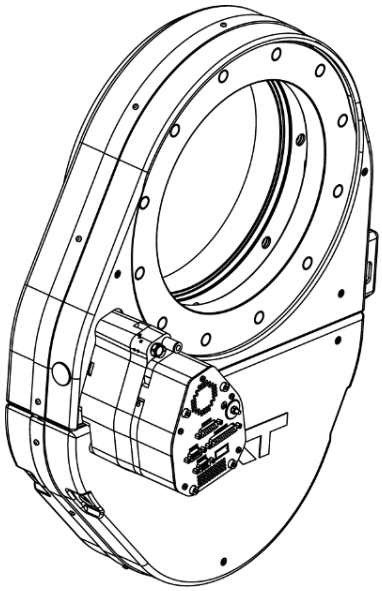
Series 650, DN 250 (I.D. 10"), RS232

Pendulum control & isolation valve

with Integrated Controller and RS232 Interface

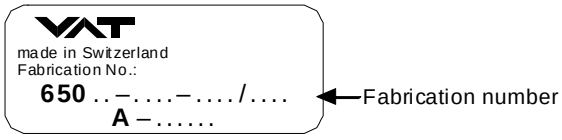


This manual is valid for the valve ordering number(s):

65048-JHGH-BHN3

configured with firmware 650L.1D.10

The fabrication number is indicated on each product as per the label below (or similar):




Read declaration carefully before you start any other action!


Attention!


Loaded springs and/or air cushions are potential hazards!


Disconnect electrical power and compressed air lines. Do not touch parts under voltage!


Keep body parts and objects away from the valve opening!


Hot surfaces; do not touch!


Wear gloves!


Read these **«Installation, Operating & Maintenance Instructions»** and the enclosed **«General Safety Instructions»** carefully before you start any other action!

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Contents:

1 Use of product

This product is a throttling pendulum valve with isolation functionality. It is intended to use for downstream pressure control applications

Use product for clean and dry indoor vacuum applications under the conditions indicated in chapter «Technical data» only! Other applications are only allowed with the written permission of VAT.

1.1 Technical data

1.1.1 Control and actuating unit

Power supply input	+ 24 V DC (±10%), 2.1A max.
Sensor power supply output	+ 24 V DC / 1500mA max.
Power consumption	50W (max. current; operation of valve with max. load) • This figure includes control and motor power consumption
Sensor signal input	0 - 10 VDC / Ri > 100kΩ
Ambient temperature	0°C to +50 °C (35 °C recommended)
Control accuracy	Pressure: 0.1% of sensor full scale Conductance: 0.1% of the valve stroke
Position resolution / position control capability	12'444 steps

1.1.2 Valve unit

Pressure range at 20°C	1×10^{-6} mbar to 1.2 bar (abs)	
Leak rate to outside at 20°C	1×10^{-5} mbar ls^{-1}	
Leak rate valve seat at 20°C	1×10^{-4} mbar ls^{-1}	
Cycles until first service - isolation cycles (open - closed - open) - throttling cycles (open - max. throttle - open)	 200'000 (unheated and under clean conditions) 1'000'000 (unheated and under clean conditions)	
Admissible operating temperature - actuator ambient - valve body	 0°C to +50 °C (35 °C recommended) 10°C to +150 °C	
Mounting position	any (valve seat on chamber side is recommended)	
Process side materials	valve body, pendulum plate	Aluminum 3.2315 (AA6082)
	sealing ring	Aluminum 3.2315 (AA6082), 1.4306 (304L)
	other parts	1.4435 (316L), 1.4404 (316L), 1.4122, 1.4310 (301), 1.4303 (304), 1.4571
	seals	all Chemraz® 657
	seals atmosphere side	- Rotary feedthrough Viton® - Shaft sealing ring feedthrough Viton®
Max. differential pressure on gate during isolation	1200 mbar in either direction	

Max. differential pressure on gate during opening and throttling	5 mbar
Min. controllable conductance (N_2 molecular flow)	15 ls^{-1}
Closing time throttling only	1.3 s typ.
Opening time throttling only	1.3 s typ.
Closing time throttling & isolation	3 s typ.
Opening time throttling & isolation	4 s typ.
Dimensions	Refer to dimensional drawing

2 Installation

2.1 Unpacking

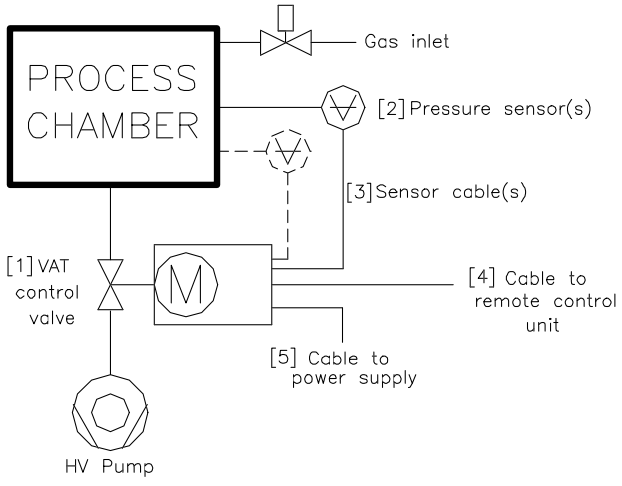
As this valve is a heavy component you should lift it with adequate equipment to prevent any injury to humans. Do not lift this product at the control and actuating unit.

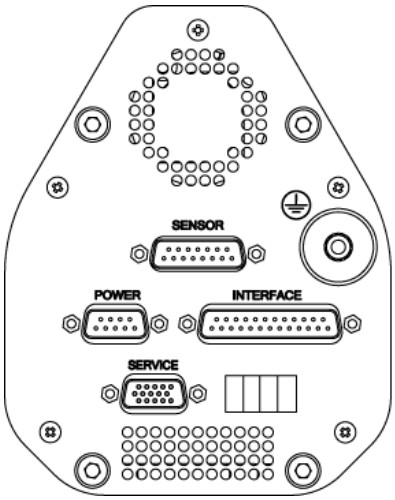
DN250 (10") valves are equipped with attachment points (tapped holes). Add eyebolts to these attachment points for lifting. The attachment points are indicated on the dimensional drawing of the specific valve part number (available on request).

Never lay the valve down with controller / actuator downwards as the controller / actuator may be damaged.

2.2 Installation into the system

Do not connect or disconnect sensor cable **when device is under power.**





1. Install S65.0 pressure control valve [1] into the vacuum system.
   Note: Make sure that enough space is kept free to do preventive maintenance work. The required space is indicated on the dimensional drawing.
   Valve seat side should face process chamber. The valve seat side is indicated by the symbol "∇" on the valve flange.
   Caution: Do not tighten the flange screws stronger than indicated under «Tightening torque».
   Caution: Do not admit higher forces to the valve than indicated under «Admissable force».

2. Connect compressed air

   Compressed air pressure (above ATM) must be in the range of: 4 - 7 bar / 55 - 100 psi.
   Use only **clean**, dry or slightly oiled air.

   Connect compressed air **supply** to actuator connection labeled '**IN**'
   Connect compressed air **return line** to actuator connection labeled '**OUT**'

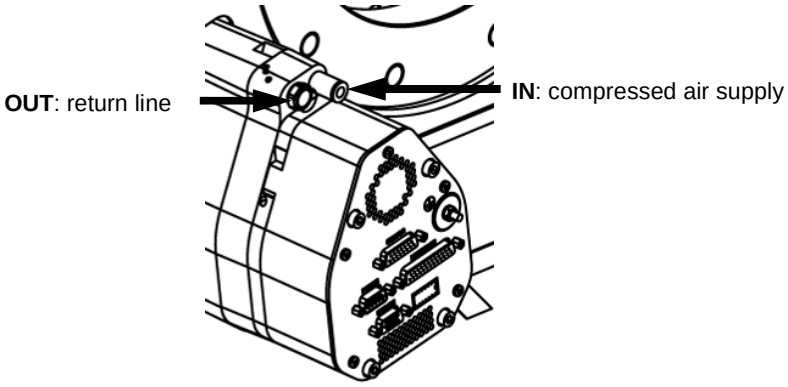


Figure 1

3. Install sensor(s) [2] according to the recommendations of the sensor manufacturer and directives given under «Requirements to sensor connection».

4. Connect sensor cable [3] to sensor(s) and then to valve (connector: SENSOR).
   Input for second sensor is available for 650 . . - . . . **Q** - . . . . only.
   Refer to chapter «Electrical connection» for correct wiring.

5. Connect valve to RS232 interface [4] (Interface connector).
   Refer to «RS232 connection» for correct wiring.

6. Connect power supply [5] to valve (connector: POWER).
   Refer to chapter «Electrical connection» for correct wiring.

7. This valve is equipped with a heating device. Connect VAT heating device according to manual of the heating device.

8. Perform «Setup procedure» to prepare valve for operation. For further information in chapter «Setup procedure».

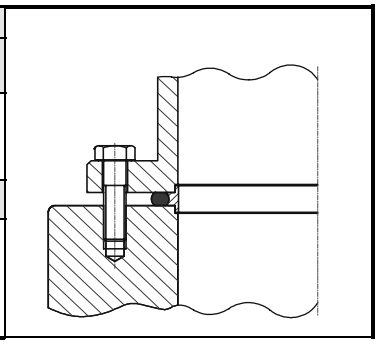
2.3 Tightening torque

Note:
The torque values below are dependent on many factors, such as materials involved, surface quality, surface treatment, and lubrication.
The torques below are valid if immersion depth of the mounting screws is at least once the thread diameter (min. 1d), and the friction coefficient of the screw-flange connection ($\mu_{total} = (\mu_{screw\ thread\text{-}helicoil} + \mu_{under\ screw\ head})/2$) is bigger than 0.12. Lower friction coefficients may damage the valve, as the resulting preload force gets too high. Therefore for other friction coefficients the torque needs to be adapted. Please review design guidelines for Helicoil-Screw connections and make sure that screws in use are capable to withstand applied torques, are appropriate for the application and are not too long. Too long screws may damage the valve, the immersion depth should not exceed (hole depth – 1 mm).

Tighten mounting screws of the flanges uniformly in crosswise order. Observe the maximum torque levels in the following tables.

2.3.1 Mounting with centering rings

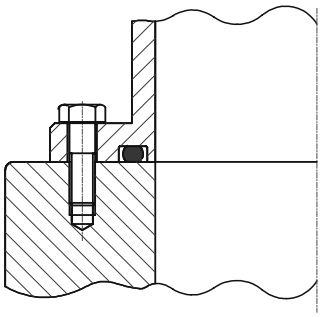
Valve size	ISO-F	ISO-F
	max. tightening torque (Nm)	max. tightening torque (lbs . ft)
DN250 / 10"	17 – 20	13 – 15
	hole depth (mm)	hole depth (inch)
DN250 / 10"	16	0.63



Refer to «Spare parts and accessories » for centering ring ordering numbers.

