Installation, Operating & Maintenance Instructions

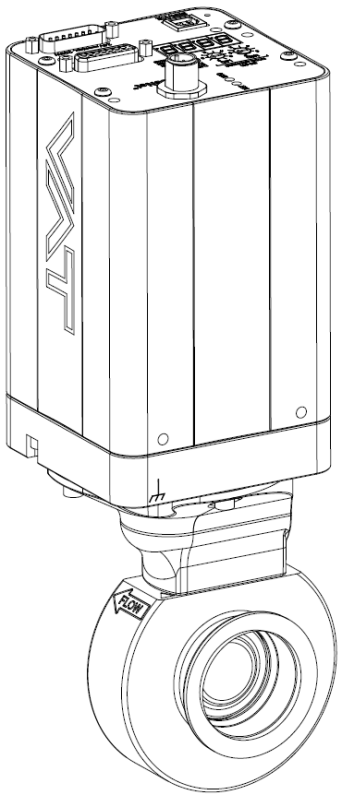
Butterfly control & isolation valve
with extended control range
with DeviceNet interface

Series 616
DN 40-100 mm (I.D. 1.5“ - 4")

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

616 . . - . .GQ -	(2 sensor inputs / analog outputs)
616 . . - . .AQ -	(2 sensor inputs / analog outputs / ±15V SPS)
616 . . - . .HQ -	(2 sensor inputs / analog outputs / PFO)
616 . . - . .CQ -	(2 sensor inputs / analog outputs / ±15V SPS / PFO)

SPS = Sensor Power Supply PFO = Power Failure Option



Sample Picture

Imprint

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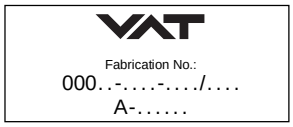
Contents

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 Firmware

Please look up the firmware version in the CPA or read it from the display at start up.
Location: CPA/Parameters: System.Identification.Firmware

1.3 Use of product

This product is a Butterfly control valve for downstream pressure control in vacuum systems.
Use product for clean and dry vacuum applications only. Other applications are only allowed with the written permission of VAT.

1.4 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

1.5 Related documents

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

1.6 Important information

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

Example:

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

1.7 Technical data

1.7.1 Control and actuating unit

See product data sheet.

1.7.2 Valve unit

See product data sheet.

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.

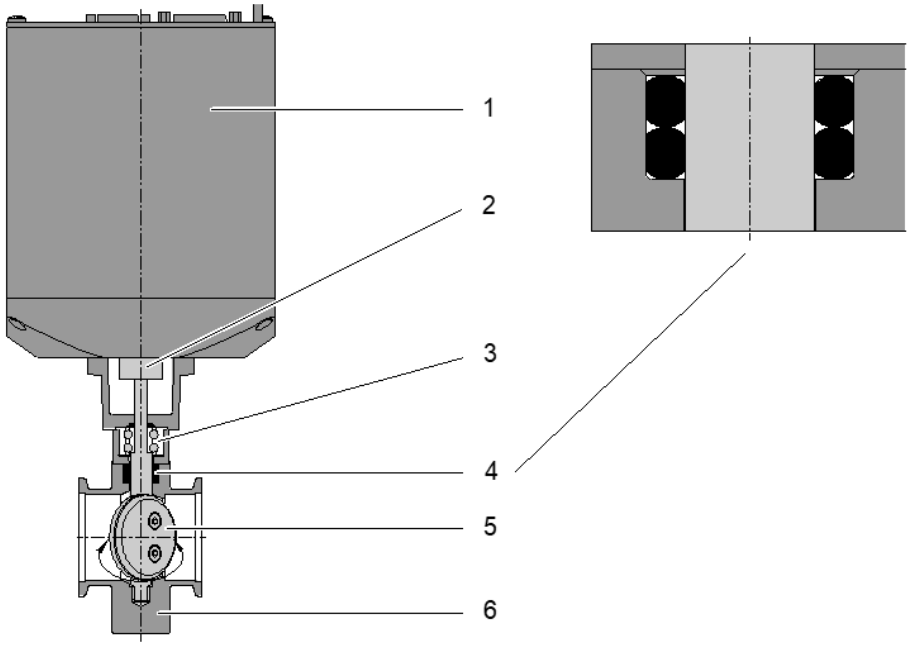
Only qualified personnel are allowed to carry out the described work.

2.4 Safety labels

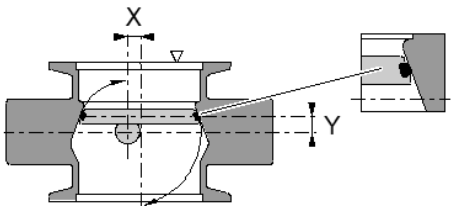
Label	Part No.	Location on valve
	T-9001-156	On protective foil covering of valve opening

3 Design and Function

3.1 Design



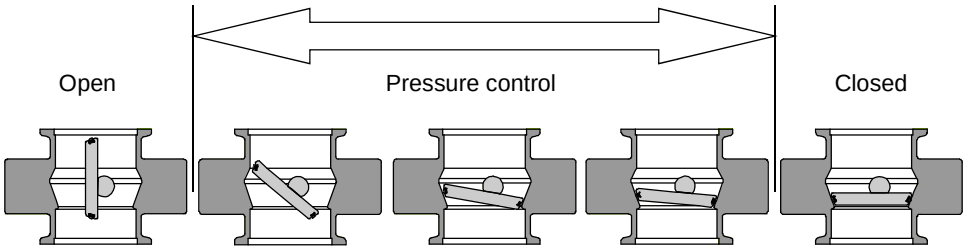
1	Controller	4	Double seal
2	Coupling	5	Plate
3	Bearing	6	Body



XY: Double excentric bearing: prevents wearing of the O-ring and particle generation

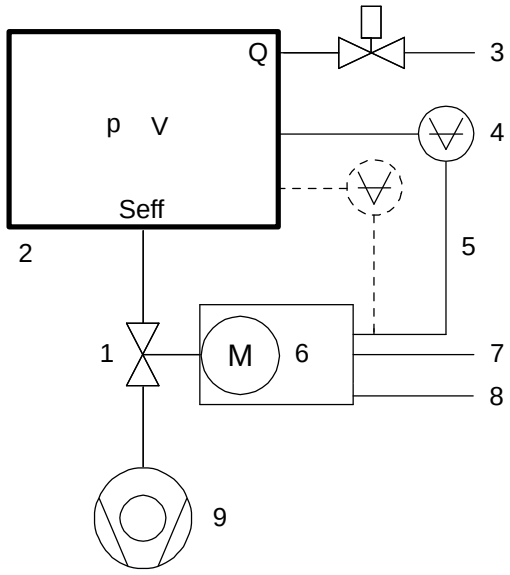
3.2 Function

The valve plate acts as a throttling element and varies the conductance of the valve opening. The integrated controller calculates the required plate position to achieve the setpoint pressure. Actuation is handled by a stepper motor with an encoder for position monitoring. This principle ensures fast and accurate process pressure control even in demanding contaminating processes. The seal being attached to the plate reduces the minimum controllable conductance and allows leak tight closing of the valve. In closed position, the seal is pressed against the body.



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:

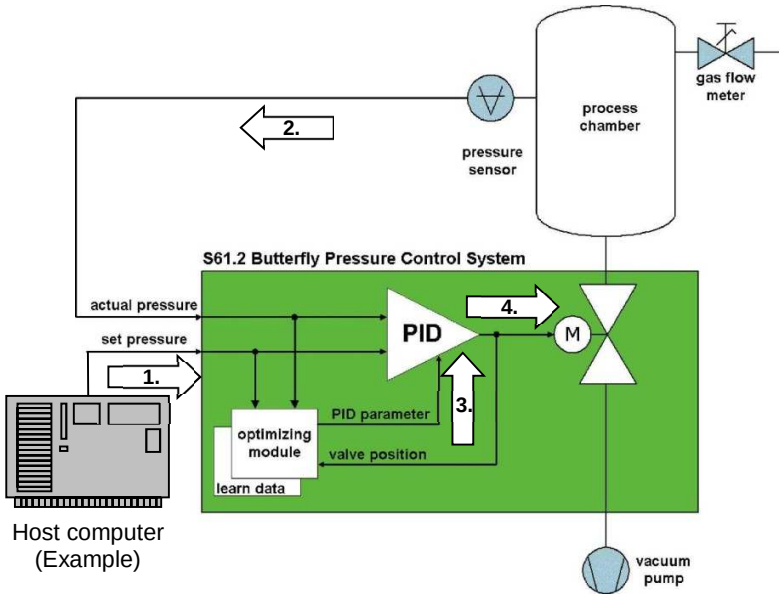
1. Downstream control (standard):
   The pressure is controlled by changing the conductance of a control valve between pump and process chamber. This changes the effective pumping speed at the process chamber. Pressure and gas flow can be independently controlled over a wide range.

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

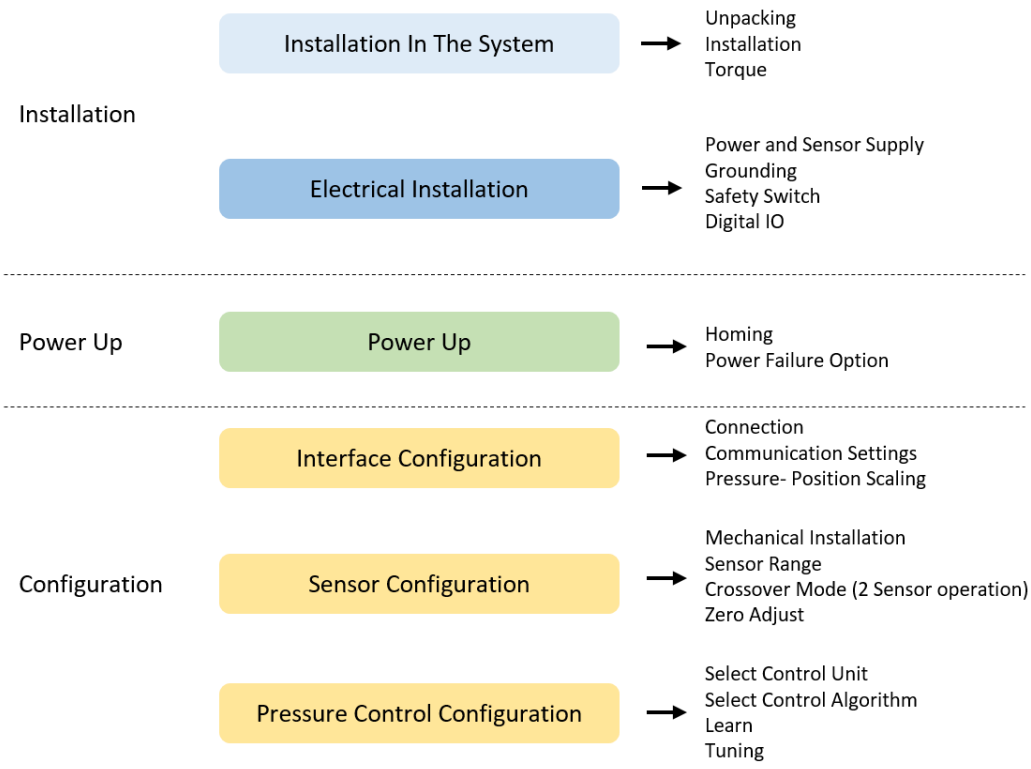
⚠ WARNING

Unqualified personnel

Inappropriate handling may cause serious injury or property damage.

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

4.1 Initial procedure



4.2 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.

NOTICE

Physical overstraining at pedestal

Inappropriate handling with the valve may cause in damage of pedestal.

Lift valve at valve body out of transport case.

- 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. Lift the valve carefully and place it on a clean place.

Do not remove protective foils from valve opening

4.3 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.

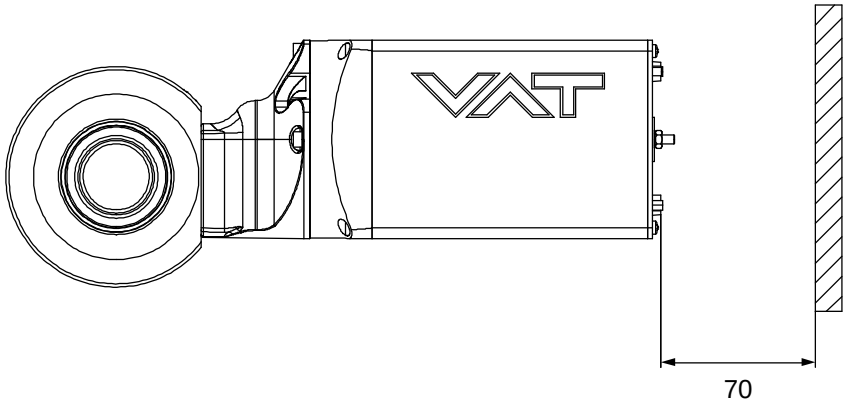
4.3.1 Installation Hints

Install valve into the vacuum system. Valve seat side shall face process chamber.

- Do not tighten the flange screws stronger than indicated under chapter «Tightening torque».
- Do not admit higher forces to the valve than indicated under chapter «Admissible forces».
- Make sure that enough space is kept free to do preventive maintenance work. The required space is indicated on the dimensional drawing.
- Control unit of valves with ISO-KF (616 . . – **K** . . .) needs support when mounted on horizontal piping and control unit does not hang.

4.3.2 Installation space condition

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



Sample picture

4.3.3 Admissible forces

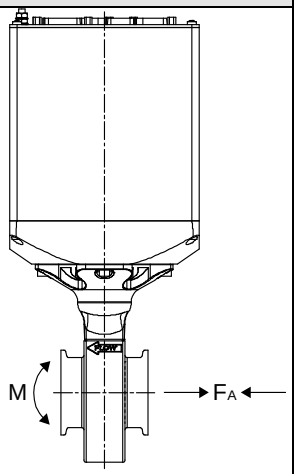
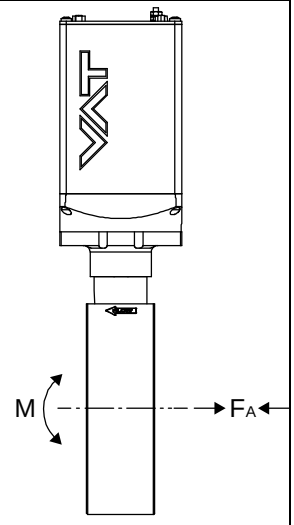
NOTICE

Force at valve body

Forces from the weight of other components can lead to deformation of the valve body and to malfunction of the valve.

Do not higher force the valve body as specified.

The following forces are admissible.

Valve size		Axial tensile or compressive force «F_A»		Bending moment «M»		
mm	inch	N	lb.	Nm	lbf.	
40	1½	100	22	6	4.5	 Sample picture
50	2	150	34	11	8	
63	2½	800	176	32	24	 sample picture
80	3	850	187	35	26.5	
100	4	1000	220	40	30	

4.3.4 Admissible forces at controller

NOTICE

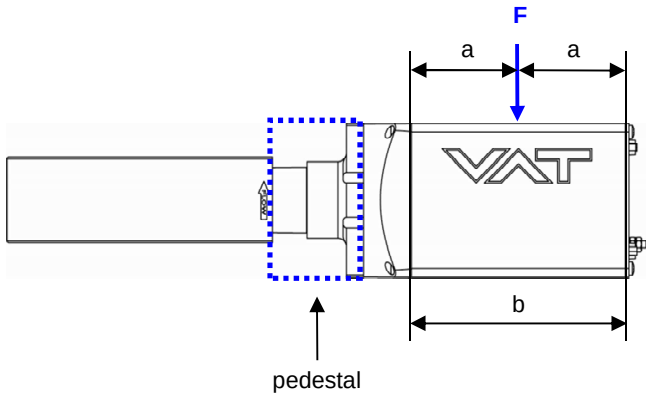
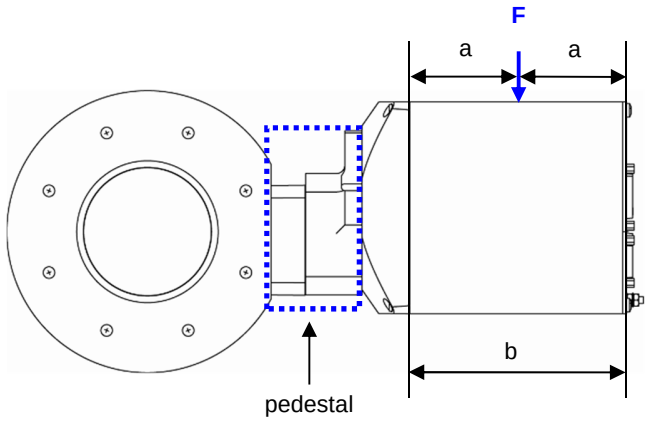
Force at pedestal

In case higher force is applied, the pedestal could be permanently damaged.

