Installation, Operating & Maintenance Instructions

Control gate valve
with Logic interface

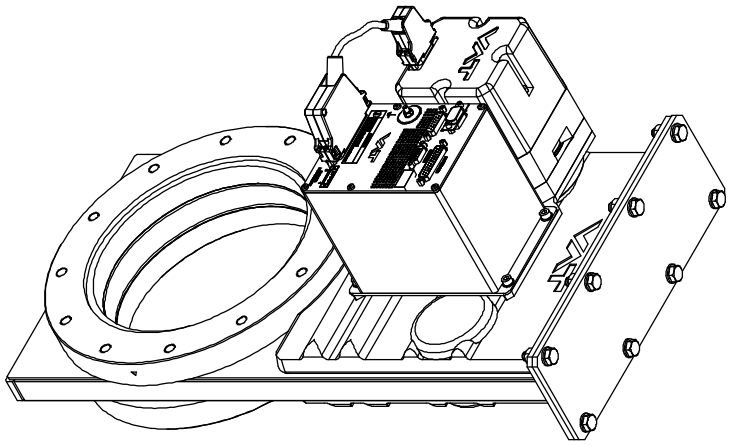
Series 642
DN 63-400 mm (I.D. 2.5“ - 16")

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

642 . . - . .GC-	(1 sensor input)
642 . . - . .GE-	(2 sensor inputs)
642 . . - . .AC-	(1 sensor input / ±15V SPS)
642 . . - . .AE-	(2 sensor inputs / ±15V SPS)
642 . . - . .HC-	(1 sensor input / PFO)
642 . . - . .HE-	(2 sensor inputs / PFO)
642 . . - . .CC-	(1 sensor input / ±15V SPS / PFO)
642 . . - . .CE-	(2 sensor inputs / ±15V SPS / PFO)

SPS = Sensor Power Supply PFO = Power Failure Option

configured with firmware **600P.1G.00.06…08**



Sample picture

Imprint

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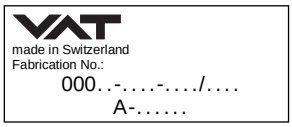
Contents

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 control gate 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)** [642 . . - . . **A** . - . . . . / 642 . . - . . **G** . - . . . .] [642 . . - . . **C** . - . . . . / 642 . . - . . **H** . - . . . .]	+24 VDC (±10%) @ 0.5 V pk-pk max. [connector: POWER] 50 W max. (operation of valve with max. load) without PFO [4] 50 W plus 10 W for PFO [4]
Sensor power supply [2] **(β)** [642 . . - . . **A** . - . . . . / 642 . . - . . **C** . - . . . .] Input Output	 +24 VDC / 1500 mA max. [connector: POWER] ±15 VDC (±5%) / 1000 mA max. [connector: SENSOR]
Sensor power supply [2] **(β)** [642 . . - . . **G** . - . . . . / 642 . . - . . **H** . - . . . .] Input Output	 + 24 VDC resp. ± 15 VDC [connector: POWER] same as input but: [connector: SENSOR] 2.0 A max. at ± 15 VDC 1.5 A max. at + 24 VDC

[1] Internal overcurrent protection by a PTC device.

[2] Refer to chapter «Sensor supply concepts» 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	 0-10 VDC / Ri>100 kΩ 0.23 mV 10 ms	 [connector: SENSOR]
Digital inputs [3]	±24 VDC max.	[connector: INTERFACE]
Digital outputs [3] Input voltage Input current Breaking capacity	 70 VDC or 70 V peak max. 0.5 ADC or 0.5 A peak max. 10 W max.	[connector: INTERFACE]
Analog outputs [3]	0-10 VDC / 1 mA max.	[connector: INTERFACE]
PFO [4] battery pack [642 . . - . . **C** . - . . . . / 642 . . - . . **H** . - . . . .] Charging time Durability	 2 minutes max. up to 10 years @ 25°C ambient; refer to «Durability of power fail battery» for details	
Ambient temperature	0 °C to +50 °C max. (<35 °C recommended)	
Pressure control accuracy	5 mV or 0.1% of setpoint, whichever is greater	

[3] Refer to chapter «Schematics» for details.
[4] PFO = Power Failure Option. Refer to «Behavior in case of power failure» for details.

1.6.2 Valve unit

Description									
Pressure range at 20°C (unheated on delivery) • DN63…200 • DN250…400					1 × 10E-8 mbar to 2.0 bar (abs) 1 × 10E-8 mbar to 1.2 bar (abs)				
Leak rate to outside / seat at 20°C (unheated on delivery)					1 × 10E-9 mbar ls^{-1}				
Differential pressure on the gate • Valve closed - DN63…200 - DN250…400 • During closing / opening					≤ 2.0 bar ≤ 1.2 bar ≤ 30 mbar				
Cycles until first service (unheated and under clean conditions) • Pressure control • Isolation cycles					1'000'000 200'000				
Admissible operating temperature • Valve body • Ambient					≤ 150°C ≤ 50°C				
Mounting position (valve seat to face chamber is recommended) • DN63…350 • DN400					Any Horizontal only (optional in vertical position with extended closing time, fewer cycles)				
Process side materials	body / plate				Stainless steel: 304 (1.4301)				
	other parts				Stainless steel: 301 (1.4310), 304 (1.4301), 420 (1.4034), 420D (1.4037), 430 (1.4016)				
Seals	plate				FKM (e.g. Viton®)				
	rotary feed through				FKM (e.g. Viton®)				
	bonnet				FKM (e.g. Viton®) (DN63…200 vulcanized)				
Operating time (s) for:	**DN 63 2½"**	**DN 80 3"**	**DN 100 4"**	**DN 160 6"**	**DN 200 8"**	**DN 250 10"**	**DN 320 12"**	**DN 350 14"**	**DN 400 16"**
Open / close	4	4	6	6	6	10	10	10	10
Pressure control (throttling)	3	3	3	5	5	9	9	9	9
Min. controllable conductance (ls^{-1}) [N_2 molecular flow]	0.65	0.8	1	1.6	2	2.5	3.2	3.5	4
Max. Conductance (ls^{-1}) [N_2 molecular flow]	440	800	1700	5000	12000	22000	30000	40000	50000
Weight (approx.) kg	14	14	17	28	34	62	112	120	155
Weight (approx.) lbs	31	31	37	62	75	136	246	264	340
Valve position indication					Visual (mechanical and on controller)				
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.

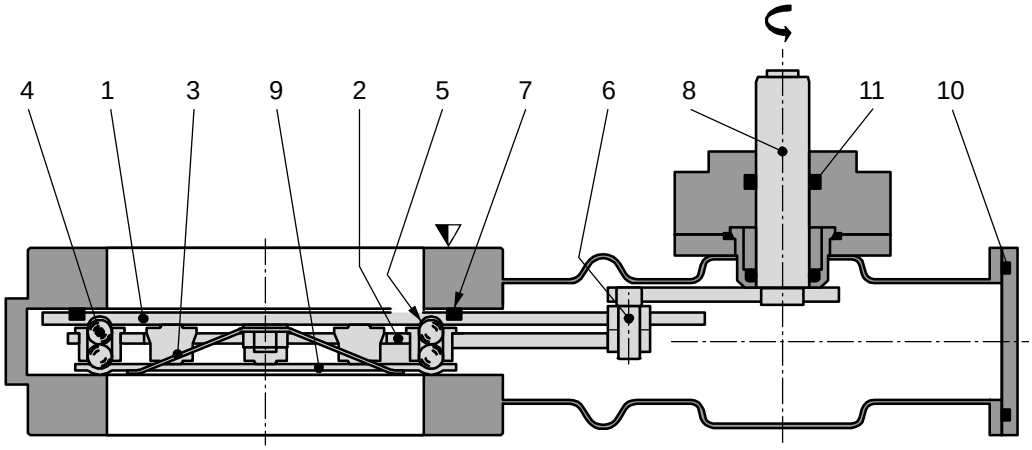
Only qualified personnel are allowed to carry out the described work.

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



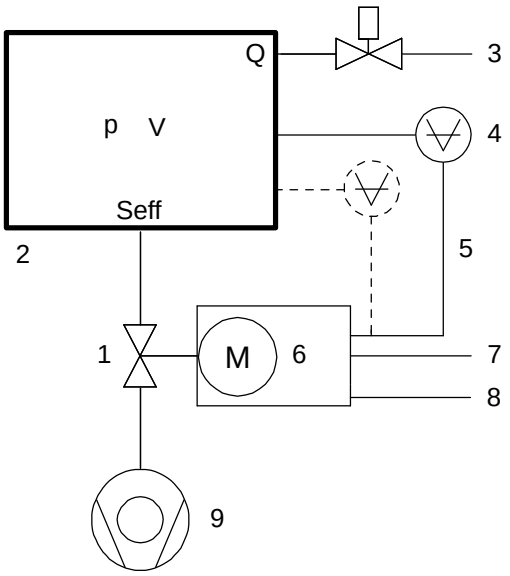
1	Valve gate	7	Gate seal
2	Ball guidance	8	Actuator shaft
3	Leaf spring	9	Counter plate
4	Ball pairs	10	Bonnet seal
5	Detents	11	Rotary feed through seals
6	Crank bolt		

3.2 Function

The valve gate (1) acts as a throttling element and varies the conductance of the valve opening. Actuation is performed with a stepper motor and controller. The stepper motor/controller version ensures accurate pressure control due to exact gate positioning. For leak tight closing the VATLOCK principle is applied. For details refer to VAT catalog.

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)
p Pressure (mbar)

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

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:

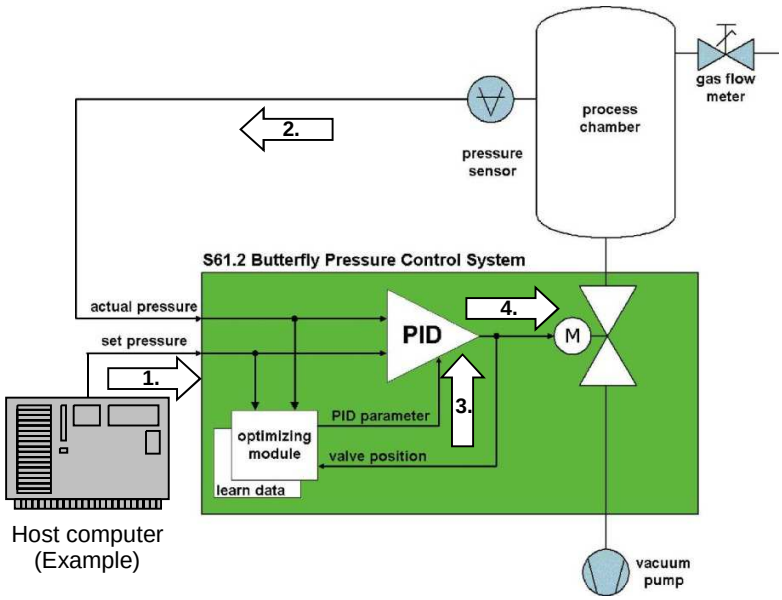
1. Downstream control (standard):
   The pressure is controlled by changing the conductance of a control valve between pump and process chamber. This changes the effective pumping speed at the process chamber. Pressure and gas flow can be independently controlled over a wide range.

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.

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

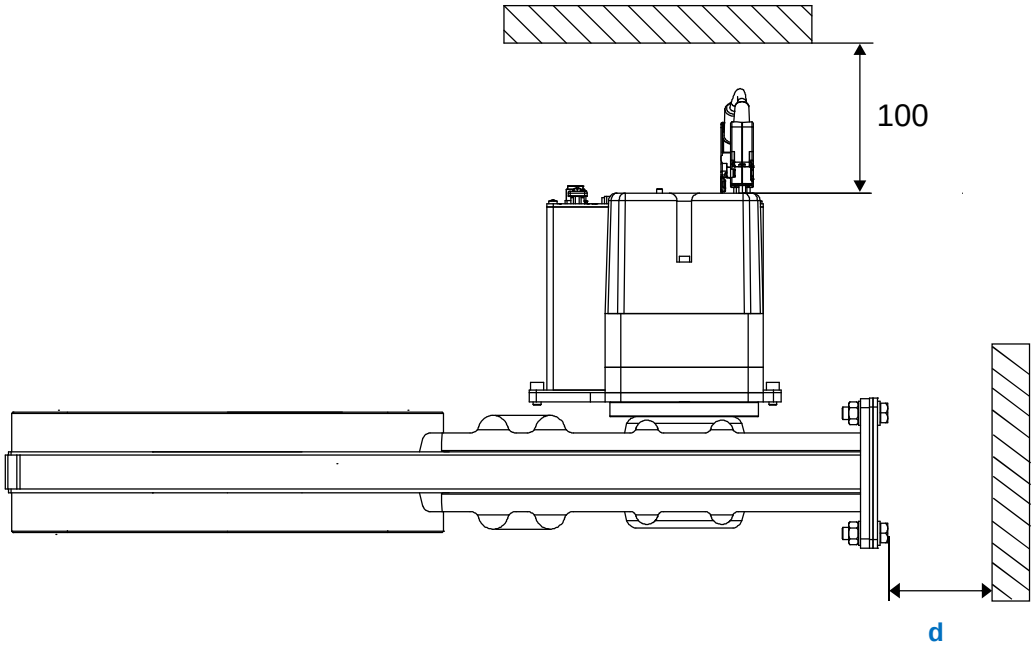
Gate and other parts of the valve must be protected from contamination.

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. (sample picture)

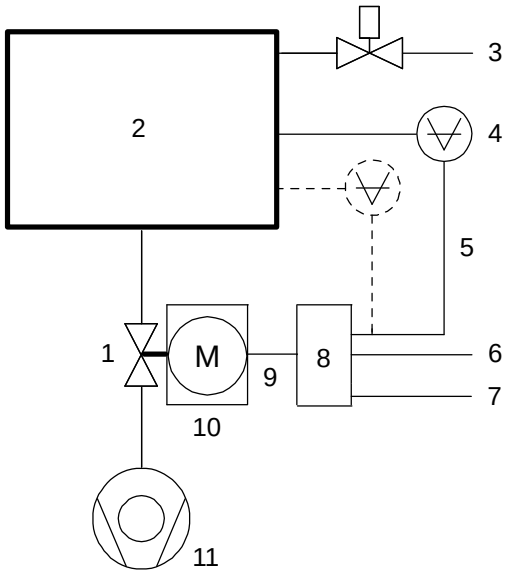


Overview table: DN to required distance (d) for maintenance.

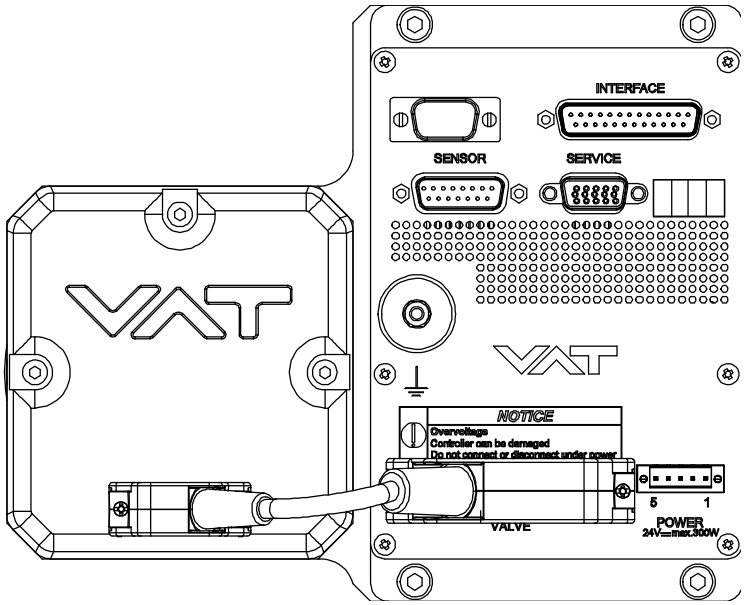
DN	63	80 / 100	160	200	250	320 / 350	400
d	180	220	300	350	450	550	600

4.2.2 Connection overview

System:



1 Valve
2 Process chamber
3 Gas inlet
4 Pressure sensor(s)
5 Sensor cable(s)
6 Cable to Logic remote control unit
7 Cable to power supply
8 Controller
9 Connection cable controller / actuator
10 Actuator
11 Pump



Actuator Controller

4.2.3 Installation procedure

1. Install valve [1] into the vacuum system, with valve seat side to process chamber. The valve seat side is indicated by the symbol "Δ" 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. Install the ground connection cable at controller. Refer to «Electrical connection»

3. Install connection cable between actuator (connector) and controller (connector: VALVE)

4. Install sensor(s) [4] according to the recommendations of the sensor manufacturer and directives given under «Requirements to sensor connection».

5. Connect pressure sensor cable [5] to sensor(s) and then to valve (connector: SENSOR). Refer to chapter «Electrical connection» for correct wiring.

Input for second sensor is available on 642 . . - . . . **H** - . . . . version only.

6. Connect valve to Logic Interface [6] (Logic connector). Refer to «Function and Wiring» for correct wiring.

7. Connect power supply [7] to valve (connector: POWER). Refer to chapter «Electrical connection» for correct wiring.

To provide power to the valve motor pins 2 and 3 must be bridged, otherwise motor interlock is active and thevalve enters the safety mode and is not operative. Refer also to «Safety mode».

