

**Air ratios
under control.**

Applications of room and system solutions with VAV-Universal

Edition 2023-06/C

Preface

Thank you for your interest in our products. In this brochure you will find information on volumetric flow, duct pressure and room pressure applications with the new VAV universal product range from Belimo.

All chapters are structured as follows:

- Brief description
- Principle diagram
- Function diagram
- Device selection
- Diagram
- Parameter and tool overview

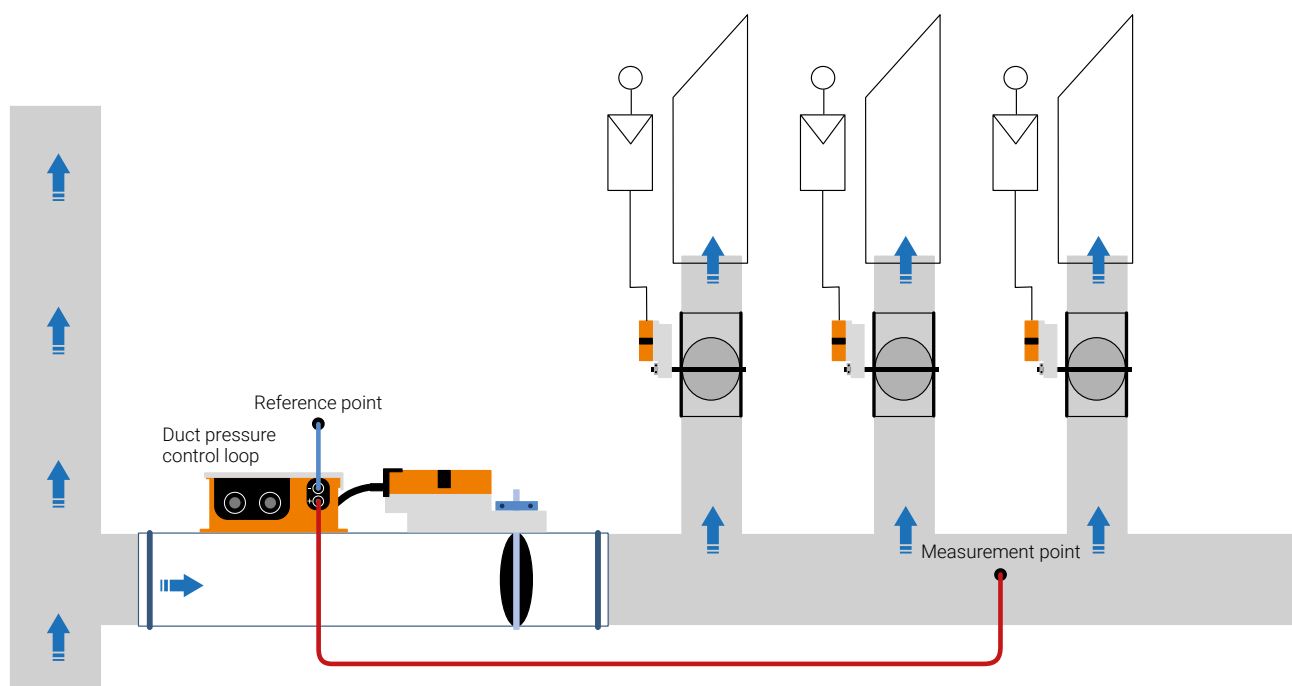
The last chapter, starting on Page 61, also provides an overview of general principles such as connections, local override controls, primary/secondary operation versus parallel control, etc.

At www.belimo.com you will find further solutions from Belimo relating to the areas of room and system solutions, bus and system integration, ventilation applications and sensors. Please contact us for more information.

Note

The Belimo VAV product range - VAV-Compact and VAV-Universal components incl. replacement devices - is only available from manufacturers of VAV units (OEM). Please contact the desired supplier. Your local Belimo representative is happy to help you if necessary.

The diagram shows an example of the principle of one duct (line) pressure control.



Belimo product types

VAV-Universal – maximum flexibility for increased requirements

Ventilation concepts according to DIN EN 15232 require modern, energy-efficient VAV control concepts and ensure operation as required from the fan to the room. Not as much as possible, but as much as necessary.

In addition to the proven VAV-Compact product range, which covers around 90 percent of VAV applications, the modern VAV-Universal product range is now available for special applications. Its modular design, consisting of a VRU controller with integrated high-quality Δp sensor technology, enables the optimum combination of controller and damper motorisation for all VAV, duct pressure and room pressure applications.

VRU controller sensor unit

The VRU controller sensor unit was developed for use in building technology and is perfectly matched to the VST actuators that belong to the system. Two sensor variants are available: in addition to the well-established, dynamic D3 sensor, the new M1 diaphragm sensor is also available.

The system supports volumetric flow (VAV), duct pressure (STP) and room pressure (RP) applications. The control via analogue, BACnet/Modbus, in hybrid mode or MP-Bus is preset with the corresponding tools by the OEM or on the system during system integration. NFC interface, service socket or a PP interface are available for easy tool connection.



VST actuator product range

The damper actuator product range with the plug-and-play function includes rotary actuators, very fast running actuators as well as rotary actuators with fail-safe. The actuator running time is detected by the VRU controller and used to optimise the control performance.



Tools for easy commissioning and parametrisation

With the Belimo Assistant App (Android, iOS), actual and setpoint values can be displayed graphically as trend data or parameters adjusted on the system via Bluetooth or NFC. The Belimo PC-Tool is available to system integrators and VAV manufacturers for the production of the VAV unit.



VAV-Compact L/N/SMV-D3-..

The system solution for volumetric flow systems to equip your VAV units for VAV or CAV applications. For analogue control or for direct integration into Modbus, BACnet, KNX or MP-Bus systems.

See www.belimo.com



Product and function overview

	Function	Characteristic	VRU-D3-BAC	VRU-M1-BAC	VRU-M1R-BAC
Application	VAV/CAV	Volumetric flow	■	■	
	Measure volumetric flow	Volumetric flow	■	■	
	Position control (Open Loop)	Volumetric flow	■	■	
	Duct pressure control	Δp	■	■	
	Room pressure control	Δp			■
	Room-pressure cascade control	Δp Room-pressure volumetric flow control	■ Flow	■ Flow	■ Δp
	Integration in DCV system	Requirement recording via damper position	■	■	■
Control	Modulating	min./max.	■	■	■
	Step mode	min./max.	■	■	■
	Local override - input z1	Motor stop/damper OPEN	■	■	■
	Local override - input z2	Damper CLOSED/max.	■	■	■
	Room-pressure mode +/-	Adjustable via Tool/Modbus/BACnet			
	Control (adjustable with Tool)	0...10 V/2...10 V/variable/bus	■	■	■
		Modbus RTU, incl. hybrid mode	■	■	■
		BACnet MS/TP, incl. hybrid mode	■	■	■
		MP-Bus	■	■	■ ¹⁾
	Feedback (Feedback U5)	0...10 V/2...10 V variable/bus	■	■	■
Δp sensor		Volumetric flow/ Δp /Position	■	■	Δp
	Measuring principle	D3 flow rate (dynamic)	■		
		M1(R) diaphragm (static)		■	■
	Measuring ranges	Application-dependent (VAV 0...500 Pa)	0...500 Pa	0...600 Pa	-75...75 Pa
	Field of application	Comfort zone	■	■	■
Actuator		Contaminated air (compatibility test required)		■	■
	Ready-to-connect connection	Plug-and-play function	■	■	■
	L/N/SM24A-VST	5/10/20 Nm, 120 s, rotary actuator	■	■	■
	L/N/SMQ24A-VST	4 Nm, 2.4 s/8 Nm, 4 s/16 Nm, 7 s, very fast running actuator	■	■	■
	NKQ24A-VST	6 Nm, 4 s, very fast running actuator, electrical fail-safe	■	■	■
	N/SF24A-VST LF24-VST	4/10/20 Nm, 120 s, mechanical fail-safe	■	■	■
Tools	Belimo Assistant App/NFC	NFC/Bluetooth	■	■	■
	PC-Tool	Default/OEM Manufacturing Tool	■	■	■

Note: VAV-Universal components incl. replacement units are only available from manufacturers of VAV units (OEM).

The components VRD../VRP../V../SRV-ST of the old VAV-Universal product range are not compatible with the VRU../VST.

Please contact your Belimo representative for further assistance.

¹⁾ RPC room-pressure cascade controllers cannot be integrated into MP-Bus systems.

Terms

CAV	Constant Air Volume
VAV	Variable Air Volume
DCV	Demand Controlled Ventilation
DN	Diameter nominal, international designation for nominal diameter
BMT	Building Management System
STP	Duct pressure controller
RP	Room-pressure controller
Open Loop	Position control (operating mode without VAV control, modulating actuator with volumetric flow measurement)
OEMs	Original Equipment Manufacturer, manufacturer VAV unit
CR24-..	Belimo CR24-B1/2/3 Stand-alone room temperature controller
D3	Δp sensor, D3 flow sensor (dynamic)
M1	Δp sensor, M1 diaphragm sensor (static)
LHV	Belimo VAV-Compact with linear actuator
LMV	Belimo VAV-Compact with rotary actuator 5 Nm
NMV	Belimo VAV-Compact with rotary actuator 10 Nm
SMV	Belimo VAV-Compact with rotary actuator 20 Nm
VC	VAV-Compact product range from Belimo – actuator with VAV controller and Δp sensor in one device
VU	VAV-Universal product range from Belimo – modular solution consisting of VAV controller with integrated Δp sensor plus external actuator
BAC	BACnet interface
KNX	KNX interface
Hybrid mode	VAV-Compact integrated in BACnet/Modbus with analogue control and/or feedback signal
MOD	Modbus interface
MP	MP-Bus interface
NFC	Near Field Communication, interface for wireless tool connection
A/D	Analogue-digital converter
D/A	Digital-analogue converter
M	Motor
U/U5	Actual value output (terminal 5)
Y	Reference value input (terminal 3)
z	Forced switching (override) to input Y
EHO	Energy Hold Off
w	Setpoint controller
ao..	Analogue output..
wK	Setpoint cooling
wH	Setpoint heating
Xp	Proportional band
cw	Clockwise rotation (direction of rotation of actuator)
ccw	Counterclockwise (anticlockwise) rotation (direction of rotation of actuator)
Mode	Setting for voltage range for reference value input/actual value output
V'_{min}	Operating mode min. according to the application V'_{min}
V'_{mid}	Operating mode min. according to the application V'_{min}
V'_{max}	Operating mode max. according to the application V'_{max}
V'_{nom}	VAV applications volumetric flow nominal setting ¹⁾
$\Delta p@V'_{nom}$	VAV applications calibration value VAV unit ¹⁾

¹⁾ OEM factory setting: fixed setting, values cannot be changed

Determination VRU hardware

Controller / Δp sensor

Field of application	Comfort? Yes No → Increased requirements, e.g. contaminated air				
	↓		↓		↓
Δp sensor	D3		M1		M1R
Application	Volumetric flow VAV	Air duct pressure STP	Volumetric flow VAV	Air duct pressure STP	Room pressure RP
Job function	<ul style="list-style-type: none"> • VAV/CAV • Volumetric flow measurement • Position control ↓	↓	<ul style="list-style-type: none"> • VAV/CAV • Volumetric flow measurement • Position control ↓	↓	↓
VRU version	VRU-D3-BAC		VRU-M1-BAC		VRU-M1R-BAC

Comfort applications in offices, administration buildings, hotels etc. in combination with special actuator solutions.

Applications with increased requirements, e.g. kitchen, restaurant extract air, hospital buildings.

- Compatibility test with the intended media required
- Use of the components in fume hoods or similar are not permitted

Δp sensor

D3	dynamic Δp sensor (flow)	0...500 Pa
M1	static Δp sensor (diaphragm)	0...600 Pa
M1R	static Δp sensor (diaphragm)	-75...75 Pa

VRU controller

VRU-D3-BAC	D3 sensor	VAV/STP
VRU-M1-BAC	M1 sensor	VAV/STP
VRU-M1R-BAC	M1R sensor	RP

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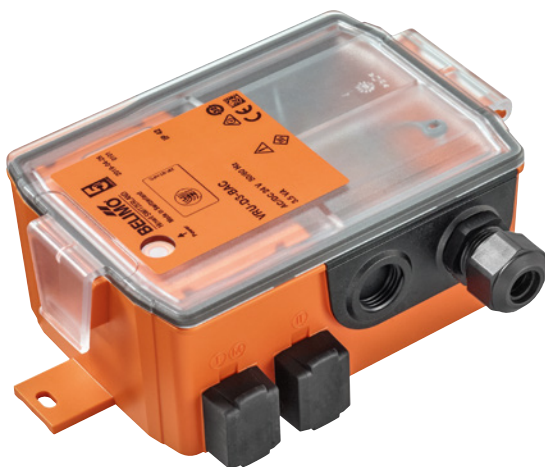
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Volumetric flow control VAV/CAV

VRU-D3-BAC/VRU-M1-BAC

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Volumetric flow control VAV/CAV

Brief description

- Variable volumetric flow control (VAV) $V'_{\min} \dots V'_{\max}$
- Constant volumetric flow control (CAV) Damper CLOSED/ V'_{\min}/V'_{\max} / Damper OPEN



Principle diagram

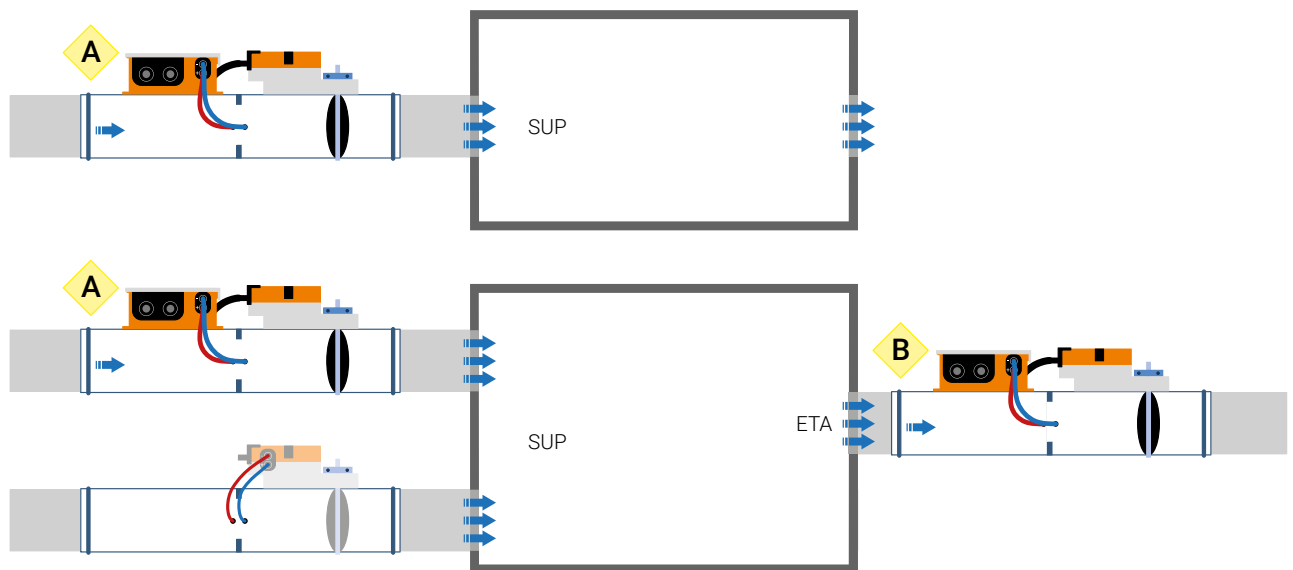


Illustration example

Ventilation system with constant [CAV] and variable air volume [VAV]

- Room and zone applications SUP unit or SUP and ETA unit, in comfort zone
- Extract air/extraction systems for contaminated air, e.g. kitchen extract air

The VAV-Universal VRU-... control unit controls the volumetric flow specified by the room automation system, e.g. via a room temperature or air quality controller for the downstream zone/room. Pressure fluctuations in the air duct system are detected and automatically corrected.

The following variants are available in combination with the actuator solution optimally suited to the application:

- VRU-D3-BAC for comfort zone
- VRU-M1-BAC for comfort zone and for polluted extract air

The damper position of the VAV unit is available for DCV applications via the selected bus system (Fan Optimiser function).

