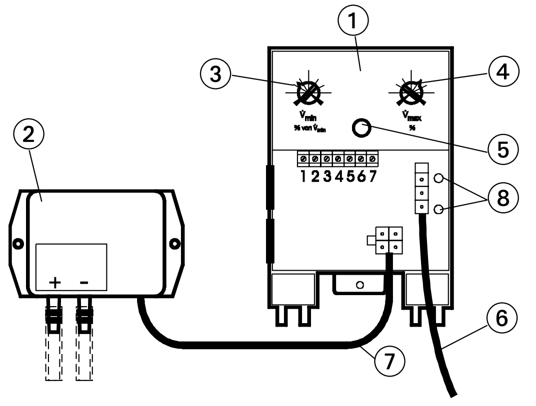
Belimo VRP

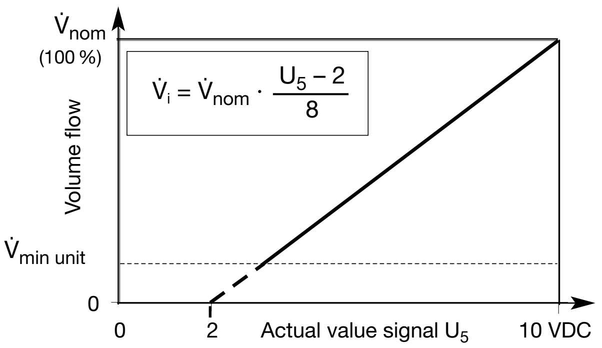
Contents

VRP

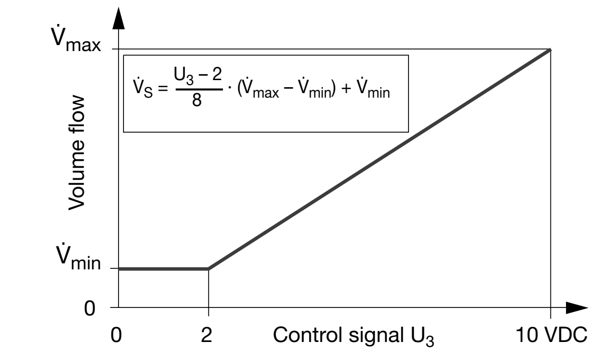


1. Controller VRP
2. Transducer VFP 300
3. $\dot{V}_{min}$ adjustment knob
4. $\dot{V}_{max}$ adjustment knob
5. Reference value potentiometer
6. Actuator connection cable
7. Transducer connection cable
8. Offset indicating lights

Characteristic of Actual Value Signal



Characteristic of Volume Flow Control Variable



Area of Application

The Belimo VRP electronic volume flow controller, combined with a membrane differential pressure transducer VFP 300, is designed for use in VAV systems and requires a room temperature controller.

Control signals can be in the range of 2 to 10 VDC (0 to 20 V phasecut also possible). Override control can be achieved by external switches. Several controllers may be connected to one room temperature controller. Supply air/extract air slave circuits are also possible.

Static Measuring Principle

The volume flow is measured using a membrane pressure transducer. Therefore the VRP is suitable for the control of extract air with contaminants and/or which is dust-loden. Terminal units with painted finish or made of plastic should be considered in such situations.

IMPORTANT

In critical cases, a material test should be carried out on the terminal unit and membrane pressure transducer, to prove suitability for chemicals and concentrations concerned.

Description of Function

The volume flow is measured on the static differential pressure principle. The differential pressure sensor in the terminal unit measures the effective pressure (Δp_e). This causes a membrane in the pressure transducer to deflect, the movement is detected and converted into a linear pressure voltage signal. The linearisation of the volume flow is carried out in the VRP.

