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1. Gruner Compact VAV Controller 227VM / GA-VM

1.1. General Description

Pressure independent control of VAV boxes

The actuator is controlled by proportional controllers, positioners or DDC-systems. Different operating modes can be realized by using override control signals.

!!! Safety remarks !!!

The actuators are not suitable for use in explosive atmospheric applications!

All service to the actuators (mounting, electrical connection, retrofitting and repair) must be carried out with the power supply disconnected. The electrical connection must be done by a trained and competent person considering the wiring diagrams, local and national regulations. Use copper twisted conductors only. Provide disconnect and overload protection if necessary.

This actuator may only be operated by 24 VAC/DC!

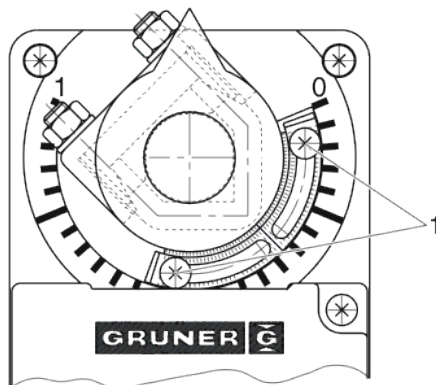
The transformer must be sized according to technical data of the actuator (see section below). Electronics and controllers **must** be powered from a separate transformer when controller power is full-wave rectified. Otherwise the controller or the actuator may be damaged.

Always read the controller installation instructions before making any connection!

Assembly

The damper actuator, type 227V contains a dynamic differential pressure sensor. The volume flow is measured according to the defined flow direction. It is therefore necessary to connect the pressurized stubs correctly. The connection (+) is the input and (-) the output. An integrated micro processor controls measurement, servomotor and communication.

Adjustment of angle of rotation



Both end stops are adjusted to 0° and 90°. For smaller rotation angles, loosen the screws at the metal end stop, adjust the end stops as requested, and fasten the screws again. Make sure that with closed damper the motor is on end stop. If necessary re-adjust the metal stop. **The necessary screwing torque is $M_d = 1\text{Nm}$ or 9in-lb.**

Montage / Mounting

Klemmbügelbefestigung 227V
Locking clamp fixing 227V

Round shaft \varnothing 5/16" to 5/8" (8 to 16 mm)
Square shaft \square 5/16" to 15/32" (8 to 12 mm)

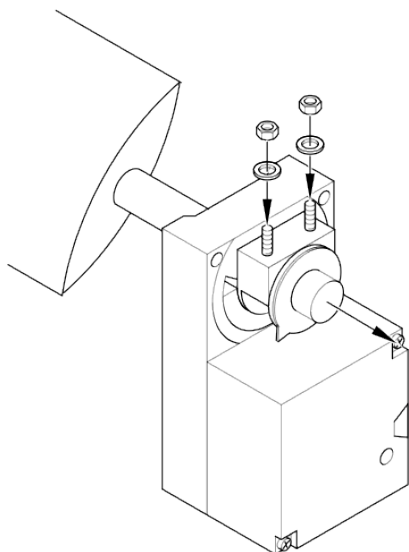


Abb. 1
Fig. 1

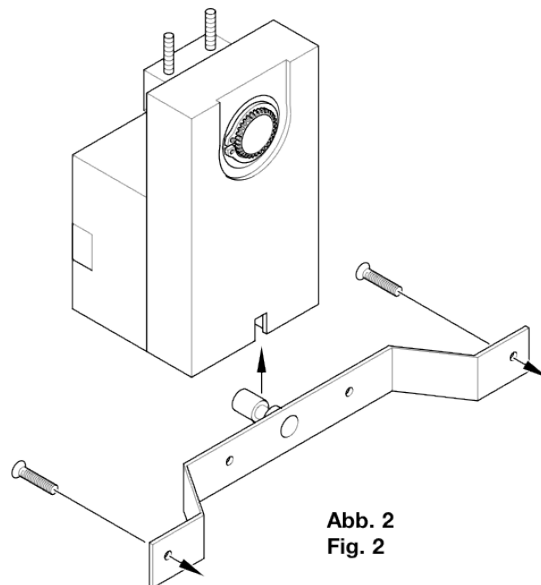


Abb. 2
Fig. 2

Direkte Montage mit der Zugbügelklemme auf der Klappenachse (Abb. 1) und Fixierung (Abb. 2) mit beiliegendem Verdrehsicherungsbügel.

Achse: \varnothing 8 - 16 mm oder \square 8 - 12 mm

Direct mounting by the locking clamp to the damper shaft (Fig. 1) and fixing (Fig. 2) by the enclosed anti-torsion bow.