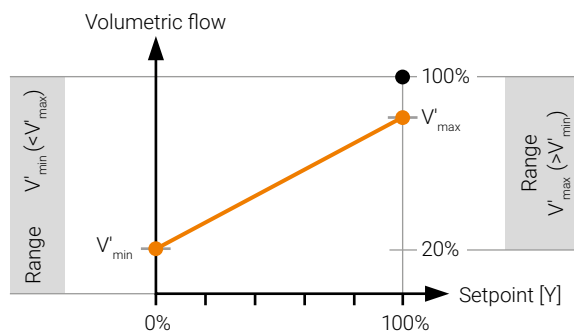
Control functions

- V'_{\min} Minimum air exchange rate, hygiene section, building protection (air humidity etc.)
- V'_{\max} Maximum air exchange rate, maximum cooling load, removal of emissions
- $V'_{\min} \dots V'_{\max}$ Partial load operation – variable volume operation (VAV)
- Local override (z1/z2) Motor stop, damper OPEN, V'_{\max} , damper CLOSED
- Control Analogue 0...10 V/2...10 V, Modbus ¹⁾, BACnet ¹⁾, MP-Bus

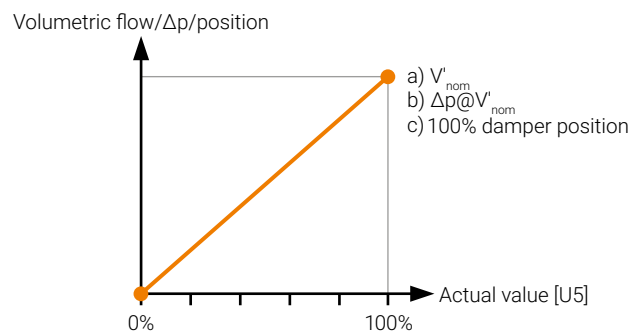
¹⁾ Hybrid mode possible

Function diagram

VAV control: analogue/bus (setpoint)



Feedback U5/bus (actual value)



Device selection

Product type from Belimo	Function	Sensor/Actuator characteristic	Field of application	SUP unit	ETA unit
VRU-D3-BAC	VAV-/CAV controller	Δp sensor, integrated D3 flow sensor 0...500 Pa	Comfort	■	■
VRU-M1-BAC	VAV-/CAV controller	Δp sensor, integrated M1 diaphragm sensor 0...600 Pa	Comfort Contaminated air	■	■
L/N/SM24A-VST	Rotary actuator, default	5/10/20 Nm, 120 s	All ranges		
LF/NF/ SM24A-VST	Rotary actuator, mechanical fail-safe	4/10/20 Nm, 120 s, spring 20 s	All ranges		
LMQ24A-VST	Rotary actuator, very fast running	4 Nm, 2.4 s	All ranges		
NMQ24A-VST	Rotary actuator, very fast running	8 Nm, 4 s	All ranges		
NKQ24A-VST	Rotary actuator, very fast running, Electrical fail-safe	6 Nm, 4 s	All ranges		
SMQ24A-VST	Rotary actuator, very fast running	16 Nm, 7 s	All ranges		

Option VAV-Compact

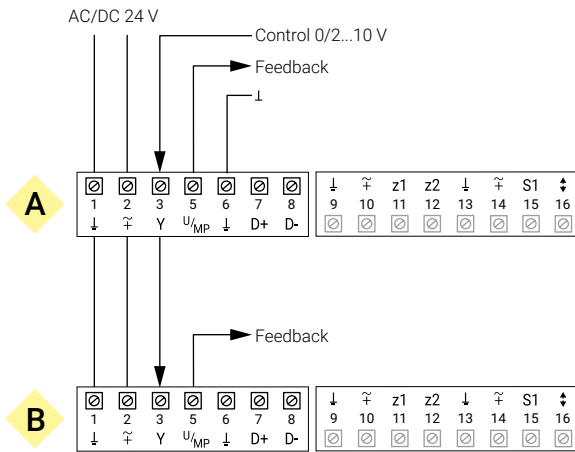
Product type from Belimo	Function	Sensor/Actuator characteristic	Field of application	SUP unit	ETA unit
L/N/SMV-D3..	VAV-Compact controller (VAV/CAV)	Δp sensor, integrated D3 flow sensor 0...500 Pa Rotary actuator 5/10/20 Nm, integrated	Comfort	■	■

See www.belimo.com

Diagram

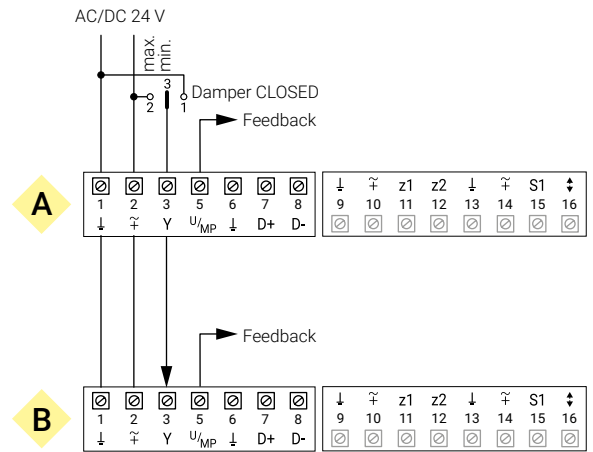
Analogue control [Mode 0...10 V/2...10 V]

– VAV mode: V'_{min} / V'_{max}

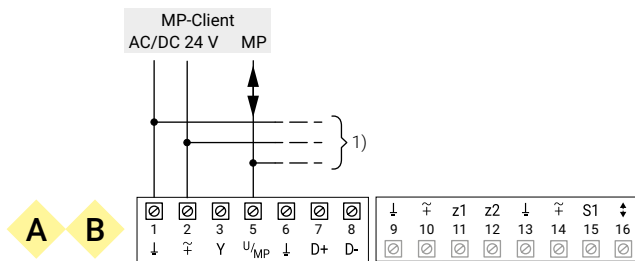


Analogue control [Mode 2...10 V]

– CAV steps: Damper CLOSED/ V'_{min} / V'_{max}

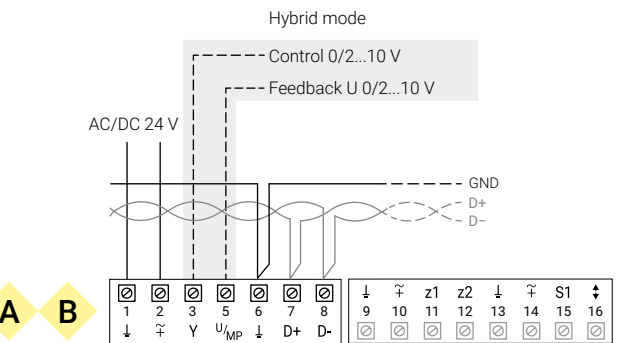


MP-Bus



¹⁾Other MP devices (total 8)

Modbus RTU, BACnet MS/TP



Safety requirements

Only authorised specialists may carry out installation. All applicable legal and government agency regulations must be complied with during use. Connection via isolating transformer.

See VAV-Universal-VRU Product Information: www.belimo.com

Explanations/notes

- Priority control Page 71
- Connection z1/z2 Page 61
- Sensor integration bus mode Page 61
- VRP-M replacement in existing MP-Bus system:
See separate instructions
VAV-Universal-VRU in
VRP-M compatibility mode (MP)

Parameter and tool overview volumetric flow control VAV/CAV

Parameter/Function	Unit/Value	Function/Description/(Area)	Applica- tion	Tool			Authori- sation
			VAV/CAV	Assistant app	PC-Tool	ZTHEU	Expert/OEM
VAV unit - manufacturer parameters (OEM values - not variable)							
Application	Volumetric flow	Application setting	■	r	r	r	0
Designation	Text	Model designation unit/Damper (16 Z.)	■	r	r	-	0
V'_{nom}	m ³ /h/l/s/cfm	Volumetric flow nominal value	■	r	r	r	0
$\Delta p @ V'_{nom}$	Pa	Calibration value VAV unit [38...500 Pa]	■	r	r	-	0
SN actuator	xxxxx-xxxxx-xxx-xxx	Actuator serial number	■	r	-	-	
Direction of rotation	ccw/cw	Actuator direction of rotation setting	■	r/w	r/w	-	E
Range of rotation	Adapted/programmed	Actuator adapted/programmed 30...95°	■	r/w	r/w	-	E
Power on behaviour	No action/Synch./adaptation	Actuator power-on behaviour	■	r/w	r/w	-	E
Damper leakage suppressed	OFF/ON	Retrofit application, damper leakage	■	r	r	-	0
NFC interface	ON/OFF	NFC communication for app access	■	r	r	-	0
Configuration – Project-specific settings							
Position	Text	System designation (64 Z./ZTH 16 Z.)	■	r/w	r/w	r	
V'_{max}	m ³ /h/l/s/cfm (ZTH %)	Operating volumetric flow V'_{max} 20...100% V'_{nom}	■	r/w	r/w	r/w	
V'_{min}	m ³ /h/l/s/cfm (ZTH %)	Operating volumetric flow V'_{min} 0...100% V'_{nom}	■	r/w	r/w	r/w	
Altitude compensation	ON/OFF	Switch function on/off	■	r/w	r/w	-	E
Altitude of installation	0 m	Compensated Δp and volumetric flow values to set system height (m a.s.l.)	■	r/w	r/w	-	E
Control function	VAV/CAV	VAV control, active	■	r/w	r/w	-	E
Room-pressure cascade	OFF	VAV: Secondary circuit room pressure cascade	■	r/w	r/w	-	E
Setpoint	Analogue/Bus	Analogue and hybrid mode/bus	■	r/w	r/w	-	E
Setpoint offset	0%	VAV: $\pm 5\%$ compensation ETA unit	■	r/w	r/w	-	E
Reference signal Y	2...10 V/0...10 V/adjustable	Setting for VAV control	■	r/w	r/w	-	E
Feedback type	Volumetric flow/ Δp /Position	Volume/ Δp /damper position	■	r/w	r/w	-	E
Feedback U	2...10 V/0...10 V/adjustable	Setting U signal	■	r/w	r/w	-	E

Availability: VAV-Universal components incl. replacement devices are only available from manufacturers of VAV units (OEM).

Permissions: [0 - OEM, manufacturer mode] - VRU controllers are calibrated and parameterised by the unit manufacturer according to the specific application and the project. These settings can only be changed by the manufacturer.
[E-Expert Mode] - Functionally relevant settings are only accessible via the Expert Mode of the Belimo Assistant App.

Legend

r Tool: read
w Tool: Write
- Tool: Does not support parameter
E Only visible in Expert Mode

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Volumetric flow measurement

VRU-D3-BAC/VRU-M1-BAC

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Volumetric flow measurement

Brief description

Volumetric flow measuring device (transmitter) for detecting or monitoring volumetric flow



Principle diagram

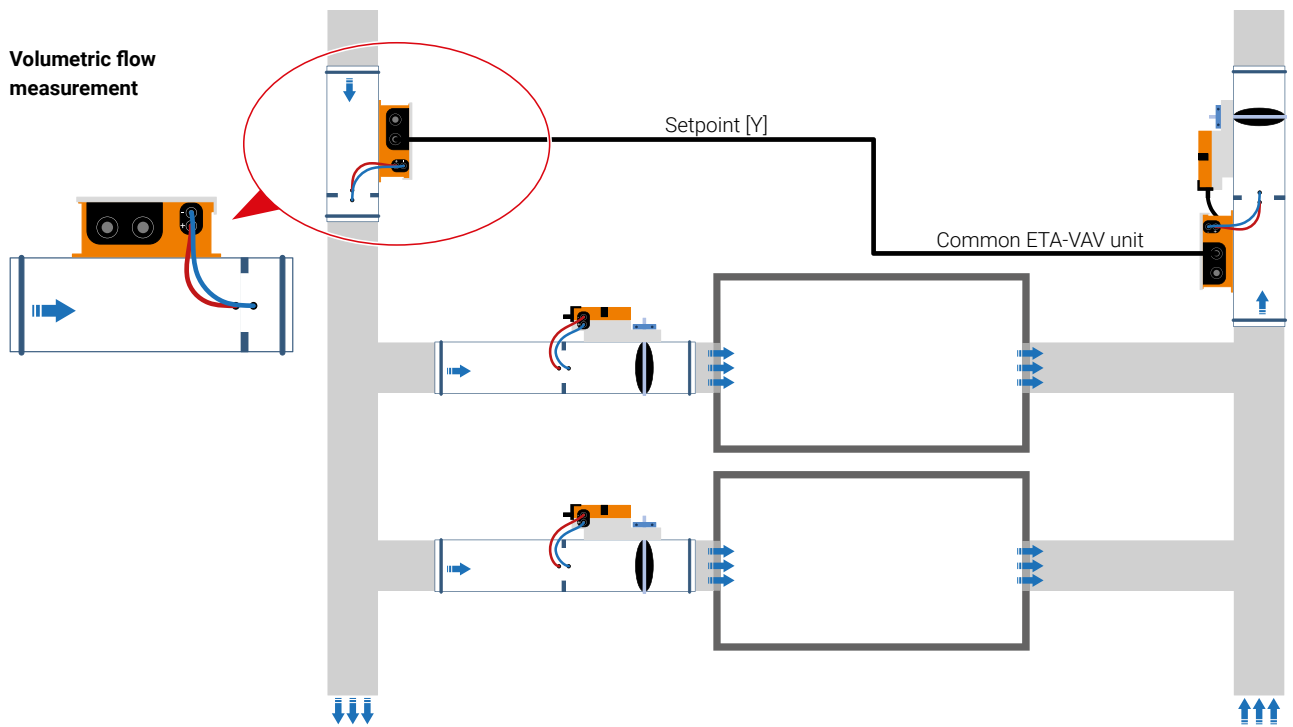


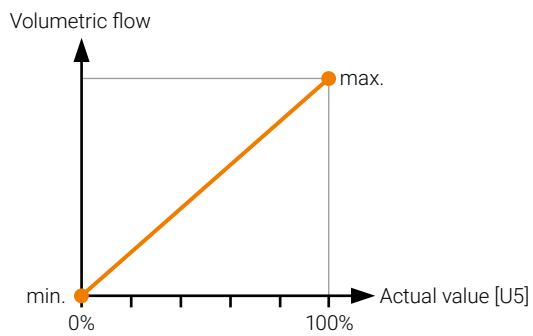
Illustration example

Volumetric flow measuring devices for detecting or monitoring volumetric flow.

- In ventilation systems in comfort zones and for contaminated air
- E.g. for recording the total supply air for the setpoint specification of a common extract air-side VAV unit
- Display function $0 \dots 100\% V'_{nom}$
- Analogue integration $0 \dots 10 \text{ V} / 2 \dots 10 \text{ V}$, Modbus, BACnet, MP-Bus

Function diagram

Feedback U5/bus (actual value)



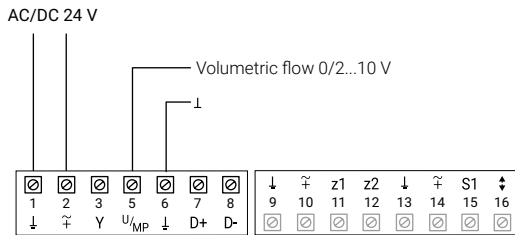
Device selection

Product type from Belimo	Function	Sensor/Actuator characteristic	Field of application	SUP unit	ETA unit
VRU-D3-BAC	VAV-/CAV controller	Δp sensor, integrated D3 flow sensor 0...500 Pa	Comfort	■	■
VRU-M1-BAC	VAV-/CAV controller	Δp sensor, integrated M1 diaphragm sensor 0...600 Pa	Comfort Contaminated air	■	■
ZG-VRU01	Blind plug for VST connector plug, for applications without actuator				

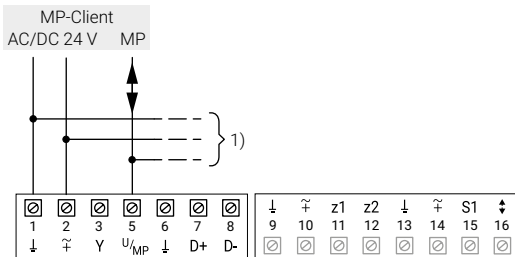
Diagram

Analogue control [Mode 0...10 V/2...10 V]

Display V'_{nom}



MP-Bus



¹⁾ Other MP devices (total 8)

Safety requirements

Only authorised specialists may carry out installation. All applicable legal and government agency regulations must be complied with during use. Connection via isolating transformer.

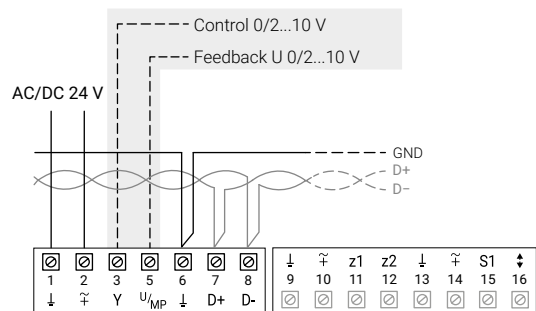
See VAV-Universal-VRU Product Information: www.belimo.com

Explanations/notes

- Priority control Page 71
- Connection z1/z2 Page 61
- Sensor integration bus mode Page 61
- VRP-M replacement in existing MP-Bus system: See separate instructions VAV-Universal-VRU in VRP-M compatibility mode (MP)

Modbus RTU, BACnet MS/TP

Hybrid mode



Parameter and tool overview volumetric flow measurement

Parameter/Function	Unit/Value	Function/Description/(Area)	Applica- tion	Tool			Authori- sation
			VAV/CAV	Assistant app	PC-Tool	ZTHEU	Expert/OEM
VAV unit - manufacturer parameters (OEM values - not variable)							
Application	Measure volumetric flow	Application setting	■	r	r	r	0
Designation	Text	Model designation measuring device (16 Z.)	■	r	r	-	0
V'_{nom}	m ³ /h/l/s/cfm	Volumetric flow nominal value	■	r	r	r	0
NFC interface	ON/OFF	NFC communication for app access	■	r	r	-	0
Configuration – Project specific settings							
Position	Text	System designation (64 Z./ZTH 16 Z.)	■	r/w	r/w	r	
Altitude compensation	ON/OFF	Switch function on/off	■	r/w	r/w	-	E
Altitude of installation	0 m	Compensated Δp and volumetric flow values to set system height (m a.s.l.)	■	r/w	r/w	-	E
Feedback type	Volumetric flow	Volume	■	r/w	r/w	-	E
Feedback U	2...10 V/0...10 V/adjustable	Setting U signal	■	r/w	r/w	-	E

Availability: VAV-Universal components incl. replacement devices are only available from manufacturers of VAV units (OEM).