2.3.2 Mounting with O-ring in grooves

Valve size	ISO-F	JIS	ASA-LP	ISO-F	JIS	ASA-LP
	max. tightening torque (Nm)			max. tightening torque (lbs . ft)		
DN250 / 10"	35-40	65-70	80-90	26-30	48-52	59-67
	hole depth (mm)			hole depth (inch)		
DN250 / 10"	16	16	16	0.63	0.63	0.63



2.4 Admissible forces

Forces from evacuating the system and from the weight of other components can lead to deformation of the valve body and to malfunction of the valve. The stress has to be relieved by suitable means. The following forces are admissible:

Valve size	Axial tensile or compressive force «F_A»		Bending moment «M»	
	N	lb.	Nm	lbf.
DN250 / 10"	2500	550	100	75
For a combination of both forces (F_A and M) the values are invalid. Verify that the depth of the mounting screws is min. 1 x thread diameter. Please contact VAT for more information.				

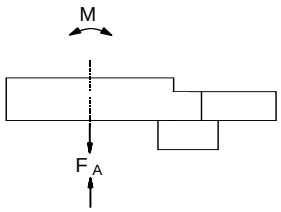


Figure 1

2.5 Requirements to sensor connection

To achieve fast and accurate pressure control a fast sensor response is required.

Sensor response time: < 50ms

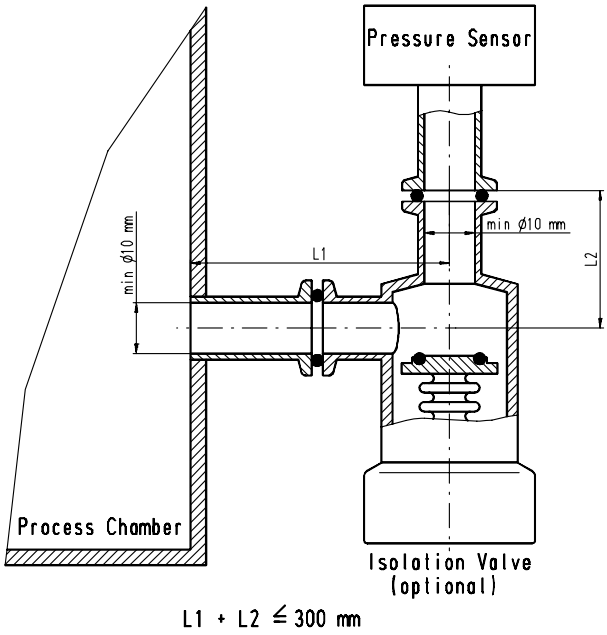
The sensor is normally connected to the chamber by a pipe. To maintain that the response time is not badly affected by the connection it needs to meet the following requirements:

Diameter of connection pipe: > = 10 mm
Length of connection pipe: < = 300 mm

These guidelines must include all valves and limiting orifices that may also be present.

Make also sure that there is no obstruction in front of sensor connection port inside the chamber.

The sensor should also be mounted free of mechanical shock and vibration.

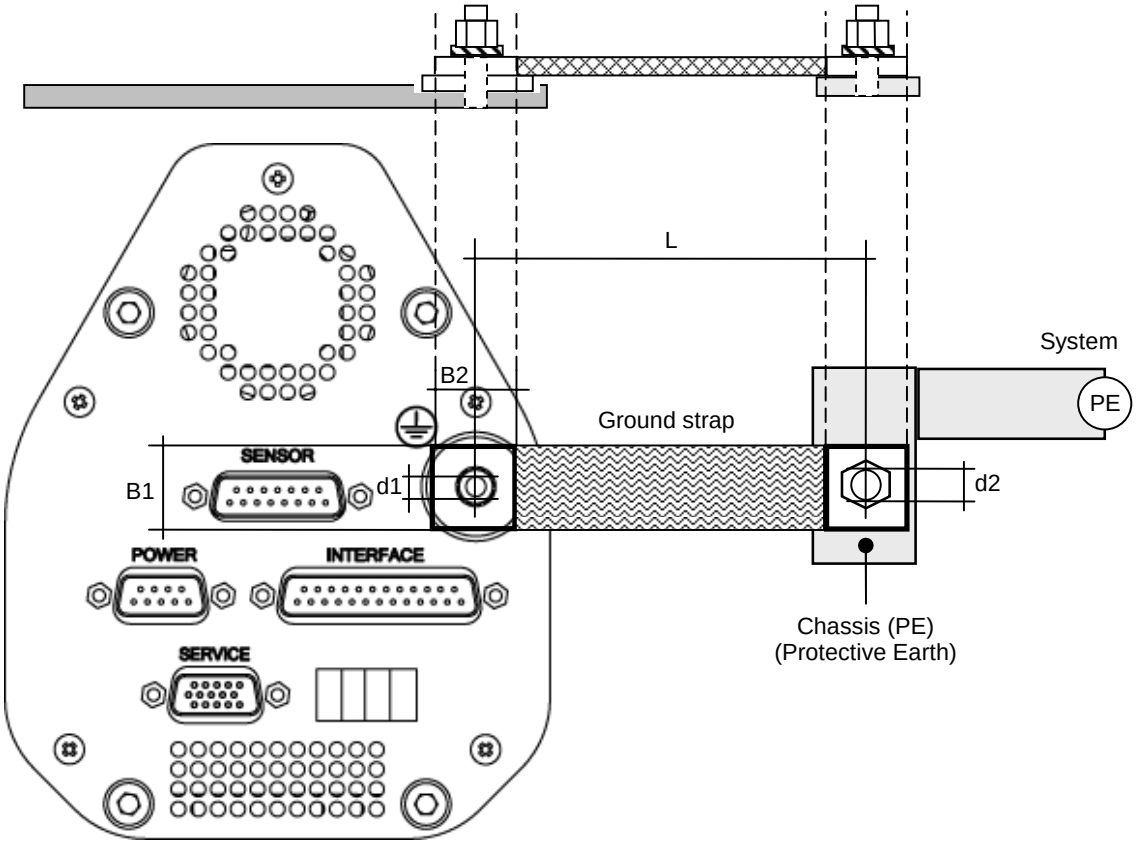


2.6 Electrical connection

2.6.1 Ground connection

Recommendation for ground strap between controller and system (chassis)

Material	L (Length max.)	B1 (min.)	B2 (min.)	d1 (⌀)	d2 (⌀)
copper tinned	200 mm	25 mm	25 mm	4.5 mm	customized



Note: Connection plates of ground strap must be total plane for a good electrical contact!

Note: The connection point at chassis (PE) must be blank metal (not coated).
It is also possible to connect the ground strap at system chamber if it is well connected to PE.

Note: Avoid low chassis cross section to the system PE connection. (Min. same cross section as ground strap)

2.6.2 Sensor supply concepts

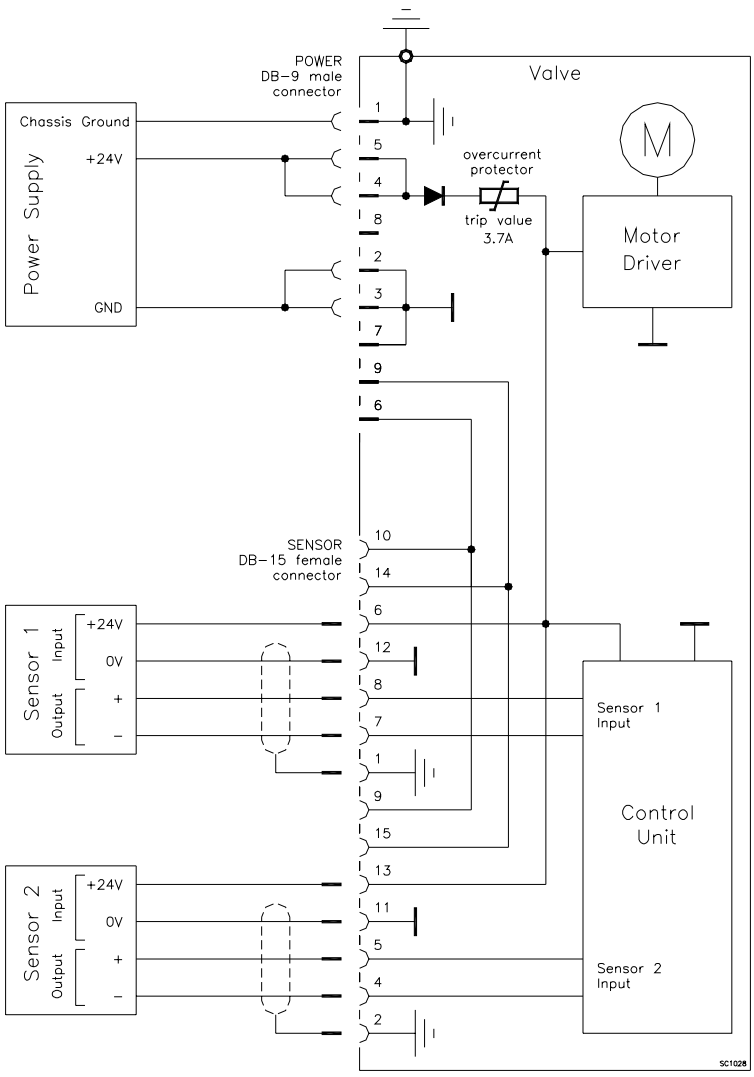
This valve offers 2 alternative concepts to supply the sensor(s) with power. This depends on the sensor type and that is used.

Concepts:

- External + 24 VDC supplied to POWER connector is feed through to SENSOR connector to supply 24 VDC sensors. Refer to chapter «Power and sensor connection (+24 VDC sensors)» for schematic and correct wiring.
  - and External + 24 VDC supplied direct to supply 24 VDC sensors.
- External ±15 VDC supplied to POWER connector is feed through to SENSOR connector to supply ±15 VDC sensors. Refer to chapter «Power and sensor connection (±15 VDC sensors)» for schematic and correct wiring.
  - and External ±15 VDC supplied direct to supply ±15 VDC.

