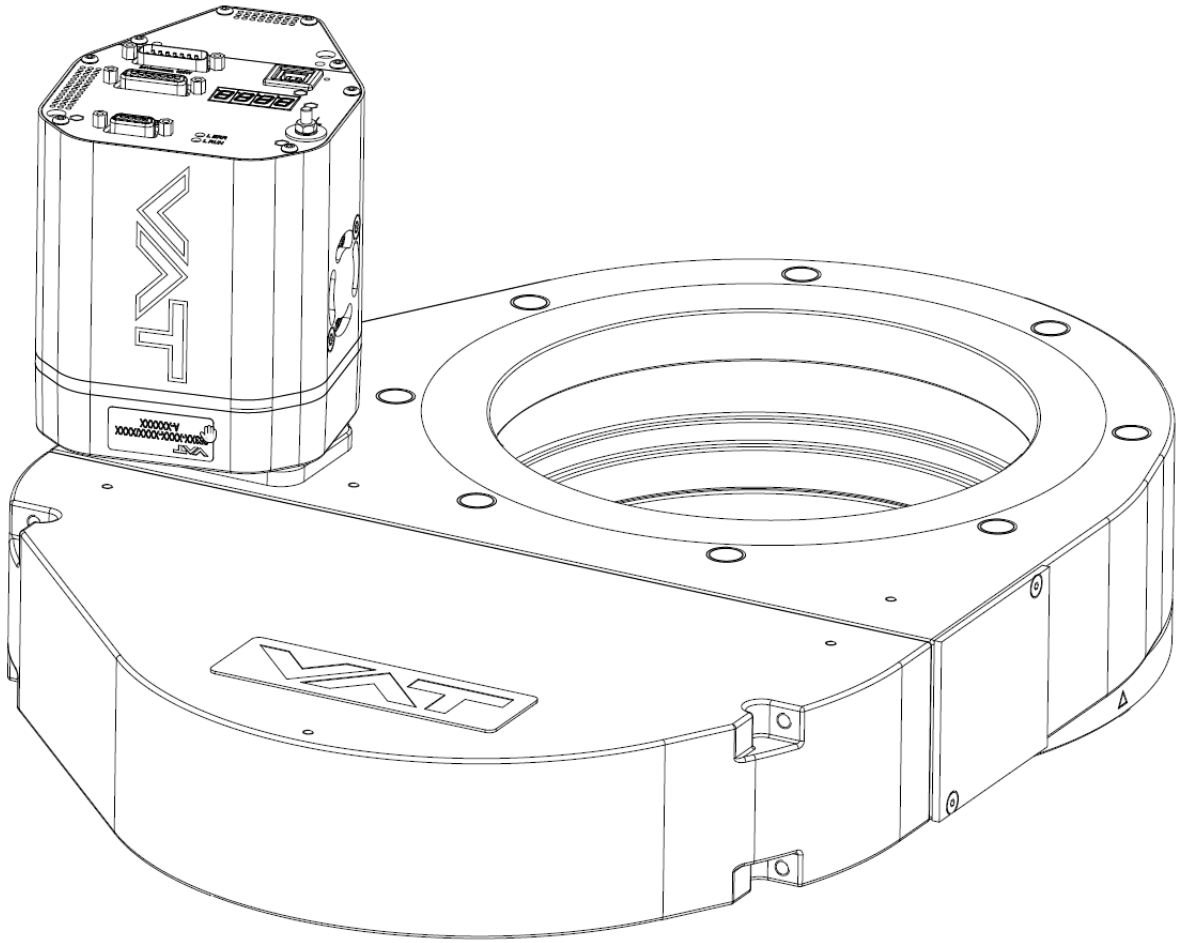
Installation, Operating & Maintenance Instructions

Pendulum control & isolation valve
With CC Link interface

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

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

653 . . - . .GN - . . . .(2 sensor inputs)
653 . . - . .AN - . . . .(2 sensor inputs / ±15V SPS)
653 . . - . .HN - . . . .(2 sensor inputs / PFO)
653 . . - . .CN - . . . .(2 sensor inputs / ±15V SPS / PFO)



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Sample picture

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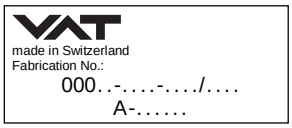
Contents

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.



← Fabrication number
← Order number

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. 70 W max. (operation of valve with max. load) without PFO [3] with optional SPS + 40 W with optional PFO + 10 W [3]	connector: POWER
Sensor power supply [2] **(β)** [653 . . - . . **A** . - . . . . / 653 . . - . . **C** . - . . . .]		
input	+24 VDC / 1500 mA max.	connector: POWER
output	±15 VDC (±5%) / 1200 mA max.	connector: SENSOR
Sensor power supply [2] **(β)** [653 . . - . . **G** . - . . . . / 653 . . - . . **H** . - . . . .]		
input	+ 24 VDC resp. ± 15 VDC	connector: POWER
output	same as input but: 2.0 A max. at ± 15 VDC 1.5 A max. at + 24 VDC	connector: SENSOR
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:
$P_{tot} = \alpha + \beta$
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 / Ri = 100 kΩ 0.1 mV 2 ms	connector: SENSOR
Digital inputs (power connector) input 1 input 2	interlock open (adjustable with CPA) interlock close (adjustable with CPA)	connector: POWER
voltage control contact control	12 … 24V / 4 … 8 mA 24V / 8 mA	connector: POWER
Digital outputs (power connector) output 1 output 2	valve closed (adjustable with CPA) valve opened (adjustable with CPA)	connector: POWER
load	max. 70 V / 0.1 A	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"** (653**40** - ....)	**DN 160** **6"** (653**44** - ....)	**DN 200** **8"** (653**46** - ....)	**DN 250** **10"** (653**48** - ....)
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** . . - . . . .)	1 × 10E-8 mbar to 1.2 bar (abs)
- Aluminum hard anodized (653 . . - . **H** . . - . . . .)	1 × 10E-6 mbar to 1.2 bar (abs)
- Aluminum nickel coated (653 . . - . **I** . . - . . . .)	1 × 10E-8 mbar to 1.2 bar (abs)
Leak rate to outside at 20°C	
- Aluminum (653 . . - . **A** . . - . . . .)	1 × 10E-9 mbar l/s
- Aluminum hard anodized (653 . . - . **H** . . - . . . .)	1 × 10E-5 mbar l/s
- Aluminum nickel coated (653 . . - . **I** . . - . . . .)	1 × 10E-9 mbar l/s
Leak rate valve seat at 20°C	
- Aluminum (653 . . - . **A** . . - . . . .)	1 x 10E-9 mbar l/s
- Aluminum hard anodized (653 . . - . **H** . . - . . . .)	1 x 10E-4 mbar l/s
- Aluminum nickel coated (653 . . - . **I** . . - . . . .)	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** . . - . . . .)	Aluminum 3.3211 (AA6061)
- Body (653 . . - . **H** . . - . . . .)	Aluminum 3.3211 (AA6061) hard anodized
- Body (653 . . - . **I** . . - . . . .)	Aluminum 3.3211 (AA6061) nickel coated
- Pendulum plate (653 . . - . **A** . . - . . . .)	Aluminum 3.3211 (AA6061)
- Pendulum plate (653 . . - . **H** . . - . . . .)	Aluminum 3.3211 (AA6061) hard anodized
- Pendulum plate (653 . . - . **I** . . - . . . .)	Aluminum 3.3211 (AA6061) nickel coated
- Sealing ring (653 . . - . **A** . . - . . . .)	Aluminum 3.3211 (AA6061), 1.4306 (304L)
- Sealing ring (653 . . - . **H** . . - . . . .)	Aluminum 3.3211 (AA6061) hard anodized, 1.4306 (304L)
- Sealing ring (653 . . - . **I** . . - . . . .)	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

Description				
	DN 100 **4"** (653**40** - ....)	**DN 160** **6"** (653**44** - ....)	**DN 200** **8"** (653**46** - ....)	**DN 250** **10"** (653**48** - ....)
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

Lack of knowledge

Failing to read this manual may result in property damage.

Firstly, read manual.

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

High risk

Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING

Medium risk

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION

Low risk

Indicates a hazardous situation which, if not avoided, may result in minor or moderate injury.

NOTICE

Command

Indicates a hazardous situation which, if not avoided, may result in property damage.

2.3 Personnel qualifications

⚠ WARNING

Unqualified personnel

Inappropriate handling may cause serious injury or property damage.

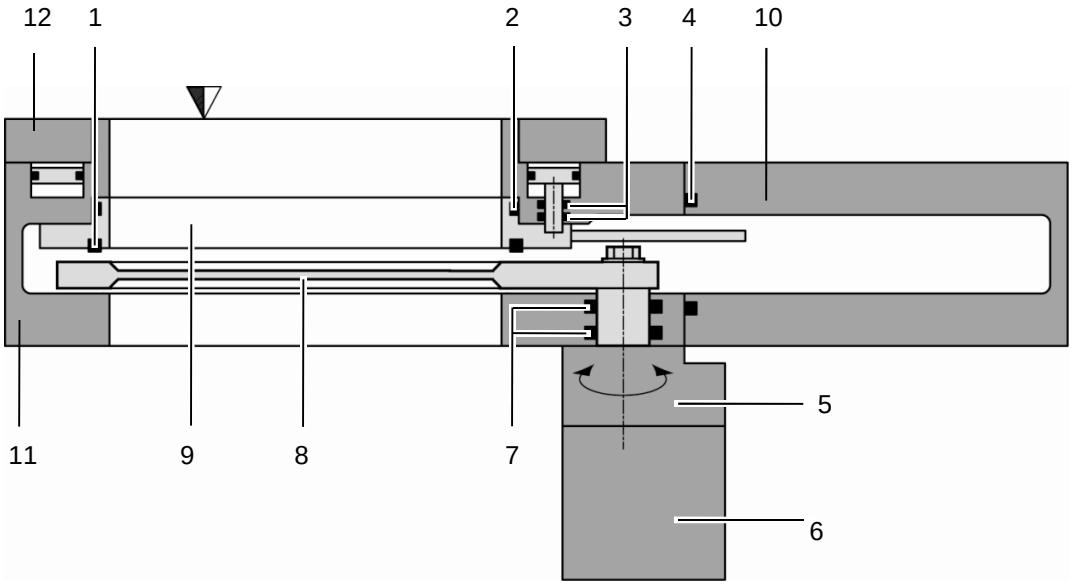
Only qualified personnel are allowed to carry out the described work.

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

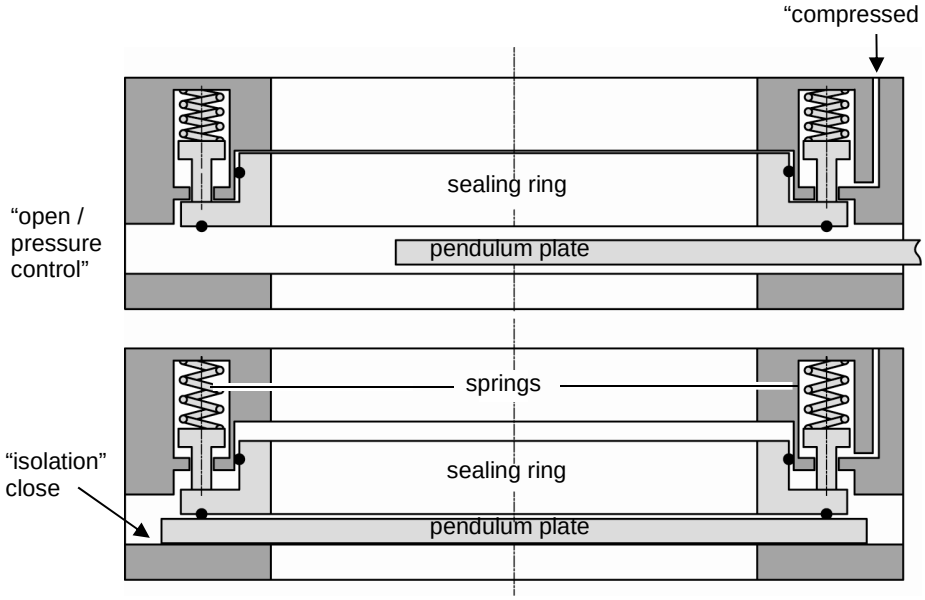


1	Plate seal	7	Rotary feed through seals
2	Body seal	8	Pendulum plate
3	Shaft feed through seals	9	Sealing ring
4	Bonnet seal	10	Bonnet
5	Actuator	11	Body
6	Integrated controller	12	Body Flange

3.2 Function

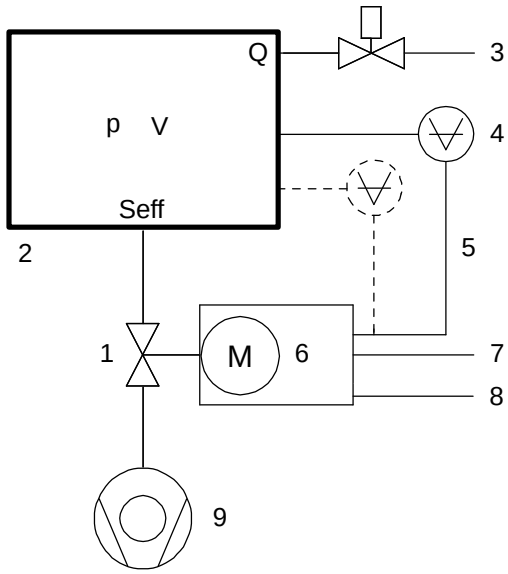
The valve plate acts, due to its pendulum motion, as a throttling element and varies the conductance of the valve opening. The integrated controller calculates the required plate position to achieve the set point pressure. Actuation is performed by a stepper motor. An encoder monitors the position. This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



Example: Downstream control

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 (ls^{-1})
Q Gas flow (mbar ls^{-1})
p Pressure (mbar)

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

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:

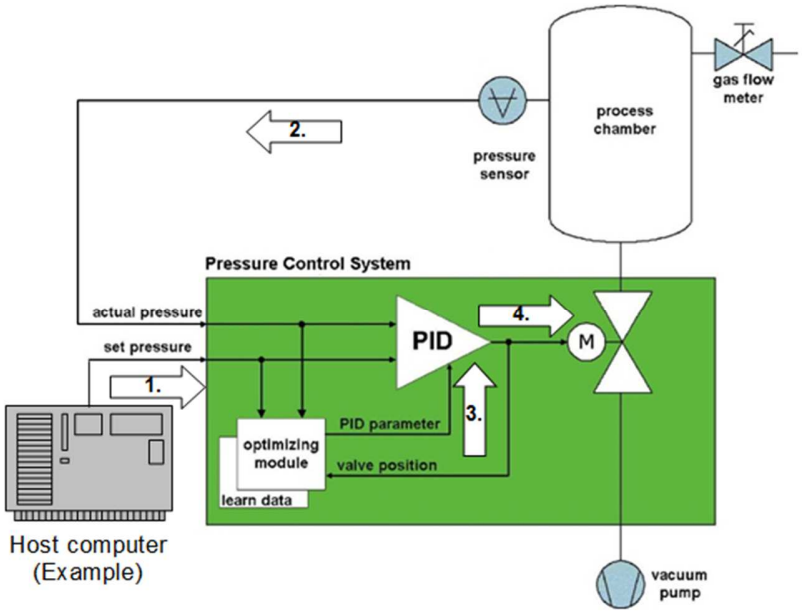
1. Downstream control (standard):
   The pressure is controlled by changing the conductance of a control valve between pump and process chamber. This changes the effective pumping speed at the process chamber. Pressure and gas flow can be independently controlled over a wide range.

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

⚠ 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.

⚠ WARNING

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

NOTICE

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.

NOTICE

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.

NOTICE

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.

NOTICE

Contamination

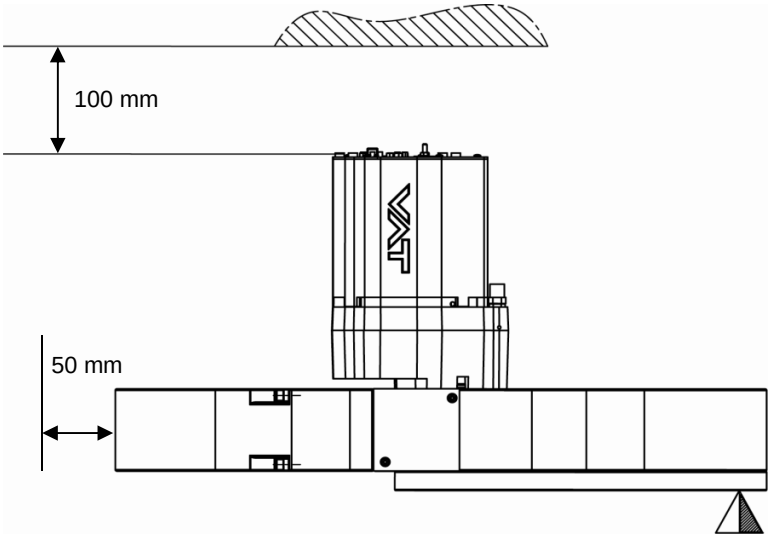
Gate and other parts of the valve must be protected from contamination.