8. This valve may optionally be equipped with a heating device. Connect VAT heating device according to manual of respective heating device.

9. Perform «Setup procedure» to prepare valve for operation.

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

4.3 Tightening torque

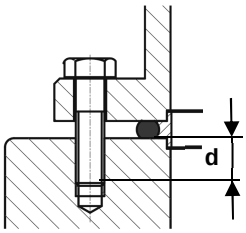
The torque values below are dependent on many factors, such as materials involved, surface quality, surface treatment, and lubrication.

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.

4.3.1 Mounting with centering rings

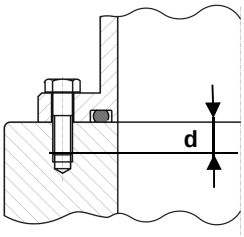
DN		max. torque (Nm)			max. torque (lbs . ft)			Max. hole depth [d] (mm)		
mm	inch	ISO-F	JIS	ASA-LP	ISO-F	JIS	ASA-LP	ISO-F	JIS	ASA-LP
63	2 1/2	8 – 10	8 – 10	8 – 10	6 – 8	6 – 8	6 – 8	13	13	15
80	3	8 – 10	8 – 10	8 – 10	6 – 8	6 – 8	6 – 8	13	13	15
100	4	8 – 10	8 – 10	8 – 10	6 – 8	6 – 8	6 – 8	13	13	15
160	6	13 – 15	13 – 15	20 - 30	9 - 11	9 - 11	15 – 22	14	14	15
200	8	13 – 15	13 – 15	20 - 30	9 - 11	9 - 11	15 – 22	16	16	20
250	10	17 – 20	17 – 20	40 – 60	13 – 15	13–15	30 – 44	16	16	20
320	12	17 - 20	17 – 20	40 - 60	13 – 15	13–15	30 - 44	16	16	20
350	12	17 - 20	17 – 20	40 - 60	13 – 15	13–15	30 - 44	16	16	20
400	16	17 – 20	30 – 35	55 – 80	13 – 15	22 – 26	41 – 59	25	25	NA



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

4.3.2 Mounting with O-ring in grooves

DN		max. torque t (Nm)			max. torque (lbs . ft)			Max. hole depth [d] (mm)		
mm	inch	ISO-F	JIS	ASA-LP	ISO-F	JIS	ASA-LP	ISO-F	JIS	ASA-LP
63	4	N/A	N/A	N/A	N/A	N/A	N/A	13	13	15
80	4	N/A	N/A	N/A	N/A	N/A	N/A	13	13	15
100	4	N/A	N/A	N/A	N/A	N/A	N/A	13	13	15
160	6	N/A	N/A	N/A	N/A	N/A	N/A	14	14	15
200	8	N/A	N/A	N/A	N/A	N/A	N/A	16	16	20
250	10	N/A	N/A	N/A	N/A	N/A	N/A	16	16	20
320	12	N/A	N/A	N/A	N/A	N/A	N/A	16	16	20
350	12	NA	N/A	N/A	N/A	N/A	N/A	16	16	20
400	16	NA	N/A	N/A	N/A	N/A	N/A	25	25	N/A



4.4 Admissible forces

NOTICE

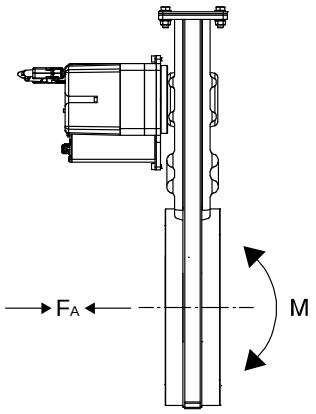
Force at flange and valve body

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.

DN (nom. I.D.)		Axial traction or pressure force «F_A»		Bending moment «M»	
mm	inch	N	lbf	Nm	lbf · ft
63	2½	1960	440	78	58
80	3	1960	440	78	58
100	4	2450	560	98	72
160	6	2940	660	147	108
200	8	2940	660	147	108
250	10	3430	770	196	145
320	12	3920	880	294	217
350	14	3920	880	294	217
400	16	7840	1760	980	722
In case of both kind of forces are occurring («FA» und «M»), the above shown values are invalid. Please contact VAT in this case.					

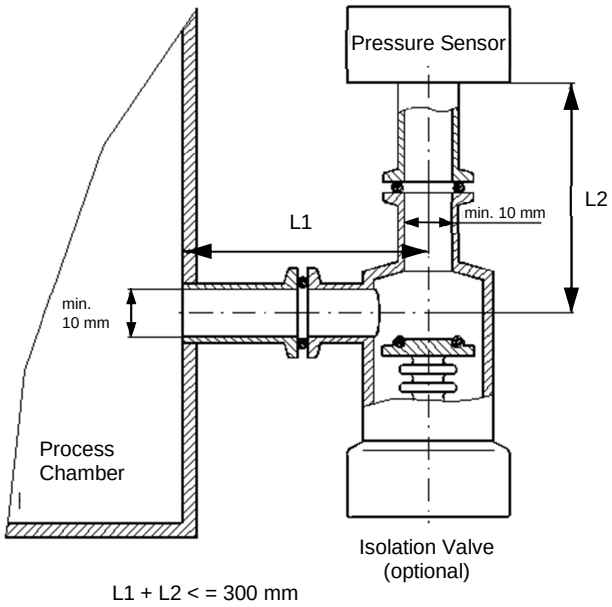


4.4.1 Requirements to sensor connection

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.



4.5 Electrical connection

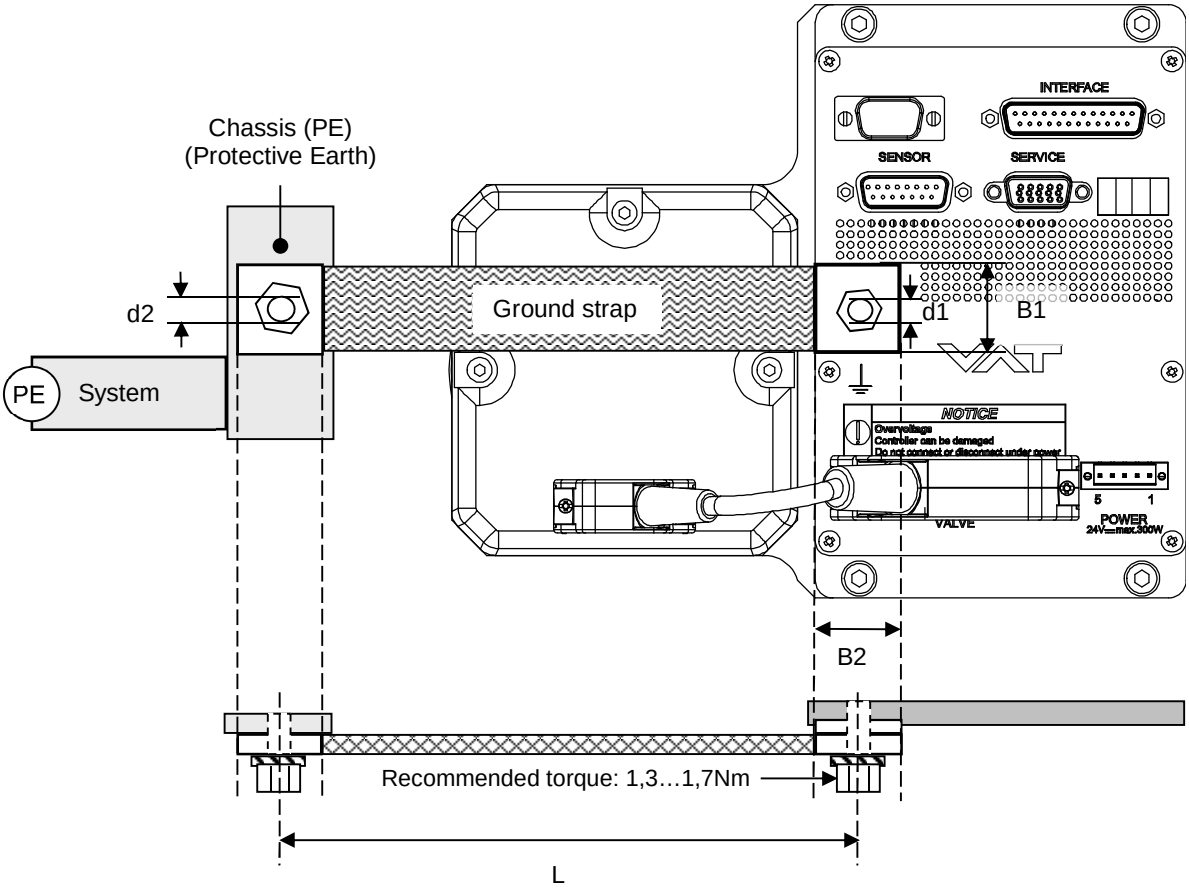
	NOTICE
	Wrong connection Wrong connection may result in damage of controller or power supply. Connect all cables exactly as shown in the following descriptions and schematics.

	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.

4.5.1 Ground connection

Recommendation for ground strap between controller ground and system chassis.

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



- 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)

4.5.2 Sensor supply concepts

Those valves offer 4 alternative concepts to supply the sensor(s) with power. This depends on the sensor type and valve version that is used.
Concepts:

- External +24 VDC supplied to POWER connector is feedthrough to SENSOR connector to supply 24 VDC sensors. Refer to chapter «Power and sensor connection (+24 VDC sensors)» for schematic and correct wiring.
    - o External +24 VDC power to supply +24 VDC sensors.

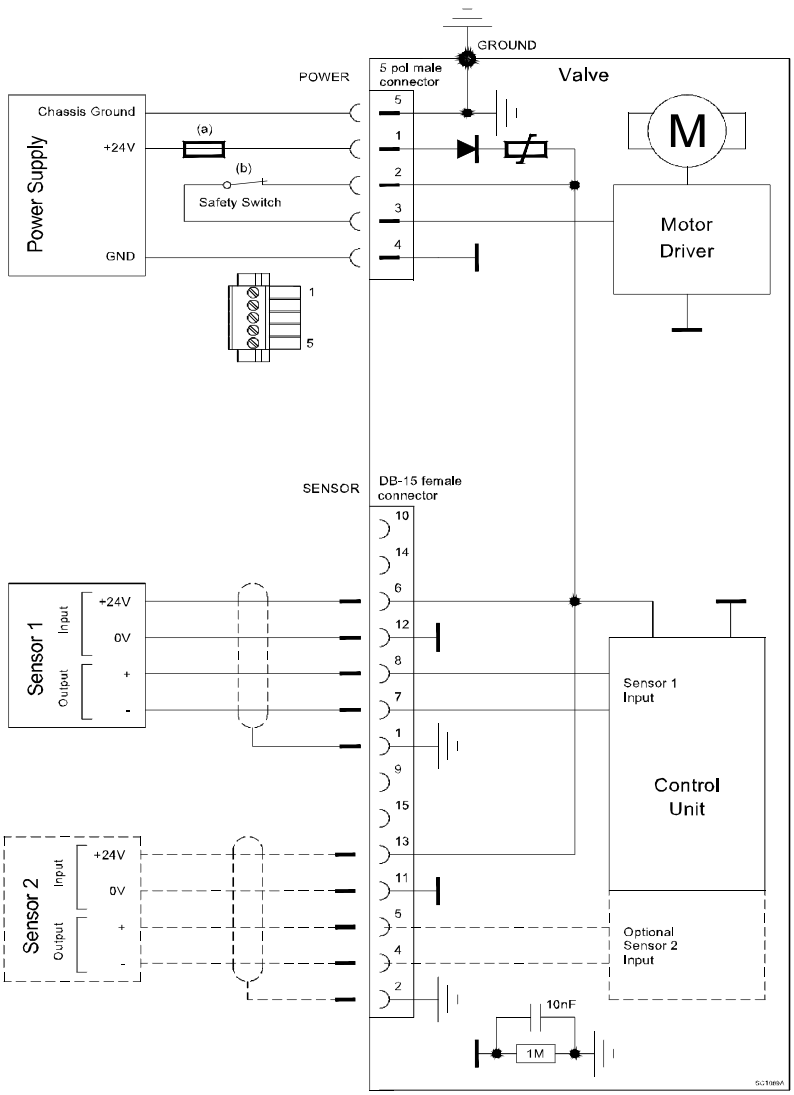
- External +24 VDC supplied to POWER connector is converted into ±15 VDC by the valve internal SPS and supplied to SENSOR connector to supply ±15 VDC sensors. Refer to chapter «Power and sensor connection (±15 VDC sensors) with opt. SPS module» for schematic and correct wiring.
    - o External ±15 VDC power to supply ±15 VDC sensors without SPS module

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

4.5.3 Power and sensor connection (+24 VDC sensors)

[642 . . - . . **G** . - . . . . / 642 . . - . . **H** . - . . . . versions recommended]

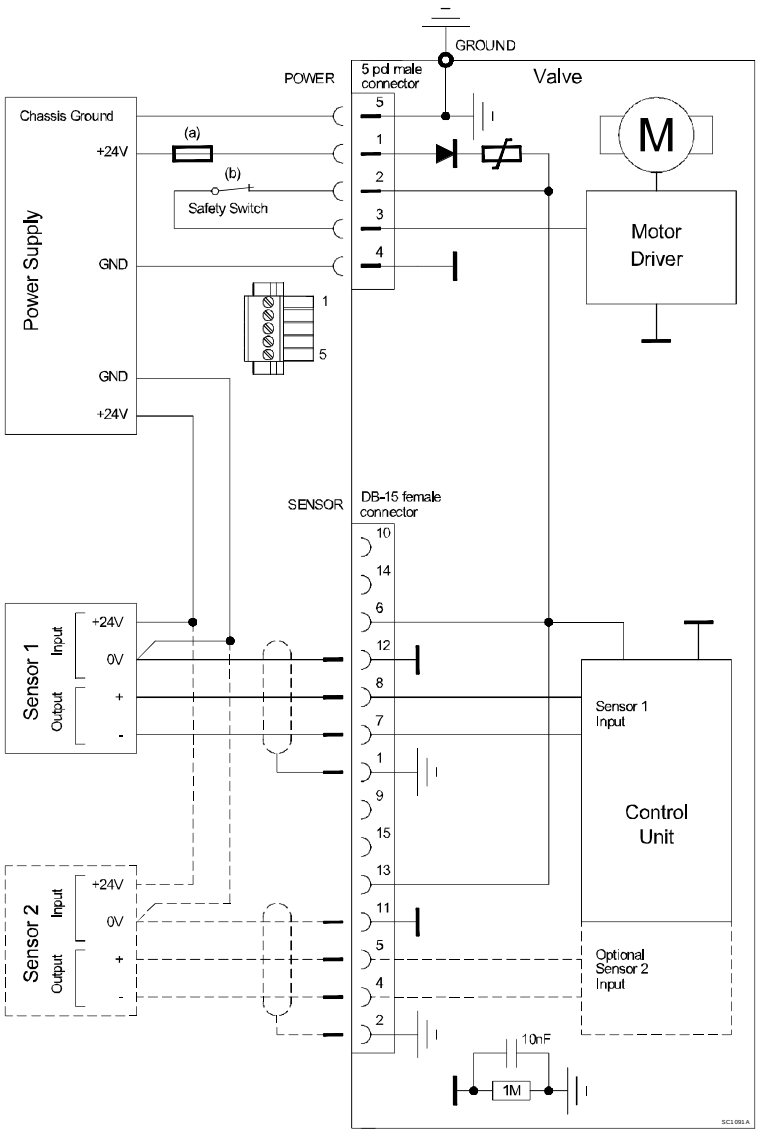
4.5.3.1 Sensor power wiring via controller



Pins 2 and 3 must be bridged for operation. An optional switch would allow for motor interlock to prevent valve from moving.

- **VAT fuse recommendation: (a) 5AF, / (b) Safety switch 3A min.**
- Use shielded sensor cable(s). Keep cable as short as possible, but locate it away from noise sources.
- Connect Power supply (+24 / GND) at power 5 pol. male connector and Sensors (+24V / 0V / + / -) at DB–15 female sensor connector exactly as shown in the drawing above!