2.6.3 Power and sensor connection (+24 VDC sensors)

2.6.3.1 Sensor power wiring via controller

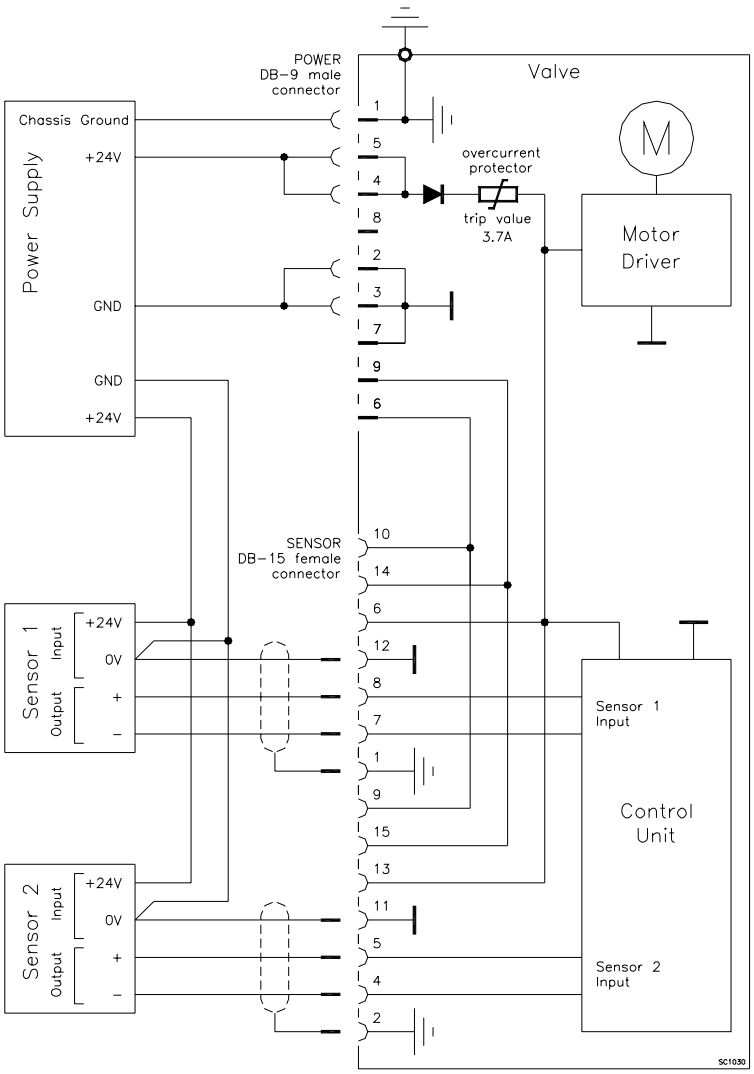


Low range sensor may be connected to sensor 1 or sensor 2 input. Do configuration accordingly.

Note:

- Use shielded sensor cable(s). Keep cable as short as possible, but locate it away from noise sources.
- Connect the +24 VDC sensors at DB–15 female sensor connector exactly as shown in the drawing above. Do not connect other pins, that may damage power supply or controller!
- Connector: Use only screws with 4-40UNC thread for fastening the connectors!

2.6.3.2 Sensor power wiring external



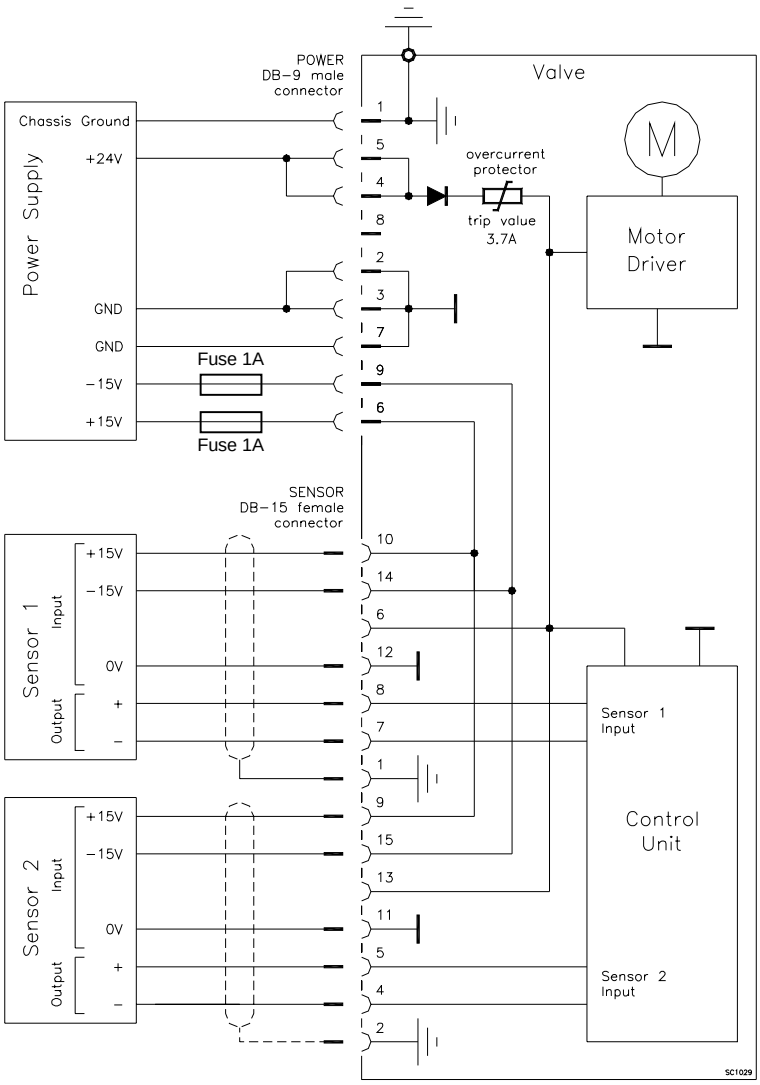
Low range sensor may be connected to sensor 1 or sensor 2 input.
Do configuration accordingly.

Note:

- Use shielded sensor cable(s). Keep cable as short as possible, but locate it away from noise sources.
- Connect the +24 VDC sensors at DB–15 female sensor connector exactly as shown in the drawing above. Do not connect other pins, that may damage power supply or controller!
- Connector: Use only screws with 4-40UNC thread for fastening the connectors!

2.6.4 Power and sensor connection (±15 VDC sensors)

2.6.4.1 Sensor power wiring via controller

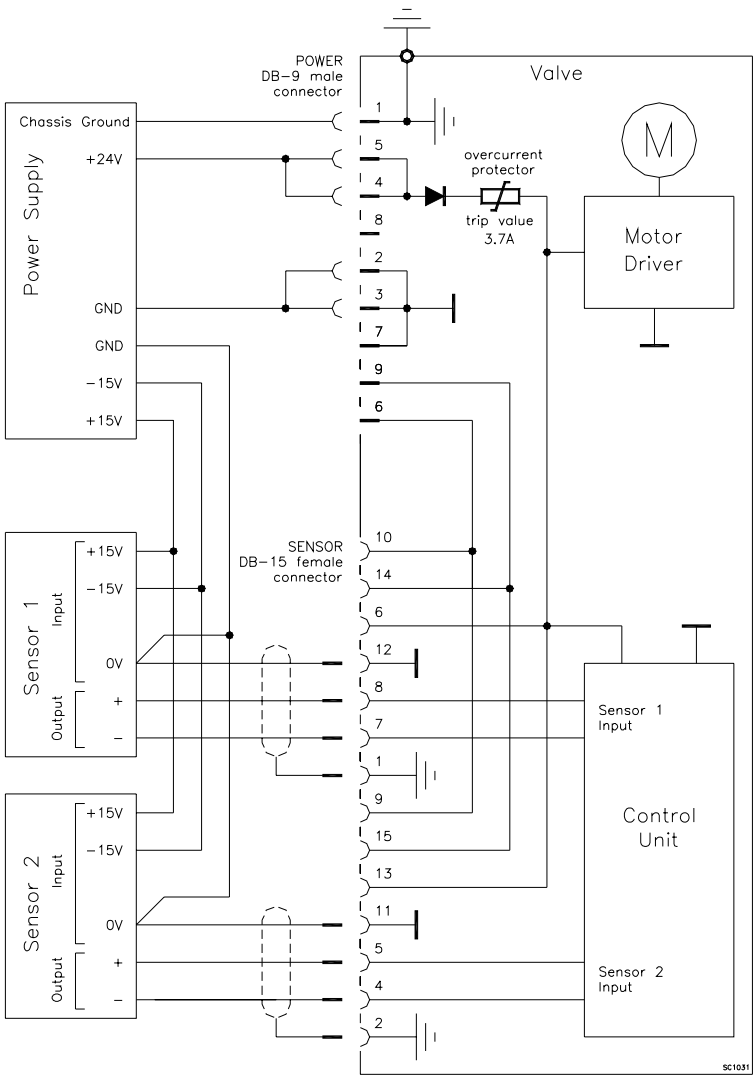


Low range sensor may be connected to sensor 1 or sensor 2 input. Do configuration accordingly.

Note:

- Use shielded sensor cable(s). Keep cable as short as possible, but locate it away from noise sources.
- Connect the ±15 VDC sensors at DB–15 female sensor connector exactly as shown in the drawing above. Do not connect other pins, that may damage power supply or controller!
- Connector: Use only screws with 4-40UNC thread for fastening the connectors!

2.6.4.2 Sensor power wiring external



Low range sensor may be connected to sensor 1 or sensor 2 input.
Do configuration accordingly.

Note:

- Use shielded sensor cable(s). Keep cable as short as possible, but locate it away from noise sources.
- Connect the ±15 VDC sensors at DB–15 female sensor connector exactly as shown in the drawing above. Do not connect other pins, that may damage power supply or controller!
- Connector: Use only screws with 4-40UNC thread for fastening the connectors!

2.6.5 RS232 connection

Refer to «Functions and Wiring» for wiring information.

2.6.6 Service port connection

The service port allows to connect the valve to a RS232 port of a computer. A special cable and the service software from VAT is required for operation. Refer to «Spare parts and accessories» for ordering numbers.

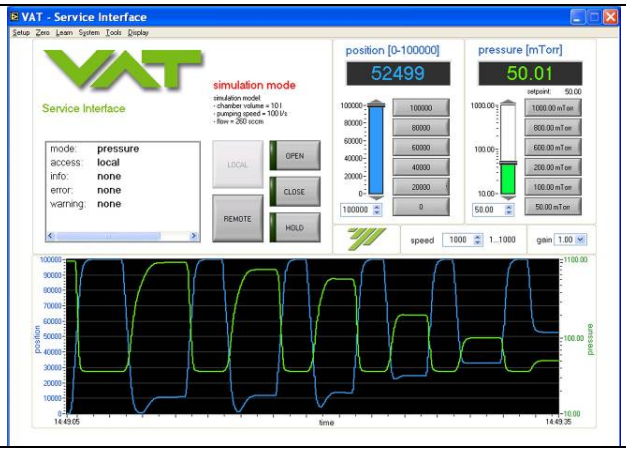
3 Operation

Operation is allowed after completion of the installation procedure only.