Always wear clean room gloves when handling the valve.

Mount valve to a clean system only.

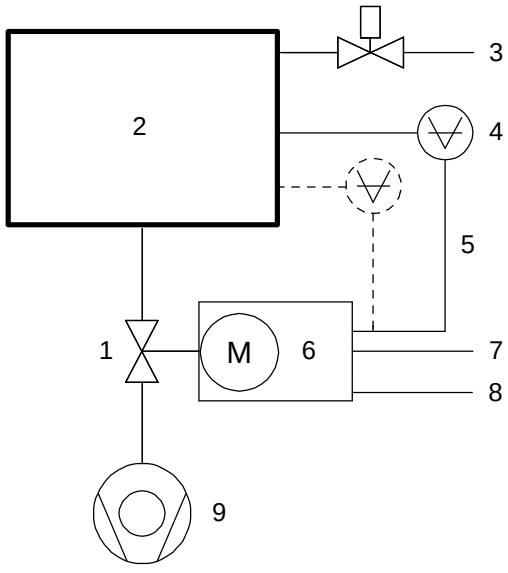
4.2.1 Installation space condition

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



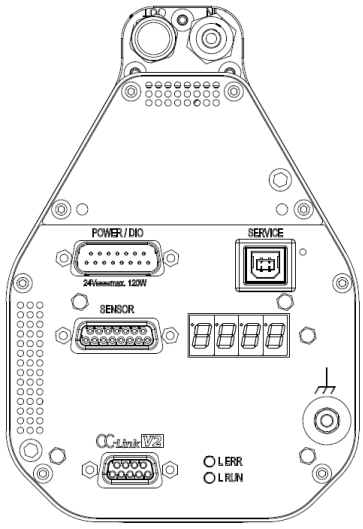
4.2.2 Connection overview

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 sensor(s) and then to valve (connector: SENSOR). Refer to chapter «Electrical connection» for correct wiring.
6. Connect valve to CC-Link [4] (connector: INTERFACE). Refer to « CC-Link schematics» 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.

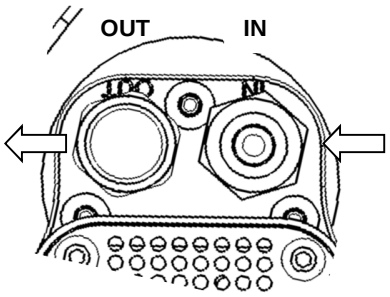


Fig. 1

Fig. 2

4.2.4 Tightening torque

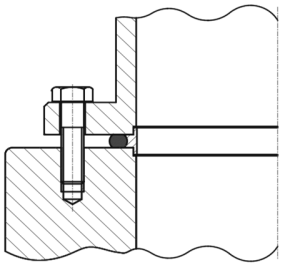
The torque values below are dependent on many factors, such as materials involved, surface quality, surface treatment, and lubrication.

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

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

4.2.5 Mounting with centering rings

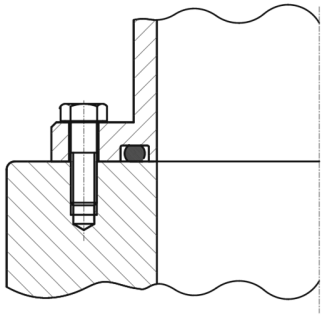
Valve size	ISO-F	ISO-F
	max. tightening torque (Nm)	**max. tightening torque (lbs . ft)**
DN100 / 4“ 653**40** - . . . . -	8-10	6-8
DN160 / 6“ 653**44** - . . . . -	13-15	9-11
DN200 / 8“ 653**46** - . . . . -	13-15	9-11
DN250 / 10“ 653**48** - . . . . -	17-20	13-15
	hole depth (mm)	**hole depth (inch)**
DN100 / 4“ 653**40** - . . . . -	12	0.47
DN160 / 6“ 653**44** - . . . . -	14	0.55
DN200 / 8“ 653**46** - . . . . -	15	0.59
DN250 / 10“ 653**48** - . . . . -	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“ 653**40** - . . . . -	20-23	35-40	35-40	15-17	26-30	26-30
DN160 / 6“ 653**44** - . . . . -	35-40	35-40	35-40	26-30	26-30	26-30
DN200 / 8“ 653**46** - . . . . -	35-40	35-40	80-90	26-30	26-30	59-67
DN250 / 10“ 653**48** - . . . . -	35-41	65-70	80-90	26-30	48-52	59-67
	hole depth (mm)			hole depth (inch)		
DN100 / 4“ 653**40** - . . . . -	12	12	12	0.47	0.47	0.47
DN160 / 6“ 653**44** - . . . . -	14	14	14	0.55	0.55	0.55
DN200 / 8“ 653**46** - . . . . -	15	15	14	0.59	0.59	0.59
DN250 / 10“ 653**48** - . . . . -	16	16	16	0.63	0.63	0.63



4.2.7 Admissible forces

NOTICE

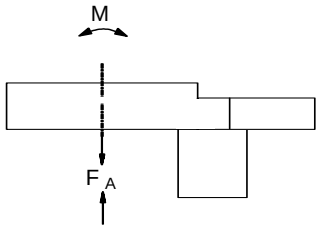
Force at valve body

Forces from evacuating the system, from the weight of other components, and from baking can lead to deformation and malfunctioning of the valve.

Do not higher force the valve body as specified.

The following forces are admissible.

Valve size	Axial tensile or compressive force «F_A»		Bending moment «M»	
	N	lb.	Nm	lbf.
DN100 / 4“ 653**40** - . . . . -	1000	220	40	30
DN160 / 6“ 653**44** - . . . . -	2000	440	80	60
DN200 / 8“ 653**46** - . . . . -	2000	440	80	60
DN250 / 10“ 653**48** - . . . . -	2500	550	100	75
For a combination of both forces (F_A and M) the values are invalid. Verify that the depth of the mounting screws is min. 1 x thread diameter. Please contact VAT for more information.				

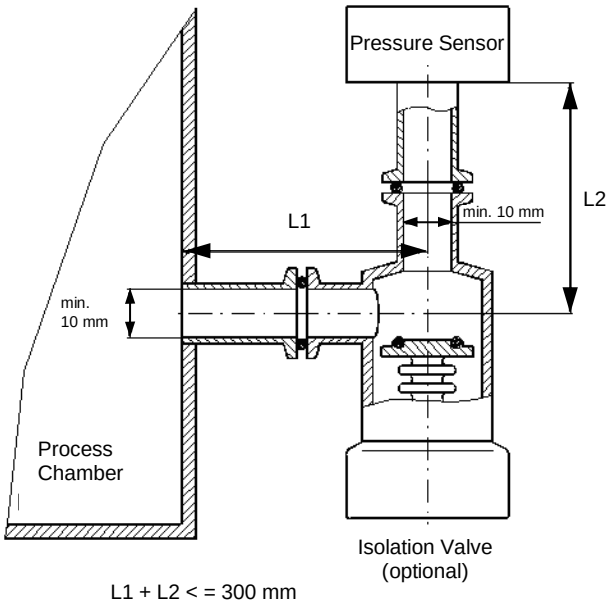


4.2.8 Requirements to sensor connection

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

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.

NOTICE

Burned connector pins (spark)

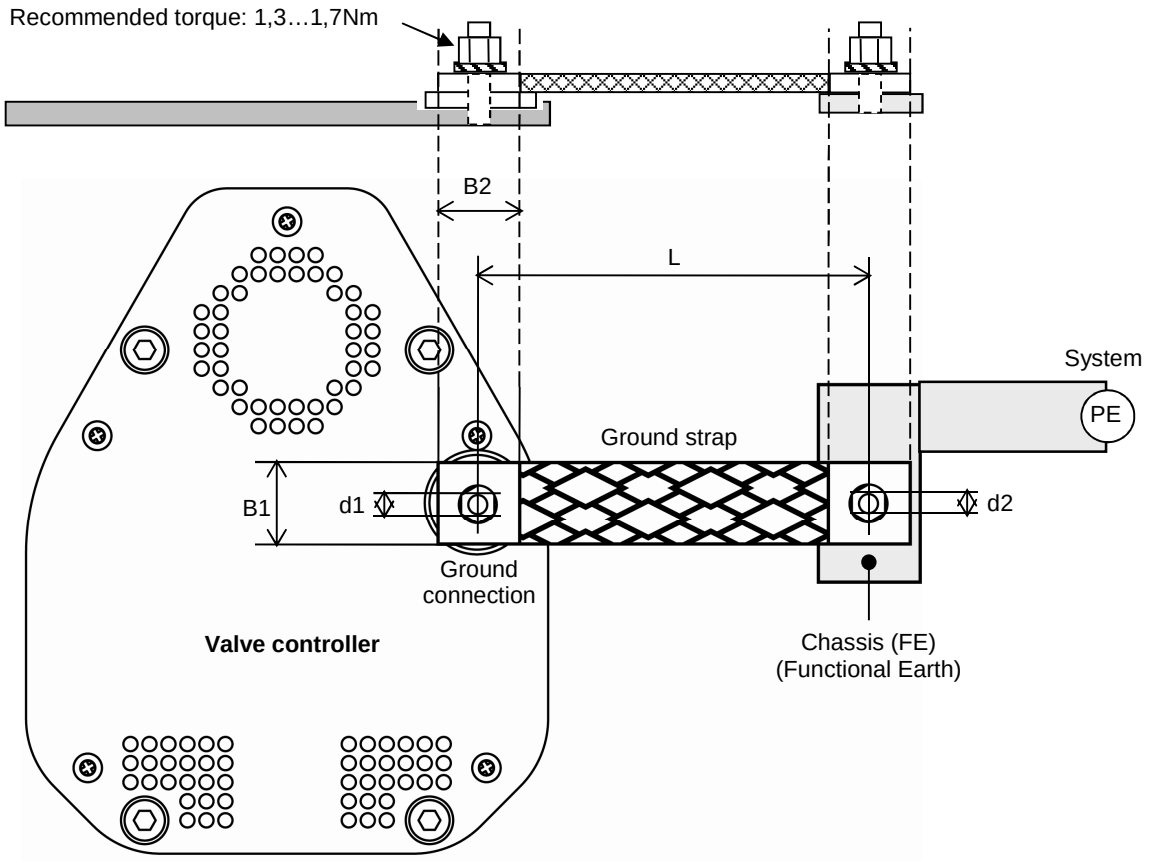
Connector pins or electronic parts could damage, if plugged and unplugged under power.

Do not plug or unplug connectors under power.

4.3.1 Ground connection

Recommendation for ground strap between controller and system chassis.

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



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.

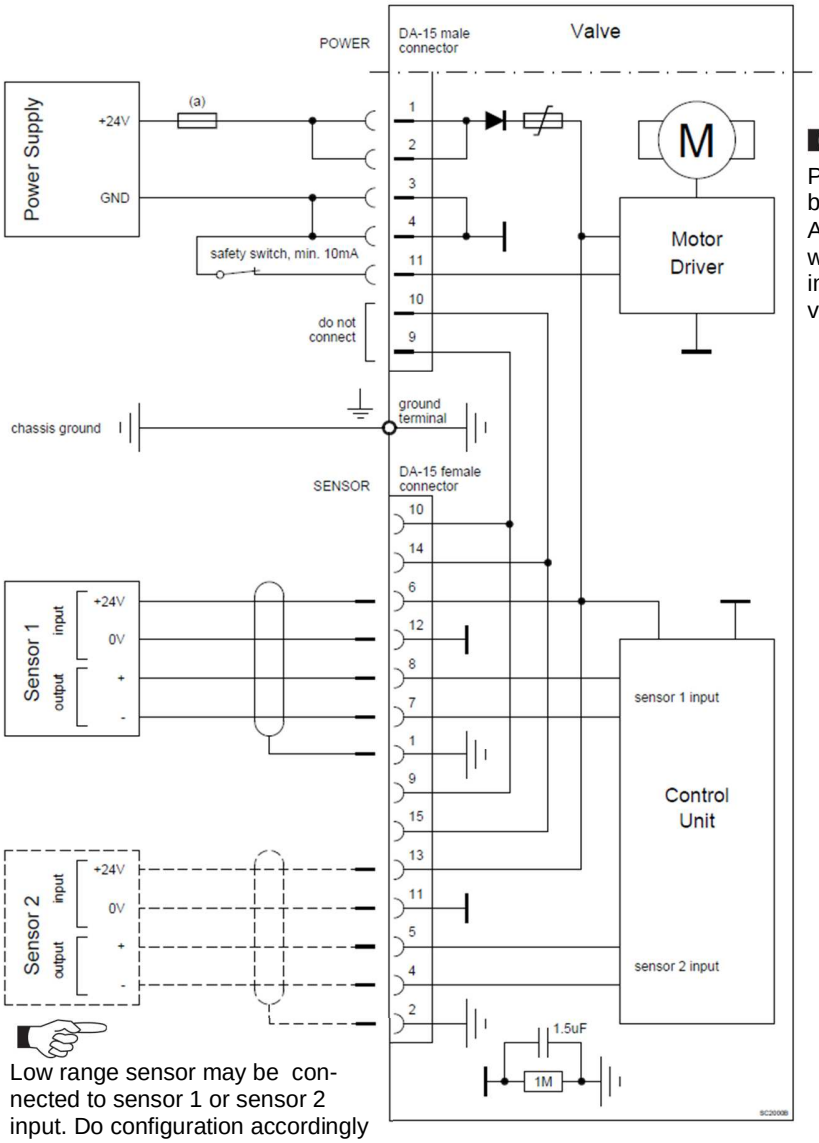
Valve versions:

- 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]



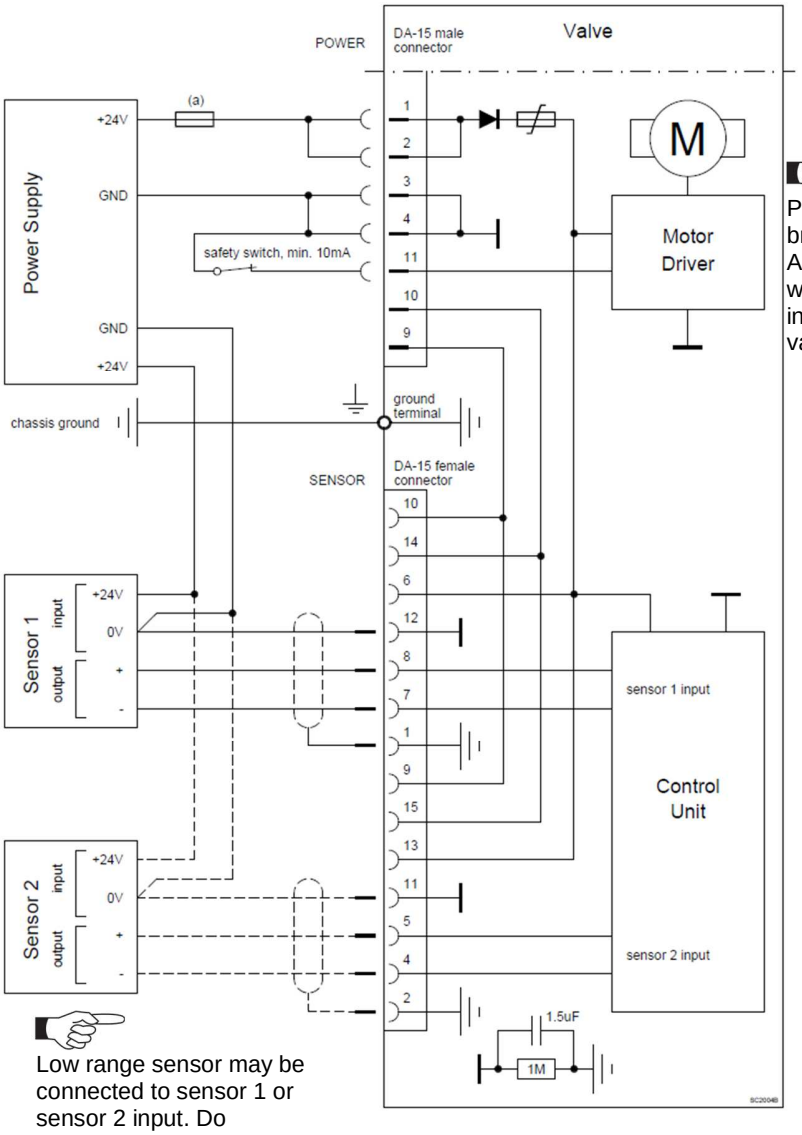
Pins 4 and 11 must be bridged for operation. An optional switch would allow for motor interlock to prevent valve from moving.

