Products no longer available
Products no longer available
Individual room control makes for contented occupants

The task of ventilation

One of the main tasks of any heating, ventilating and air-conditioning system is to provide and supply fresh, clean air to offices, workrooms, lounges, etc. and to exhaust the stale and/or polluted air.

Depending on the needs of the particular building, the system can also be used for heating, cooling, humidifying and dehumidifying.

By using an efficient combination of different types of good-quality equipment, designers seek to achieve proper "closed-loop" purging of the atmosphere in each room as demanded by the latest thinking on hygiene and occupational healthcare.

The items of equipment that comprise the distribution part of the system between the plant room and the room being supplied with air have to perform several air-flow functions:
- balancing
- shutoff
- step switching
- constant/variable control
- mixing
- distribution.

This is what is expected of the equipment manufacturers and of BELIMO VAV-Control.

From "norm" to "need"

For many years, nearly all ventilation and air-conditioning systems were designed around a standard or average sense of comfort. The number of air changes, the amount of heating, the amount of cooling, the humidification, the dehumidification, all were based on the standard sense of well-being of the "majority".

However, as we all know only too well, no two human beings are alike and it is very difficult to "standardize" them. So, ventilation and air-conditioning should take this fact into account. Instead of connecting-up whole buildings identically, it is becoming more and more important for the latest systems to provide conditions in individual rooms that are controlled according to need.

In order to keep energy consumption to a minimum, the volume of air flowing through the system must be as low as possible — a requirement that is best satisfied through the use of variable air volume systems.

A variable air volume controller does two important things:
- it ensures comfort in summer — good air-mixing, good cooling
- it ensures economy in winter — low air volume, maximum energy-saving.

The VAV-system

The classic VAV-system (VAV stands for Variable Air Volume) belongs to the so-called "air-only" group of designs. In means that all the thermal performance required is achieved through the supply air. The matching to the actual thermal load of the room is obtained by regulating (or varying) the volume of supply air. The temperature of the supply air remains constant and the volume of air delivered by the fan is reduced (so the power consumption is reduced too).

In view of the fact that the power consumption of a fan varies as the cube of its delivery volume, it is very easy to see how much energy can be saved in this way.
BELIMO VAV-Control: Individual air volume control – in response to demand and energy saving

Clear interfaces / Easy design
- Experienced designers make tough demands on VAV-systems and controllers:
  - Independent of supply pressure fluctuations
  - No minimum supply pressure
  - Large volumetric flow control range
  - Easy adjustment of operating flow rates
  - Easy servicing of sensing devices
  - High accuracy and stability (especially in the part-load range)

- Suitable for need-based control $v_{MIN}, v_{MAX}, v_{GLOBE}$
- Suitable for parallel operation (also with different work areas and sizes of equipment)
- Accurate room pressure conditions through follow-up control of supply-air and exhaust-air flow rate
- Different methods of sensing for different tasks (polluted exhaust-air, etc.)
- No link to specific makes of control-gear (i.e. universal in application, also with DDC individual-room control-systems).

The VAV-system also has enormous advantages when it is used in conjunction with the latest HVAC techniques such as "chilled ceiling" designs.

OEM / BELIMO co-operation

The designs of HVAC systems employed throughout the world vary widely and are tailored specifically to suit the needs of particular buildings and their occupants. This "tailoring" is the task of the building systems designer. HVAC plant manufacturers give him the tools to do the job properly and economically in the shape of well-designed items of equipment.

In combination with BELIMO VAV-Control he is able to set the parameters for volumetric flow rates accurately straight from the factory and to accept the guarantee for them and the proper functioning of the whole unit. Nevertheless, it is still possible to call up and check the parameters at any time subsequently after the equipment has been installed. Any corrections found necessary are simplicity itself to make.

This is why BELIMO VAV-Control is only sold through HVAC plant and equipment manufacturers.

Advantages and applications
- Precise air volume control minimizes energy consumption for fans, heating, cooling and humidification and also reduces filter costs.
- Need-based control of ventilation is ideal for adapting to different time patterns in the use and occupancy of rooms which may vary widely, e.g. offices, canteens, hotel rooms, hospital rooms, rest rooms, etc. – and again it saves energy.
- Lower capital costs and operating costs reduce the owner’s financial outlay – to everyone’s advantage.
BELIMO VAV-Control: Optimum room air control needs precise sensing

Clear interfaces and divisions of responsibility

BELIMO VAV-Control (the term includes the VAV-Universal and VAV-Compact versions) has a standard interface which gives it a very high level of compatibility with other equipment and systems. The task of adhering to the specified values of air flow and to the maximum permitted flow noise levels is the responsibility of the manufacturer of the terminal control units. If his air volume controllers are in the form of independent preset air control elements, there are no problems in linking up with normal commercial DDC (Direct Digital Control) or analog control systems.