Shaft: \varnothing 8 - 16 mm or \square 8 - 12 mm

Formschlußwelle und Flanschbefestigung 227V
Form locking shaft and flange fixing 227V

Round shaft \varnothing 5/16" to 5/8" (8 to 16 mm)
Square shaft \square 5/16" to 15/32" (8 to 12 mm)

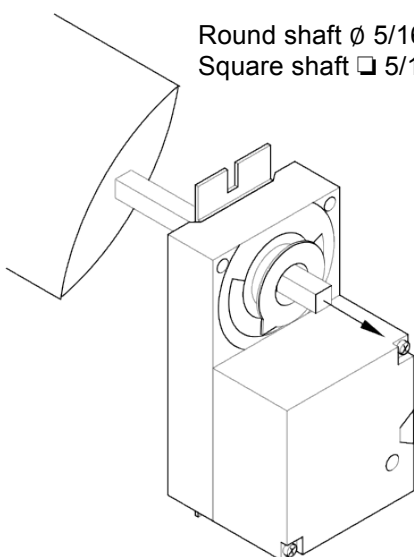


Abb. 3
Fig. 3

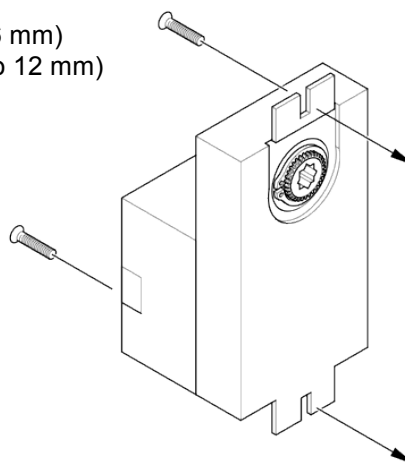


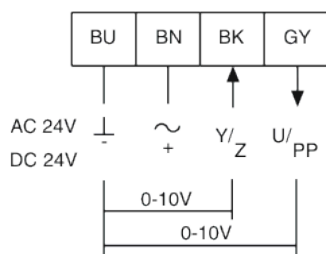
Abb. 4
Fig. 4

Direkte Montage durch Aufstecken auf die Klappenachse (Abb. 3) und Fixierung (Abb. 4) der 2 Flansche mit Schrauben M5. Achse: \square 8 mm

Direct mounting by plug-on to the damper shaft (Fig. 3) and fixing (Fig. 4) of the 2 flanges by screws M5.

Shaft: \square 8 mm

Connection scheme



BU = blau, blue
 BN = braun, brown
 BK = schwarz, black
 GY = grau, grey

BU-BN	Betriebsspannung	24 VAC / DC
BU-BK	Regelspannung	0...10 V / 2...10 V
BU-GY	Rückführsignal	0...10 V / 2...10 V
Last für Ausgang GY:		max. 0,5 mA
BU-BN	operating voltage	24 VAC / DC
BU-BK	control signal	0...10 V / 2...10 V
BU-GY	feedback signal	0...10 V / 2...10 V
load for output GY:		max. 0.5 mA

Notes:

- Actuators are provided with color coded wires. Associated to the color you find numbers as follows BU = 1, BN = 2, BK = 3 and GY = 4.
- Observe polarity on secondary of transformers. All common and signal (–) must be connected in line. Incorrect polarity can cause controller damage or operation error.
- Long wire runs requires a 4-wire configuration (connect common for power and control signal at the actuator or close by). Greater than a 0.2 V drop must be avoided for any common wire.
- Always use a separate transformer when controller power is full-wave rectified.
- Controller and actuators must have separate transformers for paralleled multi-actuator application.
- Provide overload protection for line voltage and disconnect as required

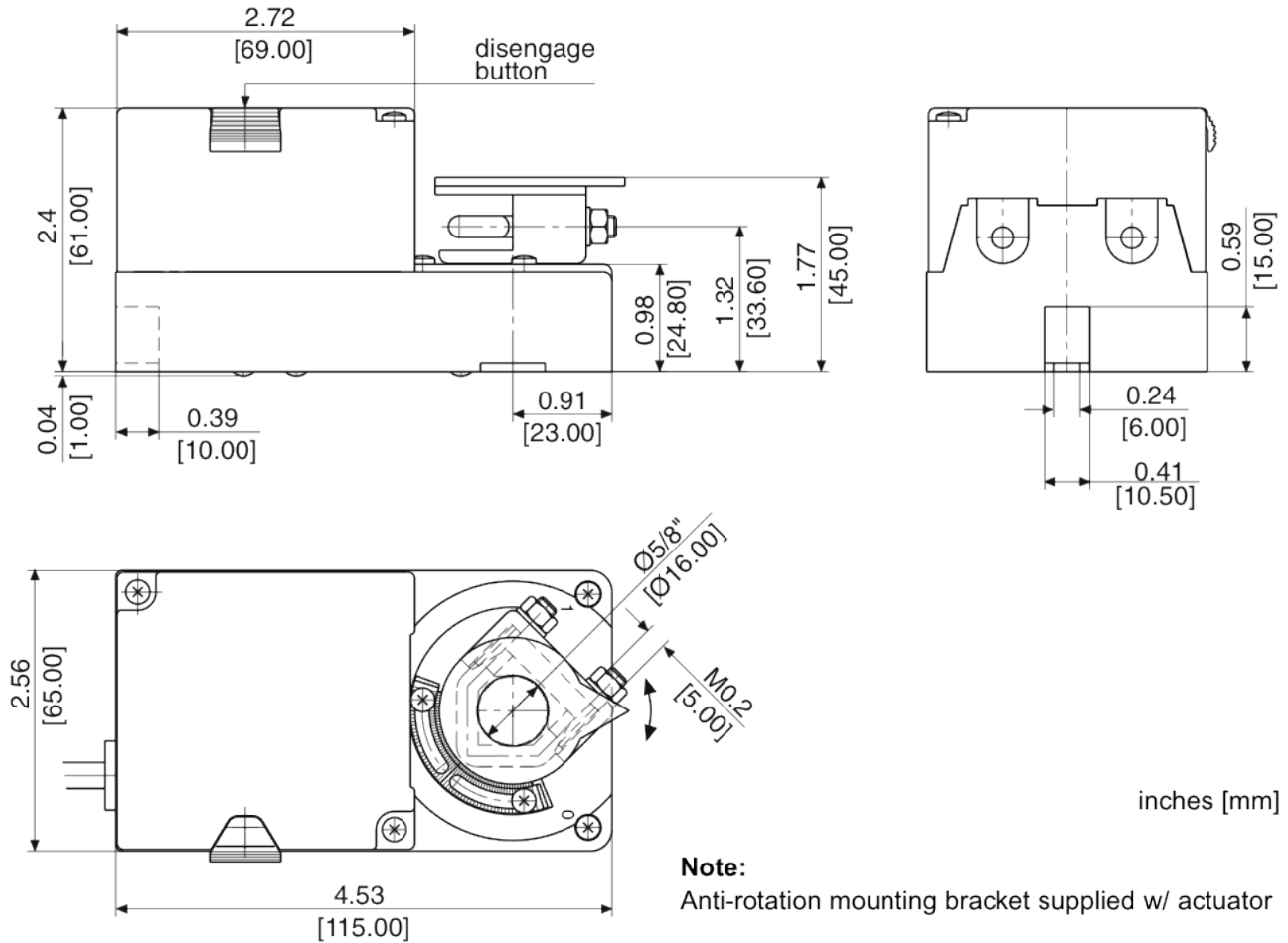
Multiple Actuators (maximum quantities)	227VM GA-VM
Parallel connection (0)2 ... 10VDC	20
Parallel Connection (0)4 ... 20mA w/500Ω resistor	10
Master – slave via U, feedback signal	10