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 (+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]



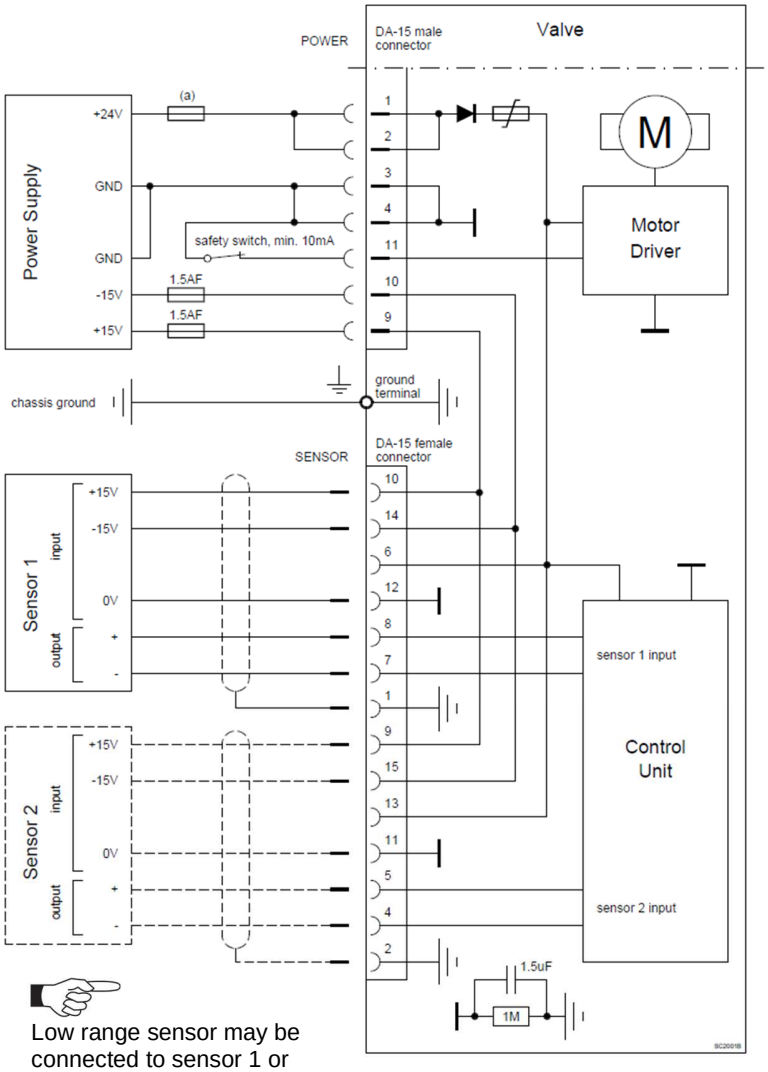
Pins 4 and 11 must be bridged for operation. An optional switch would allow for motor interlock to prevent valve from moving.

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

- **VAT fuse recommendation: (a) 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]



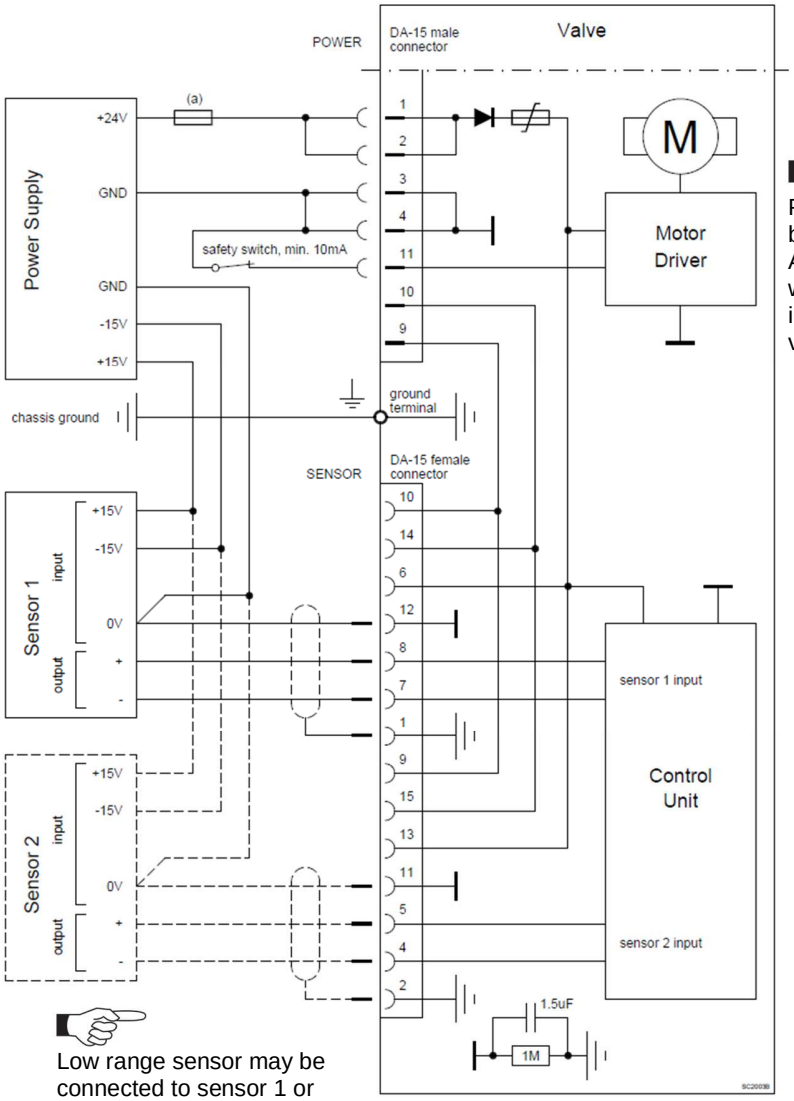
Pins 4 and 11 must be bridged for operation. An optional switch would allow for motor interlock to prevent valve from moving.

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

- **VAT fuse recommendation: (a) 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]



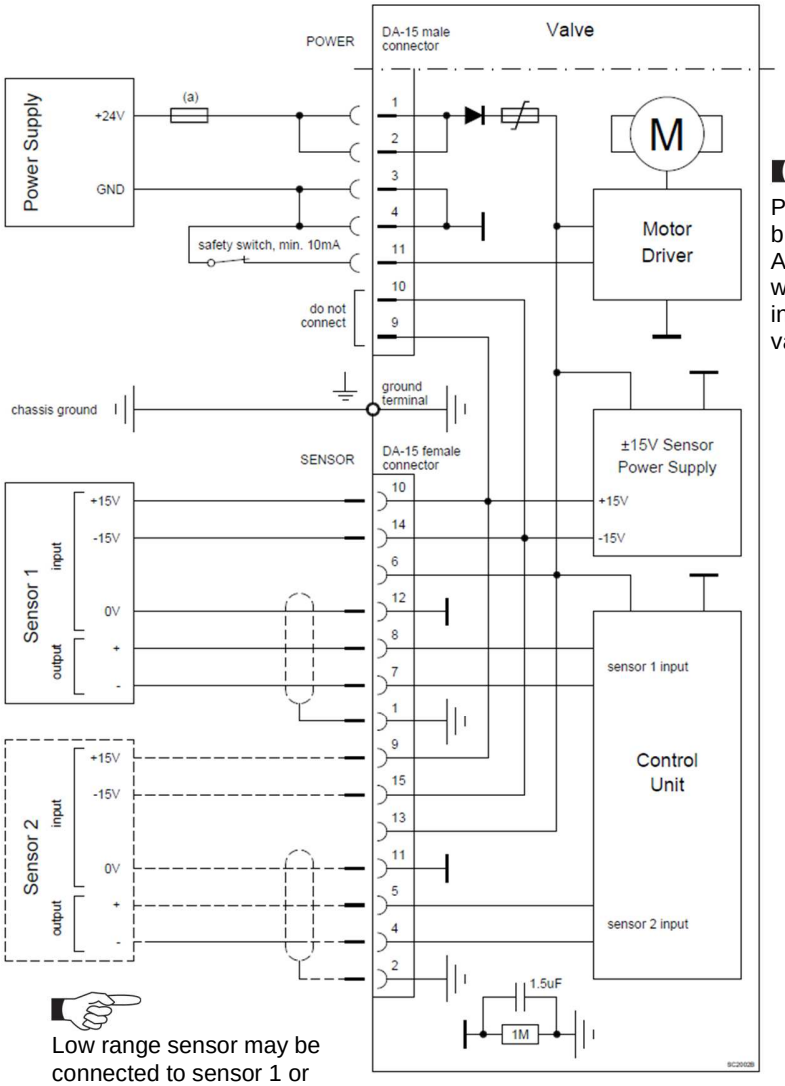
Pins 4 and 11 must be bridged for operation. An optional switch would allow for motor interlock to prevent valve from moving.

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

- **VAT fuse recommendation: (a) 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!

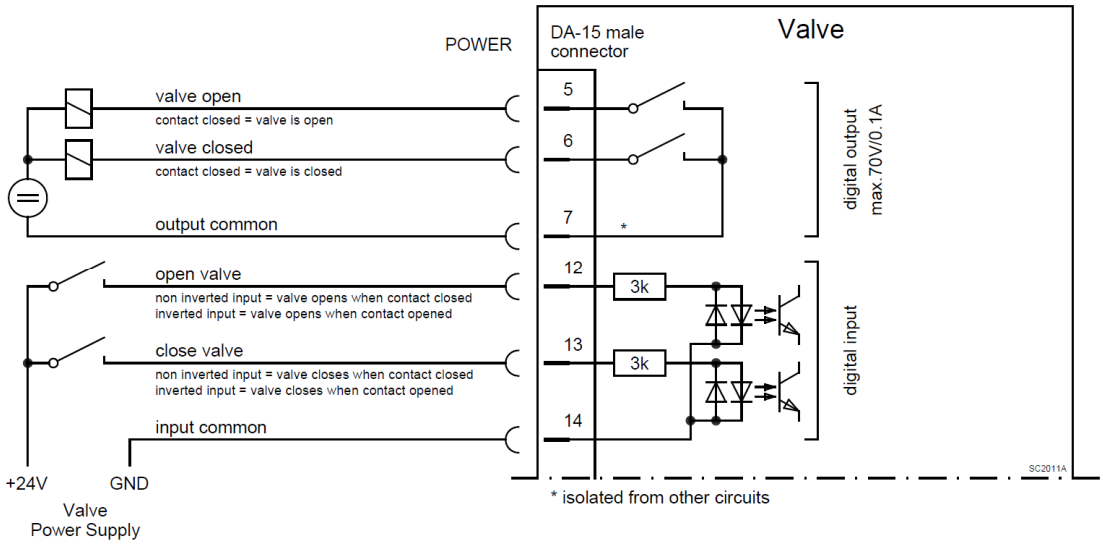
4.3.3 Digital in- output and analogue output connections

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.

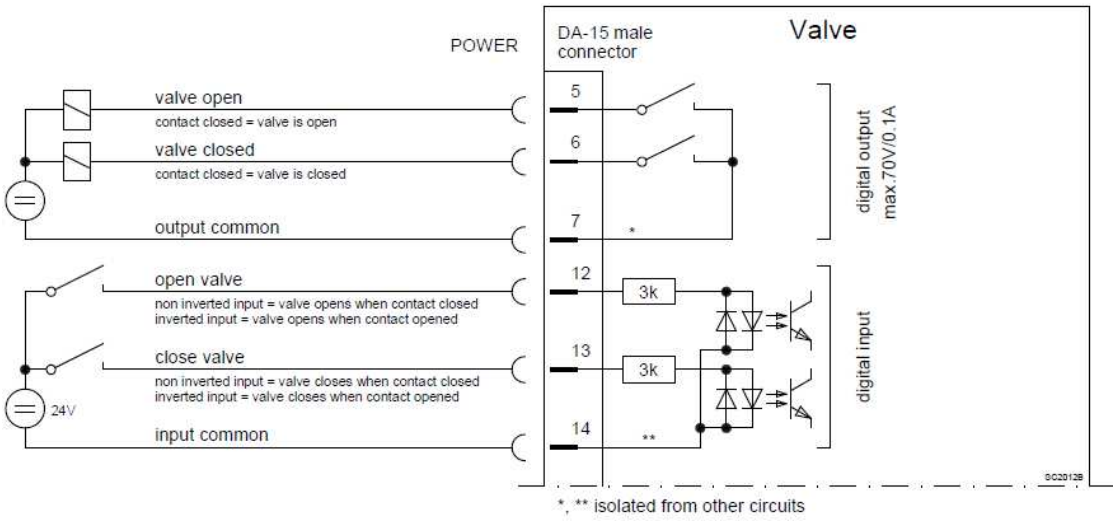
Active **digital inputs** have **higher priority than DeviceNet** commands.

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

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



4.3.3.2 Power connector: Configuration with voltage source for digital inputs



4.3.3.3 Digital inputs

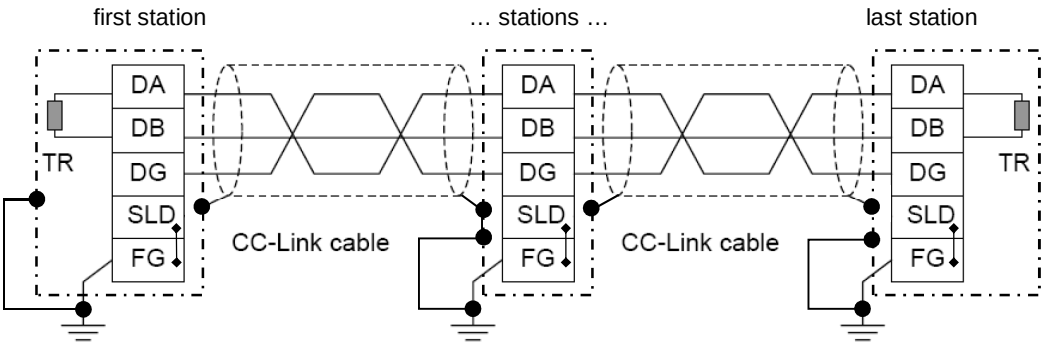
Pin	Function	Description
13	**INTERLOCK CLOSE**	This function will close the valve. • The input has priority over the remote interface • The input can be inverted • The input can be switched off • The function can be set to function INTERLOCK OPEN • INTERLOCK CLOSE has priority over INTERLOCK OPEN
12	**INTERLOCK OPEN**	This function will open the valve. • 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**	Common for all digital inputs See also «»

4.3.3.4 Digital output

Pin	Function	Signal type	Description
6	**VALVE CLOSED**	Digital output	This function will indicate that the valve is closed. • 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	This function will indicate that the valve is open. • 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	Common for all digital output. Connect + or – terminal of source with common

4.3.4 CC-Link interface connection

4.3.4.1 CC-Link cable installation (example)



TR = Terminal resister (Must be compatible to used CC-Link cable version!)

The valve can be defined as «first station», «…stations…» between first and last, or «last station».
If the valve at first or last station, «TR» must be installed between 1 (DA) and 2 (DB).

The station type for VAT valves are: Version 2 Remote Device Station.

Connector type: DSUB 9 Pin

Pin	Signal	Function
1	N.C.	
2	N.C.	
3	DA	Positive RS485 RxD/TxD
4	DG	Signal Ground
5	N.C.	
6	N.C	
7	N.C.	
8	DB	Negative RS485 RxD/TxD
9	N.C.	

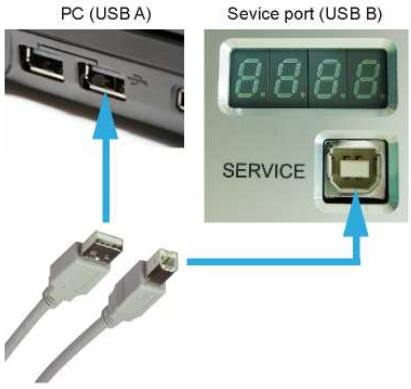
The CC-Link interface is galvanic isolated from control unit.

4.3.4.2 CC-Link network and cable

For detail information about ***«CC-Link cable, wiring and TR»*** refer to CC-Link homepage: http://www.cc-link.org > «CC-Link Cable Wiring Manual»

4.3.5 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	**CC-Link configuration**	1. Station Number 2. Transmission rate 3. Operational settings mode Refer to chapter «CC-Link configuration» for details.
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 CONFIGURATION» the valve is not able to run pressure control.

4.5 CC-Link configuration

The station type for VAT valves are: Version 2 Remote Device Station.