Permissions: [O - OEM, manufacturer mode] - VRU controllers are calibrated and parameterised by the unit manufacturer according to the specific application and the project. These settings can only be changed by the manufacturer.
[E-Expert Mode] - Functionally relevant settings are only accessible via the Expert Mode of the Belimo Assistant App.

Legend

r Tool: read
w Tool: Write
- Tool: Does not support parameter
E Only visible in Expert Mode

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Position control (open loop)

VRU-D3-BAC/VRU-M1-BAC

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Position control (open loop)

Brief description

VAV-Universal-VRU-... sensor/actuator in position control mode (Open Loop, i.e. VAV control function inactive)

- Volumetric flow display 0...100% V'_{nom}
- Damper actuator, control 0...100% range of rotation



Principle diagram

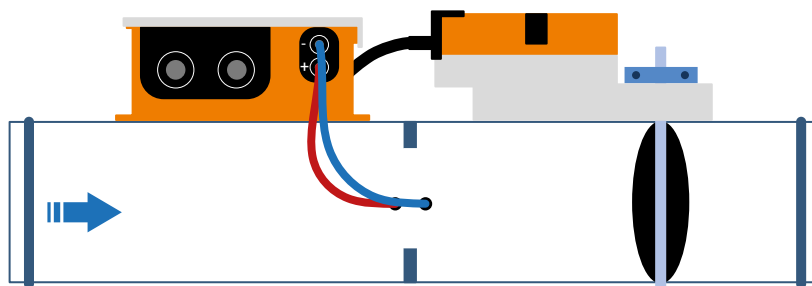


Illustration example

In this application, the VAV-Universal VRU-... functions solely as a sensor and actuator element. Position control mode: volumetric flow/pressure control inactive.

- VRU-D3-BAC for comfort zone
- VRU-M1-BAC for the comfort zone and polluted extract air

Position control function

- Volumetric flow display 0...100% V'_{nom}
- Damper actuator, control 0...100% range of rotation
- Local override (z1/z2) Motor stop, damper OPEN, damper CLOSED
- Control analogue 0...10 V/2...10 V,
Modbus ¹⁾, BACnet ¹⁾, MP-Bus

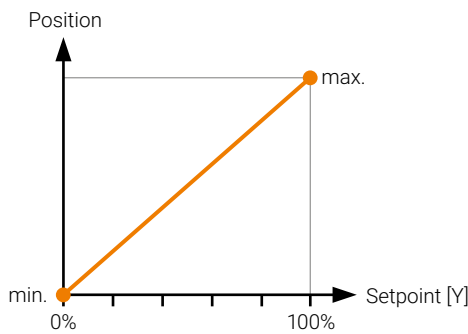
¹⁾ Hybrid mode possible

Note

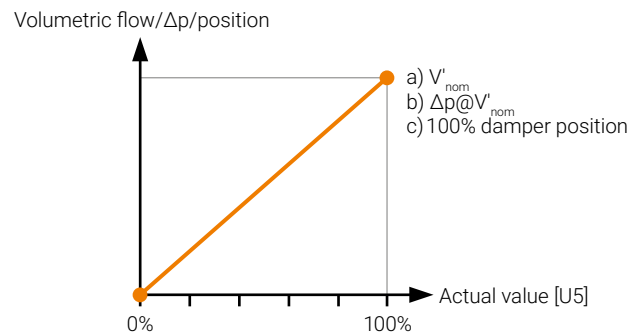
When designing the bus application, the cycle times for reading the actual values and writing the damper position must be taken into account.

Function diagram

Position control: analogue/bus (setpoint)



Feedback U5/bus (actual value)



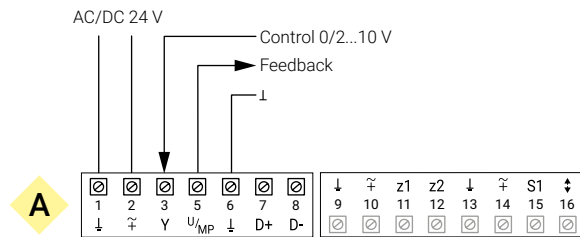
Device selection

Product type from Belimo	Function	Sensor/Actuator characteristic	Field of application	SUP unit	ETA unit
VRU-D3-BAC	Position control (open loop)	Δp sensor, integrated D3 flow sensor 0...500 Pa	Comfort	■	■
VRU-M1-BAC	Position control (open loop)	Δp sensor, integrated M1 diaphragm sensor 0...600 Pa	Comfort Contaminated air	■	■
L/N/SM24A-VST	Rotary actuator, default	5/10/20 Nm, 120 s	All ranges		
LF/NF/SF24A-VST	Rotary actuator, mechanical fail-safe	4/10/20 Nm, 120 s, spring 20 s	All ranges		
LMQ24A-VST	Rotary actuator, very fast running	4 Nm, 2.4 s	All ranges		
NMQ24A-VST	Rotary actuator, very fast running	8 Nm, 4 s	All ranges		
NKQ24A-VST	Rotary actuator, very fast running, Electrical fail-safe	6 Nm, 4 s	All ranges		
SMQ24A-VST	Rotary actuator, very fast running	16 Nm, 7 s	All ranges		

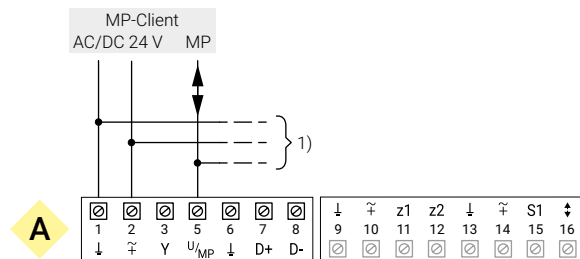
Diagram

Analogue control [Mode 0...10 V/2...10 V]

– Modulating control: 0...100% range of rotation



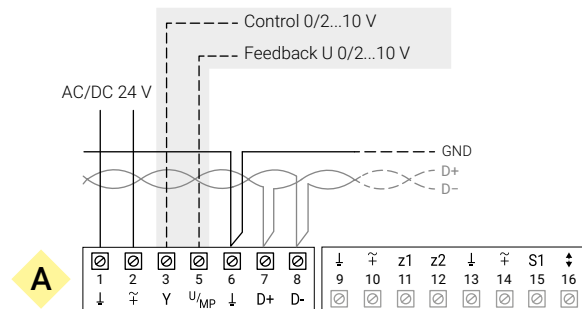
MP-Bus



¹⁾Other MP devices (total 8)

Modbus RTU, BACnet MS/TP

Hybrid mode



Safety requirements

Only authorised specialists may carry out installation. All applicable legal and government agency regulations must be complied with during use. Connection via isolating transformer.

See VAV-Universal-VRU Product Information: www.belimo.com

Explanations/notes

- Priority control Page 71
- Connection z1/z2 Page 61
- Sensor integration bus mode Page 61
- VRP-M replacement in existing MP-Bus system: See separate instructions VAV-Universal-VRU in VRP-M compatibility mode (MP)

Parameter and tool overview volumetric flow control position control

Parameter/Function	Unit/Value	Function/Description/(Area)	Applica- tion	Tool			Authori- sation
			VAV/CAV	Assistant app	PC-Tool	ZTHEU	Expert/OEM
VAV unit - manufacturer parameters (OEM values - not variable)							
Application	Volumetric flow	Application setting	■	r	r	r	O
Designation	Text	Model designation unit/Damper (16 Z.)	■	r	r	-	O
V'_{nom}	m ³ /h/l/s/cfm	Volumetric flow nominal value	■	r	r	r	O
$\Delta p @ V'_{nom}$	Pa	Calibration value VAV unit [38...500 Pa]	■	r	r	-	O
SN actuator	xxxxx-xxxxx-xxx-xxx	Actuator serial number	■	r	-	-	
Direction of rotation	ccw/cw	Actuator direction of rotation setting	■	r/w	r/w	-	E
Range of rotation	Adapted/programmed	Actuator adapted/programmed 30...95°	■	r/w	r/w	-	E
Power on behaviour	No action/Synch. / Adaption	Actuator power-on behaviour	■	r/w	r/w	-	E
NFC interface	ON/OFF	NFC communication for app access	■	r	r	-	O
Configuration – Project specific settings							
Position	Text	System designation (64 Z./ZTH 16 Z.)	■	r/w	r/w	r	
max.	%	Damper position 0...100%	■	r/w	r/w	r/w	
min.	%	Damper position 0...100%	■	r/w	r/w	r/w	
Altitude compensation	ON/OFF	Switch function on/off	■	r/w	r/w	-	E
Altitude of installation	0 m	Compensated Δp and volumetric flow values to set system height (m a.s.l.)	■	r/w	r/w	-	E
Control function	Position control	VAV control inactive (Open Loop)	■	r/w	r/w	-	E
Setpoint	Analogue/bus	Analogue and hybrid mode/bus	■	r/w	r/w	-	E
Reference signal Y	2...10 V/0...10 V/adjustable	Setting for damper control	■	r/w	r/w	-	E
Feedback type	Volumetric flow/ Δp /Position	Volume/ Δp /damper position	■	r/w	r/w	-	E
Feedback U	2...10 V/0...10 V/adjustable	Setting U signal	■	r/w	r/w	-	E

Availability: VAV-Universal components incl. replacement devices are only available from manufacturers of VAV units (OEM).

Permissions: [O - OEM, manufacturer mode] - VRU controllers are calibrated and parameterised by the unit manufacturer according to the specific application and the project. These settings can only be changed by the manufacturer.
[E-Expert Mode] - Functionally relevant settings are only accessible via the Expert Mode of the Belimo Assistant App.

Legend

r Tool: read
w Tool: Write
- Tool: Does not support parameter
E Only visible in Expert Mode

4

Duct pressure control STP

VRU-D3-BAC/VRU-M1-BAC

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Principle diagram	
Function diagram	31
Device selection	
Diagram	32
Parameter and tool overview	33



Duct pressure control STP

Brief description

Duct/duct pressure control

- Variable operation (STP) P'_{min}/P'_{max}
- Constant pressure control (STP) P'_{min}/P'_{max}
Damper CLOSED/damper OPEN



Principle diagram

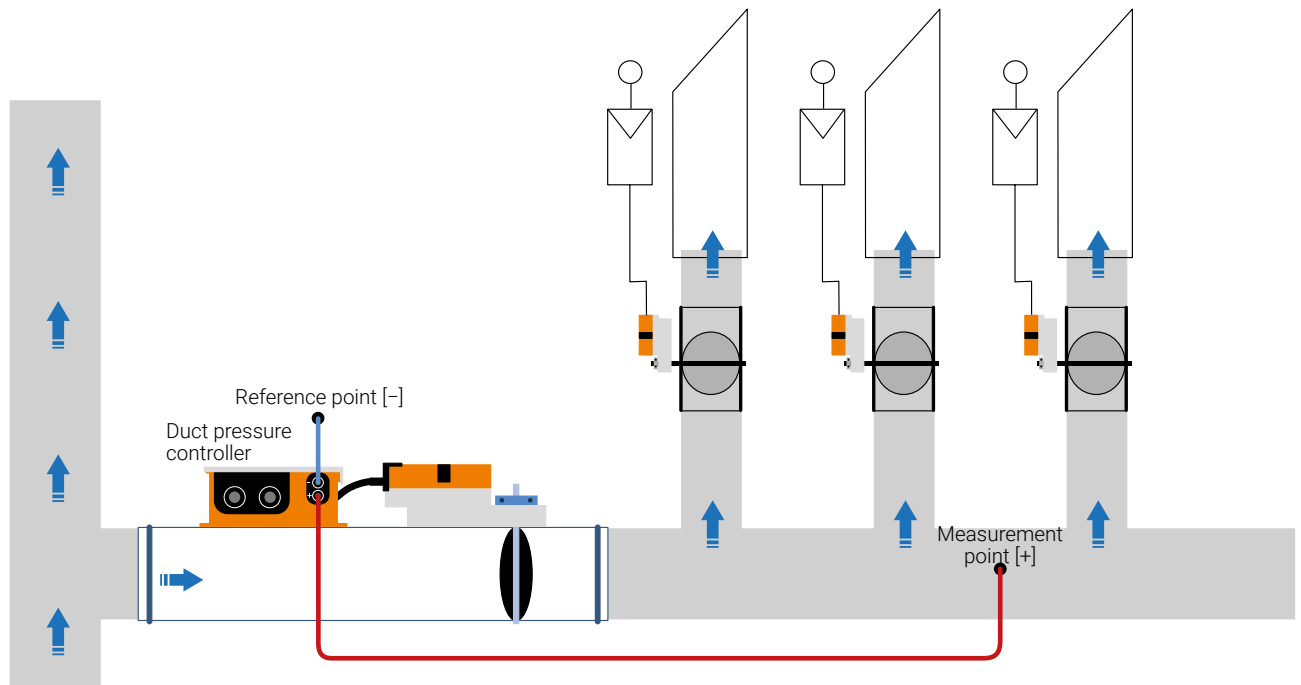


Illustration example

Duct and duct pressure control in ventilation systems

- Storey line
- Pre-pressure control e.g. for active cooling ceiling systems

The VAV-Universal VRU-... control unit controls the duct pressure required for the application. Pressure fluctuations in the air duct system are detected and automatically corrected.

The following variants are available in combination with the actuator solution optimally suited to the application:

- VRU-D3-BAC operating range 20...500 Pa
- VRU-M1-BAC operating range 20...600 Pa

The demand signal (damper position) is available for DCV applications via the selected bus system (Fan Optimiser function).

For controller settings, see Commissioning room/duct pressure applications on Page 73

Control functions

- P'_{min} Pressure level 1
- P'_{max} Pressure level 2
- $P'_{min} \dots P'_{max}$ Variable operation (STP)

- Local override (z1/z2) Motor stop, damper OPEN, V'_{max} damper CLOSED
- Control Analogue 0...10 V/2...10 V, Modbus ¹⁾, BACnet ¹⁾, MP-Bus

¹⁾ Hybrid mode possible

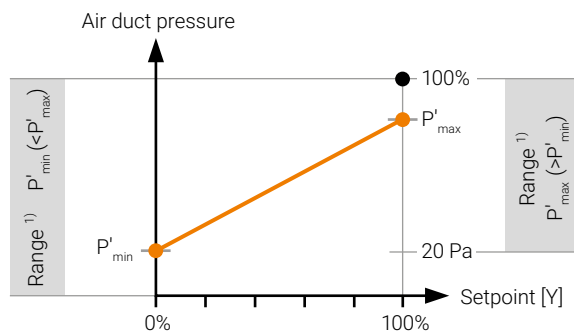
Max. length of pressure line for D3 sensor (VRU-D3-BAC)

The pressure drop in the pressure line generates a measuring error of maximum 2.5%. Use of the VRU-M1-BAC is recommended for applications with pressure lines cables >20 m.

4

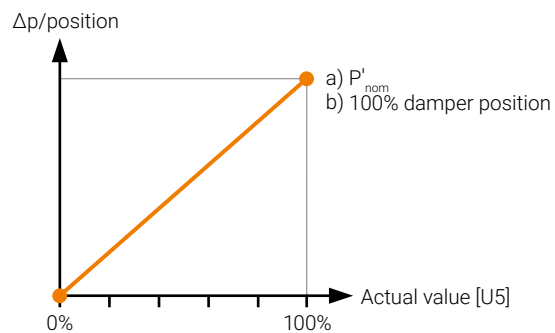
Function diagram

Δp control: Y/bus (setpoint)



¹⁾ Note: from firmware V 1.04-0001: 20 Pa
older firmware versions: 38 Pa

Feedback U5/bus (actual value)



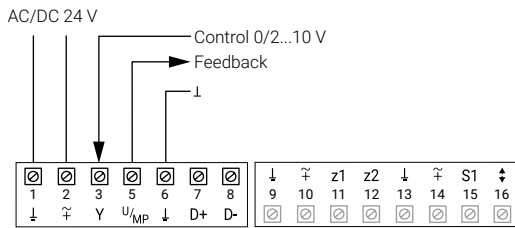
Device selection

Product type from Belimo	Function	Sensor/Actuator characteristic	Field of application
VRU-D3-BAC	Duct pressure controller - lower control limit 20 Pa	Δp sensor, integrated D3 flow sensor 0...500 Pa	Comfort
VRU-M1-BAC	Duct pressure controller - lower control limit 20 Pa	Δp sensor, integrated M1 diaphragm sensor 0...600 Pa	Comfort Contaminated air
L/N/SM24A-VST	Rotary actuator, default	5/10/20 Nm, 120 s	All ranges
LF/NF/SF24A-VST	Rotary actuator, mechanical fail-safe	4/10/20 Nm, 120 s, spring 20 s	All ranges

Diagram

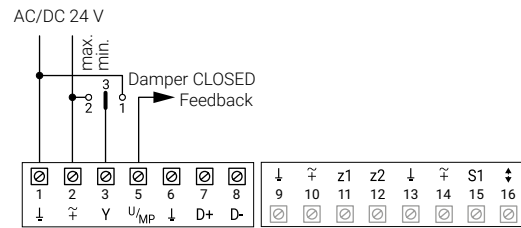
Analogue control [Mode 0...10 V/2...10 V]

– Modulating operation: $P'_{min} \dots P'_{max}$

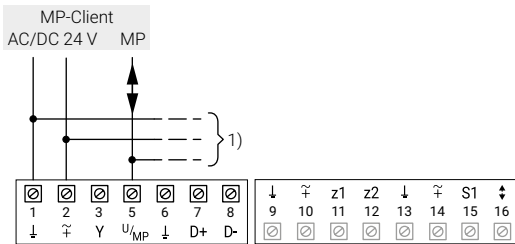


Analogue control [Mode 2...10 V]

– Step mode: damper CLOSED/ P'_{min}/P'_{max}



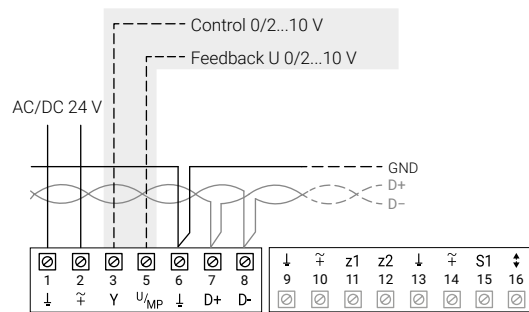
MP-Bus



¹⁾ Other MP devices (total 8)

Modbus RTU, BACnet MS/TP

Hybrid mode



Safety requirements

Only authorised specialists may carry out installation. All applicable legal and government agency regulations must be complied with during use. Connection via isolating transformer.

