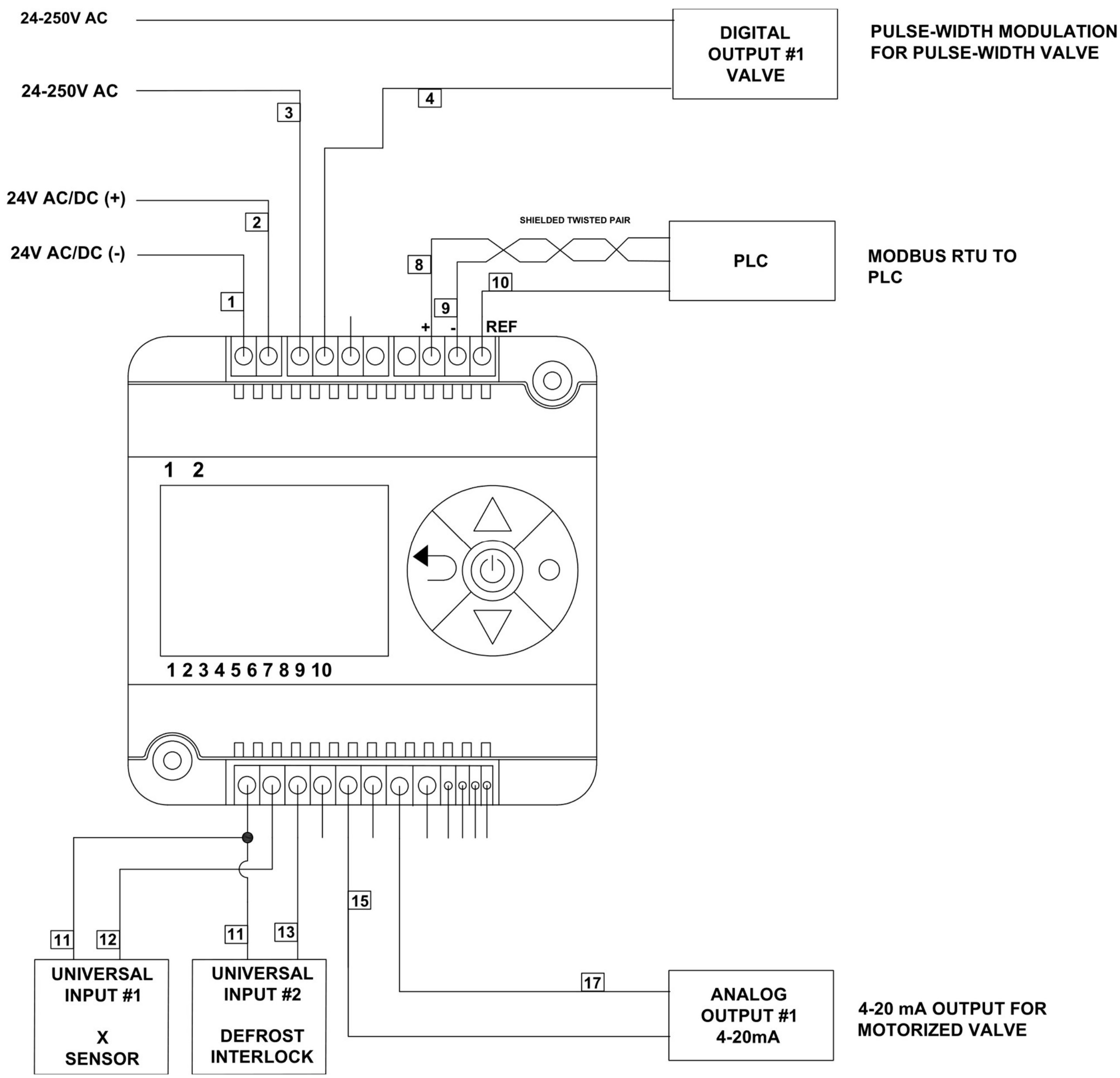


Figure 5. Controller Wiring Setup

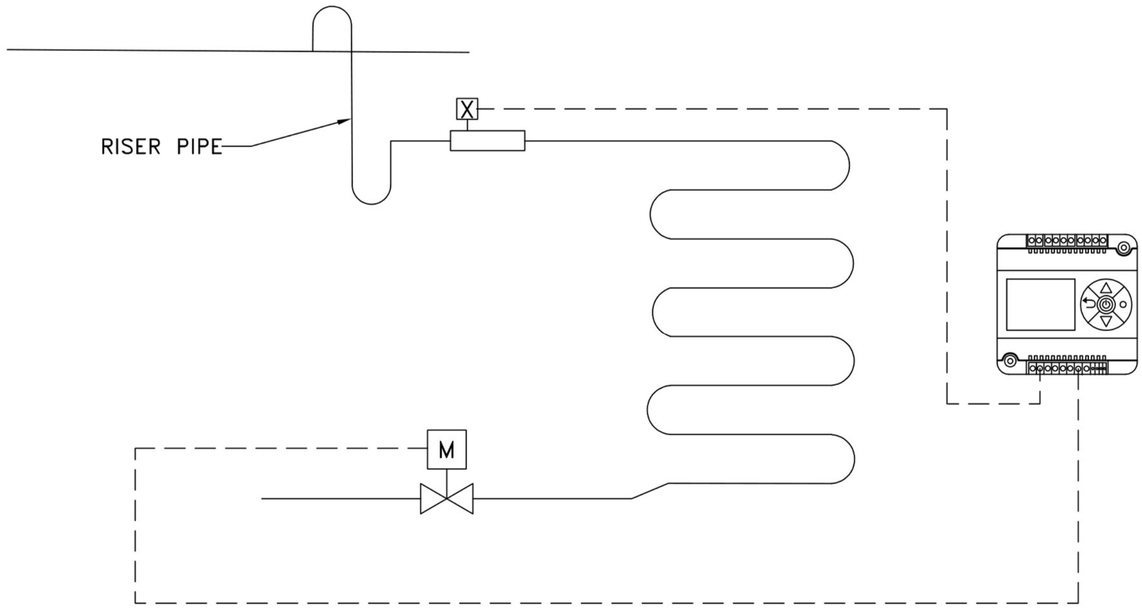


Figure 6. P&ID

SYSTEM START UP:

1. Upload the Hansen-provided program file
2. Open the defrost interlock/remote relay connected to UI2 and power on the controller. Verify ALA4 is showing on the display.
    a. If the system does not require defrost control, leave the jumper wire across the UI2 terminal.
    b. Note: When the defrost interlock is open, the PXVC2 will send a 0 mA signal to AO1. If an MCV is connected to AO1, it will show the E.02 error while the interlock is open. This is normal operation.
3. Close the defrost interlock. ALA4 will no longer show on the screen, and the screen will say OFF for 10 seconds. After 10 seconds, the screen will show the X sensor input and the set point, and the valve will fully open until the X sensor reads 10%. The valve will then stay open an additional 2 minutes afterwards.
    a. The 2-minute start-up time can be adjusted to fit the system requirements.
4. Pressing the UP or DOWN arrow will increase or decrease the set point.
5. Review the specifications of the evaporator and determine the desired circulation rate.
6. Set the desired set point and wait for the system to approach the set point.