– Do not pushing, shocking load, or stressing the valve controller

– Do not deposit anything at valve controller

The admissible force at valve controller in regards to the pedestal is shown in table below

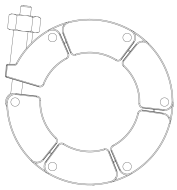
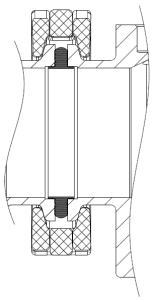
Admissible force «F»	Overview **F** = Force a = middle of aluminum part of controller (b / 2)
400 N	  sample pictures

4.3.5 Tightening torque DNs 40 – 50mm

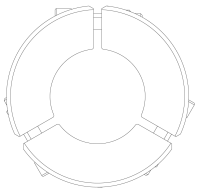
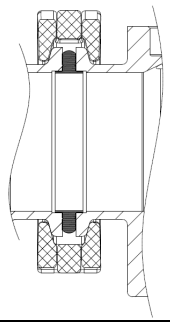
Tightening torques for ISO-KF flange connections depend on the type of seal which is used. Follow recommendations of seal manufacturer.

4.3.5.1 ISO-KF Clamping connections

Clamping chain (example)

Valve size	ISO-KF recommended tightening torque (Nm)	ISO-KF recommended tightening torque (lbs . ft)		
DN40 / 1½ “	5	3.7	 e.g.: 31032-KASA-0001 31034-KASA-0001	
DN50 / 2“	6	4.5		

Clamping device (example)

Valve size	ISO-KF recommended tightening torque (Nm)	ISO-KF recommended tightening torque (lbs . ft)		
DN40 / 1½ “	12	9	 e.g.: 31032-KASE-0001 31034-KASE-0001	
DN50 / 2“	12	9		

4.3.6 Tightening torque DNs 63 – 100mm

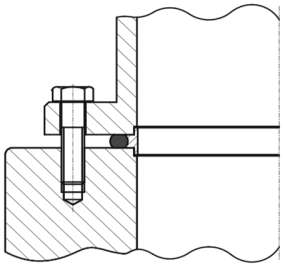
Tighten mounting screws of the flanges uniformly in crosswise order. Observe the maximum torque levels in the following table. Higher tightening torques deforms the valve body and may lead to malfunction of the valve.

4.3.6.1 Mounting of CF-F flanges

Tightening torques for CF-F flange connections depend on the type of seal which is used. Follow recommendations of seal manufacturer.

4.3.6.2 Mounting with centering rings

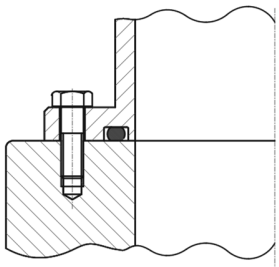
Valve size	ISO-F	ISO-F
	max. tightening torque (Nm)	max. tightening torque (lbs . ft)
DN63 / 2½ “	8-10	6-8
DN80 / 3“	8-10	6-8
DN100 / 4“	8-10	6-8
	hole depth (mm)	hole depth (inch)
DN63 / 2½ “	12	0.47
DN80 / 3“	12	0.47
DN100 / 4“	12	0.47



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

4.3.6.3 Mounting with O-ring in grooves

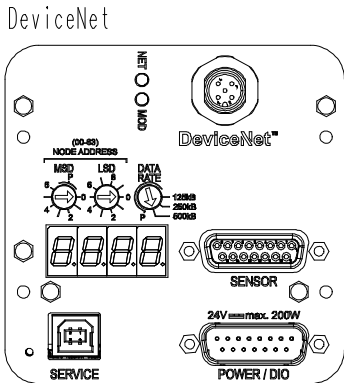
Valve size	ISO-F	JIS	ASA-LP	ISO-F	JIS	ASA-LP
	max. tightening torque (Nm)			max. tightening torque (lbs . ft)		
DN63 / 2½ “	20-23	35-40	35-40	15-17	26-30	26-30
DN80 / 3“	20-23	35-40	35-40	15-17	26-30	26-30
DN100 / 4“	20-23	35-40	35-40	15-17	26-30	26-30
	hole depth (mm)			hole depth (inch)		
DN63 / 2½ “	12	n/a	n/a	0.47	n/a	n/a
DN80 / 3“	12	n/a	n/a	0.47	n/a	n/a
DN100 / 4“	12	n/a	n/a	0.47	n/a	n/a

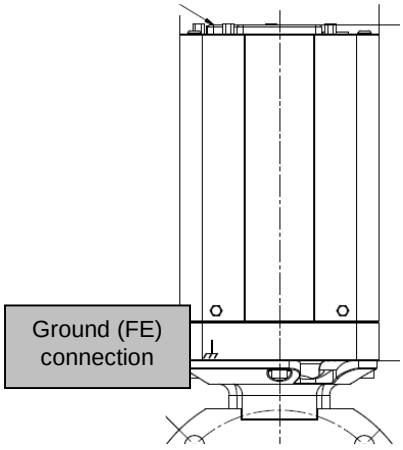


Make sure that screws in use are capable to withstand applied torques.

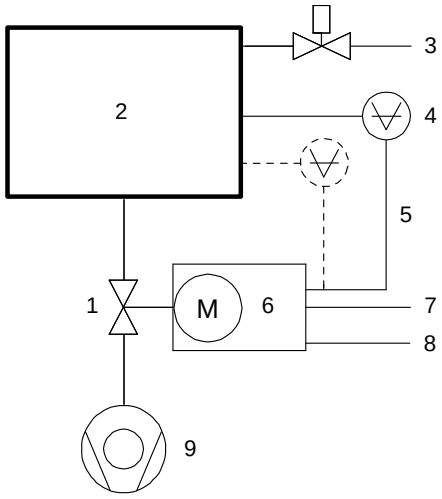
4.4 Connection overview

Controller IC2-H3:





System:



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

4.5 Power-, Ground- and Sensor 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 Connection cable recommendations

For Power Supply connection cables, VAT recommends:

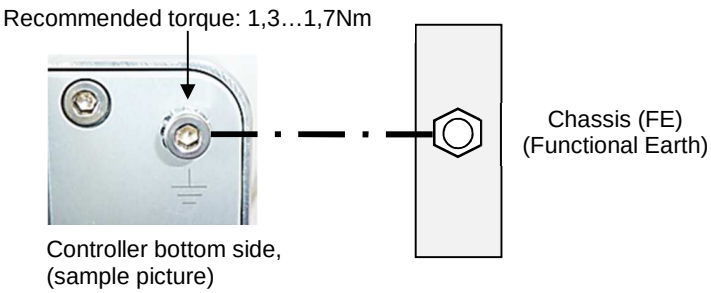
Class (min.)	L (Length max.)	d (diameter)
AWG18 (shielded)	5 m	0.823 mm^2

For Sensor & Signal connection cables, VAT recommends:

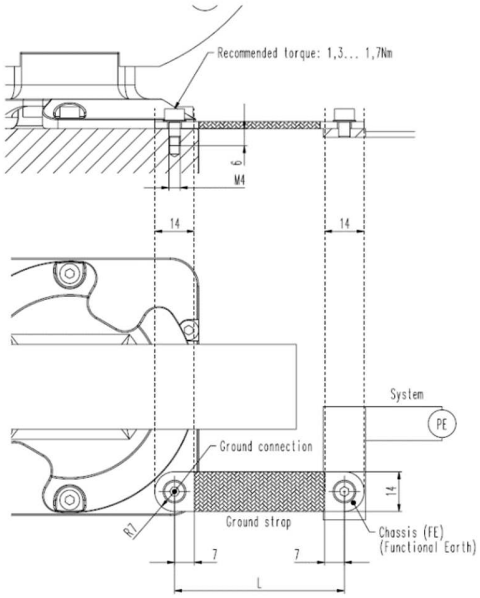
Class (min.)	L (Length max.)	d (diameter)
AWG22 (shielded)	20 m	0.326 mm^2

4.5.2 Ground connection

Recommendation for ground connection between controller and system chassis with cable or with ground strap.



- Recommendation for ground connection cable: AWG 12 (4 mm²)
- The connection point at chassis (FE) must be blank metal (not coated).



- 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)

4.5.3 Power and Sensor supply concepts

This valve offers 3 alternative concepts to supply the sensor(s) with power. This depends on the sensor type and valve version that is used.

Concepts:

24 VDC sensors:

- External +24 VDC supplied to POWER connector is feedthrough to SENSOR connector. Refer to chapter «Power and sensor connection (+24 VDC sensors) ».

±15 VDC sensors:

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

This concept is only possible when Sensor Power Supply (SPS) option is installed.

For max load consumption, refer to chapter «Technical Data – Control and actuating unit».

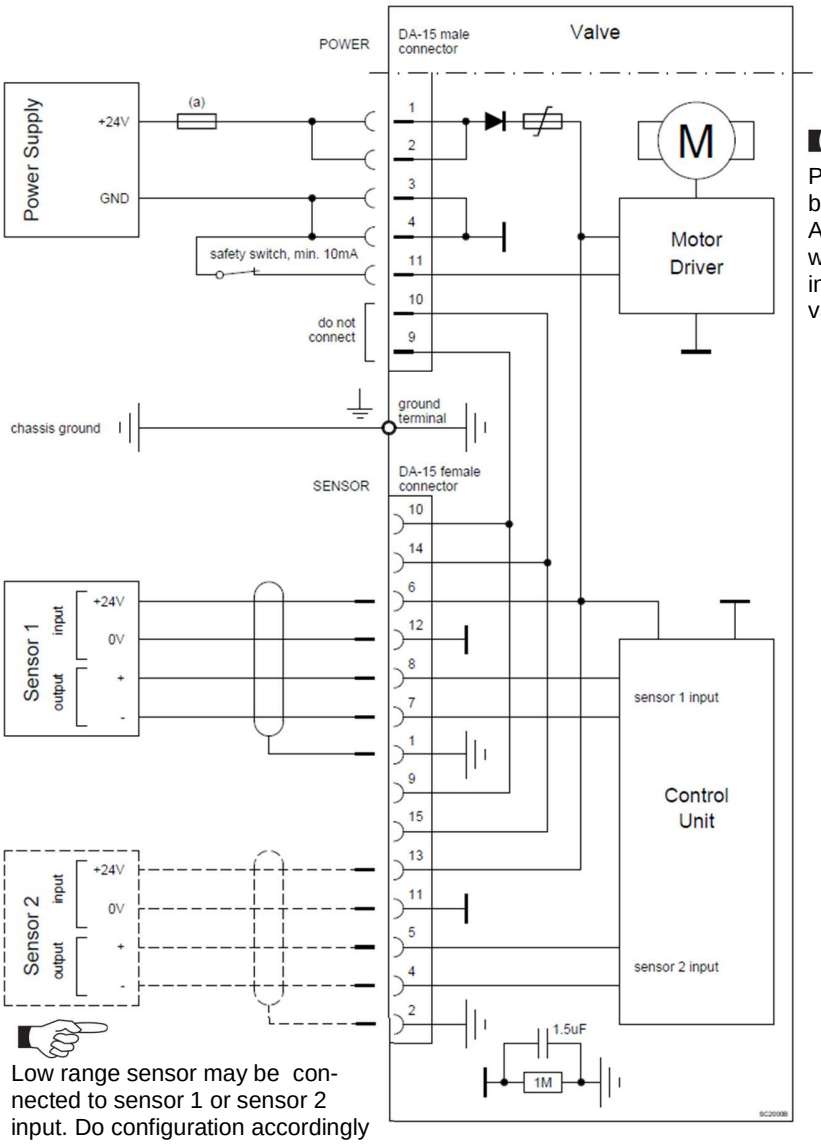
Valve versions:

- 616. . - . . **G** . - . . . . / 616 . . - . . **T** . - . . . . / 616 . . - . . **H** . - . . . . SPS module not included
- 616 . . - . . **A** . - . . . . / 616 . . - . . **C** . - . . . . SPS module included

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

4.5.3.1 Power and 24V sensor connection

[61. . . - . . **G** . - . . . . / 61. . . - . . **H** . - . . . . versions recommended]



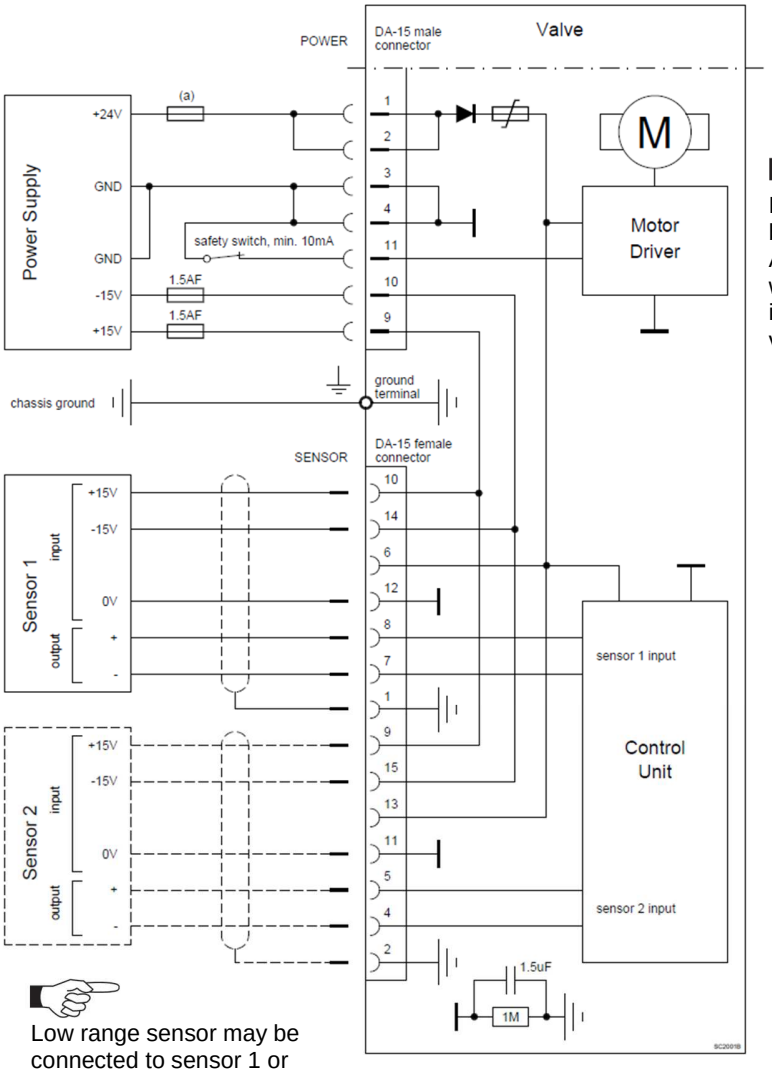
Pins 4 and 11 must be bridged for operation. An optional switch would allow for motor interlock to prevent valve from moving.

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

- **VAT fuse recommendation: (a) 3 AF**
- Use shielded sensor cable(s). Keep cable as short as possible, but locate it away from noise sources.
- Connector: Use only screws with 4–40 UNC thread for fastening the connectors!

