

Installation, Operating & Maintenance Instructions

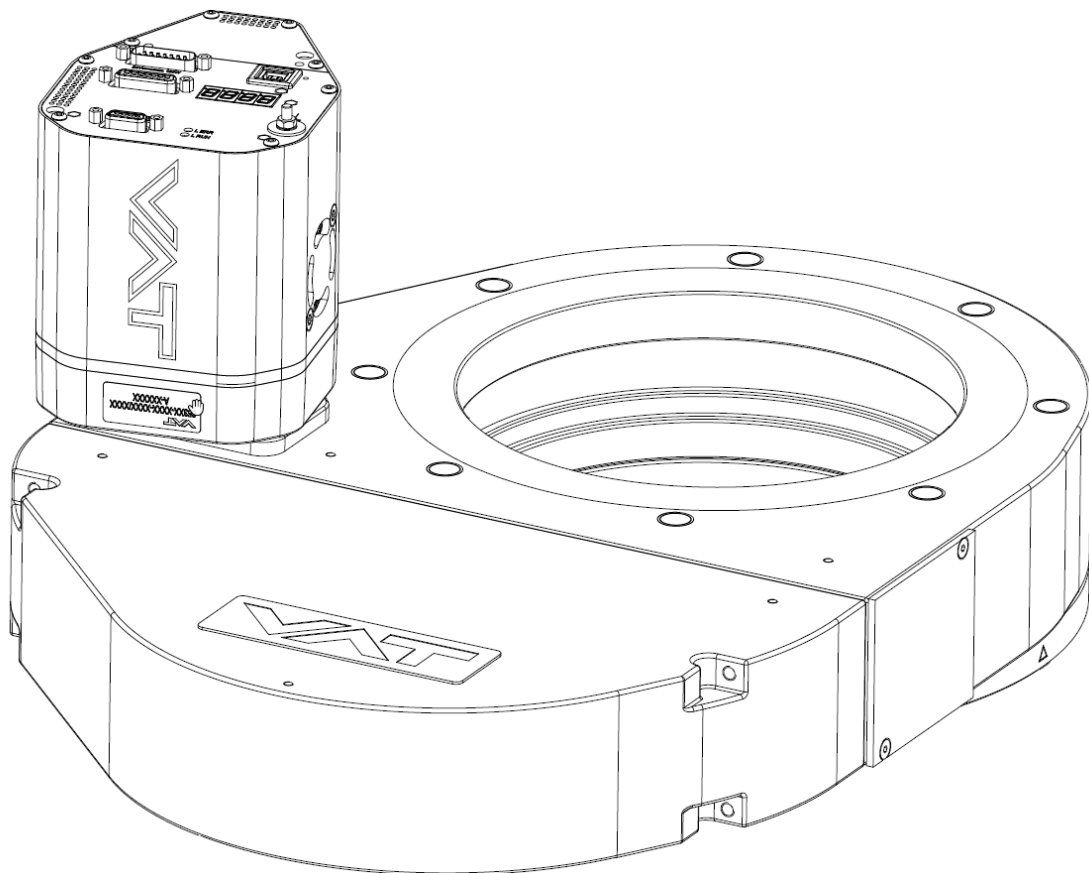


Pendulum control & isolation valve With Profibus interface VAT2 profile

Series 653 DN 100-250 mm (I.D. 4" - 10")

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

- 653GF -(2 sensor inputs)
- 653AF -(2 sensor inputs / $\pm 15V$ SPS)
- 653HF -(2 sensor inputs / PFO)
- 653CF -(2 sensor inputs / $\pm 15V$ SPS / PFO)



Sample picture

Imprint

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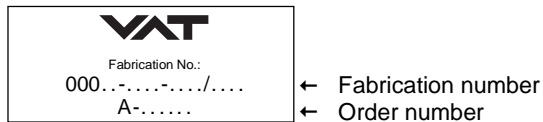
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1 Description of product

1.1 Identification of product

The fabrication number and order number are fixed on the product directly or by means of an identification plate.



1.2 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 vacuum applications only. Other applications are only allowed with the written permission of VAT.

1.3 Used abbreviations

Abbreviation	Description
CPA	Control Performance Analyzer
PFO	Power Failure Option
SFS	Sensor Full Scale
SPS	Sensor Power Supply
ADC	Analog-to-digital converter

1.4 Related documents

- Product Data Sheet
- Dimensional Drawing
- IOMI Heating device (if valve with heater)

1.5 Important information



This symbol points to a very important statement that requires particular attention.

Example:



Refer to chapter: «Technical data» for detailed information.

1.6 Technical data

1.6.1 Control and actuating unit

Description	
Power input ¹⁾ (α) [653 A / 653 H] [653 C / 653 H]	+24 VDC (±10%) @ 0.5 V pk-pk max. connector: POWER 70 W max. (operation of valve with max. load) without PFO ³⁾ with optional SPS + 40 W with optional PFO + 10 W ³⁾
Sensor power supply ²⁾ (β) [653 A / 653 C] input output	+24 VDC / 1500 mA max. connector: POWER ±15 VDC (±5%) / 1200 mA max. connector: SENSOR
Sensor power supply ²⁾ (β) [653 G / 653 H] input output	+ 24 VDC resp. ± 15 VDC connector: POWER same as input but: connector: SENSOR 2.0 A max. at ± 15 VDC 1.5 A max. at + 24 VDC
Actuator type	Stepper motor with servo control
Ingress Protection	IP30

1) Internal overcurrent protection by a PTC device.

2) Refer to chapter «Sensor supply concepts» for details.

3) PFO = Power Failure Option. Refer to «Behavior in case of power failure» for details.



Calculation of complete power consumption:

$$P_{\text{tot}} = \alpha + \beta$$

whereas β depends on sensor supply concept and sensor power consumption.

Control and actuating unit (continuation)		
Sensor input Signal input voltage ADC resolution Sampling time	-10 ... +10 V / $R_i = 100 \text{ k}\Omega$ 0.1 mV 2 ms	connector: SENSOR
Digital inputs (power connector) input 1 input 2 voltage control contact control	interlock open (adjustable with CPA) interlock close (adjustable with CPA) 12 ... 24V / 4 ... 8 mA 24V / 8 mA	connector: POWER connector: POWER
Digital outputs (power connector) output 1 output 2 load	valve closed (adjustable with CPA) valve opened (adjustable with CPA) max. 70 V / 0.1 A	connector: POWER connector: POWER
Digital inputs ⁴⁾ voltage control contact control	5 ... 24V / 2 ... 10 mA 3.3V / 2 mA	connector: INTERFACE
Digital outputs ⁴⁾ Input voltage Input current	max. 70 V max. 0.1 A	connector: INTERFACE
Analog outputs ⁴⁾	0-10 VDC / 1 mA max.	connector: INTERFACE
PFO ⁵⁾ battery pack [653 C / 653 H] charging time durability	2 minutes max. up to 10 years @ 25°C ambient; refer to «Durability of power fail battery» for details	
Compressed air supply	4 - 7 bar / 55 - 100 psi (above ATM)	
Ambient temperature	0 °C to +50 °C max. (<35 °C recommended)	
Pressure control accuracy	5 mV or 0.1% of setpoint, whichever is greater	

	DN 100 4" (65340 -)	DN 160 6" (65344 -)	DN 200 8" (65346 -)	DN 250 10" (65348 -)
Position resolution / position control capability	58000 steps (full stroke)			
Closing time throttling only (full stroke)	0.7 s typ. 0.4 s typ.	0.8 s typ. 0.45 s typ.	0.9 s typ. 0.5 s typ.	0.9 s typ. 0.5 s typ.
Opening time throttling only (full stroke)	0.7 s typ. 0.4 s typ.	0.8 s typ. 0.45 s typ.	0.9 s typ. 0.5 s typ.	0.9 s typ. 0.5 s typ.
Closing time throttling & isolation (full stroke)	3 s typ.	3 s typ.	3 s typ.	3 s typ.
Opening time throttling & isolation (full stroke)	4 s typ.	4 s typ.	4 s typ.	4 s typ.

4) Refer to chapter «Schematics» for details.

5) PFO = Power Failure Option. Refer to chapter «Behavior in case of power failure» for details.

1.6.2 Valve unit

Description	
Pressure range at 20°C - Aluminum (653 A) - Aluminum hard anodized (653 H) - Aluminum nickel coated (653 I)	1 x 10E-8 mbar to 1.2 bar (abs) 1 x 10E-6 mbar to 1.2 bar (abs) 1 x 10E-8 mbar to 1.2 bar (abs)
Leak rate to outside at 20°C - Aluminum (653 A) - Aluminum hard anodized (653 H) - Aluminum nickel coated (653 I)	1 x 10E-9 mbar l/s 1 x 10E-5 mbar l/s 1 x 10E-9 mbar l/s
Leak rate valve seat at 20°C - Aluminum (653 A) - Aluminum hard anodized (653 H) - Aluminum nickel coated (653 I)	1 x 10E-9 mbar l/s 1 x 10E-4 mbar l/s 1 x 10E-9 mbar l/s
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	+10°C to +120°C
Mounting position	horizontally only
Wetted materials - Body (653 A) - Body (653 H) - Body (653 I) - Pendulum plate (653 A) - Pendulum plate (653 H) - Pendulum plate (653 I) - Sealing ring (653 A) - Sealing ring (653 H) - Sealing ring (653 I)	Aluminum 3.3211 (AA6061) Aluminum 3.3211 (AA6061) hard anodized Aluminum 3.3211 (AA6061) nickel coated Aluminum 3.3211 (AA6061) Aluminum 3.3211 (AA6061) hard anodized Aluminum 3.3211 (AA6061) nickel coated Aluminum 3.3211 (AA6061), 1.4306 (304L) Aluminum 3.3211 (AA6061) hard anodized, 1.4306 (304L) Aluminum 3.3211 (AA6061) nickel coated, 1.4306 (304L)
- Other parts	Stainless steel 316L (1.4404 or 1.4435), 1.4122, 1.4310 (301), 1.4303 (304), 1.4571, A2 (304)
- Seals	Viton® (standard). Other materials available. Seal materials are declared on dimensional drawing of specific valve ordering number.

Description				
	DN 100 4" (65340 -)	DN 160 6" (65344 -)	DN 200 8" (65346 -)	DN 250 10" (65348 -)
Max. differential pressure on plate during isolation	1200 mbar in either direction	1200 mbar in either direction	1200 mbar in either direction	1200 mbar in either direction
Max. differential pressure on plate during opening and throttling	30 mbar	10 mbar	5 mbar	5 mbar
Min. controllable conductance (N ₂ molecular flow)	Typ. 2 l/s	Typ. 4 l/s	Typ. 7 l/s	Typ. 10 l/s
Dimensions	Refer to dimensional drawing of specific valve ordering number (available on request)			

2 Safety

2.1 Compulsory reading material

Read this chapter prior to performing any work with or on the product. It contains important information that is significant for your own personal safety. This chapter must have been read and understood by all persons who perform any kind of work with or on the product during any stage of its serviceable life.

	NOTICE
	<p>Lack of knowledge Failing to read this manual may result in property damage. Firstly, read manual.</p>



These Installation, Operating & Maintenance Instructions are an integral part of a comprehensive documentation belonging to a complete technical system. They must be stored together with the other documentation and accessible for anybody who is authorized to work with the system at any time.

2.2 Danger levels


	⚠ DANGER
	<p>High risk Indicates a hazardous situation which, if not avoided, will result in death or serious injury.</p>

	⚠ WARNING
	<p>Medium risk Indicates a hazardous situation which, if not avoided, could result in death or serious injury.</p>


	⚠ CAUTION
	<p>Low risk Indicates a hazardous situation which, if not avoided, may result in minor or moderate injury.</p>

	NOTICE
	<p>Command Indicates a hazardous situation which, if not avoided, may result in property damage.</p>

2.3 Personnel qualifications

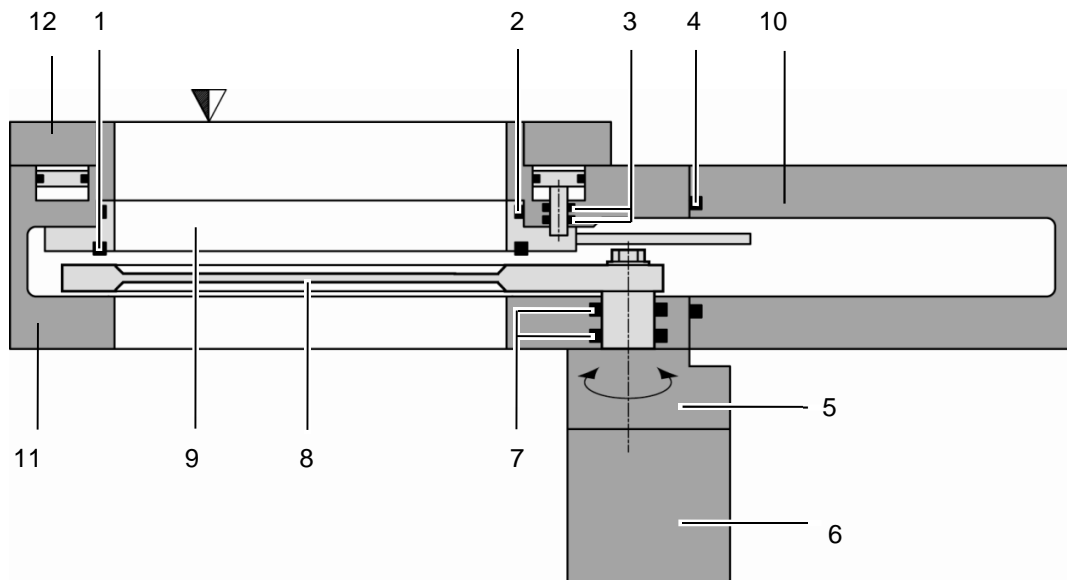
	⚠ WARNING	
	Unqualified personnel Inappropriate handling may cause serious injury or property damage. Only qualified personnel are allowed to carry out the described work.	

2.4 Safety labels

Label	Part No.	Location on valve
	T-9001-156	On protective foil covering of valve opening

3 Design and Function

3.1 Design

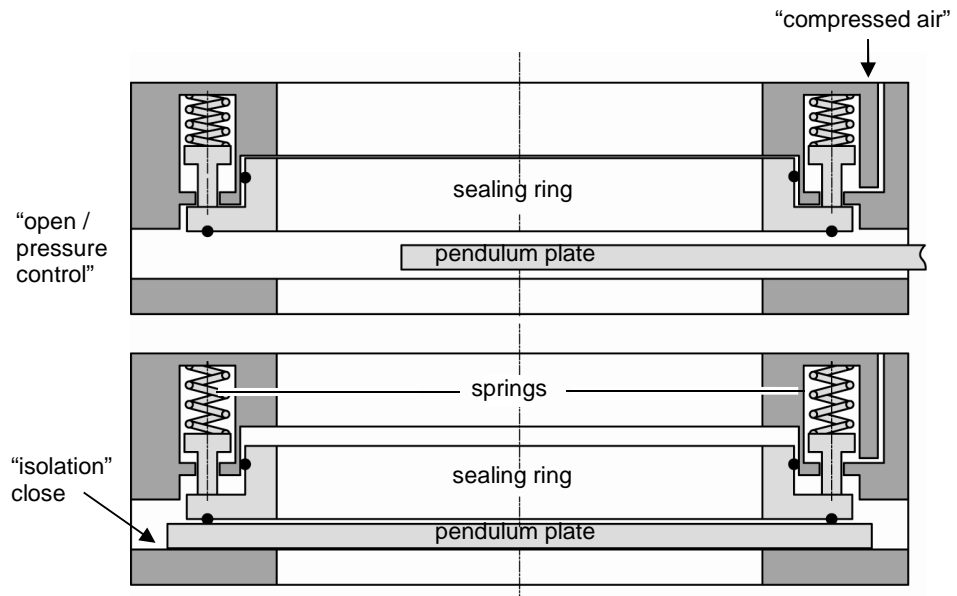


- | | | | |
|---|--------------------------|----|---------------------------|
| 1 | Plate seal | 7 | Rotary feed through seals |
| 2 | Body seal | 8 | Pendulum plate |
| 3 | Shaft feed through seals | 9 | Sealing ring |
| 4 | Bonnet seal | 10 | Bonnet |
| 5 | Actuator | 11 | Body |
| 6 | Integrated controller | 12 | Body Flange |

3.2 Function

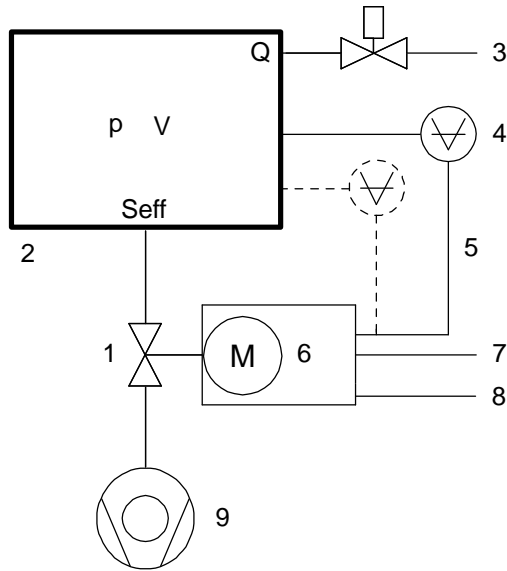
The valve plate acts, due to its pendulum motion, as a throttling element and varies the conductance of the valve opening. The integrated controller calculates the required plate position to achieve the set point pressure. Actuation is performed by a stepper motor. An encoder monitors the position. This principle ensures fast and accurate process pressure control.

For opening or control the “sealing ring” is lifted pneumatically by “compressed air”, afterwards the “pendulum plate” moves to open or do pressure control. For leak tight closing, the “sealing ring” moves downwards and press the pendulum plate to valve body for “isolation”. Closing is performed by “springs”.



3.2.1 Pressure control system overview and function

Vacuum pressures are always absolute pressures unless explicitly specified as pressure differences.



- 1 Valve
- 2 Process chamber
- 3 Gas inlet
- 4 Pressure sensor(s)
- 5 Sensor cable
- 6 Controller and actuator
- 7 Cable to remote control unit
- 8 Cable to power supply
- 9 HV Pump

$S_{eff} = Q / p$
 S_{eff} effective pump speed ($l s^{-1}$)
 Q Gas flow ($mbar l s^{-1}$)
 p Pressure ($mbar$)

or units used in USA
 $S_{eff} = 12.7 \cdot Q / p$
 S_{eff} effective pump speed ($l s^{-1}$)
 Q Gas flow ($sccm$)
 p Pressure ($mTorr$)
 V Volume

Example: Downstream control

3.2.1.1 Way of operation

The controller compares the actual pressure in the process chamber given by the pressure sensor with the preset pressure. The controller uses the difference between actual and set pressure to calculate the correct position of the control valve. The controller drives the control valve into the correct position and the actual pressure again equals the set pressure.

This control operation is performed continuously. Pressure changes in the process chamber due to leaks, desorption, and gas flow, reaction products, variations in pumping speed etc. are always corrected at once.

3.2.1.2 Pressure control

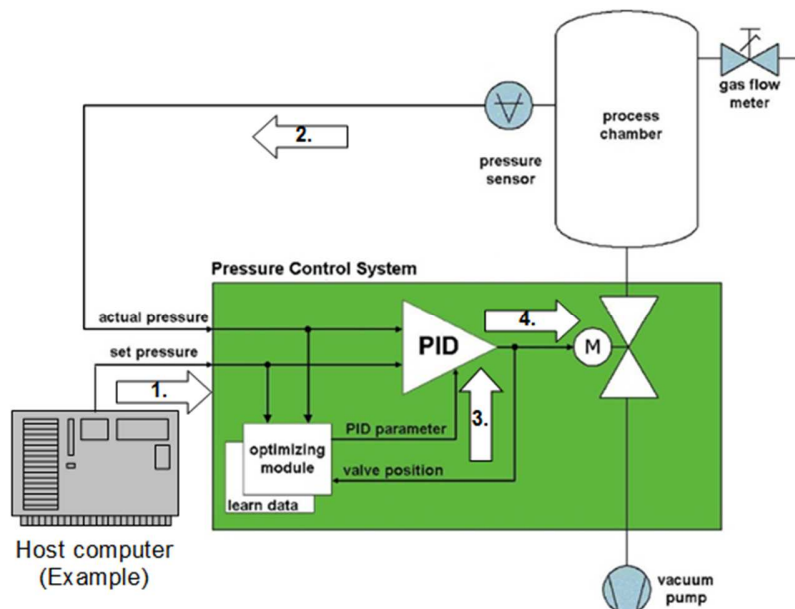
In a vacuum system which is pumped and into which gas is admitted at the same time, the pressure can be controlled in two ways:

1. Downstream control (standard):
The pressure is controlled by changing the conductance of a control valve between pump and process chamber. This changes the effective pumping speed at the process chamber. Pressure and gas flow can be independently controlled over a wide range.
2. Upstream control:
The pressure is controlled by changing the gas flow into the process chamber, while the pumping speed remains constant.

3.2.1.3 Adaptive controller (standard)


A controller adapting itself to changes in pressure, gas flow and pumping speed without any manual adjustments. This allows for a completely automatic operation of the system.

3.2.2 Principle of a pressure control system





1. Host computer sends pressure set point
2. Controller reads actual pressure from sensor
3. Optimizing module sends new PID parameters
4. Actuator sets new valve position

4 Installation

	⚠ WARNING
	Unqualified personnel Inappropriate handling may cause serious injury or property damage. Only qualified personnel are allowed to carry out the described work.

4.1 Unpacking

	NOTICE
	Physical overstraining at controller Inappropriate handling with the valve may cause in damage of controller. Do not place the valve on the controller.

	⚠ CAUTION
	Valve is a heavy component Physical overstraining. Use a crane to lift valves DN 200 (8") and larger.









- Make sure that the supplied products are in accordance with your order.
- Inspect the quality of the supplied products visually. If it does not meet your requirements, please contact VAT immediately.
- Store the original packaging material. It may be useful if products must be returned to VAT.

1. Open the transport case and remove inside packing material as far as necessary.
2. Attach lifting device for valves DN 200 (8") and larger. For attachment refer to dimensional drawing of valve.
3. Lift the valve carefully and place it on a clean place.



Do not remove protective foils from valve opening

4.2 Installation into the system

	<p style="text-align: center;">WARNING</p> <p>Valve opening Risk of serious injury. Human body parts must be kept out of the valve opening and away from moving parts. Do not connect the controller to power before the valve is installed complete into the system.</p>
	<p style="text-align: center;">WARNING</p> <p>Valve in open position Risk of injury when compressed air is connected to the valve. Connect compressed air only when: – valve is installed in the vacuum system – moving parts cannot be touched</p>
	<p style="text-align: center;">NOTICE</p> <p>Sealing surfaces Sealing surfaces of valve and vacuum system could be damage in case of incorrect handling. Only qualified personal are allowed to install the valve into the vacuum system.</p>
	<p style="text-align: center;">NOTICE</p> <p>Wrong connection Wrong connection may result in damage of controller or power supply. Connect all cables exactly as shown in the following descriptions and schematics.</p>
	<p style="text-align: center;">NOTICE</p> <p>Burned connector pins (spark) Connector pins or electronic parts could damage, if plugged and unplugged under power. Do not plug or unplug connectors under power.</p>
	<p style="text-align: center;">NOTICE</p> <p>Contamination Gate and other parts of the valve must be protected from contamination. Always wear clean room gloves when handling the valve.</p>

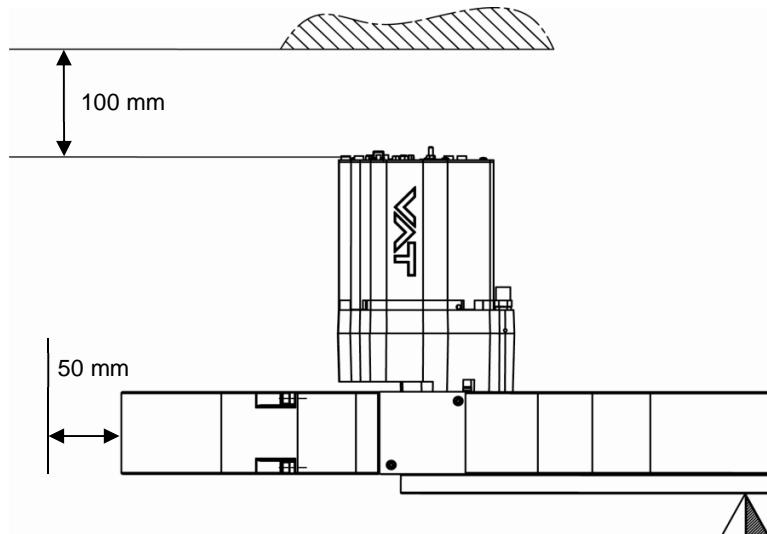


Mount valve to a clean system only.