3.1 Introduction

This product allows downstream pressure control for a vacuum chamber. Normally it will be used in pressure control mode. It is also possible to operate it in position control mode. In both cases local or remote operation is possible.

3.1.1 Local operation

For purposes as system setup, system testing and maintenance the valve can be operated via the service port by means of a computer. This requires a service software from VAT. Refer to «Spare parts and accessories » for ordering number.	
	Screenshot of the service software

3.1.2 Remote operation

This product is equipped with a RS232 interface to allow for remote operation. See section «RS232 Interface» for details.

3.1.3 Service indication

This product is able to indicate that the valve unit needs to be cleaned.

A service request is indicated when the control unit detects that motor steps are apparently not effective. This may happen when the valve unit is heavy contaminated. These ‚lost' steps are recognized an will be repeated to allow for further operation in the short term. But in the medium term the valve unit requires cleaning.

3.2 Operation under increased temperature

See «Technical data»

3.3 Behaviour at power on

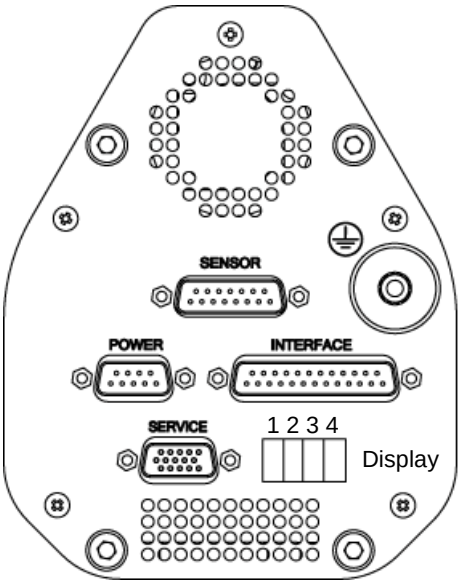
Valve position	Behaviour
closed	Valve will stay in closed position, with the 1st command the valve will be synchronized before the command is executed (max. 2 sec)
open or in throttle position	valve will synchronize without any command and finally close

3.4 Behavior in case of power failure

Valve position	Behaviour
closed	no change
open or in throttle position	no change

3.5 Display information

There is a 4 digit display located on the panel. It displays configuration, status and position information.
For details see below.



3.5.1 Power up:

Digit 1	Digit 2	Digit 3	Digit 4	Description
1	**D**	**0**	**2**	At first all dots are illuminated then configuration is displayed: • Firmware version (1^{st} information for about 3s) • Controller configuration (2^{nd} information for about 3s) '**S**' in the first digit indicates that power up synchronization is running.
S	**2** = RS232 Interface	**0** = w/o ±15 VDC Sensor Power Supply **1** = with ±15 VDC Sensor Power Supply	**1** = 1 sensor version **2** = 2 sensor version	

3.5.2 Operation:

Digit 1	Digit 2	Digit 3	Digit 4	Description
L				AUTOLEARNING running
C				Valve closed
O				Valve open
V	Valve position:	**0 . . . 100**	(%, 0 = Close / 100 = Open)	POSITION CONTROL mode active
P	Service request (service flag):	**SR**	(Valve requires cleaning)	PRESSURE CONTROL mode active
H				HOLD (position frozen) activated
Z				ZERO ADJUST running
T				Plasma mode active

Note: RxD / TxD activity of RS232 communication is displayed by 2 blinking indicators in Digit 2.

3.5.3 Fatal error:

Digit 1	Digit 2	Digit 3	Digit 4	Description
E	Error code, see section «4. Troubleshooting » for details			Fatal error occurred

3.6 Setup procedure

To enable this valve for **pressure control all setup steps must be performed**.
In case only position control is required it's sufficient to perform steps 1 to 4 and potentially step 7.

Setup step		Description
1	**POWER UP**	Turn on external 24VDC power supply (and external sensor power supply if required). **Note:** See Ⓐ3.3 Behaviour at power on▼. Display shows configuration of product until synchronization cycle is done, otherwise refer to chapter «Display information». After synchronization the valve is ready for operation.
2	**RS232 CONFIGURATION**	Select baudrate, parity, data length and number of stop bits of RS232 protocol in local operation via service port using the service software. Refer to «Spare parts and accessories» for ordering details.
3	**DEVICE CONFIGURATION**	Make the following configurations in local operation via service port or via RS232 command. 1. Select RS232 communication value range for pressure and position. Refer to «RS232 setup commands» for details. 2. Select function of CLOSE VALVE and OPEN VALVE digital inputs. These may be configured as 'not inverted', 'inverted' or 'disabled'. Refer to «RS232 setup commands» for details. 3. Disable or enable ZERO ADJUST function. Refer to «RS232 setup commands» for details. 4. Two sensor operation a) Select 1 or 2 sensor operation. b) Select sensor full scale ratio between sensor 1 and 2. Refer also to «Operation with 2 sensors» and «RS232 setup commands» for details.
4	**ZERO ADJUST**	Perform ZERO ADJUST to compensate for sensor offset by local operation via service port or via RS232 command on Interface port. 1. OPEN VALVE and evacuate process chamber to high vacuum. 2. Wait until base pressure is reached and sensor(s) do not shift anymore. 3. Initiate ZERO ADJUST. Refer to «RS232 setup commands» for details of function.

Setup step		Description
5	**AUTOLEARNING**	Perform AUTOLEARNING by local operation via service port or via RS232 command on Interface port. 1. Valve must be open and process chamber at high vacuum. 2. Set specific gas flow according to requirements below. Autolearn does not need to be performed with the process gas. Instead N_2 or Ar may be used. 3. Then initiate AUTOLEARNING. Refer to «RS232 setup commands» for details of function. **Note:** Autolearning may take several minutes. Do not interrupt the routine as **a single full run is required to ensure fast and accurate pressure control over the full position range**. The PID controller covers 5% to 5000% of the gas flow which was used for autolearning.  Do not use a different gasflow for autolearning than determined below. Otherwise pressure control performance may be insufficient. **Gasflow for autolearning (optimized):** This calculation method should be applied if the full pressure / flow regime is known. So the most suitable autolearning gas flow for a specific range can be determined. This may reduce the required time of autolearning and ensures best pressure control responses. • For that purpose the conductance that is required to control this hypothetical working point (highest pressure / lowest flow) must be calculated with the following formula. $$L_R = \frac{Q_{min}}{96 \bullet p_{max}}$$ L_R required lower conductance [l/s] Q_{min} min. gasflow while control [sccm] P_{max} max. pressure to control [Torr] • Compare this value with the minimal conductance of the valve (refer to «Technical data»). If required conductance is higher you gain from running autolearning with an optimized gasflow calculated with the following formula. $$Q_L = 80 \bullet p_{SFS} \bullet L_R$$ Q_L gasflow for autolearning [sccm] P_{max} max. pressure to control [Torr] L_R required lower conductance [l/s] • Set pressure limit for autolearning to P_{max} (max. pressure to control). Refer to «RS232 setup commands» for details. **Gasflow for autolearning (full range):** This calculation method should be applied if the full pressure / flow regime is not known. In this case an autolearning gas flow is determined that enables pressure control over the full position range of the valve. $$Q_L = 40 \bullet p_{SFS} \bullet L_{min}$$ Q_L: gasflow for autolearning [sccm] p_{SFS} sensor full scale pressure [Torr] L_{min} min. controllable conductance of valve [l/s] (refer to «Technical data»)

Setup step		Description
6	**GAIN FACTOR ADJUSTMENT**	Set gain for PID controller by local operation via service port, or via RS232 command on interface port. Adjust gain so that optimal pressure response is achieved on your system. Refer to «RS232 setup commands» for details. Default value is 1.00. Adjustment range is from 0.1 to 7.5. • gain factor > 1 means: faster response but higher overshoot of pressure • gain factor < 1 means: slower response but lower overshoot of pressure
7	**SENSOR DELAY ADJUSTMENT**	Default value is 0. Adjustment range is from 0 to 1.0s. Refer to «RS232 setup commands» for details. Pipes and orifices for sensor attachment delay response time and so badly impact pressure control stability. By adapting this parameter to the approximate delay time stability problems can be reduced. But also control response time will be reduced by this measure. Note: Whenever possible sensors should be attached to the chamber according to «Requirements to sensor connection». This is the most effective measure against stability issues. If your gauge attachment fulfills these criteria do not use this parameter. <u>Procedure:</u> Set gain to 1.0 and sensor delay to 0s. Open valve and then control a typical pressure / flow situation. Repeat with higher sensor delays until best possible stability is achieved. Then do gain adjustment as described above. <u>Execution:</u> Set sensor delay by local operation via service port.

3.7 Close Valve

Mode	Description	
CLOSE	The valve will close. Execute following steps:	
	Local operation via service port: Push CLOSE button	Remote operation via RS232 command on interface port (refer to chapter «RS232 control commands» for details):

3.8 Open Valve

Mode	Description	
OPEN	The valve will open. Execute following steps:	
	Local operation via service port: Push OPEN button	Remote operation via RS232 command on interface port (refer to chapter «RS232 control commands» for details):

3.9 Valve Position Control

Mode	Description	
POSITION CONTROL	The valve position is directly controlled according to the position SETPOINT. Execute following steps:	
	Local operation via service port: 1. Set position SETPOINT value	Remote operation via RS232 command on interface port (refer to chapter «RS232 control commands» for details):

3.10 Chamber Pressure Control

Mode	Description	
PRESSURE CONTROL	The included PID controller controls the chamber pressure according to the pressure SETPOINT by means of the valve position. The PID controller works with an adapting algorithm to achieve best results under altering conditions (gasflow, gas type). **Perform complete «Setup procedure» to prepare the valve for PRESSURE CONTROL.** Based on this, the PID controller is able to run fast and accurate pressure control cycles. Execute following steps:	
	Local operation via service port: 1. Set pressure SETPOINT value	Remote operation via RS232 command on interface port (refer to chapter «RS232 control commands» for details):

3.10.1 Operation with 2 Sensors

If 2 sensor operation is enabled changeover is done automatically. For configuration refer to chapter «Setup procedure». We recommend a ratio of 10:1 between the pressure gauges. Max. ratio is 100:1. Whereas **low range** pressure gauge has to be connected to **sensor 1** input and high range pressure gauge to sensor 2 input.