4.5.3.2 Power and 15V sensor connection

[61. . . - . . **G** . - . . . . / 61. . . - . . **H** . - . . . . versions recommended]



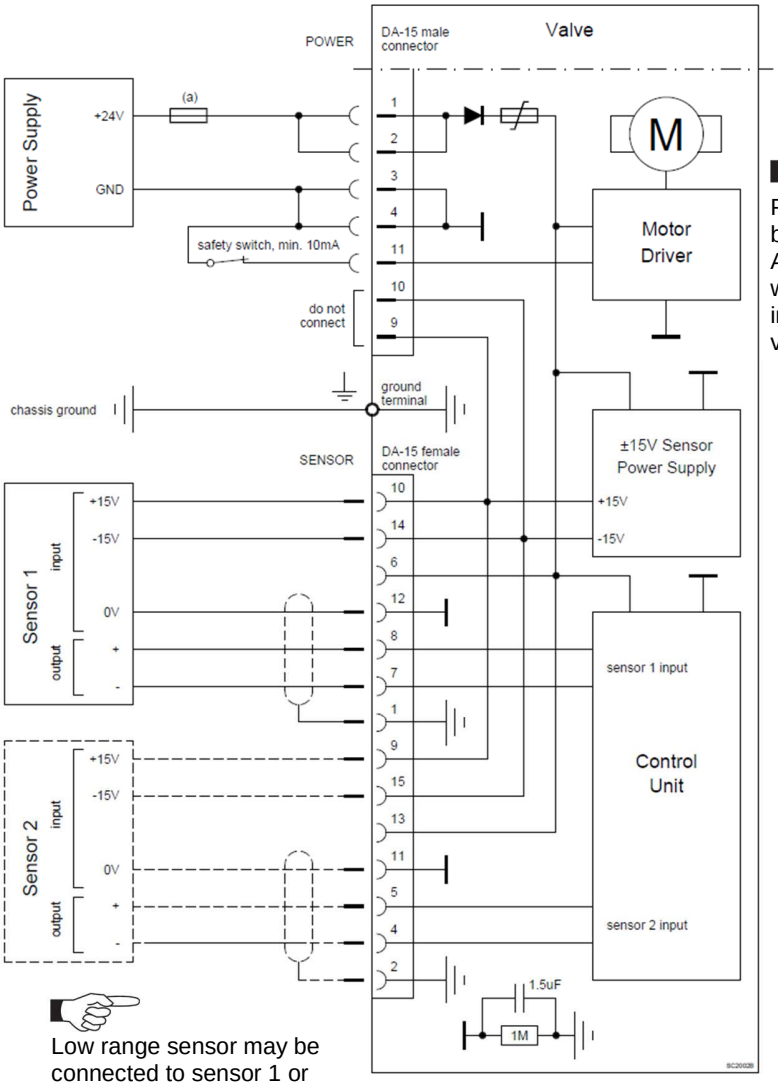
Pins 4 and 11 must be bridged for operation. An optional switch would allow for motor interlock to prevent valve from moving.

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

- **VAT fuse recommendation: (a) 3 AF**
- Use shielded sensor cable(s). Keep cable as short as possible, but locate it away from noise sources.
- Connector: Use only screws with 4–40 UNC thread for fastening the connectors!

4.5.3.3 Power and 15V sensor connection with optional SPS module

[61. . . - . . **A** . - . . . . / 61. . . - . . **C** . - . . . . versions only]

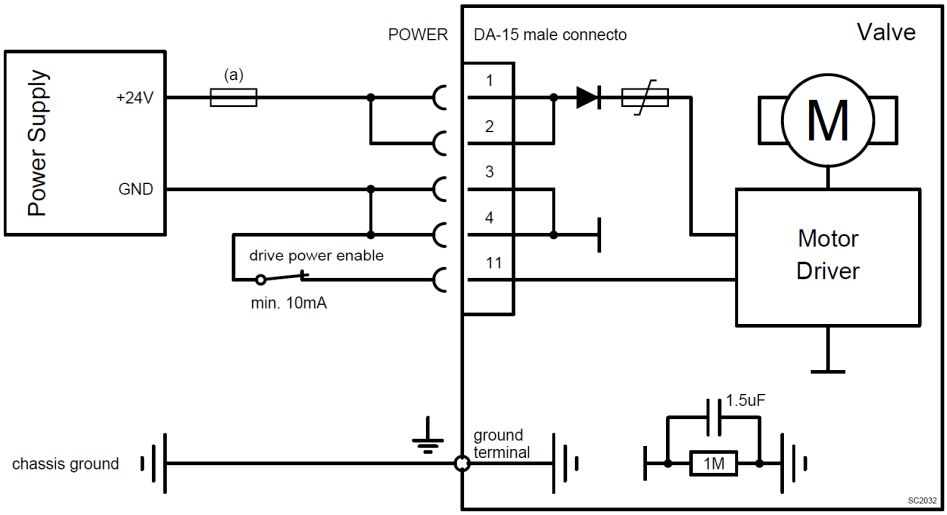


Pins 4 and 11 must be bridged for operation. An optional switch would allow for motor interlock to prevent valve from moving.

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

- **VAT fuse recommendation: (a) 3 AF**
- Use shielded sensor cable(s). Keep cable as short as possible, but locate it away from noise sources.
- Connector: Use only screws with 4–40 UNC thread for fastening the connectors!

4.5.4 Drive Power Enabled Switch, Safety Mode



- By means of an external switch the motor power supply can be interrupted.
- In this case the valve enters the ‘safety mode’.
- This motor interlock prevents the valve from moving (e.g. maintenance work).
- Data reading from the control unit remains possible.
- When motor interlock is active during power up, the valve directly enters the ‘safety mode’ and is not able to do homing.
- When ‘safety mode’ is entered from operation (i.e. pressure control mode), the unit will automatically switch to safety control mode and remain at current position.
  Once motor interlock is deactivated the valve go to control mode ‘Init’, so a homing is necessary and will carried out depending on ‘Homing’ setting (Refer to ‘Power Up, Homing’)

For safety function without human risk it is recommend using interlock function of the digital inputs, because no new homing is necessary after release of the interlock.
Refer to ‘Power connector IO’ >> ‘Digital Input’

4.6 Power Up

After power up or possibly after a reset of the valve homing is necessary to determine the plate position.
Refer to chapter «4.11.2 Homing»

4.7 Power Down, Power Failure Option

4.7.1 Power down behavior in case of power failure

Valve position before power failure:	Reaction of valve:
Closed (isolated)	Valve remains closed.
Valve open or in any intermediate position	The plate remains at the current position.

All parameters are stored in a power fail save memory.

4.7.2 Power Fail Option

Power Fail Option is circuit board that can store as much energy to close or open the valve in the event of a power failure.

Technical data

Charging Time	2 minutes max.
Durability	Up to 10 years @ 25°C ambient

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

Valve must be equipped with the 'Power Failure Option'
[61. . . - . . **C** . - . . . . or 61. . . - . . **H** . - . . . .]
For PFO retrofit and other options refer to chapter: «Spare parts».

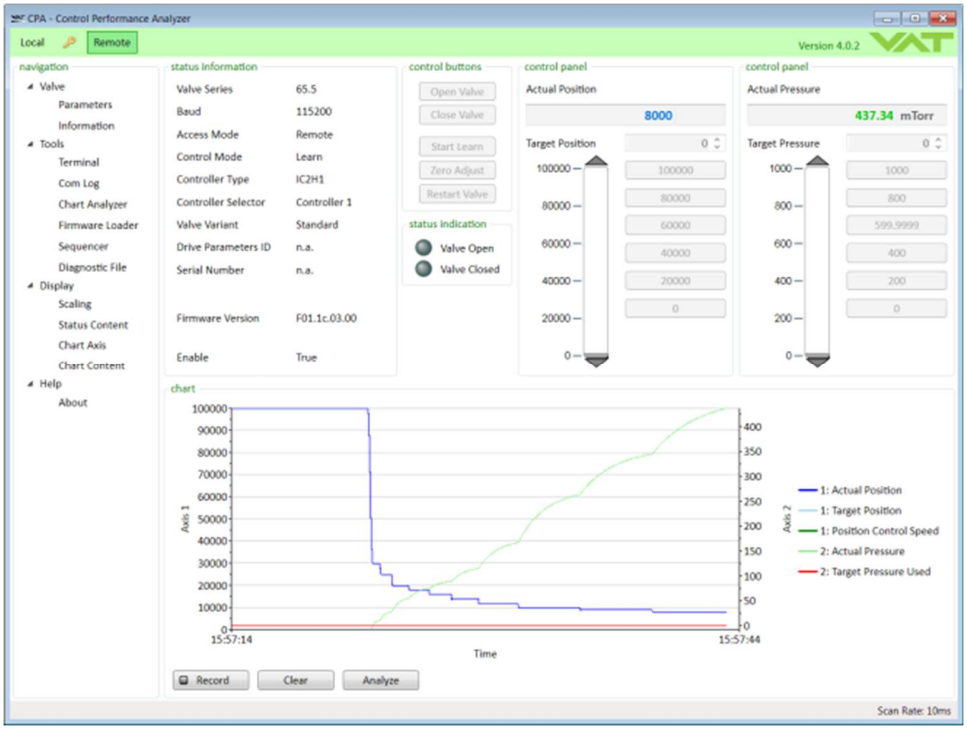
Location: CPA/Navigation/Parameters: Power Fail Option

Parameter	Description
Enable	'True' enables the power fail reaction. 'False' there is no reaction on a power fail
State	*Battery is Charging* *Ready to Use* *Active* *Failure*
Functionality	*Open* *Close*
Delay	In seconds After this delay, the power failure reaction starts after the power failed. Helps to bridge a short power interruption.
Battery Voltage	Shows state of charge
Power Fail Cycles	Counts Power Failure

4.8 Service Port, CPA software

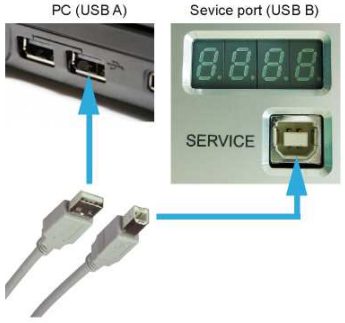
The ‘Service port is designed for ‘Local operation’ with the software CPA - Control Performance Analyzer.

Note: Detailed help on the CPA is available in the help of the CPA itself.

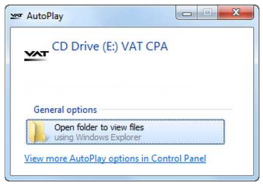


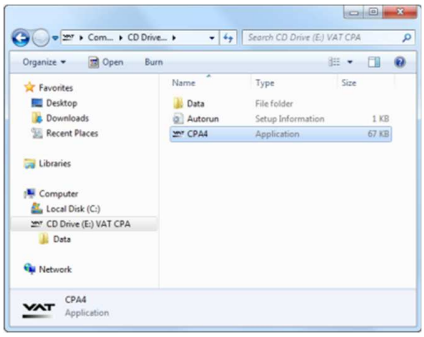
4.8.1 How to start

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

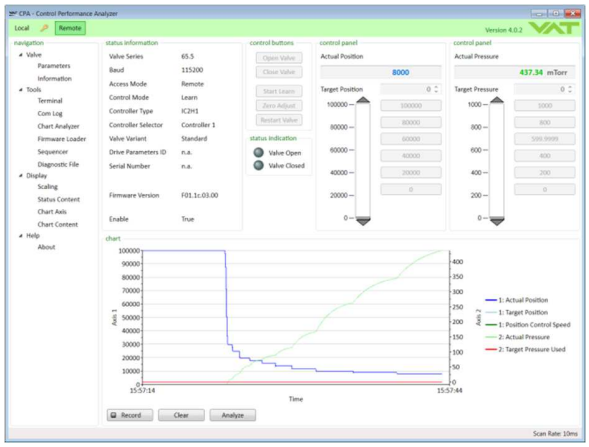


A drive opens:





2. Double Click on ‘CPA4.exe’ to open the ‘Control Performance Analyzer’

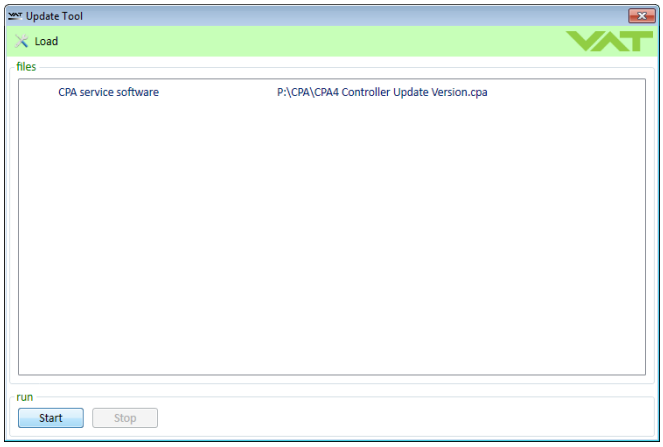


3. Click [Local] for Local operation to do configuration

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.

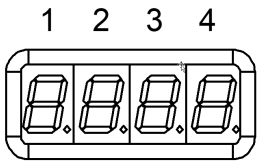
4.8.2 Update

It is easy to update to the latest version of the CPA which can be found on the VAT homepage: https://www.vatvalve.com/downloads/software



4.9 Display Information

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



4.9.1 Power up

Description	Digit 1	Digit 2	Digit 3	Digit 4
● 1st Power On: All dots are illuminated	#	#	#	#
● 2nd Valve series e.g. **67.0**		**6**	**7**	**0**
● 3rd Firmware: generation.type e.g. **01.0C**	**0**	**1**	**0**	**C**
● 4th Firmware: version.firmware e.g. **07.00**	**0**	**7**	**0**	**0**
● 5th Controller configuration: e.g. **11.00**	**Controller** **1**=H1 **2**=H2 **3**=H3 **4**=H4 **5**=H5 **6**=H6 **7**=H7	**Interface** **1**=RS232/RS485 **2**=EtherCAT **3**=DeviceNet **5**=Logic **7**=Profibus **8**=CCLink **9**=EtherNet	**Options** **00**=none **01**=SPS **02**=PFO **03**=Cluster **04**=SPS + PFO **05**=SPS + Cluster **06**=PFO + Cluster **07**=SPS + PFO & Cluster **08**=PFO2 **09**=SPS + PFO2 **0A**=PFO2 + Cluster **0B**=SPS + PFO2 + Cluster **0C**=PFO3 **0D**=SPS + PFO3 **0E**=PFO3 + Cluster **0F**=SPS + PFO3 + Cluster SPS Sensor Power Supply PFO Power Failure Option	
'Ho' homing is running	**H**	**o**		

4.9.2 Operation

Description / Mode	Digit 1	Digit 2	Digit 3	Digit 4
INIT (start up)	**I**	**n.**		
INIT (start up, leak tight)	**I**	**n.**		**C**
CLOSE	**C.**	**C, 0…100** valve position C = closed, leak tight 0 = minimal conductance 100 = maximum opened		
OPEN	**O.**			
PRESSURE control	**P.**			
POSITION control	**A.**			
INTERLOCK Valve closed or open by digital input	**I.**			
HOLD (position frozen)	**H.**			
LEARN	**L.**			
SAFETY Refer to «Safety mode» for details.	**S.**			
POWER FAILURE	**F.**			

4.9.3 Error

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

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

4.10 System Settings and States

4.10.1 Identification

4.10.1.1 Serial Number

Location: CPA/Parameters: System.Identifiaction.Serial Number

Parameter	Description
Serial Number	VAT specific number

4.10.1.2 Configuration

Location: CPA/Parameters: System.Identifiaction.Configuration

Parameter	Description
Valve Series	3-digit value representing the VAT valve series
Valve Variant	For some vale there exists different variants
Nominal Diameter	DN in mm. E.g DN250
Drive Parameter ID	ID of the last drive file loaded on the valve. Sets the parameters responsible for the movement characteristics of the valve
Configuration Parameters ID	ID of the last configuration file loaded on the valve. Configuration of Interface, Pressure Control, Pressure Sensor, …

4.10.1.3 Firmware

Location: CPA/Parameters: System.Identification.Firmware

Parameter	Description
Valve Firmware ID	VAT specific identification number
Valve Firmware Version	Faa.bb.cc.dd a = Platform, Controller Type b = Type **C**ustomer **B**asis **P**roduction **T**est c = Version d = Revision
CPA Version	VAT PC software version
Interface Firmware Version	Network controller firmware
Motion Controller Firmware Version	Motion controller firmware

4.10.1.4 Hardware

Location: CPA/Parameters: System.Identification.Hardware

Parameter	Description
Controller Type	Identification of the use controller IC2H1, IC2H2, IC2H3 …
Interface Type	RS232/RS485 EtherCAT DeviceNet Logic Profibus CCLink EtherNet
Option Type	none SPS PFO Cluster SPS & PFO SPS & Cluster PFO & Cluster SPS & PFO & Cluster SPS…Sensor Power Supply PFO…Power Failure Option

4.10.2 Statistics

Location: CPA/Parameters: System.Statistics

Parameter	Description
Start Up Counter	Each start up is counted (power on and resets) Can be used to monitor whether the valve has restarted uninvited (power loss, watchdog, …)
Total Time Powered Up	In seconds
Time Since Power On	In seconds

4.10.3 Warning/Error

Location: CPA/Parameters: System.Warning/Error

Parameter	Description		
Warning Bitmap	Bit	Hex	Description
	0	1	No Learn Data
	1	2	Isolation valve does not work
	2	4	No Sensor Active
	3	8	PFO Not Ready
	4	16	Cluster Slave Offline
	6	40	Fieldbus Data Not Valid
	8	256	Compressed Air Not Falling when valve close
	9	512	Compressed Air Too Low
	10	1024	Compressed Air Too High
	12	4096	Fan stall alarm
Error Bitmap	Bit	Hex	Description
	0	1	Homing Position Error
	1	2	Homing Not Running
	2	4	Homing Error State
	3	8	Operation Position Error
	4	10	Operation Not Running
	5	20	Operation Error State
	12	1000	Other Component
	30	40000000	General
	31	80000000	Internal
Error Number	Refer to Error Number in Troubleshooting		
Error Code	Refer to Error Code in Troubleshooting		

4.10.4 Service

4.10.4.1 Restart, Error Recovery

Location: CPA/Parameters: System.Services

Parameter	Description
Restart Controller	Emulates a power cycle of the valve
Error Recovery	Attempts to reset the Control Mode Error without restarting the valves

4.10.4.2 Settings Handling

Location: CPA/Parameters: System.Services.Store/Restore Settings

Parameter	Description
Store User Parameters	Emulates a power cycle of the valve
Restore User Parameters	Attempts to reset the Control Mode Error without restarting the valves
Restore Factory Parameters	Protective function against changing the settings. If TRUE, the settings can no longer be changed.