See VAV-Universal-VRU Product Information: www.belimo.com

Explanations/notes

- Priority control Page 71
- Connection z1/z2 Page 61
- Sensor integration bus mode Page 61
- VRP-M replacement in existing MP-Bus system: See separate instructions VAV-Universal-VRU in VRP-M compatibility mode (MP)

Parameter and tool overview duct pressure control STP

Parameter/Function	Unit/Value	Function/Description/(Area)	Applica- tion	Tool			Authori- sation
			STP	Assistant app	PC-Tool	ZTHEU	Expert/OEM
Duct pressure control damper - manufacturer parameters (OEM values - not variable)							
Application	Air duct pressure	Application setting	■	r	r	r	O
Designation	Text	Model designation damper (16 Z.)	■	r	r	-	O
P' _{nom}	Pa	Nominal value P' _{nom} VRU-D3 38...500 Pa VRU-M1 38...600 Pa	■	r	r	r	O
SN actuator	xxxxx-xxxxx-xxx-xxx	Actuator serial number	■	r	-	-	
Direction of rotation	ccw/cw	Actuator direction of rotation setting	■	r/w	r/w	-	E
Range of rotation	Adapted/programmed	Actuator adapted/programmed 30...95°	■	r/w	r/w	-	E
Power on behaviour	No action/Synch./ adaptation	Actuator power-on behaviour	■	r/w	r/w	-	E
NFC interface	ON/OFF	NFC communication for app access	■	r	r	-	O
Configuration – Project specific settings							
Position	Text	System designation (64 Z./ZTH 16 Z.)	■	r/w	r/w	r	
P' _{max}	Pa (ZTH %)	20 Pa...100% P' _{nom} ²⁾ Δp step P' _{max}	■	r/w	r/w	r/w	
P' _{min}	Pa (ZTH %)	20 Pa...100% P' _{nom} ²⁾ Δp step P' _{min}	■	r/w	r/w	r/w	
Altitude compensation ¹⁾	ON/OFF	Switch function on/off	■	r/w	r/w	-	E
Altitude of installation ¹⁾	0 m	Compensated Δp value to set the altitude of installation (m a.s.l.)	■	r/w	r/w	-	E
Setpoint	Analogue/bus	Analogue and hybrid mode/bus	■	r/w	r/w	-	E
Reference signal Y	2...10 V/0...10 V/adjustable	Setting for modulating control	■	r/w	r/w	-	E
Feedback type	Δp/position	Δp/damper position	■	r/w	r/w	-	E
Feedback U	2...10 V/0...10 V/adjustable	Setting U signal	■	r/w	r/w	-	E

¹⁾ Only for VRU-D3-BAC

²⁾ Lower control limit: from firmware V 1.04-0001: 20 Pa
older firmware versions: 38 Pa

Availability: VAV-Universal components incl. replacement devices are only available from manufacturers of VAV units (OEM).

Permissions: [O - OEM, manufacturer mode] - VRU controllers are calibrated and parameterised by the unit manufacturer according to the specific application and the project. These settings can only be changed by the manufacturer.
[E-Expert Mode] - Functionally relevant settings are only accessible via the Expert Mode of the Belimo Assistant App.

Legend

r Tool: read
w Tool: Write
- Tool: Does not support parameter
E Only visible in Expert Mode

5

Room-pressure control RP

VRU-M1R-BAC

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Room-pressure control RP

Brief description

Room-pressure control RP, suitable for rooms with non-critical leakage rates/overflows

- Modulating $P'_{min} \dots P'_{max}$ /Motor stop
- Step mode P'_{min} / P'_{max} /damper CLOSED/damper OPEN/Motor stop



Principle diagram

Setpoint volumetric flow, e.g. room-temperature or air-quality controller

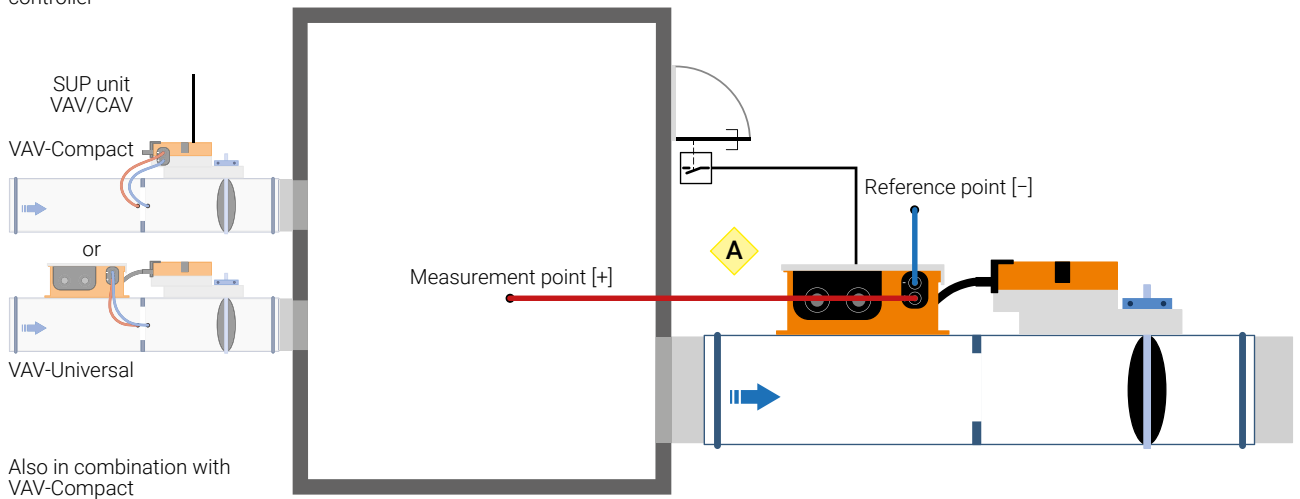


Illustration example

Ventilation systems - with non-critical leakage rates - for defined room overpressure or negative pressure conditions:

- Leakage rate of $>5-10\%$ from V'_{SUP}
- Room tightness class according to VDI 2083-19; Class 0 and 1
- Room and zone applications, e.g. with odour nuisance in restaurants, smoking rooms
- Room applications with contaminated air, e.g. extract air in commercial kitchens

The room-pressure controller - VRU-M1R-BAC Application [RP] - compares the pressure in the room relative to the reference value and controls the control damper to the adjusted room-pressure setpoint. With actuator solution optimally suited to the application.

The opposite VAV unit is responsible for the air exchange rate required for the room, e.g. external room-temperature or air-quality controller.

For controller settings, see Commissioning room/duct pressure applications on Page 73

Requirements (applies to positive room pressure and negative room pressure applications)

- VRU-M1R-BAC Room pressure application [RP] with sensor range -75...75 Pa
- Measurement room Connect pressure line to the (+) of VRU-M1R-BAC
- Reference room Connect pressure line to the (-) of VRU-M1R-BAC

Room pressure – operation mode (overpressure/negative pressure)

If necessary, the room pressure can be switched from overpressure to negative pressure (pressure lines remain unchanged!).

For this purpose, the $P'_{nom}/P'_{max}/P'_{min}$ are mirrored in the negative range.

Example: P'_{min} 10 Pa becomes -10 Pa.

The changeover takes place at:

- Analogue control/MP-Bus Belimo Assistant App
- Modbus/BACnet Belimo Assistant App or "Operating Mode" command

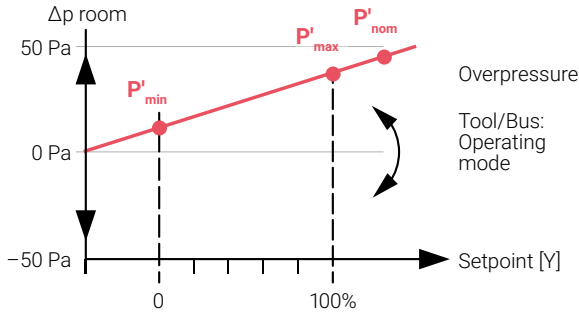
- Control functions
- P'_{min} Room-pressure setpoint 1
- P'_{max} Room-pressure setpoint 2 (Step mode or modulating control)
- Application area SUP or ETA-side assembly arrangement
- Room-pressure mode Overpressure (positive)/negative pressure (negative)

- Door monitoring - Motor stop
Actuator remains in current position when door is open (z2)
- "Operating Mode" overpressure/negative pressure
Switching via "Operating Mode" bus or Belimo Assistant App, PC-Tool
- Local override (z1/z2)
Motor stop, damper OPEN, V'_{max} damper CLOSED
- Control: Analogue 0...10 V/2...10 V, Modbus ¹⁾, BACnet ¹⁾, MP-Bus

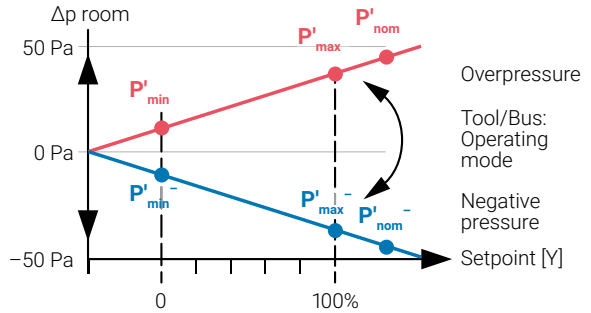
¹⁾ Hybrid mode possible

Function diagram

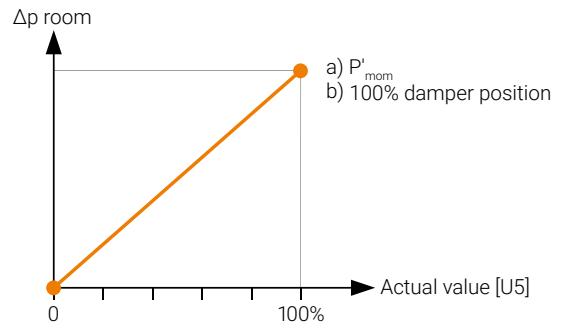
Room overpressure



Changeover operation: overpressure/negative pressure



Feedback U5/bus (actual value)



For operation in the negative-pressure range, $P'_{nom}/P'_{max}/P'_{min}$ are mirrored in the negative range.

Example:

+ Overpressure setting : P'_{min} 5 Pa/ P'_{max} 10 Pa, becomes

- Negative pressure setting: P'_{min} -5 Pa/ P'_{max} -10 Pa

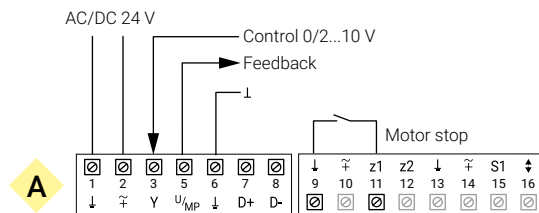
Device selection

Product type from Belimo	Function	Sensor/Actuator characteristic	Field of application	SUP	ETA
VRU-M1R-BAC	Room-pressure controller	Δp sensor, integrated M1 diaphragm sensor -75...75 Pa	Comfort Contaminated air	■	■
L/N/SM24A-VST	Rotary actuator, default	5/10/20 Nm, 120 s	All ranges		
LF/NF/SF24A-VST	Rotary actuator, mechanical fail-safe	4/10/20 Nm, 120 s, spring 20 s	All ranges		
LMQ24A-VST	Rotary actuator, very fast running	4 Nm, 2.4 s	All ranges		
NMQ24A-VST	Rotary actuator, very fast running	8 Nm, 4 s	All ranges		
NKQ24A-VST	Rotary actuator, very fast running, Electrical fail-safe	6 Nm, 4 s	All ranges		
SMQ24A-VST	Rotary actuator, very fast running	16 Nm, 7 s	All ranges		

Diagram

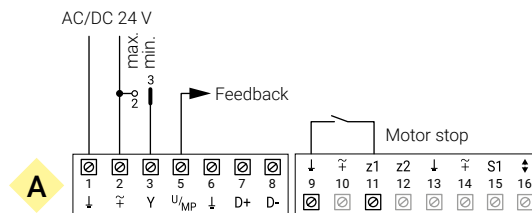
Analogue control [Mode 0...10 V/2...10 V]

– Modulating operation: $P'_{min} \dots P'_{max}$

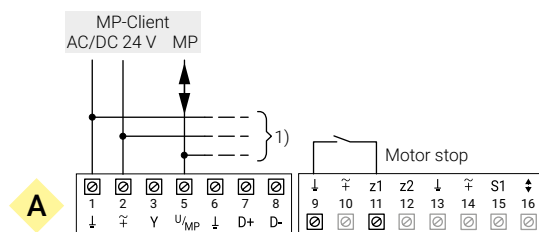


Analogue control [Mode 0...10 V/2...10 V]

– Step mode: P'_{min}/P'_{max}



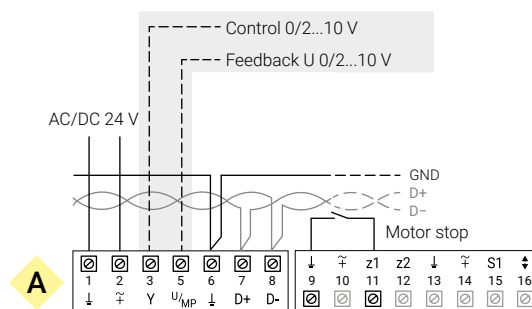
MP-Bus



¹⁾ Other MP devices (total 8)

Modbus RTU, BACnet MS/TP

Hybrid mode



Safety requirements

Only authorised specialists may carry out installation. All applicable legal and government agency regulations must be complied with during use. Connection via isolating transformer.

See VAV-Universal-VRU Product Information: www.belimo.com

Explanations/notes

Reference measurement [-] -connection	A pressure-stable environment is a prerequisite for Reference measuring point [-] connection, as this directly influences the room-pressure control. Any pressure fluctuation of the reference is transmitted to the room to be controlled. A pressure-controlled anteroom as a reference makes reliable room-pressure control impossible. An environment isolated from the ventilation system - no pressure- or volume-controlled rooms - provides this prerequisite.
Pressure line	To minimise the influence of the pressure lines, the line lengths should be kept as short as possible.
Door switch	The VRU-M1R can be equipped with a "Motor Stop" command to prevent the damper actuator from moving to the end position when the door is opened. Switch design: Note performance data of input z2!
- Priority control	Page 71
- Connection z1/z2	Page 61
- Sensor integration bus mode	Page 61
- VRP-M replacement in existing	
MP-Bus system:	See separate instructions VAV-Universal-VRU in VRP-M compatibility mode (MP)

Parameter and tool overview Room-pressure control RP

Parameter/Function	Unit/Value	Function/Description/(Area)	Applica- tion	Tool			Authori- sation
			RP	Assistant app	PC-Tool	ZTHEU	Expert/OEM
Duct pressure control damper - manufacturer parameters (OEM values - not variable)							
Application	Room pressure	Application setting	■	r	r	r	O
Designation	Text	Model designation damper (16 Z.)	■	r	r	-	O
P' _{nom}	Pa	Nominal value Δp RP [5...75 Pa]	■	r	r	r	O
SN actuator	xxxxx-xxxxx-xxx-xxx	Actuator serial number	■	r	-	-	
Direction of rotation	ccw/cw	Actuator direction of rotation setting	■	r/w	r/w	-	E
Range of rotation	Adapted/programmed	Actuator adapted/programmed 30...95°	■	r/w	r/w	-	E
Power on behaviour	No action/Synch./Adaption	Actuator power-on behaviour	■	r/w	r/w	-	E
NFC interface	ON/OFF	NFC communication for app access	■	r	r	-	O
Configuration – Project specific settings							
Position	Text	System designation (64 Z./ZTH 16 Z.)	■	r/w	r/w	r	
P' _{max}	Pa (ZTH %)	Δp step max. 20...100% P' _{nom}	■	r/w	r/w	r/w	
P' _{min}	Pa (ZTH %)	Δp step min 0...100% P' _{nom}	■	r/w	r/w	r/w	
Room-pressure mode	Overpressure/negative pressure	Room operating mode aseptic (+)/septic (-)	■	r/w	r/w	-	E
Application area	Extract air/supply air	Mounting location of the control damper	■	r/w	r/w	-	E
Room-pressure cascade	OFF	In connection with the room-pressure cascade	■	r/w	r/w	-	E
Setpoint	Analogue/bus	Analogue and hybrid mode/Bus	■	r/w	r/w	-	E
Reference signal Y	2...10 V/0...10 V/adjustable	Setting for modulating control P' _{min} ...P' _{max}	■	r/w	r/w	-	E
Feedback type	Δp/position	Δp/damper position	■	r/w	r/w	-	E
Feedback U	2...10 V/0...10 V/adjustable	Setting U signal	■	r/w	r/w	-	E

Availability: VAV-Universal components incl. replacement devices are only available from manufacturers of VAV units (OEM).

