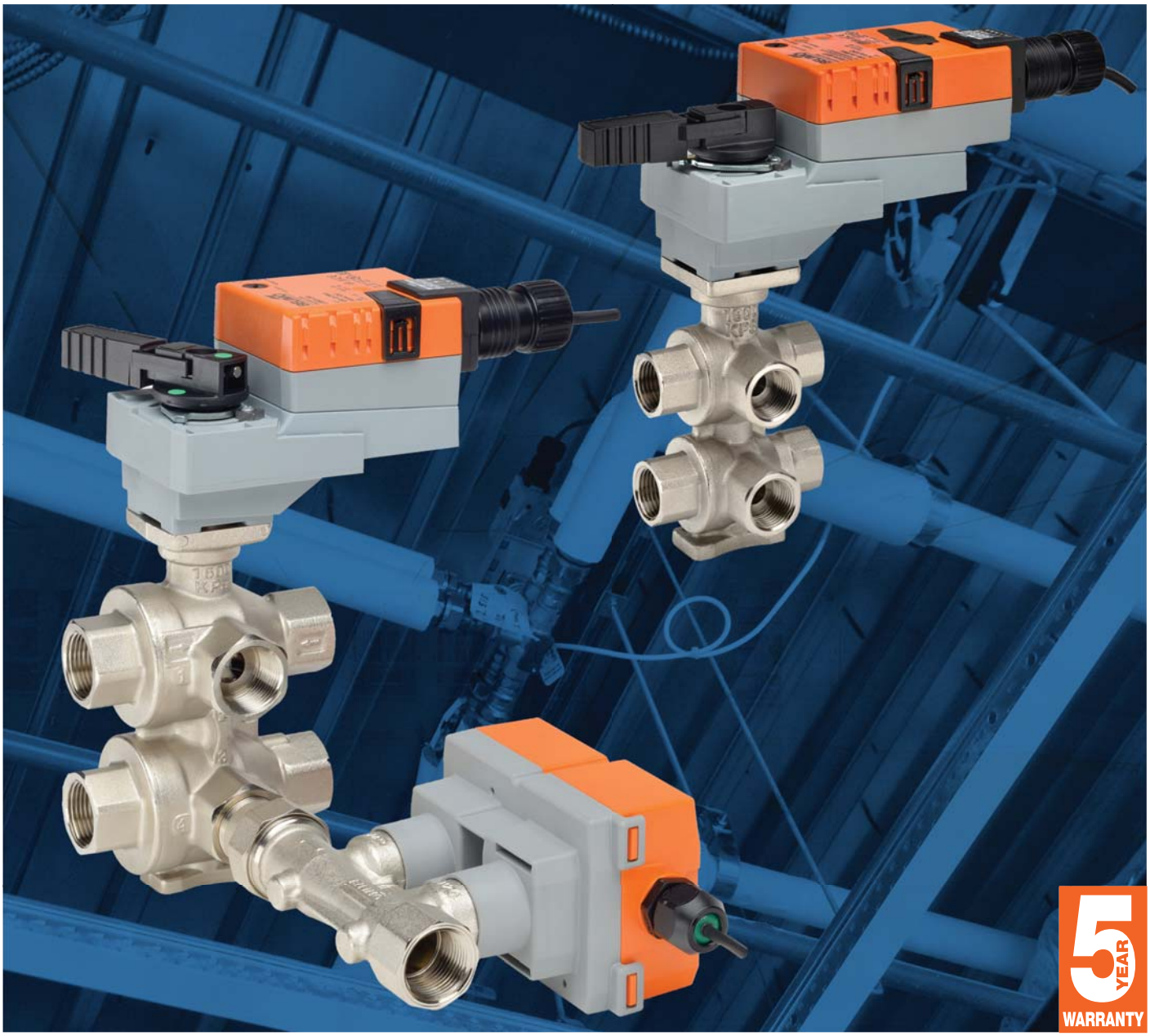
Version 09_17



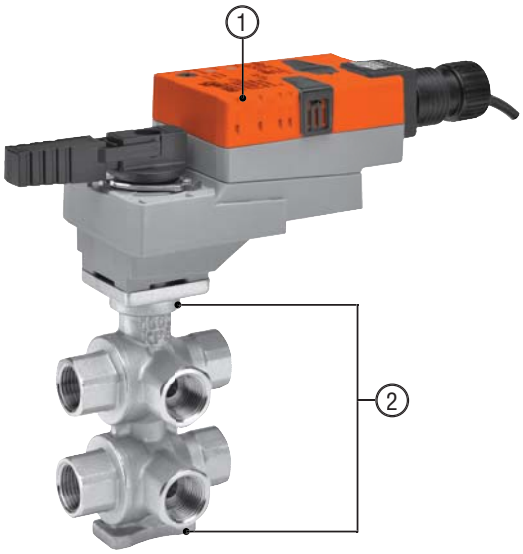
6-way Characterized Control Valve and 6-way Electronic Pressure Independent Valve Technical Documentation

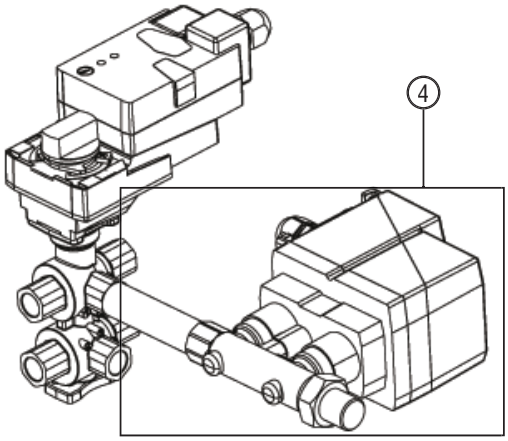
BELIMO®

Table of Contents

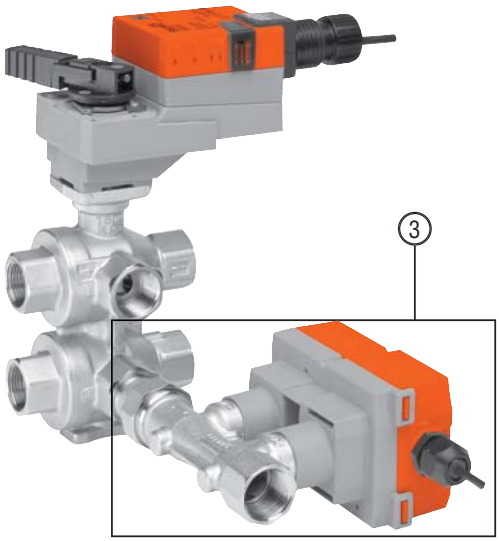
The 6-way valve is the only one of its kind designed for chilled beams, radiant ceiling panels, and 4-pipe fan coil units. It has the functionality of up to four 2-way control valves and two balancing valves saving material and installation time. The 6-way characterized control valve (CCV) with a non-spring return actuator is available in pressure dependent models and electronic pressure independent valve (ePIV) models. A single analog 2-10 VDC control signal throttles the control valve to operate two flow sequences (cooling/heating) for a single coil with one 90° rotary actuator. Electronic pressure independent models are furnished with actuator logic that utilizes feedback from the ultrasonic flow meter to maintain flow setpoint. Building management system (BMS) data integration is achieved with BACnet MS/TP, Modbus RTU, and Belimo MP-Bus communication protocol.