Specification

Control			
Input signal	Proportional to [VMIN...VMAX] w/ (0)2-10 VDC, or (0)4-20 mA w/500 Ω resistor and override controls	VNOM	Setting in three stages I. 0 to 999 in 5 increments II. 1'000 to 9'990 in 50 inc. III. 10'000 to 99'900 in 500 inc.
Input impedance	>50 kΩ	VMAX	0 % to 100 % of VNOM
Feedback signal	(0)2-10 VDC proportional to air volume flow	VMIN	0 % to 100 % of VNOM
Electrical		Performance	
Power supply	24 VAC/VDC ± 20%, 50/60 Hz	Torque	45 in-lb (5 Nm) 90 in-lb (10 Nm)
Over voltage	Up to 40 V, max. 5 sec.	Damper size	Up to 11 sq. ft. (1 m ²) Up to 22 sq. ft. (2 m ²)
Power consumption	3.0 W (5.0 VA) @ 5Nm	Angle of rotation	0-95°/95-0°, adj. angle with integral stops
Differential pressure sensor		- CCW(L) and CW(R)	L/R selector in menu
Operating pressure	0 to 1.2 in. H ₂ O (0-300 Pa)	Rotation time	15...100...120 sec/0-90° adjust.
Bursting pressure	14.5 psi (1 bar)	Power failure	Stays in last position of operation
Medium	32 °F to 158 °F / 5-95% RH non-condensing	Position indicator	0-10 divisions, and adj. visual indicator
Characteristic	OEM specific, matching the flow meter	Synchronization	± 1%
Mounting position	any position, no calibration necessary	Overload protection	Electronic throughout rotation
Material	Ultem 2200 resin	Manual override	Optional built-in disengage button
Pressurized connection	Stubs for tubes w/ inner Ø 0.157" to 0.236" (4 to 6 mm)	Motor type	BLDC motor
Working volume control		Noise level	max. 35 dB(A) @ 100s
		Environmental	
		Permissible ambient	

- working temperature	32 °F to 122 °F (0 °C to 50 °C)	- round shaft	∅ 5/16" to 5/8" (8 to 16 mm)
- storage temperature	-4 °F to 176 °F (-20 °C to 80 °C)	- square shaft	5/16" to 15/32" (8 to 12 mm)
- humidity	5-95% RH, non-condensing	Wire connection	3 ft. (0.9 m) cable, color coded, plenum rated optional
Physical		Wire size	18 AWG (0.75 mm ²)
Enclosure		Dimensions	4.53 x 2.56 x 2.40 in. (115 x 65 x 61 mm)
- cover	ABS, Cyclac	Weight	1.2 lbs. (0.53 kg)
- base	PA 6.6	Manufacturing	ISO 9001 certified
- color	White and black	Listings/Approvals	CE, (UL and CSA pending)
- protection	NEMA 2	Warranty	Five-year material and workmanship (Two-year standard, three-year conditional)
Mounting position	Any position		
Anti-rotation bracket	Included w/actuator		
Paralleling	Refer to table "Multiple Actuators"		
Clamp connection to			

Dimensions



1.1.1. Manual operation

The manual declutch button (1) is optional. It is possible to declutch the gear and have the actuator manually set to certain angles or end positions. However the actuator will control to the desired VAV (or pressure) according to the external reference signal Y.