Permissions: [O - OEM, manufacturer mode] - VRU controllers are calibrated and parameterised by the unit manufacturer according to the specific application and the project. These settings can only be changed by the manufacturer.
[E-Expert Mode] - Functionally relevant settings are only accessible via the Expert Mode of the Belimo Assistant App.

Legend

r Tool: read
w Tool: Write
- Tool: Does not support parameter
E Only visible in Expert Mode

6

Room-pressure – VAV unit with bypass control RP

VRU-D3-BAC/VRU-M1-BAC, VRU-M1R-BAC

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Principle diagram	
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Room-pressure – VAV unit with bypass control RP

Brief description

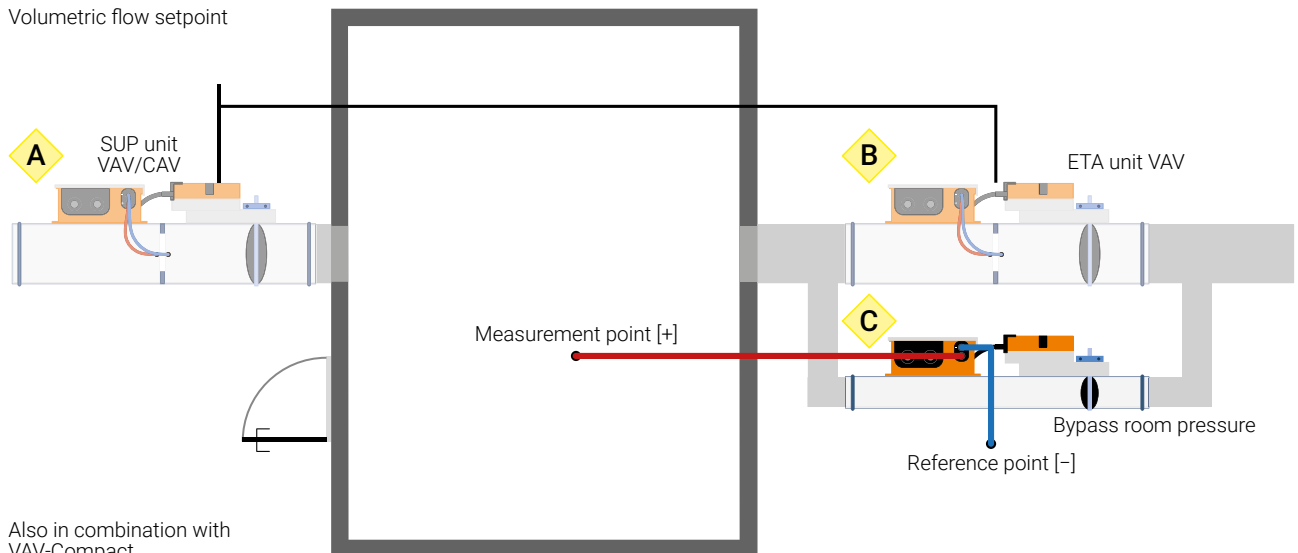
Room-pressure volumetric flow bypass damper control for rooms with low leakage rate/overflow:

<A> Volumetric flow VAV/CAV	$V'_{\min} \dots V'_{\max}$ VRU-D3-BAC/VRU-M1-BAC [VAV]
<C> Room-pressure bypass damper	$P'_{\min} \dots P'_{\max}$ VRU-M1R-BAC [RPC] -75...75 Pa



Principle diagram

Volumetric flow setpoint



Also in combination with VAV-Compact

Illustration example

Ventilation systems with defined overpressure or negative room pressure for rooms with low leakage rate/overflow.

- Leakage rate of <math><5\%</math> from V'_{SUP}
- Room tightness class according to VDI 2083-19; Class 2 and 3
- Application examples for "sensitive room pressure applications"

The two VAV units <A> and are responsible for the air exchange rate required for the room, e.g. external room-temperature or air-quality controller. The room-pressure controller VRU-M1R-BAC <C> compares the pressure in the room with the defined reference value and then controls the bypass damper to the specified room-pressure setpoint.

Requirements (applies to positive room pressure and negative room pressure applications):

- VRU-M1R-BAC Room pressure application [RP] with sensor range -75...75 Pa
Extract-air-side-mounted or supply-air-side-mounted (setting parameters)
- Measurement room Connect pressure line to the (+) of VRU-M1R-BAC
- Reference room Connect pressure line to (-) of the VRU-M1R-BAC

For controller settings, see Commissioning room/duct pressure applications on Page 73

Room pressure – operation mode (overpressure/negative pressure)

If necessary, the room pressure can be switched from overpressure to negative pressure (pressure lines remain unchanged!). For this purpose, the $P'_{nom}/P'_{max}/P'_{min}$ are mirrored in the negative range.

Example: P'_{min}

The changeover takes place at:

- Analogue control/ Belimo Assistant App
MP-Bus
- Modbus/BACnet Belimo Assistant App or "Operating Mode"
command

VAV control functions <A>

- $V'_{min}...V'_{max}$ Air exchange rate, CAV step mode or VAV
modulating control $V'_{min}...V'_{max}$

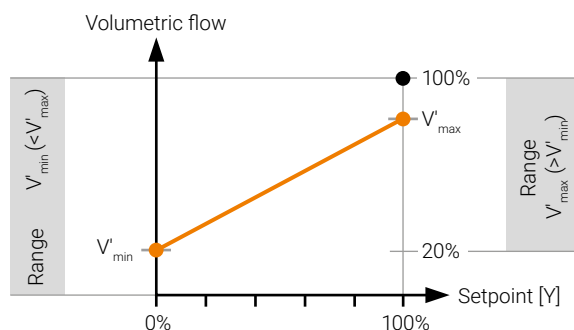
RP control functions <C>

- P'_{min} Room-pressure setpoint 1
- P'_{max} Room-pressure setpoint 2
(Step mode or modulating control)
- Application area: SUP or ETA-side assembly arrangement
- Room-pressure mode Overpressure (positive)/negative pressure (negative)
- "Operating Mode" overpressure/negative pressure
Switching via "Operating Mode" bus or Belimo Assistant App, PC-Tool
- Local override (z1/z2)
 P'_{max} , damper CLOSED, damper OPEN, motor stop
- Control: Analogue 0...10 V/2...10 V, Modbus ¹⁾, BACnet ¹⁾, MP-Bus

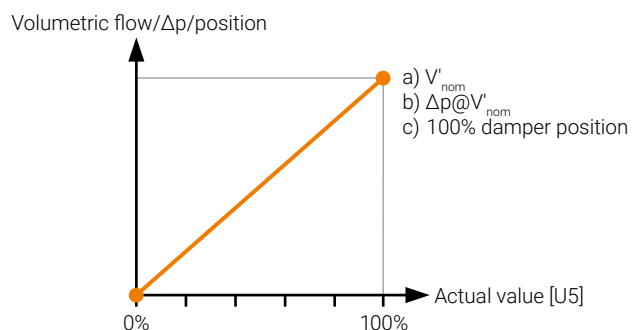
¹⁾ Hybrid mode possible

Function diagram

VAV mode: analogue/bus (setpoint)

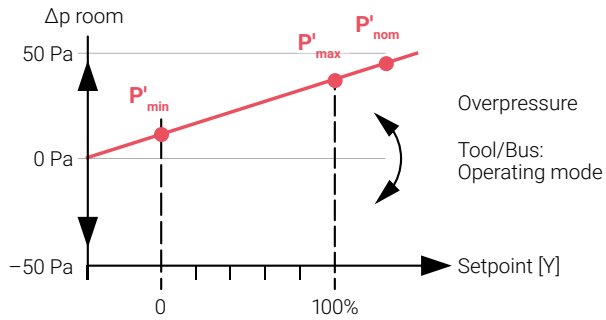


Feedback U5/bus (feedback)

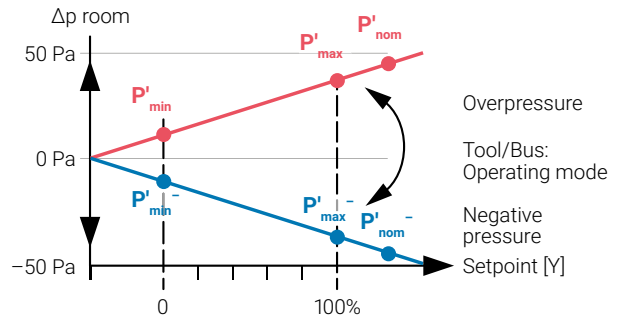


Function diagram

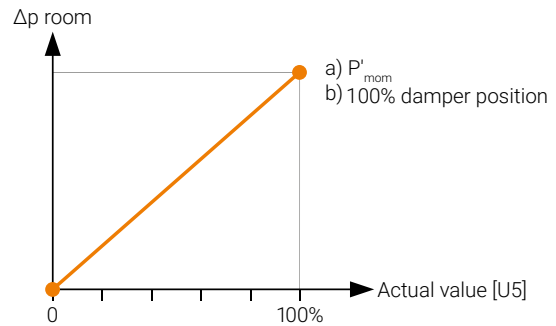
Overpressure



Changeover operation: overpressure/negative pressure



Feedback U5/bus (actual value)



For operation in the negative-pressure range, $P'_{nom}/P'_{max}/P'_{min}$ are mirrored in the negative range.

Example:

+ Overpressure setting:

P'_{min} 5 Pa/ P'_{max} 10 Pa, becomes

- Negative-pressure setting:

P'_{min} -5 Pa/ P'_{max} -10 Pa

Device selection <A> VAV units

Product type from Belimo	Function	Sensor/Actuator characteristic	Field of application	SUP unit	ETA unit
VRU-D3-BAC	Volumetric flow controller [VAV] <A> 	Δp sensor, D3 flow 0...500 Pa	Comfort	■	■
VRU-M1-BAC	Volumetric flow controller [VAV] <A> 	Δp sensor, M1 diaphragm 0...600 Pa	Comfort Contaminated air	■	■
L/N/SM24A-VST	Rotary actuator, default	5/10/20 Nm, 120 s	All ranges	■	■

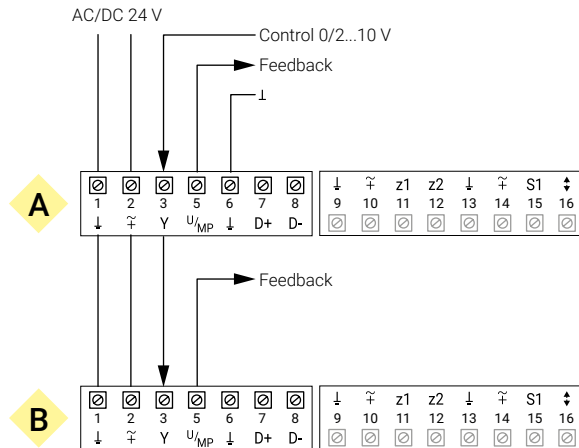
Device selection <C> bypass damper

Product type from Belimo	Function	Sensor/Actuator characteristic	Field of application	SUP unit	ETA unit
VRU-M1R-BAC	Room-pressure controller [RP] <C>	Δp sensor, M1 diaphragm -75...75 Pa	Comfort Contaminated air	■	■
L/N/SM24A-VST	Rotary actuator, default	5/10/20 Nm, 120 s	All ranges	■	■
LMQ24A-VST	Rotary actuator, very fast running	4 Nm, 2.4 s	All ranges		
NMQ24A-VST	Rotary actuator, very fast running	8 Nm, 4 s	All ranges		
NKQ24A-VST	Rotary actuator, very fast running electrical fail-safe	6 Nm, 4 s	All ranges		
SMQ24A-VST	Rotary actuator, very fast running	16 Nm, 7 s	All ranges		

Diagram

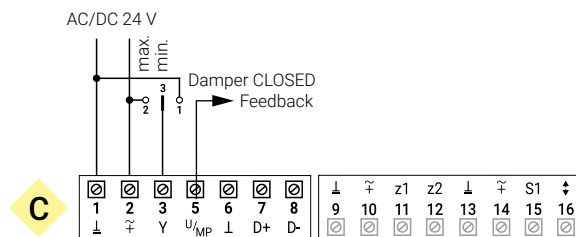
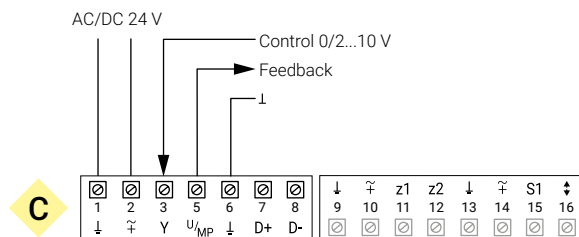
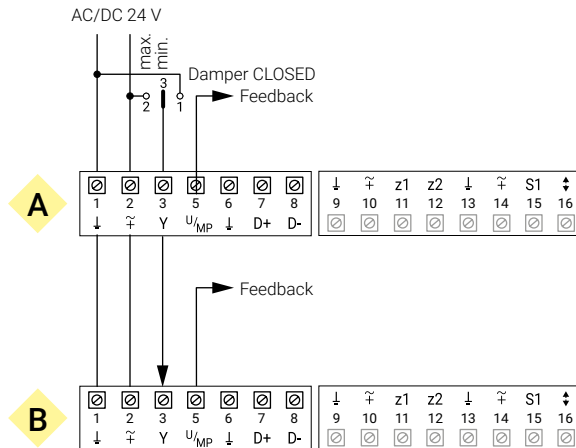
Analogue control [Mode 0...10 V/2...10 V]

– Modulating operation: $P'_{min} \dots P'_{max}$

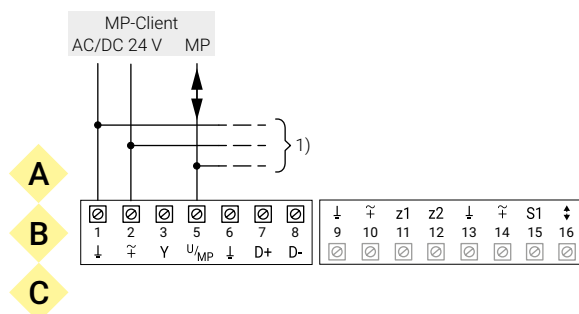


Analogue control [Mode 2...10 V]

– Step mode: damper CLOSED/ P'_{min}/P'_{max}

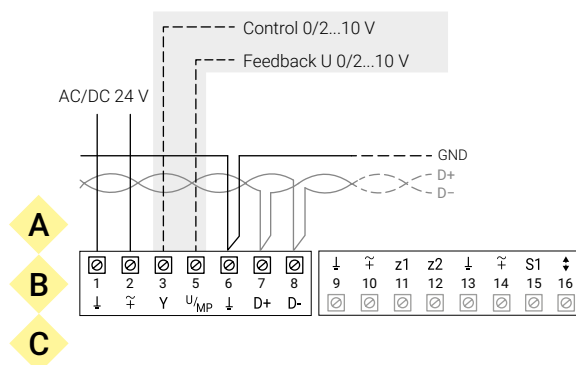


MP-Bus



Modbus RTU, BACnet MS/TP

Hybrid mode



¹⁾ Other MP devices (total 8)

Safety requirements

Only authorised specialists may carry out installation. All applicable legal and government agency regulations must be complied with during use. Connection via isolating transformer.