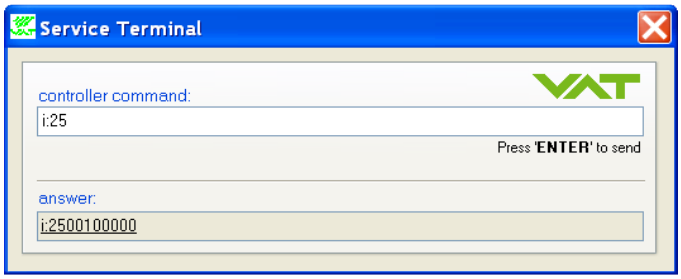
1. Station Number

The «station number» is used to distinguish between stations on the CC-Link network. Unique station numbers in consecutive order without duplication must be used, when assigning stations to the CC-Link network.

The «station number» can be configured by 'Control View', 'Control Performance Analyzer' or 'Universal Hyper Terminal'.

The **«set-command»** is: **«s:25xxx00000»**. The xxx value is the «station number». Valid range is 001 to 064.
The **«get-command»** is: **«i:25»**. The answer returns the node address → «i:25xxx00000». The xxx value is the current «station number».
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

Example «get-command» with Terminal:



2. Transmission rate

Use the same «transmission rate» for all stations in the bus and also for master station. If any of the settings for at least one station is different, data link cannot be established normally.

The «transmission rate» can select from 156 kbps / 625 kbps / 2.5 Mbps / 5 Mbps / 10 Mbps

The «transmission rate» can be configured by 'Control View', 'Control Performance Analyzer', 'Universal Hyper Terminal' or 'Service Box 2'.

The **«set-command»** is: **«s:21xxx00000»**. The xxx value is the «transmission rate» shown in the table below
The **«get-command»** is: **«i:21»**. The answer returns the «transmission rate» → «i:21xxx00000». The xxx value is the current «transmission rate».
Consider that the controller must be in local mode to accept the commands! After a s:21 command is sent the module is reseted and starts up again.
«c:0100» → change into local mode
«c:0101» → change into remote mode

Value	Transmission rate
000	156 kbps
001	625 kbps
002	2.5 Mbps
003	5 Mbps
004	10 Mbps

3. Operational settings mode

The «operational settings mode» defines the following CC-Link parameters:

- **CC-Link version**
- **Number of occupied stations**: The number of stations (occupying one stations worth of memory area) used by a single slave station in a network.
- **Extended cyclic settings**: In the extended cyclic transmission (only Ver.2), the extended cyclic points can be set as 2 times, 4 times or 8 times of the normal cyclic transmission points.

The VAT slave supports two combinations of the CC-Link parameter settings.

Value	Operational settings
001	CC-Link Ver.2 / Occupies 1 station / Octuple expanded cyclic
004	CC-Link Ver.2 / Occupies 4 stations / Double expanded cyclic

The «operational settings mode» can be configured by 'Control View', 'Control Performance Analyzer', 'Universal Hyper Terminal' or 'Service Box 2'.

The **«set-command»** is: **«s:22xxx00000»**. The xxx value is the operational settings mode!
The **«get-command»** is: **«i:22»**. The answer returns the «operational settings mode» → «i:22xxx00000». The xxx value is the current operational settings mode.
Consider that the controller must be in local mode to accept the commands! After a s:22 command is sent the module is reseted and starts up again.
«c:0100» → change into local mode
«c:0101» → change into remote mode

4. 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'.

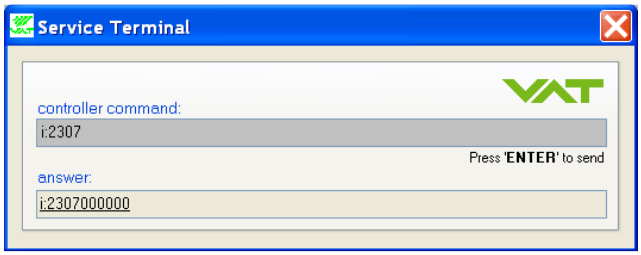
The **«set-command»** is: **«s:23xxy00000»**. The xxy value is the data type of a pressure and position signal.

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

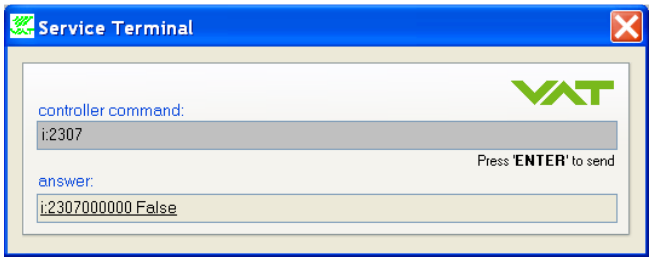
xx	Value
00	Pressure
01	Pressure sensor 1
02	Pressure sensor 2 (optional, only in case of 2 sensor version)
03	Position
04	*Not used – reserved*
05	*Not used – reserved*
06	Pressure setpoint
07	Position setpoint
08	*Not used – reserved*
09	*Not used – reserved*
10	*Not used – reserved*
11	*Not used – reserved*

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 = singed integer) and the get command i:23 add a string "False":



5. 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 View', 'Control Performance Analyzer' or 'Universal Hyper Terminal'.

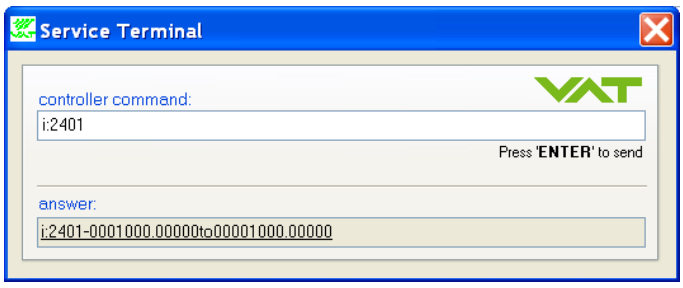
The **«set-command»** is: **«s:24xxy**to**z»**.
y: **lower scale value**, floating point, entry with a point '.' and '-' for negative values possible
z: **upper scale value**, floating point, entry with a point '.' and '-' for negative values possible
xx: signal number in the buffer

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	*Not used – reserved*	-	-	-	-
02	*Not used – reserved*	-	-	-	-
03	Position	0	100'000	-1'000'000	1'000'000
04	*Not used – reserved*	-	-	-	-
05	*Not used – reserved*	-	-	-	-
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	*Not used – reserved*	-	-	-	-
09	*Not used – reserved*	-	-	-	-
10	*Not used – reserved*	-	-	-	-
11	*Not used – reserved*	-	-	-	-

The **«get-command»** is: **«i:24xx»**. The answer returns the range → «i:24xxytoz». 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:

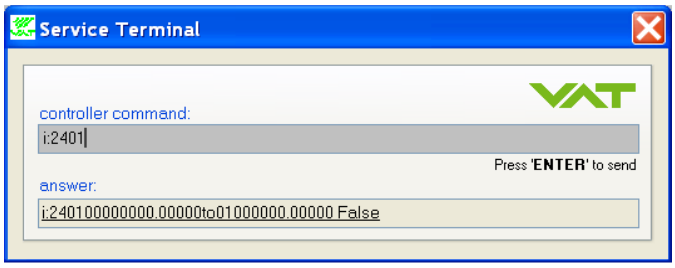


The «range of pressure and position values» is independent of the data type, equal for «signed integer» and «floating point».

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:24000to100.75 → set the range of pressure from 0 (= 0 V) to 100.75 (= 10 V)

Example: s:2411-10.5to20.5 → set the range of cluster valve freeze position from -10.5 (=closed position) to 20.5 (=opened position)

4.6 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.

4.6.1 Homing Start Option

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

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

Parameter location:

CPA	DEVICENET
Valve.Homig	Only **End Control Mode** in Pressure Controller Object (Class ID 100)

4.6.2 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	DEVICENET
Power Fail Option	Only **Functionality** in Pressure Controller Object (Class ID 100)

4.6.3 Digital I/O

On the power connecter 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	DEVICENET
Power Connector IO	Only **State** in Pressure Controller Object (Class ID 100)

4.7 Sensor configuration

4.7.1 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:

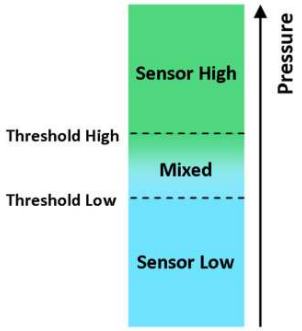
CPA	DEVICENET
Pressure Sensor.Sensor 1 Pressure Sensor.Sensor 2	Not accessible

4.7.2 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] **Threshold Low [SFS low sensor]**	Defines the crossover area (see below)
Delay	Switch over delay in Crossover Mode 'Hard Switch'

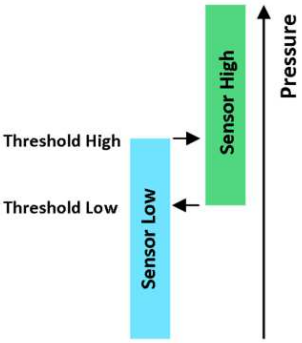
Crossover Mode Soft Switch



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.

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).

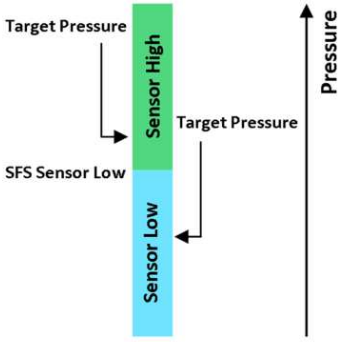
Crossover Mode Hard Switch



Switching between sensors according to the hysteresis threshold levels and an optional delay.

When to use
Preferred setting if the sensor signals don't fit together in the crossover area (for example if sensor ratio is high).

Crossover Mode Target Pressure



If target pressure is in the range of low sensor, low sensor is used; otherwise high range sensor.

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.

Note
While in position control mode, 'Soft Switch' mode is used

Parameter location:

CPA	DEVICENET
Pressure Sensor.Crossover	Only **Crossover Mode** in S-Analog Sensor Object (Class ID 49) via Sensor Mode

4.7.3 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: • 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	DEVICENET
Pressure Sensor.Zero Adjust Pressure Sensor.Sensor 1.Zero Adjust Pressure Sensor.Sensor 2.Zero Adjust	See Zero in S-Analog Sensor Object (Class ID 49) See Sensor Offset in Pressure Controller Object (Class ID 100)

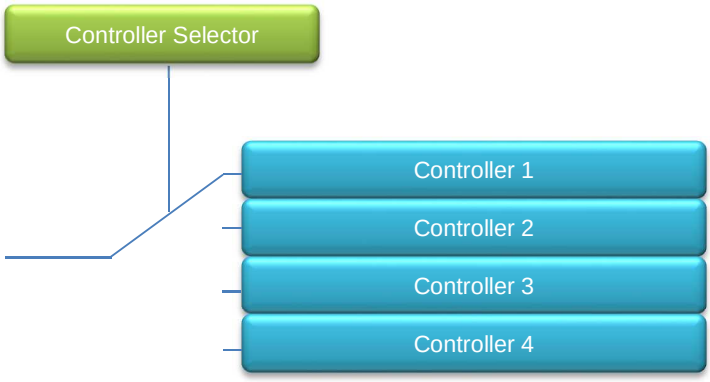
Performing a zero adjust via CPA:

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.

4.8 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.



4.8.1 Control Algorithm

Algorithm	Description
Adaptive	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. Note: The adaptive pressure control work at its best if the conditions (mainly gas flow) are close the conditions at the learn procedure. Parameter:

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:

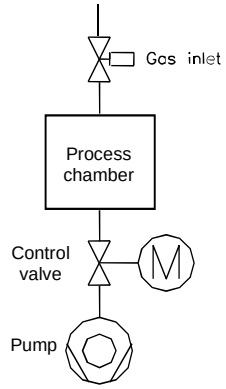
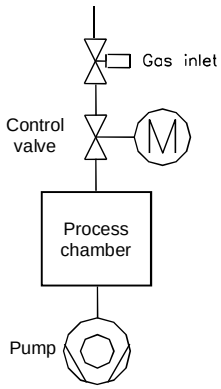
P-Gain	Same as in PI algorithm
I-Gain	Same as in PI algorithm

Parameter location:

CPA	DEVICENET
Pressure Control.Controller	Limited access in S-Single Stage Controller (Class 51)

4.8.2 Choose correct control algorithm

Select the configuration what your application needs.

<table>
<tr><th rowspan="2">System Configuration</th><th colspan="2">Constant gas flow available</th><th rowspan="2">Constant gas flow not available</th></tr>
<tr><th>Tv*<= 500 sec</th><th>Tv* > 500 sec</th></tr>
<tr><td>Downstream
 
</td><td>Adaptive pressure controller</td><td colspan="2">Fixed pressure controller</td></tr>
<tr><td>Upstream
 
</td><td colspan="3">Fixed pressure controller</td></tr>
<tr><td>Soft Pump</td><td colspan="3">Soft Pump</td></tr>
</table>

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

$$Tv = \frac{P_{SFS} \bullet CV}{q_L}$$

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

4.8.3 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	DEVICENET
Pressure Control.Adaptive Learn	Limited access in S-Single Stage Controller (Class 51)

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 N_2 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.

1. 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.

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

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**]

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

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

2. Out of these calculated conductance values choose the lowest.

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

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»).

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

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

q_L gasflow for learn [**Pa m^3/s**]
p_{SFS} sensor full scale pressure [**Pa**]
C_{min} min. controllable conductance of valve [l/s], (refer to «Technical data»)

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

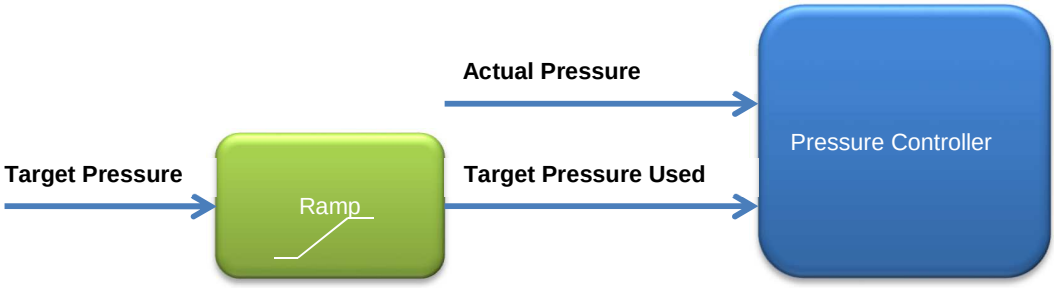
q_L gasflow for learn [**mbar l/s**]
p_{SFS} sensor full scale pressure [**mbar**]
C_{min} min. controllable conductance of valve [l/s], (refer to «Technical data»)

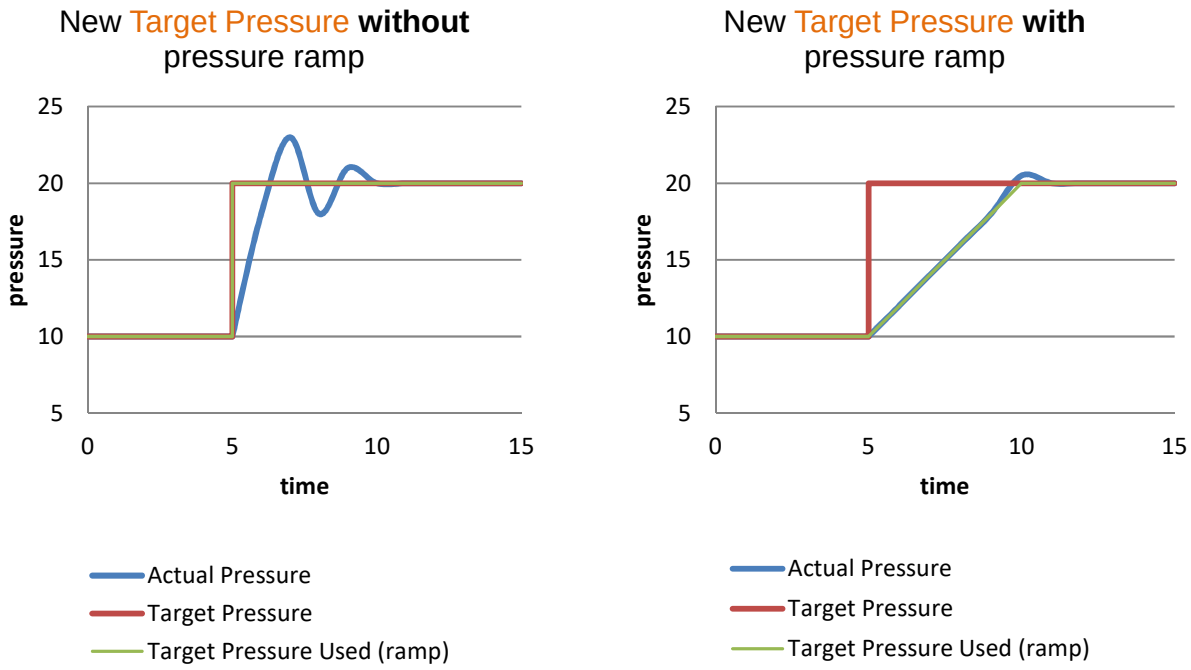
$$q_L = 71 \bullet p_{SFS} \bullet C_{min}$$

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»)

4.8.4 Pressure ramp

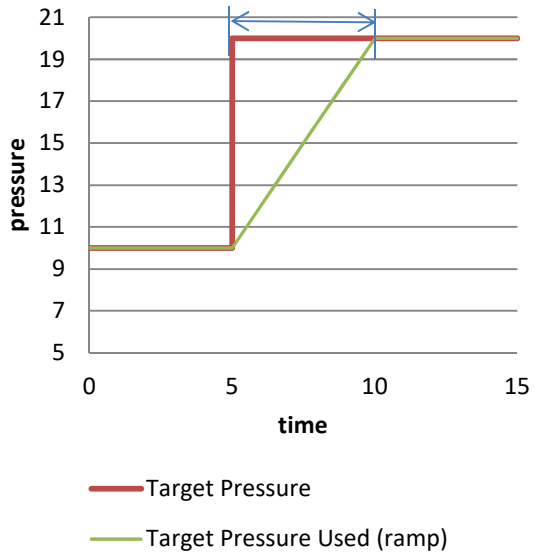
Basically, the pressure ramp is used to limit the rate of pressure change. It can also be used to minimize over- / undershoot of pressure.