The controller can be turned off in order to allow manual settings and to keep the position unchanged. (refer to diagnostic functions 1.2.2.)

1.1.2. Cover

The cover shows the appropriate units and if diagnostic functions are set. Also there is the 3-digit display to show selected functions, values and units. The units are printed on the sticker.

On the cover of the actuator there are two selectors.

- 1) Value selector (2) ($\Delta 10^\circ$ / Edit) – see 1.1.3
- 2) Function selector (3) (Vnom, Mode, Diag, Vmax, Vmin, Flow/Unit) – see 1.1.4

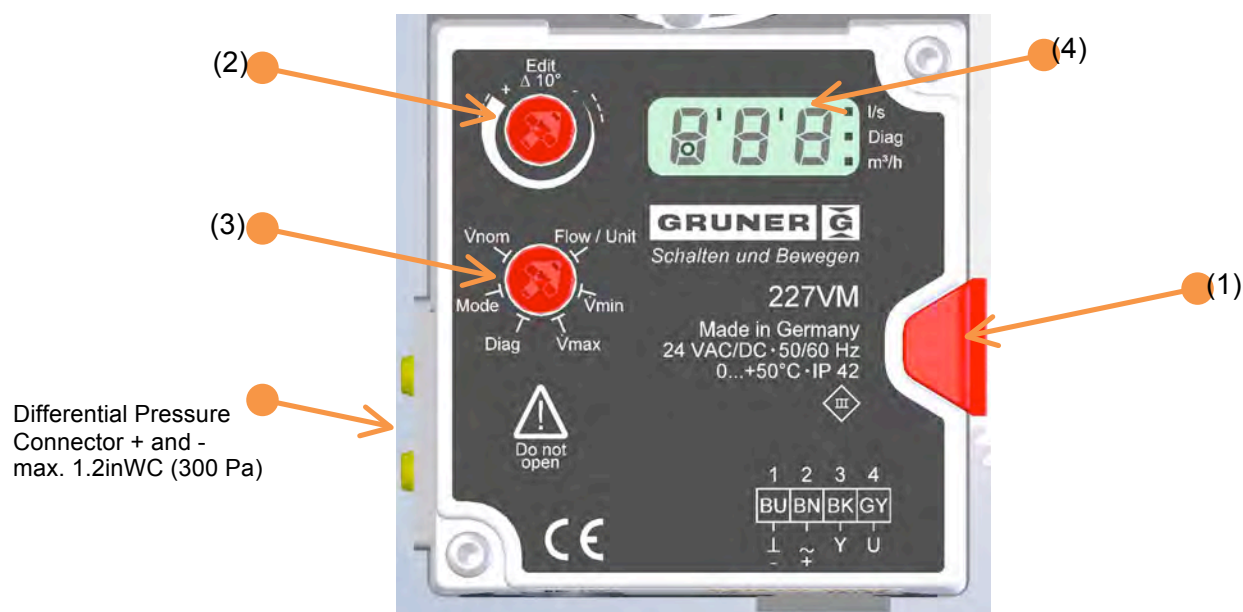


Figure 1: Cover of 227VM / GA-VM

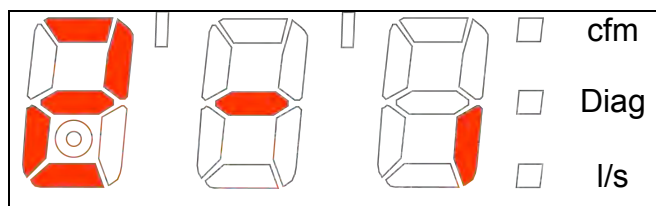
1.1.3. Value selector ($\Delta 10^\circ$ / Edit)

The value selector allows the changing of values. The position of the arrow shows the value set. The changes are displayed as soon as the selector is moved $\pm 10^\circ$ from its position. By turning the selector up or down the corresponding values are shown. For change V_{nom} one can select the appropriate thousand separators.

e.g. if V_{nom} is set to 100 and has to be set to 1'000 one has to turn the selector upwards (toward +) until the separator appears in the display. After that it is necessary to adjust to the desired value.

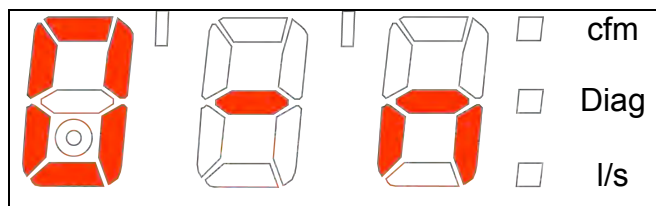
e.g. if V_{min} is set to 60 and has to be set to 50 one has to turn the selector downwards (toward -) until a change appears in the display.

e.g. if the input mode is 2...10VDC with inverse direction of rotation and has to be set to 0...10VDC and normal direction of rotation



Display for 2...10VDC input range, inverse direction of rotation

one has to turn the selector until the following is shown in the display:



Display for 0...10VDC input range, normal direction of rotation

After the selection the new value is saved and the display flashes two times for indication. The value is always saved after the selection and the usage of the function selector (3).

1.1.4. Function selector

The function selector allows choosing the function depending on its position. If there is no function selected the display will show three dashes (- - -).