Note: The controller can be disabled during operation using the power button

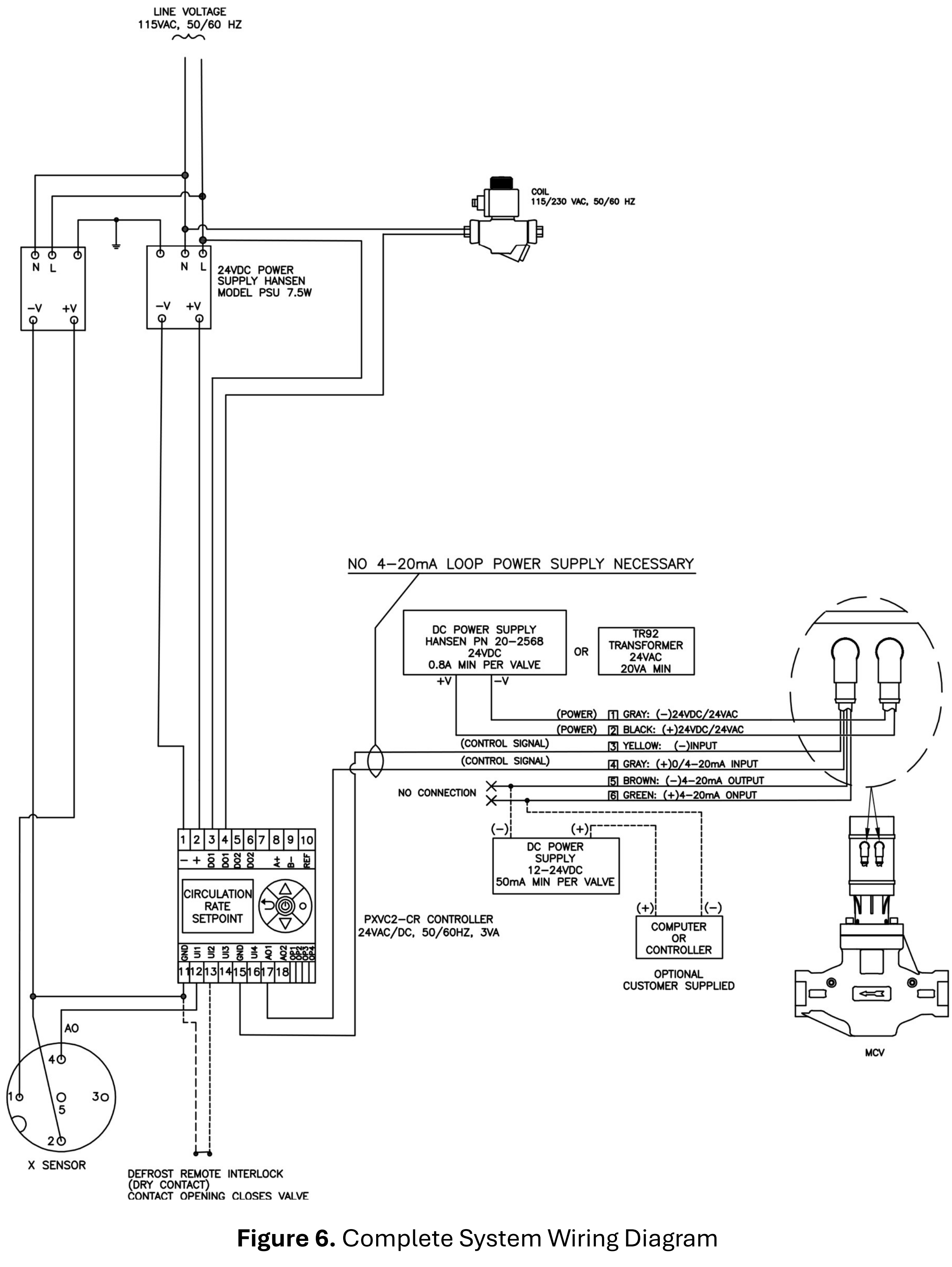


Figure 6. Complete System Wiring Diagram

PXVC2-CCR Associated Parameters – Parameter Access Code 241

The table below shows parameters that are adjustable to fit the system's needs. **It is recommended that only personnel experienced in control loops adjust control settings.**

PARAMETER	DESCRIPTION	RANGE	DEFAULT
1u 00	Input signal type: 0 = input not active 1 = 0 -10V or 0-20mA 2 = 2-10V or 4-20mA …	0 - 9	2
1u 01	Signal display minimum value	-50 – 205	0
1u 02	Signal Display maximum value	-50 – 205	100
1u 04	Unit of universal input (for analog inputs only) 0 = no unit; 1= % 2 = C/F 3 = P (Pascals)		1
1u 05	Filter samples	0 - 100	10
2u 00	Input signal type: … 4 = Open contact direct (contact open = 100%) 5 = Open contact reverse (contact open = 0%) …	0 - 9	4
2d 05	Switch On Delay Post-defrost: The amount of time the valve will be set to 100% after the X sensor reads a quality 20%	00:00:00 – 15:10:00 (hh: mm: ss)	00:02:00
1L 11	Proportional band for heating (Xp)	per input range	60%
1L 13	1L15 = 0: Reset Time heating (Tn) [note 1 & 2] 1L15 ≠ 0: Integral gain heating (Ki) (0.1 steps) low = slow reaction, high = fast reaction	00:00:00 – 15:10:00 0 – 25.5	08:00:00 0
1L 15	Measuring Interval (Ti)	00:00:00 – 15:10:00	0
1A 01	Loop Configuration 0 = Heating/Reverse 1 = Cooling/Direct …	0-8	0
1A 02	MCV Output Signal Type OFF = 0 -10V or 0-20mA ON = 2-10V or 4-20mA		ON
1d 02	Loop Configuration 0 = Heating/Reverse	0-8	0

	1 = Cooling/Direct …		
1d 06	Solenoid PWM Cycle Time	00:00:00 – 15:10:00	00:00:10

Notes:

[1] The Reset Time Tn is defined as the time required to obtain the same output as for the proportional action by using an integral action only.