See VAV-Universal-VRU Product Information: www.belimo.com

Explanations/notes

- Priority control Page 71
- Connection z1/z2 Page 61
- Sensor integration bus mode Page 61
- VRP-M replacement in existing MP-Bus system:
See separate instructions
VAV-Universal-VRU in
VRP-M compatibility mode (MP)

Parameter and tool overview VAV unit <A>

Parameter/Function	Unit/Value	Function/Description/(Area)	Applica- tion	Tool			Authori- sation
			VAV/CAV	Assistant app	PC-Tool	ZTHEU	Expert/OEM
VAV unit - manufacturer parameters (OEM values - not variable)							
Application	Volumetric flow	Application setting	■	r	r	r	O
Designation	Text	Model designation unit/Damper (16 Z.)	■	r	r	-	O
V'_{nom}	m ³ /h/l/s/cfm	Volumetric flow nominal value	■	r	r	r	O
$\Delta p @ V'_{nom}$	Pa	Calibration value VAV unit [38...500 Pa]	■	r	r	-	O
SN actuator	xxxxx-xxxxx-xxx-xxx	Serial number of the connected actuator	■	r	-	-	
Direction of rotation	ccw/cw	Actuator direction of rotation setting	■	r/w	r/w	-	E
Range of rotation	Adapted/programmed	Actuator adapted/programmed 30...95°	■	r/w	r/w	-	E
Power on behaviour	No action/Synch./Adaption	Actuator power-on behaviour	■	r/w	r/w	-	E
NFC interface	ON/OFF	NFC communication for app access	■	r	r	-	O
Configuration – Project specific settings							
Position	Text	System designation (64 Z./ZTH 16 Z.)	■	r/w	r/w	r	
V'_{max}	m ³ /h/l/s/cfm (ZTH %)	Operating volumetric flow V'_{max} 20...100% V'_{nom}	■	r/w	r/w	r/w	
V'_{min}	m ³ /h/l/s/cfm (ZTH %)	Operating volumetric flow V'_{min} 0...100% V'_{nom}	■	r/w	r/w	r/w	
Altitude compensation	ON/OFF	Switch function on/off	■	r/w	r/w	-	E
Altitude of installation	0 m	Compensated Δp and volumetric flow values to set system height (m a.s.l.)	■	r/w	r/w	-	E
Function	VAV/CAV/Position control	Control function		r/w	r/w	-	E
Room-pressure cascade	OFF	VAV: Secondary circuit room-pressure cascade		r/w	r/w	-	E
Setpoint	Analogue/bus	Analogue and hybrid mode/bus	■	r/w	r/w	-	E
Setpoint offset	0%	VAV: $\pm 5\%$ compensation ETA unit (room balance)		r/w	r/w	-	E
Reference signal Y	2...10 V/0...10 V/adjustable	Setting for modulating control $V'_{min}...V'_{max}$	■	r/w	r/w	-	E
Feedback type	Volumetric flow/ Δp /Position	Volume/ Δp /damper position	■	r/w	r/w	-	E
Feedback U	2...10 V/0...10 V/adjustable	Setting U signal	■	r/w	r/w	-	E

Parameter and tool overview Room-pressure bypass damper <C>

Parameter/Function	Unit/Value	Function/Description/(Area)	Applica- tion	Tool			Authori- sation
			RP	Assistant app	PC-Tool	ZTHEU	Expert/OEM
Duct pressure control damper - manufacturer parameters (OEM values - not variable)							
Application	Room pressure	Application setting	■	r	r	r	O
Designation	Text	Model designation damper (16 Z.)	■	r	r	-	O
$\Delta p'_{nom}$	Pa	Nominal value Δp RP [5...75 Pa]	■	r	r	r	O
SN actuator	xxxxx-xxxxx-xxx-xxx	Serial number of the connected actuator	■	r	-	-	
Direction of rotation	ccw/cw	Actuator direction of rotation setting	■	r/w	r/w	-	E
Range of rotation	Adapted/programmed	Actuator adapted/programmed 30...95°	■	r/w	r/w	-	E
Power on behaviour	No action/Synch./adaptation	Actuator power-on behaviour	■	r/w	r/w	-	E
NFC interface	ON/OFF	NFC communication for app access	■	r	r	-	O
Configuration – Project specific settings							
Position	Text	System designation (64 Z./ZTH 16 Z.)	■	r/w	r/w	r	
P'_{max}	Pa (ZTH %)	Δp step max. 20...100% P'_{nom}	■	r/w	r/w	r/w	
P'_{min}	Pa (ZTH %)	Δp step min 0...100% P'_{nom}	■	r/w	r/w	r/w	
Room-pressure mode	Overpressure/negative pressure	Room operating mode overpressure [+] / negative pressure [-]	■	r/w	r/w	-	E
Application area	Extract air/supply air	Mounting location of the bypass damper	■	r/w	r/w	-	E
Room-pressure cascade	OFF	In connection with the room-pressure cascade		r/w	r/w	-	E
Setpoint	Analogue/bus	Analogue and hybrid mode/bus	■	r/w	r/w	-	E
Reference signal Y	2...10 V/0...10 V/adjustable	Setting for modulating control $P'_{min} \dots P'_{max}$	■	r/w	r/w	-	E
Feedback type	Δp /position	Δp /damper position	■	r/w	r/w	-	E
Feedback U	2...10 V/0...10 V/adjustable	Setting U signal	■	r/w	r/w	-	E

Availability: VAV-Universal components incl. replacement devices are only available from manufacturers of VAV units (OEM).

Permissions: [O - OEM, manufacturer mode] - VRU controllers are calibrated and parameterised by the unit manufacturer according to the specific application and the project. These settings can only be changed by the manufacturer.
[E-Expert Mode] - Functionally relevant settings are only accessible via the Expert Mode of the Belimo Assistant App.

Legend

r Tool: read
w Tool: Write
- Tool: Does not support parameter
E Only visible in Expert Mode

Explanations/notes

Reference
measurement [-]
-connection

A pressure-stable environment is a prerequisite for Reference measuring point [-] connection, as this directly influences the room-pressure control. Any pressure fluctuation of the reference is transmitted to the room to be controlled. A pressure-controlled anteroom as a reference makes reliable room-pressure control impossible.
An environment isolated from the ventilation system - no pressure- or volume-controlled rooms - provides this prerequisite.

Pressure line

To minimise the influence of the pressure lines, the line lengths should be kept as short as possible.

7

Volumetric flow and room-pressure cascade control [RPC]

VRU-D3-BAC/VRU-M1-BAC, VRU-M1R-BAC

Brief description	52
Principle diagram	
Function diagram	53
Device selection	55
Diagram	56
Parameter and tool overview	58-60



Volumetric flow and room-pressure cascade control [RPC]

Brief description

Room-pressure volumetric flow cascade control consisting of
 <A> Room-pressure cascade controller: VRU-M1R-BAC [RPC] -75...75 Pa
 Volumetric-flow cascade controller: VRU-D3-BAC/VRU-M1-BAC [VAV]
 <C> Volumetric-flow controller: VRU-D3-BAC/VRU-M1-BAC [VAV]



Principle diagram

Volumetric flow setpoint

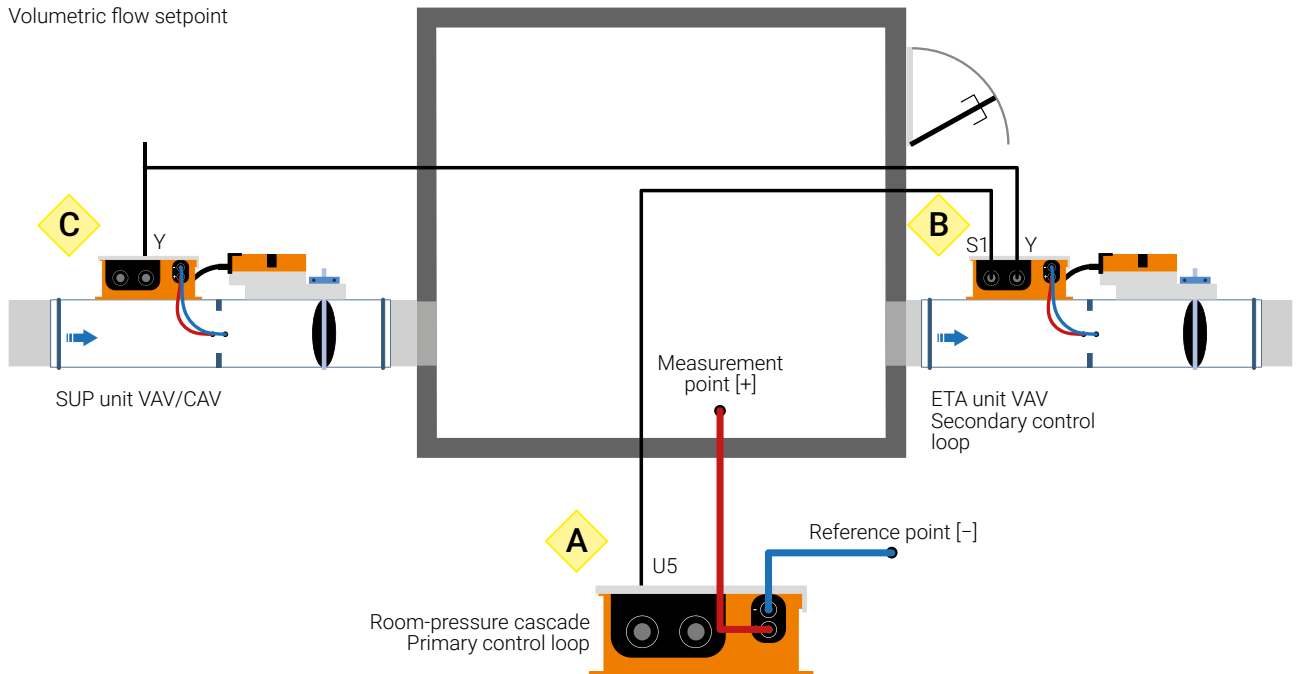


Illustration example

Ventilation systems in sensitive fields of application, with defined positive or negative room pressure. Tight rooms place higher demands on the control system. For this purpose, the VAV unit is operated with an additional room-pressure controller <A> as a so-called room-pressure volumetric-flow cascade.

– Room tightness class according to VDI 2083-19; Class 1

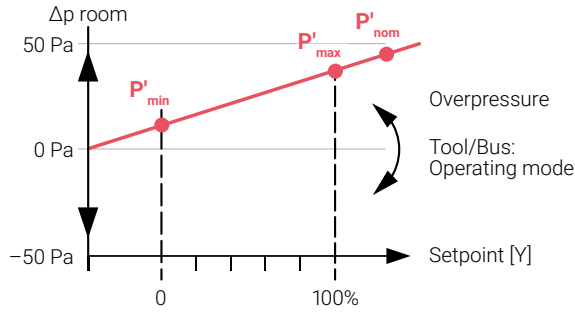
The currently required air exchange rate (room temperature, air quality, etc.) is switched to the two VAV controllers and <C>. In addition, the output signal of the room-pressure controller <A> [primary control loop] is switched to the VAV controller [secondary control loop]. The volumetric flow of the VAV controller is corrected by $\pm 20\%$ to maintain the desired room pressure. Due to the limited influence of the room pressure on the extract air volumetric flow controller, the influence is limited when the door is actuated. The damper is not moved to the end position and minimises the influence by closing the door.

Controller setting See Commissioning room/duct pressure applications on Page 73

Function diagram

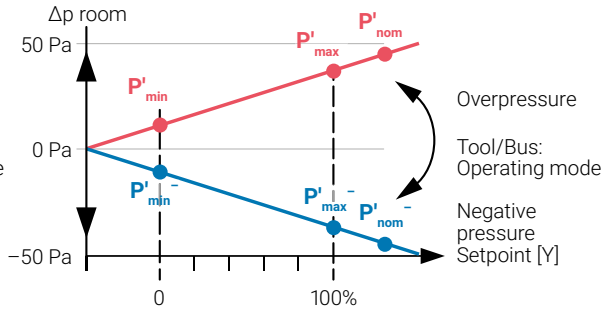
<A> Primary control-loop room pressure

– Overpressure

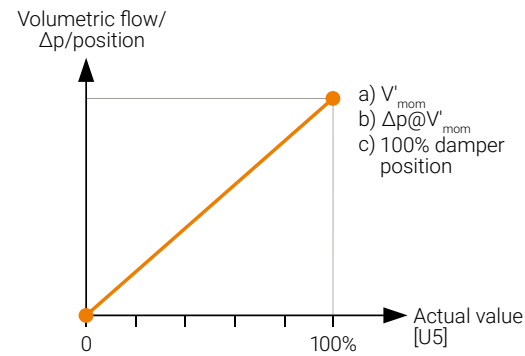


Option

– Changeover operation: overpressure/negative pressure

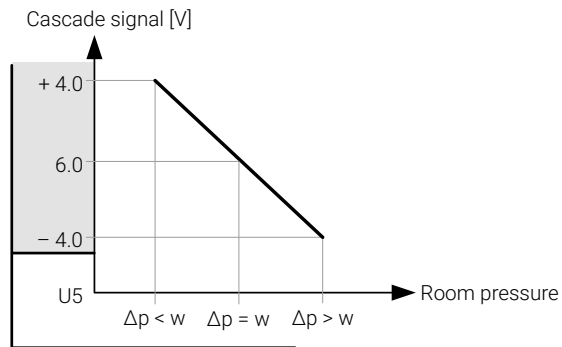


Feedback [U5]/bus (actual value)

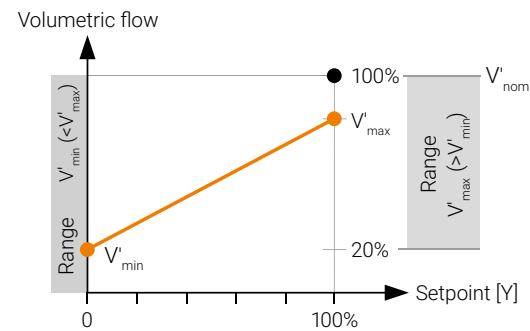


Feedback [U5] (also in bus mode)

Cascade signal [6...±4 V]

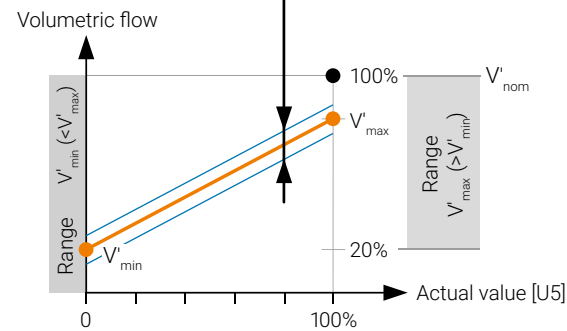


<C> VAV mode: Y/bus (setpoint)



 Secondary control loop ETA unit VAV

Control: Y/bus
(setpoint, input S1)



Requirements (positive room pressure and negative room pressure applications)

- Room-pressure controller <A> Room-pressure cascade controller, VRU-M1R-BAC ¹⁾, sensor range -75...75 Pa
Application [room pressure]
Application area: [extract air/supply air]
Room-pressure cascade parameter: [ON]
- Pressure line <A> Measurement room:
Connect pressure line to (+)
Reference point:
Connect pressure line to (-)
- VAV unit VAV unit - volumetric flow cascade, VRU-D3/M1-BAC
Application: [VAV]
Room-pressure cascade parameter: [ON]
- VAV unit <C> VAV unit - application: [VAV], VRU-D3/M1-BAC
Application: [VAV]
Room-pressure cascade parameter: [OFF]

¹⁾ Restrictions

- MP-Bus ¹⁾ The cascade pressure controller [A] cannot be integrated into an MP-Bus system.
- Hybrid mode ¹⁾ In hybrid mode, the U5 signal is not available for the cascade pressure controller <A>.
- Sensor input S1 Sensor input S1 is not available for the cascade volumetric flow controller [B].

Room pressure – operation mode (overpressure/negative pressure)

If necessary, the room pressure can be switched from overpressure to negative pressure (pressure lines remain unchanged!):

- Analogue control/MP-Bus Belimo Assistant App
- Modbus/BACnet Belimo Assistant App or "Operating Mode" command

Control function room-pressure cascade controller <A>

- P'_{min} Room-pressure setpoint 1
- P'_{max} Room-pressure setpoint 2
- Application area Extract air/supply air
- Room-pressure mode Overpressure (positive)/negative pressure (negative)

VAV control functions , <C>

- $V'_{min...V'_{max}}$ Air exchange rate, CAV step mode or VAV modulating control $V'_{min...V'_{max}}$

Local override (z1/z2)

- Room-pressure controller <A> P'_{max}
- VAV controllers , <C> V'_{max} /damper CLOSED/damper OPEN/motor stop

- Control – Analogue 0...10 V/2...10 V, Modbus ²⁾, BACnet ²⁾, MP-Bus ³⁾

²⁾ Hybrid mode possible

³⁾ The cascade pressure controller <A> cannot be integrated into an MP-Bus system.