Function	Description
Flow/Unit	Shows the actual flow in m ³ /h, l/s, cfm or % and Diag for diagnosis. This display matches with the feedback signal U. The display starts flashing if the servomotor hits an end stop before matching actual to reference flow. An overflow (higher pressure as 250Pa = 1.0inWC) is indicated in the display by a small circle. Turning the value selector allows unit selection. The appropriate dot is toggled as indicator. The units are converted according to the given precision as described below (see Vnom).
Vmin	Allows to set the desired minimum flow for the external reference signal Y=0V or Y=2V. In cfm, m ³ /h or l/s directly or in % of Vnom.
Vmax	Allows to set the desired maximum flow for the external reference signal Y=10V. In cfm, m ³ /h or l/s directly or in % of Vnom.
Mode	Allows to set the direction of rotation (normal and inverse) and the input signal range (0...10V or 2...10V) of the reference signal Y. The feedback signal range of U corresponds to Y. 0-n ... 0-10V, normal 0-i ... 0-10V, inverse 2-n ... 2-10V, normal 2-i ... 2-10V, inverse
Diag	Opens the diagnose menu. All outside input signals on Y are neglected and the controller only operates according to the selected override function. All override functions are disabled after a time-out of 10 hours. The display toggles after the selection of the function between the actual flow (8s showing time) and the function (2s showing time). Selecting another function will disable the Diag function and set it automatically to oFF oP(en) ... opens the damper cL(ose) ... closes the damper Hi(gh) ... forces the actuator to Vmax Lo(w) ... forces the actuator to Vmin on ... Test mode is switched on. The actuator stays in the current position. oFF ... Test mode is switched off. The actuator starts controlling according to external signal Y. This signal Y shall be shown in the range of 0...100 x10 ⁻¹ V 123 ... Showing the software version V123. After 3s showing the display shows oFF again.s

Vnom	<p>Set-up of the Vnom according to the flow corresponding to 1.0inWC (250 Pa) differential pressure. The setting of Vnom is done in three stages depending on the value to be selected.</p> <p>Stage I: 0 ... 999 in steps of 5 Stage II: 1'000 ... 9'990 in steps of 50 Stage III: 10'000 ... 99'900 in steps of 500 max. 18'000 l/s or 65'500 m³/h</p> <p>For the first set-up no password is needed. After this first set-up one needs to set first the OEM specific password (255 Gruner standard if no OEM is set) and wait until the display flashes and allows the setting of a different Vnom.</p>
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1.1.5. Display

The display (4) uses 7-segment numbers in full 3-digits. Additional signs include a small circle, three square dots and two rectangular slashes.

The square dots are used with the externally printed text to visualize certain functions or units (m³/h, cfm, l/s, Pa, inWC, etc.). It is meant to denote the unit of the value shown in the display. In the shown case it could be cfm, l/s or activated Diag (diagnostic function). An overflow (differential pressure above 250Pa or 1.0inWC) is indicated in the display by a small circle at the first digit.

If the controller tries to match reference and actual flow this is shown as flashing dot of the chosen unit.

If the controller cannot meet reference and actual flow and therefore hits an end stop the complete display starts flashing to indicate this problem.

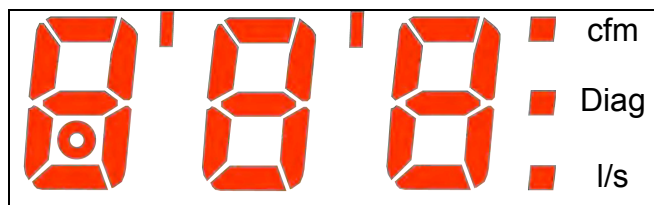


Figure 2: 3-digit 7-segment display of 227VM/GA-VM

The rectangular slashes are used to define the thousand separators. In this case the display would show numbers as followed:

1 cfm				<input checked="" type="checkbox"/> cfm <input type="checkbox"/> Diag <input type="checkbox"/> l/s
10 cfm				<input checked="" type="checkbox"/> cfm <input type="checkbox"/> Diag <input type="checkbox"/> l/s
100 cfm				<input checked="" type="checkbox"/> cfm <input type="checkbox"/> Diag <input type="checkbox"/> l/s
1'000 cfm				<input checked="" type="checkbox"/> cfm <input type="checkbox"/> Diag <input type="checkbox"/> l/s
10'000 cfm				<input checked="" type="checkbox"/> cfm <input type="checkbox"/> Diag <input type="checkbox"/> l/s
99'900 cfm				<input checked="" type="checkbox"/> cfm <input type="checkbox"/> Diag <input type="checkbox"/> l/s

1.1.6. Input signals Y (analog)

The input signal Y allows to control the VAV actuator according to the selected mode of operation.