4.5.3.2 Sensor power wiring external

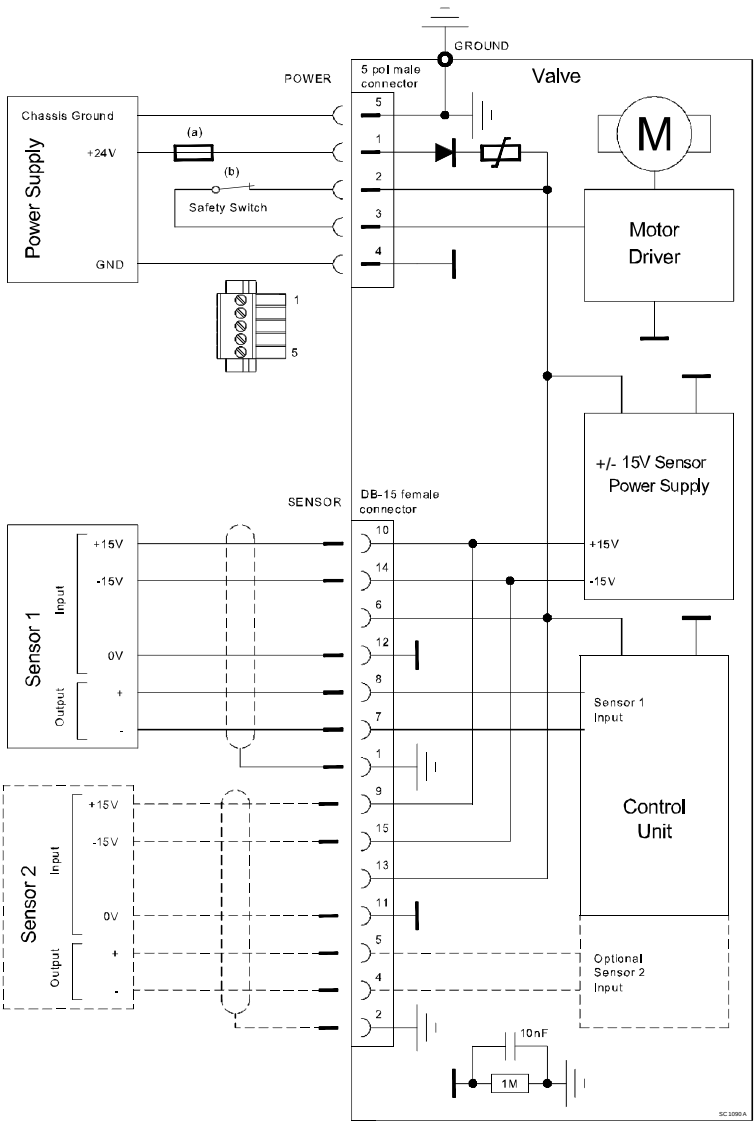


Pins 2 and 3 must be bridged for operation. An optional switch would allow for motor interlock to prevent valve from moving.

- **VAT fuse recommendation: (a) 5AF, / (b) Safety switch 3A min.**
- Use shielded sensor cable(s). Keep cable as short as possible, but locate it away from noise sources.
- Connect Power supply (+24 / GND) at power 5 pol. male connector and Sensors (0V / + / -) at DB–15 female sensor connector exactly as shown in the drawing above!

4.5.4 Power (+24 VDC) and sensor connection (±15 VDC sensors) with opt. SPS module

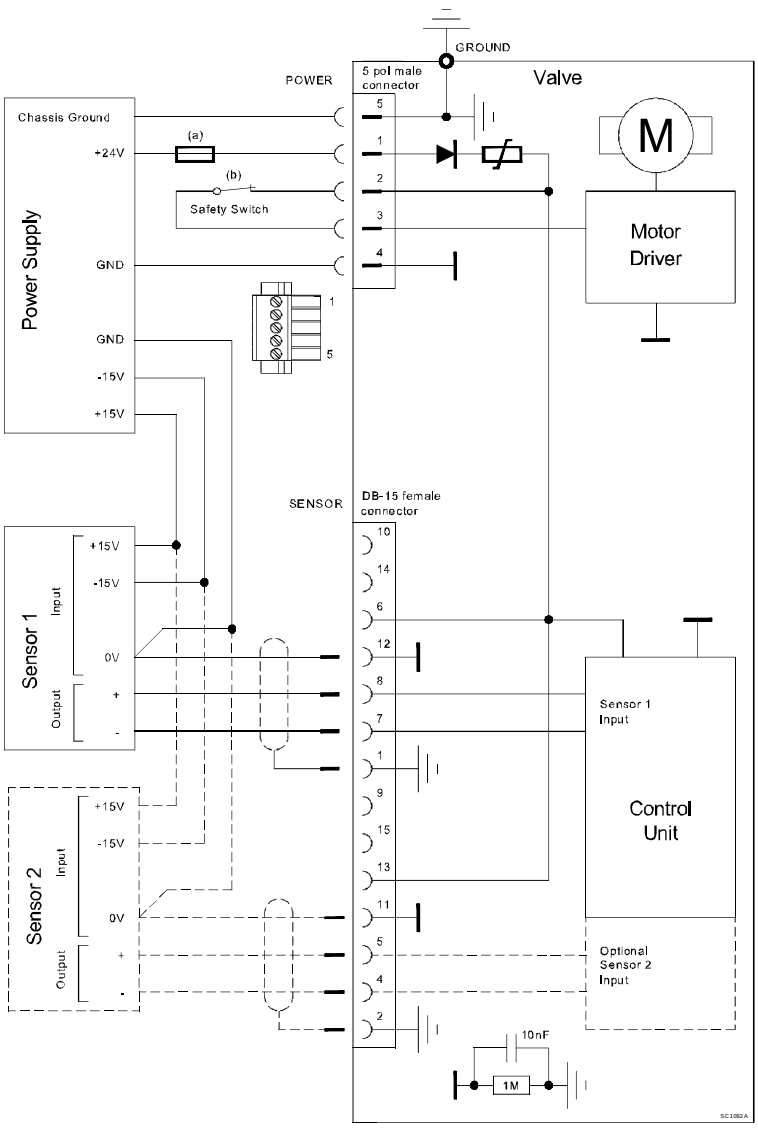
[642 . . - . . **A** . - . . . . / 642 . . - . . **C** . - . . . . versions only]



- **VAT fuse recommendation: (a) 5AF, / (b) Safety switch 3A min.**
- Use shielded sensor cable(s). Keep cable as short as possible, but locate it away from noise sources.
- Connect Power supply (+24 / GND) at power 5 pol. male connector and Sensors (0V / + / -) at DB–15 female sensor connector exactly as shown in the drawing above!

4.5.4.1 External sensor power wiring without SPS module

[642 . . - . . **G** . - . . . . / 642 . . - . . **H** . - . . . . versions only]



Pins 2 and 3 must be bridged for operation. An optional switch would allow for motor interlock to prevent valve from moving.

- **VAT fuse recommendation: (a) 5AF, / (b) Safety switch 3A min.**
- Use shielded sensor cable(s). Keep cable as short as possible, but locate it away from noise sources.
- Connect Power supply (+24 / GND) at power 5 pol. male connector and Sensors (0V / + / -) at DB–15 female sensor connector exactly as shown in the drawing above!

4.5.5 Service port connection

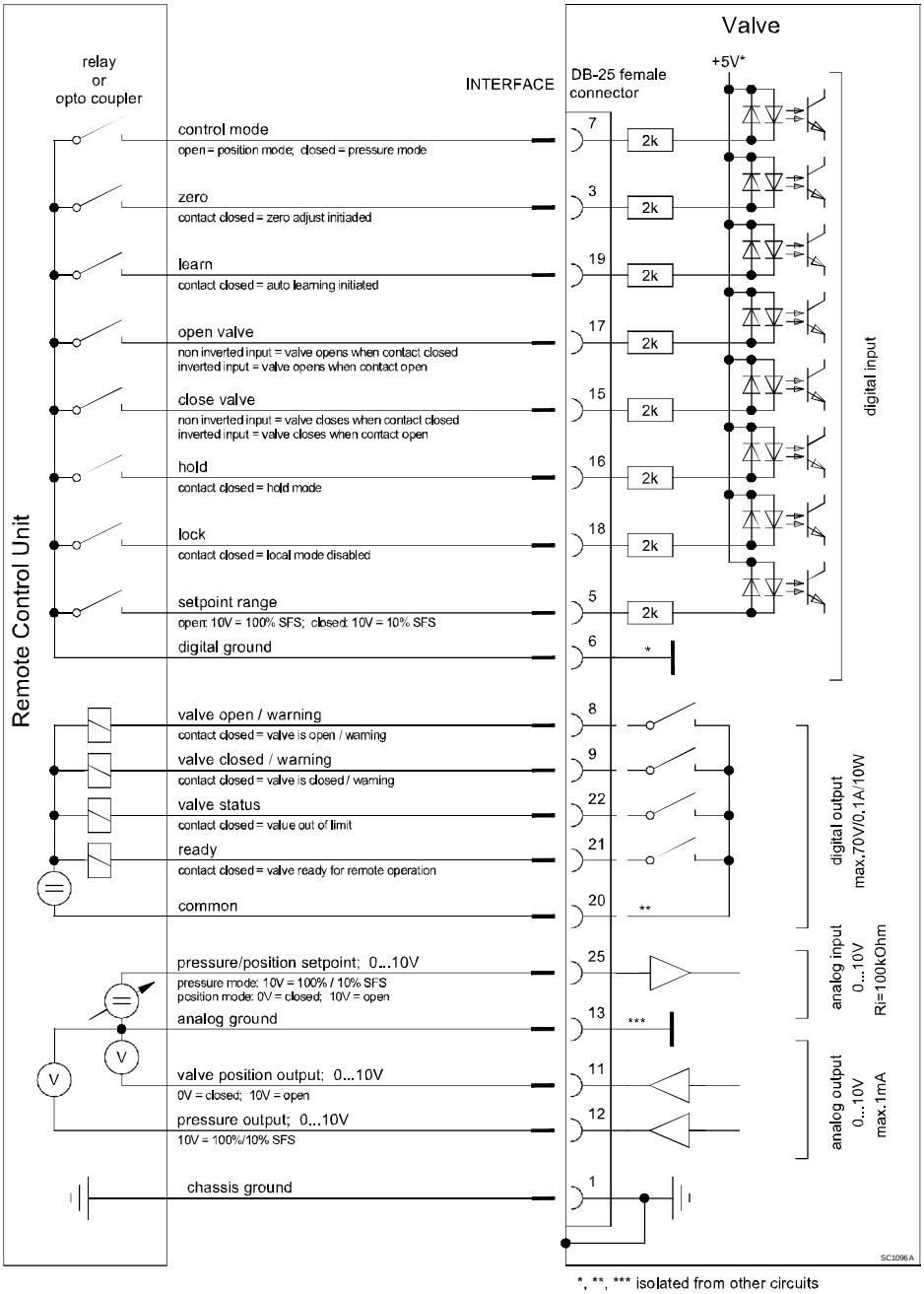
The service port (connector: SERVICE) allows to connect the valve to a RS232 port of a computer. This requires a service cable and software from VAT.
You can use our Software (freeware) 'Control Performance Analyzer' which can be downloaded from: http://www.vatvalve.com/customer-service/informations-and-downloads/control-performance-analyzer.
Alternatively the VAT Service Box2 can be connected to the service port for setup and local operation.
The service port is not galvanic isolated. Therefore we recommend using this only for setup, testing and maintenance and not for permanent control.
Refer also to chapter: «Local Operation» for details and to chapter «Spare parts / Accessories» for ordering numbers of service cable, software and Service Box 2.

Use only screws with 4–40 UNC thread for fastening the service port connector.

4.5.6 Functions and Wiring

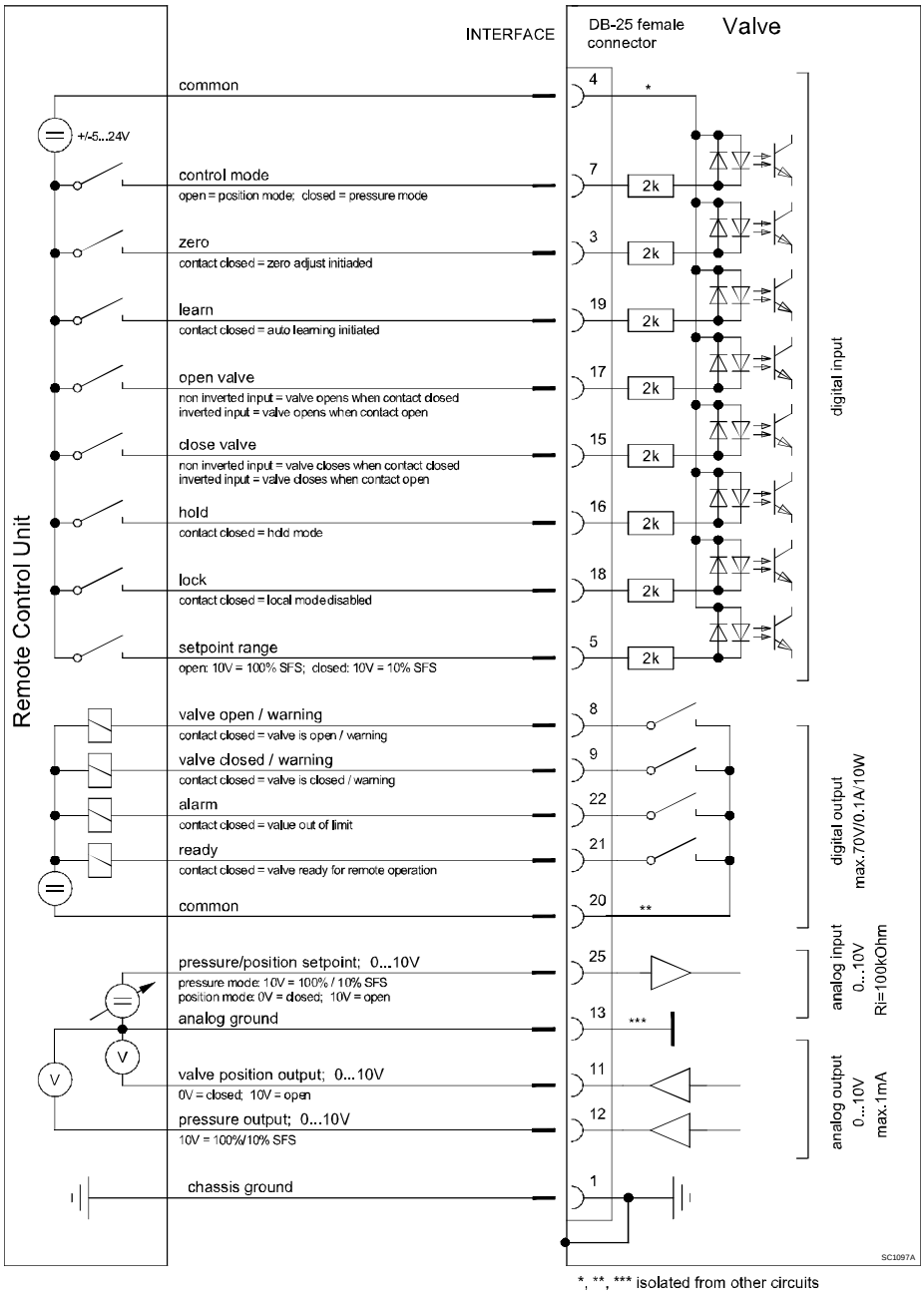
Logic interface allows for remote operation by means of digital and analog signals.
Digital inputs may be operated either by switches or by voltage sources.

a) Configuration with switches for digital inputs:



Do not connect other pins than indicated in the schematics above!
Use only screws with 4-40UNC thread for fastening the DB-25 connector!

a) Configuration with voltage source for digital inputs:



Do not connect other pins than indicated in the schematics above!
Use only screws with 4-40UNC thread for fastening the DB-25 connector!

4.5.7 Digital inputs

Pin	Function	Signal type	Description	Priority
7	**CONTROL MODE**	Digital Input [1]	This pin selects the control mode. This valve may either be operated as pressure controller or as position controller. PRESSURE CONTROL is activated as long as optocoupler is 'on'. The PID controller controls the chamber pressure according to the pressure SETPOINT by means of the valve position. POSITION CONTROL is activated when optocoupler is 'off'. The valve position is directly controlled according to the position SETPOINT.	6 [2]
5	**SETPOINT RANGE**	Digital input [1]	This pin selects the SETPOINT RANGE. Low range extension is activated as long as optocoupler is 'on'. It's effective in pressure control mode only. This function extends the lower 10% range of sensor full scale (SFS) to the full 0-10V for SETPOINT input. Herewith you can achieve better resolution, especially in case of a 2 sensor system. Example with SFS = 100mTorr: Not active (10V=100%) >> 10V setpoint = 100mTorr Active (10V=10%): >> 10V setpoint = 10mTorr	N/A
16	**HOLD**	Digital input [1]	This function stops the valve at the current position. After release of the signal the valve will return to the selected CONTROL MODE. Only PRESSURE or POSITION Mode. This function is activated as long as optocoupler is 'on'.	5 [2]
17	**OPEN VALVE**	Digital input [1]	This function will open the valve. This function is activated as long as optocoupler is 'on' in **non inverted** configuration. This function is activated as long as optocoupler is 'off' in **inverted** configuration. Configuration can be done in local operation via service port. Default settings is not inverted	3 [2]
15	**CLOSE VALVE**	Digital input [1]	This function will close the valve. This function is activated as long as optocoupler is 'on' in **non inverted** configuration. This function is activated as long as optocoupler is 'off' in **inverted** configuration. Configuration can be done in local operation via service port. Default settings is not inverted	2 [2]

1) All digital inputs are digitally filtered. Filter delay is 50ms. This means that digital signals must be applied for at least 50ms to be effective. Refer to «Function and wiring» for details about input circuit.

2) Highest priority is 1. Functions with lower priorities will not be effective as long as higher priority functions are active.