Three practical methods of sensing

Several different methods of sensing the volume of a flow of air have become generally popular and each has its own special characteristics:

- Air velocity sensing. For single-point and multi-point measurement, wide range and high accuracy using a measuring cross.
- Dynamic differential pressure sensing. Wide range and high accuracy in conjunction with individual manufacturers’ normal pressure sensors.
- Static differential pressure sensing. Suitable for polluted air and for special situations.

The differential-pressure method produces good results even when the flow conditions are difficult, although, on the other hand, the pressure drop is slightly greater than with the velocity method.

The decisive advantage

All the different methods of sensing employed by BELIMO can be combined in a single HVAC system. Depending on the particular requirements, different air volume controllers with different working ranges can be operated in parallel.

Signal conditioning

The electronic sensor signal is not proportional to the volumetric flow. It has to be converted by the air volume controller to a linear actual-value signal. This is the only way in which the volumetric flow can be accurately set and measured, and then preset and regulated with standard reference signals.

Linearized standard signals

The individual, equipment-related conditioning (or linearizing) of the sensing signal performed by the BELIMO system makes allowance for the effects of individual sensors and for the flow conditions in the various terminal units. The end result is a linear function for the overall task of sensing and actuating. Regardless of the method of sensing chosen, the actual value of volumetric flow is available as a standard linear signal of 2...10 V DC in the VAV-Universal and 0...10 V DC in the VAV-Compact.

It provides an elegant solution for many different tasks in many different areas of application, such as:
- Display of volumetric flow
- Follow-up control
- Energy demand sensing
- Plant monitoring
- Commissioning

Methods of sensing air flow in HVAC systems

Measuring the velocity in the duct

Due to the non-linear profile across the duct, the mean velocity of the air flow is not identical to that measured at a particular point so the measurement must be corrected according to the method of sensing being employed. Defined inflow conditions for the sensor and mean-forming devices such as the measuring cross, etc. will produce sufficient accuracy for the purpose of HVAC systems.

Measuring the differential pressure at a baffle

A flow of air impinging on an obstruction (i.e. a baffle) produces a pressure drop across it which is proportional to the velocity of the flow. There are a great variety of suitable baffles (such as orifice plates, nozzles, static rings and static plates). Either static pressure sensors (diaphragms) or dynamic (flow) pressure sensors are suitable for measuring differential pressure.
The product range

BELIMO VAV-Universal
Suitable for almost any type of application in heating, ventilating and air-conditioning.
- Three different methods of sensing suitable for any combination with five types of damper motor
- Suitable for variable and continuous volumetric flow
- Controlled by continuous standard signals
- Limit values $V_{MIN}$ and $V_{MAX}$ adjustable at the controller
- Override or individual or several controllers.

BELIMO VAV-Compact
Specially designed for applications with DDC systems.
- Control by continuous signal (0...10 V DC) for direct control of volumetric flow
- Control by 3-point signal for motor control
- Override and limiting of $V_{MIN}$ performed by the DDC system
- Actual-value output used for feedback or display of the actual value of volumetric flow.

Products no longer available
BELIMO VAV-Universal: Variable air volume control for quality HVAC

The BELIMO VAV-Universal product range

Systems that have been optimized for specific conditions of use or climate rarely have the same character as normal standard systems. A modern design of HVAC system must be able to employ flexible and reliable system components. The BELIMO VAV-Universal range of products offers a refined and well-proven concept of precisely optimized items of equipment for air volume control.

- Flexible, thanks to three methods of sensing, suitable for combining with different types of damper motor
- Thoroughly tested
- Simple, user-friendly method of setting parameters, 2...10 V DC control.

Easy to use

The BELIMO VAV-Universal employs a versatile method of operation that is identical for all types of controller. The concept has been developed over many years and guarantees high efficiency combined with long-term reliability. Typical design features are the external access for setting parameters and the plugable connections for the damper motor.

Three methods of sensing

Depending on the type of sensors used by the manufacturer of the VAV terminal units and the requirements regarding accuracy and impurities in the air, either of the three methods of sensing listed below can be employed:

- The VR2 air velocity sensor offers high resolution and, depending on the type of sensor system, a very low pressure drop.
- The VRD dynamic differential pressure sensor has the advantage of providing a mean value of differential pressure independent of the duct flow profile, as well as providing accurate, low-cost measurement of velocity.
- The VFP-300 static differential pressure sensor is used together with the VRP sensor and, thanks to the static principle, is very good if the air is contaminated.

Standard linear signals

The output signal $U_0$ represents the actual value of volumetric flow. 2...10 V DC corresponds to 0...100% of the preset nominal value. The linear output can be used for:

- Display
- Feedback for central energy management
- Reference variable for follow-up controllers.
The right damper motor for every application

BELIMO specialize in the motorized operation of all kinds of dampers and in particular, offer very practical designs for the different types of damper used in VAV-systems. Such applications involve the use of different levels of torque and different speeds, and the ability to bring the damper to a safe position in the event of a power failure. All VAV damper motors come fitted with a plug-in cable.