4.2.1 Installation space condition

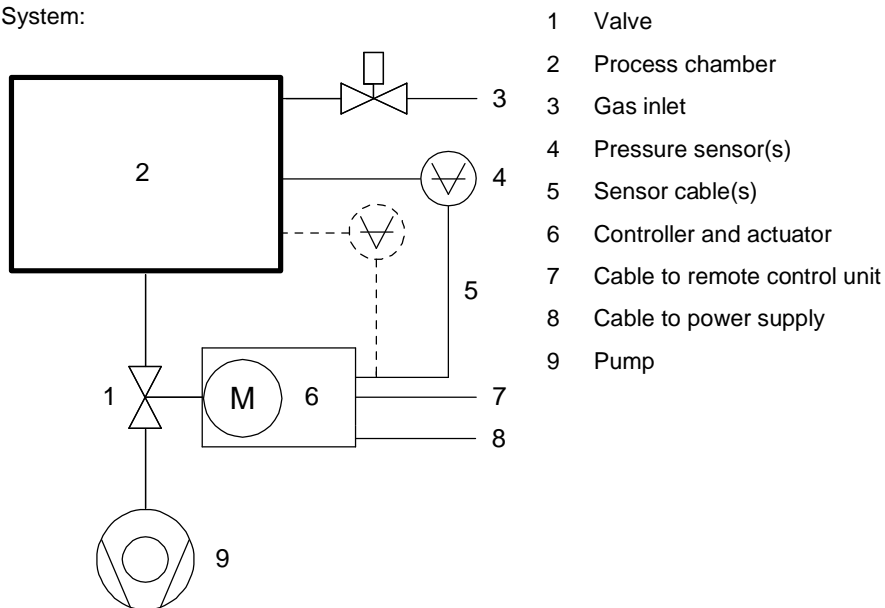


Install the valve with integrated controller with space for dismantling and air circulation as shown in figure below.



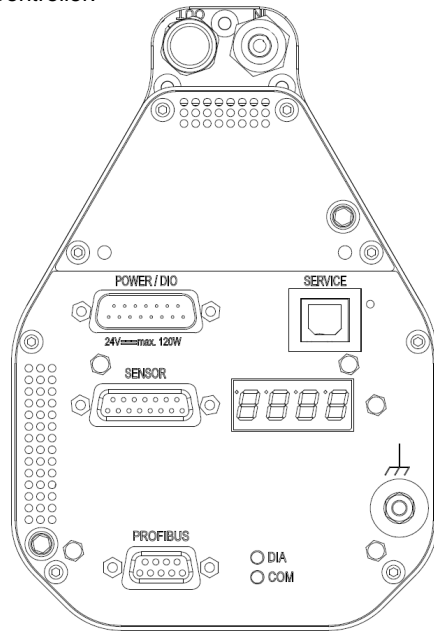
4.2.2 Connection overview

System:



- 1 Valve
- 2 Process chamber
- 3 Gas inlet
- 4 Pressure sensor(s)
- 5 Sensor cable(s)
- 6 Controller and actuator
- 7 Cable to remote control unit
- 8 Cable to power supply
- 9 Pump

Controller:



4.2.3 Installation procedure

1. Install valve [1] into the vacuum system. Valve seat side should face process chamber. The valve seat side is indicated by the symbol "∇" on the valve flange.



- Do not tighten the flange screws stronger than indicated under «Tightening torque».
- Do not admit higher forces to the valve than indicated under «Admissible forces».
- Make sure that enough space is kept free to do preventive maintenance work. The required space is indicated on the dimensional drawing.

2. Connect compressed air supply to connection labeled 'IN' located at actuator, see Figure 1 below. Connect compressed air return line connection labeled 'OUT' located at actuator, see Figure 1 below.



- Compressed air pressure must be in the range of: **4 - 7 bar / 55 - 100 psi (above ATM)**.
- Use only clean, dry or slightly oiled air. IN / OUT connections are 1/8" ISO/NPT internal threads.

3. Install the ground connection cable at controller. Refer to «Electrical connection»
4. Install pressure sensor(s) [2] according to the recommendations of the sensor manufacturer and directives given under «Requirements to sensor connection».
5. Connect sensor cable [3] to sensors and then to valve (connector: SENSOR). Refer to chapter «Electrical connection» for correct wiring.
6. Connect valve to Profibus [4] (connector: INTERFACE). Refer to «Profibus interface connection» for correct wiring.
7. Connect power supply [5] to valve (connector: POWER). Refer to chapter «Electrical connection» for correct wiring.



To provide power to the valve motor pins 4 and 11 must be bridged, otherwise motor interlock is active and the valve enters the safety mode and is not operative. Refer also to «Safety mode».

8. This valve has a double sealed rotary feedthrough and optionally an intermediate pumping port for the actuator shaft. This port (1/8" ISO/NPT) could be connected to the vacuum line, see Figure 3 below.
9. This valve may optionally be equipped with a heating device. Connect VAT heating device according to manual of respective heating device.
10. Perform «Setup procedure» to prepare valve for operation.



Without performing the setup procedure the valve will not be able to do pressure control.

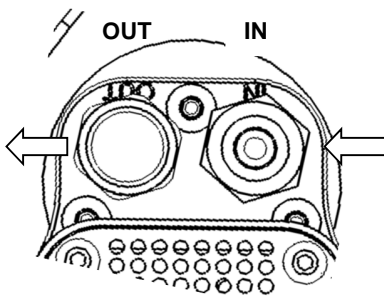


Fig. 1



Fig. 2

4.2.4 Tightening torque

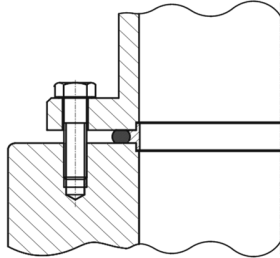


The torque values below are dependent on many factors, such as materials involved, surface quality, surface treatment, and lubrication.

The torques below are valid if immersion depth of the mounting screws is at least once the thread diameter (min. 1 d), and the friction coefficient of the screw-flange connection ($\mu_{\text{total}} = (\mu_{\text{screw thread-helicoil}} + \mu_{\text{under screw head}})/2$) 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.

4.2.5 Mounting with centering rings

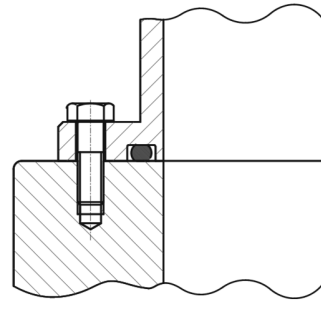
Valve size	ISO-F	ISO-F	
	max. tightening torque (Nm)	max. tightening torque (lbs . ft)	
DN100 / 4" 65340 -	8-10	6-8	
DN160 / 6" 65344 -	13-15	9-11	
DN200 / 8" 65346 -	13-15	9-11	
DN250 / 10" 65348 -	17-20	13-15	
	hole depth (mm)	hole depth (inch)	
DN100 / 4" 65340 -	12	0.47	
DN160 / 6" 65344 -	14	0.55	
DN200 / 8" 65346 -	15	0.59	
DN250 / 10" 65348 -	16	0.63	




Refer to «Spare parts / Accessories» for centering rings ordering numbers.

4.2.6 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)		
DN100 / 4" 65340 -	20-23	35-40	35-40	15-17	26-30	26-30
DN160 / 6" 65344 -	35-40	35-40	35-40	26-30	26-30	26-30
DN200 / 8" 65346 -	35-40	35-40	80-90	26-30	26-30	59-67
DN250 / 10" 65348 -	35-41	65-70	80-90	26-30	48-52	59-67
	hole depth (mm)			hole depth (inch)		
DN100 / 4" 65340 -	12	12	12	0.47	0.47	0.47
DN160 / 6" 65344 -	14	14	14	0.55	0.55	0.55
DN200 / 8" 65346 -	15	15	14	0.59	0.59	0.59
DN250 / 10" 65348 -	16	16	16	0.63	0.63	0.63



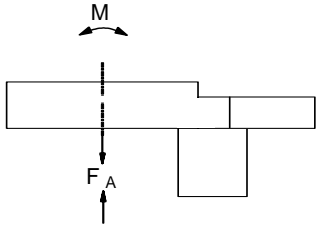
4.2.7 Admissible forces

NOTICE	
	<p>Force at valve body</p> <p>Forces from evacuating the system, from the weight of other components, and from baking can lead to deformation and malfunctioning of the valve.</p> <p>Do not higher force the valve body as specified.</p>



The following forces are admissible.

Valve size	Axial tensile or compressive force «F _A »		Bending moment «M»	
	N	lb.	Nm	lbf.
DN100 / 4" 65340 -	1000	220	40	30
DN160 / 6" 65344 -	2000	440	80	60
DN200 / 8" 65346 -	2000	440	80	60
DN250 / 10" 65348 -	2500	550	100	75
<p>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.</p>				

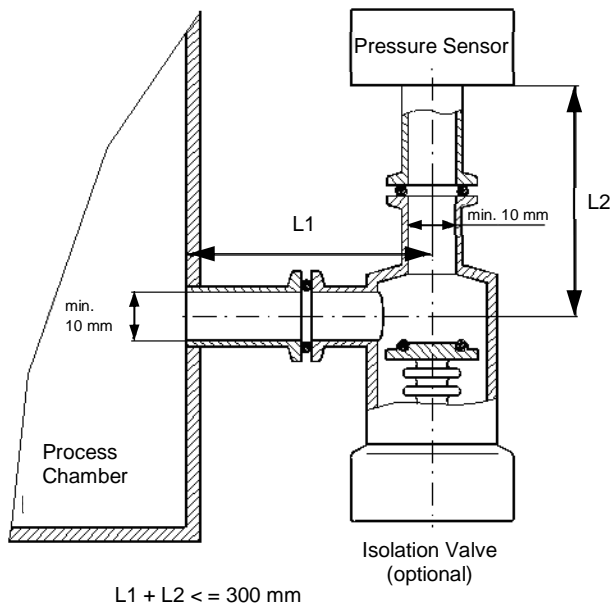


4.2.8 Requirements to sensor connection

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 degraded by this connection it needs to meet the following requirements:

- Inner diameter of connection pipe: **> = 10 mm**
- Length of connection pipe: **< = 300 mm**

These conductance 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. Dynamic stray magnetic fields may introduce noise to sensor output and should be avoided or shielded.



4.3 Electrical connection

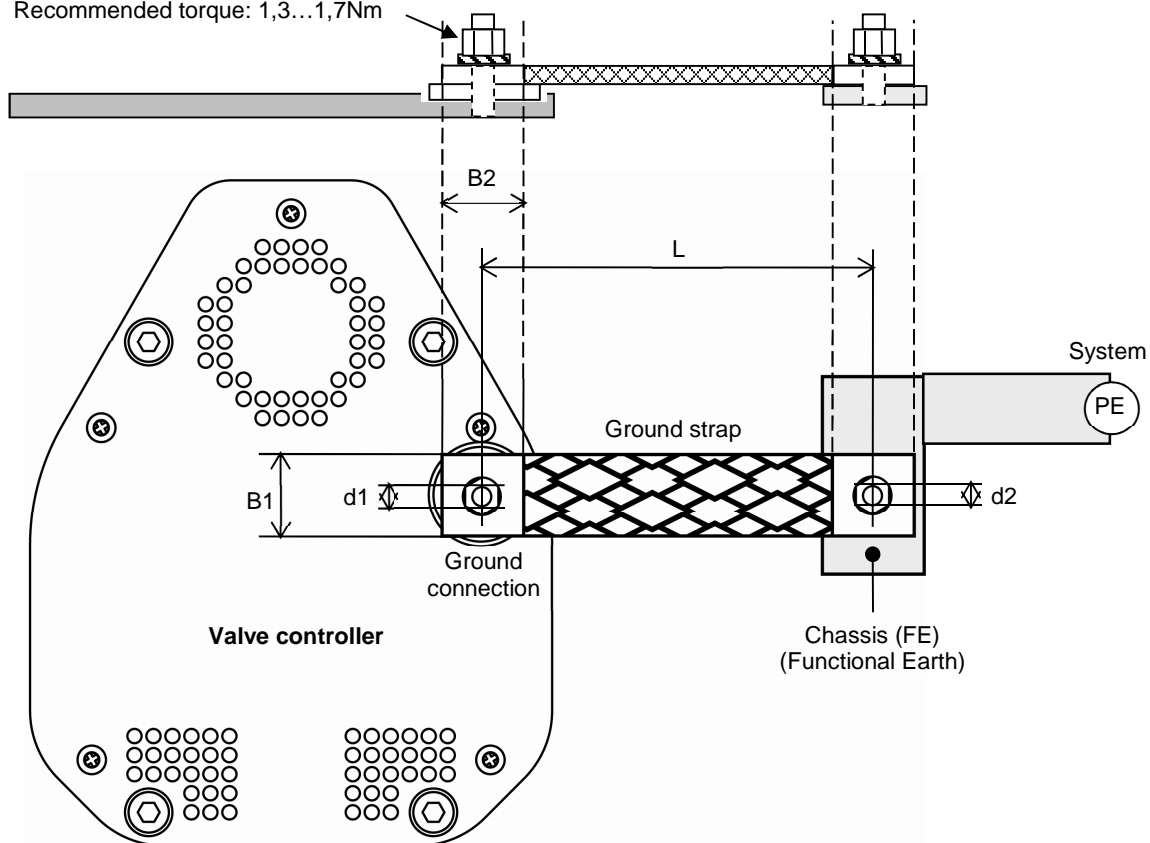
	NOTICE
<p>Wrong connection Wrong connection may result in damage of controller or power supply. Connect all cables exactly as shown in the following descriptions and schematics.</p>	
	NOTICE
<p>Burned connector pins (spark) Connector pins or electronic parts could damage, if plugged and unplugged under power. Do not plug or unplug connectors under power.</p>	

4.3.1 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

Recommended torque: 1,3...1,7Nm



sample picture



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

The connection point at chassis (FE) 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.

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

4.3.2 Power and sensor supply concepts

This valve offers 3 alternative concepts to supply the sensor(s) with power. This depends on the sensor type and valve version that is used. This valve is available with an optional sensor power supply module (SPS) that converts ± 15 VDC from the 24 VDC.

Concepts:

- **24 VDC sensors:**
External +24 VDC supplied to POWER connector is feedthrough to SENSOR connector.
Refer to chapter «Power and sensor connection (+24 VDC sensors)»
- **± 15 VDC sensors:**
 - External ± 15 VDC supplied to POWER connector is feedthrough to SENSOR connector.
Refer to chapter «Power and sensor connection (± 15 VDC sensors) without optional SPS module»
 - External +24 VDC supplied to POWER connector is converted into ± 15 VDC by the valve internal SPS and supplied to SENSOR connector.
Refer to chapter «Power and sensor connection (± 15 VDC sensors) with optional SPS module»



This concept is only possible when SPS retrofit is installed.

Valve versions:

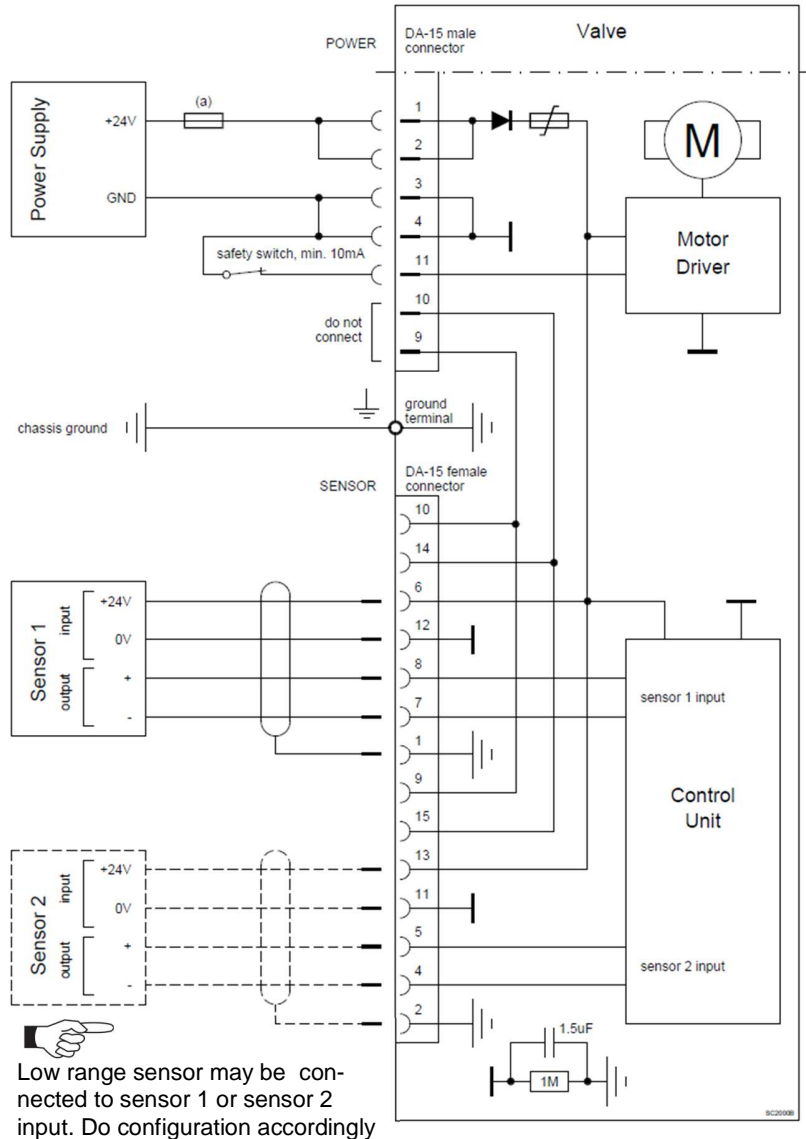
- 653 **G** and 653 **H** SPS module not included
- 653 **A** and 653 **C** SPS module included



The SPS module can be retrofitted.
Refer to chapter «Retrofit / replacement procedure» for instruction.

4.3.2.1 Power and sensor connection (+24 VDC sensors) via controller

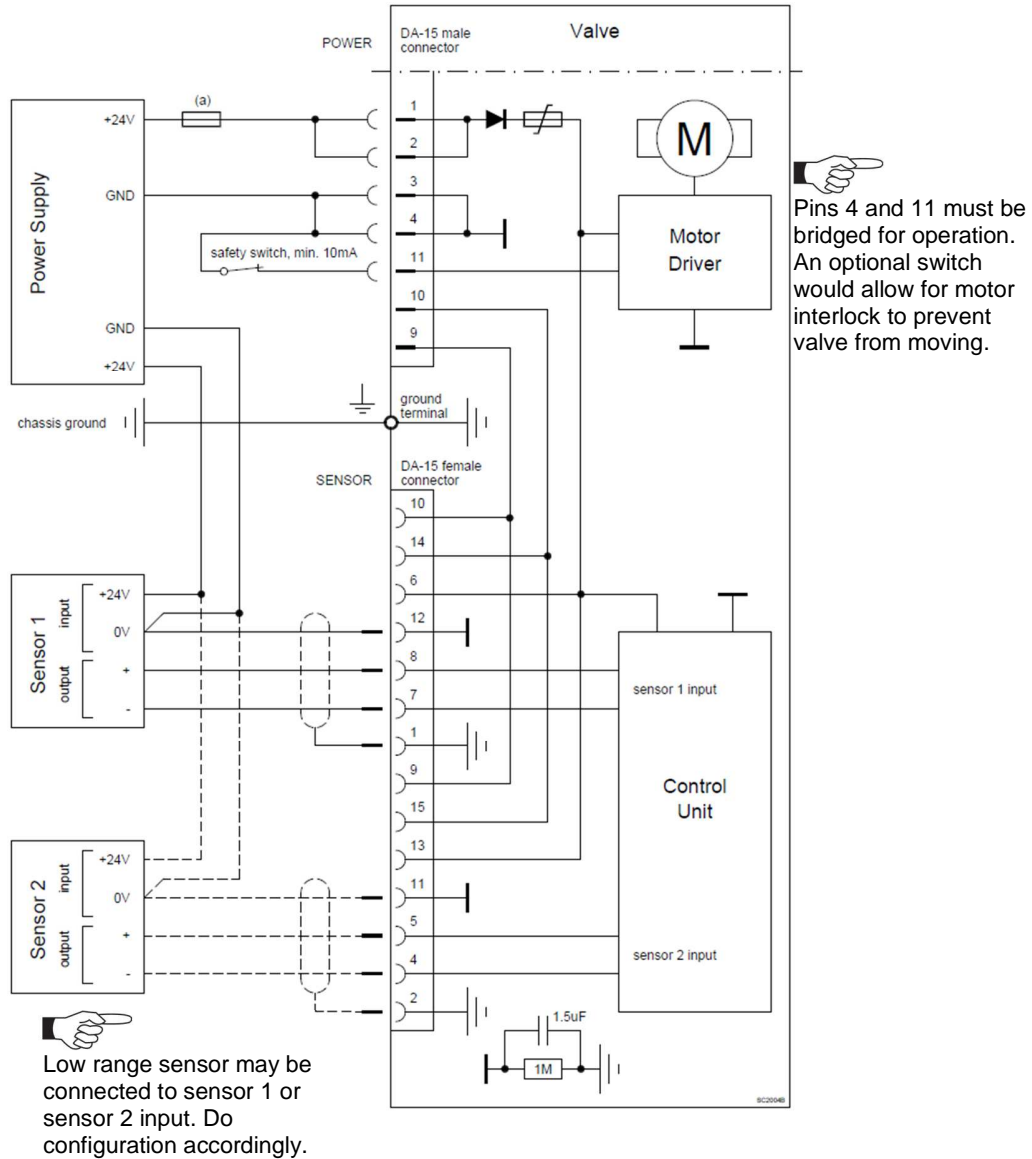
[653 G / 653 H versions recommended]



- **VAT fuse recommendation: (a) 7 AF**
- Use shielded sensor cable(s). Keep cable as short as possible, but locate it away from noise sources.
- Connect Power supply (+24 / GND) at DA-15 male power connector and Sensors (+24V / 0V / + / -) at DA-15 female sensor connector exactly as shown in the drawing above!
- Connector: Use only screws with 4-40 UNC thread for fastening the connectors!

4.3.2.2 Power and sensor connection (+24 VDC sensors) external

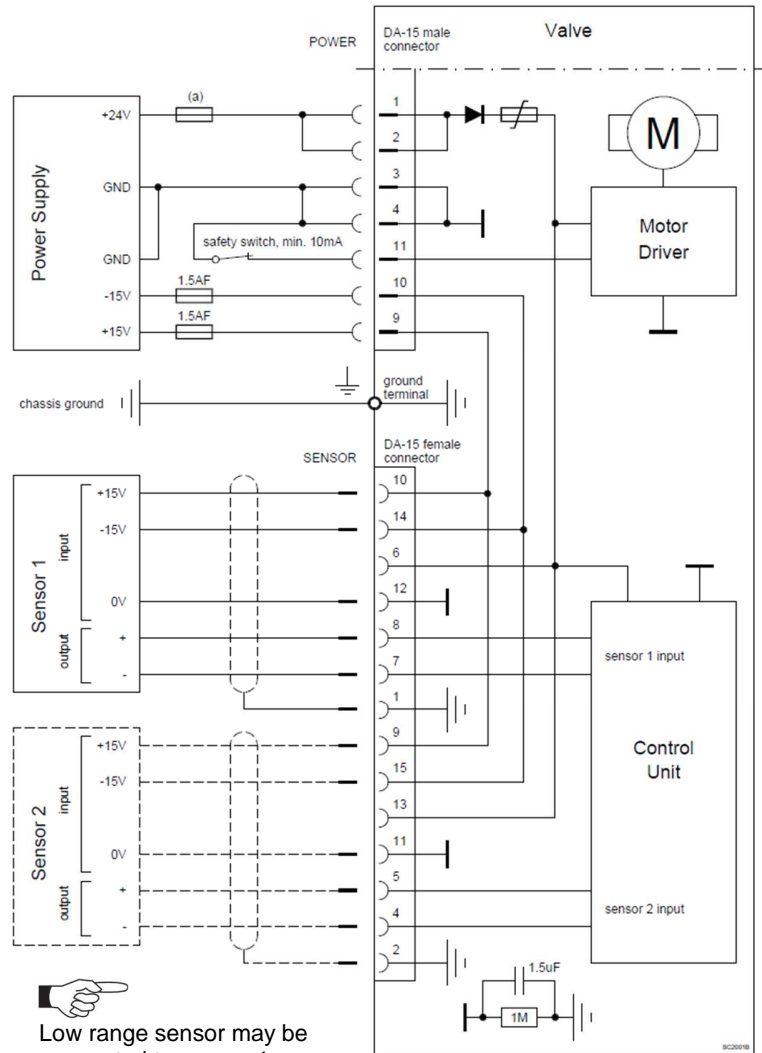
[653 G / 653 H versions recommended]



- VAT fuse recommendation: (a) 5 AF**
- Use shielded sensor cable(s). Keep cable as short as possible, but locate it away from noise sources.
- Connect Power supply (+24 / GND) at DA-15 male power connector and Sensors (0V / + / -) at DA-15 female sensor connector exactly as shown in the drawing above!
- Connector: Use only screws with 4-40 UNC thread for fastening the connectors!

4.3.2.3 Power and sensor connection (± 15 VDC sensors) without opt. SPS module via controller

[653 G / 653 H versions recommended]



Pin 4 and 11 must be bridged for operation. An optional switch would allow for motor interlock to prevent valve from moving.