[2] The integral gain (Ki) can be calculated from Tn using the following equation:

$$\frac{\mathrm{Ki}}{\mathrm{Ti}} = \frac{1084}{\mathrm{Tn}^{*}\mathrm{Xp}}, \text{ where Tn and Ti have units of seconds}$$

ORDERING INFORMATION

CONTROLLERS

PXVC2-CCR	Low Circulation Rate controller (X sensor not included)
PXVC2-DX	DX controller for PXV, PXVW, and MCV **(under development)**

SENSORS

HXS-25	HB Quality Sensor, In-line style, DN25
HXS-32	HB Quality Sensor, In-line style, DN32
HXS-40	HB Quality Sensor, In-line style, DN40
HXS-50	HB Quality Sensor, In-line style, DN50
HXS-65	HB Quality Sensor, In-line style, DN65
HXS-80	HB Quality Sensor, In-line style, DN80
HXS-100	HB Quality Sensor, In-line style, DN100

VALVES

PWV20	Pulse Width Valve, ¾” BW
PWV25	Pulse Width Valve, 1” BW
MCV	Motorized Control Valves (see this bulletin)

CAUTION

These instructions must be completely read and understood before selecting, using, or servicing Hansen valves and electronics. Only knowledgeable, trained refrigeration service personnel should install, operate, or service. Stated temperature and pressure limits should not be exceeded. When dealing with electricity, considerable caution should be exercised, and only trained electricians should install wiring for this component. See also the Safety Precautions supplied with the product.

WARRANTY

All Hansen products, except electronics, are guaranteed against defective materials or workmanship for one year F.O.B. factory. Electronics are guaranteed against defective materials or workmanship for 90 days F.O.B. factory. No consequential damages or field labor are included.

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