Pressure Dependent (6-way CCV)

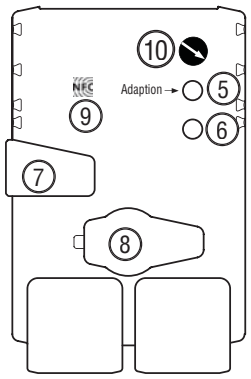




Electronic Pressure Independent (6-way ePIV)



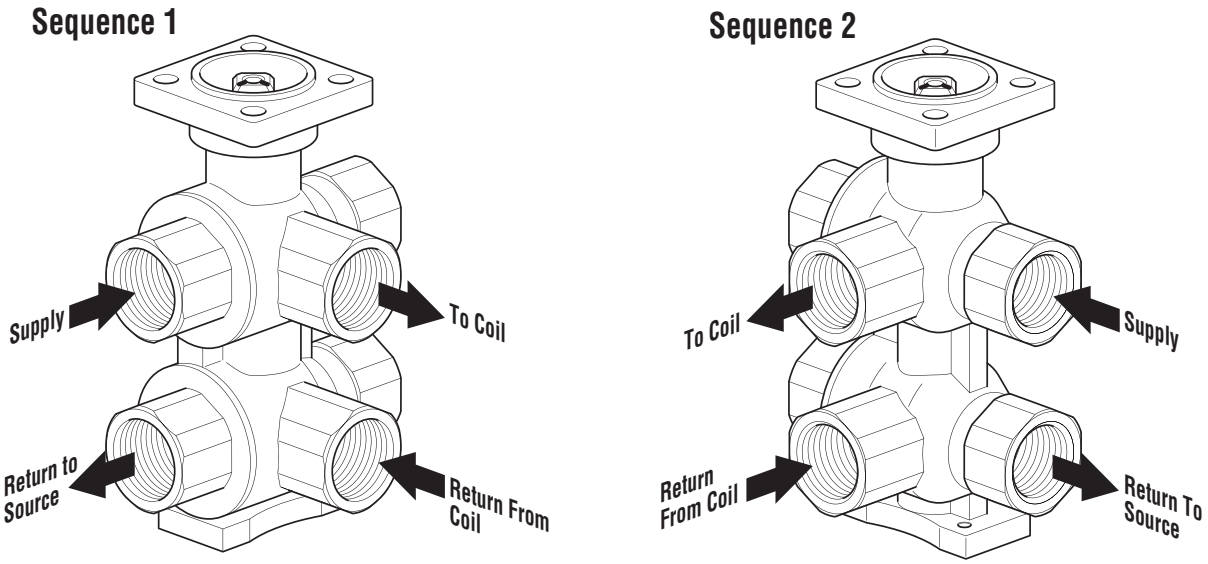
Actuator



1. Non-Spring Return Actuator (24 VAC/DC)
2. 6-way Characterized Control Valve
3. Flow Sensor Installed in Return Pipe
4. Flow Sensor Mounted in Supply Pipe
5. Push Button and LED Display- Green
   Off: No power supply or malfunction
   On: In operation
   Press Button: Triggers angle of rotation adaptation, followed by standard mode. Available only with 6-way ePIV
6. LED Display- Yellow
   Off: Standard mode
   On: Adaptation or synchronizing process active
   Flickering: Modbus or BACnet communication active
   Available only with 6-way ePIV
7. Gear Disengagement Button
   Press Button: Gear disengages, motor stops, manual override possible
   Release Button: Gear engages, synchronization starts, followed by standard mode
8. Service Plug: For connecting the ZTH US. Available only with 6-way ePIV
9. NFC Logo. Operated with Belimo Assistant App. Available only with 6-way ePIV
10. Direction of Rotation Switch. Available only with 6-way CCV

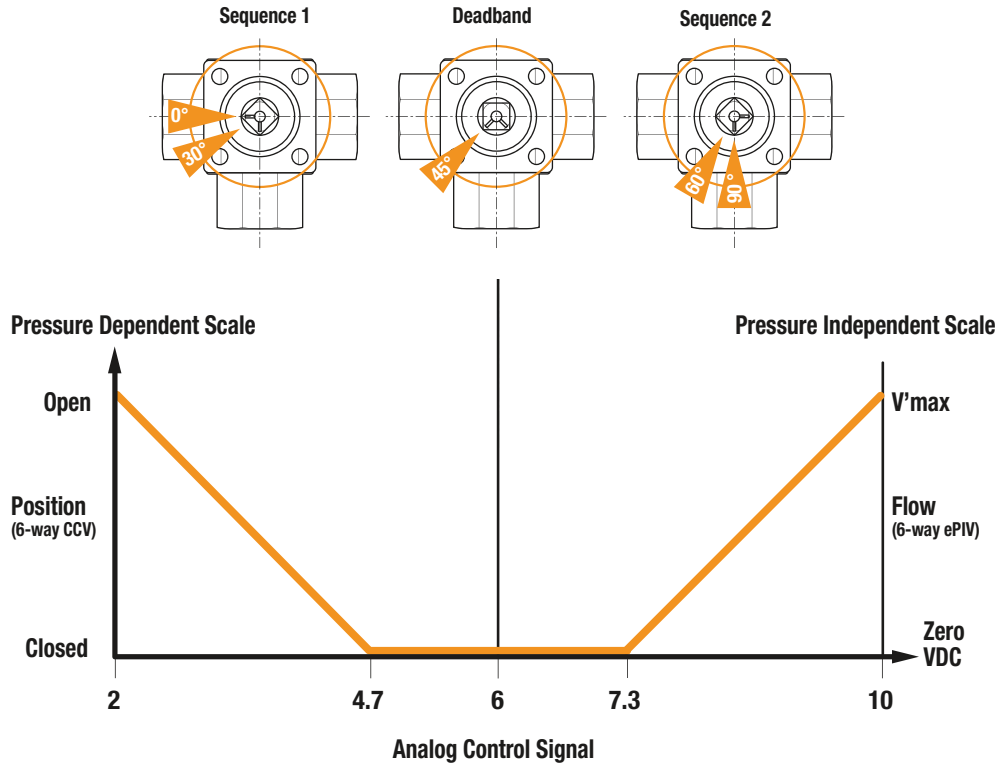
Flow Pattern

The flow direction must be observed.



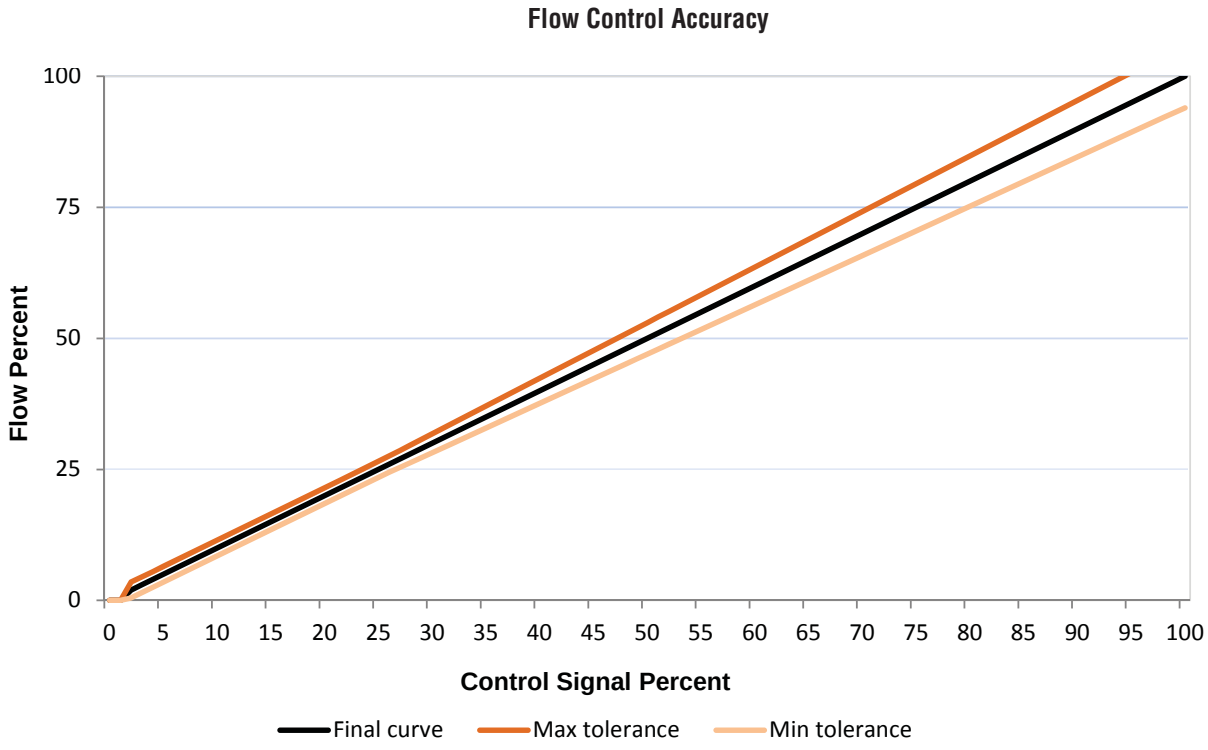
Pressure Dependent and Pressure Independent Valve Operation