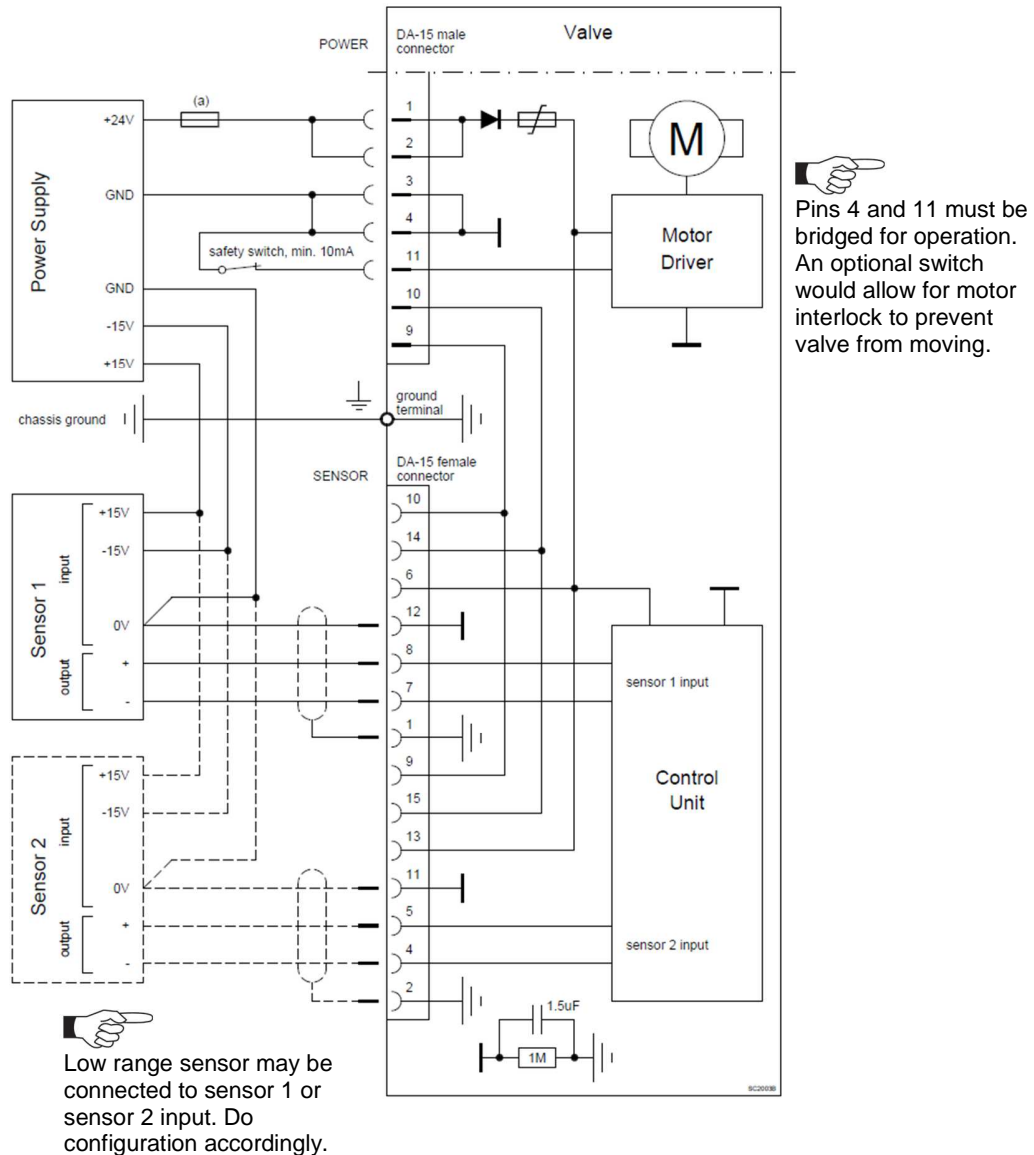
Low range sensor may be connected to sensor 1 or sensor 2 input. Do configuration accordingly.



- **VAT fuse recommendation: (a) 5 AF**
- Use shielded sensor cable(s). Keep cable as short as possible, but locate it away from noise sources.
- Connect Power supply (+24 / GND and GND / -15V / +15V) at DA-15 male power connector and Sensors (+15V / -15V / 0V / + / -) at DA-15 female sensor connector exactly as shown in the drawing above!
- Connector: Use only screws with 4-40 UNC thread for fastening the connectors!

4.3.2.4 Power and sensor connection (± 15 VDC sensors) without opt. SPS module external

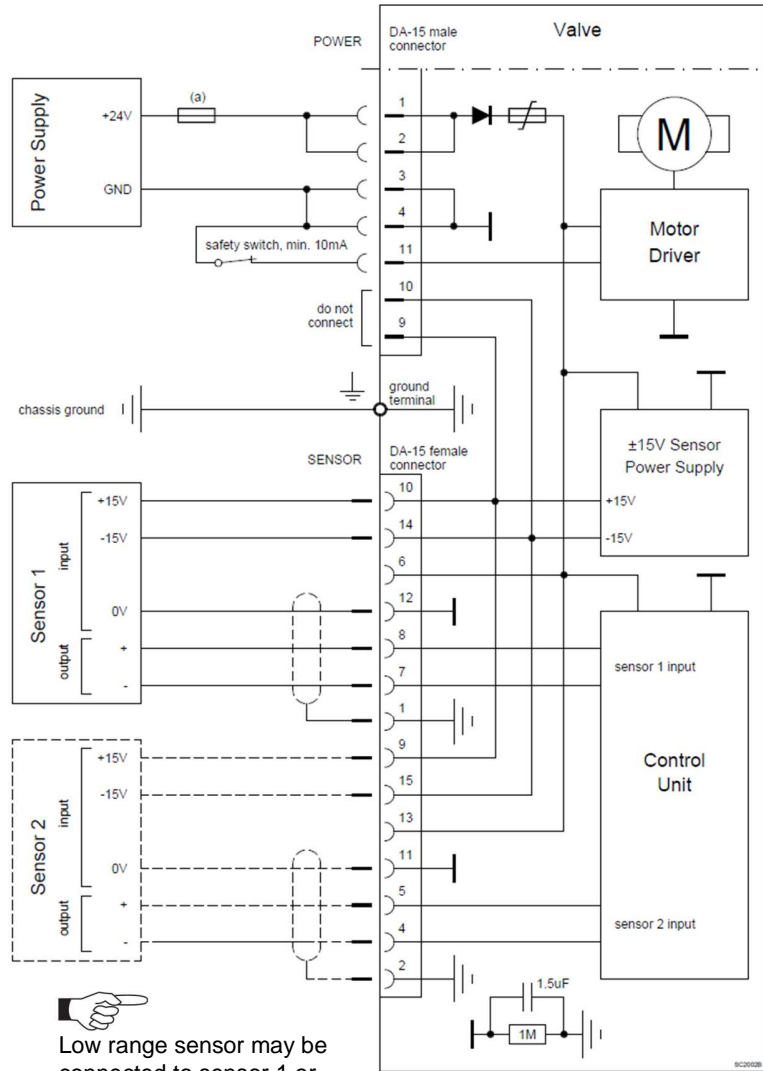
[653 G / 653 H versions recommended]



- **VAT fuse recommendation: (a) 5 AF**
- Use shielded sensor cable(s). Keep cable as short as possible, but locate it away from noise sources.
- Connect Power supply (+24 / GND) at DA-15 male power connector and Sensors (0V / + / -) at DA-15 female sensor connector exactly as shown in the drawing above!
- Connector: Use only screws with 4-40 UNC thread for fastening the connectors!

4.3.2.5 Power and sensor connection (± 15 VDC sensors) with optional SPS module

[653 A / 653 C versions only]



Pins 4 and 11 must be bridged for operation. An optional switch would allow for motor interlock to prevent valve from moving.

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



- **VAT fuse recommendation: (a) 7 AF**
- Use shielded sensor cable(s). Keep cable as short as possible, but locate it away from noise sources.
- Connect Power supply (+24 / GND) at DA-15 male power connector and Sensors (+15V / -15V / 0V / + / -) at DA-15 female sensor connector exactly as shown in the drawing above!
- Connector: Use only screws with 4-40 UNC thread for fastening the connectors!

4.3.3 Profibus interface connection

Connector type: DB9F (DB-9 pin female). Refer also to «PROFIBUS Connector»

PIN	Signal	Description
1	-	-
2	-	-
3	B Line	Positive RxD/TxD, RS485 level
4	RTS	Request to send
5	GND Bus	Ground (isolated)
6	+5V Bus Output	+5V termination power (isolated)
7	-	-
8	A Line	Negative RxD/TxD, RS485 level
9	-	-
Housing	Cable Shield	Internally connected to the protective earth via cable shield filters according to the «PROFIBUS» standard.

The PROFIBUS interface is galvanic isolated from control unit.



Any current drawn from this pin (6) will affect the total power consumption. Do not use the PROFIBUS connection for other application as shown in the table above that may damage the PROFIBUS interface!

Use only FVS1/5-K1163 screws with 4-40UNC thread for fastening the «PROFIBUS» connector!

4.3.3.1 PROFIBUS cable

The following cables are recommended for PROFIBUS (EN 50 170 "Type-A cable"):

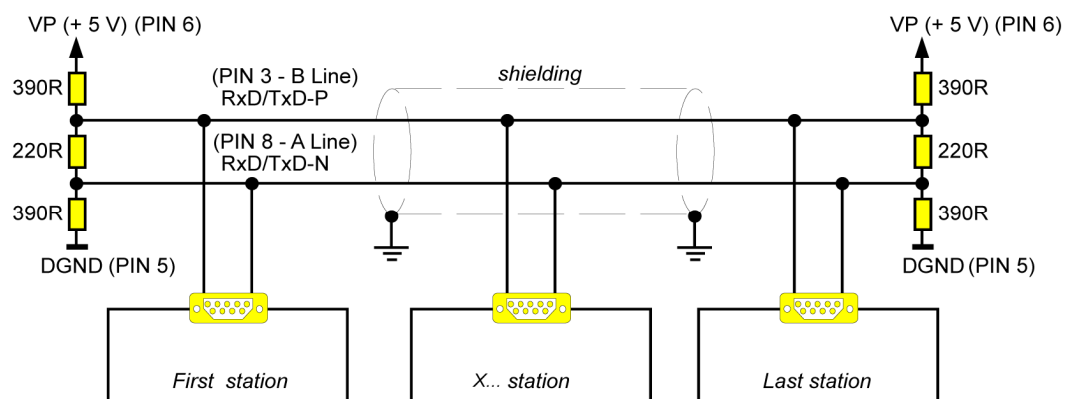
Impedance	135 ... 165 Ω
Capacitance	< 30 pF / m
resistance	< 110 Ω / km
Wire diameter	> 0,64 mm
Conductor cross section	> 0,34 mm ²

Depending on the Baud rate, the following maximum cable length must not be exceeded. See the following table:

Baud rate (kbit / s)	9,6	19,2	45,45	93,75	187,5	500	1500	3000	6000	12000
Max. cable length (m)	1200				1000	400	200	100		

At the connectors of the first and the last station, the ends of the PROFIBUS line must be terminated by a resistor network. Sometimes this network is already integrated switchable (ON or OFF) in the PROFIBUS connector. Switch position must be: ON at *First / Last-station* and OFF at *X...Station*! The shield of the cable must be connected to protection earth.

See the following schematic:



4.3.4 Digital in- output and analogue output connections

This interface allows for remote operation by means of a command set based on the DeviceNet protocol. In addition there are 2 digital inputs and 2 digital outputs. Digital inputs may be operated either by switches or by voltage sources.

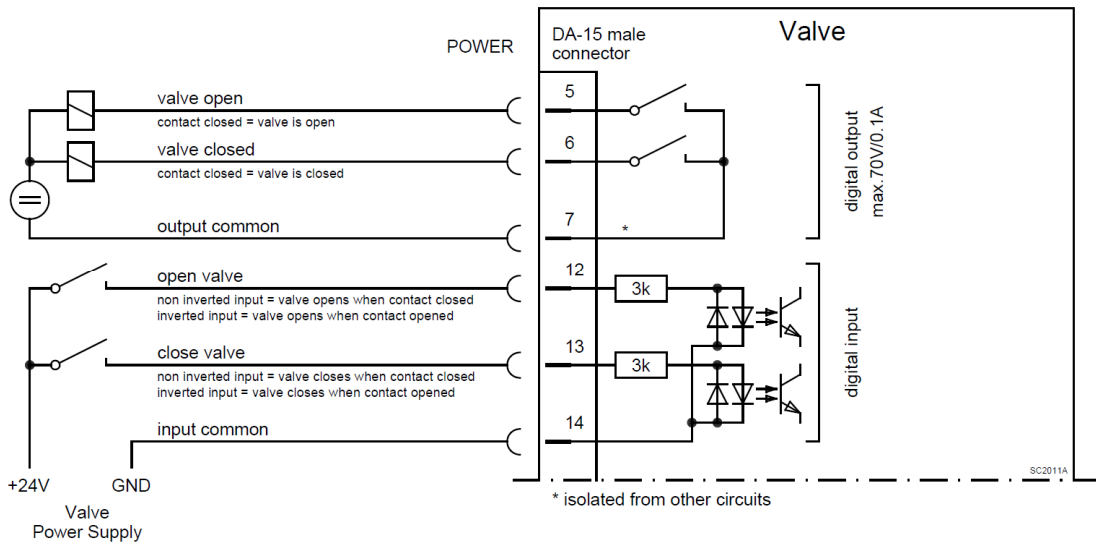


Active **digital inputs** have **higher priority than DeviceNet** commands.

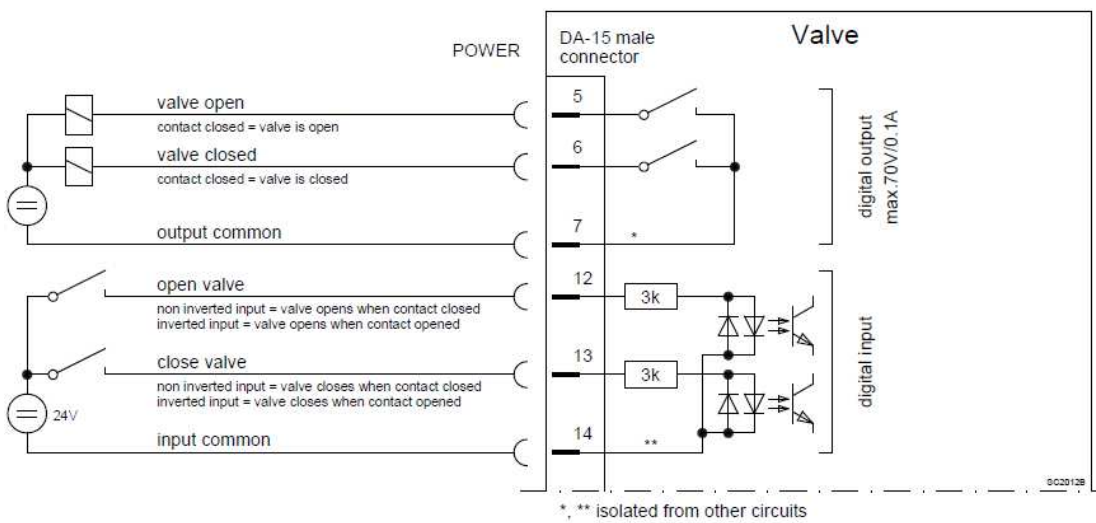


Do not connect other pins than indicated in the schematics above!
Use only screws with 4-40UNC thread for fastening the DA-15 connector!

4.3.4.1 Power connector: Configuration with switches for digital inputs “Interlock”



4.3.4.2 Power connector: Configuration with voltage source for digital inputs



4.3.4.3 Digital inputs

Pin	Function	Description
13	INTERLOCK CLOSE	<p>This function will close the valve.</p> <ul style="list-style-type: none"> • The input has priority over the remote interface • The input can be inverted • The input can be switched off • The function can be set to function INTERLOCK OPEN • INTERLOCK CLOSE has priority over INTERLOCK OPEN
12	INTERLOCK OPEN	<p>This function will open the valve.</p> <ul style="list-style-type: none"> • The input has priority over the remote interface • The input can be inverted • The input can be switched off • The function can be set to function INTERLOCK CLOSE • INTERLOCK CLOSE has priority over INTERLOCK OPEN
14	INPUT COMMON	<p>Common for all digital inputs See also « »</p>

4.3.4.4 Digital output

Pin	Function	Signal type	Description
6	VALVE CLOSED	Digital output	<p>This function will indicate that the valve is closed.</p> <ul style="list-style-type: none"> • The output can be inverted • The output can be switched off • The function can be set to function OPENED or HOLD
5	VALVE OPENED	Digital output	<p>This function will indicate that the valve is open.</p> <ul style="list-style-type: none"> • The output can be inverted • The output can be switched off • The function can be set to function CLOSED or HOLD
7	OUTPUT COMMON	Digital common	<p>Common for all digital output. Connect + or – terminal of source with common</p>

4.3.5 LOGIC I/O

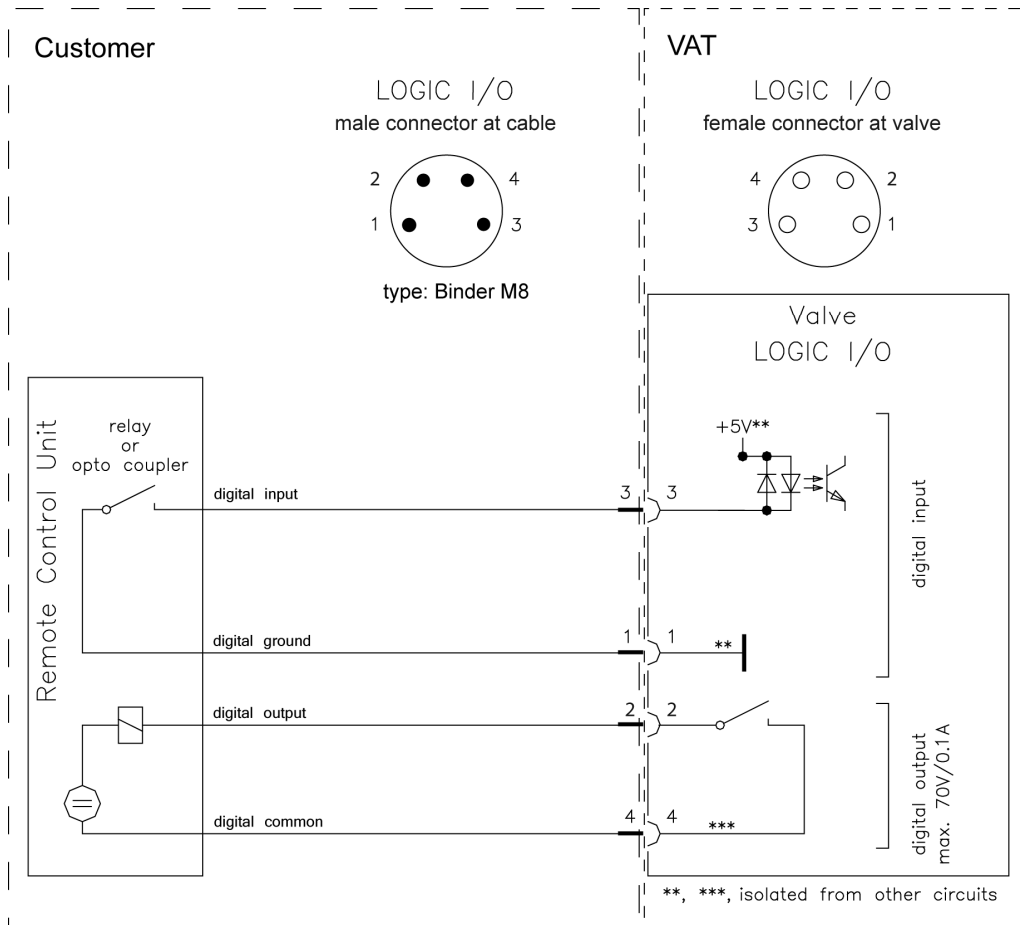
This interface allows for remote operation by means of a command set based on the Profibus protocol. In addition there is a digital input and a digital output. Digital input may only be operated by a switch.



Active **digital input** has:

- **higher priority than Profibus** commands
- **higher priority than Local** commands

Configuration with switch for digital input:



Do not connect other pins than indicated in the schematics above! Connector type: Binder M8 (99-3363-00-04).

4.3.5.1 Digital input

Pin	Signal type	Description
3	Digital input	<p>This function will close the valve. Valve will be in interlock mode as long as function is activated. After deactivation of function it will remain effective until</p> <ul style="list-style-type: none"> - converse Profibus control command have been received <p>The function is activated when optocoupler is 'on' in non inverted configuration. The function is activated when optocoupler is 'off' in inverted configuration.</p> <p>Configuration can be adjusted in local operation via service port with CPA. Refer to chapter: «LOGIC I/O configuration».</p>
1	Digital ground	<p>Ground for digital input. Connect switch to ground. See also chapter: «LOGIC I/O».</p>



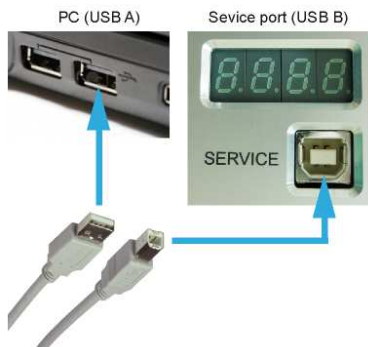
The digital input is digitally filtered. Filter delay is 50ms. This means that digital signal must be applied for at least 50ms to be effective. Refer to chapter: «LOGIC I/O » for details about input circuit.

4.3.5.2 Digital output

Pin	Signal type	Description
2	Digital output	<p>This function will indicate that the valve is closed. If the function "ON" is configured the output is continuous on.</p> <p>Configuration can be changed in local operation via service port with CPA. Refer to chapter: «LOGIC I/O configuration».</p>
4	Digital common	<p>Common for all digital output. Connect + or – terminal of source with common. See also chapter: «LOGIC I/O ».</p>

4.3.6 Service port connection

The service port (connector: SERVICE, USB - B) allows to connect the valve to a USB - A port of a computer. This requires a USB A–B cable male-male. The 'Service port is used for 'Local operation'.



You can use our Software 'Control Performance Analyzer' for Local operation, which is integrated in the IC2 controller. Refer to chapter: 'Local operation' for detail information.

4.4 Initial operation



To enable the valve cluster for **pressure control** setup **steps 1 to 6 must be performed**. In case position control is required only it's sufficient to perform steps 1 to 5.

Setup step		Description
1	Power up	Turn on external + 24VDC power supply (and external ± 15 VDC for sensor power supply if required). Refer to chapter «Behavior during power up» for details.
2	PROFIBUS configuration	The node number must be configured via CPA. There is an auto adjustment for PROFIBUS baud rate for the valve.
3	Valve configuration	Basic configurations of the valve must be adapted according to application needs. Refer to chapter «Valve configuration» for details.
4	Sensor configuration	Basic configurations of the valve must be adapted according to application needs. Refer to chapter «Sensor configuration» for details.
5	ZERO	Compensation of the sensor offset voltage. Refer to chapter «ZERO» for details.
6a	LEARN	Determination of the vacuum system characteristic to accommodate the PID controller. Refer to chapter «LEARN adaptive» for details.
6b	PRESSURE CONTROL COFIGURATION	Accommodation of PID controller to the vacuum system characteristic. Refer to chapter: «Pressure Control configuration» for details.



Without «LEARN» or «PRESSURE CONTROL COFIGURATION» the valve is not able to run pressure control.

4.5 PROFIBUS configuration



Make sure to configure the correct node number.

PROFIBUS node number for valve must be configured.



It's not the goal of this manual to describe the configuration of all parameters. Several tools and interfaces from different vendors are on the market. For communication structure and way of commanding with these tools and interfaces you need to consult the vendor.

Operation via PROFIBUS is sophisticated and requires specific knowledge and training about it and its tools.

VAT offers valve-related but not general PROFIBUS support. Contact us under: PROFIBUS-support@vat.ch .

1. Turn on external + 24VDC power supply (and external ± 15 VDC for sensor power supply if required). Refer to chapter «Behavior during power up» for details.

Download the **GSD-file** (Generic Station Description) for your PLC PROFIBUS master at <http://www.vatvalve.com/customer-service/informations-and-downloads/electronic-support-files/GSD-Files>.

Upload the GSD-file to your PLC PROFIBUS master. The GSD-file Generic Station Description (colloquially „device master data“), is a data format for PROFIBUS devices. The GSD-file specifies the characteristics of the valve, and is used for the PROFIBUS master.

2. Input and output buffer configuration

Place our valve as PROFIBUS node in your PROFIBUS master system – it is called “Anybus-CC PROFIBUS DP-V1”

Configure **first** the output buffer with/for 39 bytes by selecting the followings modules from the GSD-File in exact that order:

- Output 2 words (0xE1)
- Output 2 words (0xE1)
- Output 2 words (0xE1)
- Output 2 words (0xE1)
- Output 2 words (0xE1)
- Output 1 byte (0xA0)
- Output 1 words (0xE0)
- Output 1 words (0xE0)
- Output 1 words (0xE0)
- Output 1 words (0xE0)
- Output 1 words (0xE0)
- Output 2 words (0xE1)
- Output 1 byte (0xA0)
- Output 1 words (0xE0)
- Output 1 byte (0xA0)

Configure after the output buffer the input buffer with/for 47 bytes by selecting the following modules from the GSD-File in exact that order:

- Input 2 words (0xD1)
- Input 2 words (0xD1)
- Input 2 words (0xD1)
- Input 2 words (0xD1)
- Input 2 words (0xD1)
- Input 1 byte (0x90)
- Input 1 word (0xD0)
- Input 1 word (0xD0)
- Input 1 word (0xD0)
- Input 1 word (0xD0)
- Input 1 word (0xD0)
- Input 1 word (0xD0)
- Input 1 word (0xD0)
- Input 1 word (0xD0)
- Input 1 byte (0x90)
- Input 2 words (0xD1)
- Input 1 byte (0x90)
- Input 1 word (0xD0)
- Input 1 word (0xD0)

3. The **node** number is the slave address (PROFIBUS) and can be configured by 'Control View', 'Control Performance Analyzer' or 'Universal Hyper.

The «**set-command**» is: «**s:25xxx00000**». The xxx value is the node address!