Location: CPA/Parameters: System.Services.Configuration Lock

Parameter	Description
Configuration Lock Mode	Protective function against changing the settings. If TRUE, the settings can no longer be changed.

4.11 Valve Settings and States

4.11.1 States

Location: CPA/Navigation/Parameters: Valve

Parameter	Description
Actual Position	Show position of the valve plate
Position State	Intermediate Closed Open
Isolation State	Not Isolated Isolated

4.11.2 Homing

After power up or possibly after a reset of the valve homing is necessary to determine the plate position.

Location: CPA/Navigation/Parameters: Valve.Homing

Parameter	Description	
Start Condition	Homing start option defines when the valve performs the homing procedure.	
	Standard	Automatically if valve is not in sealed state, otherwise it is waiting for a move command.
	Open Command	On an open command
	Move Command	On any move command
	At Startup	All the time
	Homing Command	On homing command
	Move Command Without Close	On any move command except close command if the valve is closed
End Control Mode	This control mode is set after a successful homing. *Position* *Close* *Open* *Pressure Control*	
End Position	In case the **End Control Mode** is set to 2 (Position), this parameter defines which position is set after successful homing.	

Followed description of the **standard setting**:

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

4.11.3 Cycle Counter

4.11.3.1 Control Cycle

A control cycle is a complete movement of the valve, from closing to opening and back to closing, or in percentage of movement it is 200%. Each movement is added up until 200% of the movement is reached, and then the cycle counter is incremented by 1.

Location: CPA/Parameters: Valve.Position Cycle Counter

Parameter	Description
Control Cycles	The value is writable to be able to reset it
Control Cycles Total	Non-resettable value

4.11.3.2 Isolation Cycle

Counts each compression of the O-ring during the closing process
(Each transition of **Isolation State** from 'Not Isolated' to 'Isolated')

Location: CPA/Parameters: Valve.Position Cycle Counter

Parameter	Description
Isolation Cycles	The value is writable to be able to reset it
Isolation Cycles Total	Non-resettable value

4.11.4 Position Restriction

This allows the position of the valve to be limited in open direction.
The limitation is effective in any control mode
If restriction is active:

- **Position State** remains in Intermediate
- Digital outputs Open becomes not active

Location: CPA/Parameters: Valve.Position Restriction

Parameter	Description
Enable	Enable the restriction
Maximum Position	High position limit
Restriction Active	Indicates that the position is currently restricted by the Position Restriction.

4.11.5 Position Adaption

4.11.5.1 Usage

Chamber Matching
Adjustment of the conductance curve of different valves to obtain the same position at the same process points in different systems.

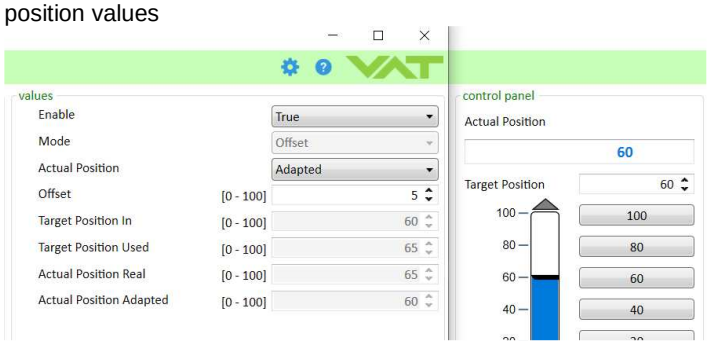
Cluster Balance
Adjusting the Position of individual valves in a valve cluster can be used to compensate certain Side-effects, e.g. keeping suction rate of downstream pump on a defined level.

4.11.5.2 Parameters

Location: CPA/Parameters: Valve.Position Adaption

Parameter	Description
Enable	Enables the adaption
Mode	Mode of the adaption. Currently only *Offset* is available.
Actual Position Mode	Selection of the position which the valve indicates *Real* *Adapted*
Offset	Amount of displacement of the position
Target Position In	Value sent via Interface or CPA Is the same as **Position Control.Target Position**
Target Position Used	Internal used Target Position = Target Position In + Offset
Actual Position Real	Internal real position If setting **Actual Position** = *Real* the valve indicates this position
Actual Position Adapted	Actual Position Real – Offset If setting **Actual Position** = *Adapted* the valve indicates this position

Example: shows parameter window with the offset values and behind the main window with the position values

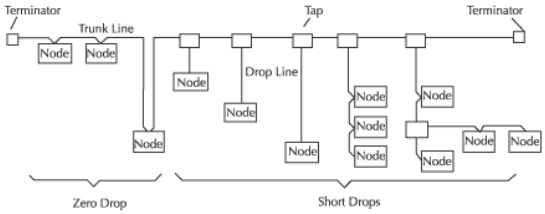


4.12 Interface DeviceNet

DeviceNet was originally developed by Allen-Bradley (now owned by Rockwell Automation). It is an application layer protocol on top of the CAN (Controller Area Network) technology, developed by Bosch. DeviceNet adapts the technology from the Common Industrial Protocol and takes advantage of CAN, making it low-cost and robust compared to the traditional RS-485 based protocols.

DeviceNet is standardized in the European standard EN 50325. Specification and maintenance of the DeviceNet standard are the responsibility of ODVA (www.odva.org). DeviceNet, like ControlNet and EtherNet/IP, belongs to the family of CIP-based networks. CIP (Common Industrial Protocol) forms the common application layer of these three industrial networks. DeviceNet is an object-oriented bus system and operates according to the producer/consumer method. DeviceNet devices can be client (master) or server (slave) or both. Clients and servers can be producer, consumer or both.

In a DeviceNet network, up to 64 bus nodes can communicate with each other at baud rates of 125, 250 or 500 kBaud. In addition to the two signals for CAN-L and CAN-H data transmission, the DeviceNet cable also provides two lines for supplying the DeviceNet bus nodes with 24-volt operating voltage. The bus nodes can be bus-powered or externally powered. The maximum length of the DeviceNet cable depends on the selected cable type and baud rate. The installation is done in a bus topology - with or without branches - and terminating resistors at both ends. The terminating resistors have a value of 120 ohms.



The main area of application for DeviceNet is factory automation with components such as I/O modules, valves, encoders, drives and controllers (PLCs). Within the CIP network family, DeviceNet thus covers a large part of the applications in which small to medium data volumes are to be transmitted with short to medium cycle times (1 ms to 500 ms).

4.12.1 Introduction

The following Object Modeling related terms are used when describing services and protocol:

- **Object** – An abstract representation of a particular component within a product.
- **Class** – A set of objects that all represent the same kind of system component. A class is a generalization of an object. All objects in a class are identical in form and behavior, but may contain different attribute values.
- **Instance** – A specific and real (physical) occurrence of an object. For example: New Zealand is an instance of the object class Country. The terms Object, Instance, and Object Instance all refer to a specific Instance.
- **Attribute** – A description of an externally visible characteristic or feature of an object. Typically, attributes provide status information or govern the operation of an Object. For example: the ASCII name of an object; and the repetition rate of a cyclic object.
- **Service** – A function supported by an object and/or object class (set, get, reset,…)

Object Model Terminology Example:

Class	Instance	Attribute	Attribute Values
Human	Mary	Gender	Female
		Age	31
	Jerry	Gender	Male
		Age	50

4.12.2 EDS File

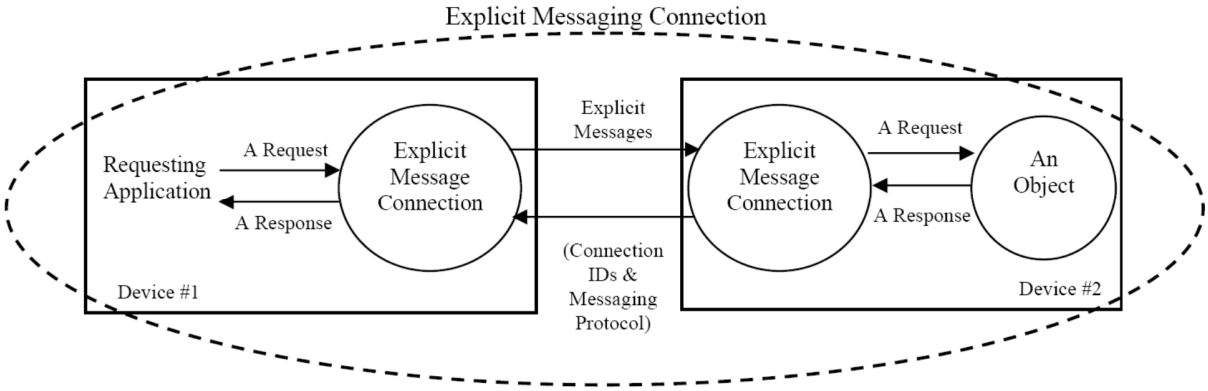
The Electronic Data Sheet (EDS) contains all communication parameters of the device as well as the available objects. The DeviceNet configuration tool reads the EDS files of the devices present in the network and calculates the configuration data from them, which are then loaded into the DeviceNet nodes.

ESI files can be downloaded from www.vatvalve.com/downloads
Select the ‘Software & Updates’ tab and enter ‘EDS’ in the search field. All available EDS files will be listed. If the appropriate EDS file is not available, please contact VAT: www.vatvalve.com/contact

4.12.3 Messaging Format

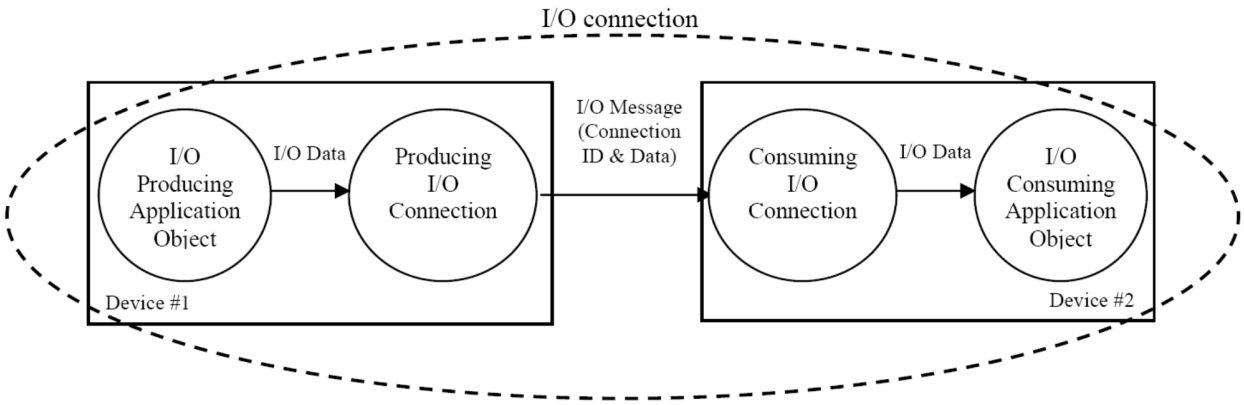
4.12.3.1 Explicit Messaging Connections

Explicit Messaging Connections, (see figure below) provide generic, multi-purpose communication paths between two devices. An Explicit Message consists of a Connection ID and associated messaging protocol information. Explicit messaging connections utilize a direct request / response format which allow you to access any attribute data. Explicit



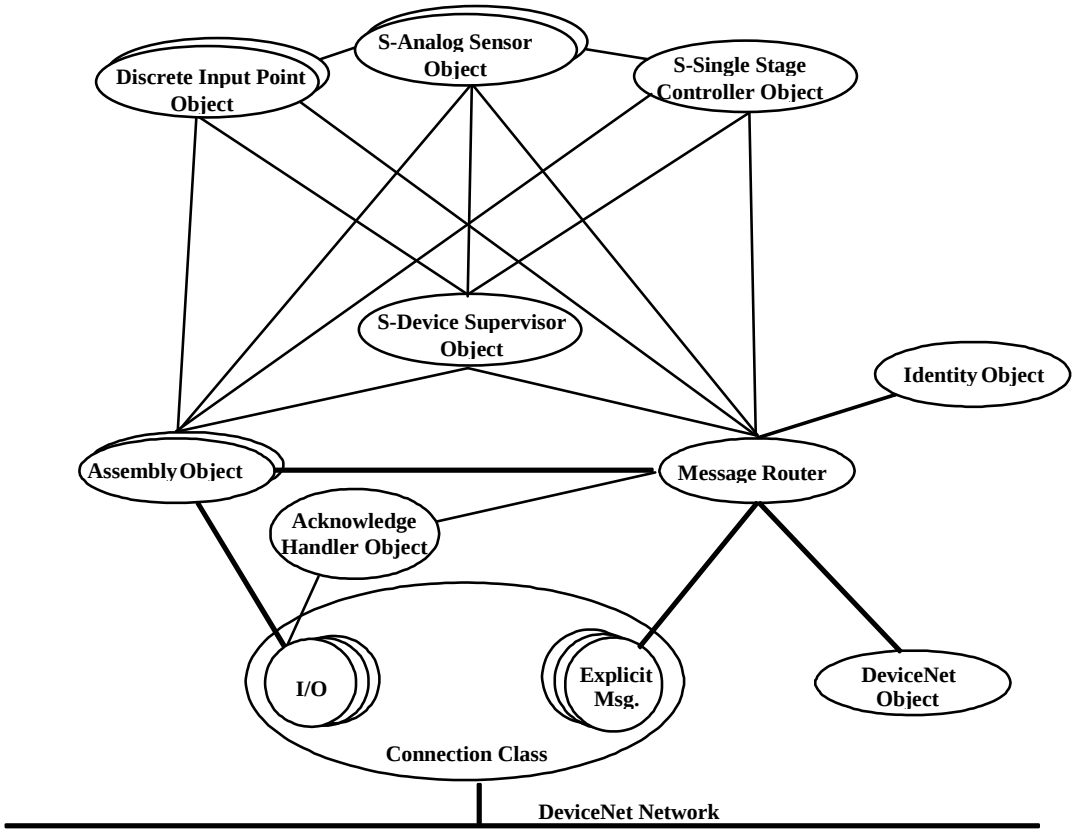
4.12.3.2 I/O Poll Messaging Connections

I/O poll messaging connections, (see figure below) utilize an assembly format to group and report data from multiple objects using a single communications command. These connections are typically used for quick reporting of information (run-time).