The position of the ball is identified from the L-marking on the stem. The illustration shows the valve response vs. control signal for the 6-way CCV and the 6-way ePIV. The 6-way CCV will modulate to a valve position proportional to the control signal between closed and open. The 6-way ePIV will modulate to maintain the flow setpoint between zero and V'max.



Flow Control for ePIV Models

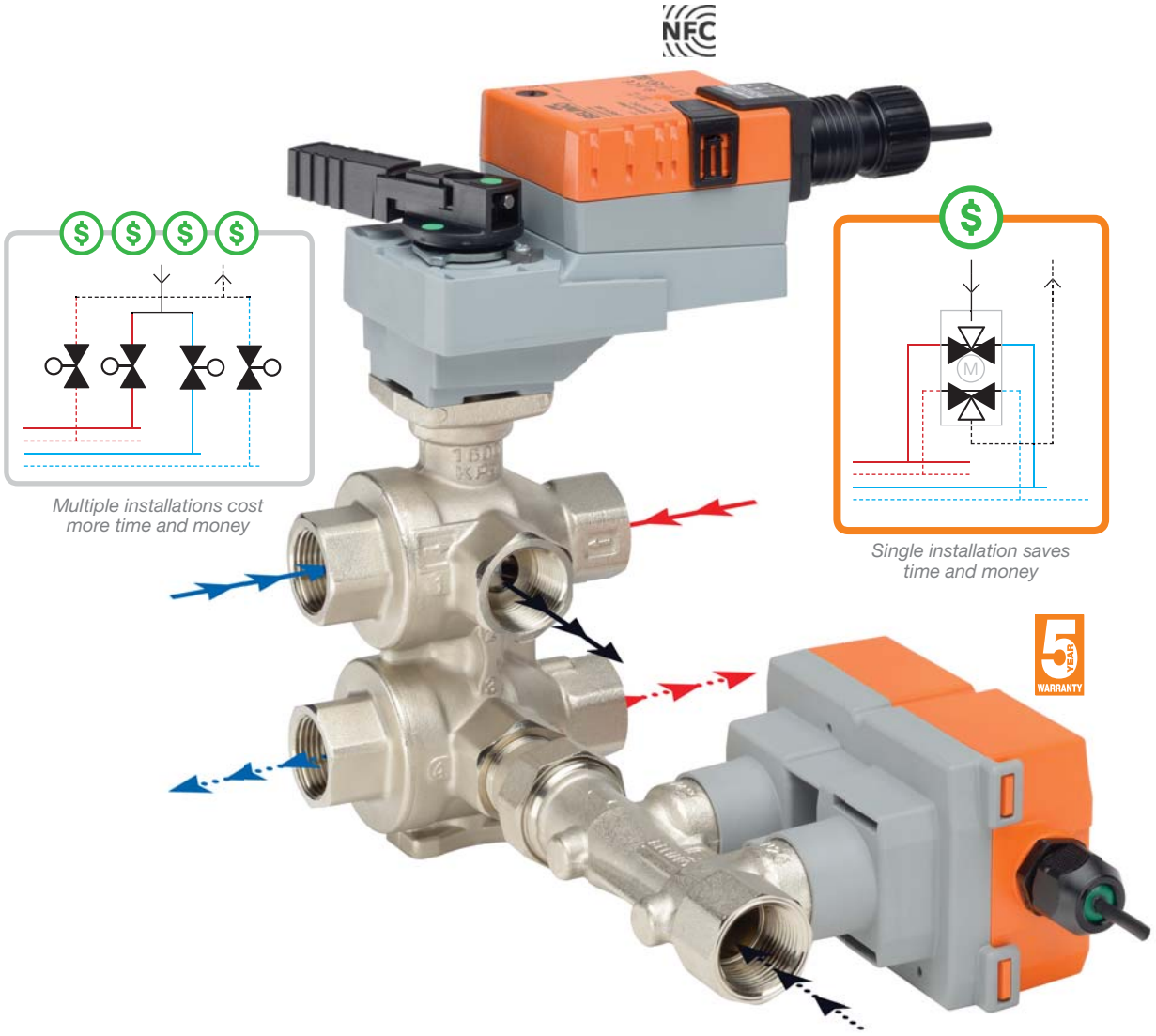
Flow measurement tolerance is ±2% of the actual flow and flow control tolerance is +6% of the actual flow @ 68°F to 77°F [20°C to 25°C] and 0% glycol. 6-way ePIV has a linear flow curve for sequence 1 and sequence 2.



6-way CCV and 6-way ePIV
Features

The Belimo 6-way pressure independent characterized control valve is the only one of its kind and is ideal for chilled beams and radiant ceilings. This compact valve has the functionality of up to four 2-way control valves saving space, material and installation time while providing true flow measurement.

- One valve performs change over and modulating control for single coil 4 pipe system providing less system maintenance.
- Support different flow requirements of both hot and chilled water with one valve (one valve multiple GPM's possible).
- True close-off to isolate both heating and cooling loops providing system efficiency.
- Less power consumption with using only one valve and actuator assembly.
- Reduced installation cost by using only one coil for heating and cooling.
- Near Field Communication (NFC) allows fast programming, commissioning and troubleshooting – even when the actuator is not powered it can be programmed
- Enhanced communication with BACnet MS/TP, and Modbus RTU provide superior application data access.
- True flow accuracy of ±2% with ultrasonic flow meter.



B3	15	-029	-	029	+LRB	24	-SR
Valve B3 = 3-way	**Valve Size** 15 = ½" 20 = ¾" 25 = 1"	**Sequence 1** 029 = 0.29 C_V 046 = 0.46 C_V 073 = 0.73 C_V 116 = 1.16 C_V 150 = 1.50 C_V 175 = 1.75 C_V 186 = 1.86 C_V 200 = 2.00 C_V 290 = 2.90 C_V 400 = 4.00 C_V 490 = 4.90 C_V 540 = 5.40 C_V 740 = 7.40 C_V	Two 3-way = 6-way	**Sequence 2** 029 = 0.29 C_V 046 = 0.46 C_V 073 = 0.73 C_V 116 = 1.16 C_V 150 = 1.50 C_V 175 = 1.75 C_V 186 = 1.86 C_V 200 = 2.00 C_V 290 = 2.90 C_V 400 = 4.00 C_V 470 = 4.70 C_V 540 = 5.40 C_V 700 = 7.00 C_V	**Actuator Type** LRB, LRX NRB, NRX	**Power Supply** 24 = 24 VAC/VDC	**Control** -SR = 2-10 VDC -MFT = Multi-Function Technology Feedback = 2-10 VDC

Ordering Example

1 Choose the valve actuator combination.

B315-029-029+LRB24-SR

NO

Tagging (if needed)