The «**get-command**» is: «**i:25**». The answer returns the node address -«i:25xxx00000». The xxx value is the current node address.

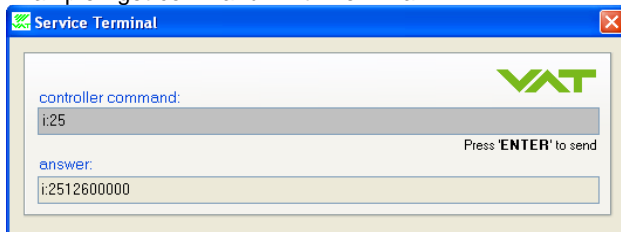
Consider that the controller must be in local mode to accept the commands! After a s:25 command is sent the module is reseted and starts up again.

«c:0100» -> change into local mode

«c:0101» -> change into remote mode

Node PROFIBUS address: Default address is 126, valid range for data exchange operation is 0...125.

Example «get-command» with Terminal:



The baud rate for the valve will be automatic selected by the PROFIBUS master.

4.5.1 Data type of pressure and position values (optional)

The «data type of pressure and position» can be configured by 'Control View', 'Control Performance Analyzer', 'Universal Hyper Terminal' or 'Service Box 2'.

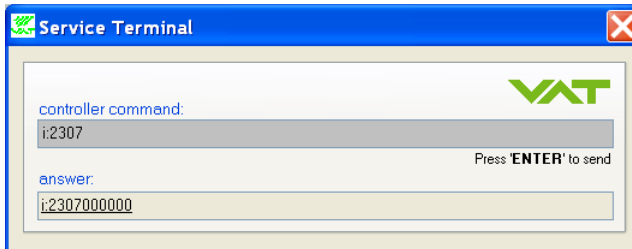
The «**set-command**» is: «**s:23xy00000**». The xxy value is the data type of a pressure and position signal.

y: 0 = signed integer(32 bit), 1 = floating point (32 bit, IEEE-754 standard), default = 0
xx: signal number in the buffer

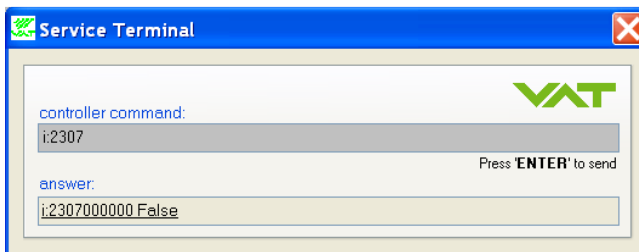
xx	Value
00	Pressure
01	Pressure sensor 1
02	Pressure sensor 2 (optional, only in case of 2 sensor version)
03	Position
04	<i>Not used – reserved</i>
05	Cluster valve position
06	Pressure setpoint
07	Position setpoint
08	<i>Not used – reserved</i>
09	<i>Not used – reserved</i>
10	<i>Not used – reserved</i>
11	Cluster valve freeze position setpoint

The «**get-command**» is: «**i:23xx**». The answer returns the data type of a pressure and position signal → «**i:23xxy00000**». The y value is the current data type of buffer value xx.

Example «get-command» with Terminal: Get the data Type of Position setpoint:



If at start up the data type value in the memory is out of range the default value is taken. In this case the data type is set to default value (0 = signed integer) and the get command i:23 add a string "False":



4.5.2 Range of pressure and position values (optional)

The «range of pressure and position values» can be adjusted. That means:

- For position values, the value for valve position “CLOSE” and the valve position “OPEN” can be set to a other ones then the default 0...100'000 is.
- For pressure values, the value for physical **0 Volt** and **10 Volt** of the sensor output can be set to other values then the default 0...1'000'000 is.

The range of pressure and position values can be configured by ‘Control Performance Analyzer’.

The «set-command» is: «s:24xytoz».

y: **lower scale value**, floating point, entry with a point ‘.’ and ‘-’ for negative values possible

z: **upper scale value**, floating point, entry with a point ‘.’ and ‘-’ for negative values possible

xx: signal number in the buffer

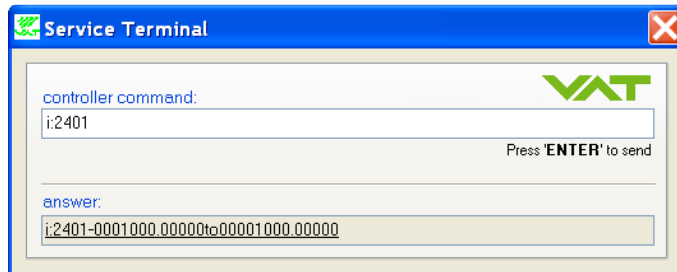
xx	Value	Default range		Min/Max range	
		Default lower scale value	Default upper scale value	Min lower scale vlaue	Max upper scale value
00	Pressure	0	1'000'000	-1'000'000	1'000'000
01	<i>Not used – reserved</i>	-	-	-	-
02	<i>Not used – reserved</i>	-	-	-	-
03	Position	0	100'000	-1'000'000	1'000'000
04	<i>Not used – reserved</i>	-	-	-	-
05	Cluster valve position	0	100'000	-1'000'000	1'000'000
06	Pressure setpoint	0	1'000'000	-1'000'000	1'000'000
07	Position setpoint	0	100'000	-1'000'000	1'000'000
08	<i>Not used – reserved</i>	-	-	-	-
09	<i>Not used – reserved</i>	-	-	-	-
10	<i>Not used – reserved</i>	-	-	-	-
11	Cluster valve freeze position setpoint	0	100'000	-1'000'000	1'000'000

The «get-command» is: «i:24xx». The answer returns the range → «i:24xytoz». The xx is the value number, y value is the current lower scale value of buffer and value z the upper scale value.

The format of y and z has following syntax: -----

Examples: i:2400-0012345.12345to00123456.12345
 i:2401-0001000.00000to00001000.00000
 i:240200001000.00000to00001500.00000

Example «get-command» with Terminal: Get the range of Pressure Sensor 1:



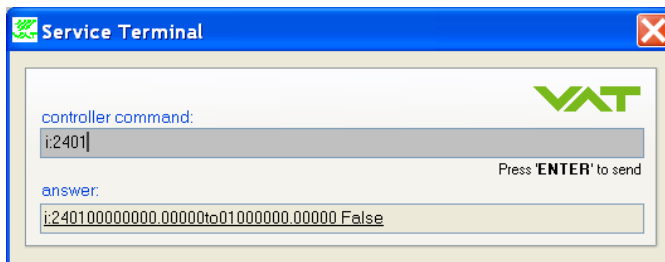
The «range of pressure and position values» is independent of the data type, equal for «signed integer» and «floating point».



The internal accuracy of valve is for all positions 100'000 steps and for all pressures 1'000'000 steps. If the range of pressure and position values is rising, the accuracy of pressure and position will not rise. There is only the gain factor between the VAT valve and the CC-Link Master which will be adapted.

(upper scale value - lower scale value) ≥ 1

If at startup the scale values in the memory are out of range or the rule above is broken the default values are taken. In this case the get command i:24 add a string "False":



Example: s:24031234.56to7890 → set the range of position from 1234.56 (= closed position) to 7890 (= opened position)

Example: s:2400to100.75 → set the range of pressure from 0 (= 0 V) to 100.75 (= 10 V)

Example: s:2407-10.5to20.5 → set the range of Position setpoint from -10.5 (=closed position) to 20.5 (=opened position)


4.6 LOGIC I/O configuration

Default configuration for LOGIC I/O is:

#	Function	Mode	Input
Digital input	close valve	non inverted	enabled

#	Function	Mode	Output
Digital output	close	non inverted	enabled

The «LOGIC I/O» Digital input and Digital output can be adjusted.

Local operation: (‘Control Performance Analyzer’)	Remote operation:
<ol style="list-style-type: none"> Open CV or CPA Switch to [LOCAL] Go to «Tools» > «Terminal» and send setup command according to application needs. (possibility of adjustment see below) <p>For Digital input: to change the configuration: s:2601abcdef[CR] to read the configuration: i:2601[CR]</p> <p> Each element is separated with square brackets for clarity. Square brackets are not part of command syntax. All elements are ASCII characters. There are no spaces between the elements necessary. Command is <u>case sensitive</u>.</p> <p>data length 6 characters</p> <p>a 0 = close valve 1 = open valve</p> <p>b 0 = non inverted 1 = inverted</p> <p>c 0 = enabled 1 = disabled</p> <p>def 000 (reserved)</p> <p>For Digital output: to change the configuration: s:2611abcdef[CR] to read the configuration: i:2611[CR]</p> <p>data length 6 characters</p> <p>a 0 = close 1 = open 2 = On</p> <p>b 0 = non inverted 1 = inverted</p> <p>c 0 = enabled 1 = disabled</p> <p>def 000 (reserved)</p> <p>For LOGIC I/O connector schematics see also chapter «LOGIC I/O».</p>	<p>It's not possible to configuration in remote operation.</p>

4.7 Valve configuration

Basic valve configuration must be adapted according to application needs.
Definition of valve plate position in case of:

- **After power up**, default is 'close'.
- **Power failure**, default is 'not defined'. Only for versions that have Power Fail Option equipped [653 **C** or 653 **H**].
- **Network failure**, for default settings refer to individual product data sheet.

4.7.1 Homing Start Option

Homing start option defines when the valve performs the homing procedure.

Parameter	Description												
Start Condition	<p>Homing start option defines when the valve performs the homing procedure.</p> <table> <tr> <td><i>Standard</i></td> <td>Do homing after restart if valve is not in sealed state</td> </tr> <tr> <td><i>Open Command</i></td> <td>Do homing on an open command</td> </tr> <tr> <td><i>Move Command</i></td> <td>Do homing on any move command</td> </tr> <tr> <td><i>At Startup</i></td> <td>Do homing after restart</td> </tr> <tr> <td><i>Homing Command</i></td> <td>Do homing on homing command</td> </tr> <tr> <td><i>Move Command (Standard)</i></td> <td>Settings from move commands, without homing in close position by close command</td> </tr> </table>	<i>Standard</i>	Do homing after restart if valve is not in sealed state	<i>Open Command</i>	Do homing on an open command	<i>Move Command</i>	Do homing on any move command	<i>At Startup</i>	Do homing after restart	<i>Homing Command</i>	Do homing on homing command	<i>Move Command (Standard)</i>	Settings from move commands, without homing in close position by close command
<i>Standard</i>	Do homing after restart if valve is not in sealed state												
<i>Open Command</i>	Do homing on an open command												
<i>Move Command</i>	Do homing on any move command												
<i>At Startup</i>	Do homing after restart												
<i>Homing Command</i>	Do homing on homing command												
<i>Move Command (Standard)</i>	Settings from move commands, without homing in close position by close command												
End Control Mode	<p>This control mode is set after a successful homing.</p> <table> <tr> <td><i>Position</i></td> <td>Moves to position defined in End Position</td> </tr> <tr> <td><i>Close</i></td> <td>Closes the valve</td> </tr> <tr> <td><i>Open</i></td> <td>Opens the valve</td> </tr> </table>	<i>Position</i>	Moves to position defined in End Position	<i>Close</i>	Closes the valve	<i>Open</i>	Opens the valve						
<i>Position</i>	Moves to position defined in End Position												
<i>Close</i>	Closes the valve												
<i>Open</i>	Opens the valve												
End Position	In case the End Control Mode is set to <i>Position</i> , this parameter defines which position is set after successful homing.												

Parameter location:

CPA	Profibus
Valve.Homing	It's not possible to do "Homing" via Profibus.

4.7.2 Power Failure Option

These settings define what the valve is doing in case the power fails.

Parameter	Description
Enable	'True' enables the power fail reaction, in case of 'False' there is no reaction on a power fail
State	Current power fail state
Functionality	Defines the functionality in case of power fails. This can be "open" or "close".
Delay	After this delay the power failure reaction starts after the power failed

Parameter location:

CPA	Profibus
Power Fail Option	It's not possible to do "PFO" via Profibus.

4.7.3 Digital I/O

On the power connector there are two digital inputs and two digital outputs available. See chapter «Power and sensor connection» to get more information about the pinning.

Each of the four IO (2 inputs and 2 outputs) has following parameters:

Parameter	Description
Enable	'True' enables the input or output
State	Current state of the input or output
Functionality	Defines the functionality of the input or output
Inverted	'True' inverts the input or output. In case of an input, an inversion means that a '0' activate (State gets 1) the functionality and a '1' means not activated (State gets 0)

Parameter location:

CPA	Profibus
Power Connector IO	It's not possible to do "Digital I/O" via Profibus.

4.8 Sensor configuration

4.8.1 Sensor configuration

It's important to do proper sensor configuration. The valve internally calculates in absolute values, so the valve has to know what sensors are connected.

Parameter	Description
Available	Set to 'True' if a sensor is connected
Enable	Set to 'True' if the sensor signal is used for pressure control
Range.Data Unit	Set the pressure data unit of the gauge
Range.Upper Limit Data Value Range.Lower Limit Data Value	Set the upper limit and lower limit of the gauge in the unit of "Range.Data Unit" Example for a 250mTorr linear sensor: Upper Limit = 250.0 Lower Limit = 0.0
Range.Upper Limit Voltage Value Range.Lower Limit Voltage Value	These parameters are only used for gauges with analog voltage interface. The values corresponds to Range.Upper Limit Data Value and Range Lower Limit Data Value Example: Upper Limit: 10.0V → 250mTorr Range Upper Limit Data Value Lower Limit: 0.0V → 0.0mTorr Range Lower Limit Data Value
Range.Scale	Select if a 'Linear' or a 'Logarithmic' type of gauge is used. Most gauges are linear type gauges.
Input Source	Select 'Analog' if a gauge with analog voltage interface is used. Select 'Digital' if an RS485 gauge is used.

Parameter location:

CPA	Profibus
Pressure Sensor.Sensor 1 Pressure Sensor.Sensor 2	It's not possible to do "Sensor configuration" via Profibus.

4.8.2 Sensor crossover (2 sensor operation mode)

When two sensors are used for pressure control the crossover handles the two pressure signals to building one system pressure (Actual Pressure).

Parameter	Description
Crossover Mode	Crossover between 2 sensors (see below)
Threshold High [SFS low sensor]	Defines the crossover area (see below)
Threshold Low [SFS low sensor]	
Delay	Switch over delay in Crossover Mode 'Hard Switch'

<p>Crossover Mode Soft Switch</p>	<p>Within the threshold levels, the resulting measurement value is a summation of the two sensors signals with a proportional ratio of the two measured values.</p> <p>When to use This is the standard mode. Values of both sensors need to fit together in the crossover area, otherwise crossover effect result (nonlinearity). Therefore, sensor ratio should not be too high (about ≤ 100).</p>
<p>Crossover Mode Hard Switch</p>	<p>Switching between sensors according to the hysteresis threshold levels and an optional delay.</p> <p>When to use Preferred setting if the sensor signals don't fit together in the crossover area (for example if sensor ratio is high).</p>
<p>Crossover Mode Target Pressure</p>	<p>If target pressure is in the range of low sensor, low sensor is used; otherwise high range sensor.</p> <p>When to use As there is no switchover during pressure control while using this setting, undesired effects like nonlinearity or continuous switching between sensors don't occur.</p> <p>Note While in position control mode, 'Soft Switch' mode is used</p>

Parameter location:

CPA	Profibus
Pressure Sensor.Crossover	It's not possible to do "Sensor Crossover" via Profibus.

4.8.3 Zero adjust

Zero Adjust allows for the compensation of the sensor offset voltage.

When Zero Adjust is performed the current value at the sensor input is equated to Zero.Adjust Target Pressure.

In case of a 2 sensor system both sensor inputs will be adjusted.

Note: A maximum offset voltage of +/- 1.4 V can be compensated.

To execute a zero adjust, the zero adjust have to be enabled (see chapter above).

Parameter	Description
Zero Adjust.Sensor Selection	Select the sensor for the zero adjust: <ul style="list-style-type: none"> • Sensor 1 + 2 • Sensor 1 • Sensor 2
Zero Adjust.Target Pressure	Normally this parameter is set to 0 in case the process chamber is fully evacuated (which means pressure value is nearly 0). If not you can align the sensor value to a known pressure. In this case set Target Pressure to the current pressure. Note: Target Pressure is in the unit of pressure, see chapter «Scaling of Pressure and Position Values»
Zero Adjust.Execute	Start the zero adjust by set Execute to 1 At this moment offset value will be calculated and Sensor x.Value = Target Pressure. The resulting offset value can be read on parameter Sensor x.Offset Value [SFS] Clear the offset values by setting Execute to 2 The result of clearing the zero adjust: Sensor x.Offset Value [SFS] = 0.0
Sensor 1.Enable Sensor 2.Enable	0: It's not possible to execute a zero adjust.A present offset value is ignored. 1: It's possible to execute a zero adjust. A present offset value is respected.
Sensor 1.Offset Value [SFS] Sensor 2.Offset Value [SFS]	Value which will be subtracted from measured sensor value The value is related to sensor full scale (0.1 means 10% of sensor full scale)

Parameter location:

CPA	Profibus
Pressure Sensor.Zero Adjust Pressure Sensor.Sensor 1.Zero Adjust Pressure Sensor.Sensor 2.Zero Adjust	1. Wait until process chamber is evacuated and sensor signal is not shifting anymore.
	2. In «OUTPUT Buffer» > «GENERAL CONTROL SETPOINT» set [ZERO] (value = 1) only short impulse ca. 1sec.
	3. Wait until «ZERO EXECUTED» (value = 1) (see INPUT Buffer).

Performing a zero adjust via CPA:

1. Wait until process chamber is evacuated and sensor signal is not shifting anymore. Do not perform Zero Adjust as long as pressure gauge voltage is shifting otherwise incorrect pressure reading is the result. Refer to manual of sensor manufacturer for warm up time.
2. Set parameter Sensor Selection
3. Set parameter Target Pressure (Zero Adjust.Target Pressure, not the Target Pressure for pressure control)
4. Set parameter Execute = 1
5. Check parameter Actual Pressure if the pressure is shifted as expected

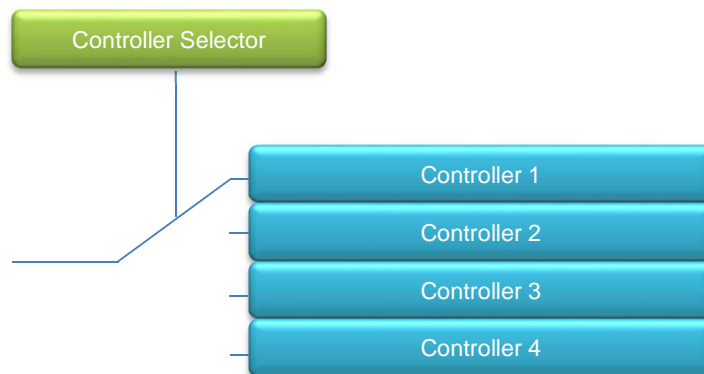


Do not perform Zero Adjust, if the base pressure of your vacuum system is higher than 1‰ of sensor full scale. We recommend disabling Zero Adjust function or using of Zero Adjust.Target Pressure other than 0.0 in this case. Otherwise incorrect pressure reading is the result.

4.9 Pressure control configuration

The valve has four identical pressure controller units. **Controller Selector** defines which unit is used for the pressure control.

Most applications do not need more than one controller units. But if the result of the pressure control does not meet the expectations, the different controller units can be an option for optimization: With the four controller units it's possible to use an own controller unit for a specific pressure working point. This controller unit can be parametrized optimally for this specific working point.



4.9.1 Control Algorithm

Algorithm	Description						
Adaptive	<p>This is the most dynamic control algorithm. Before using adaptive control algorithm, a special procedure called "learn" must be executed first (see chapter below). The valve will observe the behavior of the vacuum system by moving the valve to different positions. During the learn procedure the valve performs an internal parameter estimation correspondent to the vacuum system.</p> <p>Note: The adaptive pressure control work at its best if the conditions (mainly gas flow) are close the conditions at the learn procedure.</p> <p>Parameter:</p> <table border="1"> <tbody> <tr> <td>Gain Factor</td> <td>The Gain Factor is a control parameter to adapt the performance of the pressure control algorithm. A higher gain results in a faster response, higher over- / undershoots of pressure. A lower gain results in slower response, lower over- / undershoot of pressure.</td> </tr> <tr> <td>Sensor Delay</td> <td>The Sensor Delay is a control parameter to compensate delays during the pressure detection. Pipes and orifices for sensor attachment can cause delays in response time and could impact badly the pressure control stability. By adapting this parameter to the approximate delay time stability problems can be reduced. But control response time will be slowed down by this measure.</td> </tr> <tr> <td>Learn Data Selection</td> <td>There are up to 4 different learn data sets available. Select which Learn Data set the adaptive controller shall use for pressure control.</td> </tr> </tbody> </table>	Gain Factor	The Gain Factor is a control parameter to adapt the performance of the pressure control algorithm. A higher gain results in a faster response, higher over- / undershoots of pressure. A lower gain results in slower response, lower over- / undershoot of pressure.	Sensor Delay	The Sensor Delay is a control parameter to compensate delays during the pressure detection. Pipes and orifices for sensor attachment can cause delays in response time and could impact badly the pressure control stability. By adapting this parameter to the approximate delay time stability problems can be reduced. But control response time will be slowed down by this measure.	Learn Data Selection	There are up to 4 different learn data sets available. Select which Learn Data set the adaptive controller shall use for pressure control.
Gain Factor	The Gain Factor is a control parameter to adapt the performance of the pressure control algorithm. A higher gain results in a faster response, higher over- / undershoots of pressure. A lower gain results in slower response, lower over- / undershoot of pressure.						
Sensor Delay	The Sensor Delay is a control parameter to compensate delays during the pressure detection. Pipes and orifices for sensor attachment can cause delays in response time and could impact badly the pressure control stability. By adapting this parameter to the approximate delay time stability problems can be reduced. But control response time will be slowed down by this measure.						
Learn Data Selection	There are up to 4 different learn data sets available. Select which Learn Data set the adaptive controller shall use for pressure control.						

PI This is a solid algorithm for pressure control. The performance will be behind the adaptive control algorithm. But if the condition varies a lot, it's possible that the adaptive control algorithm does not work properly so the PI algorithm provides the best result.

Parameter:

P-Gain	The P-Gain is the proportional factor of the fixed control algorithm. A higher P-Gain results in faster response, higher over- / undershoot of pressure.
I-Gain	The I-Gain is the integral factor. The I-Gain helps to reach the target pressure exactly.
Direction	The Control Direction defines the type of application, if the valve is mounted in downstream or upstream. Downstream means the valve is after the chamber and before the pump. Upstream, valve is mounted before chamber and pump.

Soft Pump Is a modified PI control algorithm to pump down from atmospheric pressure. This control algorithm has been optimized to prevent that the pressure in the chamber is falling too fast (reduce occurrence of undershoots).

Parameter:

P-Gain	Same as in PI algorithm
I-Gain	Same as in PI algorithm

Parameter location:

CPA	Profibus
Pressure Control.Controller	It's not possible to do "Pressure control configuration" via Profibus.

4.9.2 Choose correct control algorithm

Select the configuration what your application needs.

System Configuration	Constant gas flow available		Constant gas flow not available
	$Tv^* \leq 500 \text{ sec}$	$Tv^* > 500 \text{ sec}$	
<p>Downstream</p>	Adaptive pressure controller	Fixed pressure controller	
<p>Upstream</p>	Fixed pressure controller		
Soft Pump	Soft Pump		



Use the formula below to define the applicable pressure control algorithm.

$$Tv = \frac{p_{SFS} \cdot CV}{q_L}$$

- q_L gasflow for learn [mbar/s]
- p_{SFS} sensor full scale pressure [mbar]
- Tv^* Vacuum time constant [sec]
- CV Chamber Volume [l]

4.9.3 Learn (adaptive control algorithm)

LEARN adapts the PID controller of the valve to the vacuum system and its operating conditions. LEARN must be executed only once during system setup. The LEARN routine determines the characteristic of the vacuum system. Based on this, the PID controller is able to run fast and accurate pressure control cycles. This characteristic depends on various parameters such as chamber volume, conductance and flow regime. Therefore it must be performed with a specific gas flow according to instruction below.

The result of LEARN is a pressure versus valve position data table. This table is used to adapt the PID parameters. The data table is stored in the device memory which is power fail save. The data table can be up-/downloaded via 'Control Performance Analyzer' software or remote interface. Due to encoding the data may not be interpreted directly.

By an OPEN VALVE, CLOSE VALVE, POSITION CONTROL or PRESSURE CONTROL command the routine will be interrupted.



- Gasflow calculation according to recommendation below is done automatically based on inputs
- Sensor signal must not shift during LEARN. Wait until sensor signal is stable before LEARN is performed.
- Learn may take several minutes. Do not interrupt the routine as a single full run is required to ensure fast and accurate pressure control. The PID controller covers 5% to 5000% of the gas flow which was used for learn.

Parameter	Description
Bank Selection	Select one of four learn bank to place the result of the learn procedure. Important: It's important that after the learn pressure controller select this learn bank!
Pressure Limit [SFS]	Set learn limit pressure (to which pressure the learn shall be executed). The value is related to the sensor full scale of high sensor. 1.0 means the whole pressure range of the sensors
Open Speed	Define the speed for opening the valve during the learn procedure. 1.0 means full speed
Status	State of the current learn 0: Not Started 1: In Progress 2: Completed Successfully 3: Aborted 4: Failed
Warning Info	Warning of current learn procedure: Bit 0: Learn is running Bit 1: Checksum error (learn data corrupt) Bit 2: Learn procedure terminated by user Bit 3: Pressure at position open > 50% of pressure limit Bit 4: Pressure at minimal conductance position < 10 % of pressure limit Bit 5: Pressure falls while move valve in direction of close Bit 6: Pressure at open position does not match pressure of previous open Bit 7: Learn procedure terminated by program Bit 8: Pressure <= 0 at open position (no gas flow set?)