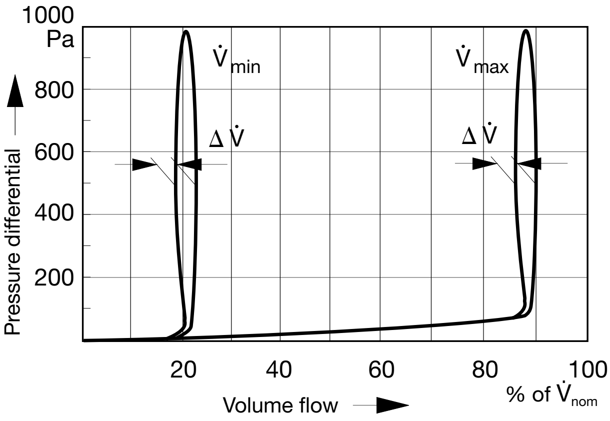
The measurement range is set to suit the unit size during factory calibration, so that 10 VDC always corresponds to the unit nominal volume flow rate ($\dot{V}_{nom}$). The actual volume flow is available as a 2 to 10 VDC signal (U_5).

The required volume flow is set by the room temperature controller via the control signal within the limits of $\dot{V}_{min}$ and $\dot{V}_{max}$. The VRP determines the required volume flow in accordance with the characteristic shown and compares this with the actual value. The damper actuator is controlled according to the deviation. The Belimo VRP can only operate with the matched Belimo actuators which are optimized for volume flow control. It is not possible to connect other 3-point or 0 to 10 VDC actuators.

Gravity Dependency

Because of the weight of the membrane the positioning of the VFP affects the measured signal. The VFP is normally calibrated for a vertical position of the membrane, i.e. pressure tube connections above or below horizontal plane. Other installation positions must be specified on order.

Pressure Independent Control Characteristic



$$\dot{V}_{max} \text{ set value} = \frac{\dot{V}_{max}}{\dot{V}_{nom}} \cdot 100\ \%$$

$$\dot{V}_{min} \text{ set value} = \frac{\dot{V}_{min}}{\dot{V}_{max}} \cdot 100\ \%$$

$$\frac{\dot{V}_{max\ M}}{\dot{V}_{min\ M}} = \frac{\dot{V}_{max\ S}}{\dot{V}_{min\ S}}$$

$$\dot{V}_{max} \text{ set value} = \frac{\dot{V}_{max\ S}}{\dot{V}_{max\ M}} \cdot \frac{\dot{V}_{nom\ M}}{\dot{V}_{nom\ S}} \cdot 100\ \%$$

Volume Flow Control

The volume flow controller works independently of the duct pressure, i.e. pressure fluctuations cause no changes to volume flow

To prevent the volume flow control becoming unstable, a dead zone is allowed within which the damper does not move. This dead zone and the accuracy of site measurements lead to volume flow deviation $\Delta\dot{V}$ shown opposite.

If the conditions given in the sales brochure (static minimum pressure differential, inlet flow conditions etc.) are not observed, greater deviations must be expected.

$\dot{V}_{max}$ Setting

The $\dot{V}_{max}$ value corresponds to the volume flow which is set with a 10 VDC control signal or $\dot{V}_{max}$ override control. The setting range is from 30 to 100 %. The percentage figures relate to $\dot{V}_{nom}$.

$\dot{V}_{min}$ Setting

The $\dot{V}_{min}$ value corresponds to the volume flow which is set with a 2 VDC control signal or $\dot{V}_{min}$ override control.

$\dot{V}_{min}$ may be set between 0 and 80 % of $\dot{V}_{max}$. The percentage figures relate to the $\dot{V}_{max}$ volume flow setting. If $\dot{V}_{min}$ is set to 0 %, a tight shut off of the damper is not guaranteed. The controller closes the damper until the actual value signal is 2 VDC corresponding to 0 l/s.

Measurement tolerances mean that a leakage air flow is present. Override control should be used for tight shut off.