2 Specify preference or configuration.

Set-Up

Non-Spring Models
NO = Normally Open - Sequence 1
-OR-
NC = Normally Closed - Sequence 1

3 Does order require tagging?

Tagging:
Valves may be tagged per customer specification. ($10.00 charge per tag)

Example:
Sequence 1
Sequence 2

Part number for tagging: 99981-00101

4 Complete Ordering Example: B315-029-029+LRB24-SR

6-way ePIV Nomenclature

P3	050	B6	-K	+LRX	24	-LP-EP6
Electronic Pressure Independent	**Valve Size** 050 = ½" 075 = ¾"	**6-Way Valve**	**Flow** K = 5.5 GPM J = 10.3 GPM	**Actuator Type** LRX	**Power Supply** 24 = 24 VAC/DC	**Control** Input = 2-10 VDC, BACnet, Modbus Feedback = 2-10 VDC, BACnet, Modbus

Ordering Example

1 Choose the valve actuator combination.

P3050B6-K+LRX24-LP-EP6

NO

Tagging (if needed)

2 Specify preference or configuration.

Set-Up

Non-Spring Models
NO = Normally Open - Sequence 1
-OR-
NC = Normally Closed - Sequence 1

3 Does order require tagging?

Tagging:
Valves may be tagged per customer specification. ($10.00 charge per tag)

Example:
Chilled/Heating Beam Room #1

Part number for tagging: 99981-00101

4 Complete Ordering Example: P3050B6-K+LRX24-LP-EP6

6-way CCV
Product Range (½" to 1")

Sequence 1 C_V	Sequence 2 C_V	Valve Nominal Size: Inches	Valve Nominal Size: DN [mm]	6-way NPT Valve: Valve Model	Suitable Actuators: Non-Spring Return	
0.29	0.29	½	15	B315-029-029	LRB24-SR	LRX24-MFT
0.29	0.46	½	15	B315-029-046		
0.29	0.73	½	15	B315-029-073		
0.29	1.16	½	15	B315-029-116		
0.29	1.50	½	15	B315-029-150		
0.46	0.29	½	15	B315-046-029		
0.46	0.46	½	15	B315-046-046		
0.46	0.73	½	15	B315-046-073		
0.46	1.16	½	15	B315-046-116		
0.46	1.50	½	15	B315-046-150		
0.73	0.29	½	15	B315-073-029		
0.73	0.46	½	15	B315-073-046		
0.73	0.73	½	15	B315-073-073		
0.73	1.16	½	15	B315-073-116		
0.73	1.50	½	15	B315-073-150		
1.16	0.29	½	15	B315-116-029		
1.16	0.46	½	15	B315-116-046		
1.16	0.73	½	15	B315-116-073		
1.16	1.16	½	15	B315-116-116		
1.16	1.50	½	15	B315-116-150		
1.50	0.29	½	15	B315-150-029		
1.50	0.46	½	15	B315-150-046		
1.50	0.73	½	15	B315-150-073		
1.50	1.16	½	15	B315-150-116		
1.50	1.50	½	15	B315-150-150		
1.75	2.0	½	15	B315-175-200		
2.0	1.75	½	15	B315-200-175		
2.0	2.0	½	15	B315-200-200		
0.73	0.73	¾	20	B320-073-073		
0.73	1.16	¾	20	B320-073-116		
0.73	1.86	¾	20	B320-073-186		
0.73	2.9	¾	20	B320-073-290		
1.16	0.73	¾	20	B320-116-073		
1.16	1.16	¾	20	B320-116-116		
1.16	1.86	¾	20	B320-116-186		
1.16	2.9	¾	20	B320-116-290		
1.86	0.73	¾	20	B320-186-073		
1.86	1.16	¾	20	B320-186-116		
1.86	1.86	¾	20	B320-186-186		
1.86	2.9	¾	20	B320-186-290		
2.9	0.73	¾	20	B320-290-073		
2.9	1.16	¾	20	B320-290-116		
2.9	1.86	¾	20	B320-290-186		
2.9	2.9	¾	20	B320-290-290		
2.9	4.0	¾	20	B320-290-400		
2.9	4.7	¾	20	B320-290-470		
4.0	2.9	¾	20	B320-400-290		
4.0	4.0	¾	20	B320-400-400		
4.0	4.7	¾	20	B320-400-470		
4.9	2.9	¾	20	B320-490-290		
4.9	4.0	¾	20	B320-490-400		
4.9	4.7	¾	20	B320-490-470		
7.4	7	1	25	B325-740-740	NRB24-SR	NRX24-MFT

Linear Characteristic

Mode of Operation
The control valve is operated by an electronic actuator that responds to a modulating 2-10 VDC control signal. The actuator will then move the ball of the valve to the position dictated by the control signal thus changing the flow.

Product Features
Linear characteristic, zero percent leakage, selectable Cv for sequence 1 and sequence 2 to meet design requirements.

Actuator Specifications

Control type	2-10 VDC multi-function technology (MFT)
Manual override	LR..., NR...
Electrical connection	3 ft. [1 m] cable with ½" conduit fitting

Valve Specifications

Service	chilled or hot water, 60% glycol
Flow characteristic	linear
Controllable flow range Sequence 1 Sequence 2	 (0 to 30° angle) Dead zone 30° to 60° (60° to 90° angle)
Sizes	½", ¾", 1"
End fitting	NPT
Materials Body Ball Stem Seats Seat o-rings Characterizing disc O-rings	 nickel plated brass chrome plated brass nickel plated brass Teflon® PTFE EPDM chrome plated steel EPDM
Media temperature range	43°F to 180°F [6°C to 82°C]
Body pressure rating	232 psi
Close-off pressure	50 psi
Maximum differential pressure (ΔP)	15 psi
Leakage	0%

6-way ePIV
Product Range

Flow	Valve Nominal Size		6-way NPT Valve	Suitable Actuators
V'nom/GPM	Inches	DN [mm]	Valve Model	Non-Spring Return
5.5	½	15	P3050B6-K	LRX24-LP-EP6
10.3	¾	20	P3075B6-J	

5 YEAR WARRANTY

ePIV

Linear Characteristic

Mode of Operation
The device works as an ePIV. The valve reacts to any change in pressure, the actuator logic with True Flow feedback modulates the valve to maintain the heating and cooling flow setpoint. Flow setpoint is with BACnet or Modbus communication, or with a single 2-10 VDC or 0.5-10 VDC analog control signal.

Product Features
Linear characteristic, zero percent leakage, and furnished ultrasonic flow meter. Flow setting for sequence 1 and sequence 2 is adjustable to meet design requirements

Actuator Specifications

Control type	modulating
Manual override	LRX24-LP-EP6
Electrical connection	3 ft. [1 m] cable with ½" conduit fitting
Controllable flow range	90°
Communication	BACnet MS/TP, Modbus RTU, Analog

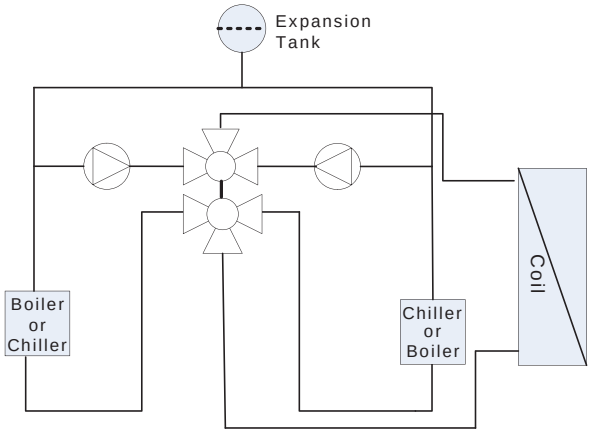
Valve Specifications

Service	chilled or hot water, 60% glycol
Flow characteristic	linear
Controllable flow range Sequence 1 Sequence 2	 (0 to 30° angle) Dead zone 30° to 60° (60° to 90° angle)
Sizes	½", ¾"
End fitting	NPT
Materials	
Body	nickel plated brass
Ball	chrome plated brass
Stem	nickel plated brass
Seats	Teflon® PTFE
Seat o-rings	EPDM
Characterizing disc	chrome plated steel
O-rings	EPDM
Media temperature range	43°F to 180°F [6°C to 82°C]
Body pressure rating	232 psi
Close-off pressure	50 psi
Maximum differential pressure (ΔP)	15 psi
Leakage	0%
Rangeability	100:1
Flow control tolerance	±6%
Flow measurement tolerance	±2%
Flow measurement Repeatability	±0.5%

All flow tolerances @ 68°F to 77°F [20°C to 25°C] and 0% glycol.