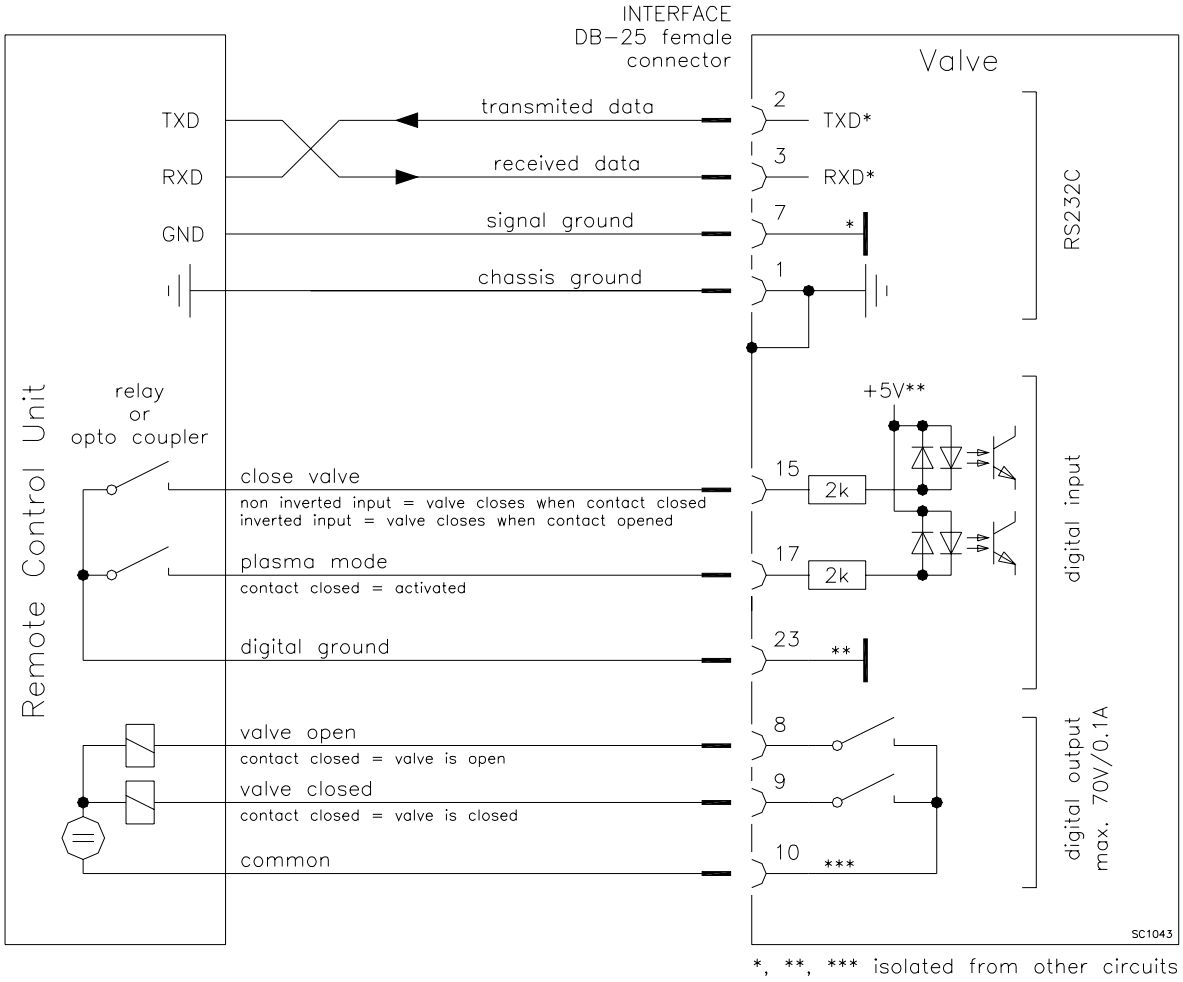
Between 90 and 100% of the low range sensor full scale, low range sensor is faded out while high range sensor is faded in. This prevents from pressure leaps during sensor transition that may be caused by pressure variations between the two sensors.

3.11 RS232 Interface

3.11.1 Functions and Wiring

This interface allows for remote operation by means of a command set based on a RS232 protocol.
In addition there are few digital inputs and outputs. Digital inputs may be operated either by switches or by voltage sources.

Active **digital inputs** have **higher priority than RS232** commands.



Note: Do not connect other pins than indicated in the schematics above!

3.11.2 Digital Inputs

Pin	Function	Signal type	Description	Priority
15	**CLOSE VALVE**	Digital input [1)]	This function is activated as long as optocoupler is 'on' in **non inverted** configuration. This function is activated as long as optocoupler is 'off' in **inverted** configuration. Configuration can be done in local operation via service port or in remote operation via RS232 command. This function will close the valve. After the function is deactivated the valve remains closed.	1 [2)]
17	**PLASMA MODE**	Digital input [1)]	This function will activate the plasma mode option. When plasma mode is activated, a 'T' is displayed on the top panel. Default duration time = 1500 ms Default filter time = 4000 ms Refer to chapter 'RS232 Commands' for commanding.	
23	**DIGITAL GROUND**	Digital ground	Ground for all digital inputs. Ground is used when digital inputs are operated by switches. Connect switches to ground. See also «Functions and Wiring» configuration a).	
25	**DIGITAL COMMON**	Digital common	Common for all digital inputs. Common is used when digital inputs are driven by voltage sources. Connect + or – terminal of source with common (input optocouplers are capable of bidirectional operation). See also «Functions and Wiring» configuration b).	

1. All digital inputs are digitally filtered. Filter delay is 100ms. This means that digital signals must be applied for at least 100ms to be effective.
   Refer to «Functions and Wiring» for details about input circuit.
2. Highest priority is 1. Functions with lower priorities will not be effective as long as higher priority functions are active. These digital inputs have higher priority than all RS232 commands. RS232 commands will not be accepted while digital inputs are active.

3.12 RS232 Commands:

Inferface settings:

Baud rate	Data bit	Parity	2nd answer	Logic input (to close valve)
9600	7	even	Enabled (S: command without 2nd answer)	Inverted (contact to be opended)

The following commands are same for PM-6 and integrated controller.

3.12.1 Control commands

Note:
Control commands are accepted only, when the PM controller is in REMOTE mode, except of all U: commands
Control commands are acknowledged by one or two acknowledgements:
1st answer: Confirmation that command has been received, within 40 ms
2nd answer: If enabled, confirmation that command has been executed (except S: command: no 2nd answer will be replied)

<CR>...Carriage Return (0D hexadecimal); <LF>...Linefeed (0A hexadecimal)

Description	Commands	Acknowledgements (2nd acknowledgement)	Examples / Explanation
Remote Operation	U:01<CR><LF>	U:<CR><LF>	= switch to Remote
Local Operation	U:02<CR><LF>	U:<CR><LF>	= switch to Local
Close valve	C:<CR><LF>	C:<CR><LF> (C:<CR<<LF>)	= close
Open valve	O:<CR><LF>	O:<CR><LF> (O:<CR<<LF>)	= open
Select valve position in 1/1000 of stroke (0000 = closed, 1000 = open)	R:xxxxxx<CR><LF>	R:<CR><LF> (R:<CR><LF>)	R:000428<CR><LF> = 428 / 1000 of stroke
Zero Sensor offset adjustment	Z:<CR><LF>	Z:<CR><LF>	automatic zero adjustment of both sensors and all voltage ranges
Autolearn Xxxxxx = maximum pressure to be learned, 0 - communication range (C.R.)	L:xxxxxx<CR><LF>	L:<CR><LF>	L:100000<CR><LF> = up to sensor full scale (communication range set to 100000)
Pressure setpoint Xxxxxx = setpoint value 0 - communication range (C.R.)	S:xxxxxx<CR><LF>	S:<CR><LF> (no 2nd answer)	S:000119<CR><LF> 119 = C.R./F.S. * setpoint
Hold mode Freeze valve position	H:<CR><LF> K:<CR><LF>	H:<CR><LF> K:<CR><LF>	= start hold = change to pressure mode Note: Command can be used in pressure and position mode.
Reduced positioning speed in 1/1000 of maximum speed (remains stored until next speed is given and is set to 1000 after mains is switched off) Function is active for R: commands only	V:xxxxxx<CR><LF>	V:<CR><LF>	V:000200<CR><LF> R:000428<CR><LF> = Actuator speed is 200* 1/1000 = 20% of maximum speed, while gate is moved to position 428* 1/1000 = 428
Disable power fail option Enable power fail option (if installed)	U:14<CR><LF> U:15<CR><LF>	U:<CR><LF> U:<CR><LF>	After power-up PFO is always enabled (if installed)
Interlock service software window with integrated controller	U:03<CR><LF> U:04<CR><LF>	U:<CR><LF> U:<CR><LF>	= interlock Local/Remote buttons = release Local/Remote buttons
Disable logic inputs Enable logic inputs	U:16<CR><LF> U:17<CR><LF>	U:<CR><LF> U:<CR><LF>	= Disable logic inputs = Enable logic inputs
Only sensor 1 used	U:18<CR><LF>	U:<CR><LF>	= only sensor 1 used
Only sensor 2 used	U:19<CR><LF>	U:<CR><LF>	= only sensor 2 used
Sensor 1 and 2 used (auto switching)	U:20<CR><LF>	U:<CR><LF>	= sensor 1and 2 used
Plasma mode duration time Xxxxxx = 000000 – 30000 ms	k:01xxxxxx<CR><LF>	K01:<CR><LF>	10 ms steps possible
Plasma mode filter time Xxxxxx = 000010 – 30000 ms	k:02xxxxxx<CR><LF>	K02:<CR><LF>	1 ms steps possible

3.12.2 Inquiry commands

<CR>...Carriage Return (0D hexadecimal); <LF>...Linefeed (0A hexadecimal)

