Room & System Solutions

the basics

Contents

- **Product range**
- **VAV – Variable Air Volume**
- **Single room control**
- **Fan Control for VAV systems**

Function	VAV-Compact		VAV-Universal	
	LON types	MP types	VRP-M system solutions	Universal range
Sensors	LONMARK®	MP-BUS® 	 VFP...	 VRD3  VFP...
Controllers	 LMV-D2LON NMV-D2LON	LMV-D2-MP NMV-D2-MP SMV-D2-MP	MP-BUS®  VRP-M	 VRP VRP-STP
Actuators		 LHV-D2-MP	 LMQ24A-SRV-ST NMQ24A-SRV-ST NM24A-V-ST	 LM24A-V NM24A-V SM24A-V  LF24A-V AF24A-V with safety function
Bus integration		MP-BUS®  In fieldbus systems via MP gateway. For LonWorks®: UK24LON gateway For Konnex: UK24EIB gateway		
Fan optimisation via MP-Bus		MP-BUS®  Fan Optimiser COU24-A-MP		
Adjustment tool	 ZTH-VAV			
Parameter-isation and service software	 PC-Tool for: VAV-Compact VRP-M			
Room controller			 CR24...	
Positioner			 SG...	

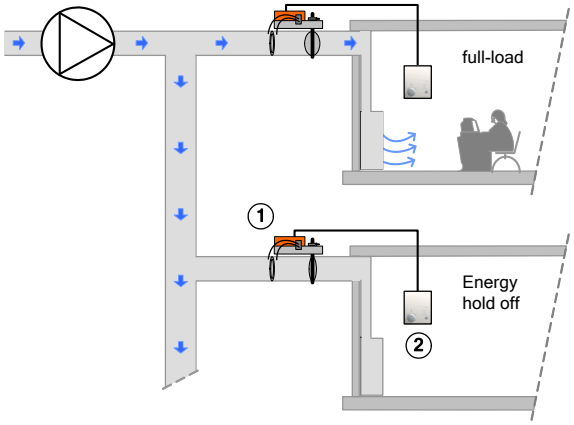
Note: Separate documentation for the VAV-Compact LON version, VRP-M system solution, VAV-Universal, CR24 single-room controller, COU24-A-MP Fan Optimiser, tools and interfaces can be found on the Internet at **www.belimo.eu**

Variable Air Volume (VAV) Systems

Indoor air quality is especially important in modern buildings, where economic operation and energy efficiency is to be taken into account. This can be achieved with variable air volume systems.

Every room or zone in a building receives exactly the air flow rate required to maintain the necessary criteria's.
The part- / full-load requirement is mostly dictated by room temperature, air quality or a combination of both criteria's.

Air conditioning system with VAV controlled rooms

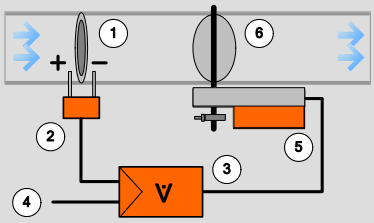


1 Belimo VAV controller (Pressure sensor, VAV Controller and actuator as VAV-Compact unit)
2 Room temperature controller
e.g. Belimo CR24-B1

Variable air volume – how it works

The air volume works as a closed control loop, i.e. measurement – comparison – control.

The VAV controller receives the flow signal based on the differential pressure from the pick-up device mounted in the duct. Pressure changes in the duct system caused e.g. by filters or influences from other rooms, are compensated automatically, a true pressure independent system.



VAV control loop – the elements

1 pressure pick-up device (orifice plate plate, cross, etc)
2 differential pressure sensor
3 Volumetric flow (VAV-) controller
4 set point input, e.g. 0…10 V from a room temp. controller
5 actuator **6** damper blade

VAV unit – the pre-adjusted control device

The VAV manufacturer delivers complete VAV-unit, incl. a ready-to-work Belimo VAV-controller.

Each VAV unit, calibrated and tested on the manufactures test rig - by the use of a PC-based manufacturing tool. At this occasion the Nominal flow V'nom [m^3/h / l/s] is set and stored in the VAV-controllers memory. This ensures optimal operation, on site commissioning is reduced to the minimum!