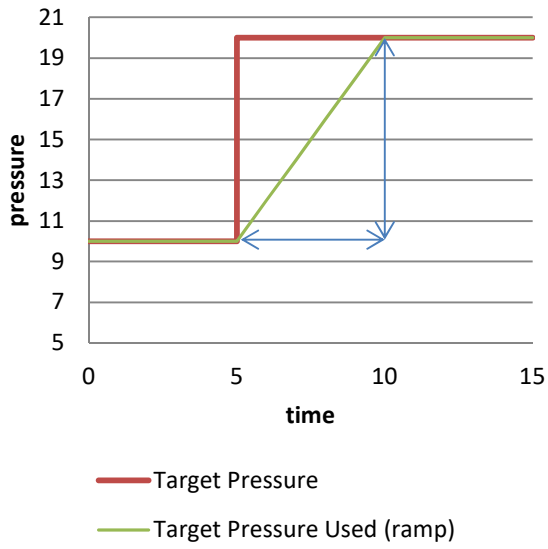


4.8.4.1 Pressure ramp configuration

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]

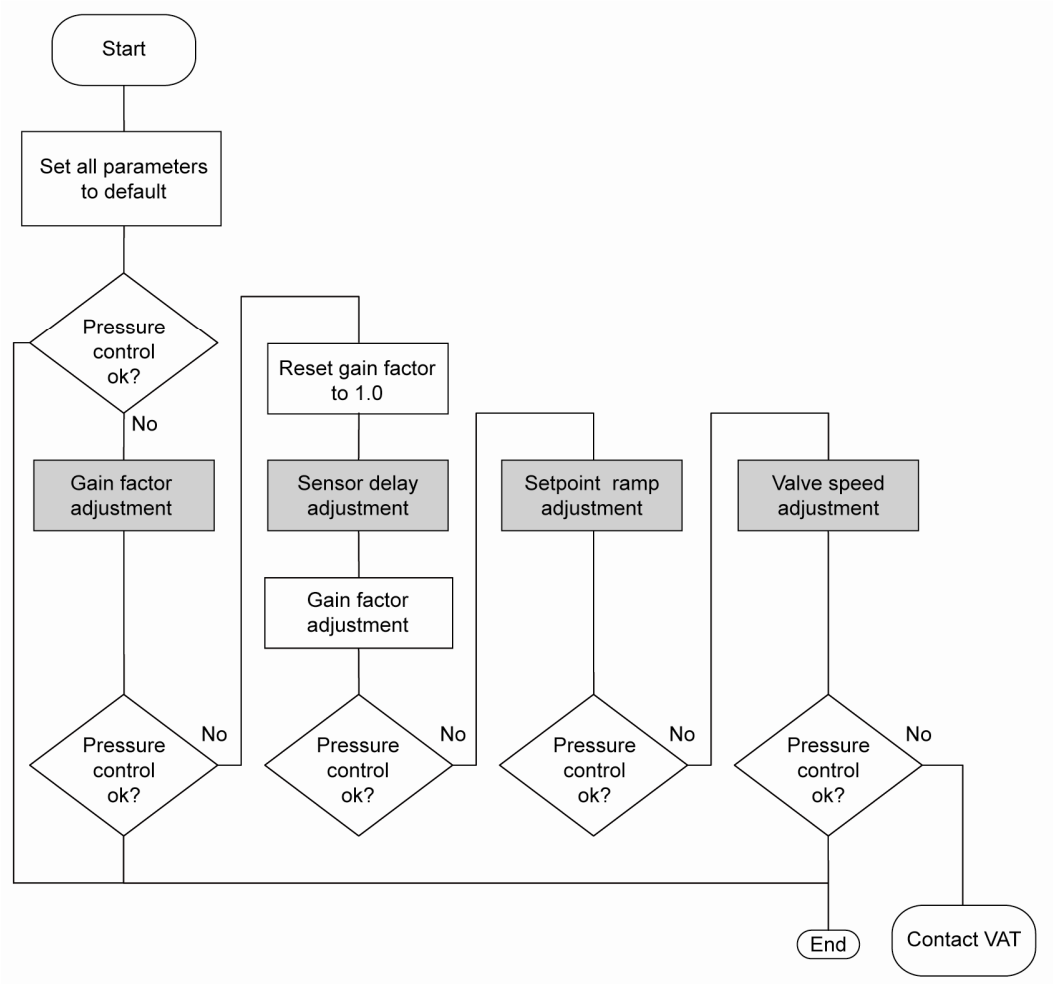


4.8.5 Tuning of control performance

- 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

4.8.5.1 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».

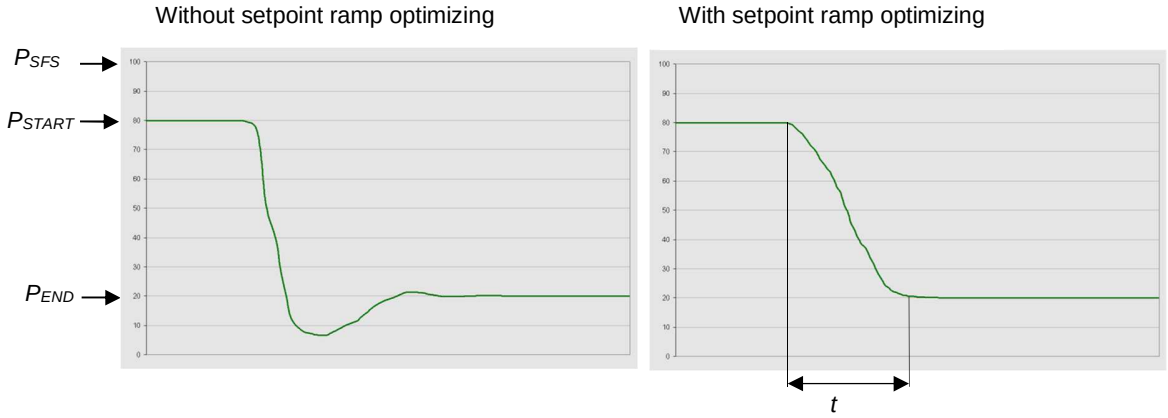
Setpoint ramp adjustment

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 = 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

4.8.5.2 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:

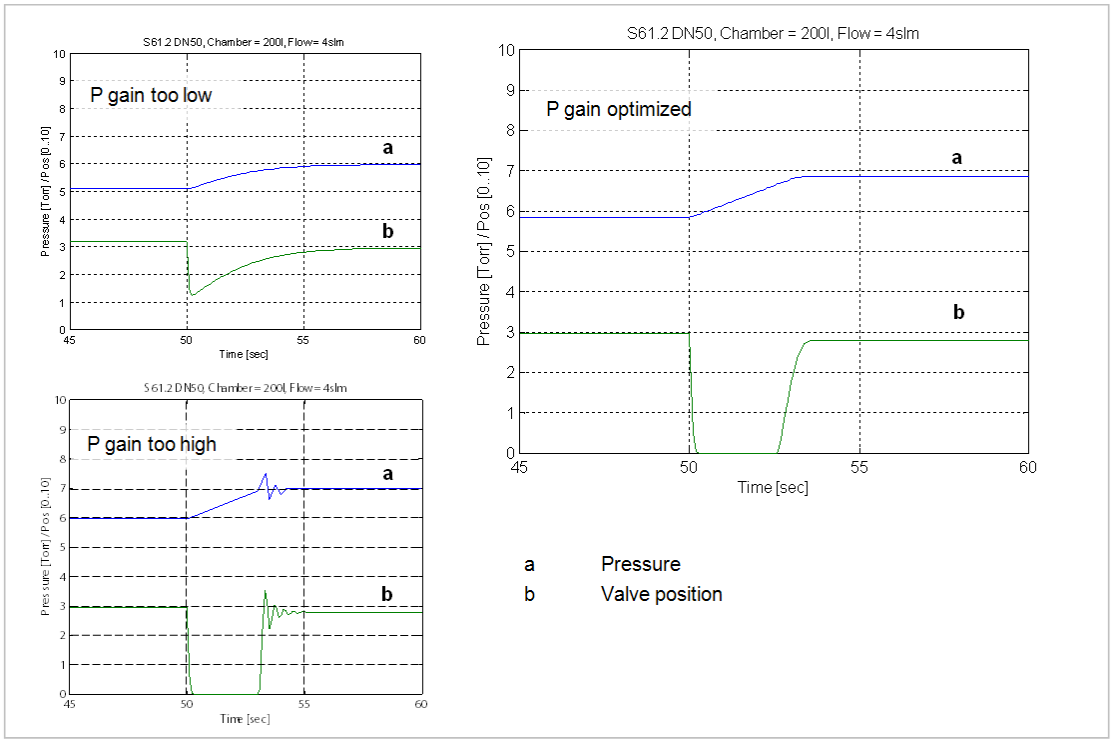
SP1	=	7 Torr
SP2	=	6 Torr
Gas flow	=	4 slm

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:

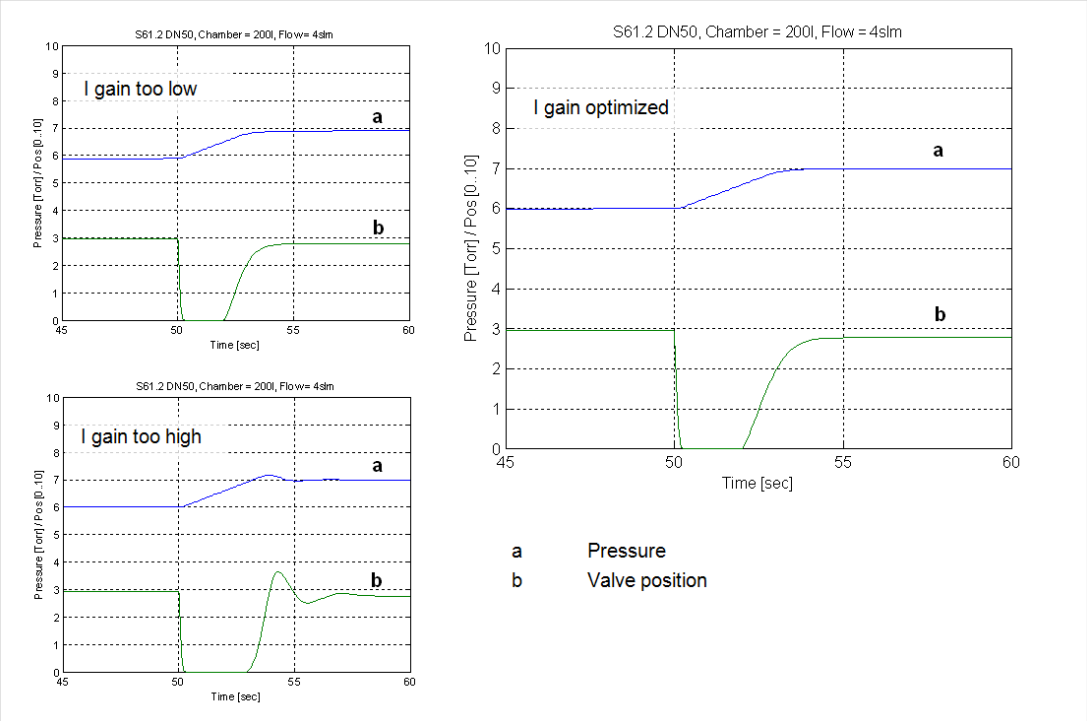

S61.2 DN50, Chamber = 200l, Flow= 4slm
P gain too low
a
b
Pressure [Torr] / Pos [0..10]
Time [sec]
S61.2 DN50, Chamber = 200l, Flow= 4slm
P gain too high
a
b
Pressure [Torr] / Pos [0..10]
Time [sec]
S61.2 DN50, Chamber = 200l, Flow = 4slm
P gain optimized
a
b
Pressure [Torr] / Pos [0..10]
Time [sec]
a Pressure
b Valve position

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 over shoot 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 result in just a slight pressure over shoot, 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

4.8.5.3 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

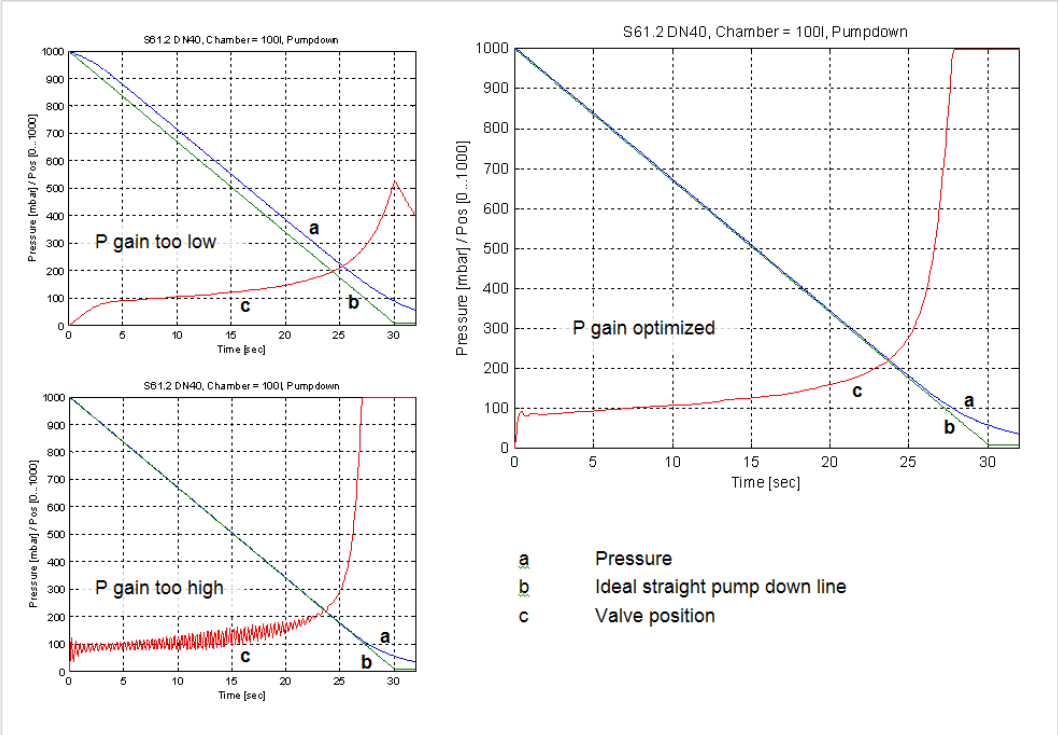
WE start by setting the P gain to 1.0 as a trial value and adjust according to the response.
The pump down routine has to be controlled as follows:

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

4.9 CC-Link interface commands

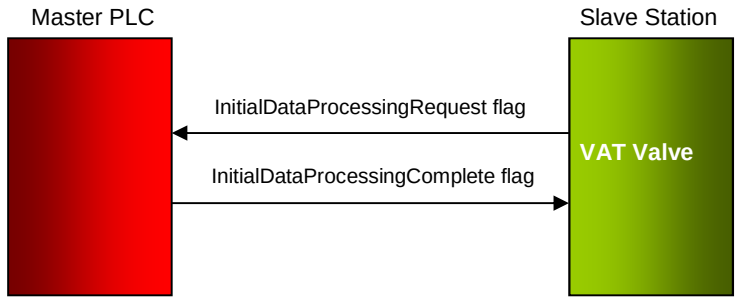
4.9.1 CC-Link Handshaking

Before the CC-Link slave station (VAT valve) can be operated by the CC-Link Master (PLC), handshaking is necessary. If the handshake is not done, no data from the master will be transmitted to station.