The damper motors have no limit switches and are overload-proof. The motor automatically stops running when the damper or motor reaches its end stop. The damper can be operated by hand after first disengaging the gearing by means of a self-resetting pushbutton (not on the KM... and FM... models).

- **KM24-V**, the smallest model delivering 2.5 Nm torque. Also with linear action.
- **NM24-V**, the compact model delivering 6 Nm. Suitable for most applications.
- **SM24-V**, the well-proven model delivering 15 Nm. Can also be used for operating larger dampers and be fitted with the many accessories from the SM range (potentiometers, switches, etc.).
- **GM24-V**, the heavy-duty model for special applications on large dampers up to 30 Nm.
- **FM24-V** suitable for applications where the damper must fail safe when the system is de-energized. In the event of a power failure, the 10 Nm provided by the built-in spring brings the motor to the fail-safe position in approximately 40 seconds.

Compatibility

BELIMO VAV-Universal controllers employ standard analog signals of 2...10 V DC or 0...20 V phasemut. It allows them to be connected directly to most types of room thermostat. All BELIMO Type VR controllers have a special override control input which allows the \( V_{\text{MIN}} \), \( V_{\text{MAX}} \) and “CLOSE” modes to be initiated from a central point over a common conductor.
Individual room control
Supply-air/exhaust-air volume control
Parallel control
- Systems with parallel air volume controllers in the supply-air and exhaust-air ducts (controlled by the same reference variable).
- Supply-air and exhaust-air units of different sizes and with different settings of minimum and maximum limit values.
- Difference or ratio control between the supply-air and the exhaust-air.
- Systems with several supply-air and/or exhaust-air units.

The reference signal \( w \) from the temperature controller is fed in parallel to the inputs of the Type VR supply-air and exhaust-air volume controllers. The minimum and maximum limit values of volumetric flow must be set individually for each controller.

Supply-air/exhaust-air volume control
Master-Slave control
(The Slave follows the Master)
- Systems with air volume controllers in the supply-air and exhaust-air ducts which must operate in sequence.
- Supply-air and exhaust-air units of the same size.
- Ratio control between supply-air and exhaust-air.

The reference signal \( w \) from the temperature controller is fed to the input of the supply-air volume controller (Master). The actual-value signal from the Master is the reference signal for the exhaust-air volume controller (Slave).
- The ratio for \( V_{Slave} / V_{Master} \) is set with the \( V_{MAX} \) potentiometer on the Slave.
- Set \( V_{MIN} \) on the Slave to 0%.
- Only enter the overrides \( V_{MIN}, V_{MAX} \) on the Master; "CLOSE" on Master and Slave.
BELIMO VAV-Universal: Typical applications

VAV zone control for supply-air and exhaust-air

- Several air volume controllers in the supply-air duct. One common controller in the exhaust-air duct.

The air volume controller in the common exhaust-air duct is fed with the actual-value signal from the flow sensor in the common supply-air duct.

The flow sensor in the common supply-air duct measures the volumetric flow as it varies according to the burden produced by the individual rooms.

The volumetric flow for the zone air is fed with the flow signal from the supply-air. Overrides such as $V_{MIN}$, $V_{MAX}$ and "CLOSE" for individual rooms are processed automatically.

Twin-duct systems

- Twin-duct system with damper-controlled mixing section.

- Twin-duct system with separate air volume controllers in the hot and cold air ducts.

The control zones are equipped with a mixing section and separate air volume controllers in the common supply-air duct and in the exhaust-air duct.

The operating value of volumetric flow is regulated by the room temperature controller for each zone within the preset values of $V_{MAX}$ and $V_{MIN}$ for the air flow.

The control range for volumetric flow is set separately for the supply-air and the exhaust-air by means of the $V_{MAX}$ and $V_{MIN}$ potentiometers on the air volume controllers.
**VR2 controller with air velocity sensor**

- Method of measurement: air velocity
- Measuring range: 0...15 m/s (VR2-8) : 0...8.5 m/s
- Temperature range: 0...50°C in use
- -20...+70°C storage/transport

**VRD controller with dynamic pressure sensor**

- Method of measurement: pressure from flow
- Measuring range: 0(3)...ca. 300 Pa (OEM-dependent)
- Temperature range: 0...50°C in use
- -20...+70°C storage/transport

**VRP controller for VFP-300 static pressure sensor**

- Method of measurement: pressure by metal diaphragm
- Measuring range*: 0...300 Pa (VFP-300)
- Position sensitivity: < ±4.5 Pa when rotated by 90° horizontal
- Calibration position: mounted vertically
- *other ranges to order