Room demand controlled VAV system

The set-point from a room temperature controller,
- such as the eu.bac proofed Belimo - CR24 represents the current active room demand. The VAV-controller compares the actual air volume with the set-point and increases resp. decreases the air volume according to the demand.

Belimo VAV product range

VAV-Compact

PC-Tool

CR24 Room controller

Advantages of VAV systems

- demand controlled air flow
- pressure independent system
- easy system integration
- can be combined with other systems chilled ceilings etc. or equipment such as re-heaters, etc.
- energy saving, fact for fast pay back
- suitable for energy recovery systems
- easy control by a 0…10 V signal or via a bus system (MP-Bus / LonWorks / Konnex / etc.)
- damper position can be used to control the fan (allows to save up to 50 % of fan energy!)

VAV systems – user benefits

- individual comfort
- room set point adjustable individually
- little energy consumption
- no emissions (noise, ...)

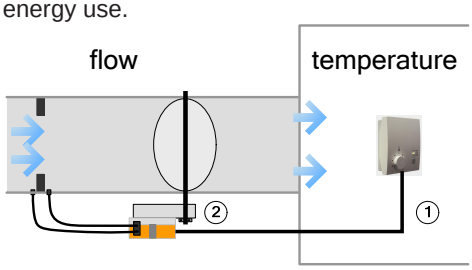
VAV - high comfort at low energy consumption…

07.11.2007

VAV Control System Solutions for Individual Room Control (IRC)

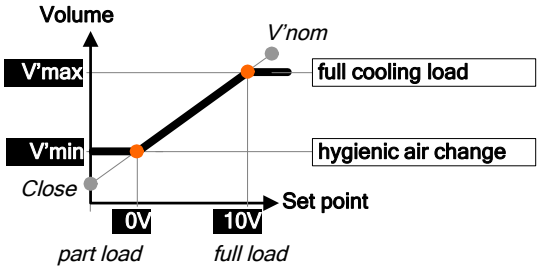
IRC System solution for individual room control

The VAV control system forms together with the room temperature controller a functional unit. The demand control guarantees individual room conditions at low energy use.



In this application the two control loops – the room temperature and the flow control – are combined to a so called cascade control loop. The temperature control – the primary loop (1) – provides the set point for the secondary loop (2) – the air flow control loop.

Operating flow setting V'min, V'max



The operating flow setting adjusts the unit to the room requirement – one could say: 'tailored to the room'. This is done by the two parameter V'min and V'max.

Whereby

V'min equals to the part load condition, normally the minimal air change rate required to cover the hygienic condition

V'max complies to the full load e.g. full cooling demand. The control signal e.g. 0…10 V from a room temperature controller matching to the flow rate V'min…V'max.

Adjusting and diagnostic

Fast and simple with **ZTH-VAV Belimo**'s '**click'n'set**' solution with: Actual flow, set point, damper position, CAV-Steps, V'min/max setting, voltage test

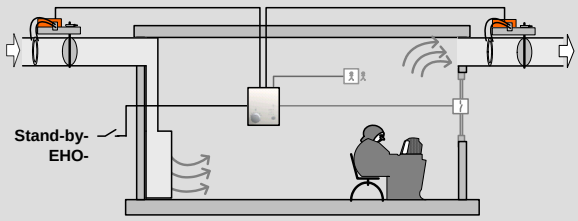
For **easy diagnosis** of a VAV unit especially during commissioning or operation aims the **Belimo PC-Tool**.

Graphic display: active set point, air flow, damper position and the V'min/ V'max setting can be monitored graphically and/or saved to the PC hard disk by means of the PC-Tool trend recording.