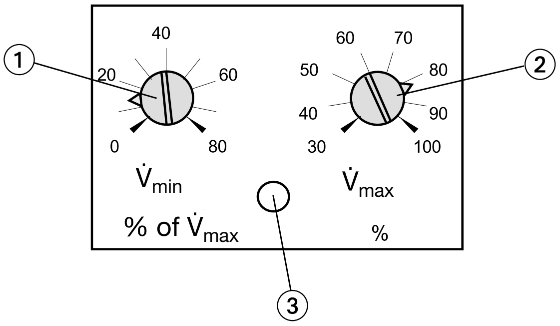
Slave Control

The VRP only provides for ratio control, i.e. the supply and extract air must be in the same ratio under all operating conditions.

The volume flow ratio is set using the $\dot{V}_{max}$ adjustment knob on the slave controller, according to the formula shown opposite. Where the volume flows are the same and the units of equal size, the setting will be 100 %.

The setting range is from 30 to 100 %. If $\dot{V}_{max}$ set value >100 %, the master and slave functions must be reversed. As a rule, the $\dot{V}_{min}$ adjustment knob on the slave is set to 0 %.

VRP Adjustment Knobs



1. $\dot{V}_{min}$ adjustment knob
2. $\dot{V}_{max}$ adjustment knob
3. Reference value potentiometer

IMPORTANT

The reference value potentiometer must not be adjusted.

Formula for $\dot{V}_{max}$

$$U_5 = \frac{\dot{V}_{max}}{\dot{V}_{nom}} \cdot 8\text{ V} + 2\text{ V}$$

Formula for $\dot{V}_{min}$

$$U_5 = \frac{\dot{V}_{min}}{\dot{V}_{nom}} \cdot 8\text{ V} + 2\text{ V}$$

Volume Flow Adjustment on Site

Volume Flow Adjustment

The set volume flow limit values can be adjusted on site using the $\dot{V}_{min}$ and $\dot{V}_{max}$ adjustment knobs on the VRP. Calculations are based on the formulae shown on page 3.

Adjustment Procedure

- First set $\dot{V}_{max}$ and then $\dot{V}_{min}$.
- If the ratio of $\dot{V}_{max}$ to $\dot{V}_{min}$ is to remain constant (e.g. $\dot{V}_{min}$ = 50 % of $\dot{V}_{max}$), only the $\dot{V}_{max}$ adjustment knob must be moved.
- Moving the $\dot{V}_{min}$ adjustment knob will have no effect on the $\dot{V}_{max}$ value.
- If $\dot{V}_{max}$ is to be altered and $\dot{V}_{min}$ to remain unchanged, $\dot{V}_{max}$ must be reset first, followed by $\dot{V}_{min}$.

Calculating the Volume Flow Using the Actual Value Signal U_5

The accuracy of the setting can be increased if the actual value signal U_5 is also measured with the system switched on.

As a rule, the controller must have been connected to the operating voltage for at least 15 minutes before measurements begin.

- Calculate the required value for U_5 at $\dot{V}_{max}$
- Disconnect all the wires from the terminal block, except for terminals 1 and 2
- Insert a link between terminals 2 and 7
- Move the $\dot{V}_{max}$ adjustment knob until the voltage U_5 corresponds to the calculated value (wait approx. 2 minutes after the adjustment, then read the voltage)
- Remove the link between 2 and 7
- Calculate the voltage for U_5 at $\dot{V}_{min}$
- Proceed with the $\dot{V}_{min}$ setting as for $\dot{V}_{max}$
- Replace original wiring

Zero Point Adjustment

It is necessary to readjust the zero point, when one of the indicating lights show a measurement off limits with measurement tubing pushed off. For further information about zero point adjustment see product information VFP.

Belimo VRP

Volume Flow Ranges TVZ, TVA, TVR, TVRK

Size	l/s				m³/h			
	$\dot{V}_{min}$		$\dot{V}_{max}$		$\dot{V}_{min}$		$\dot{V}_{max}$	
	$\dot{V}_{min\text{-}unit}$ 1)	to	from	**to $\dot{V}_{nom}$**	$\dot{V}_{min\text{-}unit}$ 1)	to	from	**to $\dot{V}_{nom}$**
100 2)	15	75	30	**95**	54	270	108	**342**
125	25	120	45	**150**	90	432	162	**540**
160	40	200	75	**250**	144	720	270	**900**
200	65	325	120	**405**	234	1170	432	**1458**
250	95	490	185	**615**	342	1764	666	**2214**
315	155	820	310	**1025**	558	2952	1116	**3690**
400	255	1345	505	**1680**	918	4842	1818	**6048**