---

**Wiring diagram**

```
1 2 3 4 5 6 7
1 — — — — — — — —
2 3 4 5 6 7 8 9

Compatible with most popular makes of controller

W1: 0...10 V DC
W2: 0...20 V phasecut

24 V AC

U8: 2...10 V DC

Parallel connection of more VR controllers possible. Note power consumption data.
```

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**General technical data: VR2, VRD, VRP**

- Power supply: 24 V AC ±20 % 50 / 60 Hz
- Power consumption: 1.0 W
- For wire sizing: 2.3 VA (without damper motor)
- Control signal: W1: 0...10 V DC  W2: 0...20 V phasecut
- Input resistance: 100 kΩ (0.1 mA)  8 kΩ (50 mW)
- Operating ranges: 2...10 V DC  2...10 V DC (V<sub>MIN</sub>...V<sub>MAX</sub>)
- Override: Z: “CLOSE” (1-7): V<sub>MAX</sub> (2-7): V<sub>MIN</sub> (2 ➔ 7)
- Reference value: LW = V<sub>NIOM</sub> (OEM setting)
- Max. flow: V<sub>MAX</sub> 30...100 % V<sub>NIOM</sub>
- Min. flow: V<sub>MIN</sub> 0...80 % V<sub>MAX</sub>
- Actual-value signal: U<sub>2</sub>: 1.9...14 VDC (2...10 V DC <0...100% V<sub>NIOM</sub>)
- Motor control signal: U<sub>2</sub>: 6±4 V DC (for damper motors ... M-V)
- Connection: terminals (2 x 1.5 mm²)
- Degree of protection/Protection class: I / III (safety extra-low voltage)
- EMC emitted interference: to EN 50081-1
- Weight: ca. 400 g (VRP + VFP-300 = ca. 600 g)
<table>
<thead>
<tr>
<th>Model</th>
<th>Technical Data</th>
</tr>
</thead>
</table>
| **KM24-V** | Power supply: 24 V AC (from VR...)  
Power consumption/For wire sizing: 1.2 W / 2.5 VA  
Control signal Y: 6.0 ± 4 V DC (from VR...)  
Torque at rated voltage: 2.5 Nm  
Direction of rotation (selected with switch): L/R (L "CLOSE" R)  
Running time for > 90° (or 95°): min. 200 s  
Degree of protection/Protection class: IP 40 / III (safety extra-low voltage)  
EMC emitted interference: to EN 50081-1  
Sound power level: max. 45 dB (A) |
| **SM24-V** | Power supply: 24 V AC (from VR...)  
Power consumption/For wire sizing: 2 W / 4 VA  
Control signal Y: 6.0 ± 4 V DC (from VR...)  
Torque at rated voltage: min. 6 Nm  
Direction of rotation (selected with switch): L/R (L "CLOSE" R)  
Running time for > 90° (or 95°): 110...150 s  
Degree of protection/Protection class: I / III (safety extra-low voltage)  
EMC emitted interference: to EN 50081-1  
Sound power level: max. 35 dB (A) |
| **GM24-V** | Power supply: 24 V AC (from VR...)  
Power consumption/For wire sizing: 2.2 W / 4 VA  
Control signal Y: 6.0 ± 4 V DC (from VR...)  
Torque at rated voltage: 15 Nm  
Direction of rotation (selected with switch): A/B (A "CLOSE" B)  
Running time for > 90° (or 95°): min. 200 s  
Degree of protection/Protection class: I / III (safety extra-low voltage)  
EMC emitted interference: to EN 50081-1  
Sound power level: max. 45 dB (A) |
| **FM24-V** | Power supply: 24 V AC (from VR...)  
Power consumption/For wire sizing: 4 W / 7 VA  
Control signal Y: 6.0 ± 4 V DC (from VR...)  
Torque at rated voltage: 30 Nm  
Direction of rotation (selected with switch): A/B (A "CLOSE" B)  
Running time for > 90° (or 95°): min. 200 s  
Degree of protection/Protection class: I / III (safety extra-low voltage)  
EMC emitted interference: to EN 50081-1  
Sound power level: max. 45 dB (A) |

*Note: Products no longer available.*
BELIMO VAV-Universal: Mode control

Open-loop and closed-loop control
- In order to operate a HVAC system economically it is necessary to have some additional operating modes: \( V_{\text{MIN}}, V_{\text{MAX}} \) and "CLOSE".
- With the VAV-Universal, these functions are easy to provide through simple wiring arrangements. Override control can be provided centrally for several controllers via the override control input "Z" or for individual controllers locally by means of the reference variables \( w_1 \) and \( w_2 \).
- The override control input "Z" overrides all signals at the reference variable inputs \( w_1 \) / \( w_2 \).