Room temperature controllers

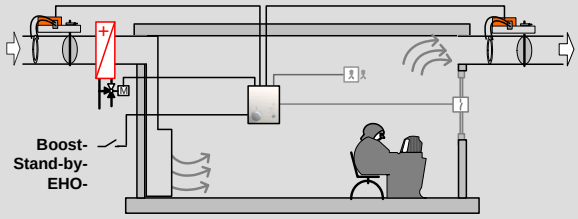
Single room controllers e.g. the Belimo eu.bac certified CR24 range support a wide range of applications with up to three output sequences, for example VAV systems with re-coolers, electric or water re-heaters, radiators, heated/ chilled ceilings and water applications.

Application example 1:



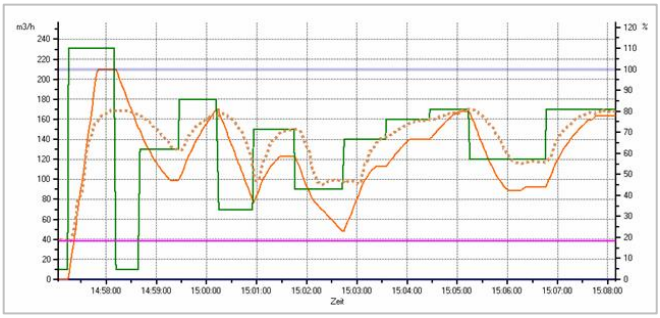
The room temperature aims as the demand related control value of the connected VAV units. The variable volumetric flow range V'min...V'max equals to:
- V'min - to the hygienic air change
- V'max - to the maximum cooling demand.

Application example 2:



The room temperature aims as the demand related control value of the connected VAV units. The variable volumetric air flow range V'min...V'max equals to:
- V'min - to the hygienic air change
- V'max - to the maximum cooling demand.

The re-heater gets controlled via the connected 0…10 V valve at heating request. To ensure the required airflow over the re-heater the volumetric air flow gets controlled V'min ... 80% V'max during that condition.



VAV - high comfort at low energy consumption…

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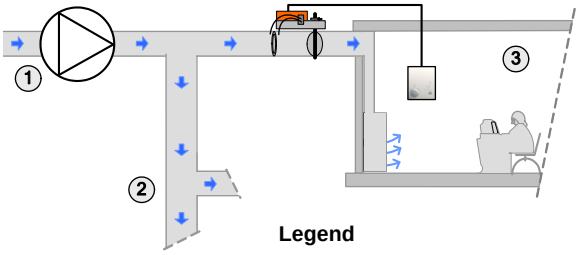
Fan Control with Variable Air Volume (VAV) System

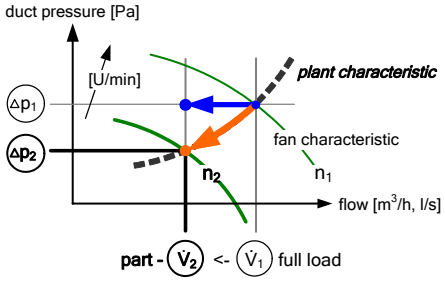
The **fan** of a **mechanical ventilation system** produces the system pressure needed to transport the required air volume through the duct system.



Legend
1 AHU – supply fan
2 duct system
3 VAV-unit for the zone control

Plant diagram – Plant characteristic

The ventilating system gets sized according to the plant dimensioning from the HVAC consultant: the **plant characteristic** line. The design data of the ventilating system guarantees the full load conditions.



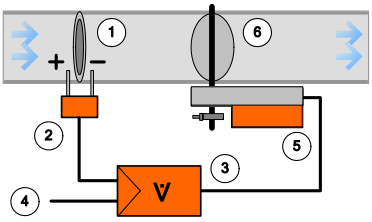
Legend

V_1	air volume at full load condition
V_2	reduced air volume at part load condition
ΔP_1	system pressure required at full load
ΔP_2	reduced pressure at part load
n_1	minimum fan speed
n_2	maximum fan speed

Zone control with VAV – how it works

The air volume works as a closed control loop, i.e. measurement – comparison – control. The VAV controller receives the flow signal based on the differential pressure from the pick-up device.

Pressure changes in the duct system caused by filters or influences from other rooms, are compensated automatically, a true pressure independent system.