Volume Flow Ranges TVJ/TVT

B x H mm	l/s				m³/h			
	$\dot{V}_{min}$		$\dot{V}_{max}$		$\dot{V}_{min}$		$\dot{V}_{max}$	
	$\dot{V}_{min\text{-}unit}$ 1)	to	from	**to $\dot{V}_{nom}$**	$\dot{V}_{min\text{-}unit}$ 1)	to	from	**to $\dot{V}_{nom}$**
200 x 100	45	170	65	**215**	162	612	234	**774**
300 x 100	65	255	95	**320**	234	918	342	**1152**
400 x 100	85	340	130	**425**	306	1224	468	**1530**
500 x 100	105	430	160	**535**	378	1548	576	**1926**
600 x 100	130	520	195	**650**	468	1872	702	**2340**
200 x 200	85	330	125	**415**	306	1188	450	**1494**
300 x 200	125	495	185	**620**	450	1782	666	**2232**
400 x 200	165	660	250	**825**	594	2376	900	**2970**
500 x 200	205	830	310	**1035**	738	2988	1116	**3726**
600 x 200	250	1000	375	**1250**	900	3600	1350	**4500**
700 x 200	290	1160	435	**1450**	1044	4176	1566	**5220**
800 x 200	330	1320	495	**1650**	1188	4752	1782	**5940**
300 x 300	185	735	275	**920**	666	2646	990	**3312**
400 x 300	245	985	370	**1230**	882	3546	1332	**4428**
500 x 300	305	1230	460	**1535**	1098	4428	1656	**5526**
600 x 300	370	1480	555	**1850**	1332	5328	1998	**6660**
700 x 300	430	1720	645	**2150**	1548	6192	2322	**7740**
800 x 300	490	1960	735	**2450**	1764	7056	2646	**8820**
900 x 300	555	2215	830	**2770**	1998	7974	2988	**9972**
1000 x 300	620	2480	930	**3100**	2232	8928	3348	**11160**
400 x 400	325	1305	490	**1630**	1170	4698	1764	**5868**
500 x 400	410	1630	610	**2040**	1476	5868	2196	**7344**
600 x 400	490	1960	735	**2450**	1764	7056	2646	**8820**
700 x 400	570	2280	855	**2850**	2052	8208	3078	**10260**
800 x 400	650	2600	975	**3250**	2340	9360	3510	**11700**
900 x 400	735	2935	1100	**3670**	2646	10566	3960	**13212**
1000 x 400	820	3280	1230	**4100**	2952	11808	4428	**14760**
500 x 500	510	2030	760	**2540**	1836	7308	2736	**9144**
600 x 500	610	2440	915	**3050**	2196	8784	3294	**10980**
700 x 500	710	2840	1065	**3550**	2556	10224	3834	**12780**
800 x 500	810	3240	1215	**4050**	2916	11664	4374	**14580**
900 x 500	915	3655	1370	**4570**	3294	13158	4932	**16452**
1000 x 500	1020	4080	1530	**5100**	3672	14688	5508	**18360**
600 x 600	730	2920	1095	**3650**	2628	10512	3942	**13140**
700 x 600	850	3400	1275	**4250**	3060	12240	4590	**15300**
800 x 600	970	3880	1455	**4850**	3492	13968	5238	**17460**
900 x 600	1100	4400	1650	**5500**	3960	15840	5940	**19800**
1000 x 600	1220	4880	1830	**6100**	4392	17568	6588	**21960**
700 x 700	990	3960	1485	**4950**	3564	14256	5346	**17820**
800 x 700	1140	4560	1710	**5700**	4104	16416	6156	**20520**
900 x 700	1280	5120	1920	**6400**	4608	18432	6912	**23040**
1000 x 700	1420	5680	2130	**7100**	5112	20448	7668	**25560**
800 x 800	1300	5200	1950	**6500**	4680	18720	7020	**23400**
900 x 800	1460	5840	2190	**7300**	5256	21024	7884	**26280**
1000 x 800	1620	6480	2430	**8100**	5832	23328	8748	**29160**
900 x 900	1640	6560	2460	**8200**	5904	23616	8856	**29520**
1000 x 900	1820	7280	2730	**9100**	6552	26208	9828	**32760**
1000 x 1000	2020	8080	3030	**10100**	7272	29088	10908	**36360**