**Damper control**
- Damper "CLOSE": For saving energy in unused zones by closing the supply-air and exhaust-air dampers.
- Damper "OPEN": For smoke extraction or safety. Note: Air volume control is inoperative in this case.

**Contacts:**
- open: auto
- closed: damper "CLOSE"/"OPEN"

**Continuous air volume control**
- \( V_{\text{MIN}} \): minimum volumetric flow
  - When unassigned, individual rooms or zones can be switched to standby operation. Minimum air flow through the rooms produces substantial savings in energy consumption.
  - Contacts: \( a \): \( b \): \( V_{\text{MIN}} \)
  - open: auto \( V_{\text{MIN}} \)
  - closed: \( V_{\text{MIN}} \) auto
  - Blocking diode e.g. 1 N4007

**\( V_{\text{MAX}} \): maximum air volume control**
- Individual or several rooms can be supplied with maximum volumetric flow for short periods of time. It allows a number of special types of operation to be effected, such as through-ventilation, night-cooling and early morning boost.
  - Contacts: \( a \): \( b \): \( V_{\text{MAX}} \)
  - open: auto auto
  - closed: \( V_{\text{MAX}} \) auto

**Constant air volume control**
- Single-flow setpoint
  - If no reference signal \( w_1/w_2 \) is fed to the VR controller, the controller maintains the value of flow preset with the \( V_{\text{MIN}} \) potentiometer constant (\( V_{\text{MAX}} \)-setting = 100%).

**Twin-flow setpoints**
- Connecting the 24 V phase to a reference value input keeps the setpoint preset by means of the \( V_{\text{MAX}} \) potentiometer constant.
- Therefore, placing a switch (or contact) in this connecting lead will allow twin-flow control to be effected.
BELIMO VAV-Universal: Setting the volumetric flow

Nominal value of volumetric flow $V_{\text{Nom}}$

Energy and noise considerations dictate that the specific value of volumetric flow for each diameter of duct must not exceed a given value. With BELIMO VAV-Control the manufacturer can calibrate his air volume controllers at the factory to a maximum value of $V_{\text{Nom}}$. This new product is the very versatile linear control unit for volumetric flow.

The presetting of units to a uniform value of $V_{\text{Nom}}$ reduces and simplifies the OEM’s work in connection with planning, fabrication, installation and commissioning. Costs are cut substantially as a result.

Operating values of volumetric flow $V_{\text{Min}}$ and $V_{\text{Max}}$

The linear characteristic of the air volume controller makes for simple setting of the plant-side operating values of volumetric flow by means of two potentiometers. The adjustments can be carried out either at the factory (OEM) or during installation or commissioning.

The $V_{\text{Max}}$ value is the upper limit value related to the nominal value of volumetric flow. The $V_{\text{Min}}$ value can be adjusted as a percentage of the set value of $V_{\text{Max}}$. The actual-value output $U_x$ is unaffected by the $V_{\text{Min}}$ and $V_{\text{Max}}$ settings.

The reference value signals $w_1/w_2$ allow the set value of volumetric flow to be moved continuously within the preset limit values.

Wire sizing (in metres)

In precisely the same way as an air duct system must be designed accurately to suit the needs of the items of equipment in the system, and of the whole HVAC system itself, so too must the wiring system in order to distribute the electric power supply efficiently.

The power rating of the supply transformer that will be needed depends on the power consumption (VA values) of all items of equipment together. The feeder cables from the transformer to the equipment must be sized by the method of maximum voltage drop. A ring main is recommended if the distribution system is larger than average.

<table>
<thead>
<tr>
<th>Power consumption</th>
<th>Current</th>
<th>0.20</th>
<th>0.25</th>
<th>0.34</th>
<th>0.50</th>
<th>0.75</th>
<th>1.00</th>
<th>1.50</th>
<th>2.50</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.5 VA</td>
<td>0.3 A</td>
<td>35</td>
<td>45</td>
<td>62</td>
<td>89</td>
<td>128</td>
<td>173</td>
<td>247</td>
<td>432</td>
</tr>
<tr>
<td>10 VA</td>
<td>0.4 A</td>
<td>26</td>
<td>34</td>
<td>46</td>
<td>66</td>
<td>96</td>
<td>130</td>
<td>185</td>
<td>324</td>
</tr>
<tr>
<td>20 VA</td>
<td>0.8 A</td>
<td>13</td>
<td>17</td>
<td>23</td>
<td>33</td>
<td>48</td>
<td>65</td>
<td>93</td>
<td>162</td>
</tr>
<tr>
<td>40 VA</td>
<td>1.7 A</td>
<td>7</td>
<td>8</td>
<td>12</td>
<td>17</td>
<td>24</td>
<td>32</td>
<td>46</td>
<td>81</td>
</tr>
<tr>
<td>60 VA</td>
<td>2.5 A</td>
<td>6</td>
<td>8</td>
<td>11</td>
<td>16</td>
<td>22</td>
<td>31</td>
<td>54</td>
<td></td>
</tr>
<tr>
<td>80 VA</td>
<td>3.3 A</td>
<td>6</td>
<td>8</td>
<td>12</td>
<td>16</td>
<td>23</td>
<td>41</td>
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<td></td>
</tr>
<tr>
<td>100 VA</td>
<td>4.2 A</td>
<td>7</td>
<td>10</td>
<td>13</td>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note:

It is important to adhere strictly to all the relevant official standards and to obey all the regulations laid down by the local power supply authorities and the owner/operator.