Pin	Function	Signal type	Description	Priority
3	**ZERO**	Digital Input [1]	This function compensates the pressure gauge offset voltage and sets the pressure value to zero. In case of a 2 sensor system both sensor inputs will be adjusted. This function is initiated by the 'off' to 'on' transition of the optocoupler. If 'on' remains established this will not re-initiate the function and does also not block functions with lower priorities. Do not perform ZERO as long as pressure gauge voltage is shifting. Do not perform ZERO, if the base pressure of your vacuum system is higher than 1%o of sensor full scale. We recommend disabling ZERO function in this case. You can disable the function in local operation via service port.	1 [2]
19	**LEARN**	Digital Input [1]	The LEARN routine determines the control characteristic of the vacuum system. This function is initiated by the 'off' to 'on' transition of the optocoupler. A transition from 'on' to 'off' while the routine is running would stop it. While running, the routine may not be interrupted by another function with higher priority. If 'on' remains established after completion this will not re-initiate the function and does also not block functions with lower priorities. Without a LEARN data set the PID controller is not able to perform pressure control.	4 [2]
18	**LOCK**	Digital input [1]	This function locks the valve in remote operation. In case the valve is in local operation it will turn to remote operation. Local operation via service port is not possible when LOCK is activated. When the signal is released the valve remains in remote operation but local operation may be activated via service port.	N/A
6	**DIGITAL GROUND**	Digital ground	Ground for all digital inputs. Ground is used when digital inputs are operated by switches. Connect switches to ground. Refer also to «Function and wiring» configuration a).	
4	**DIGITAL COMMON**	Digital common	Common for all digital inputs. Common is used when digital inputs are driven by voltage sources. Connect + or – terminal of source with common (input optocouplers are capable of bidirectional operation). Refer also to «Function and wiring» configuration b).	

1) All digital inputs are digitally filtered. Filter delay is 50ms. This means that digital signals must be applied for at least 50ms to be effective. Refer to «Function and wiring» for details about input circuit.

2) Highest priority is 1. Functions with lower priorities will not be effective as long as higher priority functions are active.

4.5.8 Digital outputs

Pin	Function	Signal type	Description
8	**VALVE OPEN or SERVICE REQUEST**	Digital output[1)]	This output is active in all operation modes and indicates either that the valve is open or that a service is requested. A service request is indicated when the valve requires cleaning due to contamination. Configuration of the functionality of this output can be done in local operation via service port. By default the output indicates open
9	**VALVE CLOSED or SERVICE REQUEST**	Digital output[1)]	This output is active in all operation modes and indicates either that the valve is close or that a service is requested. A service request is indicated when the valve requires cleaning due to contamination. Configuration of the functionality of this output can be done in local operation via service port. By default the output indicates close
22	**VALVE STATUS**	Digital output[1)]	The meaning of this output depends on the operation mode. e.g. LEARN: LEARN is not completed yet. PRESSURE CONTROL: Actual pressure is out of ±2% range of SETPOINT POSTION CONTROL: Actual position is out of ±0.1% range of SETPOINT
21	**READY**	Digital output[1)]	This signal indicates that the valve is ready for remote operation. If this signal is not active the valve is in one of the following modes: • Synchronization during power up • Local operation via service port • Safety mode. Refer to «Safety mode» for details.
20	**COMMON**	Digital common	Common for all digital outputs.

1) Refer to «Function and wiring» for details about output circuit.

4.5.9 Analog inputs and outputs

Pin	Function	Signal type	Description
25	**SETPOINT**	Analog input[1)]	The meaning of the setpoint input depends on the operation mode. LEARN: A voltage of 0-10V shall be applied to this input as pressure limit for learn. The limit pressure is in linear relation to the applied voltage. 10V relates to sensor full scale. In case of 2 sensor operation 10V relates to sensor 1 full scale (high range). To activate pressure limit function for remote operation it must be configured accordingly. Refer to «Interface configuration» PRESSURE CONTROL: A voltage of 0-10V shall be applied to this input as pressure setpoint. The pressure setpoint is in linear relation to the applied voltage. Depending on selected SETPOINT RANGE 10V means either sensor full scale or 10% of sensor full scale. In case of 2 sensor operation 10V relates to sensor 1 full scale (high range). POSITION CONTROL: A voltage of 0-10V shall be applied to this input as position setpoint. The position setpoint is in linear relation to the applied voltage. 0V is closed but not isolation function and 10V is open position. (Use digital input for isolation function)
12	**PRESSURE**	Analog output[1)]	This output indicates the current pressure as 0-10V. The output voltage is in linear relation to the pressure. Depending on the selected SETPOINT RANGE 10V means either sensor full scale or 10% of sensor full scale. In case of 2 sensor operation sensor full scale relates to sensor 1 (high range).
11	**POSITION**	Analog output[1)]	This output indicates the current valve position as 0-10V voltage range. The voltage is in linear relation to the valve position. 0V is closed but not isolation function and 10V is open position. (Use digital output for isolation function)
13	**ANALOG GROUND**	Analog ground	Ground for analog input and analog outputs.
1	**CHASSIS GROUND**	Chassis ground	Chassis ground connected to case. Shall be used to connect cable shield.

1) Refer to «Function and wiring» for details about input / output circuit.

4.6 Initial operation

4.6.1 Setup procedure

To enable the valve 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 steps		Description
1	**Power up**	Turn on external + 24VDC power supply of valve (and external ±15 VDC for sensor power supply if required). Refer to chapter «Behavior during power up» for details.
2	**Interface configuration**	Refer to chapter «Logic Interface configuration» for details.
3	**Valve configuration**	Basic configurations of valve must be adapted according to application needs. Refer to chapter «Valve configuration» for details.
4	**Sensor configuration**	Basic configurations of sensor(s) 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 adaptive» or «Pressure Control configuration» the valve is not able to run pressure control.

For ease setup (in Local mode) of 'Interface', 'Valve', 'Sensor', 'Senor ZERO', 'LEARN' and 'PRESSURE CONTROL COFIGURATION' it is possible to use the CPA 3.0, The free download is available on the VAT homepage: http://www.vatvalve.com/customer-service/informations-and-downloads/control-performance-analyzer

To enable the valve 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.

4.6.2 Logic Interface configuration

Interface configuration must be adapted according to application needs.

Default configuration:

OPEN input	CLOSE input	OPEN output	CLOSE output
not inverted	not inverted	open	close

- Functionality of digital inputs CLOSE VALVE and OPEN VALVE must be selected.
  These may be configured as ‘not inverted‘ or ‘inverted‘. Default is ‘not inverted‘.
- LEARN range configuration for remote operation must be selected.
  This may either be ‘full range’ or pressure limit according of analog SETPOINT input. Default is ‘full range‘.

Local operation: (‘Control Performance Analyzer’ or ‘Service Box 2‘)	**Remote operation**:
• With CPA, do configuration in menu ‘Interface / Setup’. • With SB2, do configuration in menu ‘Setup / Interface’.	It’s not possible to do ‘Interface configuration‘ via remote operation.

4.6.3 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 ‘closed‘. Only for versions that have Power Fail Option equipped [642 . . - . . **C** . - . . . . or 642 . . - . . **H** . - . . . .].
- **Network failure**, default setting refer to individual product data sheet.

Local operation: (‘Control View’, ‘Control Performance Analyzer’ or ‘Service Box 2‘)	**Remote operation**:
With CPA: • Do valve configuration in menu ‘Valve / Setup’. With SB2: • Do power up configuration in menu ‘Setup / Valve’. • Do power fail configuration in menu ‘Setup / Valve’.	It’s not possible to do ‘Valve configuration‘ via remote operation.

4.6.4 Sensor configuration

Basic sensor configuration must be adapted according to application needs.

- ZERO function: This may be ‘disabled’ or ‘enabled’. Default is ‘enabled‘. Refer also to chapter «ZERO».
- Sensor configuration with 2 sensor version [642 . . - . . . **E** - . . . .]. Refer also to chapter: «Pressure control operation with 2 sensors».

Local operation: (‘Control Performance Analyzer’ or ‘Service Box 2‘)	**Remote operation**:
With CPA: • Do sensor configuration in menu ‘Sensor / Setup’. With SB2: • Enable or disable ZERO function in menu ‘Setup / Sensor’. • Do sensor(s) configuration in menu ‘Setup / Sensor’.	It’s not possible to do ‘Sensor configuration‘ via remote operation.

4.6.5 ZERO

ZERO allows for the compensation of the sensor offset voltage.
When ZERO is performed the current value at the sensor input is equated to pressure zero. In case of a 2 sensor system both sensor inputs will be adjusted. A max. offset voltage of +/-1.4V can be compensated. The offset value can be read via local and remote operation.

Local operation: (‘Control Performance Analyzer’ or ‘Service Box 2‘)	**Remote operation**: (Refer to chapter «Digital inputs» for details)
With CPA: • Do the ZERO in menu ‘Sensor / Zero’. With SB2: • Go to menu ‘Zero / ZERO’ and follow instructions.	1. Send OPEN VALVE
	2. Wait until process chamber is evacuated and sensor signal is not shifting anymore.
	3. Send ZERO

- Do not perform ZERO 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.
- Do not perform ZERO, if the base pressure of your vacuum system is higher than 1‰ of sensor full scale. We recommend disabling ZERO function in this case; refer to «Valve and sensor configuration» of the setup procedure. Otherwise incorrect pressure reading is the result.

4.6.1 **LEARN** (adaptive)

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.

Local operation: ('Control View', 'Control Performance Analyzer' or 'Service Box 2')	**Remote operation**: (Refer to chapter «Digital inputs» for details)
Go to 'Learn / LEARN' menu and follow instructions. Gasflow calculation according to recommendation below is done automatically based on inputs.	1. Send OPEN VALVE
	2. 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.
	3. Set SETPOINT (= pressure limit for learn) to p_{max} (max. pressure to control during process)
	4. Set LEARN Alarm (VALVE STATUS) is set as long learn is performed, if alarm is off, learn is finished.
	5. Reset LEARN
	6. Reset OPEN VALVE

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 CR ≥ Cmin 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»)

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

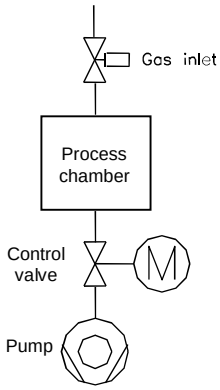
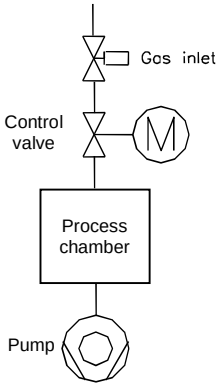
q_L gasflow for learn [**mbar l/s**]
p_{SFS} sensor full scale pressure [**mbar**]
C_{min} min. controllable conductance of valve [l/s], (refer to «Technical data»)

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

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»)

4.6.2 Pressure control algorithem

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
(Refer to chapter: Pressure controller)</td><td colspan="2">Fixed pressure controller
(Refer to chapter: Pressure controller)</td></tr>
<tr><td>Upstream
 
</td><td colspan="3">Fixed pressure controller
(Refer to chapter: Pressure controller)</td></tr>
<tr><td>Soft Pump</td><td colspan="3">Soft Pump (Refer to chapter: Pressure controller)</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]

1.1.1.1 Pressure controller

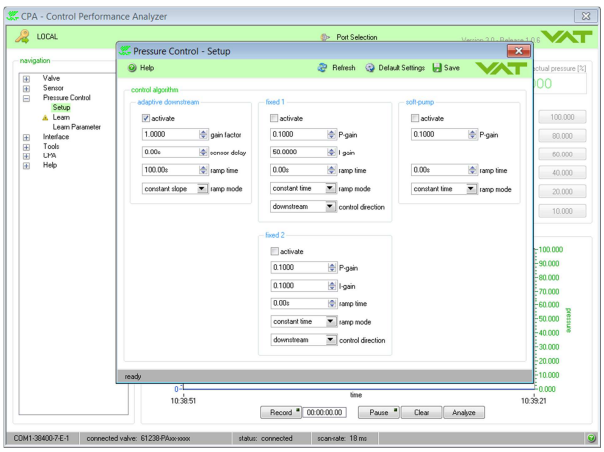
Configuration of three possible pressure controller.

<table>
<tr><th colspan="2">**Local operation**:
(‘Control View’ or ‘Control Performance Analyzer’)</th><th>**Remote operation**:</th></tr>
<tr><td colspan="2">1. Open CV or CPA
2. Go to «Tools» > «Terminal» and send setup command s:02 according to application needs. (possibility of adjustment see below)
<table><tr><th></th><th>**Command**</th><th>**Acknowledgement**
(within 10ms after reception of command)</th></tr><tr><th></th><th colspan="2">**Describtion**</th></tr><tr><td>Set</td><td>s:02Z00**a**
configure pressure controller **a**</td><td></td></tr><tr><td>Get</td><td>i:02Z00
get the actual pressure controller **a**</td><td>i:02Z00**a**</td></tr></table>This command selects pressure controller.
a Pressure controller
0 = Adaptive downstream
1 = Fixed 1
2 = Fixed 2
3 = Soft pump</td><td>It is not possible with remote operation.</td></tr>
</table>

For easy setup (Local operation) of ‘Pressure controller’ and ‘Pressure control parameter’ please use the VAT “Control Performance Analyzer” CPA 3.0.
There is a free download on the VAT home page, refer to:
http://www.vatvalve.com/customer-service/informations-and-downloads/control-performance-analyzer

4.6.2.1 With CPA 3.0 direct setup (standard)

Open the CPA. In menu ‘Pressure Control’ / ‘Setup’, select the ‘Pressure controller’ and do the setup for pressure control algorithm (parameter).



1.1.1.2 Pressure control parameter

<table>
<tr><th>Local operation:
(‘Control View’ or ‘Control Performance Analyzer’)</th><th>Remote operation:</th></tr>
<tr><td>
• Open CV or CPA
• Go to «Tools» > «Terminal» and send setup command s:02 according to application needs. (possibility of adjustment see below)
<table>
<tr><th></th><th>Command</th><th>Acknowledgement
(within 10ms after reception of command)</th></tr>
<tr><th></th><th colspan="2">Describtion</th></tr>
<tr><td>Set</td><td>s:02abbc
configure pressure control parameters</td><td></td></tr>
<tr><td>Get</td><td>i:02abbc
get pressure control parameters</td><td>i:02abbc</td></tr>
</table>
This command selects pressure control parameter.
a pressure controller (one digit) see table:
bb parameter number (two digits) see table: “Overview parameter number”
c parameter value using data type “unsigned integer” or “floating point” (dependend on the corresponding data type)

For details (commands etc.), see next tables.
Remark: Each pressure control algorithm has its own parameters. That means the adjustment of a e.g. adaptive downstream parameter (e.g. Ramp Time “Adaptive downstream”) doesn’t influence one of the other Ramp time parameter of other pressure control algorithms and vice versa.
</td><td>It is not possible with remote operation.</td></tr>
</table>

1.1.1.3 Overview parameter number

Parameter	bb Parameter number	a = A (adaptive pressure controller)	a = B (fixed 1 pressure controller)	a = C (fixed 2 pressure controller)	a = D (soft pump pressure controller)
SENSOR DELAY	00	✓	×	×	×
RAMP TIME	01	✓	✓	✓	✓
RAMP MODE	02	✓	✓	✓	✓
CONTROL DIRECTION	03	×	✓	✓	×
P-GAIN (for A = GAIN FACTOR)	04	✓	✓	✓	✓
I-GAIN	05	×	✓	✓	×

✓existent for this pressure controller
× not used for this pressure controller

Pressure control algorithem

- Local operation only:
  - o With CPA direct setup, see chapter: With CPA 3.0 direct setup (standard).
  - o With CPA, go to «Tools» > «Terminal» and send setup commands according to application needs. See next tables.

4.6.2.2 Adaptive control algorithm (downstream)

Parameter	Command		Request	Data Type	Values
SENSOR DELAY	Set	s:02A00**c**	s:02	FLOAT	**c** = 0.00…1.00 Default is: 0.00 s
	Get	i:02A00	i:02A00**c**		
RAMP TIME	Set	s:02A01**c**	s:02	FLOAT	**c** = 0.00…1'000'000.0 Default is: 0.00 s
	Get	i:02A01	i:02A01**c**		
RAMP MODE	Set	s:02A02**c**	s:02	UINT	**c** = 0 or 1 **0** = constant time **1** = constant slope Default is: 0
	Get	i:02A02	i:02A02c		
GAIN FACTOR	Set	s:02A04**c**	s:02	FLOAT	**c** = 0.0001…7.5 Default is: 1.0
	Get	i:02A04	i:02A04**c**		

Explanation:

SENSOR DELAY
Sensor response time [s]
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.

RAMP TIME
Pressure setpoint ramp time [s]

RAMP MODE

Mode = 0 Cocnstant Time	The RAMP TIME is dependent on the adjusted parameter ramp time and is always the same independent of the control deviation. That means the ramp time from the actual value to the setpoint value is the adjusted parameter ramp time value.
Mode = 1 Constant Slope	The RAMP TIME is dependent on the adjusted parameter ramp time and is different depending on the control deviation. The RAMP TIME is calculated corresponding to the sensor full scale value (10V). Ramp time = 10 sec.; ramp time slope is SFS (10V) in 10 Seconds.

In the adaptive pressure controller mode, the RAMP TIME parameter also can be a value to minimize over- / undershooting. The ramp could be used to harmonize the adaptive control algorithm.

GAIN FACTOR
The GAIN FACOTR is a control parameter to adapt the performance of the pressure control algorithm. A higher gain results in faster response, higher over- / undershoot of pressure. A lower gain results in slower response, lower over- / undershoot of pressure.

