

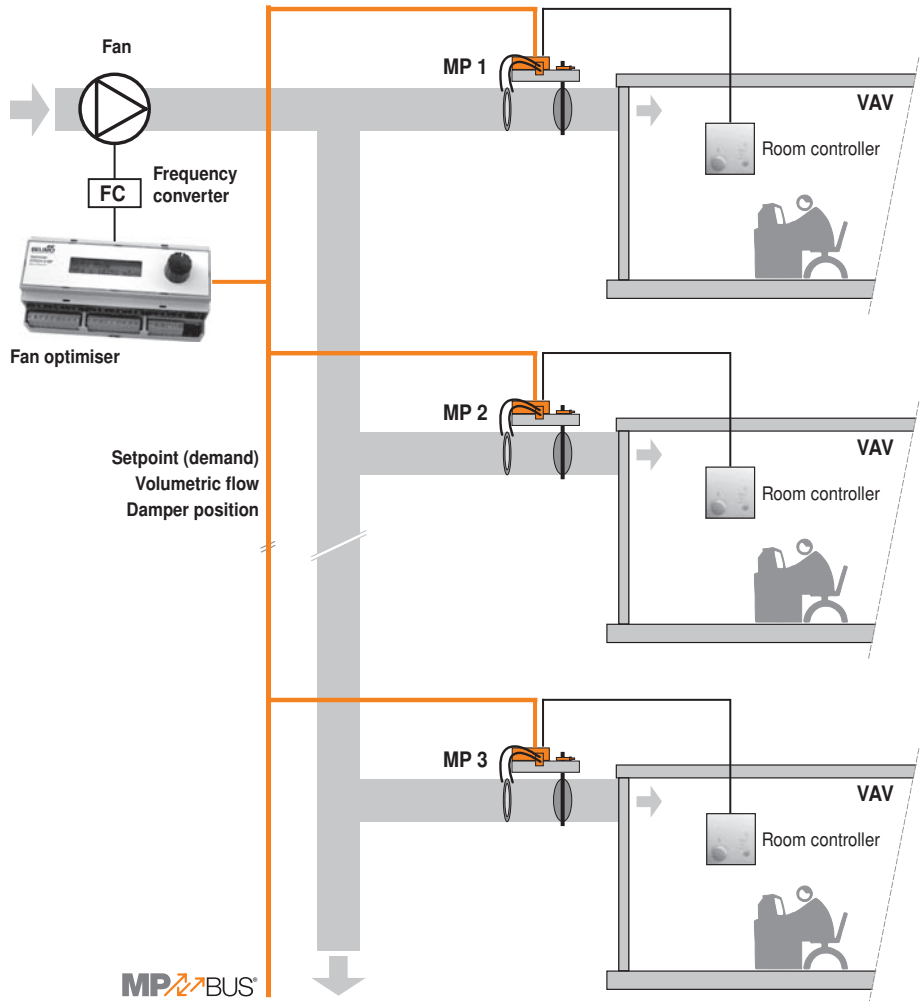
**VAV/CAV system solution
for energy-optimised fan regulation
for room ventilation**

Operating principle

The volumetric flow and its transport are determining factors for the **energy consumption of the fans.**

With **conventional, pressure-controlled systems**, the supply pressure is selected to provide enough air to the most unfavourably placed VAV unit during full load operation. The remaining oversupplied units have to eliminate the excess energy, i.e. the overpressure, by closing the dampers. These units are often operated in the most unfavourable range – for control characteristics, noise and pressure loss.
 The **greatest energy loss** occurs at **partial load**, which often accounts for the largest share of the operating time of a VAV system.

Fan optimisation: The nominal volume (space requirement), actual volume and damper position are recorded via the MP-Bus, analysed by the optimiser and specified as a setpoint for the frequency converter.
Result: The system is operated in the optimum range – for control characteristics, noise and energy consumption.
 The **greatest potential energy saving** occurs at partial load, which accounts for a considerable share of the time of a VAV system.



Fields of application

Variable and constant air volume systems for room ventilation applications with fans controlled by a frequency converter.