The adjacent table lists the maximum lengths of conductor allowed for secondary-side feeders (low voltage) according to DIN standards in relation to different conductor cross sections and to the power consumption (VA) of the connected equipment.

The length of conductor (m) refers to twin and twisted-pair cables with a maximum voltage drop of 10% between transformer and equipment.
BELIMO VAV-Compact:
Ideal for use with DDC control systems

The BELIMO VAV-Compact product range

There are now sophisticated control systems available which allow any number of functions to be distributed from a large central system to several smaller, decentralized systems. BELIMO VAV-Compact products are ideal to use in conjunction with such "DDC" systems. Since the intelligent DDC system is able to perform the functions of minimum limiting and override control, the damper motor and the control box can now be combined in a single compact housing.

BELIMO VAV-Compact offers system components that are based on proven technology and are DDC-optimized.

- Flexible, thanks to two methods of sensing
- "Compact", since damper motor and control unit are in the same housing
- DDC-optimized, thanks to 0...10 V DC signals
- Highly versatile with mode selection
  - 3-point or 0...10 V DC continuous.

Two methods of sensing

Depending on the type of sensors used by the manufacturer of the VAV terminal units and the requirements regarding accuracy and impurities in the air, either of the two methods of sensing listed below can be employed:

- The NMV 24-V employs an air velocity sensor. It offers high resolution and, depending on the type of sensor system, a very low pressure drop.
- The NMV 24-D employs a dynamic differential pressure sensor. It has the advantage of providing a mean value of differential pressure independent of the duct flow profile, as well as providing accurate, low-cost measurement of velocity.

Standard linear signals

VAV-Compact controllers employ linear volumetric flow signals for the inputs and outputs. The actual value $U_2$ represents the actual value of volumetric flow 0...10 V DC corresponding to 0...100% of the preset nominal value.

The linear output can be used for:
- Feedback to the DDC control system
- Reference variable for follow-up controllers
- A simple volumetric flow check.
BELIMO VAV-Compact

Sensing, control and damper motor in a single unit

Easy to use

All BELIMO VAV-Compact controllers are operated and used in the same way and have been specially designed to suit modern control systems. It is a proven concept which is economic and easy to install and give good reliability over many years of service.

An optimized motor system

The Compact controllers are based on the well-proven Type NM damper motors with a torque output of 6 Nm. They are suitable for most sizes of damper that are likely to be encountered.

Good functional safety

The damper motor has no limit switches and is overload-proof. It switches off automatically when it reaches the damper or motor end stop.

Easy functional check

In order to check the proper functioning of the damper, the gearing can be disengaged by means of a self-resetting pushbutton. The damper can be operated by hand while the pushbutton remains depressed.

Compatibility

BELIMO VAV-Compact controllers either use analog 0...10 V DC signals or work in the 3-point control mode. The actual value of volumetric flow is available for other functions as a 0...10 V DC standardized linear signal (0...100%V). Since DDC control systems and VAV controllers have to work together on both the hardware and software sides, a number of suitable control schemes have been developed with various controlgear manufacturers.
Integrating VAV-Compact into DDC systems

The applications software of digital control systems allow very versatile configuring of HVAC plant to suit particular requirements.

As a linear air control device, the VAV-Compact plays an important role in this connection. The functions that are already built into the VAV controller and its clear interfaces make the task of the DDC control system much easier since it only has to store the plant-specific parameters and the general logic gating to the other controllers.

In the case of the 3-point control mode, applications should be discussed with the controlgear manufacturers.

Typical application 1:
VAV-Compact as autonomous volumetric flow control device with flow feedback

The first NMV 24... controller (Master) is controlled by the DDC controller with a continuous signal. The actual-value signal of this controller is then used in the DDC controller as the input value for an internal software arithmetic module which generates the output signal for the servo-controller.

Typical application 2:
3-point control through DDC servo-controller with 0...10 V DC

The DDC controller contains a control algorithm which, according to the actual value, undertakes the task of controlling the volumetric flow by driving the damper motor through the 3-point output. In this case the VAV-Compact controller only performs the sensing and operating functions.