Example:
Set SENSOR DELAY of the adaptive pressure controller to the value 0.75

Command	Pressure controller	Parameter selection variable	Parameter value (seconds)
s:02	**A** (a)	**00** (bb)	**0.75** (c)

→ s:02A000.75

To optimize adaptive control algorithm, refer to chapter «Tuning of control performance».

4.6.2.3 Fixed 1 control algorithm

Parameter	Command		Request	Data Type	Values
RAMP TIME	Set	s:02B01**c**	s:02	FLOAT	**c** = 0.00…1'000'000.0 Default is: 0.00
	Get	i:02B01	i:02B01**c**		
RAMP MODE	Set	s:02B02**c**	s:02	UINT	**c** = 0 or 1 **0** = constant time **1** = constant slope Default is: 0
	Get	i:02B02	i:02B02**c**		
CONTROL DIRECTION	Set	s:02B03**c**	s:02	UINT	**c** = 0 or 1 **0** = downstream **1** = upstream Default is: 0
	Get	i:02B03	i:02B03**c**		
P-GAIN	Set	s:02B04**c**	s:02	FLOAT	**c** = 0.001…100 Default is: 0.1
	Get	i:02B04	i:02B04**c**		
I-GAIN	Set	s:02B05**c**	s:02	FLOAT	**c** = 0…100.0 Default is: 0.1
	Get	i:02B05	i:02B05**c**		

Explanation:

RAMP TIME
Pressure setpoint ramp time [s]

RAMP MODE

Mode = 0 Constant Time	The RAMP TIME is dependent on the adjusted parameter ramp time and is always the same independent of the control deviation. That means the ramp time from the actual value to the setpoint value is the adjusted parameter ramp time value.
Mode = 1 Constant Slope	The RAMP TIME is dependent on the adjusted parameter ramp time and is different depending on the control deviation. The RAMP TIME is calculated corresponding to the sensor full scale value (10V). Ramp time = 10 sec.; ramp time slope is SFS (10V) in 10 Seconds.

CONTROL 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.

P-GAIN / I-GAIN
The P-GAIN is the proportional factor of the fixed control algorithm. The I-GAIN is the integral factor.

Example:
Set RAMP MODE of the Fixed 1 pressure controller to the value 0 (fixed time)

Command	Pressure controller	Parameter selection variable	Parameter value
s:02	**B** (a)	**02** (bb)	**0** (c)

→ s:02B020

To optimize Fixed 1 control algorithm, refer to chapter «Tuning of control performance».

4.6.2.4 Fixed 2 control algorithm

Parameter	Command		Request	Data Type	Values
RAMP TIME Pressure setpoint ramp time [s]	Set	s:02C01**c**	s:02	FLOAT	**c** = 0.00…1'000'000.0 Default is: 0.00
	Get	i:02C01	i:02C01**c**		
RAMP MODE	Set	s:02C02**c**	s:02	UINT	**c** = 0 or 1 **0** = constant time **1** = constant slope Default is: 0
	Get	i:02C02	i:02C02**c**		
CONTROL DIRECTION	Set	s:02C03**c**	s:02	UINT	**c** = 0 or 1 **0** = downstream **1** = upstream Default is: 0
	Get	i:02C03	i:02C03**c**		
P-GAIN	Set	s:02C04**c**	s:02	FLOAT	**c** = 0.001…100 Default is: 0.1
	Get	i:02C04	i:02C04**c**		
I-GAIN	Set	s:02C05**c**	s:02	FLOAT	**c** = 0…100.0 Default is: 0.1
	Get	i:02C05	i:02C05**c**		

Explanation: Refer to: «Fixed 1 control algorithm»

4.6.2.5 Soft pump control algorithm

Parameter	Command		Request	Data Type	Values
RAMP TIME	Set	s:02D01**c**	s:02	FLOAT	**c** = 0.00…1'000'000.0 Default is: 0.00
	Get	i:02D01	i:02D01**c**		
RAMP MODE	Set	s:02D02**c**	s:02	UINT	**c** = 0…1 **0** = constant time **1** = constant slope Default is: 0
	Get	i:02D02	i:02D02**c**		
P-GAIN	Set	s:02D04**c**	s:02	FLOAT	**c** = 0.001…100 Default is: 0.1
	Get	i:02D04	i:02D04**c**		

Explanation:

RAMP TIME
Pressure setpoint ramp time [s]

RAMP MODE

Mode = 0 Constant Time	The RAMP TIME is dependent on the adjusted parameter ramp time and is always the same independent of the control deviation. That means the ramp time from the actual value to the setpoint value is the adjusted parameter ramp time value.
Mode = 1 Constant Slope	The RAMP TIME is dependent on the adjusted parameter ramp time and is different depending on the control deviation. The RAMP TIME is calculated corresponding to the sensor full scale value (10V). Ramp time = 10 sec ; ramp time slope is SFS (10V) in 10 Seconds.

P-GAIN
The P-GAIN is the proportional factor of the fixed control algorithm.

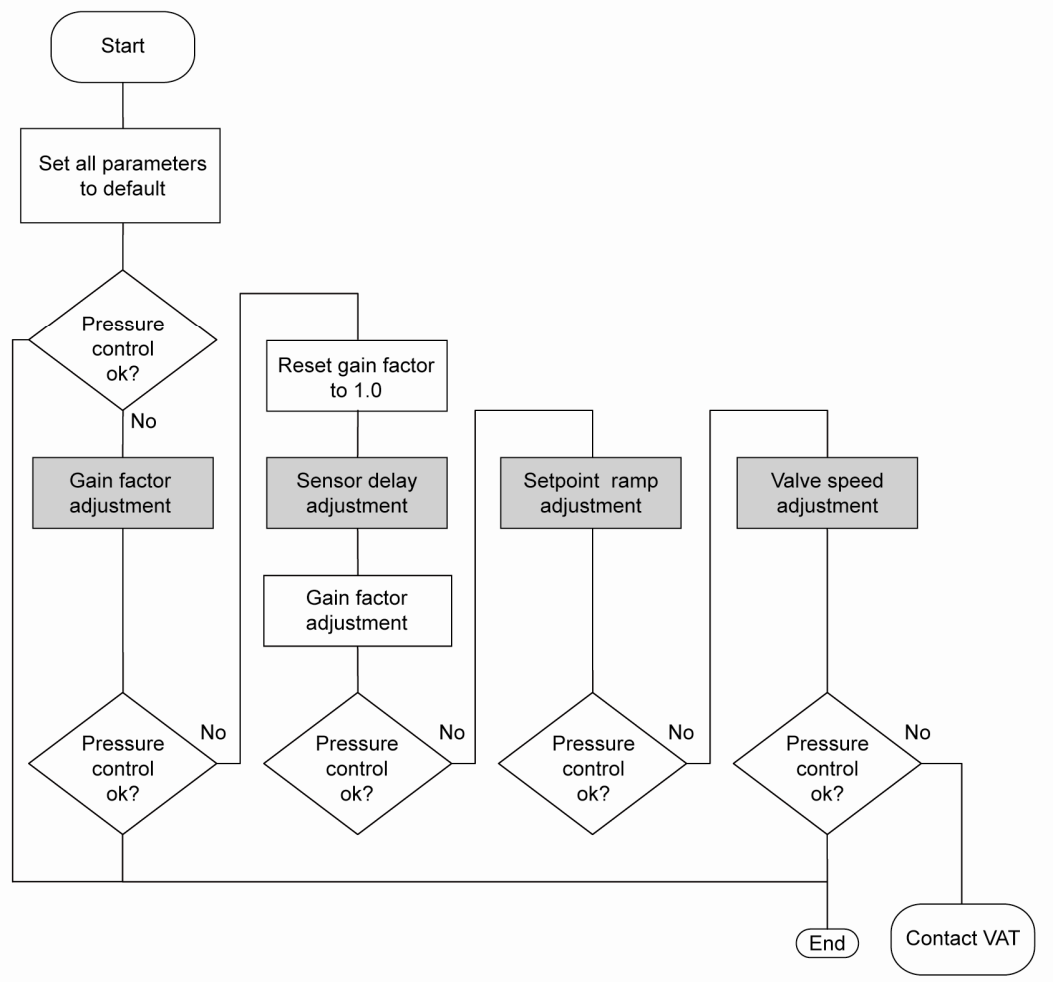
To optimize soft pump control algorithm, refer to chapter «Tuning of control performance».

4.7 Tuning of control performance

- Tuning of pressure control performance with adaptive control, refer to chapter: 4.7.1 Tuning of pressure control (adaptive)
- Tuning of pressure control performance with PI control, refer to chapter: 4.7.2 Tuning of pressure control performance with fixed PI control
- Tuning of control pressure performance with Soft pump , refer to chapter: 4.7.3 Tuning of pressure control (soft pump)

4.7.1 Tuning of pressure control (adaptive)

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.



Required information for support:

- Go to ‘Tools / Create Diagnostic File’ in ‘Control View’ resp. ‘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

4.7.1.1 Gain factor adjustment

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

Default value is 1. 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».

Local operation: ('Control View', 'Control Performance Analyzer' or 'Service Box 2')	**Remote operation**:
Set gain factor in menu 'Setup / Control Parameter'	It's not possible to do 'Gain factor adjustment' via remote operation.

4.7.1.2 Sensor delay adjustment

Sensor delay adjustment effects: **Stability**

Default value is 0sensorDeay0. 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».

Local operation: ('Control View', 'Control Performance Analyzer' or 'Service Box 2')	**Remote operation**:
Go to 'Setup / Control Parameter' menu. Select sensor delay.	It's not possible to do 'Sensor delay adjustment' via remote operation.

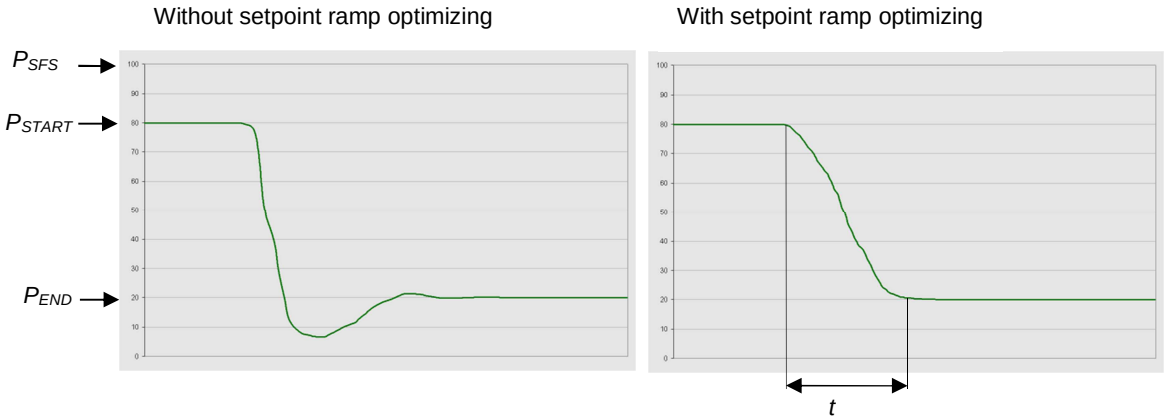
4.7.1.3 Setpoint ramp adjustment

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

Default value for Setpoint Ramp is 0. 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.

$$t = \frac{S_{RAMP}}{P_{SFS}} \bullet \left| P_{START} - P_{END} \right|$$

t	ramptime [**s**]
P_{SFS}	sensor full scale pressure
S_{RAMP}	setpoint ramp [**s**]
P_{START}	pressure start
P_{END}	pressure end

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.

Local operation: ('Control View', 'Control Performance Analyzer' or 'Service Box 2')	**Remote operation:**
Go to 'Setup / Control Parameter' menu. Select setpoint ramp.	It's not possible to do 'Setpoint ramp adjustment' via remote operation.

4.7.1.4 Valve speed adjustment

Valve speed effects: **Response time**

Default value is 1000. Adjustment range is from 1 to 1000.

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.

Local operation: (‘Control View’, ‘Control Performance Analyzer’ or ‘Service Box 2‘)	**Remote operation**:
Go to ‘Setup / Control Parameter’ menu. Select valve speed.	It’s not possible to do ‘Valve speed adjustment‘ via remote operation.

4.7.2 Tuning of pressure control performance with fixed PI control

4.7.2.1 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.

Local operation: ('Control View' resp. 'Control Performance Analyzer')	**Remote operation**:
Go to 'Tools / Terminal' menu and do the: ■ Control cofiguration → Control mode + PI-Parameters Refer to chapter « Pressure control configuration» for details.	It's not possible to do 'Valve speed adjustment' via remote operation.

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:

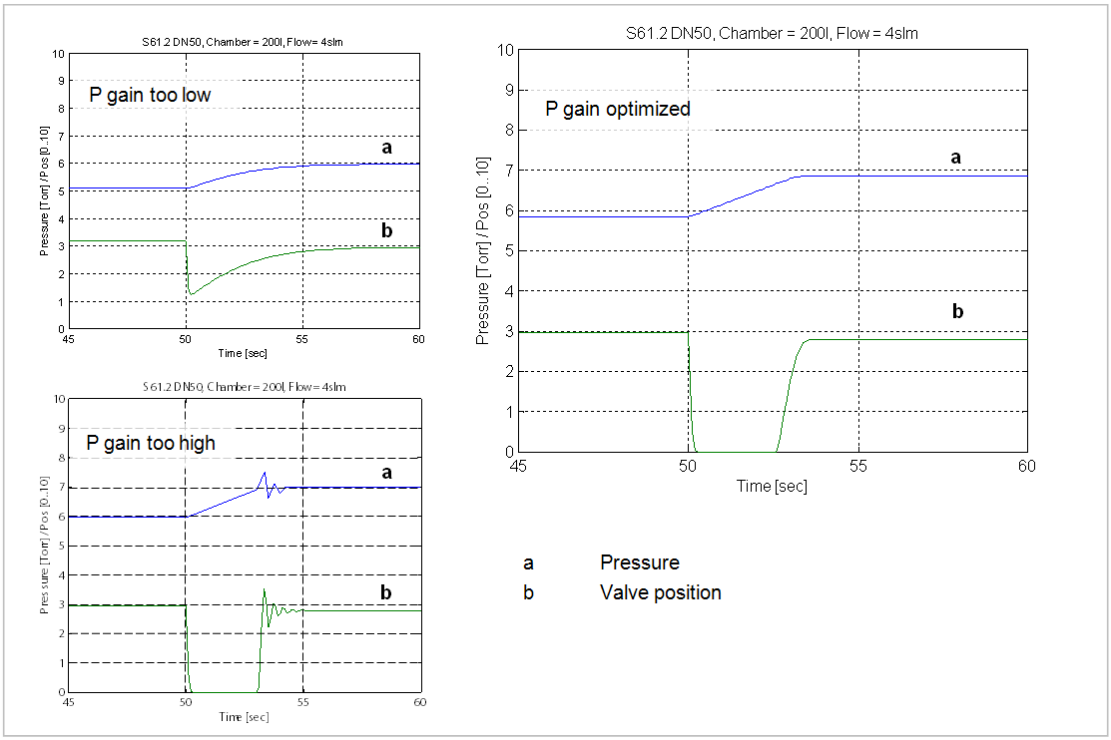
SP1	=	7 Torr
SP2	=	6 Torr
Gas flow	=	4slm

1.2 Optimizing P gain

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

Start optimization with P gain set to 1.0 and I gain set to 0.0.
Set chamber pressure to SP2, wait until the pressure is stable. Set pressure to SP1. If the transition from SP2 to SP1 results in a significant pressure over shoot or even does not stabilize at all, the P gain is too high. If there is no over shoot and the pressure reaches SP1 asymptotically and very slow, P gain is too low.
The optimal P gain value is found if the transition from SP2 to SP1 results in a slight pressure over shoot. It does not matter if there is still a deviation between SP1 and actual pressure.