In mode 0...10VDC the input signal Y matches to the following flows:

$$V_{act} = V_{min} + \frac{Y}{10VDC} \cdot (V_{max} - V_{min})$$

and the flows match to $Y = 0\text{VDC}$ as (V_{\min}) and $Y = 10\text{VDC}$ as (V_{\max})

$$Y = 10\text{ VDC} \cdot \frac{V_{act} - V_{\min}}{V_{\max} - V_{\min}}$$

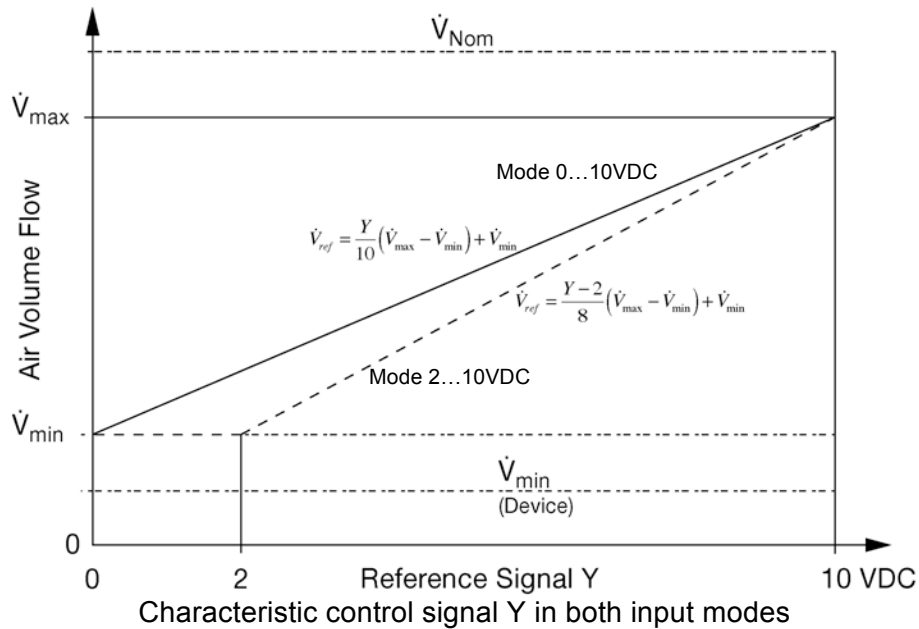
In mode 2...10VDC the input signal Y matches to the following flows:

$$V_{act} = V_{\min} + \frac{Y - 2\text{ VDC}}{8\text{ VDC}} \cdot (V_{\max} - V_{\min})$$

and the flows match to $Y = 2\text{VDC}$ as (V_{\min}) and $Y = 10\text{VDC}$ as (V_{\max})

$$Y = 2\text{ VDC} + 8\text{ VDC} \cdot \frac{V_{act} - V_{\min}}{V_{\max} - V_{\min}}$$

with the special function of $Y = 0\text{VDC}$ to (close damper)



In both modes:

- (Open) $Y = \text{pos. rectified half wave from } 24\text{VAC supply to (open damper)}$
- (Close) $Y = \text{neg. rectified half wave from } 24\text{VAC supply to (close damper)}$
- (V_{\max}) $Y = \text{full wave from } 24\text{VAC supply to (} V_{\max} \text{)}$

Schematic diagram for external override commands

Specialty of input mode 2...10VDC:

In the range of $Y = 0...0.8V$ the override command Close will be detected. The upper value of 0.8V is subject to change of the OEM. Several fixed settings are available for choice (0.8V/1.0V/1.2V/1.4V/1.6V/1.8V). Un the range of $Y = 0.8...2V$ the controller detects V_{min} .

Specialties of both input modes (0)2...10VDC:

In both modes it is possible to define a Zero value of air-flow. Thus allows the controller the programming of an air-flow value which is used as zero. If e.g. the zero value is set to $V_{Null} = 1,2\%$ of V_{nom} the controller will read all air flows smaller as V_{Null} as zero flow. If the value $V_{min} = 0$ is set the zero value allows the setting of a threshold for closing the damper.

1.1.7. Output signals U (analog)

The output signal U follows the selected mode of operation and shows the actual flow V_{act} normalized to the selected V_{nom} value.

In mode 0...10VDC the output signal U matches to the following flows:

$$U = 10 \text{ VDC} \cdot \frac{V_{act}}{V_{nom}}$$

and to calculate the actual flow V_{act} from the feedback signal U:

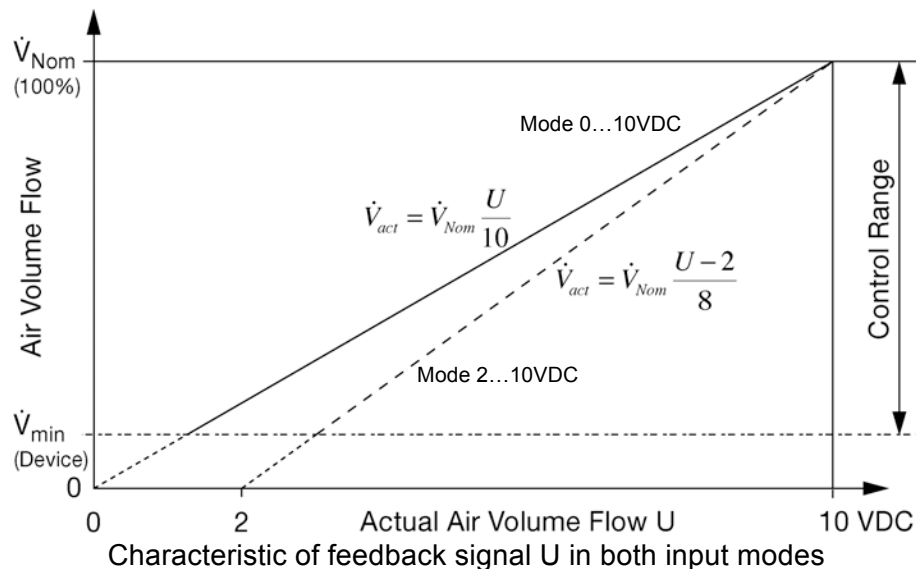
$$V_{act} = V_{nom} \cdot \frac{U}{10 \text{ VDC}}$$