4.12.4 Objects

Object Model



Nr	Object Class	# of Instances	Description
1	Identity	1	Identification of and general information about the device
2	Message Router	1	Distributes Explicit Request Messages to the appropriate handler object
3	Device Net	1	Provides the configuration and status of a DeviceNet port
4	Assembly	7 Input, 3 Output	Groups attributes of multiple objects into a single assembly
5	Connection	>4	Manage the characteristics of a communication connection
8	Discrete Input Point	2	Defines the interface to the open/close limit switches
48	S-Device Supervisor	1	Centralizes application object state definitions and related status information
49	S-Analog Sensor	2	Models the acquisition of a reading from a physical sensor in a device
51	S-Single Stage Controller	2	Models a closed-loop control system within a device
100	Pressure Controller		VAT specific attributes

4.12.5 Identity Object (Class ID 1)

The Identity Object provides general information about the device

Attr.	Name	Data Type	Min	Max	Default	Access	NV	Unit	Description Semantic Of Value
1	**Vendor ID**	UINT16	404	404	404	GET	1		Identification of each vendor by number
2	**Device Type**	UINT16	0	0	0	GET	1		Indication of general type of product
3	**Product Code**	UINT16	0	DT	0	GET	1		Identification of a particular product of an ind
4	**Revision**	STRUCT	0	DT	0	GET	1		Revision of the item the Identity Object is rep Byte 0 = Major Revision Byte 1 = Minor Revision
5	**Status**	UINT16	0	DT	0	GET	0		Summary status of device Bit 0 = Owned Bit 2 = Configured Bit 4-7 = Extended Device Status Bit 8 = Minor Recoverable Fault Bit 9 = Minor Unrecoverable Fault Bit 10 = Major Recoverable Fault Bit 11 = Major Unrecoverable Fault All other bits reserved
6	**Serial Number**	UINT32	0	DT		GET	1		Serial number of device in conjunction with V identifier
7	**Product Name**	STRING				GET	1		Human readable identification

4.12.6 Device Net Object (Class ID 3)

Attr.	Name	Data Type	Min	Max	Default	Access	NV	Unit	Description Semantic Of Value
1	**MAC ID**	UINT8	0	63	63	SET	1		
2	**Baud Rate**	UINT8	0	2	0	SET	1		125kB, 250kB, 500kB

4.12.7 Assembly Object (Class ID 4)

Groups attributes of multiple objects into a single assembly

Attr.	Name	Data Type	Min	Max	Default	Access	NV	Unit	Description Semantic Of Value
100	**Poll Output Assembly**	UINT8	7	8		SET	1		Assembly Instance used by the Poll connect 7,8,102
101	**Poll Input Assembly**	UINT8	3	101		SET	1		Assembly Instance used by the Poll connect 3,4,5,13,14,100,101
102	**Bit Strobe Input**	UINT8				SET	1		Not implemented
103	**Change of state cycling input**	UINT8	3	101		SET	1		3,4,5,13,14,100,101

4.12.7.1 Assemblies

Output

		Class/Instance/Attribute		Int			Real		
Instance	**Composition**	**Source**	**Data Type**	**Start**	**Length**	**Total**	**Start**	**Length**	**Total**
100	**Exception Status**	100/1/1	UINT8	0	1	5	0	1	9
	Pressure		Int/Real	1	2		1	4	
	Position	100/1/2	Int/Real	3	2		5	4	

Input

Number	Composition	Integer			Float		
		Start	Length	Total	Start	Length	Total
3 (default)	EXCEPTION STATUS	0	1		0	1	
	PRESSURE	1	2	5	1	4	9
	POSITION	3	2		5	4	
4	EXCEPTION STATUS	0	1		0	1	
	PRESSURE	1	2	5	1	4	9
	SETPOINT [1]	3	2		5	4	
5	EXCEPTION STATUS	0	1		0	1	
	PRESSURE	1	2		1	4	
	SETPOINT [1]	3	2	7	5	4	13
	POSITION	5	2		9	4	
13 Dh	EXCEPTION STATUS	0	1		0	1	
	EXCEPTION DETAIL ALARM	1	15	31	1	15	31
	EXCEPTION DETAIL WARNING	16	15		16	15	
14 Eh	EXCEPTION STATUS	0	1		0	1	
	PRESSURE	1	2		1	4	
	POSITION	3	2	6	5	4	10
	VALVE CLOSED / OPEN CHECK [2]	5	1		9	1	
100 64h	EXCEPTION STATUS	0	1		0	1	
	PRESSURE	1	2		1	4	
	POSITION	3	2	7	5	4	11
	CONTROLLER MODE	5	1		9	1	
	ACCESS MODE	6	1		10	1	
101 65h	EXCEPTION STATUS	0	1		0	1	
	PRESSURE	1	2		1	4	
	POSITION	3	2	7	5	4	11
	VALVE CLOSED / OPEN CHECK [2]	5	1		9	1	
	CONTROLLER MODE	6	1		10	1	

Output

Number	Composition [2]	Integer			Float		
		Start	Length	Total	Start	Length	Total
7	SETPOINT [1]	0	2	3	0	4	5
	SETPOINT TYPE	2	1		4	1	
8 (default)	CONTROL MODE	0	1		0	1	
	SETPOINT [1]	1	2	4	1	4	6
	SETPOINT TYPE	3	1		5	1	
102 66h	CONTROL MODE	0	1		0	1	
	SETPOINT [1]	1	2		1	4	
	SETPOINT TYPE	3	1		5	1	
	LEARN [3]	4	1	8	6	1	12
	LEARN PRESSURE LIMIT	5	2		7	4	
	ZERO [3]	7	1		11	1	

1) PRESSURE SETPOINT or POSITION SETPOINT depending on related SETPOINT TYPE

2) 0 = Valve is neither closed nor open, 1 = Valve is CLOSED, 2 = Valve is OPEN

3) To activate ZERO or LEARN use 1 as data else 0.
Apply always correct procedures as described in «Zero Adjust» or « Learn (adaptive control algorithm)»

4.12.8 Discrete Input Object (Class ID 8)

Defines the interface to the open/close limit switches

Attr.	Name	Data Type	Min	Max	Default	Access	NV	Unit	Description Semantic Of Value
3	**Value**	BOOL	0	1	-	GET	0		0 Open, 1 Closed
4	**Status**	BOOL	0	1					O OK, 1 Alarm
100	**Close Open Check**	UINT8	0	2					0 Closed, 1 Opened, 2 Intermediate

Instance 1 Close
Instance 2 Open

4.12.9 S-Device Supervisor Object (Class ID 48)

Centralizes application object state definitions and related status information

<table>
<tr><th rowspan="2">Command</th><th colspan="2">Service Code</th><th>Class ID</th><th>Instance ID</th><th>Attribute ID</th><th>Service data length
(number of bytes)</th><th>Service data field</th></tr>
<tr><th colspan="7">Description</th></tr>
<tr><td rowspan="2">DEVICE STATUS</td><td>Get</td><td>14</td><td>48</td><td>1</td><td>11</td><td>1</td><td>X</td></tr>
<tr><td colspan="7">X: 1 self test
2 idle
3 self test exception
4 executing
5 abort
This attribute represents the current state of the device.
Note: EXECUTING must to be selected to enable for all executing commands.
Note: A successfully established Poll-IO connection switches the DEVICE STATUS to executing.</td></tr>
<tr><td rowspan="2">EXECUTING
(START)</td><td colspan="2">6</td><td>48</td><td>1</td><td>-</td><td>3</td><td>-</td></tr>
<tr><td colspan="7">This command changes the DEVICE STATUS to executing state.
Note: If DEVICE STATUS is already in executing state a new EXECUTING results in an error return.</td></tr>
<tr><td rowspan="2">IDLE
(STOP)</td><td colspan="2">7</td><td>48</td><td>1</td><td>3</td><td>-</td><td>-</td></tr>
<tr><td colspan="7">This command changes the DEVICE STATUS to idle state.</td></tr>
<tr><td rowspan="3">EXCEPTION STATUS</td><td>Get</td><td>14</td><td>48</td><td>1</td><td>12</td><td>1</td><td></td></tr>
<tr><td colspan="7">The exception status byte only indicates that alarms or warnings are present.
For details see EXCEPTION DETAIL ALARM resp. EXCEPTION DETAIL WARNING.</td></tr>
<tr><td colspan="7"><table>
<tr><td>Bit 7</td><td>Bit 6</td><td>Bit 5</td><td>Bit 4</td><td>Bit 3</td><td>Bit 2</td><td>Bit 1</td><td>Bit 0</td></tr>
<tr><td>1</td><td>Manufacturer specific warning</td><td>reserved</td><td>reserved</td><td>reserved</td><td>Manufacturer specific alarm</td><td>reserved</td><td>reserved</td></tr>
</table></td></tr>
</table>

Command	Service Code	Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description					
EXCEPTION DETAIL ALARM EXCEPTION DETAIL WARNING	Get 14	48	1	13 Alarm 14 Warning	15	See below

Table with EXCEPTION DETAIL ALARM resp. EXCEPTION DETAIL WARNING bits.

	Data Component	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	PCV Common Exception Detail Size	0	0	0	0	0	0	1	0
1	PCV Common Exception Detail Byte #**0**	0	0	0	0	0	0	0	0
2	PCV Common Exception Detail Byte #**1**	0	0	0	0	0	0	0	0
3	PCV Device Exception Detail Size	0	0	0	0	0	1	0	0
4	PCV Device Exception Detail Byte #**0**	0	0	0	0	0	0	0	0
5	PCV Device Exception Detail Byte #**1**	0	0	0	0	0	0	0	0
6	PCV Device Exception Detail Byte #**2**	0	0	0	0	0	0	0	0
7	PCV Device Exception Detail Byte #**3**	0	0	0	0	0	0	0	0
8	Manufacturer Exception Detail Size	0	0	0	0	0	1	1	0
9	Manufacturer Exception Detail Byte #**0** **Warning**	Reserved	Reserved	**External isolation valve failure**	Reserved	**PFO not ready**	**Compressed air failure**	**Learn data set invalid**	Reserved
10	Manufacturer Exception Detail Byte #**1** **Warning**	Reserved	Reserved	Reserved	Reserved	Reserved	**ADC not responding**	Reserved	Reserved
11	Manufacturer Exception Detail Byte #**2** **Warning**	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	No sensor
12	Manufacturer Exception Detail Byte #**3** **Warning**	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	**PFO off**	**Simulation active**
13	Manufacturer Exception Detail Byte #**4** **Alarm**	Reserved	Reserved	Reserved	Reserved	**E40**	**E22**	**E21**	**E20**
14	Manufacturer Exception Detail Byte #**5** **Alarm**	Reserved	Reserved	Reserved	Reserved	**Setpoint invalid (safe state)**	**IO data missing (safe state)**	**Setpoint type invalid (safe state)**	**Control mode invalid (safe state)**

Command	Service Code	Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description					
UPLOAD LEARN DATA	50	48	1	-	3,11	X,XY
	X: Index (3 byte, range **000** .. **103**, ASCII coded) Y: Data (8 byte) This command loads the learn data sets from the valve up to the host. There are a total number of 104 data sets which need to be uploaded separately. Example: Send : “000” → 48 48 48 Response: “00000754241” → 48 48 48 48 48 55 53 52 50 52 49					
DOWNLOAD LEARN DATA	51	48	1	-	11,3	XY,X
	X: Index (3 byte, range **000** .. **103**, ASCII coded) Y: Data (8 byte) This command loads the learn data sets from host down to the valve. There are a total number of 104 data sets which need to be downloaded separately. Example: Send: “00000754241” → 48 48 48 48 48 55 53 52 50 52 49 Response: “000” → 48 48 48					

4.12.10 S-Analog Sensor Object (Class ID 49)

Models the acquisition of a reading from a physical sensor in a device

Command	Service Code		Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description						
DATA TYPE	Set	16	49	1	3	1	X
	Get	14					
	X: **195** signed integer **202** floating point This command defines the data type for all pressure and position values. Default value is 195.						
PESSURE POSITON READING	Get	14	49	1 Pressure 3 Position	6	2 integer 4 float	X
	X: Instance 1 pressure Nominal range pressure is **0** … **10’000** but it may be scaled. Refer also to command GAIN and picture on the following page for details. X: Instance 3 position Nominal range is **0** (closed) … **10’000** (open). Refer also to command GAIN and picture on the following page for details.						

<table>
<tr><th rowspan="2">Command</th><th colspan="2">Service Code</th><th>Class ID</th><th>Instance ID</th><th>Attribute ID</th><th>Service data length
(number of bytes)</th><th>Service data field</th></tr>
<tr><th colspan="7">Description</th></tr>
<tr><td rowspan="2">GAIN</td><td>Set</td><td>16</td><td rowspan="2">49</td><td rowspan="2">1 Pressure
3 Position</td><td rowspan="2">14</td><td rowspan="2">4 float</td><td rowspan="2">X</td></tr>
<tr><td>Get</td><td>14</td></tr>
<tr><td colspan="7">X: Gain, max. value is 3.2767, data type is floating point
This command selects the gain for PRESSURE/POSITION and allows for scaling. Default value is 1.0
Example:
Gain X (hex) Resulting range
0.1 3D CC CC CC 0 … 1000
1.0 3F 80 00 00 0 ... 10000
3.2767 40 51 B5 73 0 … 32767</td></tr>
<tr><td rowspan="2">SENSOR MODE</td><td>Set</td><td>16</td><td rowspan="2">49</td><td rowspan="2">1</td><td rowspan="2">101</td><td rowspan="2">1</td><td rowspan="2">X</td></tr>
<tr><td>Get</td><td>14</td></tr>
<tr><td colspan="7">X: 0 = no sensor
1 = sensor 1
2 = sensor 1 high, sensor 2 low, crossover fade
7 = sensor 1 high, sensor 2 low, crossover target pressure
9 = sensor 1 high, sensor 2 low, crossover switch point

3 = sensor 2
4 = sensor 2 high, sensor 1 low, crossover fade
8 = sensor 2 high, sensor 1 low, crossover target pressure
10 = sensor 2 high, sensor 1 low, crossover switch point

2 sensor operation are possible with 2 sensor hardware [950..-...Q -....] only.

For applications where the high range sensor is used for monitoring purpose only, select sensor operation modes 1 or 3 for pressure control with low range sensor and read high range sensor from SENSOR 1 READING resp. SENSOR 2 READING.</td></tr>
<tr><td rowspan="2">ZERO CONTROL</td><td>Set</td><td>16</td><td rowspan="2">49</td><td rowspan="2">1</td><td rowspan="2">102</td><td rowspan="2">1</td><td rowspan="2">X</td></tr>
<tr><td>Get</td><td>14</td></tr>
<tr><td colspan="7">X: 0 Disable
1 Enable
In case ZERO CONTROL is disabled ZERO ADJUST does not work.</td></tr>
<tr><td rowspan="2">ZERO ADJUST</td><td colspan="2">75</td><td>49</td><td>1</td><td>-</td><td>0</td><td>-</td></tr>
<tr><td colspan="7">This service initiates ZERO ADJUST.
Note: Refer to «Fehler! Verweisquelle konnte nicht gefunden werden.» for correct zero procedure.</td></tr>
</table>

Note: Pressure Reading and Offset Values of Sensor 1 and Sensor 2 are in Pressure Controller Object (Class ID 100)

4.12.11 S-Single Stage Controller Object (Class ID 51)

Models a closed-loop control system within a device

Command	Service Code		Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description						
SETPOINT TYPE (Single Stage Controller Instance)	Set	16	51	0	8	1	X
	Get	14					
	X: **0** instance 1 - pressure control **1** Instance 2 - position control Defines the active instance of the single stage controller						
CONTROL MODE	Set	16	51	1 pressure 2 position	5	1	X
	Get	14					
	X: **0** control **1** close **2** open **3** hold (stops the valve at the current position) **4** safe state (valve will close)						
CONTROL SETPOINT	Set	16	51	1 pressure 2 position	6	2 integer 4 float	X
	Get	14					
	X: Instance 1 pressure Target pressure, nominal pressure range is **0** … **10'000** (sensor full scale) But it may be scaled, refer also to command GAIN for details. X: Instance 2 position Target position, nominal position range is **0** (closed) … **10'000** (open) But it may be scaled, refer also to command GAIN for details.						
VALVE SPEED	Set	16	51	2	101	2 integer	X
	Get	14					
	X: valve speed, **1** … **1000** (1 = min. speed, 1000 = max. speed), This command selects/returns the actuating speed for the valve plate. Speed selection is effective for pressure control and position control. Open valve and close valve are always done with max. speed. **Note:** Refer to «Valve speed adjustment» for details.						
ADAPTIVE CONTROL GAIN FACTOR	Set	16	51	1	105	1	X
	Get	14					
	X: **0** = 0.10, **1** = 0.13, **2** = 0.18, **3** = 0.23, **4** = 0.32, **5** = 0.42, **6** = 0.56 **7** = 0.75, **8** = 1.00, **9** = 1.33, **10** = 1.78, **11** = 2.37, **12** = 3.16, **13** = 4.22 **14** = 5.62, **15** = 7.50, **16** = 0.0001, **17** = 0.0003, **18** = 0.001, **19** = 0.003, **20** = 0.01, **21** = 0.02, **22** = 0.05 **Note:** Refer to «Gain factor adjustment» for details.						