1) $\dot{V}_{min}$ = 0 is also possible

2) Only TVR

Volume Flow Control Tolerances [1)]

Volume flow in % of $\dot{V}_{nom}$	$\Delta\dot{V}$ in ± %	
	TVZ, TVA, TVR, TVRK	TVJ/TVT
100	5	5
80	5	5
60	7	7
40	7	8
20	9	14
10	20	>14
<10	>20	>14

1) Percentage figures based on $\dot{V}_{actual}$

Single Duct Units

Order Code / Examples

The available options are given in the current price list.

						$\dot{V}_{min}$ $\dot{V}_{max}$
TVZ-R	/ 160	/ 00	/ **BB3**	/ **E**	-	50 - 240 l/s
TVR	/ 160	/ 00	/ **BB3**	/ **M**	-	50 - 240 l/s
TVA-R	/ 160	/ 00	/ **BB1**	/ **S**	-	50 - 240 l/s

Operating mode

- **E** Individual
- **M** Master
- **S** Slave
- **F** Fixed

Volume Flow Parameters

Operating mode	Factory Setting
E **M**	$\dot{V}_{min}$ adjustment knob set at required $\dot{V}_{min}$ $\dot{V}_{max}$ adjustment knob set at required $\dot{V}_{max}$
S	$\dot{V}_{min}$ adjustment knob set at 0 % $\dot{V}_{max}$ adjustment knob set at volume flow ratio to the master controller
F	**$\dot{V}$ < 80 % of $\dot{V}_{nom}$** $\dot{V}_{min}$ adjustment knob set at required constant volume flow $\dot{V}_{max}$ adjustment knob set at 100 % ($\dot{V}_{nom}$)
	$\dot{V}$ > 80 % of $\dot{V}_{nom}$ $\dot{V}_{min}$ adjustment knob set at 0 % $\dot{V}_{max}$ adjustment knob set at required constant volume flow Link between terminal 2 and 4

Volume Flow Ranges TVM

Size	l/s		m³/h	
	$\dot{V}_{min}$-unit	**$\dot{V}_{nom}$**	$\dot{V}_{min}$-unit	**$\dot{V}_{nom}$**
125	45	**150**	162	**540**
160	75	**250**	270	**900**
200	120	**405**	432	**1458**
250	185	**615**	666	**2214**

Volume Flow Control Tolerances TVM [1)]

Volume flow in % of $\dot{V}_{nom}$	$\Delta\dot{V}$ in ± %	
	TVM_{cold}	**TVM_{total}**
100	5	7
80	5	10
60	5	12
40	7	15
30	8	17
20	9	-
10	20	-
<10	>20	-

1) Percentages related to $\dot{V}_{actual}$

Dual Duct Units Type TVM

Order Code / Examples

The available options are given in the current price list.