An indication of a successful handshaking is the bit «FIELDBUS DATA VALID» (= 1) in the input buffer > GENERAL STATUS.

The CC-Link “Network failure” is independent of the CC-Link handshaking. That means the “Network failure” is inactive if the handshaking is not done yet.

Procedure:

<table>
<tr>
<td>1. If the network parameter are correct the slave station will set the bit ’Initial data processing request flag’.
2. The master have to answer the request with the bit ’Initial data processing complete flag’.</td>
<td> 
</td>
</tr>
<tr>
<td>3. Now the station sets the bit ’Remote READY’. That means the normal operation mode.</td>
<td> 
</td>
</tr>
</table>

The Flag ‘Remote READY’ from slave station must be set for normal operation.

4.9.2 Location of the handshaking bits

Slave → Master		Master → Slave	
Device	*Signal name*	*Device No.*	*Signal name*
RX m0	Not used	RY m0	Not used
RX m1		RY m1	
RX m2		RY m2	
RX m3		RY m3	
RX m4		RY m4	
RX m5		RY m5	
RX m6		RY m6	
RX m7		RY m7	
RX m8		RY m8	
RX m9		RY m9	
RX mA		RY mA	
RX mB		RY mB	
RX mC		RY mC	
RX mD		RY mD	
RX mE		RY mE	
RX mF		RY mF	
to		to	
RX(m+n)0	Reserved	RY(m+n)0	Reserved
RX(m+n)1		RY(m+n)1	
RX(m+n)2		RY(m+n)2	
RX(m+n)3		RY(m+n)3	
RX(m+n)4		RY(m+n)4	
RX(m+n)5		RY(m+n)5	
RX(m+n)6		RY(m+n)6	
RX(m+n)7		RY(m+n)7	
RX(m+n)8	Initial data processing request flag	RY(m+n)8	Initial data processing complete flag
RX(m+n)9	Initial data setting complete flag	RY(m+n)9	Initial data setting request flag
RX(m+n)A	Error status flag	RY(m+n)A	Error reset request flag
RX(m+n)B	Remote READY	RY(m+n)B	Reserved
RX(m+n)C	Reserved	RY(m+n)C	
RX(m+n)D		RY(m+n)D	
RX(m+n)E		RY(m+n)E	
RX(m+n)F		RY(m+n)F	

Table 1: Bit Memory Map Profile of VAT CC-Link slave

m: Address assigned to the master module by the station number setting. This means that the address range for this slave begins at address m of the master.

n: Dependent on the VAT Operational settings mode (number of occupied stations and number of extension cycles)

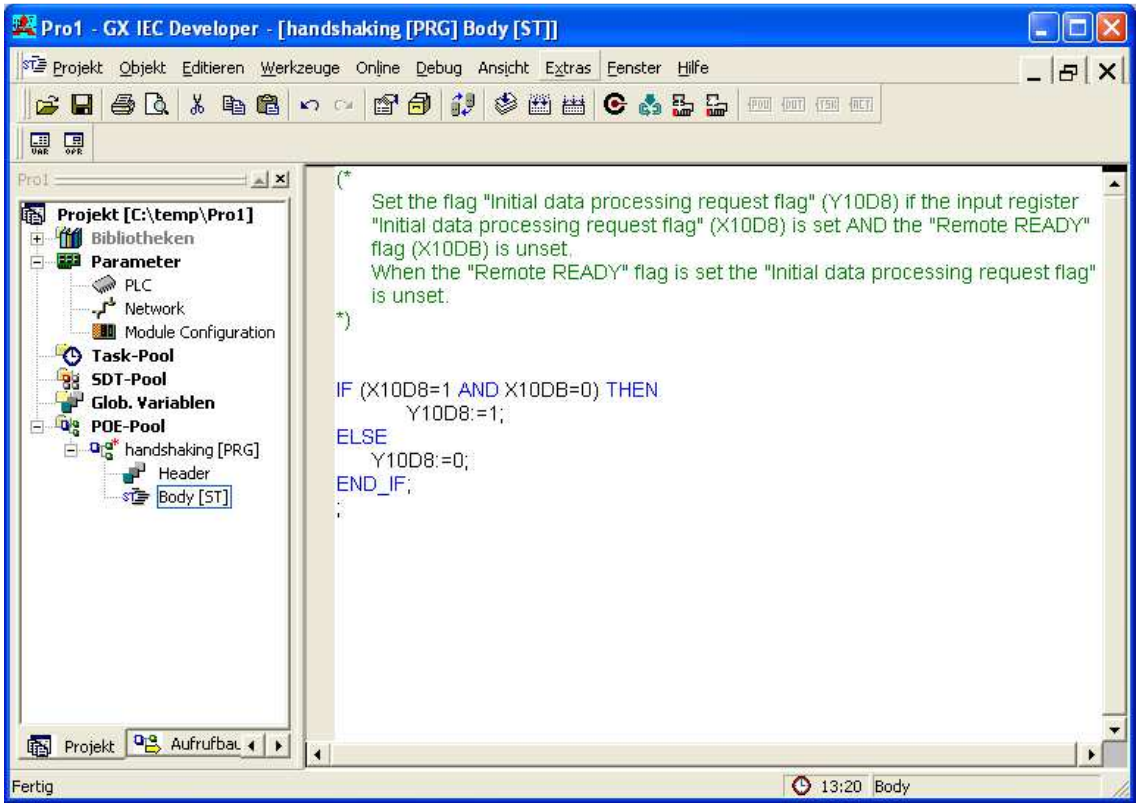
- Operational settings mode = 1 → n = 0x7 (hex)
- Operational settings mode = 4 → n = 0xD (hex)

Example see chapter: 4.7.3 Example of the handshaking by a **PLC-program**.

4.9.3 Example of the handshaking by a PLC-program

The following program sends an answer to the VAT CC-Link station which return a “Remote READY” flag. It is important to correct register address is used. In this example the address for this slave station (valve) starts at 1000 (hex). So m = 100 (see capture: Location of the handshaking **bits**). The Operational setting mode of the slave is 4 – therefore n = D.

Table 1 said RX(m+n)8 for the location of the ’Initial data processing request flag’. So the address X10D8 is used. For the ’Remote Ready’ flag the address RX(m+n)B = X10DB is used.



4.10 CC-Link interface (Process data – cyclic communication)

- The buffer naming is in view from customer (master) PLC.
- Data format: All signals are transmitted and received in intel format (low byte first).
- All one-byte signals use the least significant byte (LSB).

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

4.10.1 OUTPUT Buffer (Master PLC)

4.10.1.1 Overview

Data model	Index	Buffer	
		Contents (MSB)	**Contents (LSB)**
16 bit (Word)	0	Pressure setpoint	
	1		
	2	Position setpoint	
	3		
	4	*Not used – reserved*	
	5		
	6		
	7		
	8		
	9		
	10	*Not used – reserved*	Control mode setpoint
	11	General control setpoint	
	12	*Not used – reserved*	
	13		
	14		
	15		
	16	*Not used – reserved*	
	17		
	18	*Not used – reserved*	*Not used – reserved*
	19	*Not used – reserved*	
	20	*Not used – reserved*	*Not used – reserved*

For data consistency make sure your master PLC is supporting “block guarantee of cyclic data per station”.

4.10.1.2 Details

Signal Type	Name	Start Word	Byte Length	Data Type	Valid Range	Description
Signal	**PRESSURE SETPOINT**	0	4	signed integer (default) or floating point	0..1'000'000 (default), adjustable[1)]	In case of the valve is is pressure mode (**CONTROL MODE** = Pressure (5)), the signal is used as setpoint value.
Signal	**POSITION SETPOINT**	2	4	signed integer (default) or floating point	0..100'000 (default), adjustable[1)]	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"
Signal	**CONTROL MODE SETPOINT**	10	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**	11	2	boolean array	-	See bitmap table below
-	**NOT USED (reserved)**	16	4	-	-	-
-	**NOT USED (reserved)**	18	1	-	-	-
-	**NOT USED (reserved)**	19	1	-	-	-
-	**NOT USED (reserved)**	20	1	-	-	-

1) To adjust range refer to chapter: «Range of pressure and position values»

GENERAL CONTROL SETPOINT bitmap table:

<table>
<tr><th colspan="2">Bit</th><th>Description</th></tr>
<tr><td>0</td><td>ZERO</td><td>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…+1.4! Otherwise the sensor must be adjusted!</td></tr>
<tr><td>1</td><td>NOT USED (reserved)</td><td>-</td></tr>
<tr><td>2</td><td>PING PONG TX BIT</td><td>PING PONG TX BIT transmitted from the master (PLC), is used to check the loop "master PLC - VAT station". See chapter: 3.11.9 Communication and timing control between Master (PLC) and Station (Valve)</td></tr>
<tr><td>3</td><td>NOT USED (reserved)</td><td>-</td></tr>
<tr><td>4</td><td>ACCESS MODE LOCKED</td><td>
<table>
<tr><th>Start mode</th><th>Access mode locked bit</th><th>End mode</th></tr>
<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>
</table>
Example:
1. from local to locked
• 1st step : set bit (0→1)

2. from local to remote
• 1st step : set bit (0→1)
• 2nd step: reset bit (1→0)

3. from remote to locked
• 1st step : set bit (0→1)

4. from locked to remote
• 1st step : reset bit (1→0)
</td></tr>
<tr><td>5-15</td><td>NOT USED (reserved)</td><td>-</td></tr>
</table>

4.10.2 INPUT Buffer (Master PLC)

4.10.2.1 Overview

Data model	Index	Buffer	
		Contents (MSB)	Contents (LSB)
16-Bit (Word)	0	Pressure	
	1		
	2	Pressure Sensor 1	
	3		
	4	Pressure Sensor 2 (optional, only in case of 2 sensor version)	
	5		
	6	Position	
	7		
	8	*Not used – reserved*	
	9		
	10	*Not used – reserved*	Control mode
	11	Fatal error	
	12	*Not used – reserved*	
	13		
	14		
	15		
	16	General status	
	17	General warnings	
	18	Extended warnings	
	19	*Not used – reserved*	*Not used – reserved*
	20	*Not used – reserved*	
	21		
	22	*Not used – reserved*	*Not used – reserved*
	23	*Not used – reserved*	
	24	*Not used – reserved*	

4.10.2.2 Details

Signal Type	Name	Start Word	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[1)]	*In case of default valid range:* 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**	2	4	signed integer (default) or floating point	-270000.. 1'230'000 (default) (-2.7V..12.3V sensor signal), adjustable[1)]	*In case of default valid range:* Physical full scale value of the sensor (10 Volt) equals to 1'000'000.
Signal	**PRESSURE SENSOR 2**	4	4	signed integer (default) or floating point	-270000.. 1'230'000 (default) (-2.7V..12.3V sensor signal), adjustable[1)]	*Optional, only in case of 2 sensor version.* *In case of default valid range:* Physical full scale value of the sensor (10 Volt) equals to 1'000'000.
Signal	**POSITION**	6	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**	10	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**	11	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**	16	2	boolean array		See bitmap table below
Bitmap	**GENERAL WARNING**	17	2	boolean array		See bitmap table below

Signal Type	Name	Start Word	Byte Length	Data Type	Valid Range	Description
Bitmap	**EXTENDED WARNING**	18	2	boolean array		See bitmap table below
-	**NOT USED (reserved)**	19-22	1	-	-	-
-	**NOT USED (reserved)**	23-24	1	-	-	-

1) To adjust range refer to chapter: «Range of pressure and position values»

GENERAL STATUS bitmap table:

Bit		Description
0	**FIELDBUS DATA VALID**	**0** = Valve is not ready for communication (has not received the rising edge of "Initial Data Processing Complete") **1** = Valve is ready for communication (has received the rising edge of "Initial Data Processing Complete")
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: 4.8.3 **Communication and timing control between Master (PLC) and Slave (VAT-Valve)**
3	**PRESSURE SIMULATION**	**0** = off **1** = on
4	**PRESSURE SETPOINT REACHED**	**0** = The actual pressure is not within 2% of the pressure setpoint **1** = The actual pressure is within 2% of the pressure setpoint
5-6	**NOT USED (reserved)**	-
7-8	**ACCESS MODE**	**bit 8** **bit 7** 0 0 = LOCAL 0 1 = REMOTE 1 0 = LOCKED
9	**WARNINGS ACTIVE**	**0** = No WARNINGS **1** = At least one WARNING of the warning bitmaps is active (GENERAL WARNING bitmap and EXTENDED WARNING bitmap)
10-15	**NOT USED (reserved)**	-

GENERAL WARNING bitmap table:

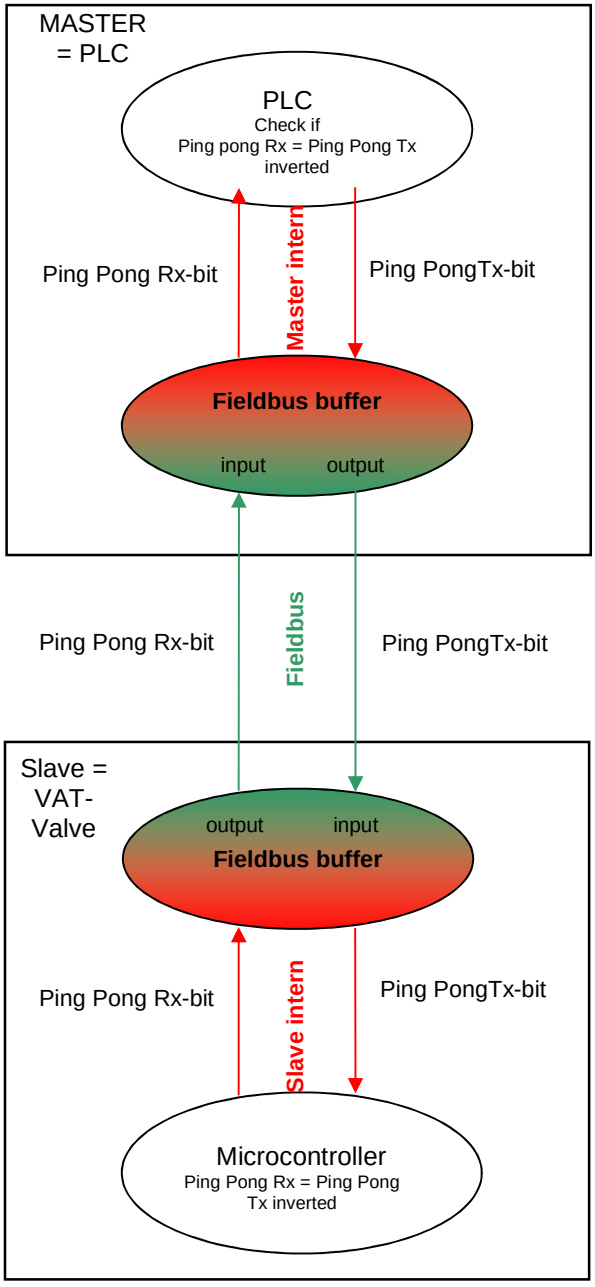
Bit		Description
0	**SERVICE REQUEST**	Valve movement tight
1	**LEARN DATA SET**	Learn data not present. Learn required for adaptive pressure control.
2	**NOT USED (reserved)**	-
3	**POWER FAILURE BATTERY**	Not ready, voltage too low
4	**SENSOR OVERLAPPING**	Sensor deviation between sensor 1 and sensor 2 >= ±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 acces 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 (for example control mode is interlock or fatal error)
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)**	-

4.10.3 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.

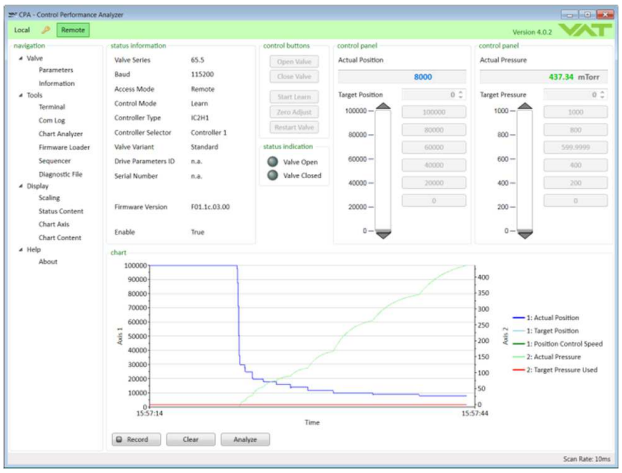
5.1 Normal operation

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



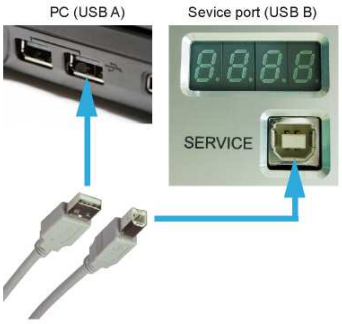
In case ‘Control Performance Analyzer’ is used, make sure ‘Remote’ button is pushed to enable for remote operation.