Device selection <A> room-pressure cascade controller

Product type from Belimo	Function	Sensor/Actuator characteristic	Field of application	SUP unit	ETA unit
VRU-M1R-BAC	Room-pressure cascade controller <A>	Δp sensor M1 diaphragm -75...75 Pa	Comfort Contaminated air	■	■
ZG-VRU01	Blind plug for VST connector plug, for applications without actuator				

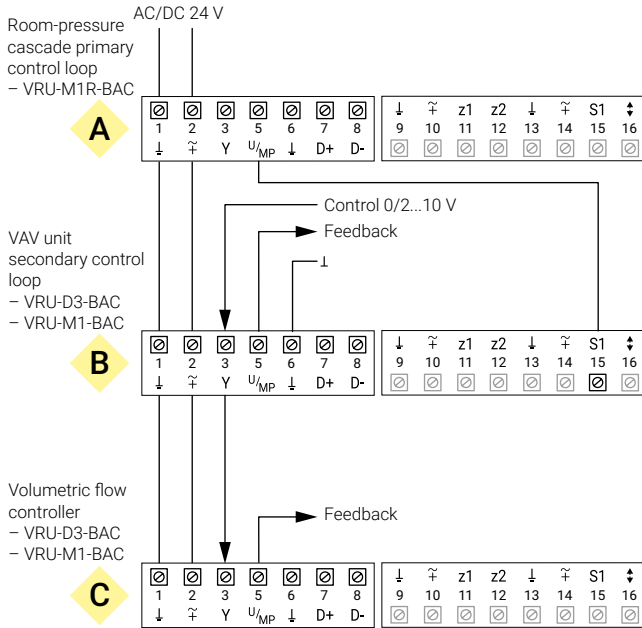
Device selection <C> VAV units

Product type from Belimo	Function	Sensor/Actuator characteristic	Field of application	SUP unit	ETA unit
i) Variant Δp sensor: D3 flow (dynamic)					
VRU-D3-BAC	VAV controller extract air [cascade]	Δp sensor, integrated D3 flow sensor	Comfort	■	■
VRU-D3-BAC	VAV controller supply air <C>	Δp sensor, integrated D3 flow sensor	Comfort	■	■
ii) Variant Δp sensor: M1 diaphragm (static)					
VRU-M1-BAC	VAV controller extract air [cascade]	Δp sensor, integrated M1 diaphragm sensor	Comfort Contaminated air	■	■
VRU-M1-BAC	VAV controller supply air <C>	Δp sensor, integrated M1 diaphragm sensor	Comfort Contaminated air	■	■
L/N/SM24A-VST	Rotary actuator, default	4/5/10/20 Nm, 120 s	All ranges		
NF/SF24A-VST	Rotary actuator, Mechanical fail-safe	10/20 Nm, 120 s, spring 20 s	All ranges		
LMQ24A-VST	Rotary actuator, very fast running	4 Nm, 2.4 s	All ranges		
NMQ24A-VST	Rotary actuator, very fast running	8 Nm, 4 s	All ranges		
NKQ24A-VST	Rotary actuator, very fast running electrical fail-safe	6 Nm, 4 s	All ranges		
SMQ24A-VST	Rotary actuator, very fast running	16 Nm, 7 s	All ranges		

Diagram

Analogue control

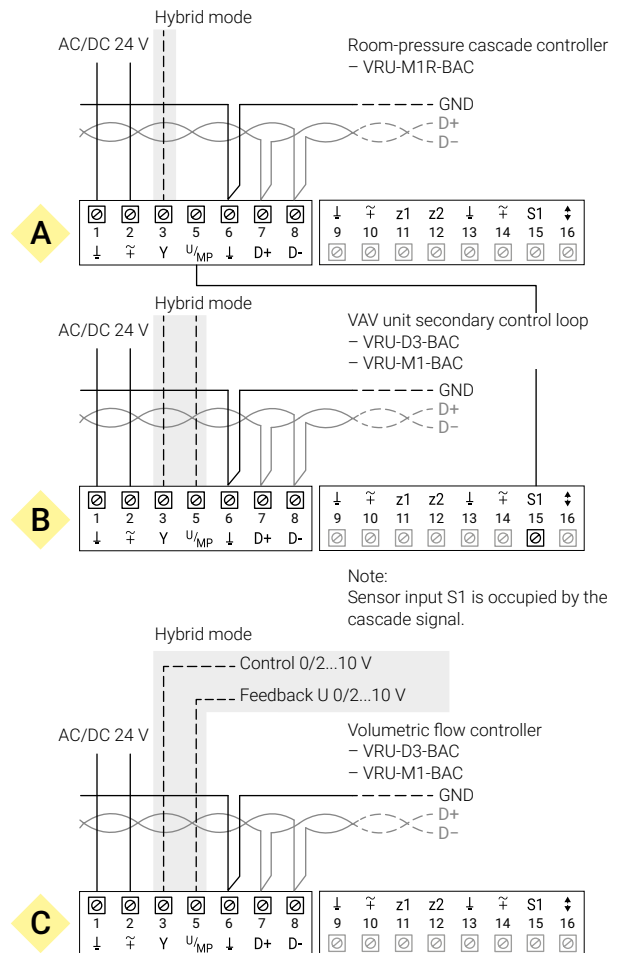
Room-pressure cascade P'_{min} constant Δp
 Volumetric flow $V'_{min} \dots V'_{max}$ [mode 0...10 V/2...10 V]
 - Operating volumetric flow $V'_{min} \dots V'_{max}$



Modbus RTU, BACnet MS/TP

Room-pressure cascade P'_{min} constant Δp
 Operating volumetric flow $V'_{min} \dots V'_{max}$
 - Operating volumetric flow $V'_{min} \dots V'_{max}$

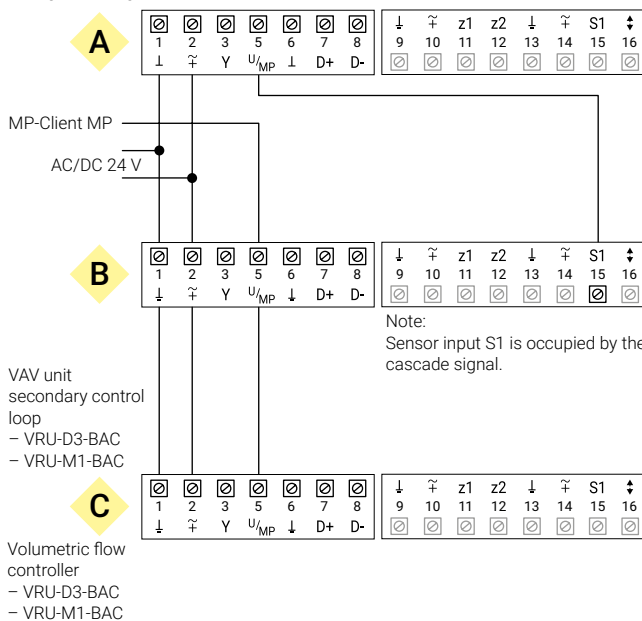
Note:
 In hybrid mode, the feedback signal is not available for the room-pressure controller <A>.



MP-Bus

Room-pressure cascade P'_{min} constant Δp
 Volumetric flow $V'_{min} \dots V'_{max}$

Note:
 The room-pressure controller <A> cannot be integrated into the MP-Bus system.



Safety requirements

Only authorised specialists may carry out installation. All applicable legal and government agency regulations must be complied with during use. Connection via isolating transformer.

See VAV-Universal-VRU Product Information: www.belimo.com

Explanations/notes

Reference measurement [-]-connection	A pressure-stable environment is a prerequisite for the reference measuring point [-] connection, as this directly influences the room-pressure control. Any pressure fluctuation of the reference is transmitted to the room to be controlled. A pressure-controlled anteroom as a reference makes reliable room-pressure control impossible. An environment isolated from the ventilation system - no pressure- or volume-controlled rooms - provides this prerequisite.
Pressure line	To minimise the influence of the pressure lines, the line lengths should be kept as short as possible.
VAV control primary/secondary operation	Primary/secondary operations (VAV controller and <C>) are not permitted in this application.
Override controls ETA unit	Override controls acting on the damper actuator for the ETA unit must be connected to the VRU .
Ground connection	Connect connecting terminal 1 or 6 GND, respectively
- Priority control	Page 71
- Connection z1/z2	Page 61
- Sensor integration bus mode	Page 61
- VRP-M replacement in existing	
MP-Bus system:	See separate instructions VAV-Universal-VRU in VRP-M compatibility mode (MP)

Parameter and tool overview Room-pressure cascade primary control loop <A>

Parameter/Function	Unit/Value	Function/Description/(Area)	Applica- tion	Tool			Authori- sation
			RPC	Assistant app	PC-Tool	ZTHEU	Expert/OEM
Pressure controller - manufacturer parameters (OEM values - not variable)							
Application	Room pressure	Application setting	■	r	r	r	O
Designation	Text	Model designation unit/Damper (16 Z.)	■	r	r	-	O
P' _{nom}	Pa	Nominal value Δp (5...75 Pa)	■	r	r	r	O
NFC interface	on/off	NFC communication for app access	■	r	r/w	-	O
Configuration – Project specific settings							
Position	Text	System designation (64 Z./ZTH 16 Z.)	■	r/w	r/w	r	
P' _{max}	Pa (ZTH %)	Δp step P' _{max} 20...100% P' _{nom}	■	r/w	r/w	r/w	
P' _{min}	Pa (ZTH %)	Δp step P' _{min} 0...100% P' _{nom}	■	r/w	r/w	r/w	
Room-pressure mode	Overpressure	Overpressure (+)/negative pressure (-)	■	r/w	r/w	-	E
Application area	Extract air/supply air	Mounting location of the control/bypass damper	■	r/w	r/w	-	E
Room-pressure cascade	ON ON fast	ON: cascade function activated ON fast: activates with VAV fast running actuator	■	r/w	r/w	-	E
Setpoint	Analogue/bus	Analogue and hybrid mode/bus	■	r/w	r/w	-	E
Reference signal Y	2...10 V/0...10 V/adjustable	Setting for modulating control P' _{min} ...P' _{max}	■	r/w	r/w	-	E

Availability: VAV-Universal components incl. replacement devices are only available from manufacturers of VAV units (OEM).

Permissions: [O - OEM, manufacturer mode] - VRU controllers are calibrated and parameterised by the unit manufacturer according to the specific application and the project. These settings can only be changed by the manufacturer.
[E-Expert Mode] - Functionally relevant settings are only accessible via the Expert Mode of the Belimo Assistant App.

Legend

r Tool: read
w Tool: Write
- Tool: Does not support parameter
E Only visible in Expert Mode

Parameter and tool overview VAV unit secondary control loop

Parameter/Function	Unit/Value	Function/Description/(Area)	Applica- tion	Tool			Authori- sation
			VAV/CAV	Assistant app	PC-Tool	ZTHEU	Expert/OEM
VAV unit - manufacturer parameters (OEM values - not variable)							
Application	Volumetric flow	Application setting	■	r	r	r	O
Designation	Text	Model designation unit/Damper (16 Z.)	■	r	r	-	O
$\Delta p @ V'_{nom}$	Pa	Nominal value Δp (38...500 Pa)	■	r	r	r	O
SN actuator	xxxxx-xxxxx-xxx-xxx	Serial number of the connected actuator	■	r	-	-	
Direction of rotation	ccw/cw	Actuator direction of rotation setting	■	r/w	r/w	-	E
Range of rotation	Adapted/programmed	Actuator adapted/programmed 30...95°	■	r/w	r/w	-	E
Power on behaviour	No action/Synch./adaptation	Actuator power-on behaviour	■	r/w	r/w	-	E
NFC interface	ON/OFF	NFC communication for app access	■	r	r/w	-	O
Configuration – Project specific settings							
Position	Text	System designation (64 Z./ZTH 16 Z.)	■	r/w	r/w	r	
V'_{max}	m ³ /h/l/s/cfm (ZTH %)	Operating volumetric flow V'_{max} 20...100% V'_{nom}	■	r/w	r/w	r/w	
V'_{min}	m ³ /h/l/s/cfm (ZTH %)	Operating volumetric flow V'_{min} 0...100% V'_{nom}	■	r/w	r/w	r/w	
Altitude compensation	ON/OFF	Switch function on/off	■	r/w	r/w	-	E
Altitude of installation	0 m	Compensates volumetric flow value at set altitude of installation (m a.s.l.)	■	r/w	r/w	-	E
Function	VAV/CAV	Control function	■	r/w	r/w	-	E
Room-pressure cascade	ON	VAV: Secondary circuit room-pressure cascade	■	r/w	r/w	-	E
Setpoint	Analogue/bus	Analogue and hybrid mode/bus	■	r/w	r/w	-	E
Setpoint offset	0% (must be 0%)	VAV: ±5% compensation ETA unit (room balance)	■	r/w	r/w	-	E
Reference signal Y	2...10 V/0...10 V/adjustable	Setting for modulating VAV control $V'_{min}...V'_{max}$	■	r/w	r/w	-	E
Feedback type	Volumetric flow/ Δp /Position	Volume/ Δp /damper position	■	r/w	r/w	-	E
Feedback U	2...10 V/0...10 V/adjustable	Setting U signal	■	r/w	r/w	-	E

Parameter and tool overview Opposite VAV unit <C>

Parameter/Function	Unit/Value	Function/Description/(Area)	Applica- tions	Tool			Authori- sation
			VAV/CAV	Assistant app	PC-Tool	ZTH EU	Expert/OEM
VAV unit - manufacturer parameters (OEM values - not variable)							
Application	Volumetric flow	Application setting	■	r	r	r	O
Designation	Text	Model designation unit/Damper (16 Z.)	■	r	r	-	O
V'_{nom}	m ³ /h/l/s/cfm	Volumetric flow nominal value	■				
$\Delta p @ V'_{nom}$	Pa	Nominal value Δp (38...500 Pa)	■	r	r	r	O
SN actuator	xxxx-xxxx-xxx-xxx	Serial number of the connected actuator	■	r	-	-	
Direction of rotation	ccw/cw	Actuator direction of rotation setting	■	r/w	r/w	-	E
Range of rotation	Adapted/programmed	Actuator adapted/programmed 30...95°	■	r/w	r/w	-	E
Power on behaviour	No action/Synch./adaptation	Actuator power-on behaviour	■	r/w	r/w	-	E
NFC interface	ON/OFF	NFC communication for app access	■			-	O
Configuration – Project specific settings							
Position	Text	System designation (64 Z./ZTH 16 Z.)	■	r/w	r/w	r	
V'_{max}	m ³ /h/l/s/cfm (ZTH %)	Operating volumetric flow V'_{max} 20...100% V'_{nom}	■	r/w	r/w	r/w	
V'_{min}	m ³ /h/l/s/cfm (ZTH %)	Operating volumetric flow V'_{min} 0...100% V'_{nom}	■	r/w	r/w	r/w	
Altitude compensation	ON/OFF	Switch function on/off	■	r/w	r/w	-	E
Altitude of installation	0 m	Compensates volumetric flow value at set altitude of installation (m a.s.l.)	■	r/w	r/w	-	E
Function	VAV/CAV	Control function	■	r/w	r/w	-	E
Room-pressure cascade	OFF (must be OFF!)	VAV: Secondary circuit room-pressure cascade	■	r/w	r/w	-	E
Setpoint	Analogue/bus	Analogue and hybrid mode/bus	■	r/w	r/w	-	E
Setpoint offset	0% (must be 0%!)	VAV: ±5% compensation ETA unit (room balance)	■				
Reference signal Y	2...10 V/0...10 V/adjustable	Setting for modulating VAV control $V'_{min}...V'_{max}$	■				
Feedback type	Volumetric flow/ Δp /Position	Volume/ Δp /damper position	■	r/w	r/w	-	E
Feedback U	2...10 V/0...10 V/adjustable	Setting U signal	■				

Availability: VAV-Universal components incl. replacement devices are only available from manufacturers of VAV units (OEM).

Permissions: [O - OEM, manufacturer mode] - VRU controllers are calibrated and parameterised by the unit manufacturer according to the specific application and the project. These settings can only be changed by the manufacturer.
[E-Expert Mode] - Functionally relevant settings are only accessible via the Expert Mode of the Belimo Assistant App.

Legend

r Tool: read
w Tool: Write
- Tool: Does not support parameter
E Only visible in Expert Mode

8

Connection

VRU-D3-BAC/VRU-M1-BAC/VRU-M1R-BAC

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Sensor integration	



Connection

Brief description

VRU...-BAC – Connection and basic functions



Principle diagram

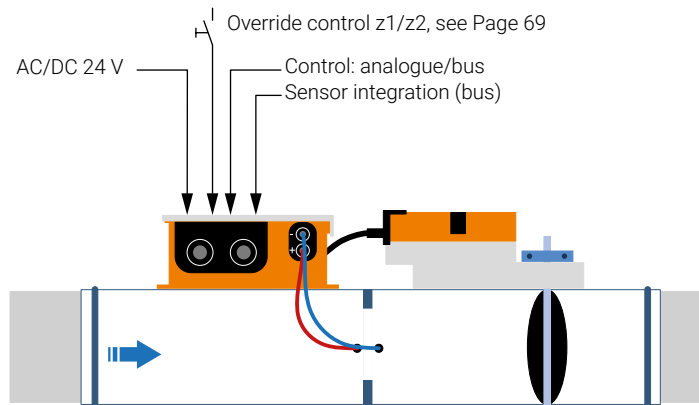


Illustration example

Explanations/notes

Safety requirements Only authorised specialists may carry out installation. All applicable legal and government agency regulations must be complied with during use.
Connection via isolating transformer.

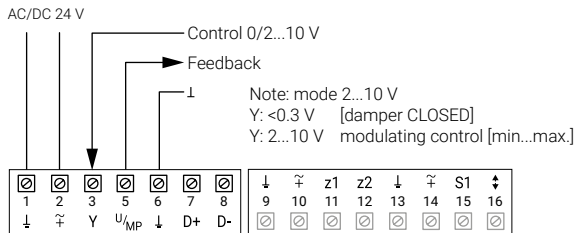
Override controls z1/z2

Connection and priority control, see Page 69

Diagram

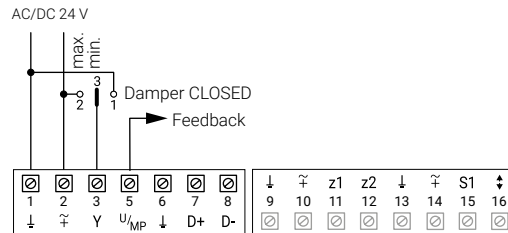
Analogue control [Mode 0...10 V/2...10 V]

– Modulating operation: min...max.

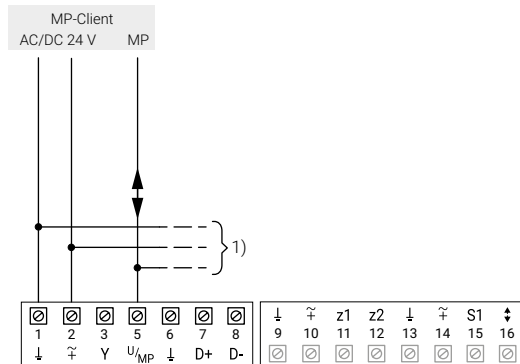


Analogue control [Mode 2...10 V]

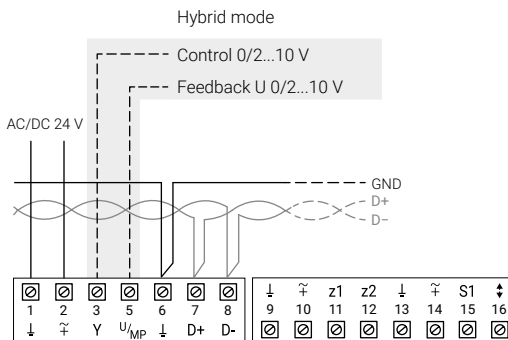
– Step mode: damper CLOSED/min./max.