Example:

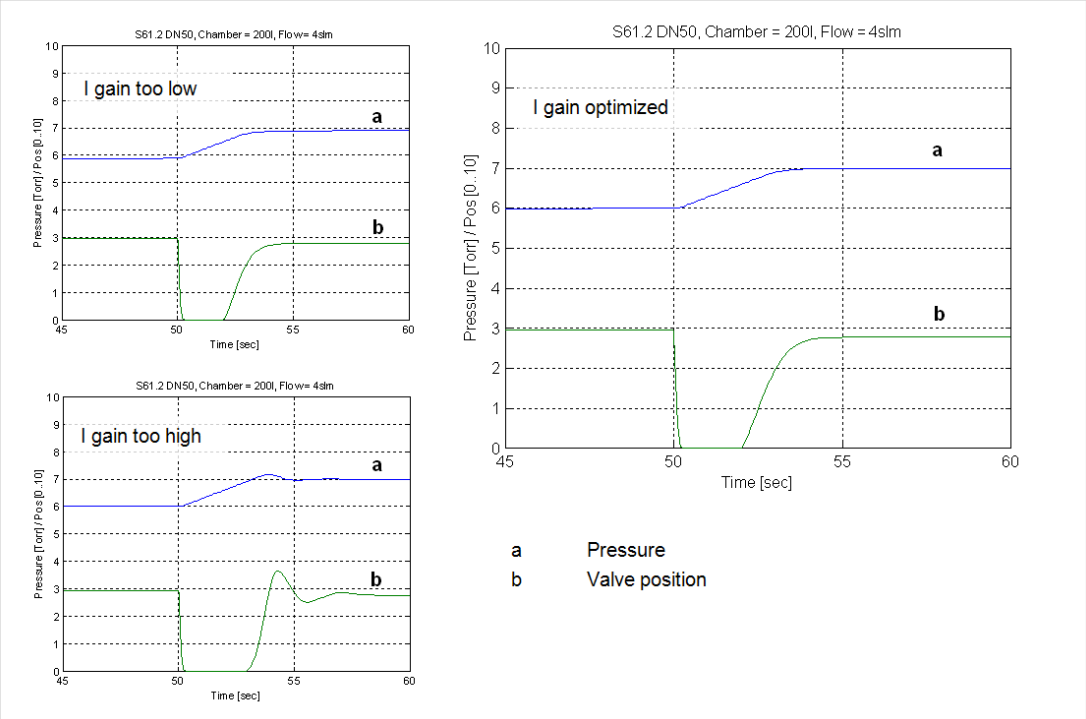


1.3 Optimizing I gain

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

Start with P gain set to half of the value found when optimizing P gain and set I gain to 1.0.
Keep the P gain constant.
Set chamber pressure to SP2, wait until the pressure is stable. Set pressure to SP1. If the transition from SP2 to SP1 results in a significant pressure over shoot or if the valve position does not stabilize, I gain is to 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 View’ resp. ‘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

4.7.3 Tuning of pressure control with soft pump

4.7.3.1 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.

Local operation: ('Control View' resp. 'Control Performance Analyzer')	**Remote operation**:
Go to 'Tools / Terminal' menu and do the: ■ Control cofiguration → Control mode + P-Parameters Refer to chapter « Pressure control configuration» for details.	(It's not possible to do 'Valve speed adjustment' via remote operation.

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 fort he 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

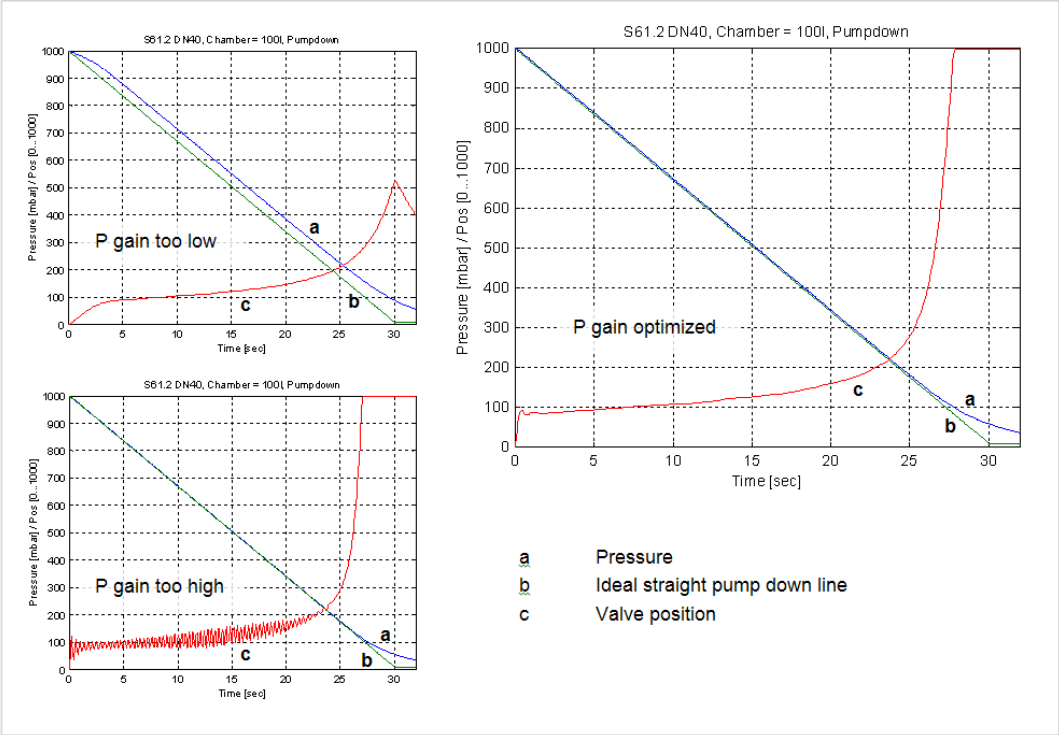
WE start by setting the P gain to 1.0 as a trial value and adjust according to the response.
The pump down routine has to be controlled as follows:

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 View’ resp. ‘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

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 downstream 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 Local operation

Local operation means that the valve is operated via the service port using a computer or the Service Box 2. When using a computer, a service cable and a software from VAT is required.
You can use our Software (freeware) 'Control Performance Analyzer' which can be downloaded from:
http://www.vatvalve.com/customer-service/informations-and-downloads/control-performance-analyzer.

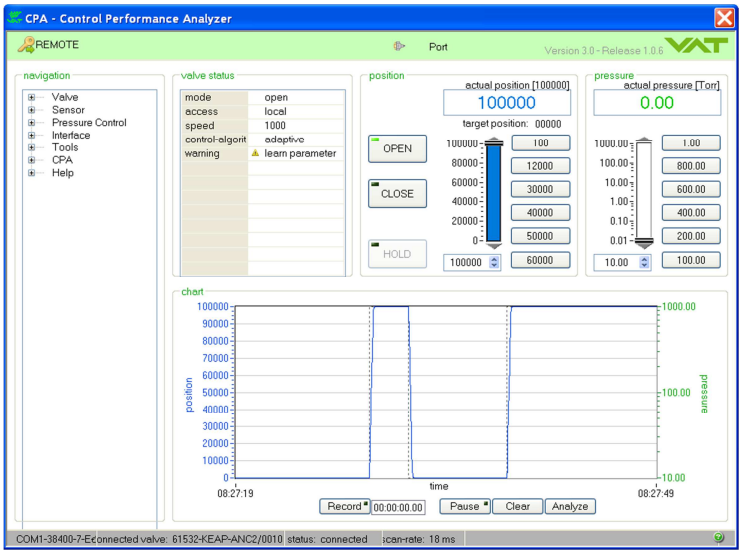
These softwares are beneficial especially for setup, testing and maintenance.

How to start:
Connect service cable between PC and valve controller, start software and push button ‘LOCAL’ to enable for operation. Then enter menu Sensor / Setup and do sensor configuration according to your application to make sure that you get the correct pressure displayed.

‘

'Control Performance Analyzer' supports:

- Valve setup
- Sensor setup
- Pressure control
- Interface setup
- Manual control
- Sequence ontrol
- Numeric and graphical monitoring
- Data recording
- Data analysis
- Advanced diagnostic



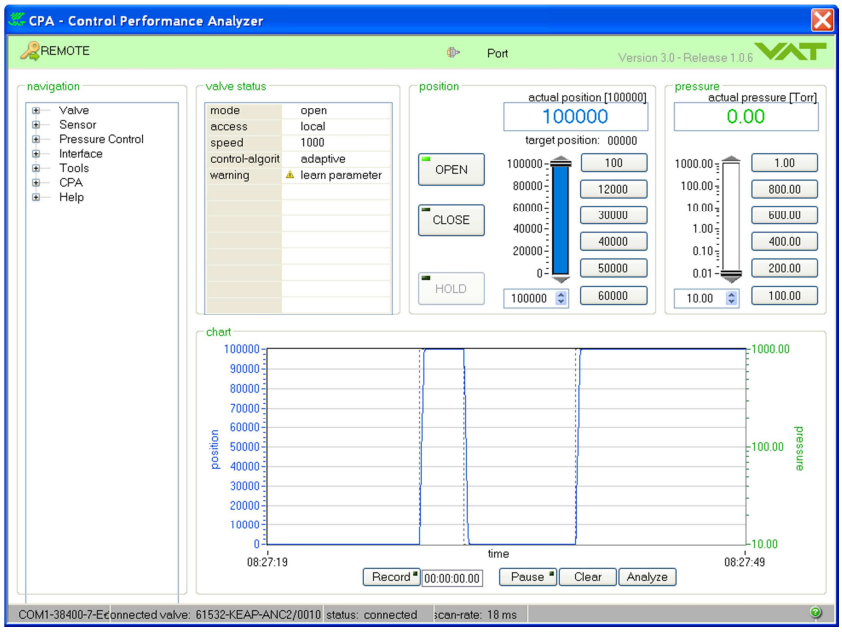
When communication to service port is interrupted the valve will change to remote operation. So when service cable will be disconnected or software will be shut down, the valve returns automatically to remote operation. This may result in an immediate movement of the valve depending on remote control.

Refer to «Accessories» for ordering numbers of service cable and Service Box 2.

5.1.2 Remote operation

This product is equipped with a Logic interface to allow for remote operation. See section «Logic interface» for details. 'Control Performance Analyzer' software or 'Service Box 2' may be used for monitoring during remote control.

'Control Performance Analyzer' software



'Service Box 2'

In case ‘Control Performance Analyzer’ software is connected to valve make sure ‘REMOTE’ button is pushed to enable for remote operation. In case Service Box 2 is connected to valve make sure the LED on button ‘LOCAL’ is OFF for remote operation.

5.2 Close valve

Local operation: ('Control View', 'Control Performance Analyzer' or 'Service Box 2')	**Remote operation**: (Refer to chapter «Digital inputs» for details)
Push CLOSE button	Send CLOSE VALVE

5.3 Open valve

Local operation: ('Control View', 'Control Performance Analyzer' or 'Service Box 2')	**Remote operation**: (Refer to chapter «Digital inputs» for details)
Push OPEN button	Send OPEN VALVE

5.4 Position control

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

Local operation: ('Control View', 'Control Performance Analyzer' or 'Service Box 2')	**Remote operation**: (Refer to chapter «Digital inputs» and «Analog inputs and outputs» for details)
Select or enter position setpoint	1. Set CONTROL MODE to POSITION CONTROL
	2. Set position SETPOINT

In case CLOSE VALVE, OPEN VALVE or HOLD is also set these have higher priority.

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. The PID controller works with an adaptive algorithm to achieve best results under altering conditions (gasflow, gas type).

Local operation: ('Control View', 'Control Performance Analyzer' or 'Service Box 2')	**Remote operation**: (Refer to chapter «Digital inputs» and «Analog inputs and outputs» for details)
Select or enter pressure setpoint	1. Set CONTROL MODE to PRESSURE CONTROL
	2. Set pressure SETPOINT

In case CLOSE VALVE, OPEN VALVE or HOLD is also set these have higher priority.

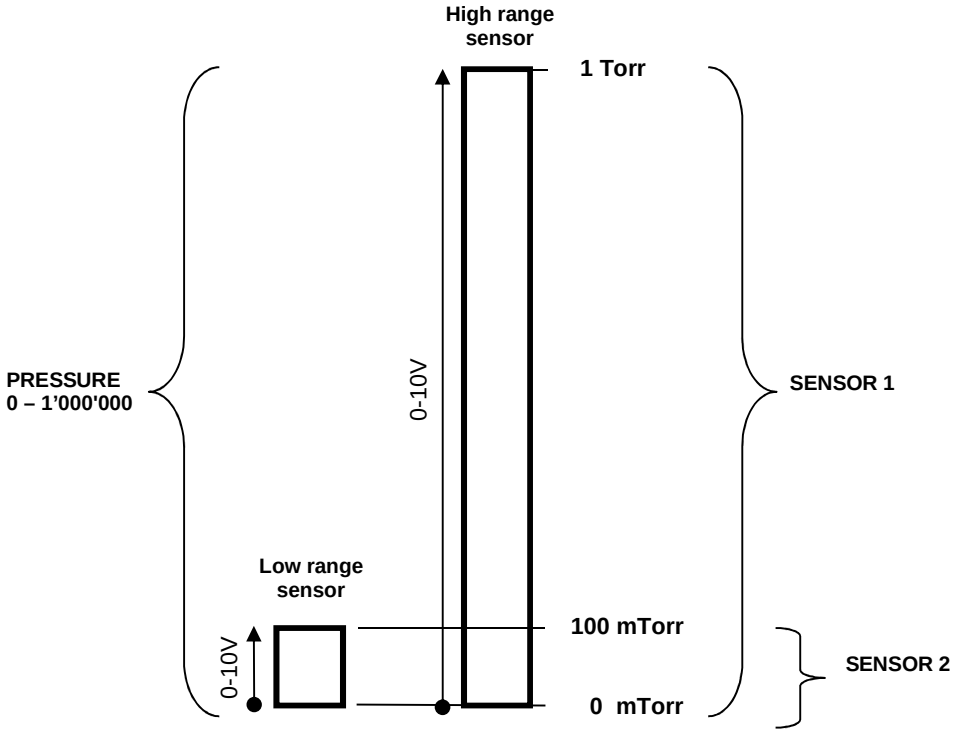
5.5.1 Operation with 2 sensors

[applicable with 612 . . - . . . **E** - . . . . version only]

If 2 sensor operation is enabled, changeover between the sensors is done automatically during pressure control. For configuration refer to chapter «Setup procedure». We recommend a ratio of 10:1 between the pressure gauges. Max. ratio is 100:1. It is required that the high range pressure gauge is connected to sensor 1 input and the low range pressure gauge to the sensor 2 input.
Between 90 and 100% of the low range sensor full scale, the low range sensor is phased out while high range sensor is phased in. This maintains a functional response behavior in case of small calibration errors between the two sensors. The pressure output in this range is a blend between both sensors.
For monitoring purpose each sensor signal may be read out individually.

Make sure that both sensors are calibrated. Do not close optional gauge isolation valves during the transition phase between the sensors.

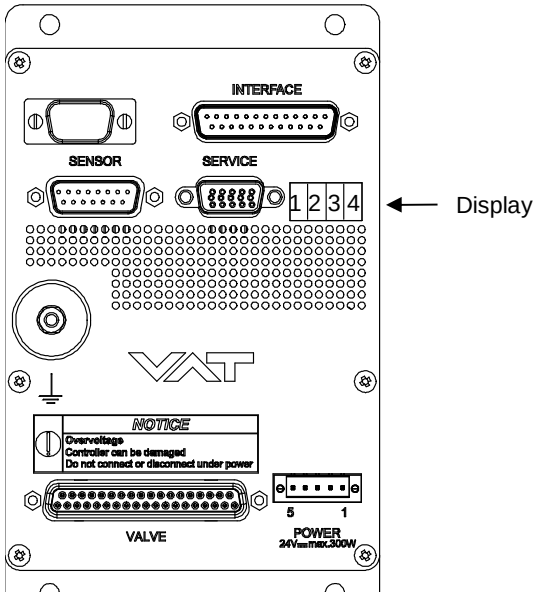
Example of PRESSURE and SENSOR READING allocation:



Above picture shows a 2 sensor system. In this configuration sensor 2 covers low range (100 mTorr) and sensor 1 covers high range (1 Torr). Switchover between sensors is done automatically according to «Pressure control operation with 2 sensors».

5.6 Display information

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



5.6.1 Power up

Description	Digit 1	Digit 2	Digit 3	Digit 4
● Power On: All dots are illuminated	#	#	#	#
● 1st information for about 3s: Firmware generation [e.g. **1G..**]	**1**	**G**		
● 2st information for about 3s: Firmware version and firmware revision [e.g. **00 05**]	**0**	**0**	**0**	**5**
● 3nd information for about 3s: Valve type [e.g. **.642**]		**6**	**1**	**2**
● 4nd information for about 3s: Controller configuration In case **D999** is displayed, motor interlock is active. Refer to «Safety mode» for details.		**1** = Logic interface	**0** = basic **1** = with SPS[1)] **2** = with PFO[2)] **3** = with SPS[1)] and PFO[2)]	**1** = 1 sensor version **2** = 2 sensor version
SYNC indicates that powerup synchronization is running.	**S**	**Y**	**N**	**C**

[1)] SPS = optional ±15 VDC Sensor Power Supply module, [2)] PFO = Power Failure Option

5.6.2 Operation

Description / Mode	Digit 1	Digit 2	Digit 3	Digit 4
PRESSURE CONTROL mode	**P**	**0…100** = valve position (%, 0 = closed / 100 = open)		
POSITION CONTROL mode	**V**			
Valve closed	**C**			
Valve open	**O**			
HOLD (position frozen) activated	**H**			
ZERO running	**Z**			
LEARN running	**L**			
Safety mode established. Refer to «Safety mode» for details.	**D**			
Power failure	**F**			
Service request [1)] (valve requires cleaning)			**S**	**R**

[1)] If SR is blinking alternatively with the actual mode display (e.g. P.11 ⇔ ..SR) the valve requires cleaning.

5.6.3 Fatal error

Description	Digit 1	Digit 2	Digit 3	Digit 4
Fatal error occurred	**E**	Error code. Refer to «Trouble shooting» for details		

5.6.4 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 synchronize. Display shows ‘D C’ or ‘D999’. In this case synchronization cycle will be done when motor interlock is deactivated. Then Display shows ‘INIT’ for a moment followed by ‘SYNC’.
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.