5.1.2 Local operation

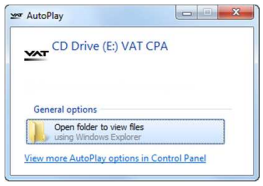
Local operation means that the valve is operated via the service port using a computer.
You can use our software 'Control Performance Analyzer' for Local operation, which is integrated in the controller. The software is beneficial especially for setup, testing and maintenance.

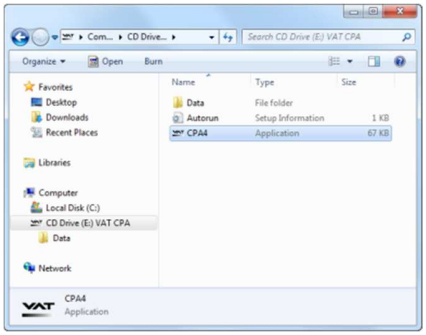
How to start:

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

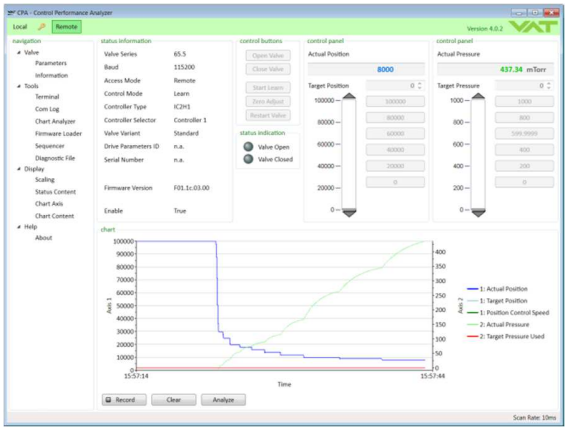


A drive opens:





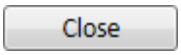
2. Double Click on ‘CPA.exe’ to open the ‘Control Performance Analyzer’



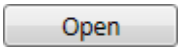
3. Click [Local] for Local operation to do configurations

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

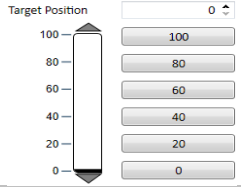
Local operation: CPA	**Remote operation**: (Refer to chapter «OUTPUT Buffer» > «CONTROL MODE SETPOINT» for details)
Push  button	1. «OUTPUT Buffer» > «CONTROL MODE SETPOINT» 2. Select [Close] (value = 3)

5.3 Open valve

Local operation: CPA	**Remote operation**: (Refer to chapter «OUTPUT Buffer» > «CONTROL MODE SETPOINT» for details)
Push  button	1. «OUTUT Buffer» > «CONTROL MODE SETPOINT» 2. Select [Open] (value = 4)

5.4 Position control

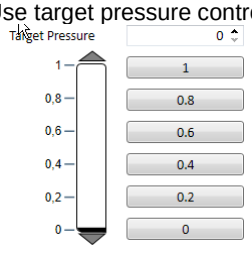
The valve position is directly controlled according to the position setpoint.

Local operation: CPA	**Remote operation**: (Refer to chapter «OUTPUT Buffer» > «POSITION SETPOINT» for details)
Use target position control 	1. In «OUTPUT Buffer» > « POSITION SETPOINT» 2. Select a valid value 3. In «OUTPUT Buffer» > «CONTROL MODE SETPOINT» 4. Select [Position] (value = 2)

5.5 Pressure control

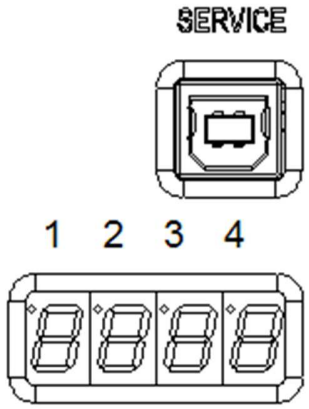
To prepare valve for PRESSURE CONTROL perform complete «Setup procedure». The valve has parameters that may be modified to tune pressure control performance. Refer to «Tuning of control performance».

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)
Use target pressure control 	1. In «OUTPUT Buffer» > «PRESSURE SETPOINT» 2. Select valid value 3. In «OUTPUT Buffer» > « CONTROL MODE SETPOINT» 4. 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
● 1st Power On: All dots are illuminated	#	#	#	#
● 2nd Valve series e.g. **67.0**		**6**	**7**	**0**
● 3rd Firmware: generation.type e.g. **01.0C**	**0**	**1**	**0**	**C**
● 4th Firmware: version.firmware e.g. **07.00**	**0**	**7**	**0**	**0**
● 5th 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.**			

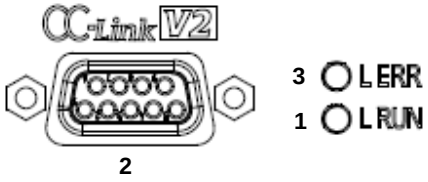
5.6.3 Error

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 CC-Link LEDs

#	Item
1	Run LED
2	CC-Link Interface connector
3	Error LED



RUN LED (1)

State	Meaning
Off	No network participation, timeout status (no power)
Green	Participating, normal operation
Red	Major fault (FATAL error)

ERR LED (3)

State	Meaning
Off	No error detected (no power)
Red	Major fault (Exception or FATAL event)
Red, flickering	CRC error (temporary flickering)
Red, flashing	Station Number or Baud rate has changed since startup (flashing)

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) 653 . . - . . **G** . - . . . . 653 . . - . . **A** . - . . . . 653 . . - . . **T** . - . . . . 653 . . - . . **V** . -	With Power Failure Option (PFO) 653 . . - . . **H** . - . . . . 653 . . - . . **C** . - . . . . 653 . . - . . **U** . - . . . . 653 . . - . . **W** . - . . . .
Closed (isolated)	Valve remains closed.	Valve will close or open depending on valve configuration[1)]. Default is not defined. Display indicates **F**.
Valve open or in any intermediate position	Sealing ring moves down and blocks the pendulum plate at the current position.	

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

⚠ CAUTION

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.

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

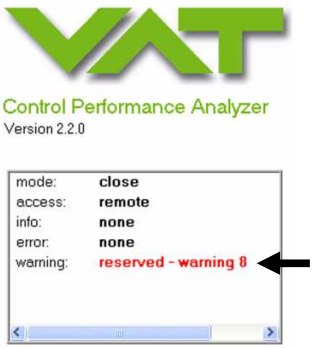
Code *u* *v* *w*	Description	Solution
1	No valve connected	Connect valve controller to the valve
2	Non volatile memory failure	Replace valve controller
3	Analog digital converter of sensor input failure	Replace valve controller
4	Initialization of motion controller failed	• Wrong motion controller firmware version → Update motion controller firmware
5	Encoder index pulse not found	• Encoder failure • O-Ring sticking • 1)
6	Initialization of interface module failed	• 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	• Check cables
1 0	Closing position can't be reached	• 1)
1 1	Homing position can't be reached	• 1) • Plate not mounted
1 2	Motion controller: Internal voltage error	• Check power supply
1 3	Motion controller: Internal error temperature	• Check for a heat accumulation
1 4	Motion controller: Unexpected behavior	Contact vat support • Axis inverted • Encoder not connected • Break not released

Code *u v w*	Description	Solution
1 5	Motion controller: Target position can't be reached	• 1) • Current settings
1 6	Motion controller: Position minimal conductance cannot be reached	• 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	• 1) • Check Different Plate • Check Parameter "Differential Plate Push Back Position [r]"
1 8	Motion controller: Minimal isolation position cannot be reached	• 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	• 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 Additional CC-Link warning

Failure detection with CPA or CV software	Check	Action
Network failure: No CC-Link communication is active (warning 8) 	- CC-Link cable ok? - Connection to master ok?	- Check CC-Link cable. - Check the CC-Link 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

⚠ 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. Disconnect power on controller before doing any work.

⚠ CAUTION

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.

NOTICE

Contamination

Gate and other parts of the valve must be protected from contamination.

Always wear clean room gloves when handling the valve.

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

Vacuum grease

Vacuum grease may be distributed and contaminate the valve.

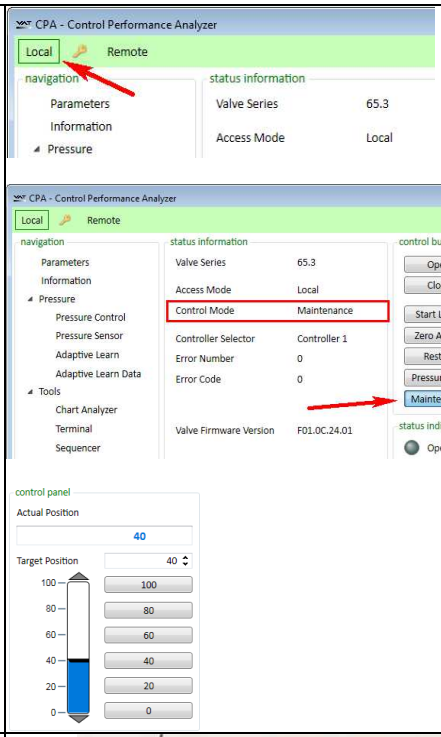
Prevent gap between body and sealing ring from air gun cleaning. Do not clean the gap between body and sealing ring with compressed air.

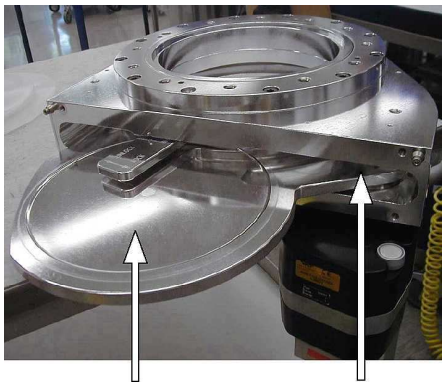
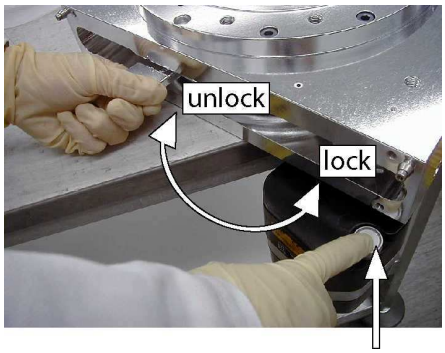
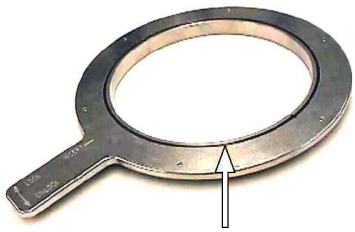
See figure below:

7.2.1 Replacement of isolation seals and valve cleaning

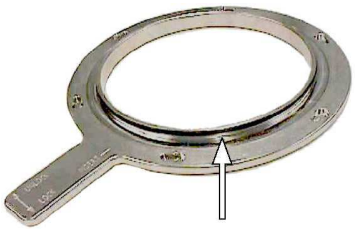
7.2.1.1 Required tools

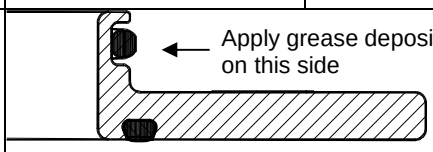
- Allen Wrench 5mm
- Open end wrench 13mm
- Service cable USB Type A to B (PC to valve Service connector)
- Clean room wiper
- Vacuum grease (see chapter spare parts)
- O-ring removal tool (see chapter Accessories)
- Isopropyl alcohol

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

Description		Required tool
5. Open valve Stand away from valve – pendulum plate moves out of the valve body. 6. Unfasten mounting screw for pendulum plate. 7. Remove pendulum plate.	 pendulum plate mounting screw for pendulum plate	Open end wrench 13mm
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. 9. Release MAINTENANCE BUTTON. 10. Remove sealing ring. 11. To prevent the shaft and retaining pins from moving during work, switch the valve to safety mode. Refer to «Safety mode» for details. Retaining pins will move up.	 maintenance button	
12. Remove gate and body o-ring from sealing ring carefully with a soft tool. 13. Remove grease residues at sealing ring with alcohol. Clean sealing ring and pendulum plate with alcohol or in an ultrasonic bath. 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.	 gate seal	

<table>
<tr><th colspan="3">Description</th><th>Required tool</th></tr>
<tr><td colspan="2">Do not directly expose seals (actuator and retaining pin feedthroughs) to air stream!

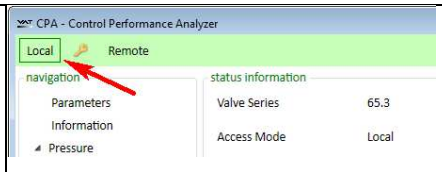
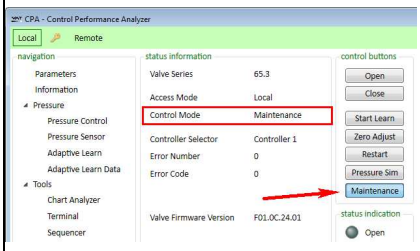
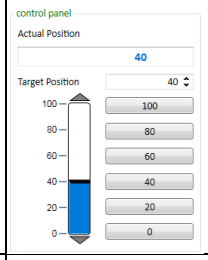
15. Clean or replace gate seal if necessary. Install gate o-ring to sealing ring without grease.</td><td colspan="2"> 
body seal</td><td></td></tr>
<tr><td colspan="2" rowspan="5">16. Clean or replace body seal if necessary.
Lubricate body with the quantity of vacuum grease listed in the table to the right.</td><td>Valve size</td><td>Quantity of grease [ml]</td><td rowspan="5">Soft tool (o-ring remover)

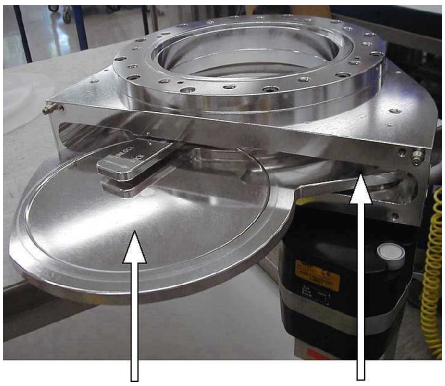
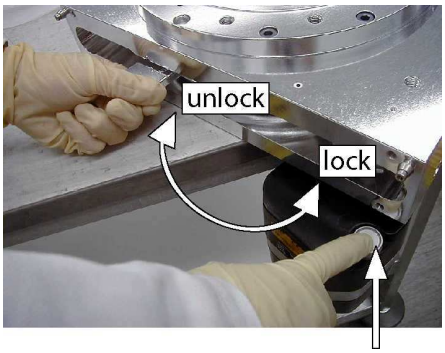
Vacuum grease</td></tr>
<tr><td>DN 100</td><td>0.1</td></tr>
<tr><td>DN 160</td><td>0.15</td></tr>
<tr><td>DN 200</td><td>0.2</td></tr>
<tr><td>DN 250</td><td>0.2</td></tr>
<tr><td colspan="2">17. Install body seal into sealing ring.</td><td colspan="2"></td><td></td></tr>
<tr><td colspan="2" rowspan="5">18. 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.</td><td>Valve size</td><td>Quantity of grease [ml]</td><td rowspan="5">Vacuum grease</td></tr>
<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>
<tr><td colspan="2"></td><td colspan="2"> 
Apply grease deposit on this side</td><td>Vacuum grease</td></tr>
<tr><td colspan="2">19. Reassembly the valve in reverse order, step 9…3.
20. Close the valve bonnet, see steps 31…33.</td><td colspan="2"></td><td></td></tr>
<tr><td colspan="2">21. Mount valve bonnet.
• Tightening torques for bonnet screws, see in table to the right.</td><td colspan="2">Max. torque 6 Nm</td><td>Allen wrench 5mm</td></tr>
<tr><td colspan="2">22. To leave the maintenance mode press “Restart” button or power cycle the controller.
23. Set the valve to remote mode</td><td colspan="2"></td><td>CPA & Service cable (PC to valve Service connector)</td></tr>
</table>