In order to save extra inputs and outputs for servo-controllers, they can be controlled directly through the actual-value signal of the first controller in continuous operation.

Typical application 3:
0...10 V DC control saving DDC outputs

In the Master-Slave configuration it is possible to operate several VAV-Compact controllers from only a single continuous output (0...10 V DC). This leaves the costly continuous outputs of the DDC controller free for other tasks. It is a very economic feature.
Products no longer available

BELIMO VAV-Compact: Technical data

NMV 24-V and NMV 24-D

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
<td>24 V AC ±20 % 50 / 60 Hz</td>
</tr>
<tr>
<td>Power consumption</td>
<td>3 W</td>
</tr>
<tr>
<td>For wire sizing</td>
<td>5.5 VA</td>
</tr>
<tr>
<td>Reference variable W</td>
<td>0...10 V DC from temperature controller or 3-point signal from air volume controller</td>
</tr>
<tr>
<td>Input resistance</td>
<td>100 kΩ</td>
</tr>
<tr>
<td>Operating ranges</td>
<td>0...10 V DC for mode &quot;0...10&quot;</td>
</tr>
<tr>
<td></td>
<td>24 V for mode &quot;OPEN&quot;</td>
</tr>
<tr>
<td>Sensing system: NMV 24-V</td>
<td>air velocity 0...15 m/s</td>
</tr>
<tr>
<td></td>
<td>dynamic pressure diff. 0(3)...ca. 300 Pa</td>
</tr>
<tr>
<td>Sensing range</td>
<td>according to manufacturer</td>
</tr>
<tr>
<td>Volumetric flow, actual value signal</td>
<td>linear, 0...10 V DC = 0...100% V_{\text{nom}}</td>
</tr>
<tr>
<td>Protection class</td>
<td>III (safety extra-low voltage)</td>
</tr>
<tr>
<td>Degree of protection</td>
<td>drip proof</td>
</tr>
<tr>
<td>Connection</td>
<td>1 m lead (5 x 0.75 mm²)</td>
</tr>
<tr>
<td>Angle of rotation</td>
<td>max. 95º, adjustable mech. stops</td>
</tr>
<tr>
<td>Torque</td>
<td>min. 6 Nm</td>
</tr>
<tr>
<td>Running time</td>
<td>110...150 s</td>
</tr>
<tr>
<td>Direction of rotation</td>
<td>selected with switch L/R</td>
</tr>
<tr>
<td>Position indicator</td>
<td>mechanical</td>
</tr>
<tr>
<td>Ambient temperature range</td>
<td>0... +50°C</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>-40...+80°C</td>
</tr>
<tr>
<td>Ambient humidity</td>
<td>class D to DIN 40040</td>
</tr>
<tr>
<td>EMC emitted interference</td>
<td>to EN 50081-1</td>
</tr>
<tr>
<td>Sound power level</td>
<td>35 dB (A) max.</td>
</tr>
<tr>
<td>Maintenance</td>
<td>maintenance-free</td>
</tr>
<tr>
<td>Weight</td>
<td>1000 g</td>
</tr>
</tbody>
</table>

Mode: "continuous" 0...10 V DC

The value of volumetric flow can be controlled continuously between zero and the preset value for V_{\text{MAX}} by means of an external signal of 0...10 V DC. The Compact controller then automatically regulates the required value of flow. The actual-value signal functions as a checkback for sensing, display or slave-controller reference signal.

Mode: 3-point "OPEN/CLOSE"

A positive AC signal is permanently available at the two inputs 3 and 4. The motor can be driven in the "OPEN" or "CLOSE" directions by shorting (by switch, relay or triac) the appropriate input to system earth (1). The actual-value signal U_{\text{max}} provides the checkback to the external controller. The "OPEN" signal remains active until the V_{\text{MAX}} value is reached. With a sustained "OPEN" command, V_{\text{MAX}} is automatically kept constant.

Products no longer available
BELIMO VAV-Universal: Functional testing

Functional testing for commissioning and service

Although the air volume controller will already have undergone a thorough check at the manufacturer’s factory, it will usually be necessary to check it again during commissioning. The continued efficient operation of any HVAC system will require further regular checks on all the equipment. Easy access to the setting potentiometers and terminals will allow quick and thorough checks to be made on all the preset values as well as ensuring reliable operation of the air volume controller at its place of use.