Parameter location:

CPA	Profibus
Pressure Control.Adaptive Learn	1. Go to «OUTPUT Buffer» > «CONTROL MODE SETPOINT», set «Open Valve» (value = 4)
	2. Set specific gas flow according to calculation below and wait until flow is stable. Autolearn does not need to be performed with the process gas. Instead N ₂ or Ar may be used.
	3. Go to «OUTPUT Buffer» > «CONTROL MODE SETPOINT»
	4. Set «Learn» (value = 7)
	5. In «INPUT Buffer» > «CONTROL MODE» value 7 (Learn) is display, as long Learn is running. If Learn is finished, value 7 is no more displayed.

Execute a learn procedure (via CPA):

1. Set specific gas flow according to calculation below and wait until flow is stable. Learn does not need to be performed with the process gas. Instead N₂ or Ar may be used.
2. Set parameter **Bank Selection**, if only one learn is used take Bank 1. Be sure that the pressure controller also selects this learn bank!
3. Set parameter **Open Speed**. If it's critical for the chamber, if the pressure falls rapidly while opening the valve, reduce the open speed.
4. Set parameter **Controller Mode = LEARN**.
5. Wait till **Controller Mode** leave to **LEARN** state → Learn procedure is finished
6. Check if the learn was successful by checking if **Status** shows value 2 (=Completed Successfully). In best case **Warning Info** shows no warning.



Sensor signal must not shift during LEARN. Wait until sensor signal is stable before LEARN is performed. Learn may take several minutes. Do not interrupt the routine as a single full run is required to ensure fast and accurate pressure control. The PID controller covers 5% to 5000% of the gas flow which was used for learn.

Gasflow calculation for LEARN:


Do not apply a different gasflow for learn than determined below. Otherwise pressure control performance may be insufficient.

Required pressure / flow regime must be known to calculate the most suitable learn gas flow for a specific application.

- At first it is necessary to find out about the required control range respectively its conductance values. Each working point (pressure / flow) must be calculated with one following formulas. Choose the applicable formula depending on units you are familiar with.

$$C_{WP} = \frac{1000 \cdot q_{WP}}{p_{WP}}$$

C_{WP} required conductance of working point [l/s]
 q_{WP} **gasflow** of working point [Pa m³/s]
 p_{WP} **pressure** of working point [Pa]

$$C_{WP} = \frac{q_{WP}}{p_{WP}}$$

C_{WP} required conductance of working point [l/s]
 q_{WP} **gasflow** of working point [mbar l/s]
 p_{WP} **pressure** of working point [mbar]

$$C_{WP} = \frac{q_{WP}}{78.7 \cdot p_{WP}}$$

C_{WP} required conductance of working point [l/s]
 q_{WP} **gasflow** of working point [sccm]
 p_{WP} **pressure** of working point [Torr]

- Out of these calculated conductance values choose the lowest.

$$C_R = \min(C_{WP1}, C_{WP2}, \dots, C_{WPn})$$

C_R required lower conductance [l/s]
 C_{WPx} required conductance of working points [l/s]



To make sure that the valve is capable to control the most extreme working point verify that $C_R \geq C_{min}$ of the valve (refer to «Technical data»).

- Calculate gasflow for learn. Choose the applicable formula depending on units you are familiar with.

$$q_L = \frac{p_{SFS} \cdot C_{min}}{1100}$$

q_L gasflow for learn [Pa m³/s]
 p_{SFS} sensor full scale pressure [Pa]
 C_{min} min. controllable conductance of valve [l/s], (refer to «Technical data»)

$$q_L = \frac{p_{SFS} \cdot C_{min}}{1.1}$$

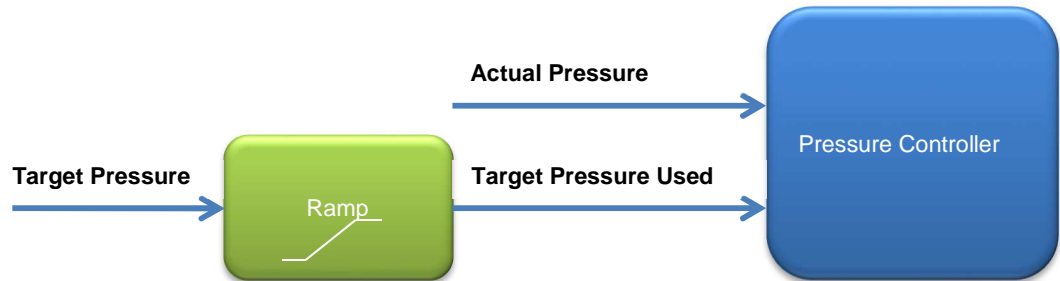
q_L gasflow for learn [mbar l/s]
 p_{SFS} sensor full scale pressure [mbar]
 C_{min} min. controllable conductance of valve [l/s], (refer to «Technical data»)

$$q_L = 71 \cdot p_{SFS} \cdot C_{min}$$

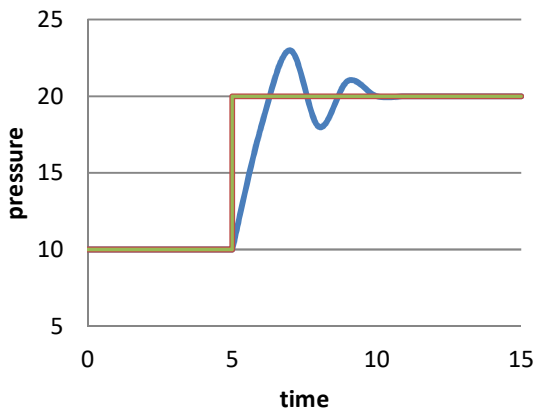
q_L gasflow for learn [sccm]
 p_{SFS} sensor full scale pressure [Torr]
 C_{min} min. controllable conductance of valve [l/s], (refer to «Technical data»)

4.9.4 Pressure ramp

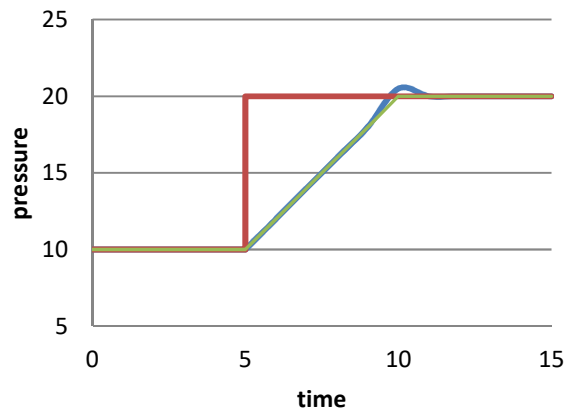
Basically, the pressure ramp is used to limit the rate of pressure change. It can also be used to minimize over- / undershoot of pressure.



New **Target Pressure without** pressure ramp



New **Target Pressure with** pressure ramp



— Actual Pressure
— Target Pressure
— Target Pressure Used (ramp)

— Actual Pressure
— Target Pressure
— Target Pressure Used (ramp)

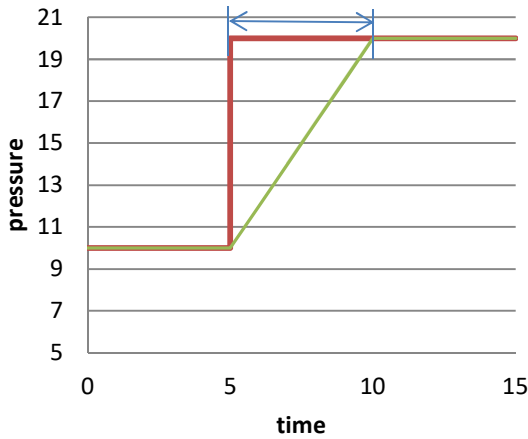
4.9.4.1 Pressure ramp configuration

Time Mode (Ramp Mode = Time)

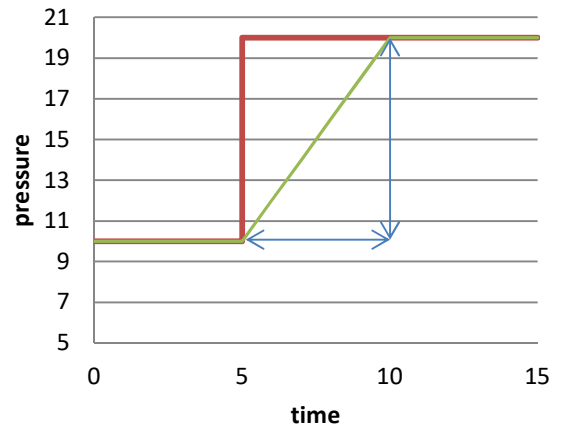
The time within **Target Pressure Used** (ramp) reaches a new **Target Pressure** is defined in parameter value **Ramp Time**. **Ramp Time** is a value in the unit [seconds].

Slope Mode (Ramp Mode = Slope)

After setting a new **Target Pressure**, **Target Pressure Used** will converge the **Target Pressure** in the slope defines in parameter **Ramp Slope**. **Ramp Slope** is a value in the unit [pressure / seconds]



— Target Pressure
— Target Pressure Used (ramp)



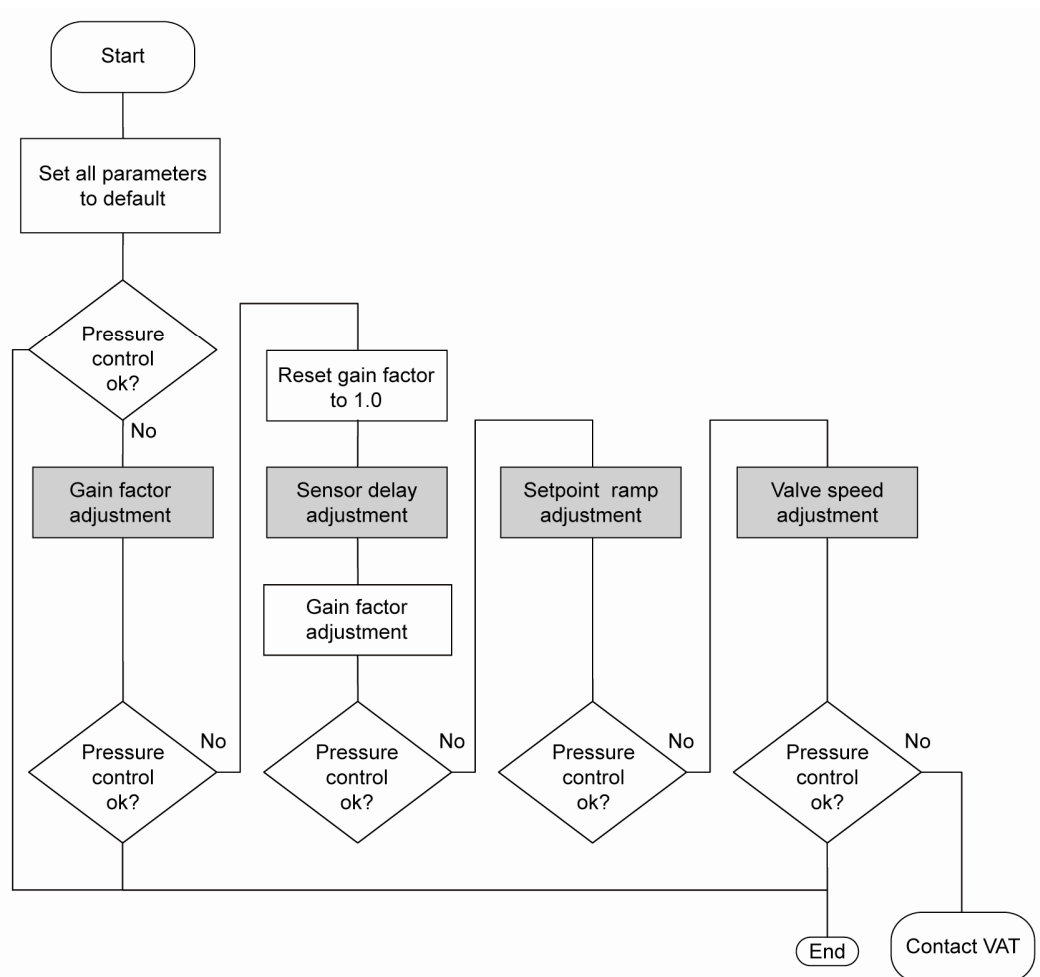
— Target Pressure
— Target Pressure Used (ramp)

4.9.5 Tuning of control performance

- Tuning of pressure control performance with adaptive control, refer to chapter: Tuning of control performance with adaptive pressure controller
- Tuning of pressure control performance with PI control, refer to chapter: Tuning of control performance with fixed PI pressure controller
- Tuning of control pressure performance with Soft pump , refer to chapter: Tuning of control performance with soft pump pressure controller

4.9.5.1 Tuning of control performance with adaptive pressure controller

Normally the default settings will result in good pressure control performance. For some applications tuning may be required to improve performance. The tuning procedures for each parameter (grey boxes) and its default values are described separately below. Strictly keep the procedure order.



Gain factor adjustment

The gain factor effects: **Stability, Response time**

Adjustment range is from 0.0001 to 7.5.

- Higher gain results in: faster response / higher over- / undershoot of pressure
- Lower gain results in: slower response/ lower over- / undershoot of pressure

Adjustment procedure:

1. Start with gain factor 1.0
2. Open valve.
3. Control a typical pressure / flow situation.
4. Repeat from step 2 with lower (higher) gain factors until optimal pressure response is achieved and stability is ok.



Normally adjustments down to gain factors of 0.42 should lead to good results. Otherwise you may need to improve sensor connection. Refer to «Requirements to sensor connection».

Sensor delay adjustment

Sensor delay adjustment effects: **Stability**

Adjustment range is from 0 to 1.0s.

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 control response time will be slowed down by this measure.



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.

Adjustment procedure:

1. Start with gain factor 1.0 and sensor delay 0s.
2. Open valve.
3. Control a typical pressure / flow situation.
4. Repeat from step 2 with higher sensor delays until best possible stability is achieved.
5. Adjustment gain factor again. Refer to «Gain factor adjustment».

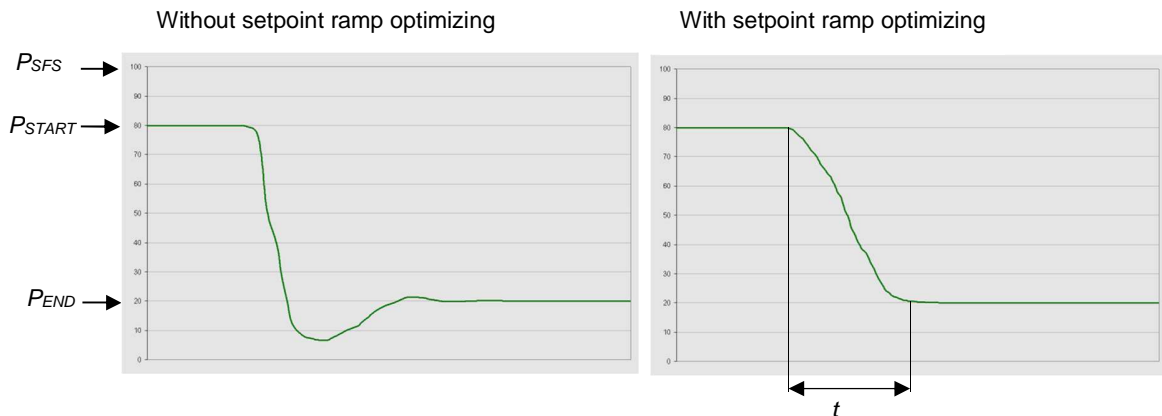
Setpoint ramp adjustment

Setpoint ramp effects: **Undershoot of pressure, Response time**

Adjustment range for Setpoint Ramp is from 0 to 10 s.

This parameter defines the time that is used to decrease / raise pressure between 2 setpoints. Especially in pressure decrease situations at low flows pressure response can be improved much by adapting setpoint ramp time.

Pressure chart



Choose the applicable formula depending on units you are familiar with.

$$t = \text{Setpoint Ramp}$$

Adjustment procedure:

1. Start with optimal gain factor and sensor delay time according to preceding tuning steps.
2. Control a typical pressure / flow situation.
3. Control a lower pressure.
4. Repeat from step 2 with longer setpoint ramps until best response is achieved.
5. Verify pressure control response for a setpoint raise situation.



In case a long ramp time is required to get optimal performance for pressure decrease situations it may be of advantage to apply different settings for decrease / raise control situations.

Valve speed adjustment

Valve speed effects: **Response time**

Default value is 1.0. Adjustment range is from 0.01 to 1.0.

This parameter effects valve plate actuating speed.

Speed adjustment is effective for PRESSURE CONTROL and POSITION CONTROL.



Normally best pressure control response is achieved with max. valve speed. In particular applications it may be of advantage to have a slower valve response. OPEN and CLOSE are always done with maximum speed.

Adjustment procedure:

1. Use optimal gain factor, sensor delay time and setpoint ramp according to preceding tuning steps.
2. Open valve.
3. Control a typical pressure / flow situation.
4. Repeat from step 2 with slower valve speed until required response is achieved.

Required information for support:

- Go to 'Tools / Create Diagnostic File' in 'Control Performance Analyzer' and save file
- Pressure / flow / gas conditions to be controlled
- Chamber volume
- Pumping speed (l/s) and pump type (e.g. turbo pump)
- System description
- Problem description

Send diagnostic file with and all required information to tuning-support@vat.ch

4.9.5.2 Tuning of control performance with fixed PI pressure controller

Optimizing P gain and I gain

This valve may be used for downstream or upstream pressure control depending on configuration. The PI parameters of the pressure controller require correct adjustment. These parameters must be set once during system setup and are stored in the device memory which is power fail save. Based on the PI controller configuration, the valve is able to run fast and accurate pressure control cycles. The PI parameters can be evaluated using below instruction.



- In downstream control mode valve will move towards open when current pressure is higher than set point.
- In upstream control mode valve will move towards close when current pressure is higher than set point.

Introduction

PI controller mode is used if for any reason (e.g. too long system time constant) the adaptive control mode does not provide satisfying control performance.

In PI controller mode the parameters P gain and I gain have to be set according to the systems characteristics. The best set of parameters can be found by using the empiric method below.

1. Optimizing P gain and I gain

1.1 Pressure and gas flow for optimization

A PI controller delivers the best results for a certain working point (pressure/gas flow). If there is only one working point, this pressure and gas flow has to be used for optimizing P and I gain. If there are several working points that have to be covered, the pressure for optimizing is the medium pressure between highest and lowest pressure to be controlled, the gas flow for optimizing is the highest flow out of all working points.

Two different pressure set points are necessary for optimization. Set point 1 (SP1) is the pressure for optimizing as determined above. Set point 2 (SP2) is about 10 - 20% lower than SP1.

Example: pressure range: 4 – 10 Torr
Flow range: 2 – 4 slm

Pressure set points and gas flow for optimization:

SP1	=	7 Torr
SP2	=	6 Torr
Gas flow	=	4 slm

1.2 Optimizing P gain

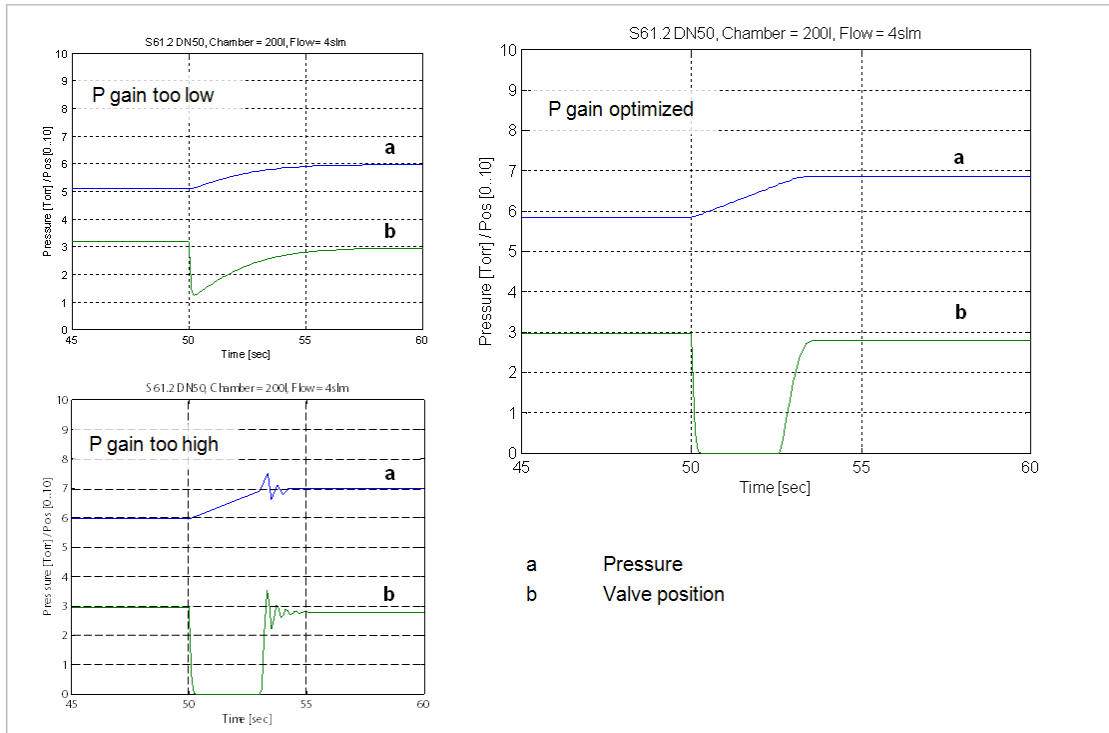
While optimizing P gain, the gas flow determined above has to be constant all the time.

Start optimization with P gain set to 1.0 and I gain set to 0.0.

Set chamber pressure to SP2, wait until the pressure is stable. Set pressure to SP1. If the transition from SP2 to SP1 results in a significant pressure over shoot or even does not stabilize at all, the P gain is too high. If there is no over shoot and the pressure reaches SP1 asymptotically and very slow, P gain is too low.

The optimal P gain value is found if the transition from SP2 to SP1 results in a slight pressure over shoot. It does not matter if there is still a deviation between SP1 and actual pressure.

Example:



1.3 Optimizing I gain

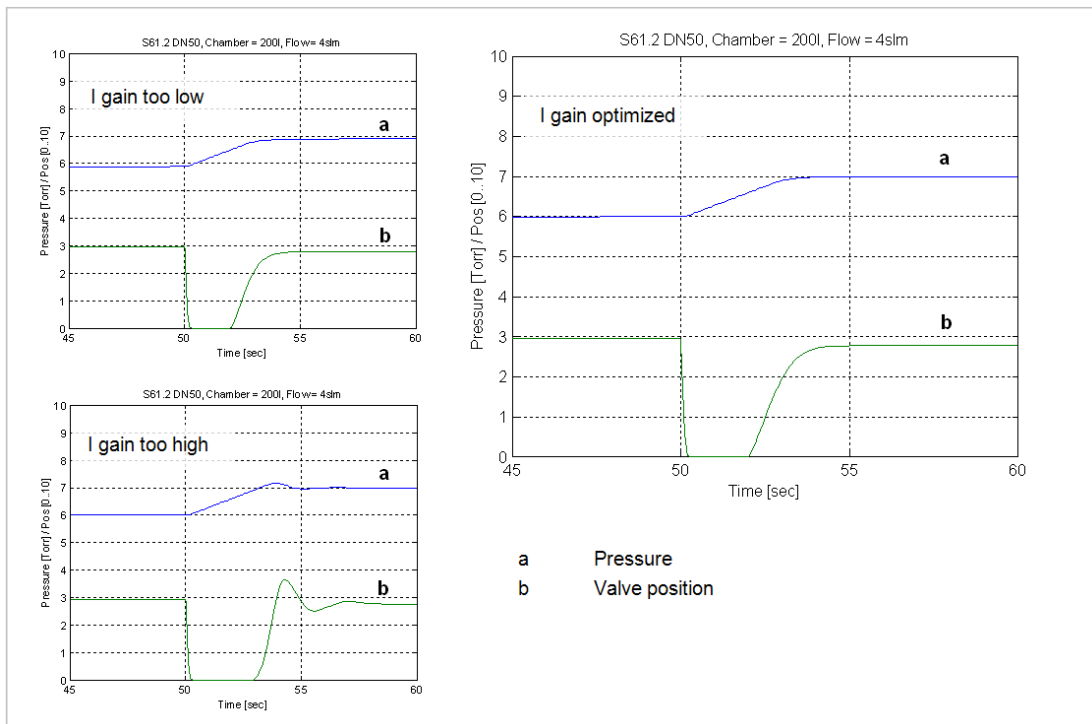
While optimizing I gain, the gas flow determined above has to be constant all the time.

Start with P gain set to half of the value found when optimizing P gain and set I gain to 1.0. Keep the P gain constant.

Set chamber pressure to SP2, wait until the pressure is stable. Set pressure to SP1. If the transition from SP2 to SP1 results in a significant pressure overshoot or if the valve position does not stabilize, I gain is too high. If the transition results in a slow asymptotical pressure rise and there is still a constant deviation to SP2, the I gain is too low.

The optimal value for I gain is found if the transition from SP2 to SP1 results in just a slight pressure overshoot, a stable valve position and the actual pressure matches SP2 exactly.

Example:



Check control performance over the whole control range with parameters above.