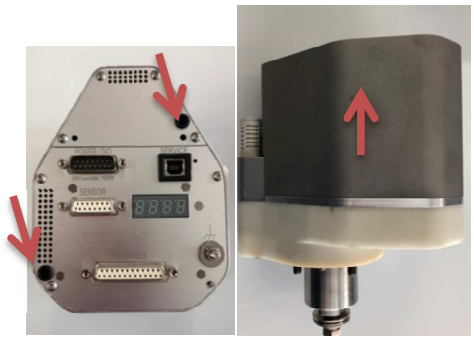
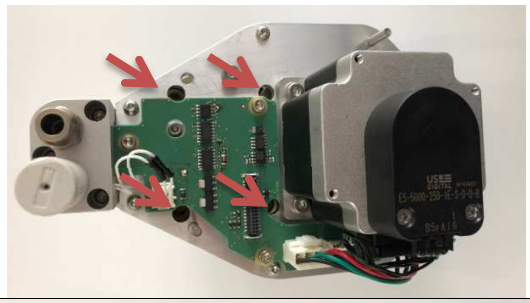
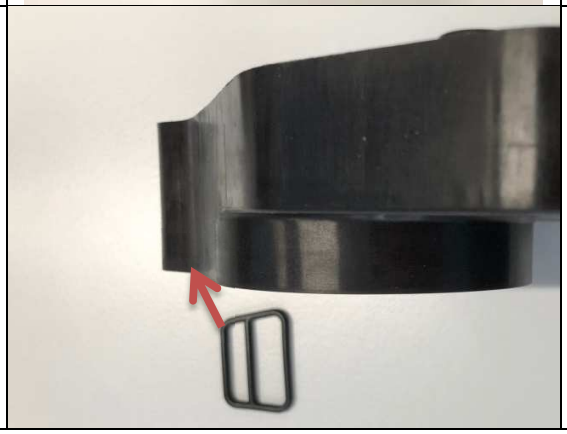
7.2.2 Replacement of actuator shaft seals

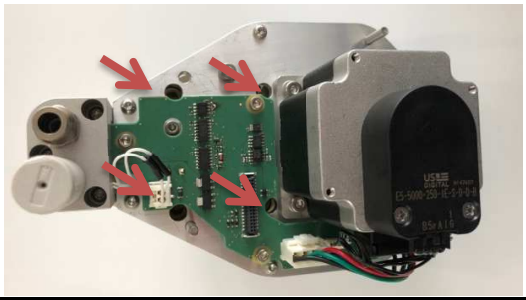
7.2.2.1 Required tools

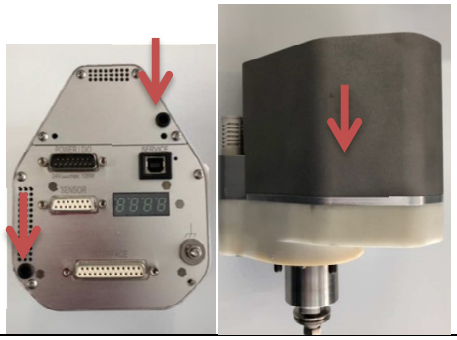
- Allen Wrench 2mm
- Allen Wrench 4mm
- Allen Wrench 5mm
- O-ring removal tool (see chapter Accessories)
- Vacuum grease (see chapter spare parts)
- Open end wrench 13mm
- Clean room wiper
- Isopropyl alcohol
- Service cable USB Type A to B (PC to valve Service connector)

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

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

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

Description		Required tool
19. Remove actuator shaft seals carefully with a soft tool. 20. Clean actuator feedthrough with alcohol. 21. Lubricate each o-ring groove with 0.1 ml vacuum grease. Pay attention that grease is distributed constantly over the whole circumference.	 	Soft tool (o-ring remover) Vacuum grease
22. Clean or replace seals if necessary. Lubricate each o-ring with 0.05 ml vacuum grease. 23. Install o-rings. 24. Deposit 0.1 ml vacuum grease on each o-ring. Pay attention that grease is distributed constantly over the whole circumference.		Vacuum grease
25. Remove fixation kit and mounting screw for pendulum plate. 26. Clean screw and slightly lubricate thread. Then reinstall fixation kit. 27. Clean actuator shaft and lubricate it with 0.1 ml vacuum grease.		Vacuum grease
28. Install actuator • Tighten actuator screws with 10 Nm. • Remove vacuum grease from actuator shaft face after installation.		Allen Wrench 5mm

29. Install controller • Tighten the controller screws with 3 Nm. • Connect cables at controller • Connect compressed air at actuator		Allen Wrench 4mm
30. Turn on power of controller. Valve moves to close position. 31. Open valve and install sealing ring and pendulum plate in reverse order as they had been disassembled (steps 11 to 2).		open end wrench 13mm
32. Clean the valve sealing surface		Lint-and dust-free towel a little soaked with isopropyl alcohol
33. Clean the valve bonnet o-ring		Lint-and dust-free towel
34. Mount valve bonnet. • Tightening torques for bonnet screws, see in table to the right.	**Max. torque 6 Nm**	Allen wrench 5mm
35. To leave the maintenance mode press “Restart” button or power cycle the controller. 36. Set the valve to remote mode		CPA & Service cable (PC to valve Service connector)

7.2.3 Replacement of Option board

NOTICE

Electrostatic discharge

Electronic components could be damage.

All work on the control and actuating unit has to be done under ESD protected environment to prevent electronic components from damage.

NOTICE

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.

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

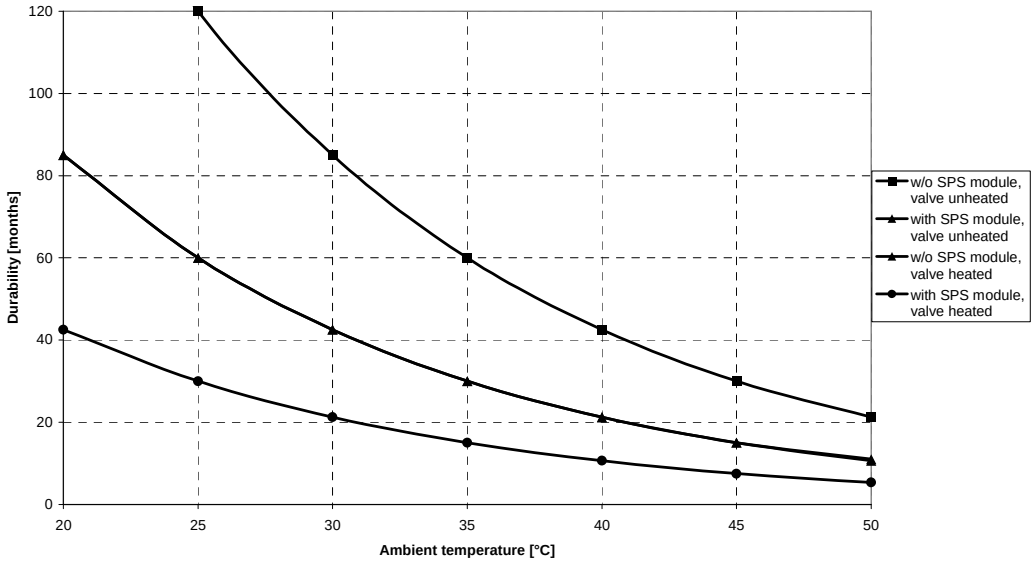
The modules may be retrofitted or replaced easily. The battery lifetime of the PFO module depends on the ambient temperature (see below). To assure PFO function the option board must be replaced after battery life has expired. For ordering number of the modules refer to chapter «Spare parts».

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.

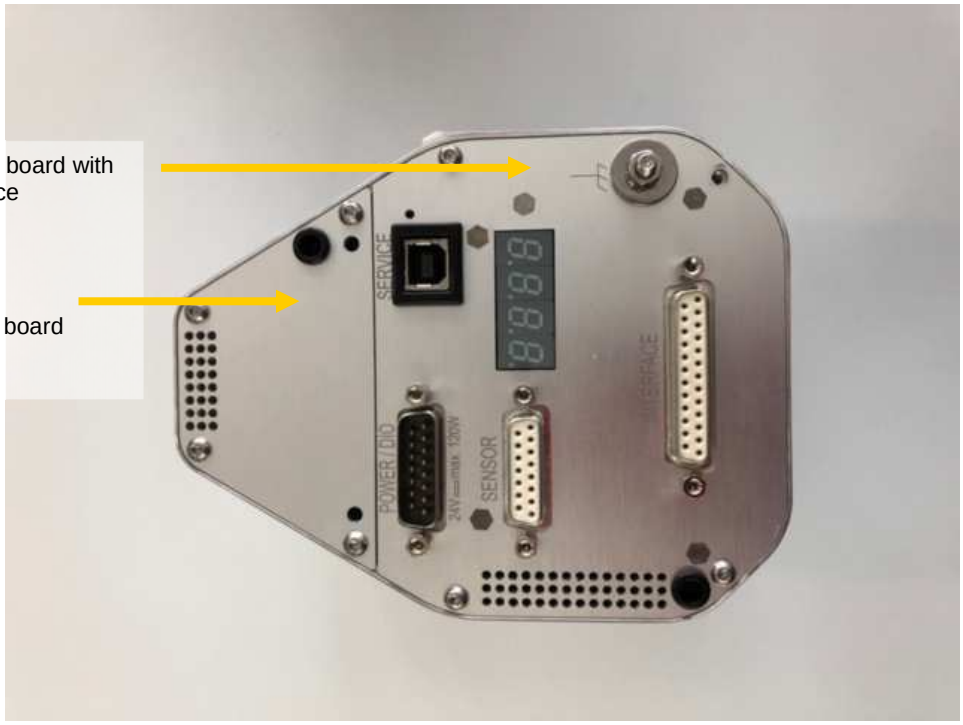
Therefore please determine the equivalent maintenance period for replacing the Ultra Cap battery (Option board).



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

7.2.4 Retrofit / replacement procedure

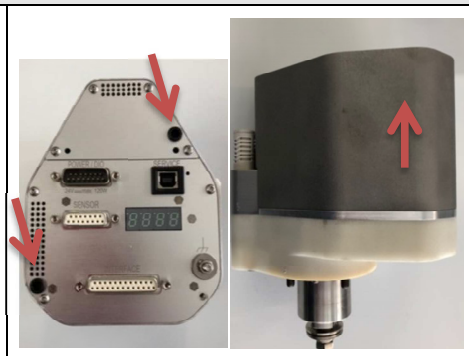
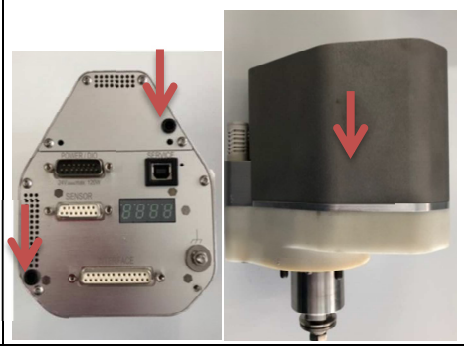
Top view on control and actuating unit with panel removed:



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
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.		Allen Wrench 4 mm
3. Place Option board from behind in the controller. 4. Tighten option board with the 2 screws with 1.1Nm.	5. 	Pozidriv screw driver size 1
6. Fasten all 2 controller screws and lift controller carefully from actuator. 7. Connect cables and compressed air to valve actuator.		Allen Wrench 4mm

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 dismounting the valve.

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

9.2 Storage

NOTICE

Wrong storage

Inappropriate temperatures and humidity may cause damage to the product.

Valve must be stored at:
– relative humidity between 10% and 70%
– temperature between +10 °C and +50 °C
– non-condensing environment

NOTICE

Inappropriate packaging

Product may get damaged if inappropriate packaging material is used.

Always use the original packaging material and handle product with care.

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

Unqualified personnel

Inappropriate handling may cause serious injury or property damage.

Only qualified personnel are allowed to carry out the described work.

⚠ WARNING

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.

NOTICE

Inappropriate packaging

Product may get damaged if inappropriate packaging material is used.

Always use the original packaging material and handle product with care.

- 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

Valve in open position

Valve mechanism may get damaged if valve is in open position.

Make sure that the valve is closed.

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

Inappropriate packaging

Product may get damaged if inappropriate packaging material is used.

Always use the original packaging material and handle product with care.

VAT disclaims any liability for damages resulting from inappropriate packaging.

11 Disposal

Observe the local regulations for disposal

⚠ WARNING

Harmful substances

Environmental pollution.

Discard products and parts according to the local regulations.

⚠ WARNING

Unqualified personnel

Inappropriate handling may cause serious injury or property damage.

Only qualified personnel are allowed to carry out the disposal.

⚠ CAUTION

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.

- Observe local regulations in regard to waste disposal without fail.
- Commission an authorized waste disposal company for the professional disposal of your waste.

NOTICE

Improper disposal

Some built-in materials can cause damage, if improperly handled**.**

- When disposing, take into account all the different materials used

- 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

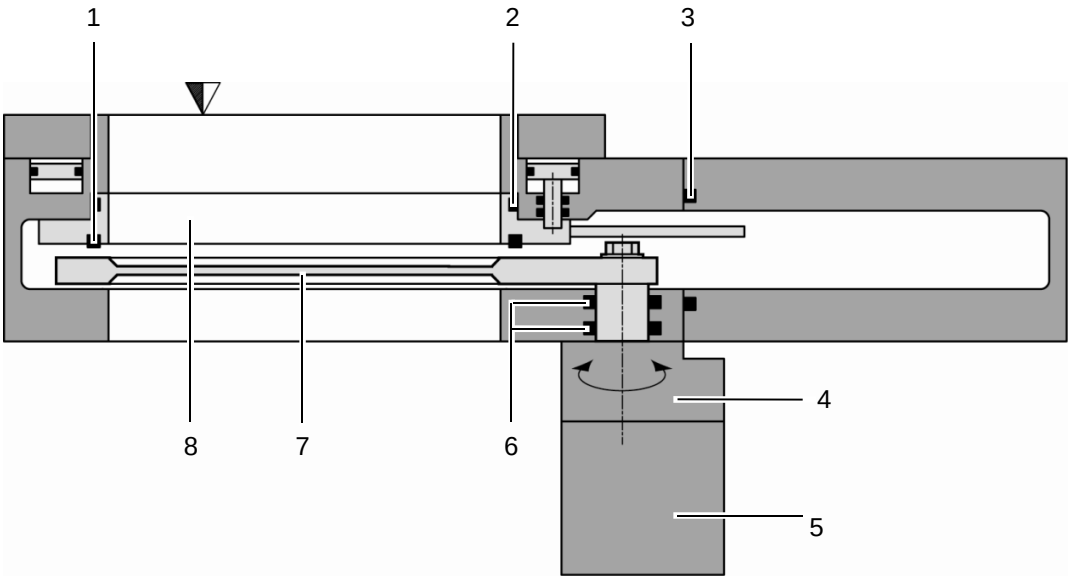
Non-original spare parts

Non-original spare parts may cause damage to the product.

Use original spare parts from VAT only.

- 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»

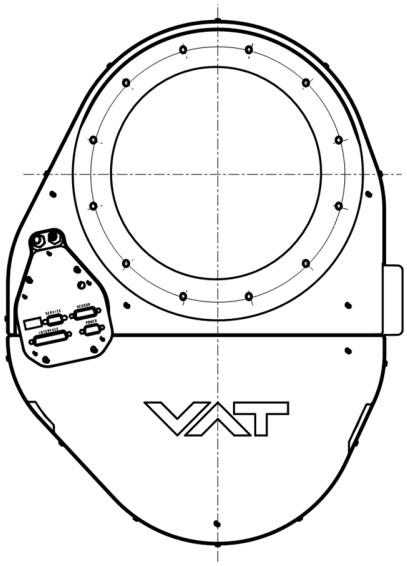
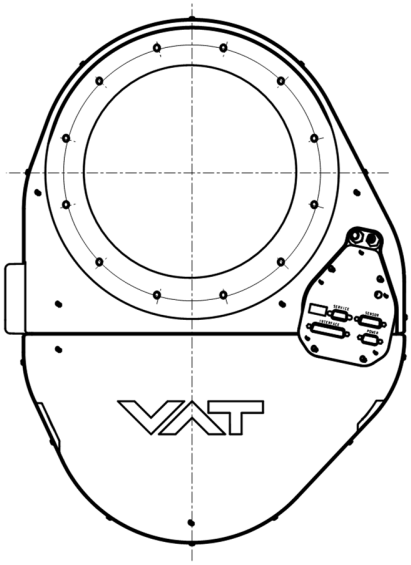
12.1.1 Valve unit with seals and grease

Item	Description				
	Valve size **Valve part number**	**DN100** **65340 - . . . . - . . . .**	**DN160** **65344 - . . . . - . . . .**	**DN200** **65346- . . . . - . . . .**	**DN250** **65348 - . . . . - . . . .**
1	Gate seal Viton 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 seal Viton 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:

Valve with **B1** actuator (standard)	Valve with **B2** actuator (option)
	

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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