Description	Commands	Acknowledgements	Examples / Explanation
Actual valve position in 1/1000 of stroke (0 = closed, 1000 = open)	A:<CR><LF>	A:xxxxxx<CR><LF>	A:000428<CR><LF> = 428 * 1/1000 of stroke
Actual pressure in units of 1/communication range of sensor 1 full scale	P:<CR><LF>	P:xxxxxx<CR><LF>	P:000119<CR><LF> = 119 / communication range * sensor 1 full scale pressure P:-00004<CR><LF> = -4 / communication range * sensor 1 full scale pressure
Pressure setpoint in units of 1/communication range of sensor 1 full scale	W:<CR><LF>	W:xxxxxx<CR><LF>	W:000119<CR><LF> = 119 / communication range * sensor full scale pressure
Read remote / local status	I:<CR><LF>	I:REMOTE<CR><LF> I: LOCAL<CR><LF>	= remote mode = local mode
Read control mode	M:<CR><LF>	M: POS<CR><LF> M: PRESS<CR><LF>	= position mode = pressure mode
Self test	T:<CR><LF>	T: OK<CR><LF> T:PAR-ER<CR><LF> T:ROM-ER<CR><LF>	= memory o.k. = parameter error = EPROM error (see section «Trouble shooting» if «PAR-ER» or «ROM-ER» appears)
Read valve cycle counter	c:<CR><LF>	c:xxxxxxxxxx<CR><LF>	c:0000125013<CR><LF> = 125'013 cycles
Reset valve cycle counter	n:<CR><LF>	n:<CR><LF>	= set counter to zero
Software version	i:01<CR><LF>	i:01xxxxxxxx<CR><LF>	i:0165PM3G00<CR><LF> = software version 65PM.3G.00
Read current sensor setup	i:02<CR><LF>	i:02abcdefg<CR><LF>	Current sensor setup; for abcdefg refer to setup command s:
Read offset of sensor 1	i:08<CR><LF>	i:08xxxxxx<CR><LF>	i:08-00013<CR><LF> offset = 13 /1000 * sensor 1 full scale pressure
Read offset of sensor 2	i:07<CR><LF>	i:07xxxxxx<CR><LF>	i:07-00009<CR><LF> offset = -9 /1000 * sensor 2 full scale pressure
Position / air error	p:<CR><LF>	p:____OK<CR><LF> p:POS-ER <CR><LF> p:AIR-ER <CR><LF>	= position o.k. = plate position error = compressed air failure
Valve status	i:04<CR><LF>	i:04V1:aV2:b<CR><LF>	a = 1 (valve 1 active) a = 0 (valve 1 inactive) b = - (not connected)
Valve position	i:05<CR><LF>	i:05V1:aV2:b<CR><LF>	a = 0 (valve 1 open) a = C (valve 1 closed) a = N (valve 1 in intermediate pos.) b = - (not connected)
Plasma mode duration	I:01<CR><LF>	I:01xxxxxx<CR><LF>	xxxxxx = ms
Plasma mode filter time	I:02<CR><LF>	I:02xxxxxx<CR><LF>	xxxxxx = ms

3.12.3 Setup command

The setup command can be used same with PM-6 and integrated controller, but the single values in the command can be different as mentioned in the following table.

Description	Command / Acknowledgement		Difference
Sensor Setup	`s:abcdefg<CR><LF> / s:<CR><LF>`		
a = Sensor Type	0 = Torr 1 = mbar		Ignored with integrated controller (can be set via service software)
b = Sensor 1 Full Scale Range (Torr or mbar)	0 = 0 - 0.010 1 = 0 - 0.020 2 = 0 - 0.025 3 = 0 - 0.050 4 = 0 - 0.100 5 = 0 - 0.200 6 = 0 - 0.250 7 = 0 - 0.500 8 = 0 - 1.0 9 = 0 - 2.0 A = 0 - 2.5 B = 0 - 5.0	C = 0 – 10 D = 0 – 20 E = 0 – 25 F = 0 – 50 G = 0 – 100 H = 0 – 200 I = 0 – 250 J = 0 – 500 K = 0 – 1000 L = not connected	Sensor 1 has to be the sensor with lower range Therefore sensor 1 cannot be used alone with integrated controller
c = Sensor 2 Full Scale Range (Torr or mbar)	0 = 0 - 0.010 1 = 0 - 0.020 2 = 0 - 0.025 3 = 0 - 0.050 4 = 0 - 0.100 5 = 0 - 0.200 6 = 0 - 0.250 7 = 0 - 0.500 8 = 0 - 1.0 9 = 0 - 2.0 A = 0 - 2.5 B = 0 - 5.0	C = 0 – 10 D = 0 – 20 E = 0 – 25 F = 0 – 50 G = 0 – 100 H = 0 – 200 I = 0 – 250 J = 0 – 500 K = 0 – 1000 L = not connected (only with PM-6)	Sensor 2 has to be the sensor with higher range L is not available with integrated controller because sensor 2 always has to be connected (sensor 1 cannot be used alone)
d = Display Unit	0 = mbar 1 = µbar 2 = Torr 3 = mTorr 4 = Pa 5 = kPa 6 = position mode only		Ignored with integrated controller (can be set via service software)
e = RS232 Communication Range, CR (range represents the range of higher range sensor)	0 = 0 – 1000 1 = 0 – 2000 2 = 0 – 2500 3 = 0 – 5000	4 = 0 - 10000 5 = 0 - 20000 6 = 0 - 25000 7 = 0 - 50000 8 = 0 - 100000	

Description	Command / Acknowledgement	Difference
f = Gain Factor	0 = 1.00 8 = 0.10 1 = 1.33 9 = 0.13 2 = 1.78 A = 0.18 3 = 2.37 B = 0.23 4 = 3.16 C = 0.32 5 = 4.22 D = 0.42 6 = 5.62 E = 0.56 7 = 7.50 F = 0.75	
g = Zero Adjust	0 = enable 1 = disable	

3.12.4 Sensor delay command

Description	Commands	Acknowledgements	Examples / Explanation
	t:abcdefg<CR><LF>	**t:<CR><LF>**	t:4000000<CR><LF>
a = Response Time	0 = 0 ms 8 = 250 ms 1 = 20 ms 9 = 300 ms 2 = 40 ms A = 350 ms 3 = 60 ms B = 400 ms 4 = 80 ms C = 500 ms 5 = 100 ms D = 600 ms 6 = 150 ms E = 800 ms 7 = 200 ms F = 1000 ms		4 = Sensor response time 80 ms
bcdefg = Reserved	000000		Use 000000 only

3.12.5 Error messages

Error messages	Description
E:000001<CR><LF>	Parity error
E:000002<CR><LF>	<CR> or <LF> is missing
E:000003<CR><LF>	«:» is missing
E:000004<CR><LF>	Wrong letter code
E:000005<CR><LF>	Numerical value not given in 6 digits
E:000006<CR><LF>	Numerical value larger 1000
E:000007<CR><LF>	PRESSURE MODE, ZERO or LEARN have been selected with no sensor connected (display format set for no sensor)
E:000008<CR><LF>	Controller is not in correct mode for the given command (e.g. ***L:XXXXXX*** given while a logic input is activated)
E:000200<CR><LF>	Error with ZERO - valve is not in open position - PM controller is switched in control mode PRESSURE MODE - function ZERO blocked (= DISABLED)
E:000201<CR><LF>	Sensor with the higher full scale: if zero offset is higher than +/- 1.4 V
E:000202<CR><LF>	Sensor with the lower full scale: if zero offset is higher than +/- 1.4 V (this error message is not active when only one sensor is connected)
E:000203<CR><LF>	Sensor setup error The full scale ratio Sensor 1 / Sensor 2 is either >100 or <= 1
E:000204<CR><LF>	Commands U:19 or U:20 sent with one or no sensor connected

4 Trouble shooting

Failure	Check	Action
No dots lighted on display	- 24 V power supply ok?	- Connect valve to power supply according to «Electrical connection» and make sure that power supply is working.
Remote operation (Interface) does not work	- Local operation via service port active?	- Switch to remote operation.
Display shows «**E 20**» (**fatal error** - limit stop of valve unit not detected)	- Valve plate proper mounted?	- Replace control and actuating unit according to « Maintenance procedure ».
Display shows «**E 21**» (**fatal error** - rotation angle of valve plate limited during power up)	- Valve plate proper mounted? - Valve unit heavy contaminated? - Valve plate mechanically obstructed?	- Adjust valve plate according to «Maintenance procedure». - Clean valve unit according to « Maintenance procedure ». - Resolve obstruction.
Display shows «**E 22**» (**fatal error** - rotation angle of valve plate limited during operation)	- Valve unit heavy contaminated? - Valve plate mechanically obstructed?	- Clean valve unit according to « Maintenance procedure ». - Resolve obstruction.
Display shows «**E 40**» (**fatal error** - motor driver failure detected)		- Replace control and actuating unit according to « Maintenance procedure ».
POSITION CONTROL does not work	- POSITION CONTROL selected, check for V on display?	- Select POSITION CONTROL. Refer to «RS232 control commands» for details.

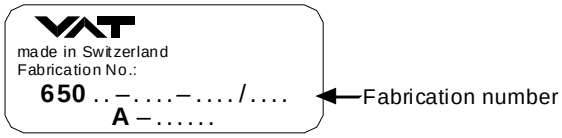
Failure	Check	Action
Pressure reading is wrong or pressure reading is negative	- Sensor(s) connected? - 2 sensor version - (650 . . - . . **Q** . - . . . .)? - ZERO ADJUST done? - Does sensor power supply provide enough power for sensor(s)?	- Refer to « Electrical connection». - Verify configuration. - Refer to «Operation with 2 sensors». - Perform ZERO ADJUST when base pressure is reached. Refer to «RS232 control commands» for details. - Verify sensor supply voltage.
ZERO ADJUST does not work	- Valve in open position, check for O on display? - ZERO ADJUST disabled?	- OPEN VALVE and bring chamber to base pressure before performing ZERO ADJUST. - Enable ZERO ADJUST. Refer to « RS232 setup commands» for details.
Pressure is not '0' after ZERO ADJUST PRESSURE CONTROL does not work	- Sensor voltage shifting? - System pumped to base pressure? - Sensor offset voltage exceeds ±1.4V - PRESSURE CONTROL selected, check for P on display?	- Wait until sensor does not shift any more before performing ZERO ADJUST. - OPEN VALVE and bring chamber to base pressure before performing ZERO ADJUST. - Replace pressure gauge. - Select PRESSURE CONTROL mode. Refer to «RS232 control commands» for details.
PRESSURE CONTROL not optimal	- ZERO ADJUST performed before AUTOLEARNING? - AUTOLEARNING interrupted? - Was gas flow stable during AUTOLEARNING? - Is sensor range suited for application? - Noise on sensor signal?	- Perform ZERO ADJUST then repeat AUTOLEARNING. Refer to «RS232 control commands» for details. - Repeat AUTOLEARNING. Refer to «RS232 control commands» for details. - Repeat AUTOLEARNING with stable gas flow. Refer to «RS232 control commands» for details. - Use a sensor with suitable range (controlled pressure should be >3% and < 98% of sensor full scale). - Make sure a shielded sensor cable is used.

If you need any further information, please contact one of our service centers. You can find the addresses on our website: http://www.vat.ch

5 Maintenance & repairs

Under clean operating conditions, the valve does not require any maintenance during the specified cycle life. Contamination from the process may influence the function and requires more frequent maintenance.