<table>
<tr><th rowspan="2">Command</th><th colspan="2">Service Code</th><th>Class ID</th><th>Instance ID</th><th>Attribute ID</th><th>Service data length
(number of bytes)</th><th>Service data field</th></tr>
<tr><th colspan="7">Description</th></tr>
<tr><td rowspan="3">ADAPTIVE CONTROL SENSOR DELAY</td><td>Set</td><td>16</td><td rowspan="2">51</td><td>1</td><td>107</td><td>1</td><td>X</td></tr>
<tr><td>Get</td><td>14</td><td colspan="5"></td></tr>
<tr><td colspan="7">X: 0 = 0, 1 = 0.02, 2 = 0.04, 3 = 0.06, 4 = 0.08, 5 = 0.10, 6 = 0.15
7 = 0.20, 8 = 0.25, 9 = 0.30, 10 = 0.35, 11 = 0.4, 12 = 0.5, 13 = 0.6
14 = 0.8, 15 = 1.0
Note: Refer to «Sensor delay adjustment» for details.</td></tr>
<tr><td rowspan="3">PRESSURE CONTROL SETPOINT RAMP</td><td>Set</td><td>16</td><td rowspan="2">51</td><td>1</td><td>108</td><td>1</td><td>X</td></tr>
<tr><td>Get</td><td>14</td><td colspan="5"></td></tr>
<tr><td colspan="7">X: 0 = 0, 1 = 0.5, 2 = 1.0, 3 = 1.5, 4 = 2.0, 5 = 2.5, 6 = 3.0
7 = 3.5, 8 = 4.0, 9 = 4.5, 10 = 5.0, 11 = 5.5, 12 = 6.0, 13 = 6.5
14 = 7.0, 15 = 7.5, 16 = 8.0, 17 = 8.5, 18 = 9.0, 19 = 9.5, 20 = 10.0
Note: Refer to «Setpoint ramp adjustment» for details.</td></tr>
<tr><td rowspan="2">LEARN
(calibration service)</td><td colspan="2">99</td><td>51</td><td>1</td><td>0</td><td>-</td><td>-</td></tr>
<tr><td colspan="7">This command starts LEARN.
With CONTROL MODE commands open valve or close valve the routine may be interrupted.
Note: Without LEARN the PID controller is not able to perform pressure control.
4.12.12 Refer to «Adaptive algorithm
This control algorithm may be used for downstream pressure control.
Before using adaptive control algorithm, a special procedure called “learn” must be executed first (see chapter below).
4.12.12.1 Control Parameter
Location: CPA/Navigation/Parameters: Pressure Control.Controller x.Control Settings
<table>
<tr><th>Parameter</th><th>Description</th></tr>
<tr><td>Gain Factor</td><td>Main parameter to adapt the performance of the pre algorithm. A higher gain results in a faster response, undershoots of pressure. A lower gain results in slow over- / undershoot of pressure.</td></tr>
<tr><td>Sensor Delay</td><td>For compensation of delays during the pressure dete orifices for sensor attachment can cause delays in re could impact badly the pressure control stability. By parameter to the approximate delay time stability pro reduced. But control response time will be slowed do</td></tr>
<tr><td>Learn Data Selection</td><td>There are up to 4 different learn data sets available. data set the adaptive controller shall use for pressur</td></tr>
<tr><td>Ramp</td><td>A set poin ramp can be use to avoid over shoots… See chapter «Pressure Ramp»</td></tr>
</table>
Learn» for correct learn gas flow and procedure.</td></tr>
<tr><td></td><td>Set</td><td>16</td><td rowspan="2">51</td><td>1</td><td>100</td><td>2 integer
4 float</td><td>X</td></tr>
<tr><td></td><td>Get</td><td>14</td><td colspan="5"></td></tr>
</table>

<table>
<tr><th rowspan="2">Command</th><th>Service Code</th><th>Class ID</th><th>Instance ID</th><th>Attribute ID</th><th>Service data length
(number of bytes)</th><th>Service data field</th></tr>
<tr><th colspan="6">Description</th></tr>
<tr><td>LEARN PRESSURE LIMIT
(calibration scale)</td><td colspan="6">X: learn pressure limit according to selected DATA TYPE,
nominal pressure range is 0 … 10’000 (sensor full scale) but it may be scaled,
refer also to command GAIN for details.
This command transfers/reads the pressure limit for LEARN.
4.12.13 Note: Refer to «Adaptive algorithm
This control algorithm may be used for downstream pressure control.
Before using adaptive control algorithm, a special procedure called “learn” must be executed first (see chapter below).
4.12.13.1 Control Parameter
Location: CPA/Navigation/Parameters: Pressure Control.Controller x.Control Settings
<table><tr><th>Parameter</th><th>Description</th></tr><tr><td>Gain Factor</td><td>Main parameter to adapt the performance of the pre algorithm. A higher gain results in a faster response, undershoots of pressure. A lower gain results in slo over- / undershoot of pressure.</td></tr><tr><td>Sensor Delay</td><td>For compensation of delays during the pressure det orifices for sensor attachment can cause delays in r could impact badly the pressure control stability. By parameter to the approximate delay time stability pr reduced. But control response time will be slowed d</td></tr><tr><td>Learn Data Selection</td><td>There are up to 4 different learn data sets available. data set the adaptive controller shall use for pressur</td></tr><tr><td>Ramp</td><td>A set poin ramp can be use to avoid over shoots… See chapter «Pressure Ramp»</td></tr></table>Learn» for correct learn pressure limit setting.</td></tr>
<tr><td></td><td>Get</td><td>14</td><td>51</td><td>1</td><td>106</td><td>2</td><td>X</td></tr>
</table>

Command	Service Code	Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description					
LEARN STATUS (calibration state)	This command returns the status of the LEARN procedure. The status is binary coded. X: Bit — Explanation: (LSB) 0 — LEARN running 1 — LEARN data set not present 2 — LEARN terminated by user 3 — Pressure in position OPEN > 50% sensor full scale (of high range sensor in case of a 2 sensor system) or > LEARN PRESSURE LIMIT 4 — pressure in position 0 < 10% sensor full scale (of low range sensor in case of a 2 sensor system) 5 — Pressure falling during LEARN 6 — Sensor not stable during LEARN 7..9 — reserved 10 — LEARN terminated by controller 11 — Pressure in position OPEN negative (MSB) 12..15 — reserved					

4.12.14 Pressure Controller Object (Class ID 100)

VAT specific attributes

Command	Service Code		Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description						
CONTROLLER MODE	Get	14	100	1	103	1	X
	This command returns the device status. X: **1** = synchronization, **2** = POSITION CONTROL, **3** = CLOSED **4** = OPEN, **5** = PRESSURE CONTROL, **6** = HOLD , **7** = LEARN **12** = power failure, **13** = safety mode **14** = fatal error (read EXCEPTION DETAIL ALARM for details)						
ACCESS MODE	Set	16	100	1	107	1	X
	Get	14					
	X: **0** Local (operation via service port) **1** Remote (operation via DeviceNet®) **2** Locked (remote, no access from service port)						
THROTTLE CYCLE COUNTER	Get	14	100	1	101	4	X
	X: Data type is unsigned long integer. A movement from max. throttle position to open back to max. throttle position counts as one cycle. Partial movements will be added up until equivalent movement is achieved.						
ISOLATION CYCLE COUNTER	Get	14	100	1	106	4	X
	X: Data type is unsigned long integer. Each closing of the sealing ring counts as one cycle.						
HOMING END CONTROL MODE	Set	16	100	1	112	1	X
	Get	14					
	X: **0** closed **1** open This command controls / returns the valve position after power up.						
POWER FAIL FUNCTIONALITY	Set	16	100	1	113	1	X
	Get	14					
	X: **0** closed **1** open This command controls / returns the target valve position in case of a power failure. Only for versions that have Power Fail Option equipped [612 . . - . . **C** . - . . . . or 612 . . - . . **H** . - . . . . or 612 . . - . . **U** . - . . . . or 612 . . - . . **W** . - . . . .].						

Command	Service Code		Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description						
SENSOR 1 READING	Get	14	100	1	108	2 integer 4 float	
	Nominal range is **0** … **10'000** but it may be scaled. Refer also to command GAIN and picture on the following page for details.						
SENSOR 2 READING	Get	14	100	1	109	2 integer 4 float	
	Nominal range is **0** … **10'000** but it may be scaled. Refer also to command GAIN and picture on the following page for details.						
SENSOR 1 OFFSET	Get	14	100	1	110	2 integer 4 float	
	This command returns the offset voltage adjusted by ZERO. Value range is **-1400** … **+1400** (-1.40V … +1.40V).						
SENSOR 2 OFFSET	Get	14	100	1	111	2 integer 4 float	
	This command returns the offset voltage adjusted by ZERO Value range is **-1400** … **+1400** (-1.40V … +1.40V).						

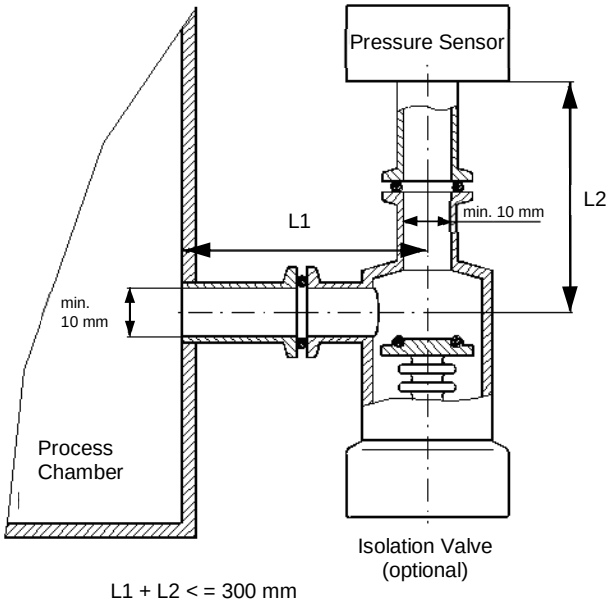
4.13 Pressure Sensor

4.13.1 Mechanical connection requirements

Fast and accurate pressure control requires a fast sensor response. Sensor response time: < 50ms. The sensor is usually connected to the chamber by a pipe. The line must be short enough and the conductance must not be reduced by a too small line diameter or a low conductance shut-off valve, 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**
- Total length L1 + L2: **< = 300 mm**

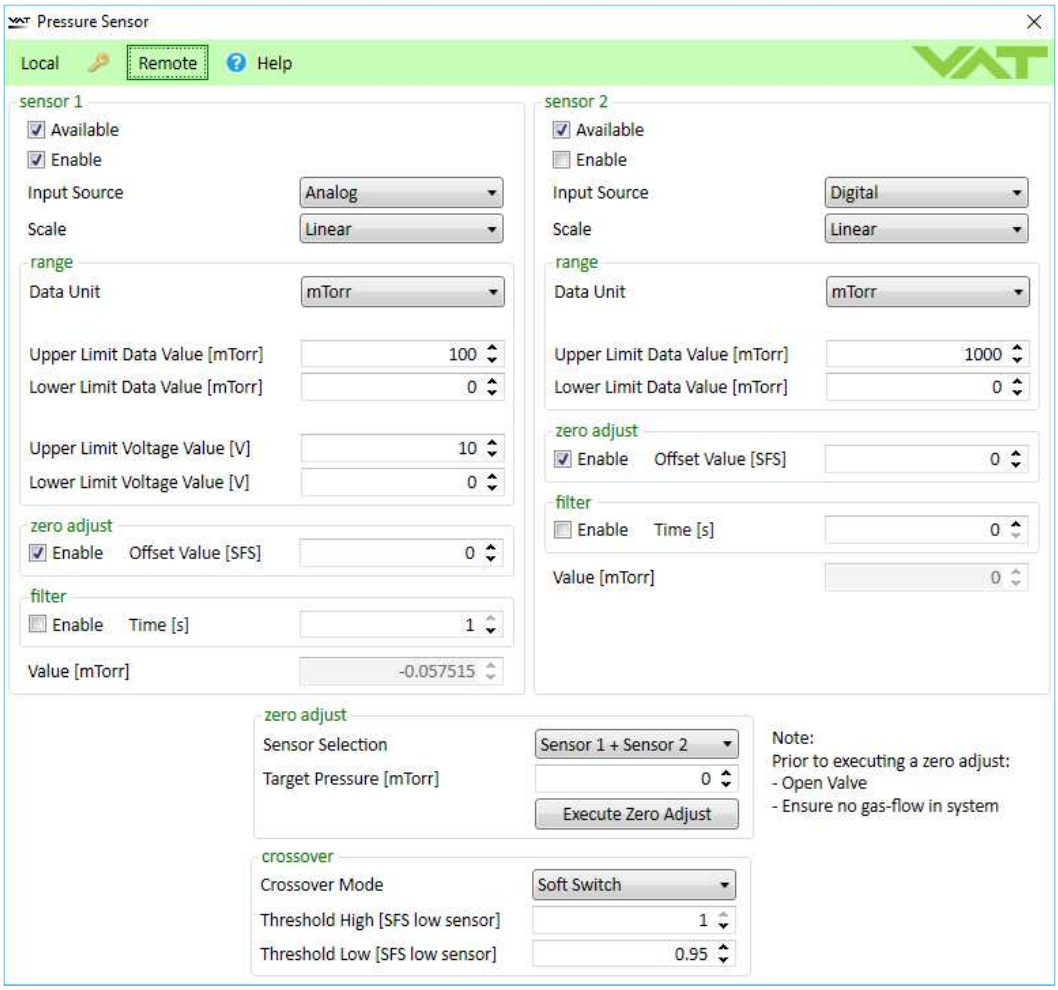
The total conductance value must include all valves and limiting orifices that may also be present. Make also sure that there is no obstruction in front of sensor connection port inside the chamber. The sensor should also be mounted free of mechanical shock and vibration. Dynamic stray magnetic fields may introduce noise to sensor output and should be avoided or shielded.



L1 + L2 < = 300 mm

4.13.2 Configuration

The CPA window shows a good overview of the sensor settings:
- The valve supports 2 sensors.
- Zero Adjust is for offset compensation of linear sensors
- Crossover is automatic switch over between 2 linear sensors



Location: CPA/Navigation/Parameters: Pressure Sensor.Sensor 1, Pressure Sensor.Sensor 2

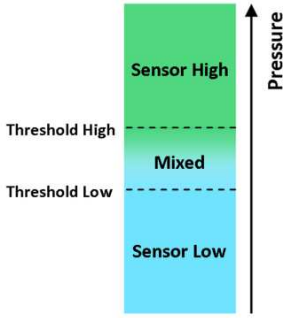
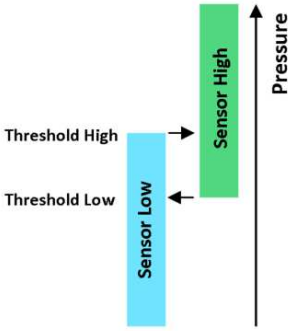
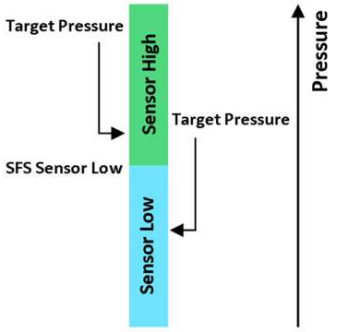
Parameter	Description
Available	Set to 'True' if a sensor is connected
Enable	Set to 'True' if the sensor signal is used for pressure control
Input Source	'**Analog'** Sensor has an analog voltage interface and is direct connected to the valve. '**Digital'** Sensor has an EtherCAT interface and is connected to the EtherCAT bus '**Simulation'** Testing the valve and pressure control without being connected to the system
Range.Scale	Select type of the sensor signal '**Linear'** '**Logarithmic'** Most gauges are linear type gauges.
Range.Data Unit	Set the pressure data unit of the gauge: **Pa, kPa, bar, mbar, Torr, mTorr, psia, psig**
Range.Upper Limit Data Value **Range.Lower Limit Data Value**	Set the upper limit and lower limit of the gauge in the unit of "Range.Data Unit" Example for a 250mTorr linear sensor: Upper Limit = 250.0 Lower Limit = 0.0
Range.Upper Limit Voltage Value **Range.Lower Limit Voltage Value**	These parameters are only used for gauges with analog voltage interface. The values corresponds to Range.Upper Limit Data Value and Range Lower Limit Data Value Example: Upper Limit: 10.0V → 250mTorr Range Upper Limit Data Value Lower Limit: 0.0V → 0.0mTorr Range Lower Limit Data Value
Filter.Enable	'True' enables the filter
Filter.Type	Set the filter type, which should be applied to the related Sensor Input: **Low-pass, Low-pass Simple, Median, Moving Average, Line Frequency Suppression, FIR custom**
Filter.Time	Set filter time in the range of 0.0 to 1.0 second. Note: Filter delays the sensor signals which is detrimental for pressure control
Value	The actual Pressure value of the regarding Sensor

4.13.3 Crossover (2 sensor operation mode)

If two sensors are connected to the controller uses both for pressure control and pressure feedback. The controller selects each sensor or blends both sensor signals to the "**Actual Pressure**" used for control and feedback. Three different modes are selectable.