Principle of operation

The system is operated by the fan optimiser with optimum damper positions based on current demand signals. The objective is to keep the pressure loss across the VAV units as low as possible and thus permanently reduce operating costs by decreasing the fan output. The damper position of each VAV unit is recorded and transferred to the fan optimiser via the MP-Bus. These values are used there as a control variable for regulating the fan controlled by the frequency converter. As a result of this technology – which is based on the Belimo MP-Bus – an **energy saving of up to fifty percent** can be achieved compared to conventional systems in which fans are controlled by air duct pressure.

Proportionality laws

The proportionality laws form the basis of the volumetric flow transport.

- The volumetric flow is proportional to the speed $\left(\frac{\dot{V}_1}{\dot{V}_2}\right) = \left(\frac{n_1}{n_2}\right)$
- Pressure increases change to the second power with the volumetric flow ratio $\left(\frac{\Delta p_1}{\Delta p_2}\right) = \left(\frac{\dot{V}_1}{\dot{V}_2}\right)^2 = \left(\frac{n_1}{n_2}\right)^2$
- The power consumption changes to the third power with the volumetric flow ratio $\left(\frac{P_1}{P_2}\right) = \left(\frac{\dot{V}_1}{\dot{V}_2}\right)^3 = \left(\frac{n_1}{n_2}\right)^3$

Damper diagrams

• Pressure-controlled system

Damper opening



Operating status

Optimum range
 Unfavourable range (for energy efficiency and control characteristics)

• Fan-optimised system

Damper opening



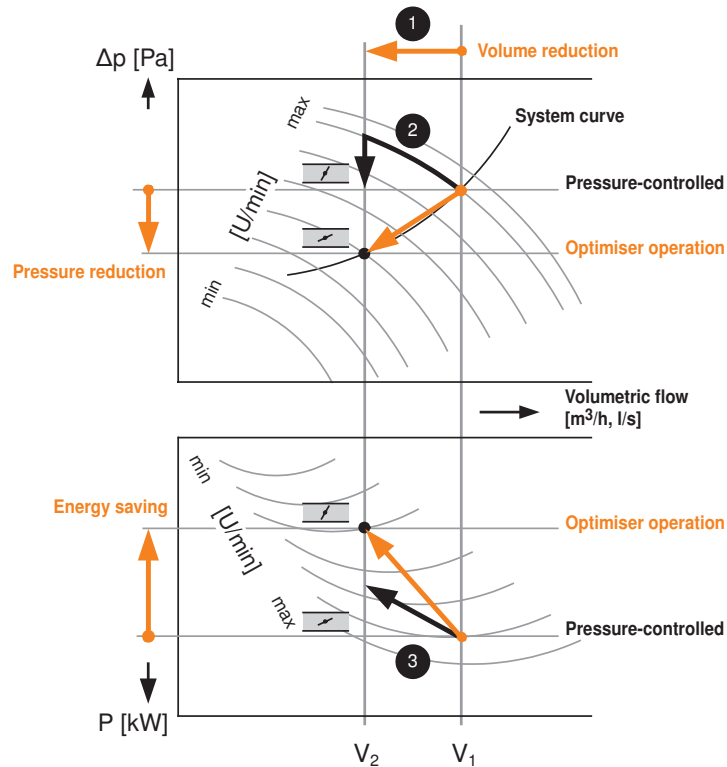
Operating status

Optimum range
 Unfavourable range (for energy efficiency and control characteristics)

Operating principle

(continued)