Before carrying out any maintenance or repairs, please contact VAT. It has to be individually decided whether the maintenance/repair can be performed by the customer or has to be carried out by VAT. The fabrication number on the valve



has always to be specified.

All supplies (e. g. compressed air, electrical power) must be disconnected for removal/installation of the valve from/into the system.

Even with disconnected supply, loaded springs and/or air cushions in cylinders can be potential hazards.

Keep fingers and objects away from the valve opening!

Products returned to VAT must be free of harmful substances such as e.g. toxical, caustic or micro-biological ones. If products are radioactively contaminated, fill in the VAT form «Contamination and Radiation Report» and send it with the product. The form is available at VAT. The maximum values indicated in the form must not be exceeded.

5.1 Preventive maintenance procedures

Keep fingers out of the valve body during preventive maintenance work. The sealing ring or its retaining pins will lower in case of electrical power failure or loss of compressed air.

Take precautions to protect yourself from harmful substances that may have contaminated the valve during use.

Two preventive maintenance procedures are defined for this valve. These are:

- **Replacement of isolation seals** (gate and body seal of sealing ring) **and valve cleaning**
- **Replacement of actuator feedthrough seals**

Required frequency of cleaning and replacement of seals is depending on process conditions.

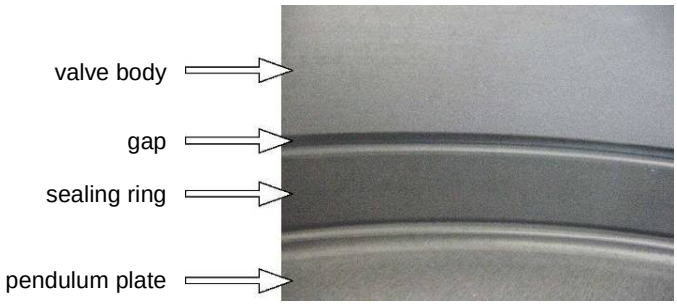
A critical factor influencing the maintenance period is the lifetime of the vacuum grease, being limited under increased temperature. In this case grease will separate to PTFE and oil. The oil may flow and contaminate the valve parts.

VAT can give the following **recommendations for preventive maintenance**:

	unheated *)	heated ≤ 80°C *)	heated > 80°C *)
isolation seals (gate and body seal of sealing ring)	200'000 cycles	6 months	3 months
actuator feedthrough seals	1 Mio. cycles	6 months	3 months

*) These figures are reference values for clean conditions under various temperatures. These values do not include any impact of the process. Therefore preventive maintenance schedule has finally to be checked for the actual process conditions.

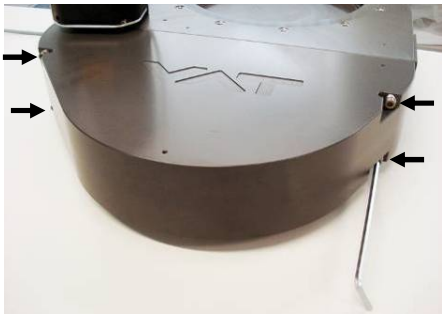
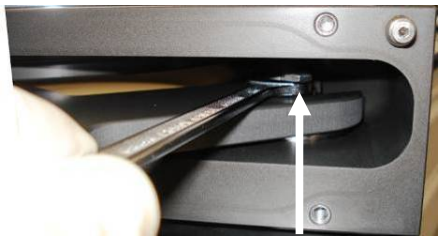
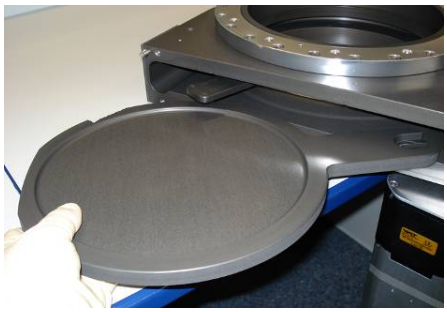
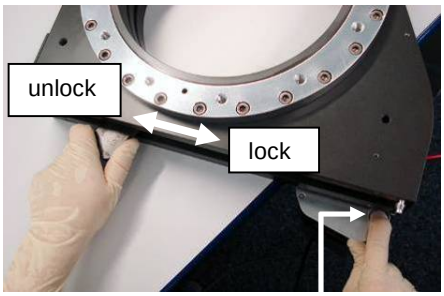
Prevent gap between body and sealing ring from air gun cleaning. Otherwise vacuum grease may be distributed and contaminate the valve.

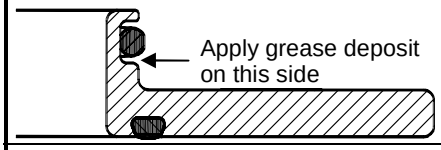


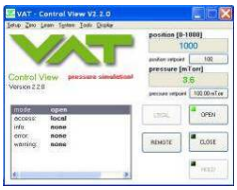
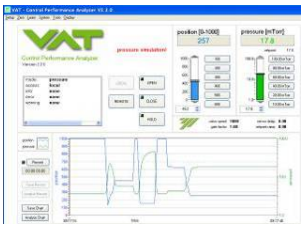
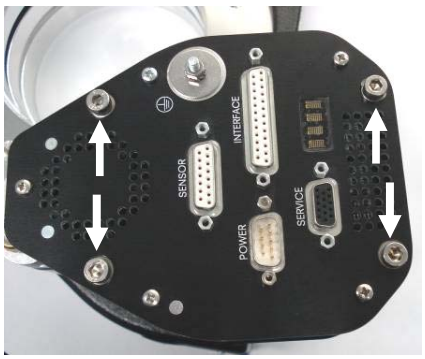
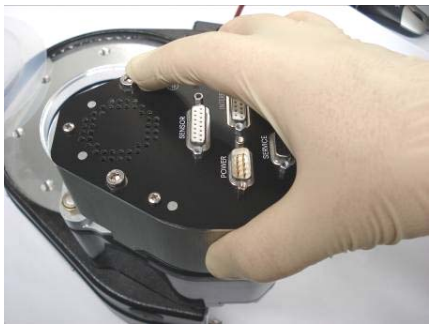
Replacement of isolation seals (gate and body seal of sealing ring) **and valve cleaning**

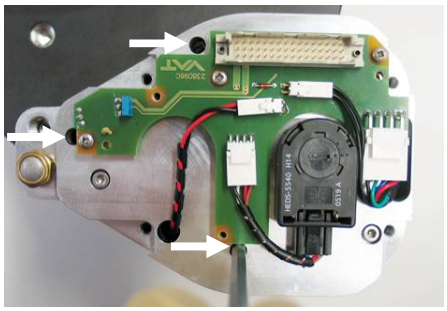
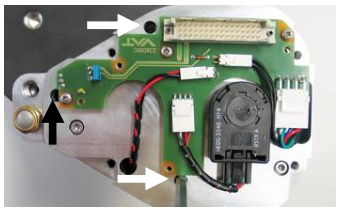
Replacement of actuator feedthrough seals

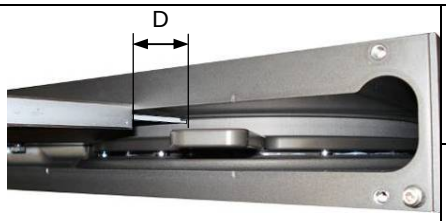
Note: Electrical power and compressed air is required to perform steps 2 to 8 during disassembly respectively 9 to 2 during assembly.

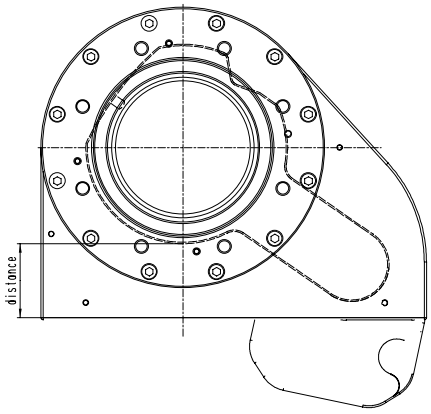
Description		Required tool		
1. Vent both valve chambers. 2. Open the 4 bonnet screws and remove valve bonnet.		Allen wrench 5mm		
3. Open valve **Caution:** Stand away from valve – pendulum plate moves out of the valve body. 4. Unfasten mounting screw for pendulum plate. (For reinstall the pendulum plate, tighten the mounting screw to block.) 5. Remove pendulum plate.	 mounting screw for pendulum plate 	open end wrench 13mm		
6. With one hand press the MAINTENANCE BUTTON to lower the sealing ring, with your second hand unlock the sealing ring by pressing the handle. 7. Release MAINTENANCE BUTTON. 8. Remove sealing ring.	 maintenance button			

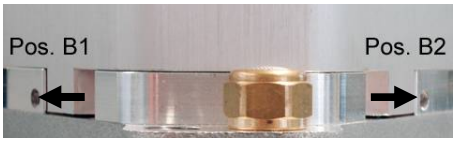
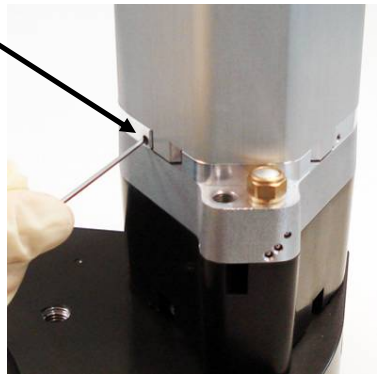
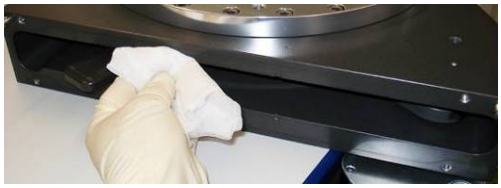
<table>
<tr><th colspan="3">Description</th><th>Required tool</th></tr>
<tr><td>9. Remove gate and body seal from sealing ring carefully with a soft tool.
10. Remove grease residues at sealing ring with lint-and dust-free towel a little soaked with isopropyl alcohol. Clean sealing ring and pendulum plate with lint-and dust-free towel little soaked with isopropyl alcohol or in an ultrasonic bath.
11. Clean out valve body with alcohol. Use an appropriate non metal tool with a cloth to enter valve body. Do not enter valve body with hands!
Then blow out valve body with clean air.
Do not directly expose seals (actuator and retaining pin feedthroughs) to air stream!
12. Clean or replace gate seal if necessary. Install gate seal to sealing ring without grease.</td><td colspan="2"> 
gate seal
 
body seal</td><td>Soft tool (o-ring remover)
VAT cleaning tool for valve body (Part No. see chapter spare parts / accessories)</td></tr>
<tr><td>13. Clean or replace body seal if necessary. Lubricate body with the quantity of vacuum grease listed in the table to the right.</td><td>Valve size
250</td><td>Quantity of grease [ml]
0.2</td><td>• Soft tool (o-ring remover)
• Vacuum grease</td></tr>
<tr><td>14. Install body seal into sealing ring.</td><td colspan="2"></td><td></td></tr>
<tr><td>15. Deposit vacuum grease on the bottom side of the body seal according to drawing below. Pay attention that the quantity of vacuum grease listed in the table to the right is distributed constantly over the whole circumference.</td><td>Valve size
250</td><td>Quantity of grease [ml]
0.4</td><td>Vacuum grease</td></tr>
<tr><td> 
Apply grease deposit on this side</td><td colspan="2">  </td><td>Vacuum grease</td></tr>
<tr><td>Note: For Replacement of actuator or actuator shaft seals, proceed with step 18 otherwise go to step 17.
16. Reassembly the valve in reverse order, step 9…3.
17. Close the valve bonnet, see steps 39…41.</td><td colspan="2"></td><td></td></tr>
</table>