Location: CPA/Navigation/Parameters: Pressure Sensor.Crossover

Parameter	Description
Crossover Mode	Crossover between 2 sensors (see below)
Threshold High [SFS low sensor] **Threshold Low [SFS low sensor]**	Defines the crossover area (see below) The value is related to sensor full scale of low sensor (0.1 means 10% of sensor full scale of low sensor)
Delay	Switch over delay in Crossover Mode 'Hard Switch'

Crossover Mode Soft Switch	
	Between the *Threshold Low* and *Threshold High* the controller blends both pressure signals to the actual pressure. **When to use** This is the standard mode. Both pressure signals need to match in the crossover range otherwise crossover effect result (nonlinearity). Sensor full scale ratio low range to high range sensor must not exceed 1:100
Crossover Mode Hard Switch	
	Switching between sensors according to the hysteresis threshold levels and an optional delay. **When to use** Preferred setting if the sensor signals do not fit together in the crossover area (for example if sensor ratio is high).
Crossover Mode Target Pressure	
	If Target Pressure is below low range sensor full scale low sensor is used; otherwise high range sensor. **When to use** As there is no switchover during pressure control while using this setting, undesired effects like nonlinearity or continuous switching between sensors don't occur. **Note** While in position control mode, 'Soft Switch' mode is used

4.13.4 Zero Adjust

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

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

Location: CPA/Navigation/Parameters: Pressure Sensor.Zero Adjust

Parameter	Description
Zero Adjust.Sensor Selection	Select the sensor for the zero adjust: • Sensor 1 + 2 • Sensor 1 • Sensor 2
Zero Adjust.Target Pressure	Normally this parameter is set to 0 in case the process chamber is fully evacuated (pressure <=1‰ of sensor full scale). If not you can align the sensor value to a known pressure (displayed on another readout in the system). In this case set **Target Pressure** to the known pressure. Note: Target Pressure is in the unit of pressure, see chapter «Scaling of Pressure and Position Values»
Zero Adjust.Execute	1: Start the zero adjust 2: Clear offset value After executing value return to 0
Sensor 1.Enable **Sensor 2.Enable**	0: It is not possible to execute a zero adjust. A present offset value is ignored 1: It is possible to execute a zero adjust. A present offset value is respected.
Sensor 1.Offset Value [SFS] **Sensor 2.Offset Value [SFS]**	Value which is deducted from the measured sensor value. The value is related to sensor full scale (0.1 means 10% of sensor full scale)

Performing a zero adjust:

1. Turn the gas flow off
2. Fully open the valve
3. Wait until the sensor signal is not shifting anymore. Refer to manual of sensor manufacturer for warm up time.
4. Wait until process chamber is evacuated.

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

5. Perform zero with setting of Zero Adjust.Execute to 1
6. Check parameter Actual Pressure if the pressure is shifted as expected

4.13.5 Logarithmic Pressure

To control wide pressure ranges, it is advantageous to control with a logarithmic signal. Note: Only the PI and the Softpump controller can control with a logarithmic signal. Adaptive controller needs a linear signal.

Location: CPA/Parameters: Pressure Sensor.General Settings.Logarithmic Pressure

Parameter	Description
Upper Limit Value	Highest Value of the logarithmic value. Corresponds to the sensor full scale defined in the sensor setup.
Percent Per Decade	Defines the logarithmic scale
Lowest Pressure	Defines the lowest pressure that is converted to a logarithmic value. Corresponds to the smallest valid signal**.**
Pressure On Interface	Defines which signal scale is used on the interface. Linear Logarithmic
Use Logarithmic Sensor	Set to True to use direct the signal of a logarithmic sensor. **Percent Per Decade** is then not used. This parameter becomes active only if **Pressure Sensor.Sensor X.Range.Scale** is set to **Logarithmic**
Actual Logarithmic Values	Shows the logarithmic value. Full Scale is **Upper Limit Value**

EXAMPLE:
Sensor 1 linear 1000Torr, Sensor 2 linear 10Torr
With these sensors the measuring range is: 0.001Torr … 1000Torr, so we cover 6 decades

Percent Per Decade	15 With 15% we cover 6.6 decades (100/15 = 6.6)
Lowest Pressure	0.001Torr (~1mV of Low Sensor)
Upper Limit Value	Shows 1000 (because SFS is 1000)
Actual Logarithmic Value Example Values	Torr 1000 1000 850 100 700 10 550 1 400 0.1 250 0.01 100 0.001
Pressure On Interface	Linear We want the logarithmic signal only on the pressure controller but not on the interface.
Use Logarithmic Sensor	False Since the sensor signal is linear, there is no possibility to use a logarithmic signal from the sensor.

Application: Soft Pump
Use of **Actual Logarithmic Value** in the pressure controller: Set **Pressure Control.Controller X.Control Settings.Pressure Scaler** to **Logarithmic**.

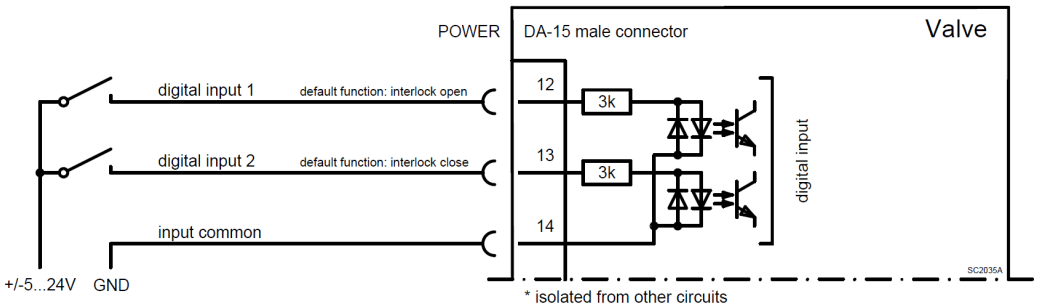
Note: Ramp value use logarithmic signal too, so **Ramp.Slope** is related to logarithmic scale.
For above example: **Slope [Torr]** = 15 means 15 of 1000 per Second what is 1.5% what corresponds to 0.15 Decade per Second.

4.14 Power Connector Digital IO

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

4.14.1 Digital Input

4.14.1.1 Connection



valve power supply can be used: pin 1,2 (24V) and 3,4 (GND)

Pin		Default Function
12	**INPUT 1**	Interlock Open
13	**INPUT 2**	Interlock Close
14	**COMMON**	

4.14.1.2 Configuration

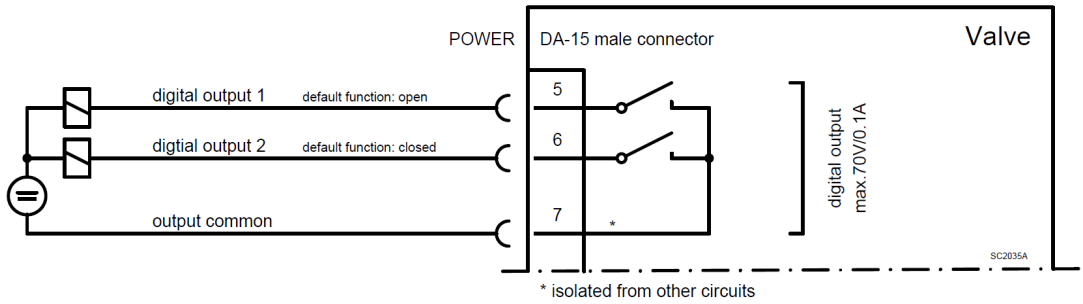
Location: CPA/Navigation/Parameters: Power Connector IO.Digital Input

Parameter	Description			
Enable	**1** enables the input			
State	**0** Not active **1** Active			
Functionality	**0** Interlock Open **1** Interlock Close **2** Hold			
Inverted		**Input**	**State**	**Function**
	0 Not Inverted	Off	0	Off
		On	1	On
	1 Inverted	Off	1	Off
		On	0	On

The INTERLOCK function has **priority** over the remote interface (HOLD does not)
INTERLOCK CLOSE has **priority** over INTERLOCK OPEN

4.14.2 Digital Output

4.14.2.1 Connection



Pin		Default Function
5	**OUTPUT 1**	Open
6	**OUTPUT 2**	Closed
7	**COMMON**	

4.14.2.2 Parameter, Configuration

Location: CPA/Navigation/Parameters: Power Connector IO.Digital Output

Parameter	Description			
Enable	**1** enables the output			
State	**0** Not active **1** Active			
Functionality	**0** OPEN **1** CLOSE **2** HOLD	valve is fully open valve is fully closed (isolated if valve has an isolation function) valve is in hold state		
Inverted		**Function**	**State**	**Output**
	0 Not Inverted	inactive	0	Off
		active	1	On
	1 Inverted	inactive	1	On
		active	0	Off

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 Access Mode

5.1.1 Overview

Defines whether the interface or the CPA via the service port has the rights to control the valve
Location: CPA/Parameters System

Access Mode	Control Permission	Comment
Local	CPA	
Remote	INTERFACE Master	CPA can switch to Local
Locked	INTERFACE Master	CPA can't switch to Local

Power On state is '**Remote'**

5.1.2 Remote and Locked operation

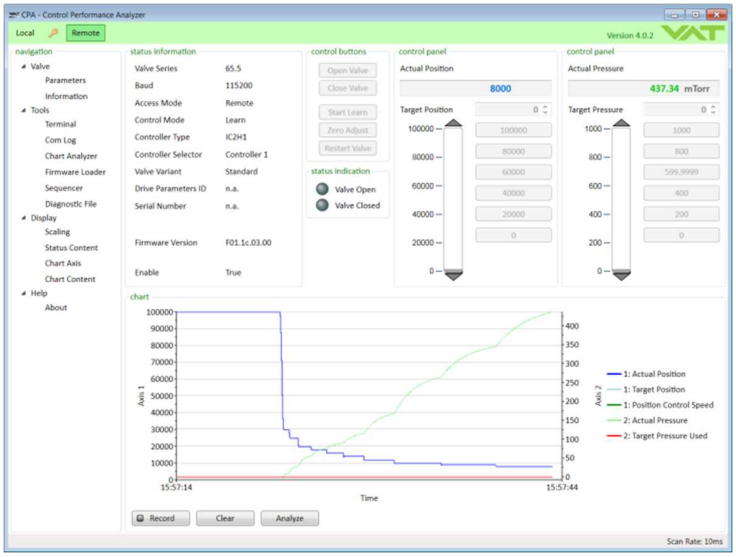
This product is equipped with an interface to allow for remote operation.
See section «Interface» for details.

'Control Performance Analyzer' software may be used for monitoring during remote control.

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

5.1.3 Local operation

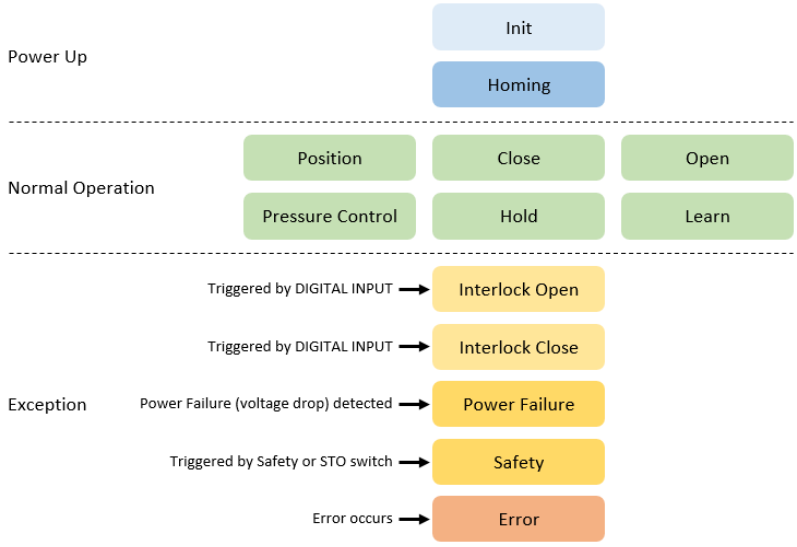
Local operation means that the valve is operated via the service port using a computer.
You can use our software 'Control Performance Analyzer' for Local operation, which is integrated in the controller. The software is beneficial especially for setup, testing and maintenance.



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

5.2 Control Mode

The **Control Mode** represents the state machine of the valve. Writing to **Control Mode** requests a change in the state while reading **Control Mode** returns the actual state of the state machine.

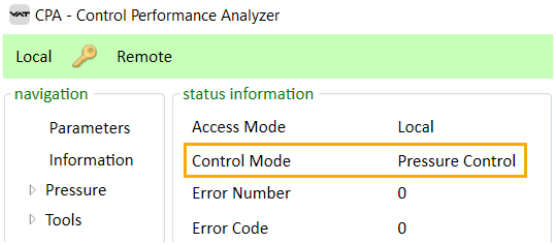


Init	**State after power up. Remains if Homing is not started or no Exception occurs**
Homing	The valve performs the homing procedure to initialize the position. Refer to chapter Homing
Position	The valve moves to the desired **Target Position**.
Close	The valve closes.
Open	The valve opens.
Pressure Control	The valve controls to the desired **Target Pressure.** Refer to chapter Pressure Control
Hold	The valve remains in the actual position. Usage during Pressure Control: Reduce valve reaction during plasma ignition. Stopping the valve movement to evaluate the stability of the sensor, flow meter, … Note: Change from **Control Mode** *Close* to *Hold* is not possible
Learn	The valve performs the system learn. Necessary for Adaptive Pressure Control. Refer to chapter Pressure Control/Adaptive Algorithm/Learn
Interlock Open	The valve opens and locks due to the actuation of a digital input. Release behavior: **Control Mode** changes to *Open* or to *Init* if no Homing was performed yet. Refer to Chapter Power IO
Interlock Close	The valve closes and locks due to the actuation of a digital input. Release behavior: **Control Mode** changes to *Close* or to *Init* if no Homing was performed yet. Refer to Chapter Power IO
Power Failure	Power loss occurred. The valve opens or closes (Only with optional Power Failure Option) Closing or opening behavior depends on set **Power Failure.Functionality** Refer to chapter Power Failure
Safety	The motor of the valve is powerless due to a digital input. Release behavior: **Control Mode** changes to *Init* Refer to chapter xxx
Error	The valve is in an error state, no movement possible. Recovery via **Services.Error Recovery** or **Services.Restart Controller**. Refer to chapter Trouble Shooting.

Location: CPA/Parameter: System.Control Mode

5.2.1 View

CPA



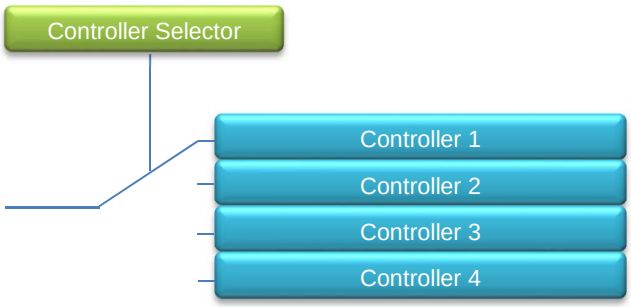
First digit on display

I	Init
H	Homing
C	Close
O	Open
P	Pressure Control
A	Position
I	Interlock Open or Close
H	Hold
L	Learn
S	Safety Mode
F	Power Failure
E	Error

5.3 Pressure Control

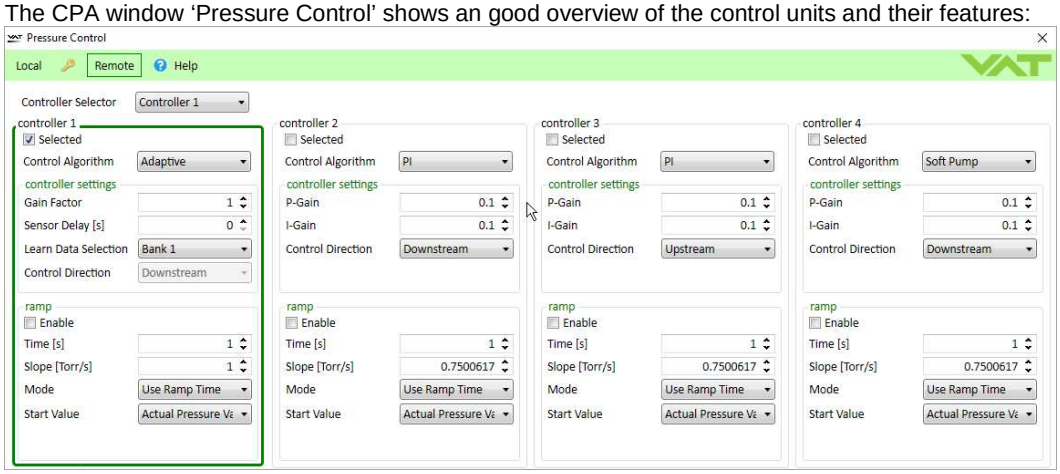
5.3.1 Controller units

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



Most applications do not need more than one controller unit. But if the result of the pressure control does not meet the expectations, different controller units can be an option for optimization: With the four controller units it is possible to use a certain controller unit for a specific pressure set point. This controller unit can be parametrized optimally for this specific set point.
With the **Automated Controller Selector** (see below) it is possible to change Controller depending on pressure ranges or on up- and down control.