$\dot{V}_{warm}$ $\dot{V}_{cold}$

TVM-R / 160 / **BE7** / **E** - 50 - 240 l/s

$\dot{V}_{warm} = \dot{V}_{cold}$

TVM-R / 160 / **BE7** / **F** - 400 l/s

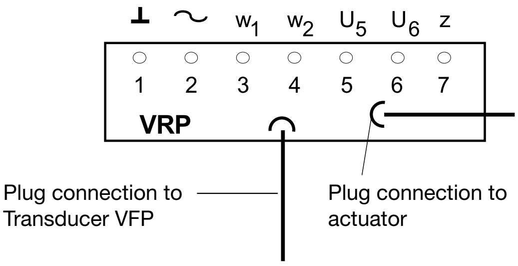
Operating mode

- **E** Individual
- **M** Master
- **F** Fixed

Volume Flow Parameters

Operating mode	Factory Setting	
	Cold Duct Controller	**Warm Duct Controller**
E **M** **F**	$\dot{V}_{min}$ adjustment knob set at 0 % $\dot{V}_{max}$ adjustment knob set at required volume flow ($\dot{V}_{cold}$)	**$\dot{V}_{warm}$ ≦ 80 % of $\dot{V}_{nom}$** $\dot{V}_{min}$ adjustment knob set at required volume flow $\dot{V}_{warm}$ $\dot{V}_{max}$ adjustment knob set at 100 %
		$\dot{V}_{warm}$ > 80 % of $\dot{V}_{nom}$ $\dot{V}_{min}$ adjustment knob set at 0 % $\dot{V}_{max}$ adjustment knob set at required volume flow $\dot{V}_{warm}$ Link between 2 and 4

Terminal Connections



IMPORTANT

The examples illustrated show the most common arrangements for volume flow control. The Belimo specifications must be observed in the overall control system design, selection of the other control components and wire sizing. Details of other circuits are available from Belimo.

Nomenclature

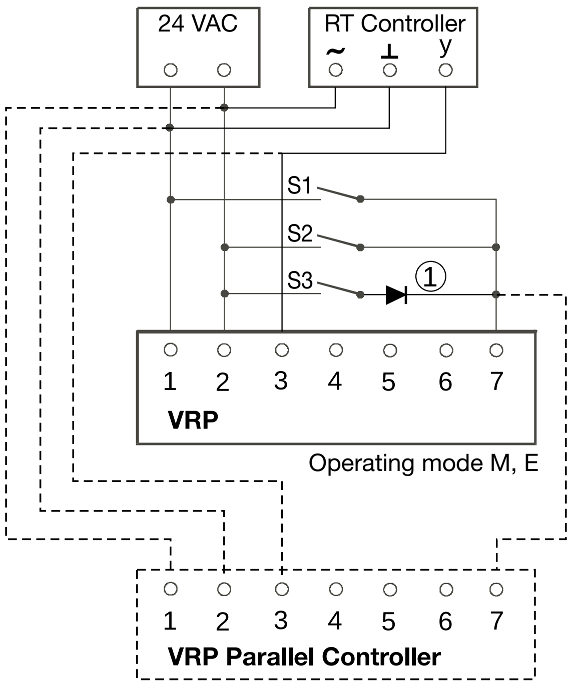
⊥ Ground, neutral
~ Supply voltage 24 VAC
w_1 Input voltage for set volume flow (2 to 10 VDC)
w_2 Input voltage for set volume flow (0 to 20 V phasecut)
U_5 Output voltage for actual volume flow (2 to 10 VDC)
U_6 Actuator signal
z Input for override control

Wiring

Actuator and volume flow controller are factory wired. The 24 VAC voltage supply must be wired up by the customer. Safety transformers must be used (EN 60742).

If several volume flow controllers are connected to one 24 V network, it is important to ensure that a common neutral or ground wire is used and that this is not connected to other wires.

Room Temperature Control with Override and Parallel Control



① Diode 1N 4007

Room Temperature Control

A suitable room temperature controller or a DDC out-station with a 2-10 VDC output is connected with at least two wires (terminals 1 and 3) as shown in the circuit diagram. If there is a common 24 VAC mains supply voltage, it is important to ensure that terminal 1 on the VRP is also the ground for the control signal.

Parallel Control

Several volume flow controllers (supply or extract air) can be operated in parallel by one room temperature controller. If the terminal units are the same size and the $\dot{V}_{min}$ and $\dot{V}_{max}$ adjustment knobs are set at the same values, all the units control the same volume flow. If the settings differ, the units control an equal percentage.