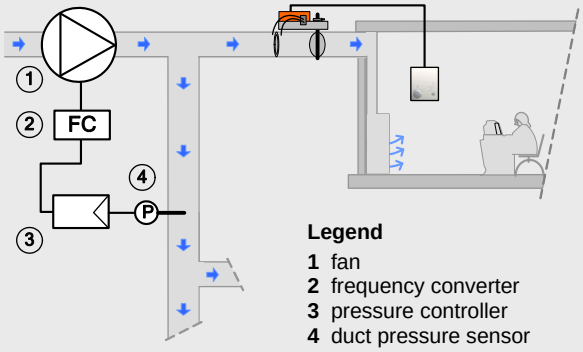
the VAV control loop
1 pick-up device (orifice plate, cross, etc)
2 differential pressure sensor
3 Volumetric flow (VAV-) controller
4 set point input, e.g. 0…10 V from a room temp. controller
5 actuator **6** damper blade

Fan control

The flow reduction, during part-load operation, is nowadays realized by the use of a frequency converter driven fan unit. The fan output can be controlled either by
a) a duct pressure controller, the old fashioned way or
b) a Fan Optimiser system, the energy efficient way

a) Duct pressure control

The duct pressure aims as control variable for the fan control.

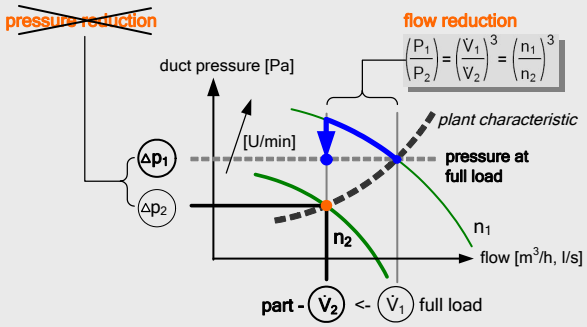


Legend
1 fan
2 frequency converter
3 pressure controller
4 duct pressure sensor

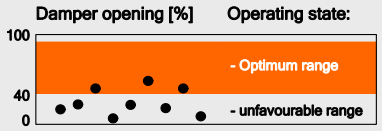
- **how it works, principle of operation**

at the volume reduction the duct pressure follows along the fan characteristic curve. The pressure controller reduces its output to meet the (P1) high pressure again. All VAV-units are forced to destroy the resulting overpressure by closing their dampers. Result: flow noise and high consumption.

- **plant diagram**



- **duct pressure control – damper diagram**



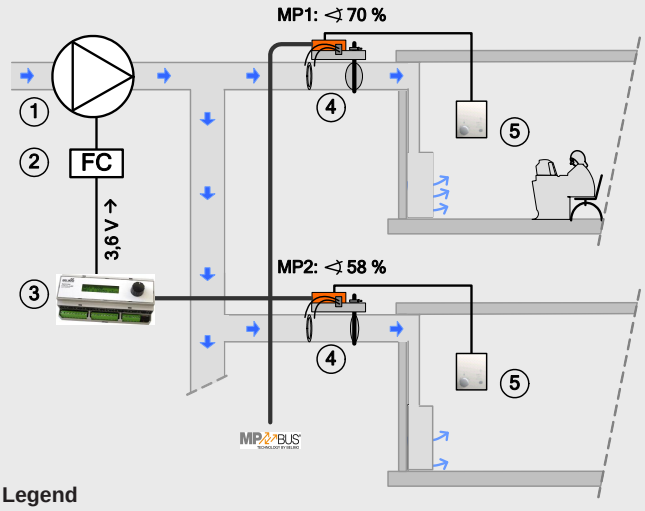
- **the disadvantages**

- open loop operation, no feedback from the zones
- system pressure equals always to full-load (P1)!
- at full-load:
  - security factors means additional energy consumption
  - filter factor means additional energy consumption
- at part load level (V2):
  - high pressure drop due to the 'closing' dampers
  - high flow noises
  - unnecessary fan energy consumption
- sensor location!?! At the worst point? Yes, but where is it? Difficult thing! This is a dynamic point in the duct system…
- high effort for correct commissioning (see point above!)