Function diagram

Block diagram

In the sensing unit (electronic sensing, linearizing and calibration) the non-linear signal from the sensor is converted to a linear actual-value signal taking into account the manufacturer’s specific parameters. The signal is also available for further, external use. The input signals, reference variables and override control signals are conditioned to an internal setpoint signal according to the preset limit values, compared with the actual value and, if there is a deviation, used to produce a suitable output signal for the damper motor (…eV). BELIMO damper motors have an integral running characteristic, i.e. the smaller the deviation, the slower the speed.
BELIMO VAV-Compact: Functional testing

**Power supply**
- 24 V AC to terminals 1 + 2, tolerance ± 20% Check polarity of system earth conductor.
  - Yes: Inspect wiring and check against diagram. Check rated power of transformer.
  - No: NMV 24-V/ID 5.5 VA

**Damper motor**
- Is the function selector set correctly?
  - No: Change the setting so that it corresponds to the type of controller being used.
  - Yes: Switch on motor labelled L/R.

**Damper motor**
- Set the function selector to 3P and link terminals 1 and 3. Does the motor run to "CLOSE"?
  - No: Check the reversing switch. Check operation of the damper.
  - Yes: Check the V_max potentiometer. Check the settings against the technical data on the VAV unit.

**Input signal w₁**
- Actual-value signal U₅

**Function diagram**

**Block diagram**

In the sensing unit (electronic sensing, linearizing and calibration) the non-linear signal from the sensor is converted to a linear actual-value signal taking into account the manufacturer's specific parameters. The signal is also available for further, external use.

Depending on the setting of the function selector (3P or 0...10 V DC), the input signals at terminals 3 and 4 are conditioned either as a setpoint for the internal volumetric flow control loop or as an "OPEN" or "CLOSE" control signal and used to drive the damper motor.

The running speed of the motor varies according to the magnitude of the system deviation (i.e., an integral characteristic). In the case of 3-point control, the "OPEN" signal is limited by the maximum setpoint.
BELIMO VAV-Control: Maintenance / Service

Zero adjustment VFP-300

The pressure sensing unit is based on a static pressure cell, which means that special attention must be paid to careful handling and correct installation (the screw-fixed lid must be vertical so that the sensor is vertical).

If the diaphragm is placed at an angle to the vertical it will shift the output curve and cause inaccuracy in the readings, primarily in the lower part of the range.

The sensor can be adjusted as follows when necessary:

1. Plug the VFP-300 into the VRP and connect a 24 V AC power supply to the VRP.
2. Remove the lid of the VFP 300.
3. Remove the plug from the damper motor at the VFP.
4. Detach the pressure hoses from the connectors.
   Note: Mark + and –.
5. Connect a voltmeter to terminals 1 and 5 on the VRP.
6. The actual value \( U_0 \) (on the VRP) should now be reading 1.7...2 V.
7. Use potentiometer \( P_1 \) (ZERO) to adjust the actual value to 1.6...2 V.
8. Replace the lid.
9. Reconnect the pressure hoses (+ and – as before).
10. Replace the damper motor plug.

If the master reference value is also adjusted with the zero already adjusted, the readjustment of the zero will have no effect on the setting of the master reference value.

Restrictions on the use of the sensors with polluted air

BELIMO velocity sensors and dynamic pressure sensors have been designed for use in typical "comfort" HVAC systems. The usual types of dust filters fitted in the supply-air ducts of such systems provide sufficient protection for the sensors against dust. Suitable exhaust-air filters will have to be fitted if there is a large amount of dust or fluff in the spaces being air-conditioned. If this is impossible, it is advisable to use the BELIMO static pressure sensor (VFP-300).

For industrial applications where the air might be contaminated with sticky or chemical substances, the use of the static pressure sensor is strongly advised (the precise limits of use should be discussed with the manufacturer of the equipment).

Cleaning the sensor elements

The velocity sensors and dynamic pressure sensors require very little maintenance. If any flow errors are detected that are probably related to contamination of the air, the sensors will have to be carefully cleaned by a dry method.

Air velocity sensors VR2 and NMV 24-V

1. Carefully remove the sensor from its mounting in the duct.
   Note: Mark the direction of air flow (with → on the top).
2. Clean both sensor elements with a fine brush or by blowing out with compressed air. Ensure that the position of each element is not disturbed while this is being done.
3. Examine the sensor elements for corrosion because corrosion is a sign of harmful substances in the air flow.
4. Replace the sensor in the mounting, ensuring the correct direction of air flow.
5. Check the proper functioning of the controller.

Dynamic pressure sensors VRD and NMV 24-D

1. Remove the two screws and carefully lift off the lid from the bottom section.
   Note: Take care not to disturb the positions of the sensor elements in the inside of the lid.
2. Use a fine, dry brush or compressed air to clean out the dirt in the bottom of the housing.
3. If there is severe contamination, also clean the differential pressure sensors and the connecting hoses.
4. Also carefully brush out any dirt from the lid.
5. Reassemble the sensor and replace the screws.
6. Reconnect the pressure hoses.
7. Check the proper functioning of the controller.

Note:

Cleaning of the sensor elements will only be needed on rare occasions and must be carried out with extreme care. In particular, be careful not to damage the elements in any way and not to disturb their positions.