In mode 2...10VDC the output signal U matches to the following flows:

$$U = 2 \text{ VDC} + 8 \text{ VDC} \cdot \frac{V_{act}}{V_{nom}}$$

And to calculate the actual flow V_{act} from the feedback signal U:

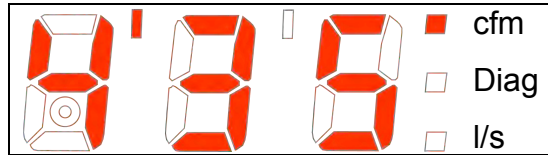
$$V_{act} = V_{nom} \cdot \frac{U - 2 \text{ VDC}}{8 \text{ VDC}}$$



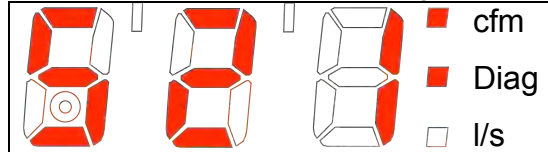
1.1.8. Examples for the display

Display of actual flow (or Vmin or Vmax according to functional selector)

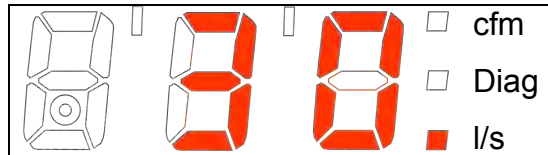
The display shows the flow in 4'350 cfm.



The display shows the flow in 521 cfm and the diagnose mode is turned on.



The display shows the flow in 30 l/s.



1.2. Setup of VAV actuator

1.2.1. Step by step set-up procedure

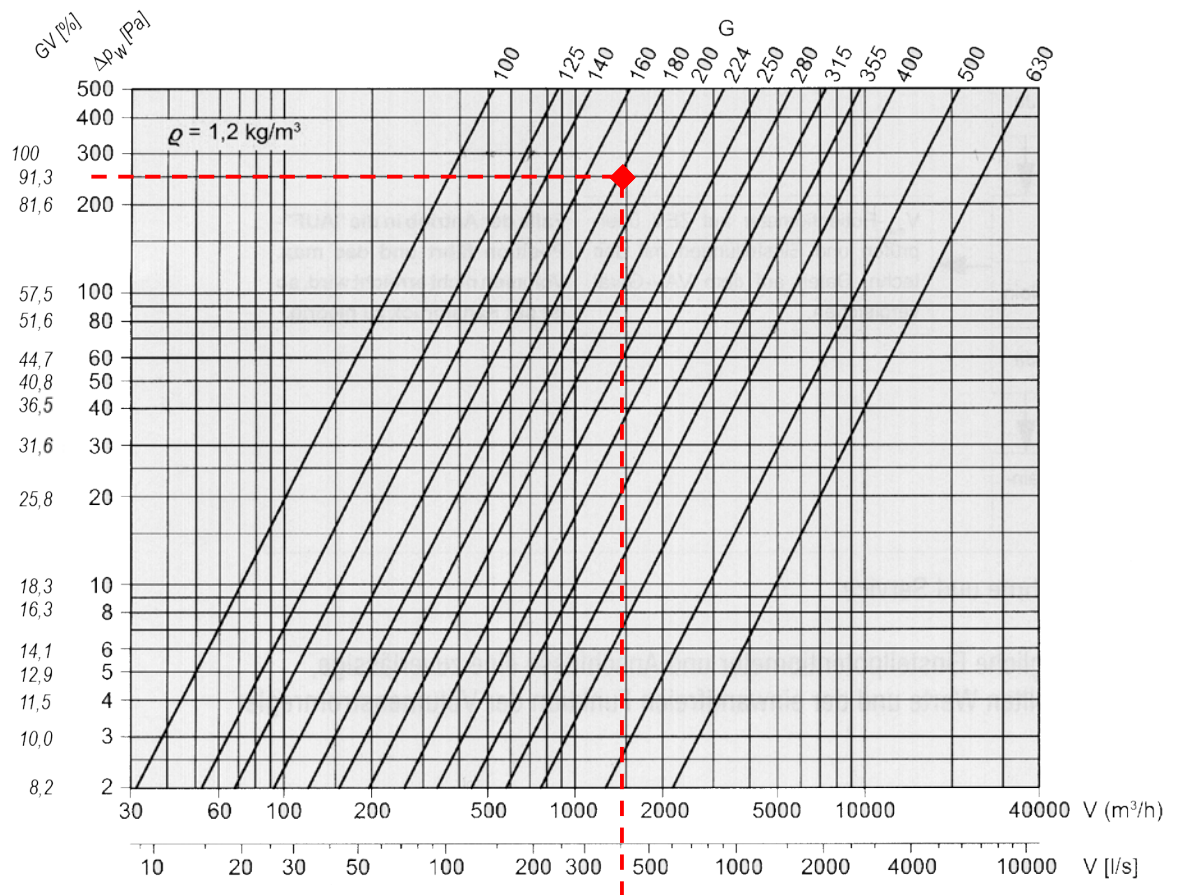
- 1) Connect the actuator to the damper and install the pressurized stubs

ATTENTION: Ensure right connection of over-pressure side to + input of the stubs and under-pressure side to – input

- 2) Connect the actuator to the power supply. **For safety remarks see first page !!!**

- 3) Use the function selector - see 1.1.2. (3) and read 1.1.4.
Set (3) to Flow/Unit and choose with the value selector (2) the unit that will be used to set-up the controller.