Belimo Fan Optimiser Solution

b) Fan Optimiser System (damper position controlled)

The new **Belimo Fan Optimiser** system solves the drawback of duct pressure controlled fan systems. The demand signals from the individual zones / rooms are collected and used to generate the energy efficient set-point for the fan system.



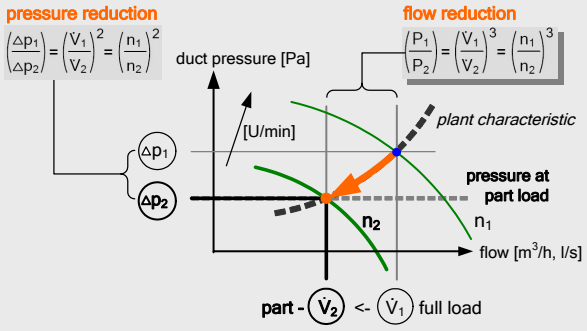
Legend

1 fan
2 frequency converter
3 Optimiser COU24-A-MP
4 VAV-controller with MP-Bus interface
5 Single room controller

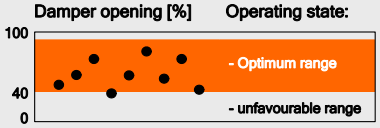
• how it works, principle of operation

The system is operated by the Fan Optimiser with optimum damper positions of the VAV-units based on current demand signals. The objective is to keep the pressure drop 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 read by 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 – energy savings of up to 50% can be achieved compared to systems controlled by the duct pressure. The Fan Optimiser does not influence or cut the required air flow!

• plant diagram



• damper diagram



Savings due to a Fan Optimiser System

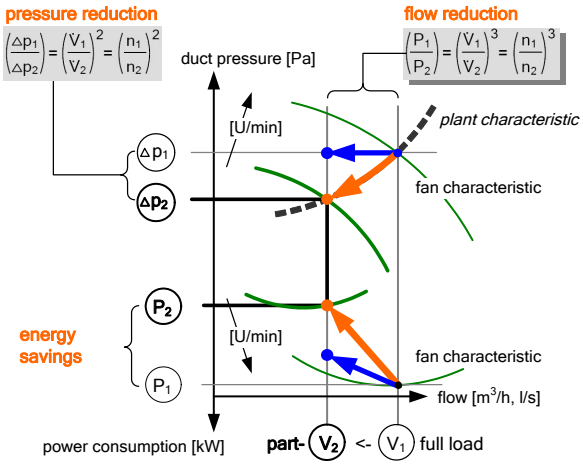
The volumetric flow and its transport are determining factors for the energy consumption of the fans.
The proportionality laws form the basis of the volumetric flow transport and they are valid for all HVAC systems! Whereby the:

- 3rd law describes the volume reduction V1 ►V2

The power consumption changes to the third power with the volumetric flow ratio.

- 2nd law describes the pressure reduction P1 ►P2

Pressure increases change to the second power with the volumetric flow ratio.



The massive energy savings are a practical way to achieve better values with regard to the new EU energy efficiency directives.

Example: savings potential for a reduction of 1,0 kW
Reduction: 1,0 kW, running time: 24 hours, 365 days
Energy price: 0,11 Euro
Annual savings: 8'760 kWh, 964 Euro, 4'820 kg CO_2 [1)]

Fan Optimiser system – the advantages

- Fan energy consumption reduced by up to 50%.
- CO_2 saving - 550g CO_2 per saved kW/h [1)]
- Cost saving the pressure controls are eliminated.
- Reduced flow noise thanks to the lower pressure.
- compensation of pressure losses – filter contamination.
- Rapid payback – even in small… medium-sized buildings.
- System size open, due to cascade option
- Flexible system concepts
  - VAV, CAV, mixed VAV/CAV systems
  - can be realised by the use of the same technology
  - in DDC controllers with MP-Interface.
- Reduction in cabling thanks to MP-Bus wiring.
- Simple engineering and efficient commissioning thanks to pre-configuration, LCD display and adaptive control characteristics.

1) according to the German energy mix 2004 – Source: www.energieverbraucher.de

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