5.6.5 Service indication

This product is able to indicate that the valve unit needs to be cleaned, or an obstruction is present.
A service request is indicated when the control unit detects that motor steps are apparently not effective. This may happen when the valve unit is heavily contaminated. These ‚lost‘ steps are recognized and will be repeated to attempt target position in the short term. But in the medium term the valve unit requires cleaning or inspection. ‘Service request’ (SR) would be indicated on the display or could be read via remote operation. Refer to «Display information» for details.

5.7 Operation during power up

Valve position before power up:	**Reaction of valve:**	
	Valve power up configuration = closed (default)	Valve power up configuration = open
Closed (isolated)	Valve remains closed. Display shows alternately 'C C' and 'INIT'. Synchronization will be done when first movement command is received.	Valve runs to max. throttle position to detect the limit stops to synchronize. Display shows configuration of product resp. 'SYNC' until synchronization is done. Valve position after power up is open.
All other than closed (not isolated)	Valve runs to max. throttle position to detect limit stop for synchronization. Display shows configuration of product resp. 'SYNC' until synchronization is done.	
	Valve position after power up is closed	Valve position after power up is open

Refer also to chapter: «Display information».

5.8 Behavior in case of power failure

Valve position before power failure:	**Reaction of valve:**	
	Without Power Failure Option (PFO) 642 . . - . . **G** . - . . . . 642 . . - . . **A** . - . . . . 642 . . - . . **T** . - . . . . 642 . . - . . **V** . -	With Power Failure Option (PFO) 642 . . - . . **H** . - . . . . 642 . . - . . **C** . - . . . . 642 . . - . . **U** . - . . . . 642 . . - . . **W** . - . . . .
Any	Valve remains at current position.	Valve will close or open depending on valve configuration 1). Default is closed. Display indicates **F**.

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

All parameters are stored in a power fail save memory.

5.9 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».

6 Trouble shooting

Failure	Check	Action
No dots lighted on display	- 24 V power supply ok?	- Connect valve to power supply according to «Electrical connection» and make sure that power supply is working.
Remote operation does not work	- Local operation via service port active - Safety mode active, check for D on display?	- Switch to remote operation. - Provide power to motor to allow for operation. - Refer to «Electrical connection» for details.
Display shows «E 20» (fatal error - limit stop of valve unit not detected)	- Clamp coupling screw not fastened?	- Tighten screw. Refer to chapter «Maintenance» for details.
Display shows «E 21» (fatal error - rotation angle of valve plate limited during power up)	- Valve plate centric adjusted? - Valve unit heavy contaminated? - Valve plate mechanically obstructed?	- Adjust valve plate according to «Maintenance procedure». - Clean valve unit according to « Maintenance procedure ». - Resolve obstruction. - Reset control unit. Cycle power (OFF→ON) or - Send reset command: local via service port with CV/CPA/Service Box2
Display shows «E 22» (fatal error - rotation angle of valve plate limited during operation)	- Valve unit heavy contaminated? - Valve plate mechanically obstructed?	- Clean valve unit according to «Maintenance procedure». - Resolve obstruction - Reset control unit. Cycle power (OFF→ON) or - Send reset command: local via service port with CV/CPA/Service Box2
Display shows «E 40» (fatal error - motor driver failure detected)		- Replace control and actuating unit according to «Maintenance procedure».
Display shows «D 0» Motor Interlock is open	- Motor power supplied?	- Provide power to motor to allow for operation. - Refer to «Electrical connection» for details.
Display shows «SR» (Service Request)	- Valve unit heavy contaminated?	- Clean valve unit according to «Maintenance procedures». - Reset control unit. Cycle power (OFF→ON) or - Send reset command: local via service port with CV/CPA/Service Box2
Display shows «M C» Maintenance mode active		- Pin 14 of service connector is connected to ground. Plate will close. Further movement of plate is blocked. [1)]
Display shows «M100» Maintenance mode active		- Pin 13 of service connector is connected to ground. Plate will open. Further movement of plate is blocked. [1)]
POSITION CONTROL does not work	- Safety mode active, check for D on display?	- Provide power to motor to allow for operation. - Refer to «Electrical connection» for details.
	- POSITION CONTROL selected, check for V on display?	- Select POSITION CONTROL mode. Refer to «Position control» for details.

[1)] Priority of pin 14 is higher than pin 13. If pin 14 is connected to ground after pin 13 the valve will close. Ground of service connector is at pin 4 and 8.

Failure	Check	Action
Pressure reading is wrong or pressure reading is negative	- Sensor(s) connected?	- Refer to «Electrical connection».
	- 2 sensor version present at valve controller?	- Check valve version on page 1. Verify configuration. Refer to «Setup procedure».
	- ZERO done?	- Perform ZERO when base pressure is reached. Refer to «ZERO» for details.
	- Does sensor power supply provide enough power for sensor(s)?	- Verify sensor supply voltage.
CLOSE VALVE does not work	- Safety mode active, check for D on display? - Maintenance mode active	- Provide power to motor to allow for operation. - Refer to «Electrical connection» for details. - Refer to “Display shows «**M C**»” in this table
OPEN VALVE does not work	- Safety mode active, check for D on display? - Maintenance mode active	- Provide power to motor to allow for operation. - Refer to «Electrical connection» for details. - Refer to “Display shows «**M100**»” in this table
ZERO does not work	- Valve in open position, check for O on display?	- OPEN VALVE and bring chamber to base pressure before performing ZERO.
	- ZERO disabled?	- Enable ZERO. Refer to «Valve configuration» for details.
Pressure is not ‘0’ after ZERO	- Sensor voltage shifting?	- Wait until sensor does not shift any more before performing ZERO.
	- System pumped to base pressure?	- OPEN VALVE and bring chamber to base pressure before performing ZERO.
	- Sensor offset voltage exceeds ±1.4V	- Replace pressure gauge.
PRESSURE CONTROL does not work	- Safety mode active, check for D on display?	- Provide power to motor to allow for operation. - Refer to «Electrical connection» for details.
	- PRESSURE CONTROL selected, check for P on display?	- Select PRESSURE CONTROL mode. Refer to «Pressure control» for details.
	- LEARN done?	- Perform LEARN. Refer to «Setup procedure» for details.
PRESSURE CONTROL not optimal	- Setup done completely?	- Perform «Setup procedure» completely.
	- LEARN done?	- Perform LEARN. Refer to «LEARN» for details.
	- ZERO performed before LEARN?	- Perform ZERO then repeat LEARN. Refer to «Setup procedure» for details.
	- LEARN interrupted?	- Repeat LEARN. Refer to «LEARN» for details.
	- Was gas flow stable during LEARN?	- Repeat LEARN with stable gas flow. Refer to «LEARN» for details.
	- Tuning done?	- Tune valve for application. - Refer to «Tuning of control performance» for details.
	- Is sensor range suited for application?	- Use a sensor with suitable range (controlled pressure should be >3% and < 98% of sensor full scale).
	- Noise on sensor signal?	- Make sure a shielded sensor cable is used.

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

One maintenance procedures are defined for this valve:

- **Replacement of gate seal** (gate and bonnet seal) **and valve cleaning**

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

VAT can give the following recommendations for preventive maintenance:

Replacement of	**Recommendation**
Gate seal (gate and bonnet seal)	Every 100’000 cycles

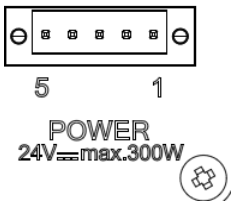
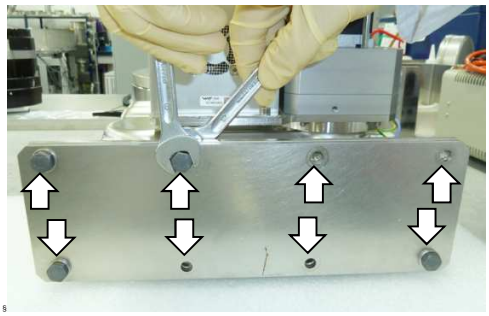
For spare parts of gate and bonnet seal refer to chapter: «Spare parts»

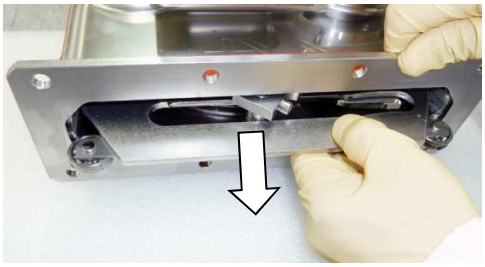
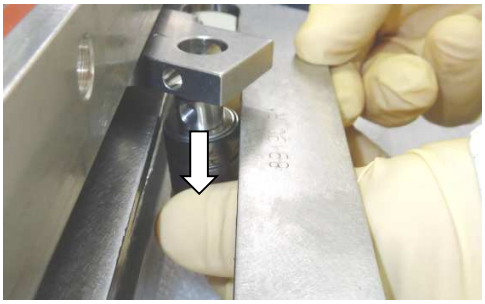
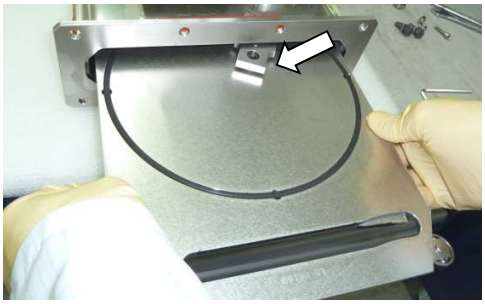
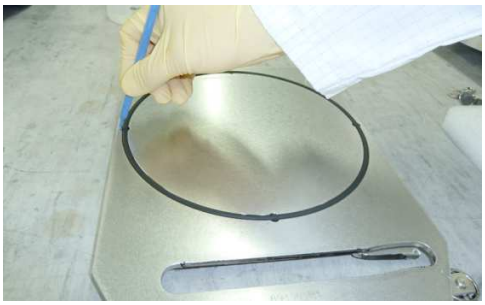
All pictures in maintenance procedure are sample pictures (DN63…400)

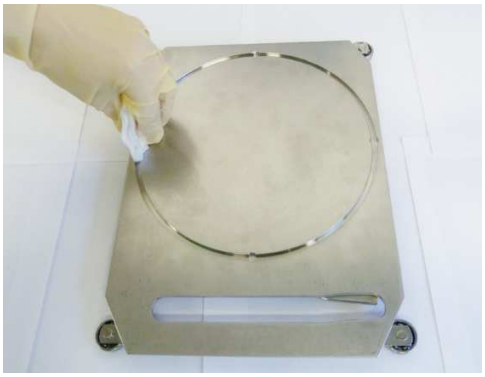
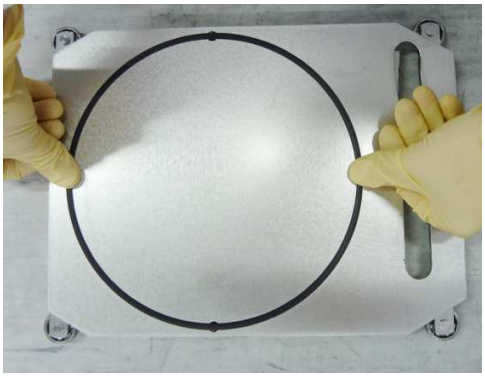
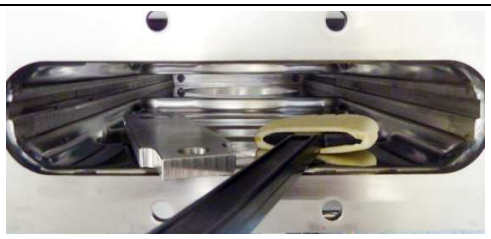
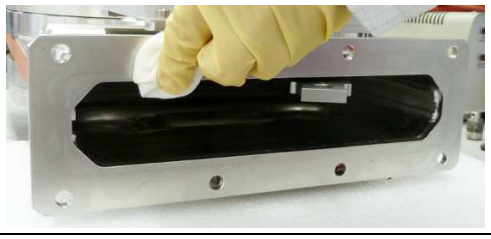
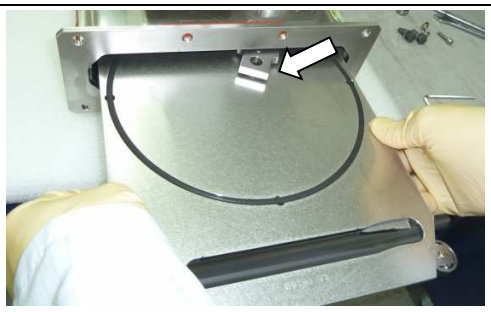
7.2.1 Replacement of gate seals and valve cleaning

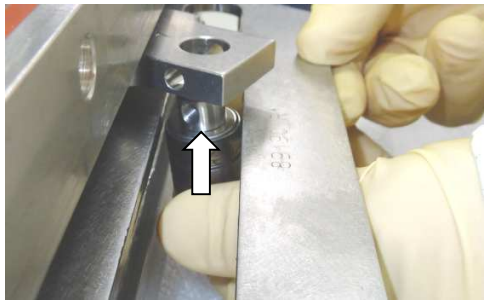
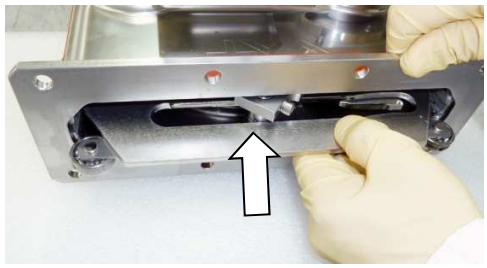
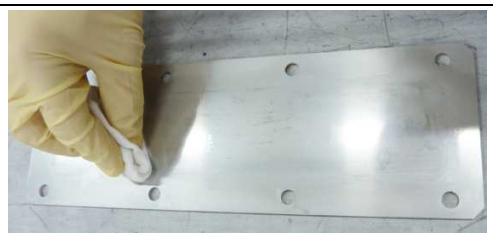
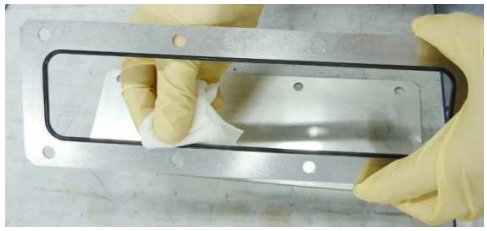
7.2.1.1 Required tools

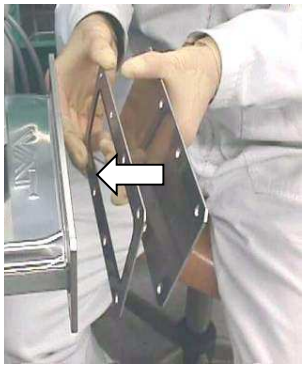
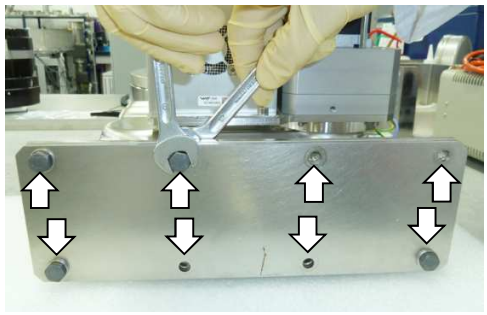
- Allen Wrench 4 mm (Allen torque wrench 4 mm)
- 2 × Open end wrench 13 mm
- Open end torque wrench 13 mm
- 2 × Open end wrench 10 mm
- Open end torque wrench 10 mm
- Isopropyl alcohol
- Vacuum grease (see chapter spare parts)
- O-ring removal tool (see chapter Accessories)
- Clean room wiper

Description		Required tool
1. Vent both valve chambers 2. Open the valve 3. Turn off power to valve controller 4. Disable power-fail option (wait 60 seconds)		CPA or Service Box 2
5. Disconnect power cable at controller		
6. Unfasten and remove the bonnet screws		2 × Open end wrench 10 mm (DN 63 / 100) 2 × Open end wrench 13 mm (DN160…400)
7. Remove valve bonnet and bonnet seal 8. Deposit both parts on a clean place		

Description		Required tool
9. Pull out the gate until the crank bolt can be reached		
10. Loosen and remove the crank bolt screw		Allen wrench 4 mm
11. Remove the crank bolt from lever		
12. Pull out the gate assembly complete **Caution!** Take care that gate is not scratching at lever while pulling out		
13. Place the gate on a clean place 14. Remove the gate o-ring		O-ring removal tool

Description		Required tool
15. Clean the o-ring groove and the gate assembly		Clean room wiper a little soaked with isopropyl alcohol
16. Install the new o-ring equally in o-ring groove (for new o-ring refer to chapter: «Spare parts»)		
17. Clean the valve body inside		Cleaning tool a little soaked with isopropyl alcohol (refer to chapter «Spare parts» for cleaning tool)
18. Clean the sealing surface of valve		Clean room wiper a little soaked with isopropyl alcohol
19. Push in the gate assembly until…see step 20 **Caution!** Take care that gate is not scratching at lever and body while pushing in.		