Description		Required tool		
18. Move the valve to position 50% (half opened) This is necessary, in order to dismount the actuator. See step 23. 19. Turn off the power	  	• CV software • CPA software or • Service Box 2		
20. Disconnect 24VDC power. Wait for 60s, then disconnect cables and compressed air from valve actuator. 21. Unfasten all 4 controller screws and lift controller carefully from actuator. Unfasten the 4 screws of the shift adaptor plat and remove it carefully. 22. Remove the controller carefully from actuator.	 	Allen Wrench 4 mm		

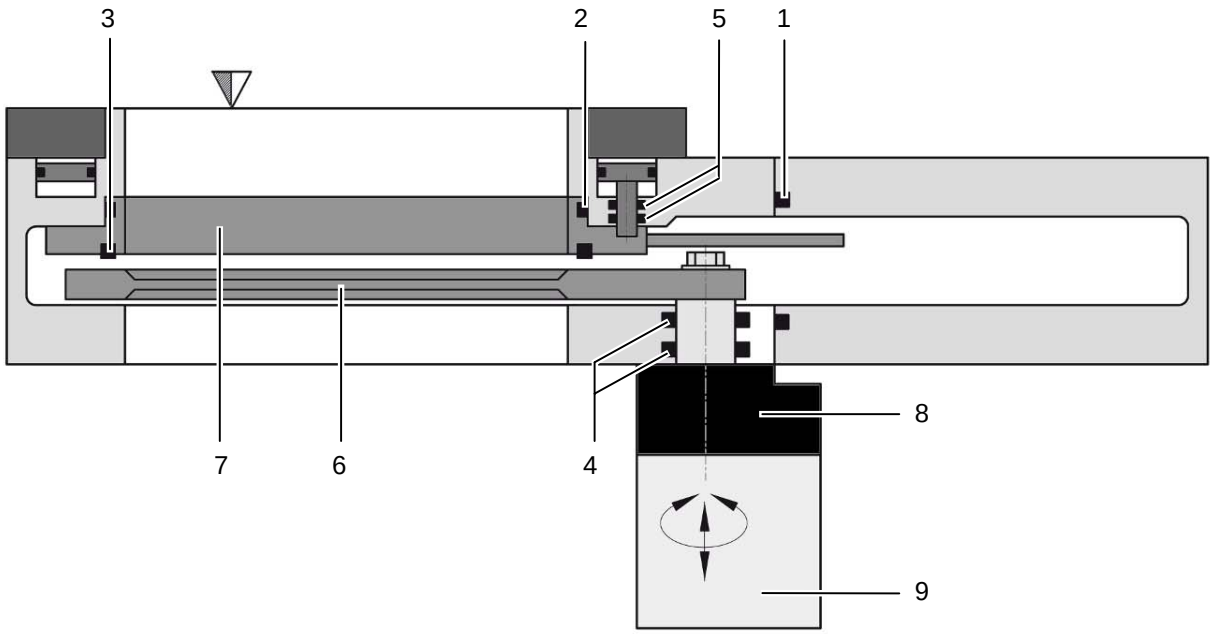
Description		Required tool		
23. Unfasten all 3 actuator screws and remove actuator.		Allen Wrench 5 mm		
24. Remove actuator shaft seals carefully with a soft tool. 25. Clean actuator feedthrough with alcohol. 26. Lubricate each o-ring groove with 0.1 ml vacuum grease. Pay attention that grease is distributed constantly over the whole circumference.	 	• Soft tool (o-ring remover) • Vacuum grease		
27. Clean or replace seals if necessary. Lubricate each o-ring with 0.05 ml vacuum grease. 28. Install o-rings. 29. Deposit 0.1 ml vacuum grease on each o-ring. Pay attention that grease is distributed constantly over the whole circumference.		Vacuum grease		
30. Remove fixation kit and mounting screw for pendulum plate. 31. Clean screw and slightly lubricate thread. Then reinstall fixation kit. 32. Clean actuator shaft and lubricate it with 0.1 ml vacuum grease.		Vacuum grease		
33. Install actuator • Tighten actuator screws with 6 Nm. • Remove vacuum grease from actuator shaft face after installation.		Allen Wrench 5mm		

<table>
<tr><th colspan="3">D e s c r i p t i o n</th><th>Required tool</th><th></th><th></th></tr>
<tr><td>34. Install controller
• Tighten the controller screws with 1 Nm.
• Connect cables at controller
• Connect compressed air at actuator</td><td colspan="2">  </td><td>Allen Wrench 4mm</td><td></td><td></td></tr>
<tr><td>35. Turn on power of controller.
Note: valve moves to close position.
36. Open valve and install sealing ring and pendulum plate in reverse order as they had been disassembled (steps 8 to 3).</td><td colspan="2"></td><td>open end wrench 13mm</td><td></td><td></td></tr>
<tr><td rowspan="2">If actuator was replaced, proceed with step 37, otherwise go to step 39.
37. Close valve and check if pendulum plate is in center of flange. Check can be done either visual or by measurement.
When the valve is mounted to a tool, the bonnet has to be removed and the center position can be measured by a depth gauge (see picture).
If the centering (or distance D) is not correct, proceed with step 38.</td><td rowspan="2"> 

 
</td><td>DN</td><td>Distance D[mm] between bonnet flange surface and pendulum plate.</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>250</td><td>50.0 ±0.5</td></tr>
</table>

Description		Required tool		
38. If necessary adjust pendulum plate: a. Move pendulum plate a little towards open (e.g. position 1% of full stroke) b. Use adjustment screw at flange side of actuator (1 turn clockwise adjusts pendulum plate by about 3mm towards open). c. Restart valve in menu 'System/Recovery' d. Check pendulum plate position according step 37 and redo adjustment procedure if necessary.	Adjusting screw mounted either in actuator position «B1 standard» or «B2 option»  	Allen wrench 2mm		
39. Clean the valve sealing surface		Lint-and dust-free towel a little soaked with isopropyl alcohol		
40. Clean the valve bonnet o-ring		Lint-and dust-free towel		
41. Mount valve bonnet. • Tightening torques for bonnet screws, see in table to the right.	**Max. torque 6 Nm**	Allen wrench 5mm		

6 Drawing



1 Bonnet seal
2 Body seal
3 Plate seal
4 Rotary feedthrough seals
5 Shaft feedthrough seals
6 Pendulum plate
7 Sealing ring
8 Actuator
9 Control unit

7 Spare parts

Please specify the **fabrication number of the valve** (see yellow label on valve) when ordering spare parts. This is to ensure that the appropriate spare parts are supplied.

7.1 Control and actuating unit

The item numbers refer to chapter 6, Drawing

Item	Description		Product ordering number
8	Actuator unit		342943
9	Control unit		449859
1	Bonnet seal (Chemraz SC657)		340016
2	Body seal (Chemraz SC657)		246478
3	Gate seal (Chemraz SC657)		246479
	Syringe of vacuum grease	2ml	206792
		5ml	206793
4	Actuator shaft seals	Inner side (Chemraz SC657)	1 x 301075
		Outer side (Viton)	1 x N-5111-329
5	Sealing ring shaft seals	Inner side (Chemraz SC657)	8 x 301073
		Outer side (Viton)	8 x N-7121-112
6	Pendulum plate		92228-01
7	Sealing ring		203217

Note: Use only spare parts manufactured by VAT to assure safe and reliable operation!

7.2 Accessories

Item	Description	Product ordering number
	24 VDC power supply unit (input: 100 –240 V AC)	249775
	'Control Performance Analyzer' package for Windows® consisting of software and service port cable	600SP-99LB-0001
	'Control View' software for Windows®	Free download from www.vatvalve.com or Against charge under ordering number 248126
	2m service port cable (PC to valve connection)	Free wiring information from www.vatvalve.com or Against charge under ordering number 230327
	Connector kit consisting of: •DB-9 female power plug •DB-15 male sensor plug	242410

8 Warranty

Each product sold by VAT Vakuumventile AG (VAT) is warranted to be free from the manufacturing defects that adversely affect the normal functioning thereof during the warranty period stated in VAT's «Terms of Sale» immediately following delivery thereof by VAT, provided that the same is properly operated under conditions of normal use and that regular, periodic maintenance and service is performed or replacements made, in accordance with the instructions provided by VAT. The foregoing warranty shall not apply to any product or component that has been repaired or altered by anyone other than an authorized VAT representative or that has been subject to improper installation or abuse, misuse, negligence or accident. VAT shall not be liable for any damage, loss, or expense, whether consequential, special, incidental, direct or otherwise, caused by, arising out of or connected with the manufacture, delivery (including any delay in or failure to deliver), packaging, storage or use of any product sold or delivered by VAT shall fail to conform to the foregoing warranty or to the description thereof contained herein, the purchaser thereof, as its exclusive remedy, shall upon prompt notice to VAT of any such defect or failure and upon the return of the product, part or component in question to VAT at its factory, with transportation charges prepaid, and upon VAT's inspection confirming the existence of any defect inconsistent with said warranty or any such failure, be entitled to have such defect or failure cured at VAT's factory and at no charge therefor, by replacement or repair of said product, as VAT may elect. VAT MAKES NO WARRANTY OR REPRESENTATION OF ANY KIND, EXPRESS OR IMPLIED, (INCLUDING NO WARRANTY OR MERCHANTABILITY), EXCEPT FOR THE FOREGOING WARRANTY AND THE WARRANTY THAT EACH PRODUCT SHALL CONFORM TO THE DESCRIPTION THEREOF CONTAINED HEREIN, and no warranty shall be implied by law.

Furthermore, the «Terms of sale» at the back of the price list are applicable.