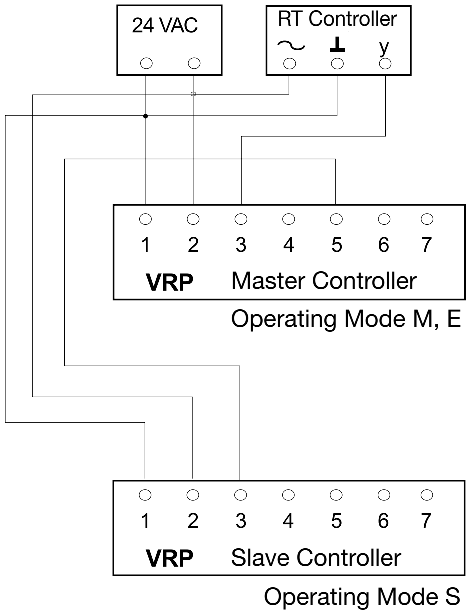
Override Controls

Potential-free switch contacts provided by the customer can override the variable volume flow control. This forced control can be applied separately for each controller (see overleaf for examples) or centrally as in the circuit diagram shown for one building section.

S1, S2, S3 open	: Room temperature control mode
S1 closed	: Shut off
S2 closed	: Constant volume flow $\dot{V}_{max}$
S3 closed	: Constant volume flow $\dot{V}_{min}$

With a combination of several override controls, the switches must be interlocked such that no short-circuits occur. One switch can control several volume flow controllers if there is a common ground and the control signal is wired in parallel. The circuits apply even if room temperature controller with 0 to 20 V phase cut signal is used.

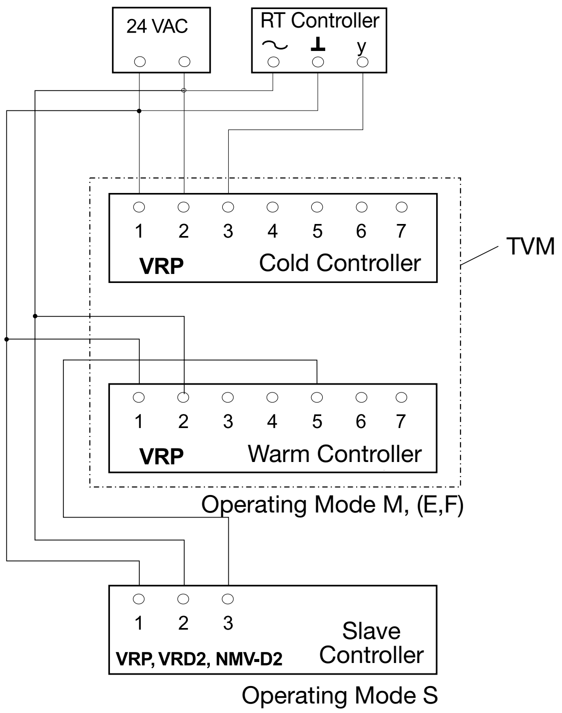
Slave Control



Supply / Extract Air Slave Control (Master/Slave)

With parallel control of the units, an undesirable difference between supply and extract air can occur if the pressure in one duct is to low. It is therefore preferable to use the volume flow actual value, usually of the supply air, as the control signal for the slave volume flow controller.

Supply / Extract Air Slave Control for Dual Duct Unit TVM



Volume Flow Control of TVM Units

The two controllers fitted to the dual duct unit TVM (cold, warm) must be wired by the customer as shown in the circuit diagram opposite (including the 24 VAC cross-connection).

The room temperature controller provides the cold duct controller with its set point signal.