Description		Required tool
20. Insert the crank bolt at lever If necessary use a new crank bolt (for new crank bolt refer to chapter: «Spare parts»).		
21. Fasten the crank bolt screw adequately		Allen torque wrench 4 mm
22. Push in the gate assembly into valve body		
23. Clean the valve bonnet		Clean room wiper a little soaked with isopropyl alcohol
24. Clean or replace the bonnet seal 25. Lubricate the seal side with 0.1 ml vacuum grease If necessary to use a new bonnet seal (for new bonnet seal refer to chapter: «Spare parts»). If new bonnet seal is used (also in case of VATSEAL), no cleaning and lubrication is needed.		Clean room wiper Vacuum grease

Description		Required tool
26. Reassemble the bonnet and bonnet seal with valve		
27. Fasten the bonnet screws with: • DN 63 / 100 with 10 Nm • DN 160…400 with 18 Nm		DN 63 / 100 1 × Open end torque wrench 13 mm 1 × Open end wrench 13 mm DN 160…400 1 × Open end torque wrench 13 mm 1 × Open end wrench 13 mm

7.2.2 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

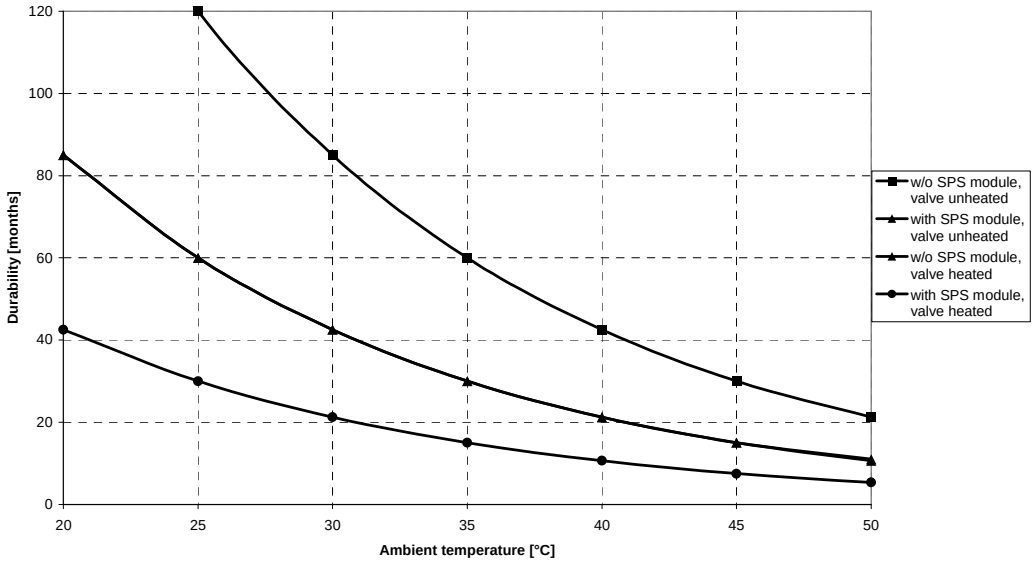
The modules may be retrofitted or replaced easily. The battery lifetime of the PFO module depends on the ambient temperature (see below). To assure PFO function the option board must be replaced after battery life has expired. For ordering number of the modules refer to chapter «Spare parts».

7.2.2.1 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.

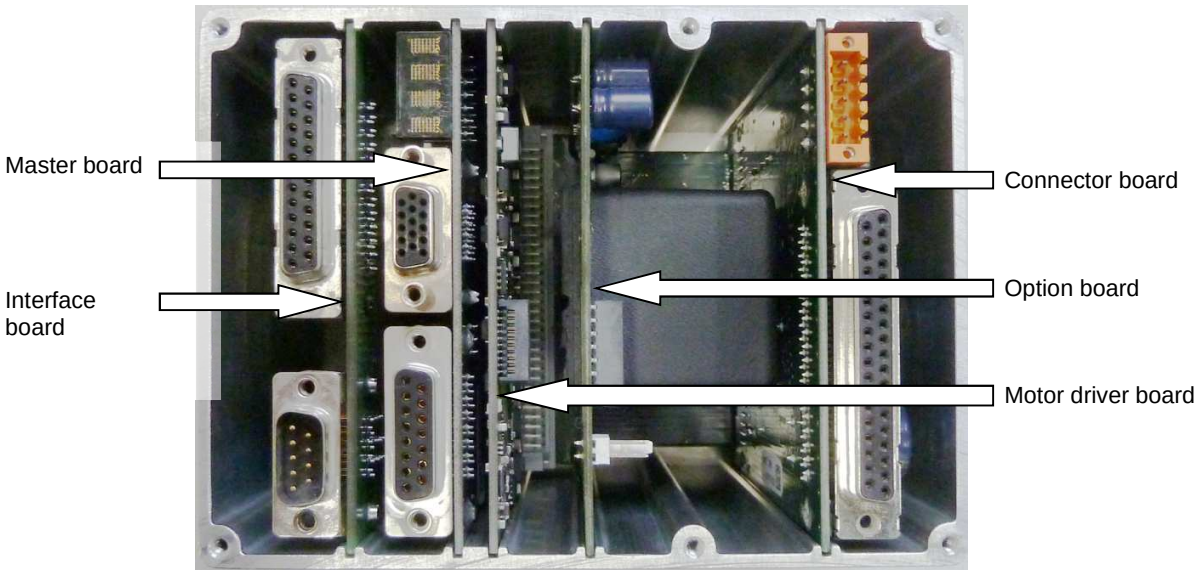
Therefore please determine the equivalent maintenance period for replacing the Ultra Cap battery (Option board).



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

7.2.3 Retrofit / replacement procedure

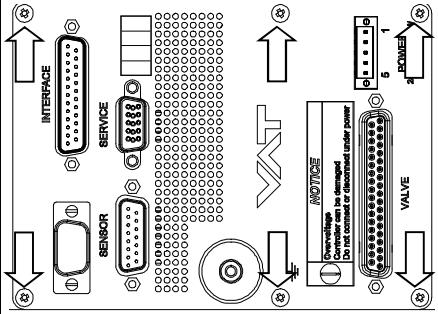
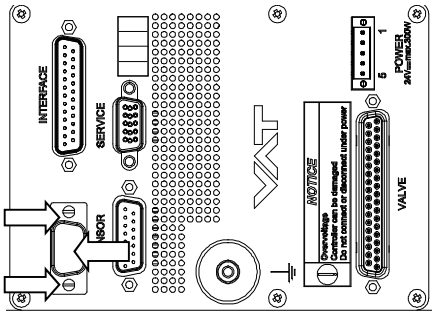
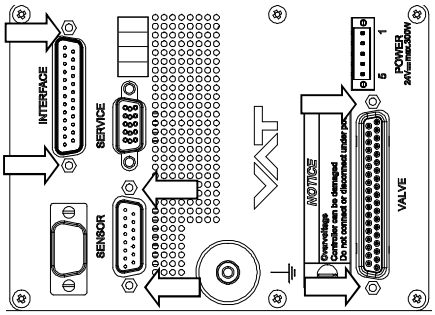
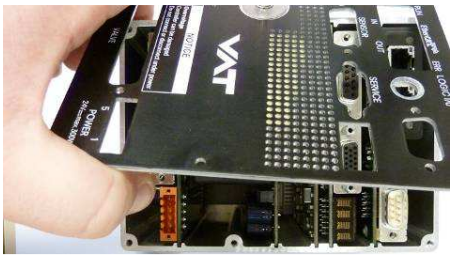
Top view on control and actuating unit with panel removed:

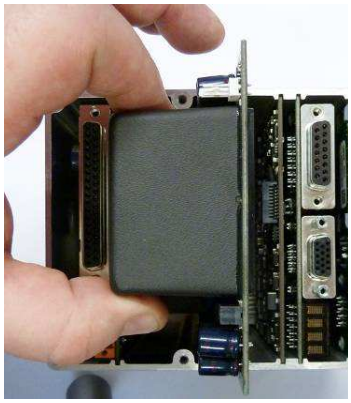


All boards have a fixed position into control and actuating unit. It is not possible to fit a board in other position as shown in picture above!

7.2.3.1 Required tools

- Open end wrench 4.5 mm
- Open end wrench 7 mm
- Pozidriv screw driver size 1
- Screw driver size 2

Description		Required tools
1. Disconnect all electrical connections at controller.	**Attention to ESD protection!** 	Pozidriv screw driver size1 Open end wrench 7 mm
2. Remove the panel screws.		Pozidriv screw driver size1
3. Remove this screws and the cover.		Screw driver size 2
4. Remove female screw locks from connectors.		Open end wrench 4.5 mm
5. Lift controller panel carefully.		(sample picture)

Description		Required tools
6. Remove or replace option board.		(sample picture)
7. Reassemble all parts in reverse order (see steps 6…3). 8. Tighten panel screws with 1.1 Nm (see step 3).		
9. Connect all electrical connections.		Pozidriv screw driver size1 Open end wrench 7 mm

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

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

⚠ WARNING

Unqualified personnel

Inappropriate handling may cause serious injury or property damage.

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

12 Spare parts

NOTICE

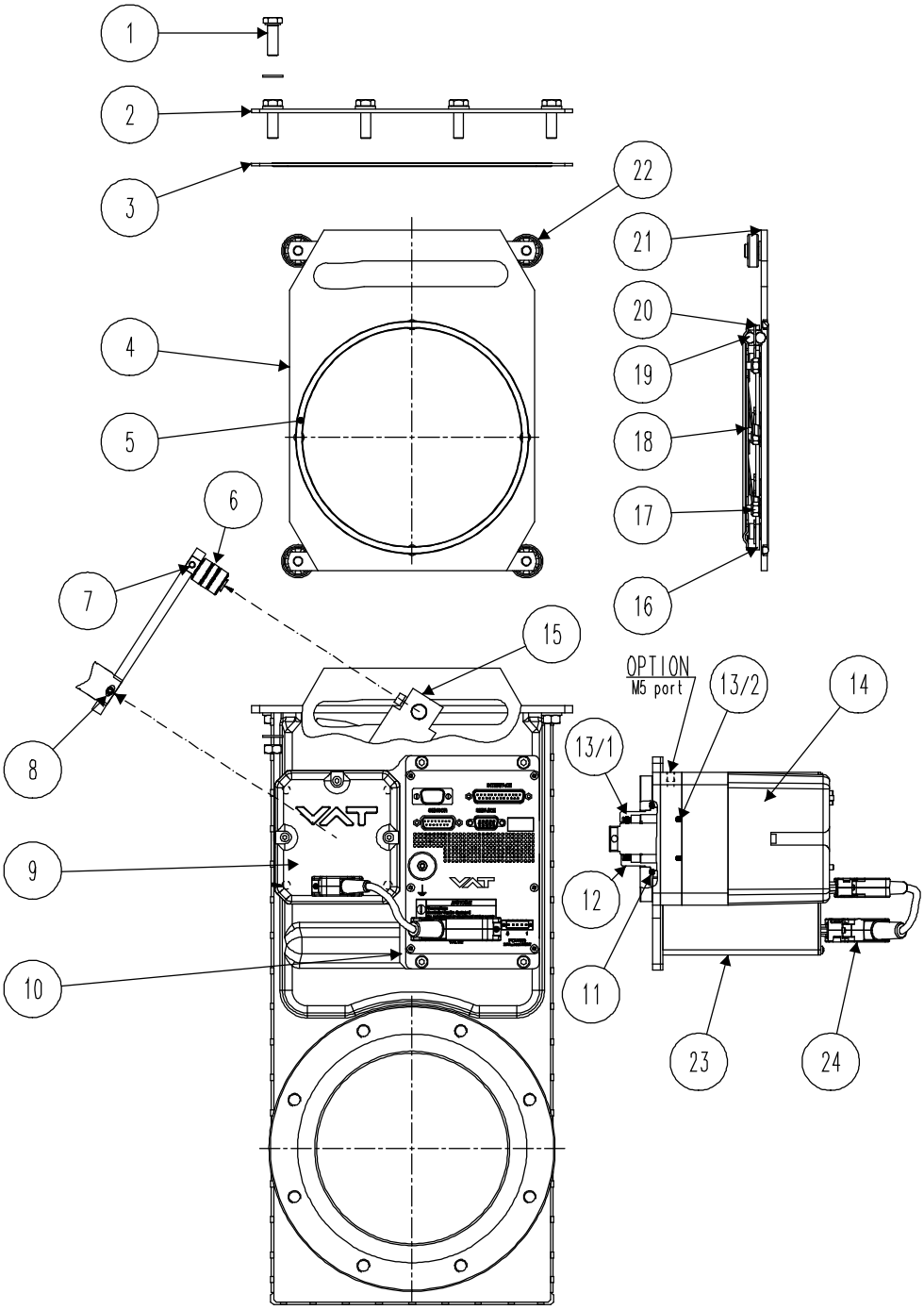
Non-original spare parts

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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OPTION
M5 port
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All “Item“ refer to chapter «Drawing»

12.1.1 Valve unit with seals and grease

Item	Description	DN 63	DN 80	DN 100	DN 160	DN 200	DN 250	DN 320 DN 350	DN 400
3	Bonnet seal	77775-R1	77775-R1	77778-R1	77781-R1	77784-R1	N-5100-378	N-5100-382	N-5100-383
4	Gate assembly	591063	590996	590858	84275-R1	84608-R1	83481-R1	409173	215561
5	Gate O-ring	N-5102-340	220113	N-5102-351	N-5102-364	N-5100-372	N-5102-453	N-5102-457	N-5100-461
6	Crank bolt	79090-R1	79090-R1	79090-R1	79090-R1	79090-R1	85783-R1	85783-R1	87749-R1
7	Crank bolt mounting screw with spring washer	N-6005-458 N-6162-405	N-6005-458 N-6162-405	N-6005-458 N-6162-405	N-6005-458 N-6162-405	N-6005-458 N-6162-405	N-6005-502 N-6162-407	N-6005-502 N-6162-407	N-6005-502 N-6162-407
8	Feedtrough connection pin	N-6097-478	N-6097-478	N-6097-478	N-6097-480	N-6097-480	N-6097-509	N-6097-509	N-6097-509
14	Actuator: standard with pumping port	546656 489236	546656 489236	546656 489236	478357 487706	478357 487706	711045 539937	711045 539937	707681 587193
11	Static actuator seal	N-5100-222	N-5100-222	N-5100-222	N-5100-225	N-5100-225	N-5100-228	N-5100-228	N-5100-228
21	Locking balls	N-6121-052 (8 pcs)	N-6121-052 (8 pcs)	N-6121-052 (12 pcs)	N-6121-051 (18 pcs)	N-6121-051 (24 pcs)	N-6121-081 (18 pcs)	N-6121-081 (24 pcs)	N-6121-097 (32 pcs)
23	Controller	On request. To many to list.							
22	Ball bearing assembly	66856-R1 (1 pc)	66856-R1 (1 pc)	67064-R1 (2 pcs)	84326-R1 (2 pcs)	80642-R1 (2 pcs)	99205-R1 (4 pcs)	99205-R1 (4 pcs)	77286-01 (4 pcs)
	Seal kit vacuum	97442-R1	225315	97446-R1	85047-R1	95939-R1	98472-R1	98474-R1	98476-R1
	Feedtrough assembling tool		91001-R1				227400		
	VAT vacuum grease (40g)		N-6951-012						

12.1.2 Controller

Item	Description	Part number
	Control and actuating unit	Too many to list. Please contact VAT.
	Option board with SPS module (±15 VDC sensor power supply)	371399
	Option board with PFO module DN63…250 (power failure option)	376419
	Option board with PFO module DN320…400 (power failure option)	875669
	Option board with SPS und PFO module DN63…250 (power failure option)	376098
	Option board with SPS und PFO module DN320…400 (power failure option)	875668

12.1.3 Accessories

Description	Part number
24 VDC power supply unit (input: 100 – 240 VAC)	572699
'Control Performance Analyzer' package for Windows®	free download from: http://www.vatvalve.com/customer-service/informations-and-downloads/control-performance-analyzer
Service cable (PC to valve Service connector)	230327 http://www.vatvalve.com/customer-service/informations-and-downloads/control-performance-analyzer
Connector kit consisting of: •DB-9 female POWER plug •DB-15 male SENSOR plug •DB-25 male INTERFACE plug	242411
Service Box 2	601BS-29NN-000
Control panel (rack-mount version of Service Box 2)	602BS-29LE-000
O-ring removal tool	234859
VAT valve cleaning tool	305709

12.1.3.1 Centering ring with Viton o-ring

Valve size **Product ordering number**		**DN 63 / 2½"** **64236 - . . . .**	**DN 80 / 3"** **64238 - . . . .**	**DN 100 / 4"** **64240 - . . . .**
Centering ring with Viton o-ring (for ISO-F installation only)	Aluminum	32036-QAZV	32038-QAZV	32040-QAZV
	Stainless steel	32036-QEZV	32038-QEZV	32040-QEZV

Valve size Product ordering number		DN 160 / 6” 64244 -	DN 200 / 8” 64246 -	DN 250 / 10” 64248 - . . . .
Centering ring with Viton o-ring (for ISO-F installation only)	Aluminum	32044-QAZV	32046-QAZV	32048-QAZV
	Stainless steel	32044-QEZV	32046-QEZV	32048-QEZV

Valve size Product ordering number		DN 320 / 12” 64250 -	DN 350 / 14” 64251 -	DN 400 / 16” 64252 - . . . .
Centering ring with Viton o-ring (for ISO-F installation only)	Aluminum	32050-QAZV	none	32052-QAZV

13 Appendix

No information entered on time.

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