- 4) Use the function selector - see 1.1.2. (3) and read 1.1.4.
Set (3) to Vnom and choose the flow thru according to 1.0inWC (250Pa) differential pressure. Refer to the box manufactures data.



For the selected box type G180 the following values have to be selected:
Vnom = 180 m³/h ≈ 500 l/s ≈ 1060 cfm @ 250 Pa ≈ 1.0"WC

- 5) Use the value selector - see 1.1.2. (2) and read 1.1.3.
Set the appropriate value according to the desired unit.
If one needs m³/h the value 1'800 has to be set. The display shows 1'80

If one needs l/s the value 500 has to be set. The display shows 500
 If one needs cfm the value 1'05 has to be set. The display shows 1'05

NOTE: To switch between the stages (see 1.1.4.) one has to turn (2) towards + until the ' appears in the right position. Turning towards – decreases the position of '. This ' symbol is used as a thousand separator.

NOTE: For the first set-up no password is needed. After this first set-up one needs to set first the OEM specific password (255 Gruner standard if no OEM is set) and wait until the display flashes and allows the setting of a different Vnom.

- 6) Set (3) to Mode using the function selector and use the value selector (2) to choose the right input mode and direction of rotation.
 The direction of rotation is defined as follows:
- Normal, if the marking 0 matches to the closed position of the damper and the marking 1 matches to the open position. In the display it is abbreviated by n
 - Inverse, if the marking 1 matches to the closed position of the damper and the marking 0 matches to the open position. In the display it is abbreviated by i

The analog input signal Y to control the air flow according to the set maximum flow Vmax and minimum flow Vmin can be 0...10VDC or 2...10VDC (see 1.1.6.)

If one wants to have 0...10VDC analog input and normal direction of rotation, the selector (2) has to be turned until 0-n appears in the display.

- 7) Set (3) to Vmax using the function selector and use the value selector (2) to choose the desired maximum flow.
 The values that can be selected in the range from 0 to Vnom in 255 steps.

So in the given example from:

0 ... 1'800 m³/h with increments of 7.06 m³/h

0 ... 500 l/s with increments of 1.96 l/s

0 ... 1'050 cfm with increments of 4.12 cfm

The controller always takes the next smallest integer for the display. It is not possible to set any value smaller than the increments.

If one needs Vmax = 1'200m³/h the value 1'200 has to be set. [1'20]

If one needs Vmax = 340l/s the value 339 or 341 has to be set. [339] or [341]

If one needs Vmax = 700cfm the value 700 has to be set. [700]

- 8) Set (3) to Vmin using the function selector and use the value selector (2) to choose the desired minimum flow.
 The values that can be selected range from 0 to Vnom in 255 steps.
 The setting is similar to Vmax and the controller always takes the next smallest integer for the display. It is not possible to set any value smaller than the increments shown in step 6.

If one needs Vmin = 200m³/h the value 197 or 204 has to be set. [200] or [204]

If one needs Vmin = 60l/s the value 60 has to be set. [60]

If one needs Vmin = 120cfm the value 120 or 123 has to be set. [119] or [123]

- 9) Set (3) to Flow/Unit using the function selector and use the value selector (2) to choose the right unit.
Turning (2) toggles the dots that assign the appropriate unit. It does change any settings of V_{nom} , V_{max} or V_{min} . The values set are converted between the different units.
The display shows the current flow detected by the controller.

1.2.2. Step by step diagnosis procedure

- 1) Set (3) to Flow/Unit using the function selector.
The display shows the actual flow.
If the display flashes this number it means that the controller is unable to reach the desired air flow. This can result in either too much air (turbulences) or too less air.

e.g. the display flashes 50 l/s
- 2) Set (3) to Diag using the function selector.
One should read in the display oFF.
Using (2) it is possible to set the following diagnostic functions:
cL this closes the damper and keeps it close.
oP this opens the damper and keeps it open.
Hi this forces the controller to V_{max} .
Lo this forces the controller to V_{min} .
on this turns the test function on.
oFF this turns the test function off.
If any diagnostic cL, oP or on, Hi, Lo function is selected the display shows the Diag dot.

e.g. set diagnostic function to Lo
- 3) The display starts toggling between actual flow and the selected function.
- 4) Set (3) to Flow using the function selector. This turns off the Diag function automatically. If the diagnostic function is not turned off the controller resets this setting after 16 hours.

1.2.3. Setting the controller to a constant air flow

The controller can be set to a constant air flow neglecting all analog inputs Y. This functionality can be used as an advanced diagnostic function.
To activate this function one needs to set V_{max} to 0. In this case the Diag dot in the display starts flashing and the controller uses V_{min} as the constant air flow to control to.