Required information for support:

- Go to 'Tools / Create Diagnostic File' in 'Control Performance Analyzer' and save file
- Pressure / flow / gas conditions to be controlled
- Chamber volume
- Pumping speed (l/s) and pump type (e.g. turbo pump)
- System description
- Problem description

Send diagnostic file with and all required information to tuning-support@vat.ch

4.9.5.3 Tuning of control performance with soft pump pressure controller

Optimizing P gain

This valve may be used to control pressure ramps during pump down. The P parameter of the pressure controller requires correct adjustment. This parameter must be set once during system setup and is stored in the device memory which is power fail save. Based on the soft pump controller configuration, the valve is able to run fast and accurate pressure control cycles. The P parameter can be evaluated using below instruction.

Introduction

Pump down control mode allows a completely user-defined pressure profile, usually from atmosphere down to some process pressure

1. Optimizing P gain

The P gain value evaluated for soft pump control mode might be different than the P gain value evaluated for PI controller mode. When switching to pump down control mode the P gain value evaluated for the PI controller has to be send to the valve controller. When switching back into PI controller mode the respective P gain value has to be send again. Adaptive pressure control mode ignores any P gain value.

1.1 Basic settings

The pump down characteristic is determined by start pressure, end pressure and pump down time. This straight line from start pressure to end pressure. The VAT soft pump controller requires a pump down time shorter than 10 sec. for good control results. If the required pump down time is longer than 10 sec., the pump down curve has to be partitioned into sections shorter than 10 sec. with corresponding end pressure.

Example:
 Start pressure: 760 Torr
 End pressure: 10 Torr
 Pump down time: 30 sec.

Here the pump down time and the corresponding pressure is being divided into three sections. The host sends a new pressure set point every 10 sec.:

Time	Set point
0 sec.	760 Torr
10 sec.	510 Torr
20 sec.	260 Torr
30 sec.	10 Torr

1.2 Optimizing P gain

We start by setting the P gain to 1.0 as a trial value and adjust according to the response. The pump down routine has to be controlled as follows:

Move control valve into close position

Start pump down by opening the pump isolation valve or starting the pump and sending the first pressure set point to the valve controller. With the example above, the first pressure set point is 510 Torr.

At each new interval (exceeding 10 sec) send the new pressure set point.

Repeat until process pressure is achieved.

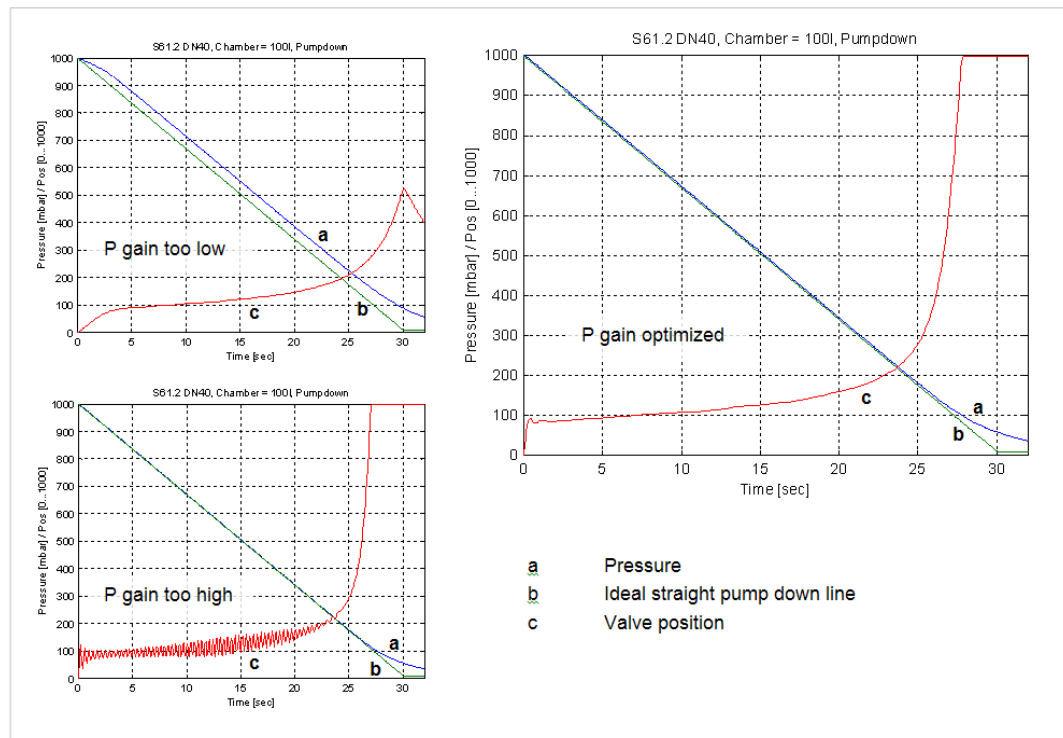
While pumping down chamber pressure and valve position should be data logged to compare the actual pump down curve with the ideal straight pump down line.

If the pressure follows the ideal pump down line with significant delay, the P gain is too low.

If the pressure oscillates around the ideal pump down line or if the valve position oscillates, P gain is too high.

P gain is optimized if the pressure follows the ideal pump down line closely and the valve position is not oscillating at all.

Example:



Required information for support:

- Go to 'Tools / Create Diagnostic File' in 'Control Performance Analyzer' and save file
- Pressure / flow / gas conditions to be controlled
- Chamber volume
- Pumping speed (l/s) and pump type (e.g. turbo pump)
- System description
- Problem description

Send diagnostic file with and all required information to tuning-support@vat.ch

4.10 PROFIBUS interface (General)

- General information about PROFIBUS is available on the homepage <http://www.profibus.com>
- The buffer naming is in view from customer (master) PLC
- Data format: All signals are transmitted and received in motorola format (high byte first)
- Float32 signals are used corresponding to the standard data format IEEE754

4.11 PROFIBUS interface (Process data – cyclic communication)



Neither valve display information nor CONTROL MODE values or any other fieldbus cyclic/acyclic data are related to any fieldbus states/notation

4.11.1 OUTPUT Buffer (Master PLC)

4.11.1.1 Overview

Data model	Index	Buffer
8 bit (Byte)	0	Pressure setpoint
	1	
	2	
	3	
	4	Position setpoint
	5	
	6	
	7	
	8	Not used – reserved
	9	
	10	
	11	
	12	Not used – reserved
	13	
	14	
	15	
	16	Not used – reserved
	17	
	18	
	19	
	20	Control mode setpoint
	21	General control setpoint
	22	
	23	Not used – reserved
	24	Not used – reserved
	25	Not used – reserved
	26	Not used – reserved
	27	Not used – reserved
	28	Not used – reserved
	29	Not used – reserved
	30	Not used – reserved
	31	Not used – reserved
	32	
	33	
	34	
	35	Not used – reserved
	36	Not used – reserved
	37	Not used – reserved
38	Not used – reserved	

4.11.1.2 Details

Signal Type	Name	Start Byte	Byte Length	Data Type	Valid Range	Description
Signal	PRESSURE SETPOINT	0	4	signed integer (default) or floating point	0..1'000'000 (default), adjustable	In case of the valve is is pressure mode (CONTROL MODE = Pressure (5)), the signal is used as setpoint value.
Signal	POSITION SETPOINT	4	4	signed integer (default) or floating point	0..100'000 (default), adjustable	In case of the valve is is position mode (CONTROL MODE = Position (2)), the signal is used as setpoint value. min signal value (default 0) = "valve is closed" max signal value (default 100'000) = "valve is opened" Note: If you want to close the valve completely, set bit CONTROL MODE SETPOINT = 3 (Close) (only 650)
Signal	CONTROL MODE SETPOINT	20	1	unsigned integer	2...7	2 = Position: Position control mode 3 = Close: The valve is closed 4 = Open: The valve is opened 5 = Pressure: Pressure control mode 6 = Hold: Valve is kept in current position; only valid in CONTROL MODE position and pressure 7 = Learn: Valve starts the internal learn procedure
Bitmap	GENERAL CONTROL SETPOINT	21	2	boolean array	-	See bitmap table below

GENERAL CONTROL SETPOINT bitmap table:

Bit		Description												
0	ZERO	<p>0 = No Operation 1 = ZERO adjust, the actual pressure signal is set to internal pressure 0. The valid range for adjustment is limited to -1.4V...+1.4V! Otherwise the sensor must be adjusted!</p>												
1	NOT USED (reserved)	-												
2	PING PONG TX BIT	<p>PING PONG TX BIT transmitted from the master (PLC), is used to check the loop "master PLC - VAT station". See chapter: 4.9.3 Communication and timing control between Master (PLC) and Slave (VAT-Valve).</p>												
3	NOT USED (reserved)	-												
4	ACCESS MODE LOCKED	<table border="1"> <thead> <tr> <th>Start mode</th> <th>Access mode locked bit</th> <th>End mode</th> </tr> </thead> <tbody> <tr> <td>local</td> <td>Set bit: 0→1</td> <td>locked</td> </tr> <tr> <td>locked</td> <td>Reset bit: 1→0</td> <td>remote</td> </tr> <tr> <td>remote</td> <td>Set bit: 0→1</td> <td>locked</td> </tr> </tbody> </table>	Start mode	Access mode locked bit	End mode	local	Set bit: 0→1	locked	locked	Reset bit: 1→0	remote	remote	Set bit: 0→1	locked
		Start mode	Access mode locked bit	End mode										
local	Set bit: 0→1	locked												
locked	Reset bit: 1→0	remote												
remote	Set bit: 0→1	locked												
<p>Example:</p> <ol style="list-style-type: none"> from local to locked <ul style="list-style-type: none"> 1st step : set bit (0→1) from local to remote <ul style="list-style-type: none"> 1st step : set bit (0→1) 2nd step: reset bit (1→0) from remote to locked <ul style="list-style-type: none"> 1st step : set bit (0→1) from locked to remote <ul style="list-style-type: none"> 1st step : reset bit (1→0) 														
5-15	NOT USED (reserved)	-												

4.11.2 INPUT Buffer (Master PLC)

4.11.2.1 Overview

Data model	Index	Buffer
8-Bit (Byte)	0	Pressure
	1	
	2	
	3	
	4	Pressure Sensor 1
	5	
	6	
	7	
	8	Pressure Sensor 2 (optional, only in case of 2 sensor version)
	9	
	10	
	11	
	12	Position
	13	
	14	
	15	
	16	<i>Not used – reserved</i>
	17	
	18	
	19	
	20	Control mode
	21	Fatal error
	22	<i>Not used – reserved</i>
	23	
	24	
	25	
	26	<i>Not used – reserved</i>
	27	<i>Not used – reserved</i>
	28	<i>Not used – reserved</i>
	29	<i>Not used – reserved</i>
	30	<i>Not used – reserved</i>
	31	General status
32		
33	General warnings	
34		
35	Extended warnings	
36		
37	<i>Not used – reserved</i>	
38	<i>Not used – reserved</i>	
39		
40		
41		
42	<i>Not used – reserved</i>	
43	<i>Not used – reserved</i>	
44	<i>Not used – reserved</i>	
45	<i>Not used – reserved</i>	
46	<i>Not used – reserved</i>	

4.11.2.2 Details

Signal Type	Name	Start Byte	Byte Length	Data Type	Valid Range	Description
Signal	PRESSURE	0	4	signed integer (default) or floating point	-270000..1'230'000 (default) (-2.7V..12.3V sensor signal), adjustable	<i>In case of default valid range:</i> Physical full scale value of the sensor (10 Volt) equals to 1'000'000. (In case of 2 sensor operation the full scale of high range sensor equals to 1'000'000.)
Signal	PRESSURE SENSOR 1	4	4	signed integer (default) or floating point	-270000..1'230'000 (default) (-2.7V..12.3V sensor signal), adjustable	<i>In case of default valid range:</i> Physical full scale value of the sensor (10 Volt) equals to 1'000'000.
Signal	PRESSURE SENSOR 2	8	4	signed integer (default) or floating point	-270000..1'230'000 (default) (-2.7V..12.3V sensor signal), adjustable ¹⁾	<i>Optional, only in case of 2 sensor version.</i> <i>In case of default valid range:</i> Physical full scale value of the sensor (10 Volt) equals to 1'000'000.
Signal	POSITION	12	4	signed integer (default) or floating point	0..100'000 (default), adjustable ¹⁾	min signal value = "valve is closed" max signal value = "valve is opened" The position 9'999'999 (or 9'999'999.0 for floating point) show an unknown valve position – e.g. during synchronization at startup
Signal	CONTROL MODE	20	1	unsigned integer	0...14	0 = init 1 = synch 2 = position 3 = close 4 = open 5 = pressure 6 = hold 7 = learn 8 = interlock open 9 = interlock close 10 = maintenance open 11 = maintenance close 12 = power failure 13 = safety 14 = fatal error
Signal	FATAL ERROR	21	2	unsigned integer	20,21,22,25,40	20 = no stop detected during synch mode 21 = valve blocked during synch mode 22 = valve blocked 25 = step loss during synch mode 40 = motor driver fault
Bitmap	GENERAL STATUS	31	2	boolean array		See bitmap table below
Bitmap	GENERAL WARNING	33	2	boolean array		See bitmap table below
Bitmap	EXTENDED WARNING	35	2	boolean array		See bitmap table below

GENERAL STATUS bitmap table:

Bit		Description
0	FIELD BUS DATA VALID	<p>1 = if the valve fulfils the following PROFIBUS issues:</p> <ul style="list-style-type: none"> • Master Mode = Operate • DP state = DataExchange • MS0 connection established • MS2 connection is open • Parametrization and configuration data has been accepted <p>0 = if the valve does not fulfil the above mentioned PROFIBUS issues</p>
1	ZERO EXECUTED	ZERO successful executed, active for 2 seconds
2	PING PONG RX-BIT	PING PONG RX BIT, is inverted and transmitted back to the fieldbus master (PLC), See chapter: 4.9.3 Communication and timing control between Master (PLC) and Slave (VAT-Valve)
3	PRESSURE SIMULATION	<p>0 = off</p> <p>1 = on</p>
4	PRESSURE SETPOINT REACHED	<p>0 = The actual pressure is not within 2% of the pressure setpoint</p> <p>1 = The actual pressure is within 2% of the pressure setpoint</p>
5-6	NOT USED (reserved)	-
7-8	ACCESS MODE	<p>bit 8 bit 7</p> <p>0 0 = LOCAL</p> <p>0 1 = REMOTE</p> <p>1 0 = LOCKED</p>
9	WARNINGS ACTIVE	<p>0 = No WARNINGS</p> <p>1 = At least one WARNING of the warning bitmaps is active (GENERAL WARNING bitmap and EXTENDED WARNING bitmap)</p>
10-15	NOT USED (reserved)	-

GENERAL WARNING bitmap table:

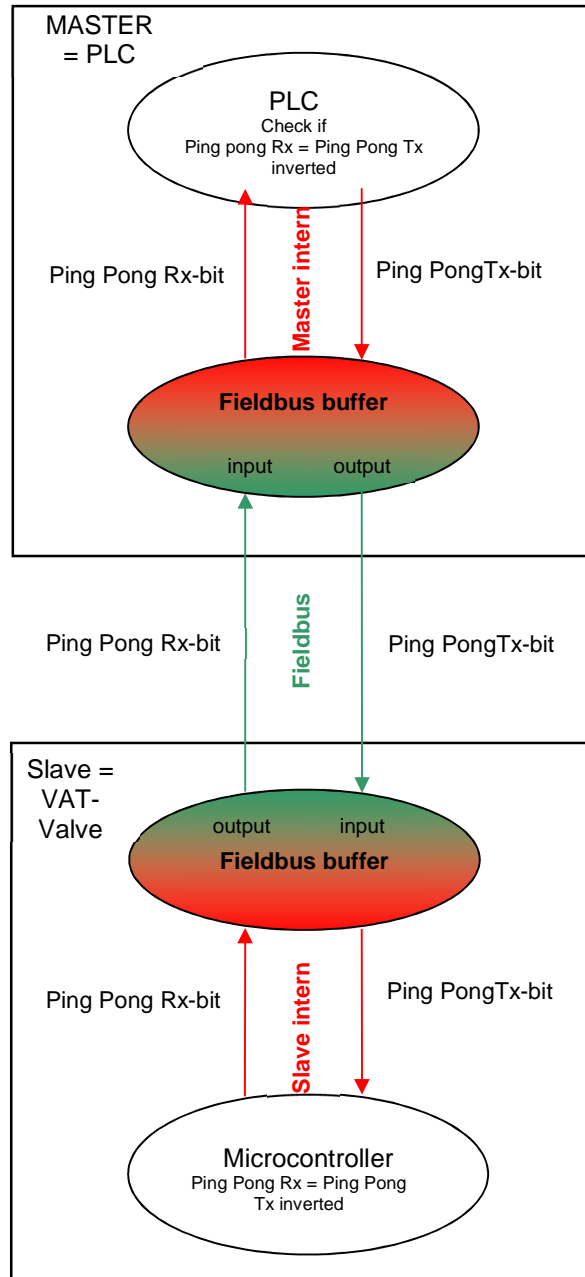
Bit		Description
0	SERVICE REQUEST	Valve movement tight
1	LEARN DATA SET	Learn data not present. Learn required for adaptive pressure control. Just active if adaptive pressure control algorithm is chosen.
2	NOT USED (reserved)	-
3	POWER FAILURE BATTERY	Not ready, voltage too low
4	SENSOR OVERLAPPING	Sensor deviation between sensor 1 and sensor 2 $\geq \pm 10\%$
5	NOT USED (reserved)	-
6	NOT USED (reserved)	-
7-9	NOT USED (reserved)	-
10	SENSOR MEASUREMENT UNIT FAULTY	AD-converter of Sensor input 1 and/or 2 (optional, only in case of 2 sensor version) on the master board is faulty.
11-15	NOT USED (reserved)	-

EXTENDED WARNING bitmap table:


Bit		Description
0	REMOTE CONTROL NOT POSSIBLE	Remote control not possible, access mode local is active, change to access mode remote or access mode locked
1	ACTUAL CONTROL MODE SETPOINT NOT ALLOWED	Not possible to switch the actual control mode to CONTROL MODE SETPOINT <ul style="list-style-type: none"> Control mode is interlock or fatal error CONTROL MODE SETPOINT is 5 (pressure), 6 (hold) or 7 (learn) and no sensor is selected (sensor mode configuration)
2	ZERO DISABLED	Using zero function not possible
3	PFO DEACTIVATED	Power Failure Option is deactivated
4	NOT USED (reserved)	-
5	OUT OF RANGE: PRESSURE SETPOINT	Value of PRESSURE SETPOINT is out of range
6	OUT OF RANGE: POSITION SETPOINT	Value of POSITION SETPOINT is out of range
7-9	NOT USED (reserved)	-
10	OUT OF RANGE: CONTROL MODE SETPOINT	Value of CONTROL MODE SETPOINT is out of range
11	OUT OF RANGE: GENERAL CONTROL SETPOINT	Value of GENERAL CONTROL SETPOINT is out of range
12	PROCESS DATA SETTING(S) NOT VALID	Value of PROCESS DATA SETTING(S) not valid (DATA TYPE or RANGE of pressure and position signals)
13-15	NOT USED (reserved)	-


4.11.3 Communication and timing between Master (PLC) and Slave (VAT-Valve)

See chapter: «OUTPUT Buffer» > «PING PONG TX-BIT» and «INPUT Buffer» > «PING PONG RX-BIT». For visual overview see the diagram below.





5 Operation

 **WARNING**



Unqualified personnel
Inappropriate handling may cause serious injury or property damage.
Only qualified personnel are allowed to carry out the described work.

 **WARNING**



Valve opening
Risk of serious injury.
Human body parts must be kept out of the valve opening and away from moving parts.
Do not connect the controller to power before the valve is installed complete into the system.

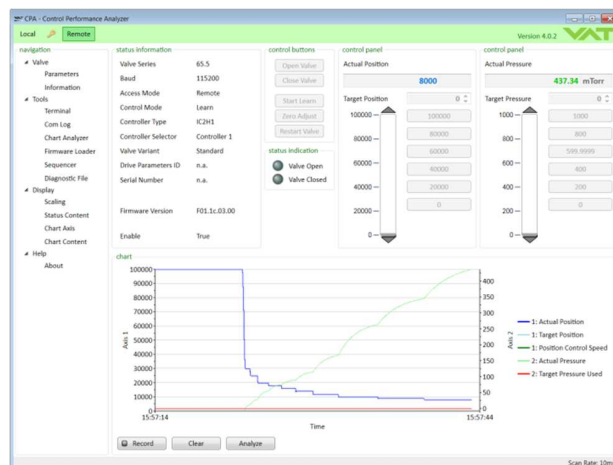
5.1 Normal operation

This valve is designed for pressure control in vacuum chambers. It can be employed in a pressure control mode or a position control mode. In both cases local or remote operation is possible.

5.1.1 Remote operation

This product is equipped with a CC-Link interface to allow for remote operation. See section «CC-Link interface» for details. 'Control Performance Analyzer' software may be used for monitoring during remote control.

'Control Performance Analyzer' software



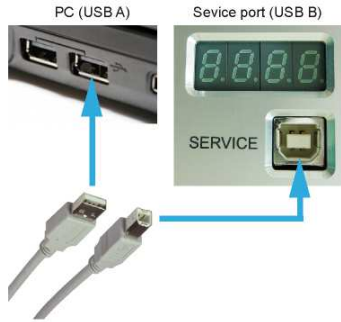
In case 'Control Performance Analyzer' is used, make sure 'Remote' button is pushed to enable for remote operation.

5.1.2 Local operation

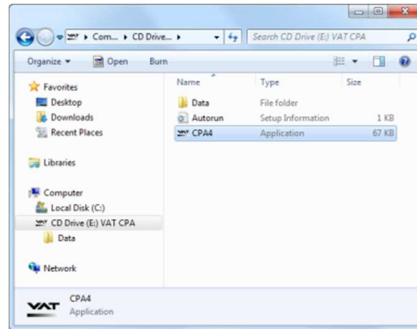
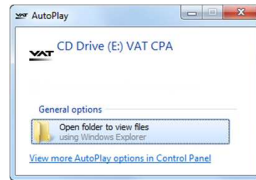
Local operation means that the valve is operated via the service port using a computer. You can use our software 'Control Performance Analyzer' for Local operation, which is integrated in the controller. The software is beneficial especially for setup, testing and maintenance.

How to start:

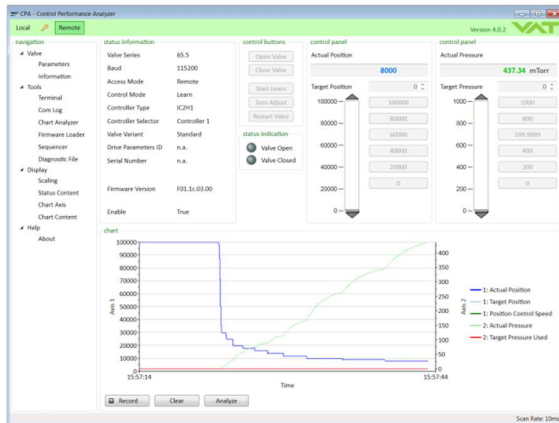
1. Connect service cable (USB A–B cable male-male) between PC and valve:



A drive opens:



2. Double Click on 'CPA.exe' to open the 'Control Performance Analyzer'

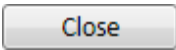


3. Click [Local] for Local operation to do configurations

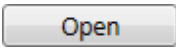


When communication to service port is interrupted the valve will change to remote operation. So when service cable will be disconnected or software will be shut down, the valve returns automatically to remote operation. This may result in an immediate movement of the valve depending on remote control.

5.2 Close valve

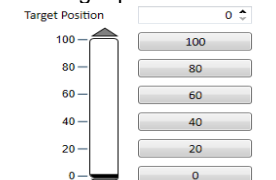
Local operation: CPA	Remote operation: (Refer to chapter «OUTPUT Buffer» > «CONTROL MODE SETPOINT» for details)
Push  button	<ol style="list-style-type: none"> «OUTPUT Buffer» > «CONTROL MODE SETPOINT» Select [Close] (value = 3)

5.3 Open valve

Local operation: CPA	Remote operation: (Refer to chapter «OUTPUT Buffer» > «CONTROL MODE SETPOINT» for details)
Push  button	<ol style="list-style-type: none"> «OUTPUT Buffer» > «CONTROL MODE SETPOINT» Select [Open] (value = 4)

5.4 Position control

The valve position is directly controlled according to the position setpoint.

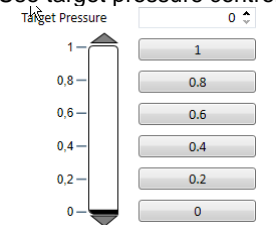
Local operation: CPA	Remote operation: (Refer to chapter «OUTPUT Buffer» > «POSITION SETPOINT» for details)
<p>Use target position control</p> 	<ol style="list-style-type: none"> In «OUTPUT Buffer» > « POSITION SETPOINT» Select a valid value In «OUTPUT Buffer» > «CONTROL MODE SETPOINT» Select [Position] (value = 2)

5.5 Pressure control



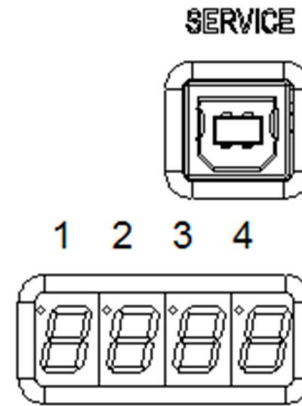
To prepare valve for PRESSURE CONTROL perform complete «Setup procedure». The valve has parameters that may be modified to tune pressure control performance. Refer to «Tuning of control performance».