Piping

Built in pressure relief
A loop pressure relief is designed into port number two (sequence 2). This allows the increased pressure to dissipate to the supply loop on port number one (sequence 1).This is intended to release any pressure build up in the loop (coil) when the valve is in the closed position and is isolated from the system expansion vessel. The change in pressure occurs due to a change in the media temperature in the coil while isolated from the pressure vessel. The pressure relief does not affect the efficiency of the system because cross-flow cannot occur between the heating and cooling loops. The system loops (heating/cooling) should share a common expansion vessel to keep the system pressure and volume balanced.

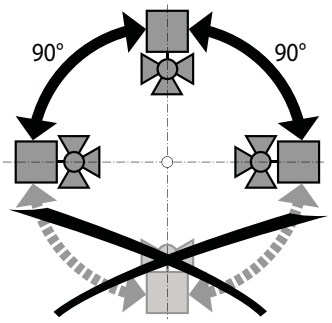


Common load 4 pipe system

Per ASHRAE mechanical piping handbook, 4-pipe common load system should share a common expansion tank.

Mounting

The control valve can be mounted either vertically or horizontally.
Do not install the ball valve with the stem pointing downwards.



Installation

Inspect shipping package, valve, linkage, and actuator for physical damage. If shipping damage has occurred notify appropriate carrier. Do not install.

1. Install valve with the proper ports as inlets and outlets. See drawings on page 1. Flow direction arrows must be correct.
2. Blow out all piping and thoroughly clean before valve installation.
3. Clean male pipe threads with wire brush and rag. If threads have been damaged or exposed to weather, running a tap or die over the threads may straighten them. Clean pipes, threads, and valve threads before installation; check for any foreign material that can become lodged in trim components. Strainers should be cleaned after initial startup.
4. Pipe sealing compound should be applied sparingly after cleaning and may not be applied to the two lead threads of a screwed pipe, which are innermost inside the valve. Sealing compound is to be placed on male threads only. The purpose is to lubricate the pipes when tightening.
5. Valve must be installed with the stem towards the vertical, not below horizontal.
6. Start the connection by turning the valve or pipe by hand as far as possible. Be certain the threads mate by the "feel" of the connection.
7. Use wrenches to tighten the valve to the pipe. Do not over tighten or strip the threads. Two wrenches are necessary to avoid damaging the valve.
8. Valves must be installed in closed loop systems only.

Do not force. Do not use the actuator to turn the pipe or the stem. Do not use any toothed tool such as pliers, which may damage the stem.

Warning!

- Valve should not be used for combustible gas applications. Gas leaks and explosions may result. Do not install in systems, which exceed the ratings of the valve.
- Avoid installations where valve may be exposed to excessive moisture, corrosive fumes, vibration, high ambient temperatures, elements, or high traffic areas with potential for mechanical damage.
- Valve assembly location must be within ambient ratings of actuator. If temperature is below -22°F a heater is required.
- The valve assembly will require heat shielding, thermal isolation, or cooling if combined effect of medium and ambient temperatures – conduction, convection, and radiation – is above 180°F for prolonged time periods at the actuator.
- Following standard procedure, a strainer should be installed before the coil and valve or in another appropriate place in the system.
- Visual access must be provided. Assembly must be accessible for routine schedule service. Contractor should provide unions for removal from line and isolation valves.
- Avoid excessive stresses. Mechanical support must be provided where reducers have been used and the piping system may have less structural integrity than full pipe sizes.
- Sufficient upstream and downstream piping runs must be provided to ensure proper valve capacity and flow response. Five diameters in each direction are recommended.
- Life span of valve stems and O-rings is dependent on maintaining non-damaging conditions. Poor water treatment or filtration, corrosion, scale, other particulate can result in damage to trim components. A water treatment specialist should be consulted.
- Normal thread engagement between male pipe thread and valve body should be observed. Pipe run that is in too far will damage the valve.

Storage: The valves should be stored in the open or closed position. The valves must always be either completely open or completely closed to avoid deformation of the PTFE seat on one side. The valves must be protected against dust and dirt.

Wiring

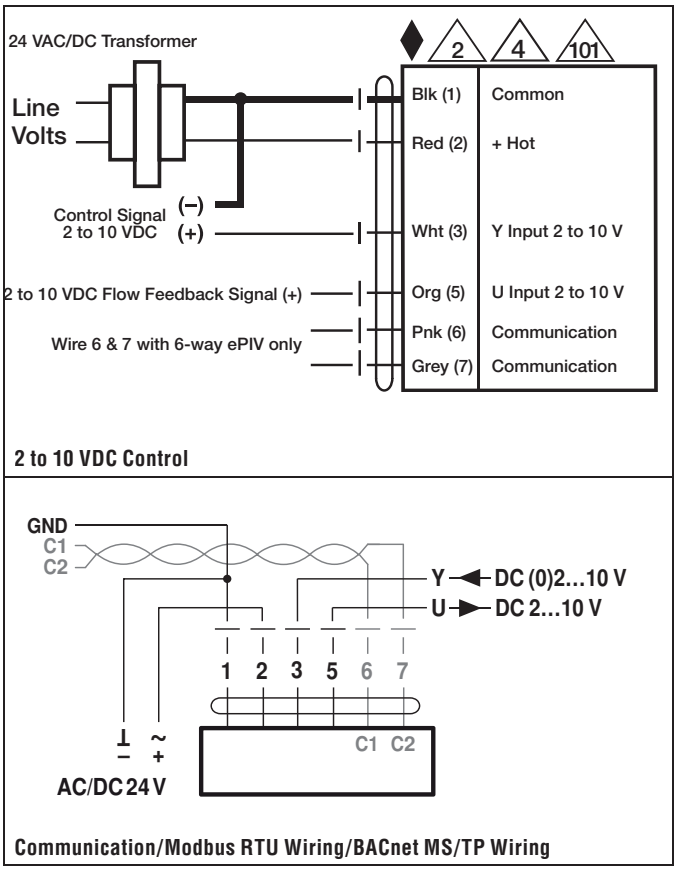
INSTALLATION NOTES

1. Provide overload protection and disconnect as required.
2. Actuators may be connected in parallel. Power consumption and input impedance must be observed.
4. Actuators are provided with color coded wires. Wire numbers are provided for reference.
101. NFC

Meets cULus requirements without the need of an electrical ground connection.

WARNING! LIVE ELECTRICAL COMPONENTS!

During installation, testing, servicing and troubleshooting of this product, it may be necessary to work with live electrical components. Have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these tasks. Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury.