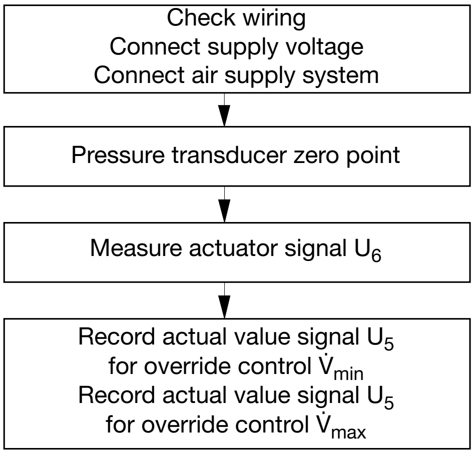
In most cases, the proportion of warm air is increased from 0 to the required $\dot{V}_{warm}$ as a maximum set point. The warm duct controller ($\dot{V}_{total}$ is measured) is therefore set as a constant value controller and does not require a control signal.

For a more detailed functional description, refer to the TVM literature.

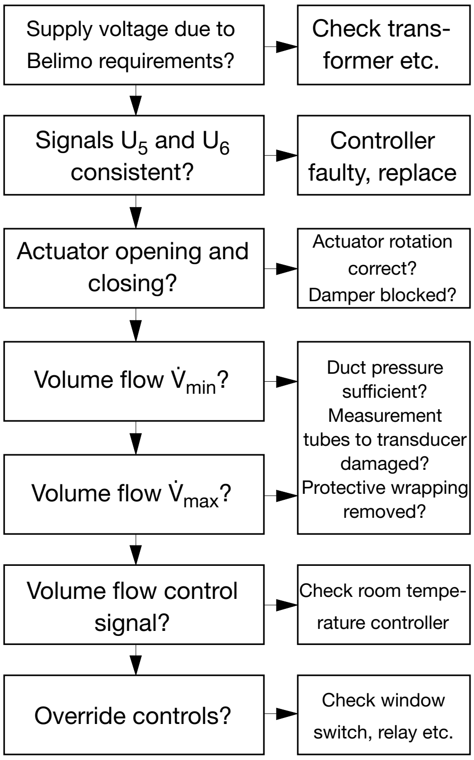
Supply / Extract Air Slave Control with Dual Duct TVM

The actual value output signal U_5 of the warm duct controller is proportional to the total volume flow $\dot{V}_{total}$. It can therefore be used as the control signal for a slave controller.

Function Test



Fault Finding Check



Order Example Replacement Controller

Belimo VRP, preset for TVZ 125, 60...140 l/s and VFP 300
Belimo VFP 300

Commissioning

A function test for commissioning can be carried out by measuring the actuator signal U_6 (terminal 6 to 1). If U_6 is between 5.8 and 6.2 VDC, the required volume flow is controlled. If U_6 deviates from this range, wait for the actuator to settle.

If the commissioning procedure is to include verification of the set volume flows $\dot{V}_{min}$ and $\dot{V}_{max}$, these must be set as described below.

The actual value signal U_5 is measured in each operating situation (check U_6 first) and the volume flow is then calculated using the formulae given on page 4.

NOTE

Severe vibration during transport or caused by different installation conditions can necessitate subsequent zero point adjustment. The procedure is described in the product information for VFP.

In many cases, incorrect wiring can be the cause of the faults. Therefore a careful check should be carried out to ensure that all connections are secure. Wires in terminals 3 to 7 should be disconnected and the actuator connection plug removed before the following checks are made.

If the actuator drive is disengaged and the damper opened manually, the voltage U_5 must increase and the voltage U_6 deviate from 6 VDC.

Connect the actuator plug, link terminals 1 and 7: The actuator must close.

Change link to terminals 2 and 7: The actuator must open.

Remove the link. The controller must control $\dot{V}_{min}$. If U_6 is approx. 6 volts, measure U_5, calculate the volume flow and compare it with the design value.

Link terminals 2 and 7: Repeat measurement for $\dot{V}_{max}$, as above.

Remove link. Apply the control signal U_3 . Calculate the set volume flow and compare it with the actual volume flow.

Apply the override control (terminal 7) and test the desired functions in sequence.

Replacement Controller

When replacing faulty controllers, calibrated controllers set for the terminal box type and size must be used. Uncalibrated controllers can only be used as a temporary solution. When ordering replacement controllers, specify $\dot{V}_{min}$ and $\dot{V}_{max}$.