The included PID controller controls the chamber pressure according to the pressure setpoint by means of the valve position.

Local operation: CPA	Remote operation: (Refer to chapter «OUTPUT Buffer» > «PRESSURE SETPOINT» for details)
<p>Use target pressure control</p> 	<ol style="list-style-type: none"> In «OUTPUT Buffer» > «PRESSURE SETPOINT» Select valid value In «OUTPUT Buffer» > « CONTROL MODE SETPOINT» Select [Pressure] (value = 5)

5.6 Display information

There is a 4 digit display located on the controller. It displays configuration, status and position information. For details refer to following tables.



5.6.1 Power up

Description	Digit 1	Digit 2	Digit 3	Digit 4
• 1 st Power On: All dots are illuminated	#	#	#	#
• 2 nd Valve series e.g. 67.0		6	7	0
• 3 rd Firmware: generation.type e.g. 01.0C	0	1	0	C
• 4 th Firmware: version.firmware e.g. 07.00	0	7	0	0
• 5 th Controller configuration: e.g. 11.00	Controller 1=H1 2=H2 3=H3 4=H4 5=H5 6=H6 7=H7	Interface 1=RS232/RS485 2=EtherCAT 3=DeviceNet 4=Onboard 5=Logic 7=Profibus 8=CC-Link	Options 00=none 01=SPS 02=PFO 03=Cluster 04=SPS & PFO 05=SPS & Cluster 06=PFO & Cluster 07=SPS & PFO & Cluster	
'Ho' homing is running	H	o		

5.6.2 Operation

Control Mode	Digit 1	Digit 2	Digit 3	Digit 4
Init (start up)	I	n.	-	-
Init (start up, leak tight)	I	n.	-	C
Close	C.	C, 0...100 valve position C = closed, leak tight 0 = minimal conductance 100 = maximum opened		
Open	O.			
Pressure control	P.			
Position control	A.			
Interlock Valve closed or open by digital input	I.			
Hold (position frozen)	H.			
Learn	L.			
Safety. Refer to «Safety mode» for details.	S.			
Power failure	F.			

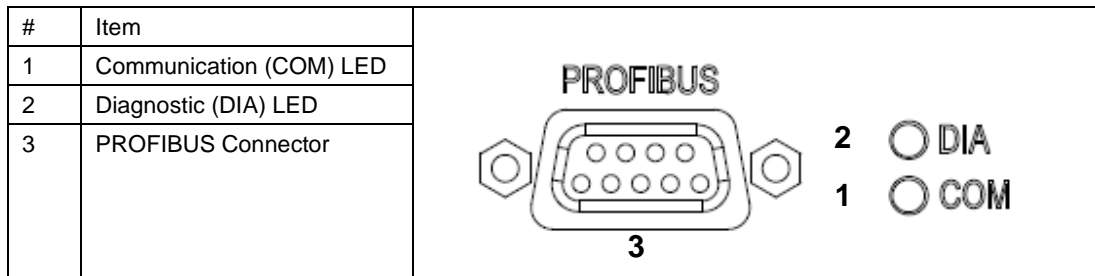
5.6.3 Error

Description	Digit 1	Digit 2	Digit 3	Digit 4
Error number (xyz)	E.	x	y	z
alternately (if error code exist)				
Error code	-	u	v	w



For Error number / code. Refer to «Trouble shooting» for details

5.6.4 PROFIBUS LEDs



5.6.4.1 LED Communication (COM)

State	Indication	Comments
Off	Not online / No power	-Device not power connected, no voltage is applied
Green	On-line, data exchange	-Run, cyclic communication
Flashing Green	On-line clear	-Master in Status "Clear"
Red	Wrong Profibus DP-Configuration	- Refer to chapter «Trouble shooting»
Flashing Red (1 Hz)	Parametrization error	- Refer to chapter «Trouble shooting»
Flashing Red (2 Hz)	PROFIBUS Configuration error	- Refer to chapter «Trouble shooting»

5.6.4.2 LED Diagnostic (DIA)



LED always on, no diagnoses are displayed because this is an application-specific function

5.7 Safety mode

By means of an external switch (see connection diagrams «Electrical connection») the motor power supply can be interrupted. In this case the valve enters the 'safety mode'. This motor interlock prevents the valve from moving (e.g. maintenance work). Data reading from the control unit remains possible. When motor interlock is active during power up the valve directly enters the 'safety mode' and is not able to do homing. Display shows 'S.XXX' (XXX = value position of valve or C..C for close). In this case homing cycle will be done when motor interlock is deactivated. Then Display shows 'Ho' (Homing) for a moment followed by 'A. 0'

When 'safety mode' is entered from operation (i.e. pressure control mode), the unit will automatically switch to position control mode and remain at current position. Once motor interlock is deactivated the unit remains in position control mode.

5.8 Operation during power up

Behavior of the valve depends of the homing settings.
Refer also to chapter: «**Homing Start Option**».

Followed description of the **standard setting**:

Valve position before power up:	Reaction of valve:
Closed (isolated)	Valve remains closed. Homing will be done when first movement command is received.
All other than closed (not isolated)	Valve do homing to initialize position. Display shows 'Ho' until homing is done Valve position after homing is closed

5.9 Behavior in case of power failure

Valve position before power failure:	Reaction of valve:	
	Without Power Failure Option (PFO)	With Power Failure Option (PFO)
	653 G	653 H
	653 A	653 C
	653 T	653 U
	653 V	653 W
Closed (isolated)	Valve remains closed.	Valve will close or open depending on valve configuration ¹⁾ .
Valve open or in any intermediate position	Sealing ring moves down and blocks the pendulum plate at the current position.	Default is not defined. Display indicates F .


Refer also to chapter: «Power Failure Option».

¹⁾ Provide that battery pack of the VAT controller is charged. Charging time after power up is 2 minutes max..



All settings are stored in a power fail save memory.

5.10 Operation under increased temperature

	<p>⚠ CAUTION</p>
	<p>Hot valve Heated valve may result in minor or moderate injury. Do not touch valve and heating device during operation. Once heating is switched off (valve and system) await until the valve is cooled down complete before doing any work.</p>



This valve may be operated in the temperature range mentioned in chapter «Technical data».

5.11 Behavior In case of compressed air pressure drop

Valve position before pressure drop:	Reaction of valve:
Valve closed	Valve remains closed.
Valve open or in any intermediate position	Sealing ring moves down and blocks the pendulum plate at the current position.




Refer to chapter: «Troubleshooting» for details.

6 Trouble shooting

6.1 Controller Display

Description	Digit 1	Digit 2	Digit 3	Digit 4
Error number (xyz)	E	x	y	z
alternately (if error code exist)				
Error code	-	u	v	w

6.2 Error numbers

 Error numbers are three-digit decimal numbers (**xyz**) whereas:

x = component	y = mode	z = error type
1 = All Motor Units 2 = Motor Unit 1 3 = Motor Unit 2 4 = Motor Unit 3 8 = Other	0 = Homing 2 = Operation Mode 8 = Other	0 = Position Error ¹⁾ 1 = Not running: No communication with component x 2 = Error State: component x is running but in Status Error 8 = Other

¹⁾ Only in combination with component 1, 2, 3

6.3 Error code

Code <i>u v w</i>	Description	Solution
1	No valve connected	Connect valve controller to the valve
2	Non volatile memory failure	Replace valve controller
3	Analog digital converter of sensor input failure	Replace valve controller
4	Initialization of motion controller failed	<ul style="list-style-type: none"> Wrong motion controller firmware version → Update motion controller firmware
5	Encoder index pulse not found	<ul style="list-style-type: none"> Encoder failure O-Ring sticking 1)
6	Initialization of interface module failed	<ul style="list-style-type: none"> Fieldbus: Valve firmware does not support interface type → Update valve firmware Wrong interface firmware version → Update interface firmware
7	Initialization of external drive eeprom failed	<ul style="list-style-type: none"> Check cables
1 0	Closing position can't be reached	<ul style="list-style-type: none"> 1)
1 1	Homing position can't be reached	<ul style="list-style-type: none"> 1) Plate not mounted
1 2	Motion controller: Internal voltage error	<ul style="list-style-type: none"> Check power supply
1 3	Motion controller: Internal error temperature	<ul style="list-style-type: none"> Check for a heat accumulation
1 4	Motion controller: Unexpected behavior	Contact vat support <ul style="list-style-type: none"> Axis inverted Encoder not connected Break not released

Code <small>u v w</small>	Description	Solution
1 5	Motion controller: Target position can't be reached	<ul style="list-style-type: none"> • 1) • Current settings
1 6	Motion controller: Position minimal conductance cannot be reached	<ul style="list-style-type: none"> • 1) • Check Plate and Seal ring • Check Parameter "Isolation Position Enter [r]"
1 7	Motion controller: Position to push back the Differential Plate cannot be reached	<ul style="list-style-type: none"> • 1) • Check Different Plate • Check Parameter "Differential Plate Push Back Position [r]"
1 8	Motion controller: Minimal isolation position cannot be reached	<ul style="list-style-type: none"> • 1) • Check Plate and Seal ring • Check Parameter "Isolation Position [r]"
2 0	Break slippery detected	Replace actuator
3 0	SFV: Motion controller failure in master-slave communication	Contact vat support
4 0	Compressed air error	Check compressed air
4 2	Power supply, low voltage detected	Check if power supply is ok and is able to deliver needed power
9 6	SFV: Position deviation axis1 to axis2 at homing procedure	<ul style="list-style-type: none"> • O-Ring sticking • 1)
9 7	SFV: Position deviation axis1 to axis2 at operating	1)
9 8	Position error during closing procedure	1)
9 9	Position error at operating	1)
2 0 0	Valve configuration error, not possible to operate the valve with these configuration	Contact VAT support
7 0 1	Wrong ident code axis 1	Check wiring
7 0 2	Wrong ident code axis 2	
7 0 3	Wrong ident code axis 2 AND axis 1	
7 0 4	Wrong ident code axis 3	
7 0 5	Wrong ident code axis 3 AND axis 1	
7 0 6	Wrong ident code axis 3 AND axis 2	
7 0 7	Wrong ident code axis 3 AND axis 2 AND axis 1	
7 7 7	Do not operating mode active	

1) Mechanical movement problem:

- Check for differential pressure
- Remove foreign object in movement area
- Eliminate tight movement
- Repair mechanical failure



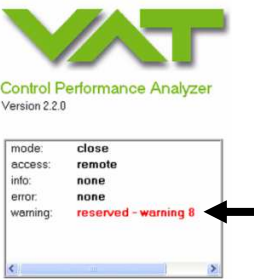
If you need any further information, please contact one of our service centers. You will find the addresses on our website: www.vatvalve.com.

6.4 Profibus

Failure Interface	Check	Action
PROFIBUS Communication (COM) LED 1 is off (Not online / No power)	<ul style="list-style-type: none"> - Connection to master ok? - PROFIBUS power supply ok? 	<ul style="list-style-type: none"> - Check the PROFIBUS connection to master - Check the power supply of valve controller.
PROFIBUS Communication (COM) LED 1 is red	<ul style="list-style-type: none"> - Wrong Profibus DP-Configuration - Is the configuration of the input- and output buffer PROFIBUS master (PLC) correct? 	<ul style="list-style-type: none"> - Check and correct configuration. - Refer to chapter «PROFIBUS configuration» step 3 to check the configuration
PROFIBUS Communication (COM) LED 1 is flashing red (acyclic 1 Hz ¹⁾)	<ul style="list-style-type: none"> - Device is not configured - Is the configuration of the input- and output buffer PROFIBUS master (PLC) correct? 	<ul style="list-style-type: none"> - Do a configuration. - Refer to chapter «PROFIBUS configuration» step 3 to check the configuration
PROFIBUS Communication (COM) LED 1 is flashing red (cyclic 2 Hz ¹⁾)	STOP, no communication, connection error	Refer to chapter «PROFIBUS configuration» step 3 to check the configuration.
Valve does not communicate to PROFIBUS master	<ul style="list-style-type: none"> - PROFIBUS cable ok? - Switch position at PROFIBUS connector ok? - Valve slave address ok? - Valve controller power supply ok? - GSD file for master ok? 	<ul style="list-style-type: none"> - Check PROFIBUS cable. - Check switch position PROFIBUS connector. Refer to terminated resistor network, see chapter: «PROFIBUS connection» or schematic diagram of superordinate plant system. - Check slave address. Refer to schematic diagram of superordinate plant system. - Check the power supply of valve controller. - Check or download GSD file from: www.vatvalve.com > Select your country > Service > Downloads.

¹⁾ Flashing frequency of acyclic 1 Hz = LED on for 750 ms, off for 250 ms. Cyclic 2Hz = on for 250 ms, off for 250 ms.

6.5 Additional Profibus warning

Failure detection with CPA	Check	Action
<p>Network failure: No PROFIBUS communication is active (warning 8)</p> 	<ul style="list-style-type: none"> - PROFIBUS cable ok? - Connection to master ok? 	<ul style="list-style-type: none"> - Check PROFIBUS cable. - Check the PROFIBUS connection to master.



If you need any further information, please contact one of our service centers. You will find the addresses on our website: www.vatvalve.com.

7 Maintenance

	<p style="text-align: center;">⚠ WARNING</p> <p>Unqualified personnel Inappropriate handling may cause serious injury or property damage. Only qualified personnel are allowed to carry out the described work.</p>
	<p style="text-align: center;">⚠ WARNING</p> <p>Valve opening Risk of serious injury. Human body parts must be kept out of the valve opening and away from moving parts. Disconnect power on controller before doing any work.</p>
	<p style="text-align: center;">⚠ CAUTION</p> <p>Hot valve Heated valve may result in minor or moderate injury. Do not touch valve and heating device during operation. Once heating is switched off (valve and system) await until the valve is cooled down complete before doing any work.</p>
	<p style="text-align: center;">NOTICE</p> <p>Contamination Gate and other parts of the valve must be protected from contamination. Always wear clean room gloves when handling the valve.</p>

7.1 Maintenance intervals

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, please contact VAT. It has to be individually decided whether the maintenance can be performed by the customer or has to be carried out by VAT. Please write down the fabrication number of the valve before contact VAT. Refer to chapter «Identification of product» for fabrication number.

7.2 Maintenance procedures

Two 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 shaft seals**



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

VAT can give the following recommendations for preventive maintenance:

Replacement of	unheated ¹⁾	heated ≤ 80 °C ¹⁾	heated > 80 °C ¹⁾
isolation seals (gate and body seal of sealing ring)	12 month but max. 200'000 cycles	6 months but max. 200'000 cycles	3 months but max. 200'000 cycles
actuator shaft seals	1'000'000 cycles	6 months	3 months



¹⁾ Those 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.

NOTICE	
	<p>Vacuum grease</p> <p>Vacuum grease may be distributed and contaminate the valve.</p> <p>Prevent gap between body and sealing ring from air gun cleaning. Do not clean the gap between body and sealing ring with compressed air.</p>


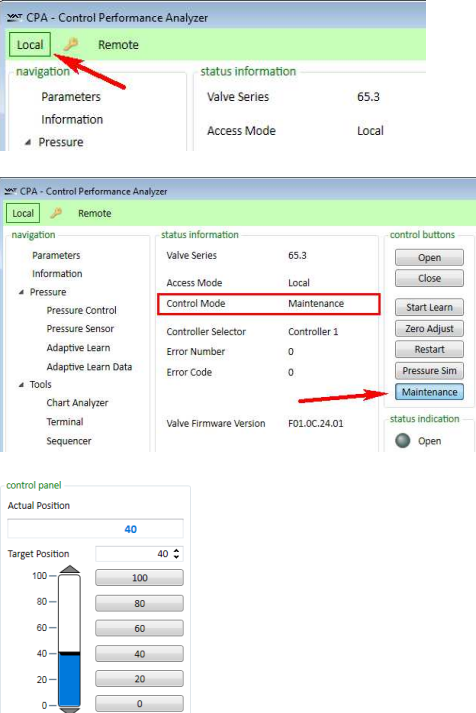

See figure below:


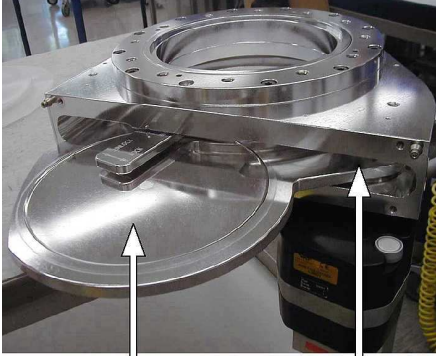

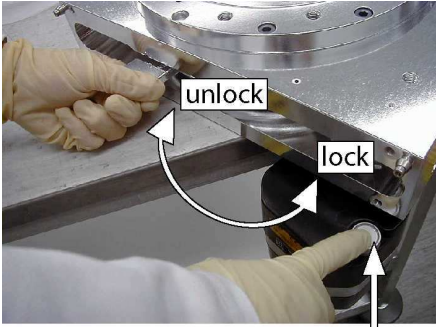
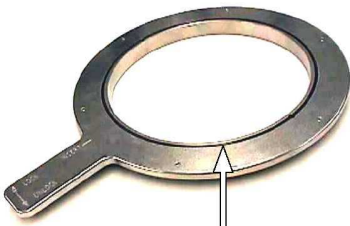


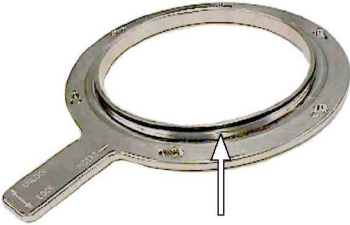
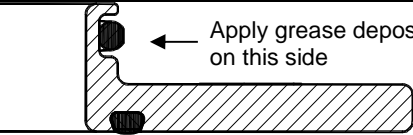
7.2.1 Replacement of isolation seals and valve cleaning

7.2.1.1 Required tools

- Allen Wrench 5mm
- Open end wrench 13mm
- Service cable USB Type A to B (PC to valve Service connector)
- Clean room wiper
- Vacuum grease (see chapter spare parts)
- O-ring removal tool (see chapter Accessories)
- Isopropyl alcohol

Description	Required tool	
 <p>Electrical power and compressed air is required to perform steps 1 to 11 during disassembly respectively 11 to 1 during assembly.</p>		
<p>1. Set the valve to local mode</p> <p>2. Activate “Maintenance” (reduced speed)</p> <p>Now us the position buttons to move the valve plate. The valve will now move in a very low speed</p> <p>Alternatively, the remote interface can be used:</p> <p>Set “Control Mode” to ‘Maintenance’</p> <p>Now use “Target Position” to move the valve</p>		<p>Service cable (PC to valve Service connector)</p>
<p>3. Vent both valve chambers.</p> <p>4. Open the 4 bonnet screws and remove valve bonnet.</p>		<p>Allen wrench 5mm</p>


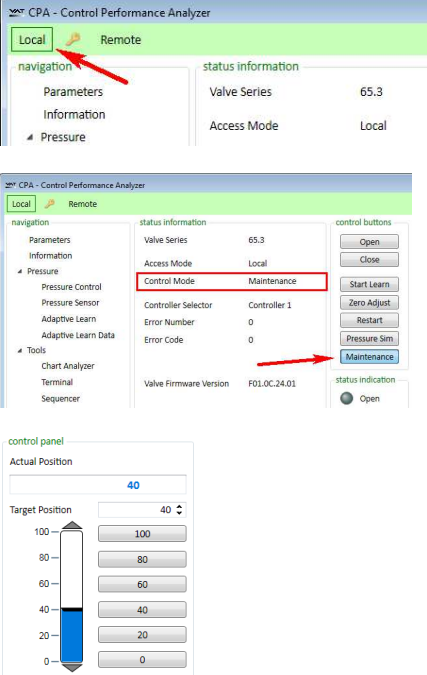

Description	Required tool
<p>5. Open valve</p> <p> Stand away from valve – pendulum plate moves out of the valve body.</p> <p>6. Unfasten mounting screw for pendulum plate.</p> <p>7. Remove pendulum plate.</p>	 <p>pendulum plate</p> <p>mounting screw for pendulum plate</p>
<p>8. With one hand press the MAINTENANCE BUTTON to lower the sealing ring, with your second hand unlock the sealing ring by pressing the handle.</p> <p>9. Release MAINTENANCE BUTTON.</p> <p>10. Remove sealing ring.</p> <p>11. To prevent the shaft and retaining pins from moving during work, switch the valve to safety mode. Refer to «Safety mode» for details.</p> <p> Retaining pins will move up.</p>	 <p>unlock</p> <p>lock</p> <p>maintenance button</p>
<p>12. Remove gate and body o-ring from sealing ring carefully with a soft tool.</p> <p>13. Remove grease residues at sealing ring with alcohol. Clean sealing ring and pendulum plate with alcohol or in an ultrasonic bath.</p> <p>14. 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.</p>	 <p>gate seal</p>


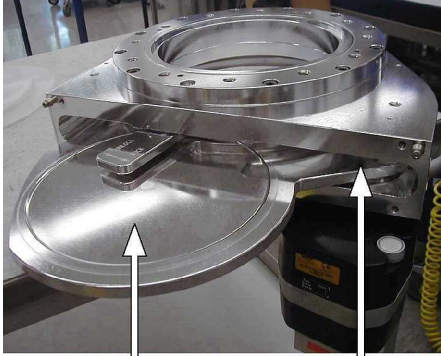

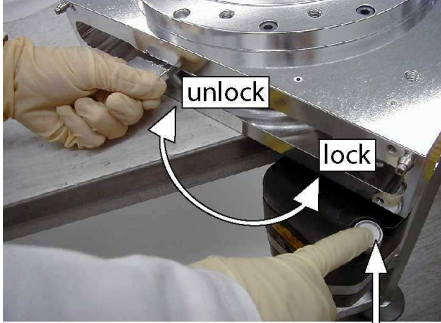
Description		Required tool										
<p>Do not directly expose seals (actuator and retaining pin feedthroughs) to air stream!</p> <p>15. Clean or replace gate seal if necessary. Install gate o-ring to sealing ring without grease.</p>	 <p style="text-align: center;">body seal</p>											
<p>16. Clean or replace body seal if necessary. Lubricate body with the quantity of vacuum grease listed in the table to the right.</p>	<table border="1"> <thead> <tr> <th>Valve size</th> <th>Quantity of grease [ml]</th> </tr> </thead> <tbody> <tr> <td>DN 100</td> <td>0.1</td> </tr> <tr> <td>DN 160</td> <td>0.15</td> </tr> <tr> <td>DN 200</td> <td>0.2</td> </tr> <tr> <td>DN 250</td> <td>0.2</td> </tr> </tbody> </table>	Valve size	Quantity of grease [ml]	DN 100	0.1	DN 160	0.15	DN 200	0.2	DN 250	0.2	<p>Soft tool (o-ring remover)</p> <p>Vacuum grease</p>
	Valve size	Quantity of grease [ml]										
	DN 100	0.1										
	DN 160	0.15										
DN 200	0.2											
DN 250	0.2											
<p>17. Install body seal into sealing ring.</p>												
<p>18. 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.</p>	<table border="1"> <thead> <tr> <th>Valve size</th> <th>Quantity of grease [ml]</th> </tr> </thead> <tbody> <tr> <td>DN 100</td> <td>0.2</td> </tr> <tr> <td>DN 160</td> <td>0.25</td> </tr> <tr> <td>DN 200</td> <td>0.3</td> </tr> <tr> <td>DN 250</td> <td>0.4</td> </tr> </tbody> </table>	Valve size	Quantity of grease [ml]	DN 100	0.2	DN 160	0.25	DN 200	0.3	DN 250	0.4	Vacuum grease
	Valve size	Quantity of grease [ml]										
	DN 100	0.2										
	DN 160	0.25										
DN 200	0.3											
DN 250	0.4											
		Vacuum grease										
<p>19. Reassembly the valve in reverse order, step 9...3.</p> <p>20. Close the valve bonnet, see steps 31...33.</p>												
<p>21. Mount valve bonnet.</p> <ul style="list-style-type: none"> Tightening torques for bonnet screws, see in table to the right. 	Max. torque 6 Nm	Allen wrench 5mm										
<p>22. To leave the maintenance mode press "Restart" button or power cycle the controller.</p> <p>23. Set the valve to remote mode</p>		CPA & Service cable (PC to valve Service connector)										

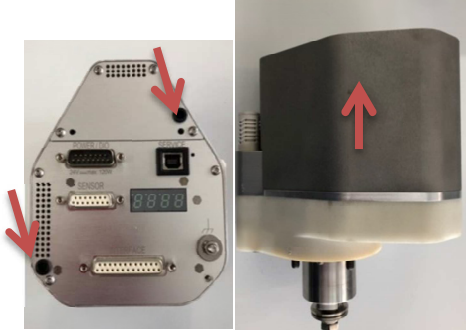
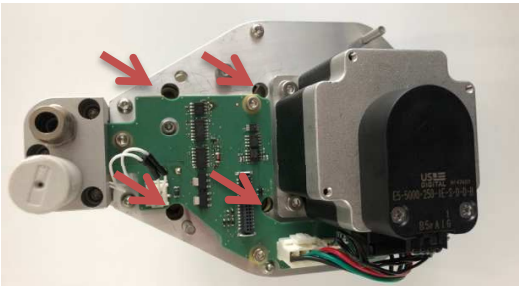
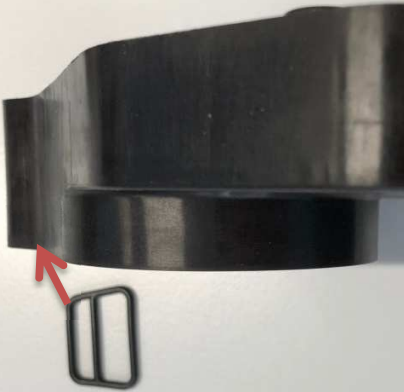
7.2.2 Replacement of actuator shaft seals