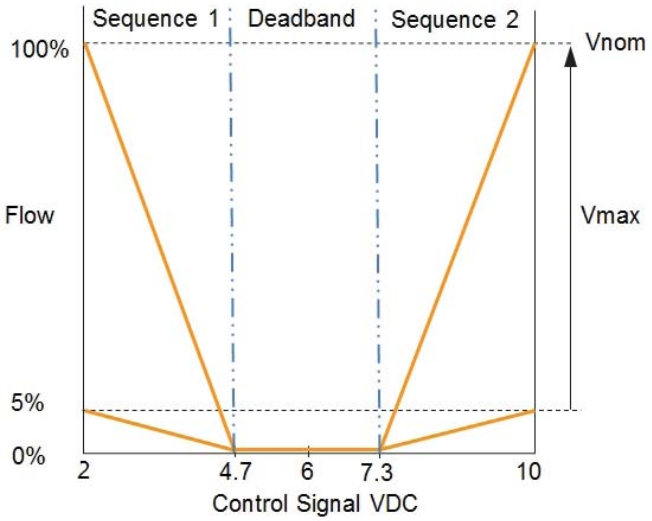
6-way ePIV Replacement

The actuator and flow sensor must be replaced as a unit. To replace, separate the flow unit from the valve assembly, unthread the coupler/union that connects the flow unit to the control valve assembly. Unscrew the single actuator mounting screw and remove the actuator.

IMPORTANT: The flow sensor is directly embedded in the flow unit. Before removing the flow sensor, the system must be relieved of pressure, drained and or closed directly upstream and downstream of the valve to circumvent any system leakage. The valve must not be lifted from the flow sensor or actuator. Disassembly and or lifting by the actuator or flow sensor will damage the assembly and void warranty.

Control Mode Sequence

Flow Control
The device works as an ePIV (Electronic Pressure Independent Valve). The valve reacts to any change in pressure, the actuator logic with True Flow feedback modulates the valve to maintain the heating and cooling flow setpoint. Flow setpoint is with BACnet or Modbus communication or with a single 2-10 VDC or 0.5-10 VDC analog control signal. V'max (design flow setting) is adjustable from 5% to 100% of V'nom (maximum flow capacity of each sequence. V'max1 is the maximum design flow setting for sequence 1, and V'max2 is the maximum design flow setting for sequence 2.



ePIV Sequence Response vs. Control Signal Input

Position Control
The device works as a pressure dependent 6-way CCV with True Flow status feedback. The control signal modulates the valve position.

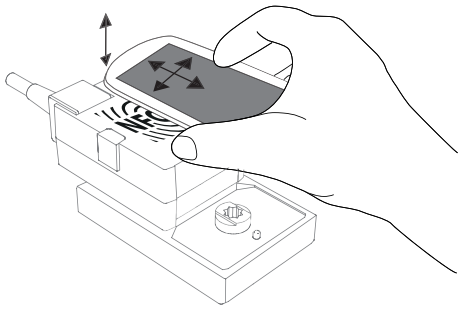
Opening and Closing Logic for Flow Control
The valve remains closed until the control signal (flow setpoint) is greater than or equal to 1% of V'nom, then it will open and modulate to maintain the flow setpoint within the control tolerance.

An open valve will modulate within the control tolerance to maintain the control signal (flow setpoint) when it is greater than or equal to 1% of V'nom. The flow rate is maintained at 1% of V'nom when the flow setpoint is between 0.5% to 1% of V'nom. The valve will close when the flow setpoint is below 0.5% of V'nom.

Adaptation logic
The first time the supply voltage is switched on, i.e. at the time of commissioning, the actuator carries out an adaptation, which is when the operating range and position feedback adjust themselves to the mechanical setting range. After this process the actuator moves into the required position in order to ensure the flow rate defined by the control signal.

NFC App

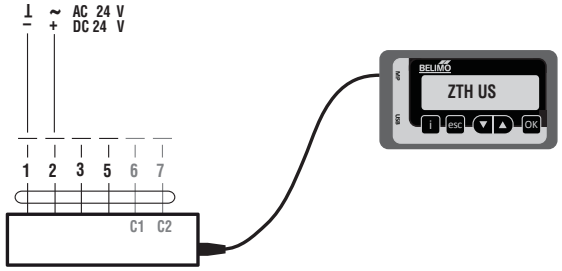
Near Field Communication (NFC) allows fast programming, commissioning and troubleshooting; even when the actuator is not powered, it can be programmed. Simply download and install the Belimo Assistant app from the Apple Store (Belimo gateway part# ZIP-BT-NFC is required) or on Google Play. Align the smartphone to the actuator, access data, and write new program values to the actuator.



The NFC App includes three data screens:
Dashboard: Valve location text, actuator series details, and basic system information such as the actuator sequence position, running time, status of power supply, and flow.
Configuration: Settings for V'max, control signal input, control mode (position or flow), BACnet or Modbus settings, and override options for sequence 1&2.
Diagnosis: Health status for the valve actuator and flow meter.

ZTH US

Connect the ZTH US hand-held tool to the actuator service plug to view and set parameters; the actuator must be powered. The data options are similar to those found in the NFC app.



Protocol Implementation Conformance Statement - PICS

General information

Date:	12 December 2016
Vendor Name:	BELIMO Automation AG
Vendor ID:	423
Product Name:	6way EPIV
Product Model Number:	P3...-LP-EP6, e.g. P3050B6-K+LRX24-LP-EP6
Applications Software Version:	01.02.0410
Firmware Revision:	07.01.0000
BACnet Protocol Revision:	1.12
Product Description:	Electronic pressure-independent 6 way characterized control valve.
BACnet Standard Device Profile:	BACnet Application Specific Controller (B-ASC)

BACnet Interoperability Building Blocks supported:
Data Sharing - ReadProperty-B (DS-RP-B)
Data Sharing - ReadPropertyMultiple-B (DS-RPM-B)
Data Sharing - WriteProperty-B (DS-WP-B)
Data Sharing - WritePropertyMultiple-B (DS-WPM-B)
Device Management - DynamicDeviceBinding-B (DM-DDB-B)
Device Management - DynamicObjectBinding-B (DM-DOB-B)
Device Management - DeviceCommunicationControl-B (DM-DCC-B)

Segmentation Capability:	No
Data Link Layer Options:	MS/TP master, baud rates: 9'600, 19'200, 38'400, 76'800, 115'200
Device Address Binding:	No static device binding supported
Networking Options:	None
Character Sets Supported:	ANSI X3.4

6-way ePIV
BACnet PIC Statement

PICS

Object processing

Object type	Optional properties	Writeable properties
Analog Input [AI]	Description	
Analog Output [AO]	Description	Present Value Relinquish Default
Analog Value [AV]	Description	Present Value
Binary Value [BV]	Description Active Text Inactive Text	
Device	Description Location Max Master Max Info Frames Profile Name	Object Identifier Object Name Location Description APDU Timeout Number Of APDU Retries Max Master Max Info Frames
Multi-state Input [MI]	Description State Text	
Multi-state Value [MV]	Description State Text	Present Value
Multi-state Output [MO]	Description State Text	Present Value Relinquish Default

- The properties Object Name, Location and Description of the Device Object support up to 255 characters (all other character strings are read-only).
- The device does not support the CreateObject and DeleteObject service.

Service processing

- The device supports DeviceCommunicationControl service. No password is required.