Duct pressure diagram with system curve



	Pressure-controlled	Optimiser operation
Volume reduction ①	VAV units: Dampers close until set volume reached	VAV units: Dampers close until volume setpoint is reached
Response of air duct pressure ②	<ul style="list-style-type: none"> – Air duct pressure rises – Pressure control corrected to set constant pressure, i.e. pressure at full load – VAV dampers close in order to compensate (eliminate) the excess air duct pressure – Increased flow noise 	<p>The optimiser determines the new situation from the change in the damper diagram and reduces the fan speed until the dampers of the downstream VAV units are operated in the optimum range</p>
Energy saving ③	<p>The fan is operated at a lower speed owing to the reduced volumetric flow. The downstream VAV units are not taken into account and are operated in an unfavourable range as a result of the excess pressure.</p> <p>The result:</p> <ul style="list-style-type: none"> – Unnecessary pressure loss in the air duct system – Unnecessarily high power consumption 	<ul style="list-style-type: none"> – Fan operated with lower speed – volumetric flow ratio – Significantly lower air duct pressure than with the air duct type due to the smaller pressure drop in the air duct network (optimum damper position)

Notes

Fan optimisations with Belimo VAV-Compact controllers can – as a result of their MP functions – also be realised in control devices with an integrated MP-Bus interface. In this case, the optimisation function must be realised in the application software of the control device. Alternatively, the fan optimiser COU24-A-MP can be integrated in such control solutions, which relieves the controller. Control devices with integrated MP interface are available on the market from various DDC / PLC manufacturers.

Please contact your local BELIMO representative for more information.

Customer benefits

Fan optimisation

- Is an effective measure to fulfil EU Directive 2002/91/EC on the overall efficiency of buildings and derived implementation measures, e.g. DE: DIN V 18599.
- Is an effective measure for permanently reducing operating costs.

Short payoff period

- The massive potential energy savings mean that the initial costs of the fan optimisation solution are quickly recovered

- Energy saving – up to fifty percent lower fan energy consumption due to the reduced drop in pressure across the downstream VAV units.
- Lower costs – supply and exhaust air pressure controls are eliminated.
- Quicker installation – standard cable for the 3-pole MP-Bus.
- Easier commissioning – owing to the elimination of pressure controls.
- Greater system convenience thanks to the lower flow noise – the flow noise through the units and in the air duct system is reduced by the lower supply pressure.
- Increased operational reliability – pressure losses due to filter contamination are automatically compensated. Complaints such as «the system does not supply enough air» are a thing of the past.
- Optimum cost-benefit ratio – the investment pays even with small and medium-sized buildings.
- Flexible system designs – for example as:
 - CAV system: volume changeover OFF / \dot{V}_{\min} / \dot{V}_{\max} via motion detector, etc.
 - VAV system: demand-controlled via CR24-B1 room temperature controller
 - VAV system: demand-controlled via room or DDC system controller or UK24LON/EIB
 - Mixed VAV / CAV system
- Can be used for new systems, retrofitting for system optimisations and renovation of existing systems – all VAV-Compacts (LMV-D2M / NMV-D2M from 2001 and later) support the optimiser function!
- Simple engineering and efficient commissioning – thanks to pre-configuration, LC display and self-adaptive control function.

Interfaces

Control	The energy requirements of the single-room or DDC controller are transferred to the COU24-A-MP fan optimiser via analogue signals or the MP-Bus.
VAV controllers	As a result of the MP-Bus technology, the VAV controllers provide access to all relevant data such as the current actual volumetric flow, damper position, etc. Setting and control functions are possible at any time with the Belimo PC-Tool.
Frequency converter	The frequency converter is controlled via a 0 ... 10 V analogue output. In the case of mixed systems with VAV and mechanical CAV units, a minimum fan speed can be set.

System size

The system size is unlimited; more fan optimisers can be operated in a sequential circuit via the optimiser's cascade output.
Number of VAV / CAV units per fan optimiser: 1 to 8

Operation and display

	All relevant information (overall / individual actual volumes, damper positions, frequency converter setpoint, etc.) are shown on the LC display. There is a user-guided setting and display menu for easy operation with an encoder button.
VAV controllers	The VAV controllers can be addressed and checked via the fan optimiser. In addition to the actual volumetric flow and damper position information, the operating volumetric flow settings \dot{V}_{\min} and \dot{V}_{\max} can be displayed and adjusted if necessary. The PC-Tool can be used for service work, for example. It is plugged into the central RJ12 connection.

Perfect solutions for volumetric flow applications

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