MP-Bus



Modbus RTU, BACnet MS/TP

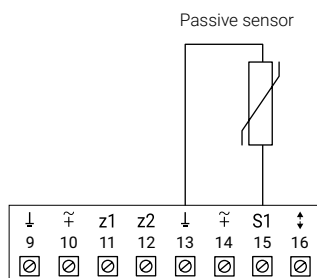


¹⁾ Other MP devices (total 8)
z1/z2 see Page 69 for connection and priority control

Sensor integration (Modbus, BACnet, MP-Bus)

Connection of passive sensors

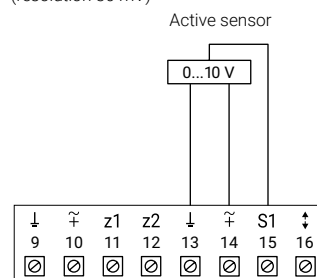
e.g. Pt1000/Ni1000/..



Connection of active sensors

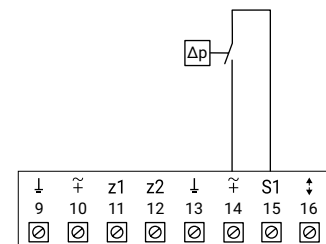
e.g. 0...10 V @ 0...50°C

Possible voltage ranges: 0...32 V
(resolution 30 mV)



Connection of the switching contact

e.g. Δp monitor
Switching contacts: The switching contact must be able to accurately switch a current of 16 mA at 24 V.



9

SUP/ETA unit in conjunction

VRU-D3-BAC/VRU-M1-BAC

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Recommendation	
Diagram	68



SUP/ETA unit in conjunction

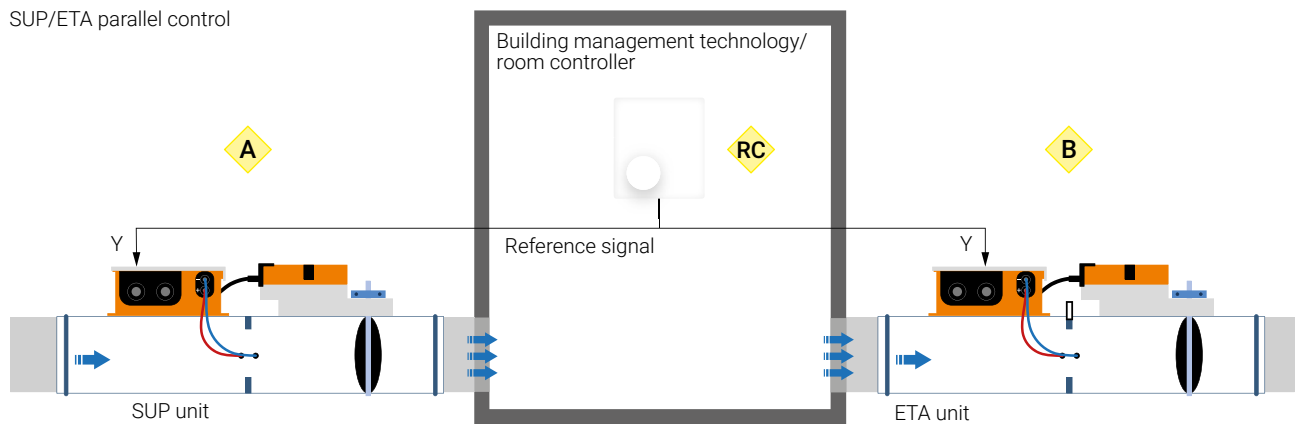
Brief description

Network of SUP and ETA units, jointly controlled by building management technology/room controller/CAV circuit



Principle diagram

SUP/ETA parallel control



Primary/secondary operation

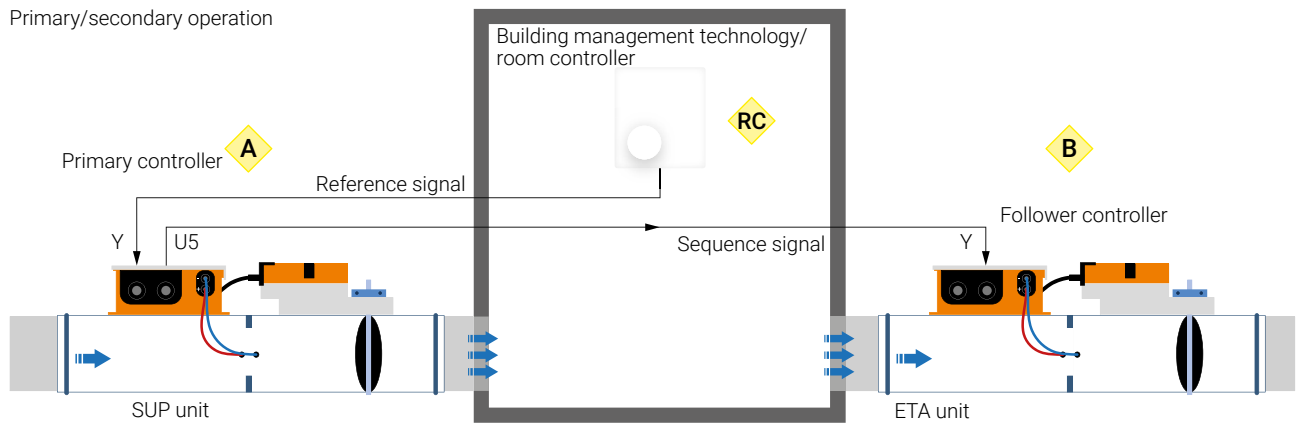


Illustration example

Function

Parallel control

With **parallel control**, the reference signal of the higher-level room automation (building management technology, room temperature or air quality control, CAV steps) is wired in parallel to the VAV controllers of the SUP and ETA unit (connecting terminal 3 - Y). For even room balance, the operating volumetric flow settings $V'_{\min} \dots V'_{\max}$ of both VAV units are set to identical values. If necessary, the room-pressure balance can be adjusted with the "Setpoint Offset" parameter.

Primary/secondary operation

The operating volumetric flow is set on the primary controller, the secondary controller follows the setting automatically. In a sequential circuit, the secondary controller follows the current volumetric flow of the primary controller. Undersupply by the fan is detected (e.g. unfavourable simultaneity factors at fan full load), and the room-pressure balance is maintained.

For this purpose, the reference signal of the higher-level room automation (building management technology, room temperature or air quality control, CAV steps) is wired to the primary controller unit (connecting terminal 3 - Y). The current volumetric flow of the primary controller (connecting terminal 5 - U) serves as the reference variable of the secondary controller unit (connecting terminal 3 - Y). The operating volumetric flow is usually set on the primary controller; the secondary controller is set for this purpose (for identical nominal diameter or V'_{nom}) at $V'_{\min} 0\%/V'_{\max} 100\%$. With different unit sizes, the setting on the follower controller is: $V'_{\min} 0\%/V'_{\max} = V'_{\max}$ Of the primary controller Ideally, the primary controller is placed on the more important side of the system (SUP or ETA).

Advantages/disadvantages

Parallel control

- + Simple planning/ordering/installation/commissioning.
- Identical setting of the operating volumetric flow for SUP and ETA units.
- + The two units are interchangeable from a control engineering point of view.

Primary/secondary operation

- + Inlet pressure influences on the primary controller side are "supported" by the secondary controller.
- + The operating volumetric flow is set on the primary controller; the secondary controller follows the setting automatically.
- Complicated handling of ordering, installation, wiring.
- If the SUP and ETA units are switched during installation, then the operating volumetric flow settings $V'_{\min} \dots V'_{\max}$ must be adapted on both units and the signals must be corrected by adapting the wiring.
- Recognition and rectification of system errors (SUP/ETA units switched, wiring errors) requires expert know-how.

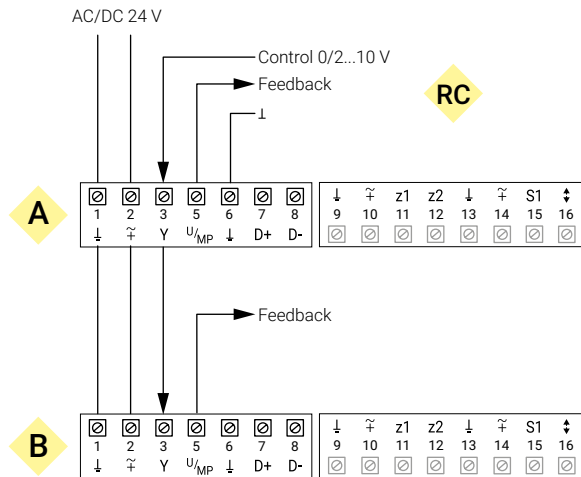
Recommendation

In practice, parallel circuits have proven to be much easier than primary/secondary operations. If monitoring in the SUP and/or ETA duct is required, this can be implemented much more easily and comprehensively with the bus systems commonly used today.

Diagram

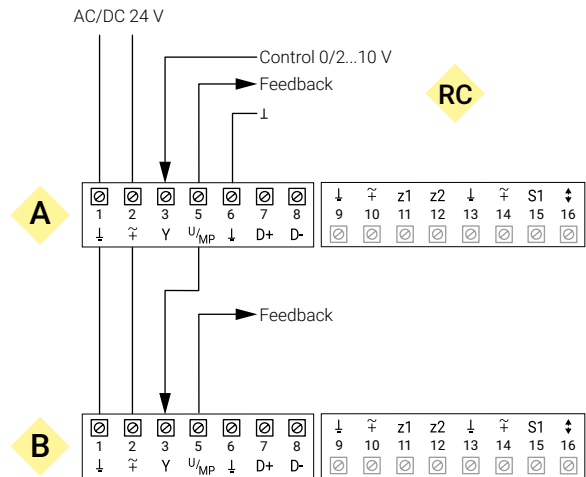
Parallel control

e.g. VAV mode: V'_{min}/V'_{max}



Primary/secondary operation

e.g. VAV mode: V'_{min}/V'_{max}



Explanations/notes

Safety requirements Only authorised specialists may carry out installation. All applicable legal and government agency regulations must be complied with during use.
Connection via isolating transformer.

CAV steps see Page 61

Override controls z1/z2
The override commands must be wired to both VAV controllers.

Connection z1/z2 see Page 61

Priority control see Page 71

10

Local override control z1/z2 Priority control

VRU-D3-BAC/VRU-M1-BAC/VRU-M1R-BAC

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Priority control	



Local override control z1/z2 Priority control

Brief description

Local override - input z1/z2

Description of the priorities and the interaction of the individual regulation and control functions



Principle diagram

Override control z1/z2

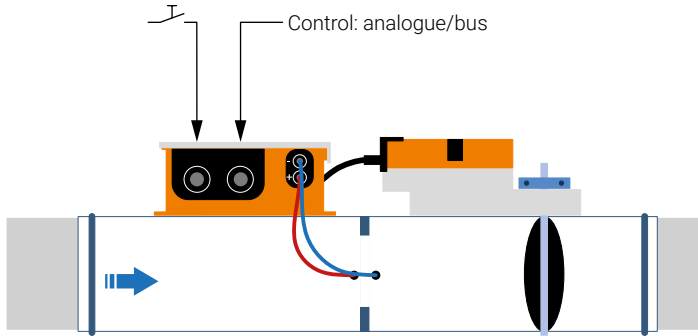
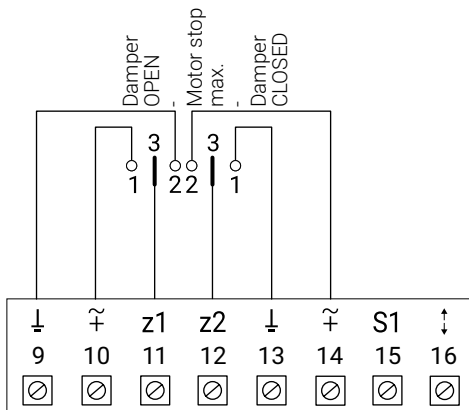


Illustration example

Diagram



Function

The two inputs z1/z2 are available for local intervention or higher-level control commands. The interaction of the control and setpoint signals for each operating mode is shown in the table below.

Priority control

Prio	Analogue operation Modulating 0/2...10 V: min...max.	Analogue operation Step mode: Damper CLOSED/min./ max.	MP-Bus	Modbus	BACnet	Hybrid mode (Modbus/BACnet)
1	z1	z1	z1	z1	z1	z1
2	z2	z2	z2	z2	z2	z2
3	a) Adaptation b) Synchronisation	a) Adaptation b) Synchronisation	Bus Watchdog	Bus Watchdog	Bus Watchdog	Bus Watchdog
4	Setpoint min...max.	Steps damper CLOSED/min./max.	a) Adaptation b) Synchronisation	a) Adaptation b) Synchronisation	a) Adaptation b) Synchronisation	a) Adaptation b) Synchronisation
5	–	–	Y steps Damper CLOSED/ min./max.	Bus override	Bus override	Bus override
6	–	–	Bus override	Bus setpoint: min...max.	Bus setpoint: min...max.	Y Hybrid steps: Damper CLOSED/ min./max.
7	–	–	Bus setpoint: min...max.	–	–	Y Hybrid modulating: Damper CLOSED/ min./max.

Exception: Application room-pressure volumetric flow cascade control

The damper CLOSED/damper OPEN/(motor stop) functions are not available with the room-pressure cascade controller <A> and must be connected to the VRU-D3-BAC/VRU-M1-BAC of the VAV unit extract air .

See Page 51

Explanations/notes

Safety requirements Only authorised specialists may carry out installation. All applicable legal and government agency regulations must be complied with during use.
Connection via isolating transformer.

CAV steps Connection Y, see Page 61

11

Commissioning room/duct pressure applications - Controller setting/commissioning

Brief description

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Commissioning room/duct pressure applications - Controller setting/commissioning

Brief description

A room or duct pressure control must be adapted to the controlled system on site when the system is commissioned. Unadjusted control loops lead to malfunctions and increased wear of the actuators.

Two parameters are available to the commissioning technician for the controller setting,

- Controller sensitivity - to adapt the controller speed to the control section
- Controller deadband - the controller operates as soon as the measured Δp value is outside the deadband

The two parameters are accessible with PC-Tool V3.16.4 or newer. The controller operates as soon as the measured Δp value is outside the set deadband (setpoint +/- deadband). This function protects the actuator from continuous motion (lifetime) and helps maintain the pressure balance in stable conditions. If, for example, the Δp actual value falls below the setpoint, the actuator starts to correct the deviation after the value falls below the lower deadband limit. To do so, the pressure controller changes the damper position until the actual value corresponds to the setpoint.

Room pressure – RP [VRU-M1R-BAC]

Recommended actuation time: 2.4...120 s

Controller sensitivity

In tight rooms - low leakage rates and/or high air exchange rates - it may be necessary to dampen (brake) the sensitivity of the controller to ensure stable operation. Too much damping of the control loop, in turn, can cause the controller to become too slow to compensate for disturbances within a reasonable time. The room pressure setpoint must be selected such that the room pressure balance does not, unintentionally, shift to negative pressure or overpressure.

Range	Function
0.1...10	Default = 1.0
0.1	10 times slower than normal
10	10 times faster than normal

Controller deadband

The setting must be selected so that the actuator does not run continuously. With deadband settings $<\pm 5$ Pa, the stability of the system must be checked.

Range	Function
$\pm 1...10$ Pa	Default = ± 5 Pa

Duct pressure – STP [VRU-D3-BAC/VRU-M1-BAC]

Recommended actuation time: 120 s

In order to operate the downstream control devices in a stable manner, the duct pressure control is normally a slow control loop. The default setting will work well for duct pressure control systems with connected volumetric flow controllers (e.g. VAV-Compact). If mechanical constant volumetric flow controllers (CAV) are used, the controller speed can be increased if necessary.

P'_{nom} - setting for duct pressure application STP

The parameter P'_{nom} determines the operating range of the channel pressure controller and influences the controller deadband. The controller deadband (see below) is set in % P'_{nom} .

Adjustment range P'_{nom}

Product type from Belimo	Control range	P'_{nom} – available adjustment range
VRU-D3-BAC	20...500 Pa	38...500 Pa ¹⁾
VRU-M1-BAC	20...600 Pa	38...600 Pa ¹⁾

For duct pressure applications in the control range <38 Pa, the setting value for P'_{nom} must be set to 100 Pa to use the recommended deadband setting of 5%.

¹⁾ VRU controllers are calibrated and parameterised by the OEM (unit manufacturer/supplier of the control damper) according to the application and project. Settings such as P'_{nom} can only be changed by the OEM.

Controller sensitivity

The deadband defines a neutral zone around the Δp setpoint. If the deadband is exceeded or undershot, the VRU controller regulates back to the currently required setpoint. The deadband must be set so that the actuator does not continuously move.

Range	Function
0.1...10	Default = 1.0
0.1	10 times slower than normal
10	10 times faster than normal

Controller deadband

The deadband must be set so that the actuator does not continuously move.

Range	Function
$\pm 1...10\%$ of P'_{nom}	Default = $\pm 5\%$ of P'_{nom}

Duct pressure control with VRU-D3-BAC:

The pressure drop in the pressure line generates a measuring error of maximum 2.5%. Use of the VRU-M1-BAC is recommended for applications with pressure lines >20 m.

All inclusive.

Belimo as a global market leader develops innovative solutions for the controlling of heating, ventilation and air-conditioning systems. Damper actuators, control valves, sensors and meters represent our core business.

Always focusing on customer value, we deliver more than only products. We offer you the complete product range for the regulation and control of HVAC systems from a single source. At the same time, we rely on tested Swiss quality with a five-year warranty. Our worldwide representatives in over 80 countries guarantee short delivery times and comprehensive support through the entire product life. Belimo does indeed include everything.

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