BACnet object description

Object Name	Object Type / Instance	Description *Comment*	Values	Default	Access
Device Name	Device[x]				
SpRel	AO [1]	Setpoint Relative in %[1)] *The set point is related either to the position or the flow (of Vmax)*	0 … 100	50	C
Override	MO [1]	Override Control	None Seq1 Open Seq2 Open Close Seq1 Vmax Seq2 Vmax	None	C
RelPos	AI [1]	Relative Position in %	0 … 100	-	R
AbsPos	AI [2]	Absolute Position in °	0 … 90	-	R
SpAnalog_V	AI [5]	Setpoint Analog in V	0 … 10	-	R
RelFlow	AI [10]	Relative Flow in % *Related to Vmax*	0 … 100	-	R
AbsFlow_lh	AI [15]	Absolute Flow in l/h	0 … Vnom	-	R
AbsFlow_gpm	AI [18]	Absolute Flow in gpm	0 … Vnom	-	R
AbsFlow_UnitSel	AI [19]	Absolute Flow in selected unit *→ MV [121]*	0 … Vnom	-	R
SpAbsFlow_UnitSel	AI [109]	Setpoint Absolute Flow in selected unit *→ MV [121]*	0 … Vnom	-	R
ActSequence	MI [1]	Active Sequence	Sequence 1 Sequence 2 Dead Band	-	R
SummaryStatus	BI [101]	Summary Status *Summarizes all status from MI 103 - 106*	OK not OK	-	R
StatusSens	MI [103]	Status Sensor *Indicates informations within the flow sensor*	OK Flow sensor not OK	-	R
StatusFlow	MI [104]	Status Flow *Setpoint cannot be reached within 3min during flow control* *Flow is measured but position of valve is closed (Dead band)*	OK Flow not reached Flow in closed position	-	R
StatusMedia	MI [105]	Status Media *Airbubbles in the hydronic system*	OK Airbubbles	-	R
StatusAct	MI [106]	Status Actuator *Mechanical overload e.g. blocked valve* *Gear disengaged button is pressed*	OK Actuator cannot move Gear disengaged	-	R

[1)] Setpoint Relative in %:

Position Control	Setpoint 0…100% refers to relative position 0…100%	
Flow Control	Setpoint 0…33% refers to range Vmax1…0 i.e. Setpoint 0% = Vmax1 / Setpoint 33% = 0	Setpoint 67…100% refers to 0…Vmax2 i.e. Setpoint 67% = 0 / Setpoint 100% = Vmax2

BACnet object description *(continued)*

Object Name	Object Type / Instance	Description	Values	Default	Access
Vmax1	AV [99]	Maximum Flow Limit of Seq1 in % *Related to Vnom*	0 … 100	100	W
Vmax2	AV [100]	Maximum Flow Limit of Seq2 in % *Related to Vnom*	0 … 100	100	W
Vnom_gpm	AV [102]	Nominal Volume Flow in gpm	Depending on DN size	-	R
Vnom_lh	AV [115]	Nominal Volume Flow in l/h	Depending on DN size	-	R
Vnom_UnitSel	AV [119]	Nominal Volume Flow in selected unit *→ MV [121]*	Depending on DN size	-	R
ControlMode	MV [100]	Control Mode *The value defines the interpretation of the setpoint.*	PosCtrl FlowCtrl	FlowCtrl	W
UnitSelFlow	MV [121]	Unit Selection Flow *Defines the unit of the following objects* *AI [19]* *AI [109]* *AI [119]*	m^3/s m^3/h l/s l/min l/h gpm cfm	l/h	W
SpSource	MV [122]	Setpoint Source *The actuator has the possibility to be controlled from an analog input even though integrated on BACnet. Depending on this setting the setpoint by bus or analog input will be followed.* *Analog: Setpoint from analog signal 0…10V on wire 3* *Bus: Setpoint from BACnet → AO [1]*	Analog Bus	Analog	W

Modbus General Notes

General information

Protocol:	Modbus RTU / RS-485
Number of nodes:	Max. 32 (without repeater)
Transmission formats:	1-8-N-2, 1-8-N-1, 1-8-E-1, 1-8-O-1 *Default: 1-8-N-2*
Baud rate:	9,600, 19,200, 38,400, 76,800, 115,200 Bd *Default: 38,400 Bd*
Terminating resistor:	120 Ω (to be done with external resistor)
Parameterisation:	With Belimo Assistant App

Register implementation

All data is arranged in a table and addressed by 1..n (register) or 0..n-1 (address). No distinction is made between data types (Discrete Inputs, Coils, Input Registers and Holding Registers). As a consequence, all data can be accessed with the two commands for Holding Register. The commands for Discrete Inputs and Input Registers can be used as an alternative.

Standard commands

Read Holding Registers [3]
Write Single Register [6]
Read Discrete Inputs [2]
Read Input Registers [4]
Write Multiple Registers [16]

Command "Read Discrete Inputs"

The command reads one or more bits and can alternatively be used for Register No. 105 (Malfunction and Service information).

Example: The start address to be used is 1664 → **104** (Register Address) *** 16** (Bit) **= 1664**

Interpret values in the registers

All values in the register are unsigned integer datatypes.

Example: Read (Function 03, 1 Register) Value Register No. 12 = $0001'1010'1100'1000_2 = 6'856_{10}$
Actual Value = Value * Scaling factor * Unit = 6'856 * 0.01 * m^3/h = **68.56 m^3/h**

32-Bit values in two registers

Values that exceed 65,535 are stored in two consecutive Registers and have to be interpreted as "little endian" / LSW (Least Significant Word) first

Example:
Register No. 10 (AbsFlow LowByte) = $14,551_{10} = 0011'1000'1101'0111_2$
Register No. 11 (AbsFlow HighByte) = $19_{10} = 0000'0000'0001'0011_2$

AbsFlow HighByte	AbsFlow LowByte
19	14,551
0000'0000'0001'0011	0011'1000'1101'0111

→ AbsFlow = $0000'0000'0001'0011'0011'1000'1101'0111_2 = 1,259,735_{10}$ = **1259.735 l/h**

Math formula:
AbsFlow = (AbsFlow HighByte * *65,536*) + AbsFlow LowByte
AbsFlow = (19 * *65,536*) + 14,551 = 1,259,735 = **1259.735 l/h**

Modbus Register Overview

	No.	Adr	Register		R/W
In operation	1	0	**Setpoint [%]**		R/W
	2	1	**Override control**		R/W
	3	2	-		R
	4	3	Actuator type		R
	5	4	Relative position [%]		R
	6	5	Absolute position [°]		R
	7	6	Relative Flow [%]		R
	8	7	Absolute Flow [UnitSel]	LData	R
	9	8		HData	
	10	9	Absolute Flow [l/h]	LData	R
	11	10		HData	
	12	11	Absolute Flow [gpm]	LData	R
	13	12		HData	
	14	13	Setpoint Absolute Flow [UnitSel]	LData	R
	15	14		HData	
	16	15	Setpoint Analog [V]		R
	17	16	Active Sequence		R
Service	101	100	Series number 1st part		R
	102	101	Series number 2nd part		
	103	102	Series number 4th part		
	104	103	Firmware version		R
	105	104	Malfunction & Service information		R
	106	105	**Vmax Sequence 1 [%]**		R/W
	107	106	**Vmax Sequence 2 [%]**		R/W
	108	107	-		
	109	108	-		
	110	109	-		
	111	110	Absolute Vnom [UnitSel]	LData	R
	112	111		HData	
	113	112	Absolute Vnom [l/h]	LData	R
	114	113		HData	
	115	114	Absolute Vnom [gpm]	LData	R
	116	115		HData	
	117	116	**Control Mode**		R/W
	118	117	**Unit Selection Flow**		R/W
	119	118	**Setpoint Source**		R/W

Modbus Register Description

Register 1: Setpoint
Setpoint for actuator setting in hundredths of one percent
Scaling factor: 0.01 → i.e. 0…10,000 corresponds to 0…100%

Position Control
Setpoint 0…100% refers to relative position 0…100%

Flow Control
Setpoint 0…33% refers to range Vmax1…0
i.e. Setpoint 0% = Vmax1 / Setpoint 33% = 0

Setpoint 67…100% refers to 0…Vmax2
i.e. Setpoint 67% = 0 / Setpoint 100% = Vmax2

Register 2: Override control
Overriding the setpoint (Register No. 1) with defined values

0	None
1	Open Sequence 1 (0%)
2	Open Sequence 2 (100%)
3	Close (50%)
4	Vmax Sequence 1
5	Vmax Sequence 2

Register 3: (Reserved)
Not used in this device. Constant value 65'535

Register 4: Actuator type
Actuator type; the allocation may deviate from the basic category with some actuators.