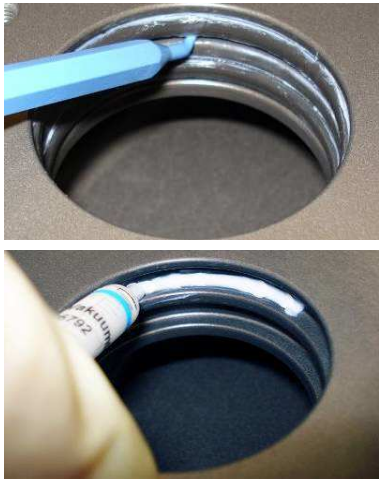


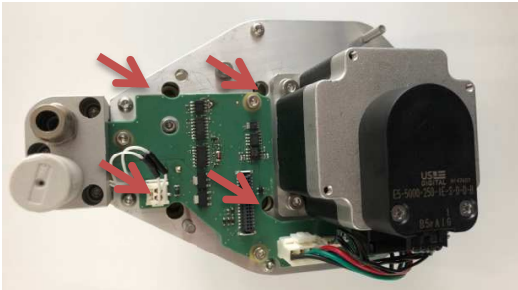
7.2.2.1 Required tools

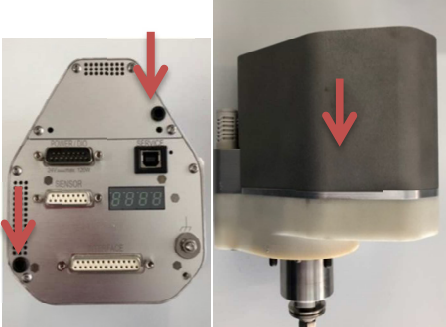



- Allen Wrench 2mm
- Allen Wrench 4mm
- Allen Wrench 5mm
- O-ring removal tool (see chapter Accessories)
- Vacuum grease (see chapter spare parts)
- Open end wrench 13mm
- Clean room wiper
- Isopropyl alcohol
- Service cable USB Type A to B (PC to valve Service connector)

Description	Required tool
 <p>Electrical power and compressed air is required to perform steps 1 to 11 during disassembly respectively 11 to 1 during assembly.</p>	
<p>1. Set the valve to local mode</p> <p>2. Activate "Maintenance" (reduced speed)</p> <p>Now us the position buttons to move the valve plate. The valve will now move in a very low speed</p> <p>Alternatively, the remote interface can be used:</p> <p>Set "Control Mode" to 'Maintenance'</p> <p>Now use "Target Position" to move the valve</p>	 <p>CPA & Service cable (PC to valve Service connector)</p>
<p>3. Vent both valve chambers.</p> <p>4. Open the 4 bonnet screws and remove valve bonnet.</p>	 <p>Allen wrench 5mm</p>


Description	Required tool
<p>5. Open valve</p> <p> Stand away from valve – pendulum plate moves out of the valve body.</p> <p>6. Unfasten mounting screw for pendulum plate.</p> <p>7. Remove pendulum plate.</p>	 <p>pendulum plate mounting screw for</p>
<p>8. With one hand press the MAINTENANCE BUTTON to lower the sealing ring, with your second hand unlock the sealing ring by pressing the handle.</p> <p>9. Release MAINTENANCE BUTTON.</p> <p>10. Remove sealing ring.</p> <p>11. To prevent the shaft and retaining pins from moving during work, switch the valve to safety mode. Refer to «Safety mode» for details.</p> <p> Retaining pins will move up.</p>	 <p>unlock lock</p> <p>maintenance button</p>
<p>12. Release the valve from safety mode. Refer to «Safety mode» for details</p> <p>13. Move the valve to position 50% (half opened) This is necessary, in order to dismount the actuator. See step 15.</p> <p>14. Disable PFO option feature via 'Power Fail Status' in menu 'System' of CV or CPA software, and turn off the power</p>	<p>• CPA software</p>


Description	Required tool
<p>15. Disconnect 24VDC power. Wait for 60s, then disconnect cables and compressed air from valve actuator.</p> <p>16. Unfasten all 2 controller screws and lift controller carefully from actuator.</p>	 <p>Allen Wrench 4 mm</p>
<p>17. Unfasten all 4 actuator screws and remove actuator.</p>	 <p>Allen Wrench 5 mm</p>
<p>18. Replace pressed air gasket</p>	 <p>927458</p>

Description	Required tool
<p>19. Remove actuator shaft seals carefully with a soft tool.</p> <p>20. Clean actuator feedthrough with alcohol.</p> <p>21. Lubricate each o-ring groove with 0.1 ml vacuum grease. Pay attention that grease is distributed constantly over the whole circumference.</p>	 <p>Soft tool (o-ring remover)</p> <p>Vacuum grease</p>
<p>22. Clean or replace seals if necessary. Lubricate each o-ring with 0.05 ml vacuum grease.</p> <p>23. Install o-rings.</p> <p>24. Deposit 0.1 ml vacuum grease on each o-ring. Pay attention that grease is distributed constantly over the whole circumference.</p>	 <p>Vacuum grease</p>
<p>25. Remove fixation kit and mounting screw for pendulum plate.</p> <p>26. Clean screw and slightly lubricate thread. Then reinstall fixation kit.</p> <p>27. Clean actuator shaft and lubricate it with 0.1 ml vacuum grease.</p>	 <p>Vacuum grease</p>
<p>28. Install actuator</p> <ul style="list-style-type: none"> • Tighten actuator screws with 10 Nm. • Remove vacuum grease from actuator shaft face after installation. 	 <p>Allen Wrench 5mm</p>

Description	Required tool	
<p>29. Install controller</p> <ul style="list-style-type: none"> • Tighten the controller screws with 3 Nm. • Connect cables at controller • Connect compressed air at actuator 		<p>Allen Wrench 4mm</p>
<p>30. Turn on power of controller.</p> <p> Valve moves to close position.</p> <p>31. Open valve and install sealing ring and pendulum plate in reverse order as they had been disassembled (steps 11 to 2).</p>		<p>open end wrench 13mm</p>
<p>32. Clean the valve sealing surface</p>		<p>Lint-and dust-free towel a little soaked with isopropyl alcohol</p>
<p>33. Clean the valve bonnet o-ring</p>		<p>Lint-and dust-free towel</p>
<p>34. Mount valve bonnet.</p> <ul style="list-style-type: none"> • Tightening torques for bonnet screws, see in table to the right. 	<p>Max. torque 6 Nm</p>	<p>Allen wrench 5mm</p>
<p>35. To leave the maintenance mode press "Restart" button or power cycle the controller.</p> <p>36. Set the valve to remote mode</p>		<p>CPA & Service cable (PC to valve Service connector)</p>

7.2.3 Replacement of Option board

NOTICE	
	<p>Electrostatic discharge</p> <p>Electronic components could be damaged.</p> <p>All work on the control and actuating unit has to be done under ESD protected environment to prevent electronic components from damage.</p>

NOTICE	
	<p>Burned connector pins (spark)</p> <p>Connector pins or electronic parts could be damaged, if plugged and unplugged under power.</p> <p>Do not plug or unplug connectors under power.</p>

The option board may or may not be equipped in your valve depending on the order. Refer to page 1 of this manual to check valve version. This board includes the optional modules for the valve which are:

- ± 15 VDC sensor power supply (SPS)
- Power failure option (PFO)

It is available in 3 versions. These are:

- SPS module only
- PFO module only
- SPS and PFO module

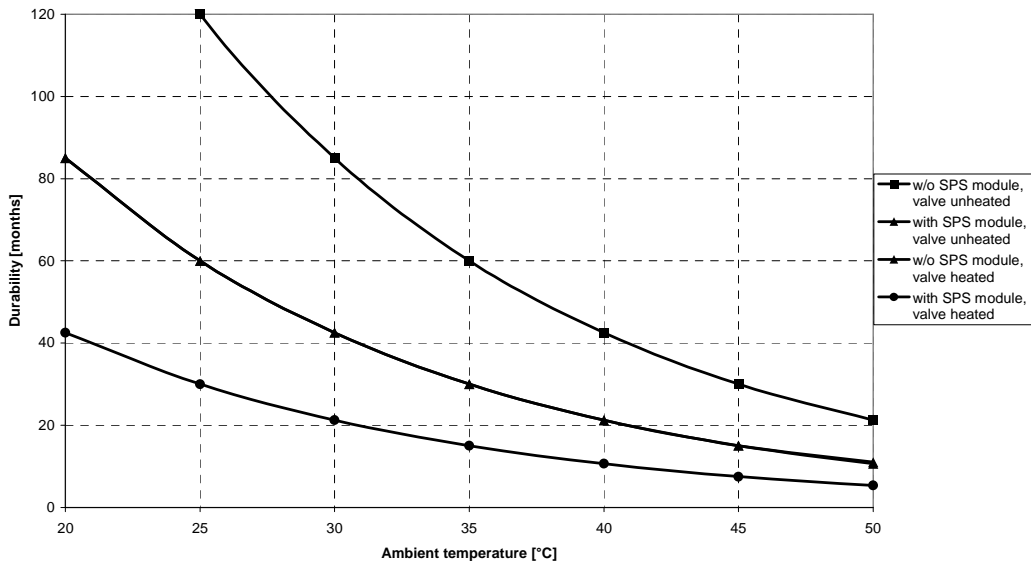
The modules may be retrofitted or replaced easily. The battery lifetime of the PFO module depends on the ambient temperature (see below). To assure PFO function the option board must be replaced after battery life has expired. For ordering number of the modules refer to chapter «Spare parts».

7.2.3.1 Durability of power fail battery

The curves in the graph show the estimated life of Ultra Cap PFO in the worst condition (max. sensor load = 1 A, valve heating temperature = 150 °C).

If the SPS is not fully loaded (< 1 A) or heating temperature of valve body is lower than 150 °C, the corresponding life time curve will be somewhere in between the upper and the lower curve.

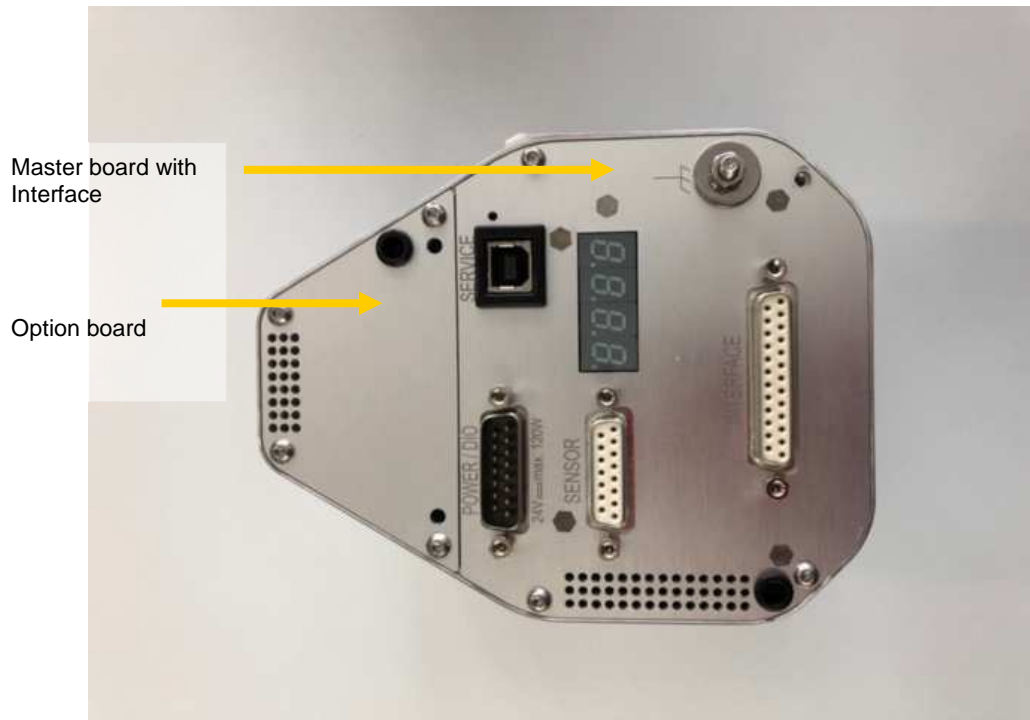
Therefore please determine the equivalent maintenance period for replacing the Ultra Cap battery (Option board).



This graph shows estimated life of Ultra Cap PFO for reference and not as guaranteed value.

7.2.4 Retrofit / replacement procedure



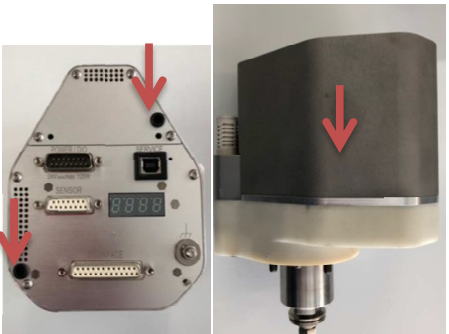
Top view on control and actuating unit with panel removed:



All boards have a fixed position into control and actuating unit. It is not possible to fit a board in other position as shown in picture above! Do not try out other positions, which maybe destroy the socket of boards!

7.2.4.1 Required tools

- Pozidriv screw driver size 1
- Open end wrench 4.5mm

Description	Required tool
<ol style="list-style-type: none"> 1. Disconnect 24VDC power. Wait for 60s, then disconnect cables and compressed air from valve actuator. 2. Unfasten all 2 controller screws and lift controller carefully from actuator. 	
<ol style="list-style-type: none"> 3. Place Option board from behind in the controller. 4. Tighten option board with the 2 screws with 1.1Nm. 	
<ol style="list-style-type: none"> 5. 6. Fasten all 2 controller screws and lift controller carefully from actuator. 7. Connect cables and compressed air to valve actuator. 	



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




8 Repairs


Repairs may only be carried out by the VAT service staff. In exceptional cases, the customer is allowed to carry out the repairs, but only with the prior consent of VAT.


Please contact one of our service centers. You will find the addresses on our website www.vatvalve.com.

9 Dismounting and Storage

	⚠ WARNING
	Unqualified personnel Inappropriate handling may cause serious injury or property damage. Only qualified personnel are allowed to carry out the described work.


9.1 Dismounting


	NOTICE
	Contamination Gate and other parts of the valve must be protected from contamination. Always wear clean room gloves when handling the valve.

	NOTICE
	Valve in open position Valve body may become damaged if valve gate is in open position. Move valve gate to the closed position before dismantling the valve.

1. Close the valve
2. For dismantling the valve please follow the instructions of chapter: «Installation», however in reverse order.

9.2 Storage

NOTICE	
	<p>Wrong storage</p> <p>Inappropriate temperatures and humidity may cause damage to the product.</p> <p>Valve must be stored at:</p> <ul style="list-style-type: none">– relative humidity between 10% and 70%– temperature between +10 °C and +50 °C– non-condensing environment

NOTICE	
	<p>Inappropriate packaging</p> <p>Product may get damaged if inappropriate packaging material is used.</p> <p>Always use the original packaging material and handle product with care.</p>

1. Clean / decontaminate valve.
2. Cover all valve openings with a protective foil.
3. Pack valve appropriately, by using the original packaging material.

10 Packaging and Transport

	⚠ WARNING
	<p>Unqualified personnel Inappropriate handling may cause serious injury or property damage. Only qualified personnel are allowed to carry out the described work.</p>


	⚠ WARNING
	<p>Harmful substances Risk of injury in case of contact with harmful substances. Remove harmful substances (e. g. toxic, caustic or microbiological ones) from valve before you return the valve to VAT.</p>

	NOTICE
	<p>Inappropriate packaging Product may get damaged if inappropriate packaging material is used. Always use the original packaging material and handle product with care.</p>



- When returning products to VAT, please fill out the VAT form «Declaration of Chemical Contamination of Vacuum Valves and Components» and send it to VAT in advance. The form can be downloaded from our website www.vatvalve.com (Section: Services – Aftersales).
- If products are radioactively contaminated, the VAT form «Contamination and Radiation Report» must be filled out. Please contact VAT in advance.
- If products are sent to VAT in contaminated condition, VAT will carry out the decontaminating procedure at the customer's expense.

10.1 Packaging


	NOTICE
	<p>Valve in open position Valve mechanism may get damaged if valve is in open position. Make sure that the valve is closed.</p>

1. Cover all valve openings with a protective foil.
2. Pack valve appropriately, by using the original packaging material.



VAT disclaims any liability for damages resulting from inappropriate packaging.

10.2 Transport

	NOTICE
	<p>Inappropriate packaging Product may get damaged if inappropriate packaging material is used. Always use the original packaging material and handle product with care.</p>



VAT disclaims any liability for damages resulting from inappropriate packaging.

11 Disposal

Observe the local regulations for disposal

	WARNING
	<p>Harmful substances Environmental pollution. Discard products and parts according to the local regulations.</p>

	WARNING
	<p>Unqualified personnel Inappropriate handling may cause serious injury or property damage. Only qualified personnel are allowed to carry out the disposal.</p>

	CAUTION
	<p>Risk of damage Indicates a hazardous situation which, if not avoided, may result in minor or moderate injury. A large number of diverse materials are used in the product. Some of them could cause human and machine damage in the case of improper handling.</p> <ul style="list-style-type: none"> • Observe local regulations in regard to waste disposal without fail. • Commission an authorized waste disposal company for the professional disposal of your waste.

	NOTICE
	<p>Improper disposal Some built-in materials can cause damage, if improperly handled. - When disposing, take into account all the different materials used</p>




- Hire an authorised waste disposal company to dispose of the waste in a professional manner.

The following list should help you to dismantle your product without making serious errors and to properly separate out the product scrap.

Material groups	Hazard level
non-ferrous metals	high
stainless steel	low
aluminium	low
plastics	medium
lubricants	high
electronic scrap	high
batteries	very high
cables and wires	medium
motors	medium
seals and rubber parts	high

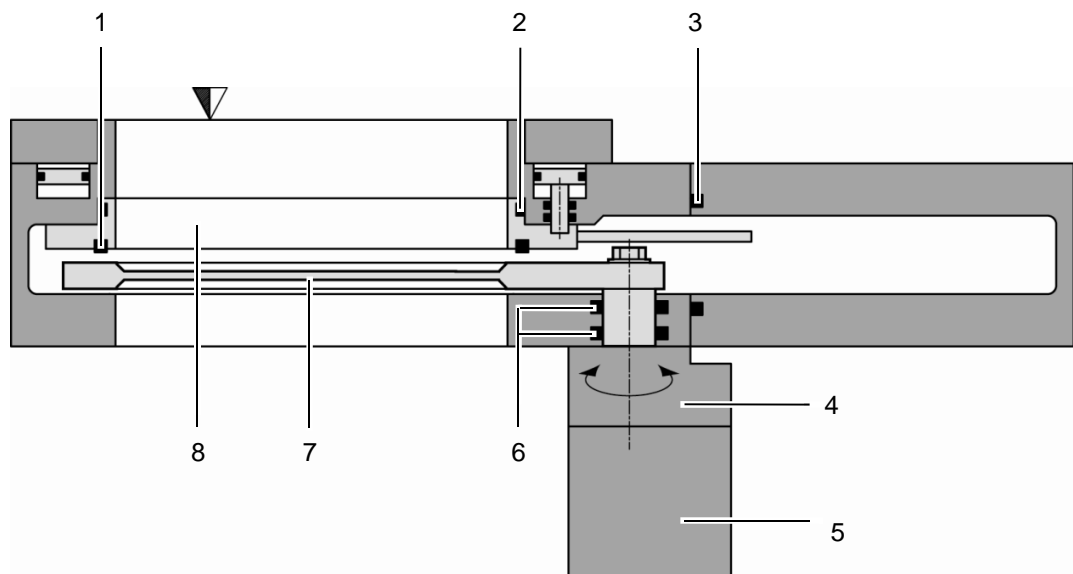
12 Spare parts

	NOTICE
<p>Non-original spare parts</p> <p>Non-original spare parts may cause damage to the product. Use original spare parts from VAT only.</p>	



- Please specify the fabrication number of the product when you place an order for spare parts; see chapter: «Identification of product». This is to ensure that the appropriate spare parts are supplied.
- VAT makes a difference between spare parts that may be replaced by the customer and those that need to be replaced by the VAT service staff.
- The following table(s) contain spare parts that may be replaced by the customer. If you need any other spare parts, please contact one of our service centers. You will find the addresses on our website www.vatvalve.com.

12.1 Drawing



- | | | | |
|---|-------------|---|--------------------------|
| 1 | Plate seal | 5 | Integrated controller |
| 2 | Body seal | 6 | Rotary feedthrough seals |
| 3 | Bonnet seal | 7 | Pendulum plate |
| 4 | Actuator | 8 | Sealing ring |



All "Item" refer to chapter «Drawing»

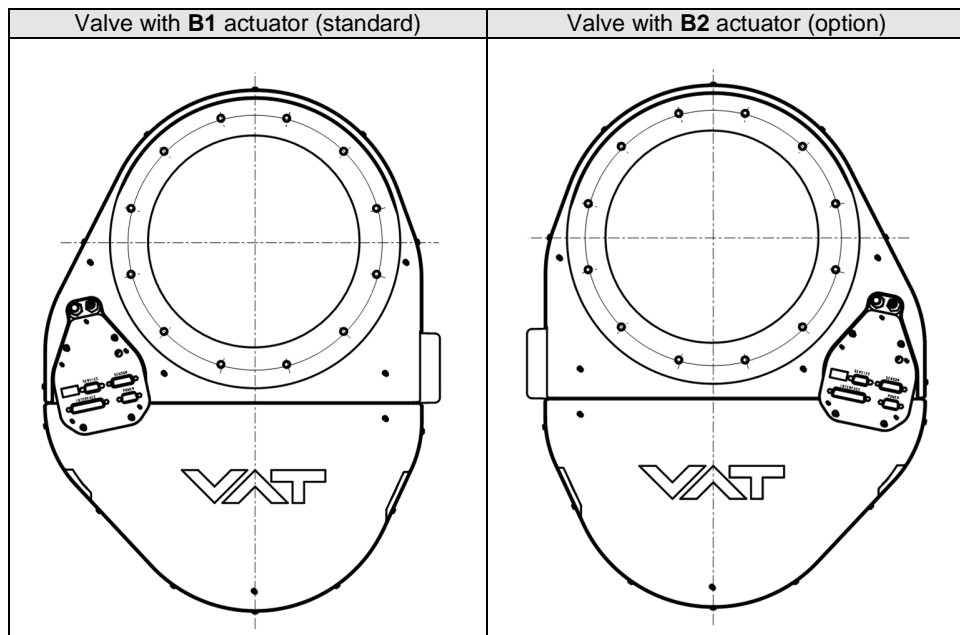
12.1.1 Valve unit with seals and grease

Item	Description	DN100	DN160	DN200	DN250
Valve size	Valve part number	65340 - -	65344 - -	65346- -	65348 - -
1	Gate Viton seal other materials	N-5100-155 on request	N-5100-258 on request	N-5100-266 on request	N-5100-275 on request
2	Body seal (Viton) This includes a 2ml syringe of vacuum grease	204884	206527	200468	202592
	Seal kit vacuum (Viton). This consists of item 2 and 3.	204883	206526	204204	203883
3	Bonnet Viton seal other materials	N-5100-259 on request	N-5100-267 on request	N-5100-272 on request	N-5100-277 on request
4	Actuator B1 *) B2 *)	on request on request	342943 on request		
	Syringe of vacuum grease 2ml 5ml	206792 206793			
6	Actuator shaft seals (Viton) Actuator compressed air gasket	N-5100-326 (2 pcs required per valve) 927458			
7	Pendulum plate: - Blank B1 *) - Blank B2 *) - Hardanodized B1 *) - Hardanodized B2 *) - Nickel coated B1 *) - Nickel coated B2 *)	on request on request on request on request on request on request	on request on request on request on request on request on request	on request on request on request on request on request on request	on request on request on request on request on request on request
8	Sealing ring - Blank - Hardanodized - Nickel coated	on request on request on request	on request on request on request	on request on request on request	on request on request on request

*) Refer to figures on next page to check for actuator position options.


 Use only spare parts manufactured by VAT to assure safe and reliable operation All "

Actuator position options:



All "Item" refer to chapter «Drawing»

12.1.2 Control and actuating unit

Description	Part number
Control and actuating unit	Too many to list. Please contact VAT.
Option board with SPS module (±15 VDC Sensor Power Supply)	936205
Option board with PFO module (Power Failure Option)	936200
Option board with SPS and PFO module	936202

12.1.3 Accessories

Description	Part number
24 VDC power supply unit (input: 100 – 240 VAC)	891528
O-ring removal tool	234859
VAT valve cleaning tool	305709
Adapter cable for power supply with D-Sub9 connector	(735567) (D-Sub15 to D-Sub9)
Service cable (PC to valve Service connector)	809474 (USB A–B male-male)
Adapter cable CC-Link	on request

12.1.3.1 Centering ring with Viton o-ring

		Description			
Valve size	Product ordering number	DN 100 / 4" 65340 -	DN 160 / 6" 65344 -	DN 200 / 8" 65346 -	DN 250 / 10" 65348 -
Centering ring with Viton o-ring (for ISO-F installation only)	Aluminum	32040-QAZV	32044-QAZV	32046-QAZV	32048-QAZV
	Stainless steel	32040-QEZV	32044-QEZV	32046-QEZV	32048-QEZV



13 Appendix

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