0	Unknow
1	Air & Water
2	EPIV / VAV
3	Fire
4	EnergyValve
5	**6way EPIV**

Register 5: Relative position
Relative position of actuator in hundredths of one percent [%]
Scaling factor: 0.01 → i.e. 0…10,000 corresponds to 0…100%

Register 6: Absolute Position
Absolute position of actuator in hundredths of one degree [°]
Scaling factor: 0.01 → i.e. 0 … 9,000 corresponds to 0…90°

Register 7: Relative Flow
Relative flow in hundredths of one percent of active Vmax (Vmax1 or Vmax2)
Scaling factor: 0.01 → i.e. 0 … 10,000 correspond to 0 … 100%

Register 8/9: Absolute Flow UnitSel
Absolute Flow in unit which is selected in Register No. 118
Scaling factor: 0.001

Register 10/11: Absolute Flow in l/h
Absolute Flow in l/h
Scaling factor: 0.001 → i.e. 1,260,000 corresponds to 1,260.000 l/h

Register 12/13: Absolute Flow in gpm
Absolute Flow in gpm
Scaling factor: 0.001 → i.e. 1,200 corresponds to 1.200 gpm

Register 14/15: Setpoint Absolute Flow UnitSel
Setpoint as Absolut Flow in unit which is selected in Register No. 118
Scaling factor: 0.001

Register 16: Setpoint Analog
Setpoint as analog value in hundredths of a Volt
i.e 0…1,000 corresponds to 0.00…10.00V

Register 17: Active Sequence
Indicates Active Sequence

0	Sequence 1 (0…33%)
1	Sequence 2 (67…100%)
2	Dead Band (34…66%)

Register 101-103:
Series number

Each device has an unambiguous series number which is either impressed on or glued to the housing. The series number consists of 4 segments, although only parts 1, 2 and 4 are displayed on Modbus.
Example: 00839-31324-064-008

Register 101	Register 102	Register 103
1st part	2nd part	4th part
00839	31234	008

Register 104:
Firmware Version

Firmware version of Modbus module (VX.XX)
e.g. 101 V1.01

Register 105:
Malfunction and service information

The status information is split into messages about the actuator (malfunctions) and other service information

	Bit	Description
Malfunctions (low byte)	0	-
	1	-
	2	Error flow sensor
	3	Actuator can't move
	4	Flow with closed valve
	5	Airbubbles
	6	Flow not reached
	7	-
Service (high byte)	8	-
	9	Gear disengagement active
	10	-
	11	-
	12	-
	13	-
	14	-
	15	-

Description

Error Flow Sensor: Error with the flow sensor
Actuator can't move: Mechanical overload due to blocked valve, etc.
Flow with closed valve: Flow is measured but position of valve is closed (Dead Band)
Airbubbles: Airbubbles in the hydronic system
Flow not reached: Setpoint cannot be reached within 3min during flow control
Gear disengagement active: Gear disengaged button is pressed

Register 106:
Vmax of Sequence 1

Maximum limit of Flow of Sequence 1 in hundredths of one percent of Vnom
Scaling factor: 0.001 → i.e. 50…10,000 correspond to 5…100%

Register 107:
Vmax of Sequence 2

Maximum limit of Flow of Sequence 2 in hundredths of one percent of Vnom
Scaling factor: 0.001 → i.e. 50…10,000 correspond to 5…100%

Register 108:
(Reserved)

Not used in this device. Constant value 65'535

Register 109:
(Reserved)

Not used in this device. Constant value 65'535

Register 110:
(Reserved)

Not used in this device. Constant value 65'535

Register 111/112:
Vnom in UnitSel

Nominal volume in selected unit in Register No. 118
Scaling factor: 0.001

Register 113/114:
Vnom in l/h

Nominal volume in l/h
Scaling factor: 0.001 → i.e. 350 corresponds to 0.350 l/h

Register 115/116:
Vnom in gpm

Nominal volume in gpm
Scaling factor: 0.001 → i.e. 1,200 corresponds to 1.200 gpm

Register 117: Control mode

Control Mode of the EPIV. Further information see Register No. 1 (Setpoint)

0	Position Control
1	Flow Control

Register 118: Unit Selection Flow

Selection of Flow Unit defines unit of Register No. 8/9, 14/15, 111/112

0	m^3/s
1	m^3/h
2	l/s
3	l/min
4	l/h
5	gpm
6	cfm

Register 119: Setpoint Source

Source of setpoint. The actuator has the possibility to be controlled from an analog input even though integrated on Modbus. Depending on this setting the setpoint by bus or analog input will be followed.

0	Analog
1	Bus

Description

Analog: Setpoint from analog signal 0…10V on wire 3
Bus: Setpoint from Modbus → Register No. 1

6-Way CCV
A valve designed for chilled beams, radiant ceiling panels, and 4-pipe fan coil units. It has the functionality of up to four 2-way control valves.

6-Way ePIV
Like the 6-way CCV, but with furnished ultrasonic flow meter and pressure independent flow logic within the actuator. It has the functionality of up to four 2-way control valves and two balancing valves.

Analog
A linear signal from one device to another. Used to move or read values. It is used by a controller to modulate an actuator. Typical analog signal range is 2-10 VDC, 0-10 VDC, or 4-20 mA.

BACnet
A standard world-wide communication protocol that is used in building automation. BACnet uses two common communication mechanisms, BACnet IP which communicates over Ethernet networks. BACnet MS/TP communicates over 2 or 3-wire RS485 networks.

BAS
(Building Automation System)
A computer-based control system installed in buildings to control and monitor the building's mechanical and electrical equipment.

CCV
(Characterized Control Valve)
Belimo patented ball valve with characterizing disc that is designed to provide a linear coil flow output.

Deadband
Both Sequence 1 & 2 have zero flow to the coil. This occurs between 4.7 to 7.3 VDC, and from 30° to 60° valve rotation.

DDC
(Direct Digital Control)
A controller with software to operate control valves, dampers and other devices.

ePIV
(Electronic Pressure Independent Control Valve)
The ePIV directly measures flow by combining an electronic flow meter and a control valve. The actuator has a powerful algorithm that modulates the control valve to maintain the flow setpoint from the DDC controller. The flow reading is reported back to the controller using a standard analog signal, and this value can be used by the BAS to perform advanced control and energy strategies.

Modbus RTU
Used in serial communication and makes use of a compact, binary representation of the data for protocol communication. The RTU format follows the commands/data with a cyclic redundancy check checksum as an error check mechanism to ensure the reliability of data. Modbus RTU is the most common implementation available for Modbus. A Modbus RTU message must be transmitted continuously without inter-character hesitations. Modbus messages are framed (separated) by idle (silent) periods. (Wikipedia 17Aug2017)

MP-Bus (MP)
Belimo communication protocol. The ZTH US tool uses this protocol to view and change actuator settings.

Sequence 1
Maximum to minimum flow for either heating or cooling flow to the coil. This occurs between 2.0 to 4.7 VDC, and from 0° to 30° valve rotation.

Sequence 2
Minimum to maximum flow for either cooling or heating flow to the coil. This occurs between 7.3 to 10.0 VDC, and from 60° to 90° valve rotation.

True Flow
Flow signal from the ultrasonic flow meter.

Ultrasonic Flow Meter
Utilizing ultrasonic transit time technology, the transducers perform as both emitter and receiver while acoustic mirrors provide accurate signal reflection. The flow meter also incorporates an embedded temperature sensor which enables Belimo's patented temperature and glycol compensation logic to accurately read flow over a wide range of water variables.

V'max
The maximum flow setting for sequence 1 and sequence 2, which is equal to or less than V'nom. Flow settings can be different for each sequence.

V'nom
The maximum allowable flow for sequence 1 and sequence 2.