The CPA window ‘Pressure Control’ shows an good overview of the control units and their features:



5.3.2 Control algorithm

5.3.2.1 Overview

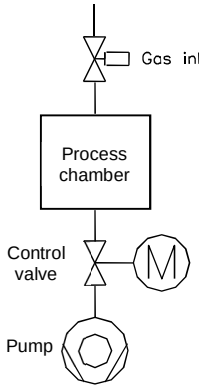
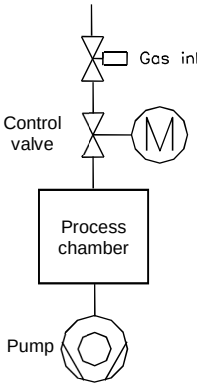
Adaptive This is the most dynamic control algorithm. Before using adaptive control algorithm, a special procedure called “learn” must be executed first (see chapter below). The valve will observe the behavior of the vacuum system by moving the valve to different positions. During the learn procedure the valve performs an internal parameter estimation correspondent to the vacuum system.

Note: Adaptive control algorithm requires a **linear** sensor signal. If a logarithmic sensor is used the signal has to be linearized or PI algorithm has to be used.

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

Soft Pump/Vent Is a modified PI control algorithm to pump down from atmospheric pressure or vent to atmospheric pressure. This control algorithm has been optimized to starts very carefully when opening the valve.

5.3.2.2 Choose correct control algorithm

<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</td><td colspan="2">PI</td></tr>
<tr><td>Upstream
 
</td><td colspan="3">PI</td></tr>
<tr><td>Soft Pump</td><td colspan="3">Soft Pump</td></tr>
</table>

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

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

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

5.3.3 Adaptive algorithm

This control algorithm may be used for downstream pressure control.

Before using adaptive control algorithm, a special procedure called “learn” must be executed first (see chapter below).

5.3.3.1 Control Parameter

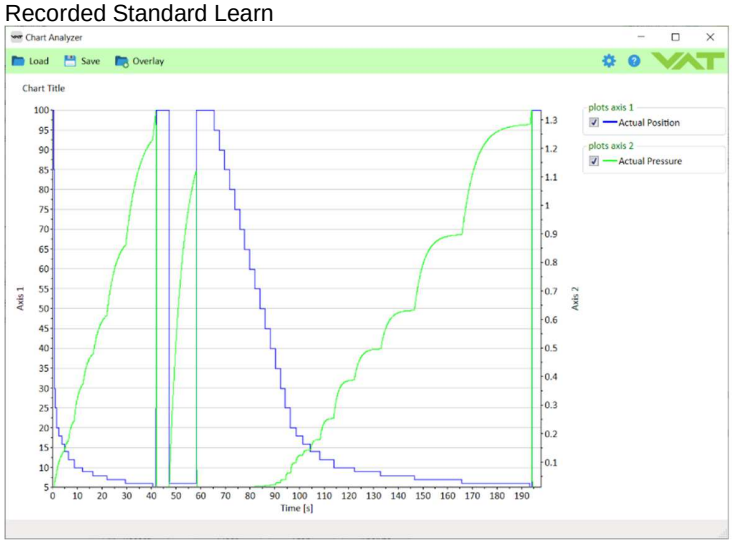
Location: CPA/Navigation/Parameters: Pressure Control.Controller x.Control Settings

Parameter	Description
Gain Factor	Main parameter to adapt the performance of the pressure control algorithm. A higher gain results in a faster response, higher over- / undershoots of pressure. A lower gain results in slower response, lower over- / undershoot of pressure.
Sensor Delay	For compensation of delays during the pressure detection. Pipes and orifices for sensor attachment can cause delays in response time and could impact badly the pressure control stability. By adapting this parameter to the approximate delay time stability problems can be reduced. But control response time will be slowed down by this measure.
Learn Data Selection	There are up to 4 different learn data sets available. Select which Learn data set the adaptive controller shall use for pressure control.
Ramp	A set poin ramp can be use to avoid over shoots… See chapter «Pressure Ramp»

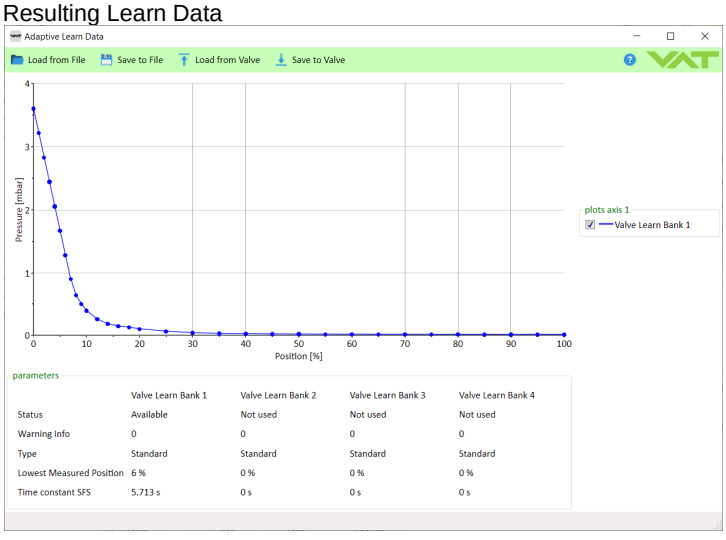
5.3.3.2 Learn

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.

Recorded Standard Learn



Resulting Learn Data



Parameters Executing

Location: CPA/Navigation/Parameters: Pressure Control.Adaptive Learn

Parameter	Description	
Start Learn	Starts the learn	
Type	Standard	A positioning sequence is executed and various measured values are recorded in the process.
	Short	Opens the valve and measures the pumping speed. Information about flow and volume is required.
	Calculated	Calculated the learn data with the pumping speed information.
	Short or Calculated can be used when there is no way to set a constant gas flow.	
Bank Selection	Select one of four learn bank to place the result of the learn procedure. Note: Be sure pressure controller select this learn bank!	
Pressure Limit [SFS]	Limit pressure to which pressure the learn shall be executed. The value is related to the sensor full scale of high sensor. 1.0 means the whole pressure range of the sensors	
Pressure Limit	Same value as above but in Pressure Unit	
Open Speed	Define the speed for opening the valve during the learn procedure. May be necessary to prevent a pump from crashing. 1.0 means full speed	
Status	State of the current learn **0**: Not Started **1**: In Progress **2**: Completed Successfully **3**: Aborted **4**: Failed	
Warning Info	Warning of current learn procedure: Bit **0**: Learn is running Bit **1**: Checksum error (learn data corrupt) Bit **2**: Learn procedure terminated by user Bit **3**: Pressure at position open > 50% of pressure limit Bit **4**: Pressure at minimal conductance position < 10 % of pressure limit Bit **5**: Pressure falls while move valve in direction of close Bit **6**: Pressure at open position does not match pressure of previous open Bit **7**: Learn procedure terminated by program Bit **8**: Pressure <= 0 at open position (no gas flow set?)	

Sort Learn Parameter

Parameter	Description
Chamber Volume	Volume above the valve plate in Liter
Gas Flow	Gas flow during the short learn, must be constant during the short learn
Gas Flow Unit	Gas flow unit for above Gas Flow
Pumping Speed	Resulting pumping speed

Calculated Learn Parameter

Parameter	Description
Pumping Speed	Set pumping speed to calculate the learn data

Parameters Learn Bank

Location: CPA/Navigation/Parameters: Pressure Control.Adaptive Learn.Learn Bank x

Parameter	Description	
Status	Not Used Available Available with warnings	Empty learn bank Data available. Evaluation possible with the pressure position curve in the CPA/Navigation/Adaptive Learn Data The data may still be suitable for pressure control. Evaluation possible with the pressure position curve in the CPA/Navigation/Adaptive Learn Datas
Data	Captured data in a non-readable format	
Warning Info	Displays warnings that occurred while learning for this learning bank. Show Warning Info above	
Type	Standard Short Calculated ..See description above	
Delete Learn Bank Data	Deletes the data of the learn bank	

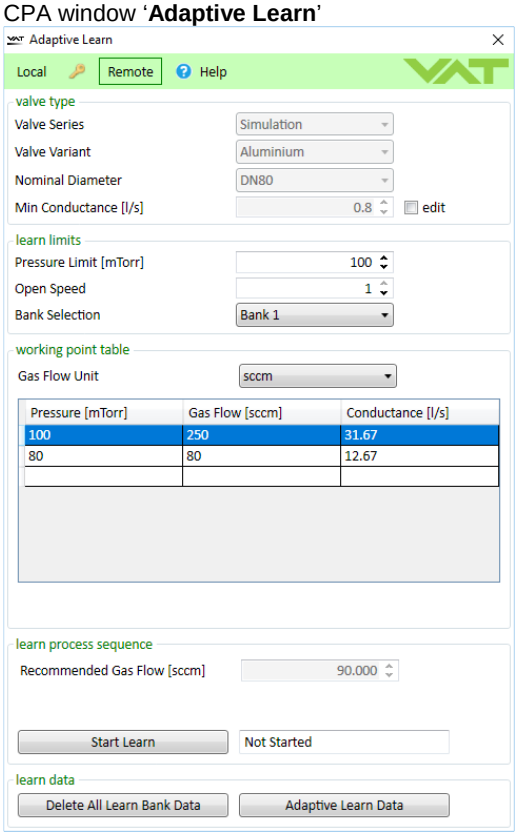
Execute a learn procedure

1. Set specific gas flow according to calculation below or the calculation in the CPA → '**Adaptive Learn**' window:

   Learn does not need to be performed with the process gas. Instead N_2 or Ar may be used.
2. Set parameter **Bank Selection**, if only one learn is used take Bank 1. Be sure that the pressure controller also selects this learn bank!
3. Reduce **Open Speed** if it is critical for the chamber if the pressure drops rapidly when the valve is opened.
4. Set a **Pressure Limit [SFS]** limit if sensor full scale cannot or should not be reached.
5. Set parameter **Controller Mode** to **LEARN**.
6. Wait until the **Controller Mode** leaves the **LEARN** state → Learn is finished
7. Check if the learn was successful by checking if **Status** shows value 2 (=Completed Successfully). In best case **Warning Info** shows no warning.

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

CPA window '**Adaptive 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.

Note: The subsequent calculation can be conveniently performed in the CPA/Navigation/Adaptive Learn > Gas Flow Calculation > Calculate

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»)

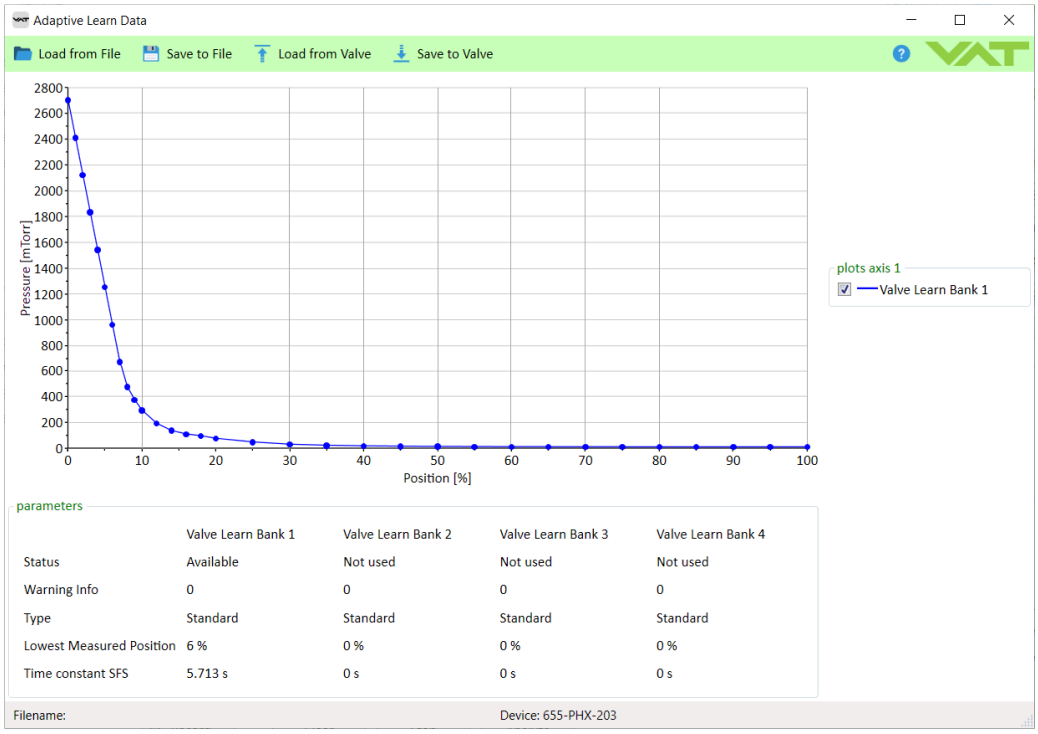
$$q_L = 71 \bullet p_{SFS} \bullet C_{min}$$

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»)

Evaluation and exchange of learn data

Location: CPA/Navigation/Adaptive Learn Data

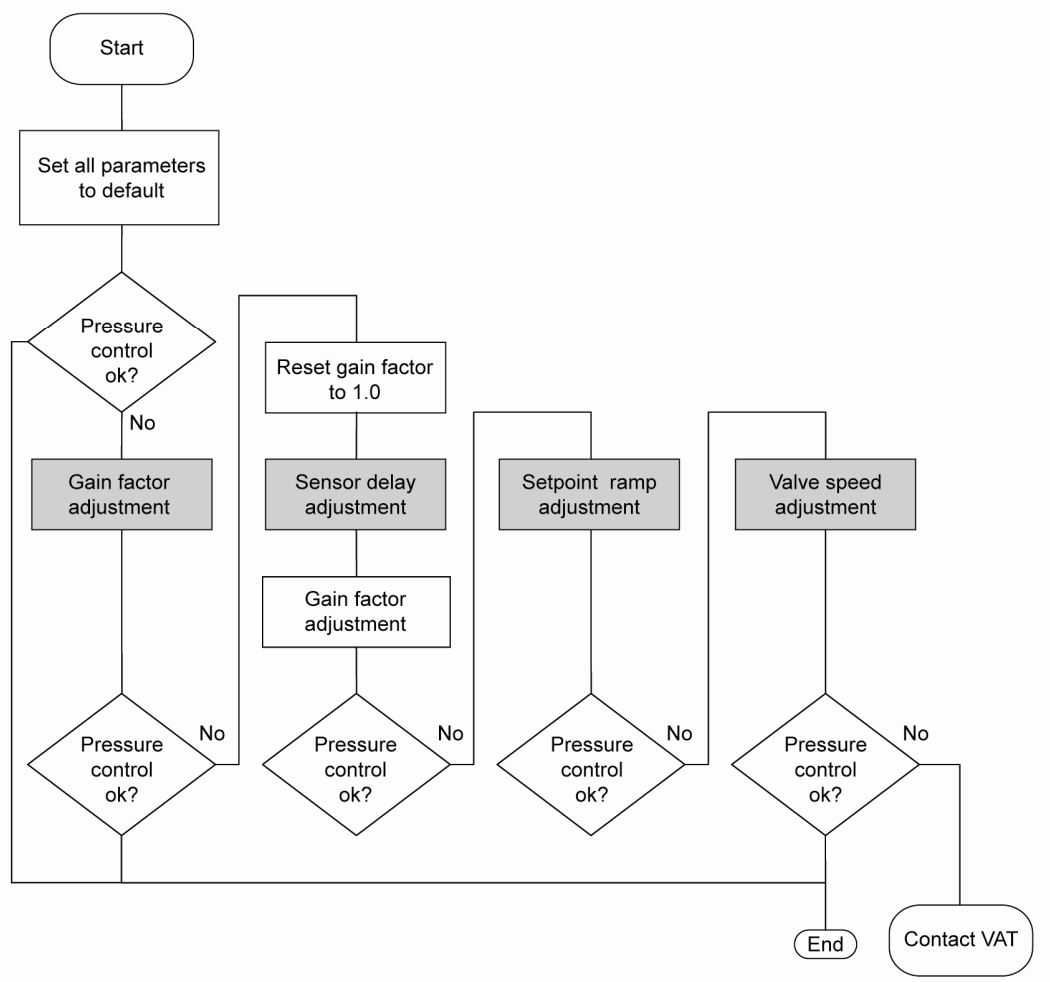
The window shows the pressure position curve of the stored data in the learning banks
With the menu buttons it is possible to exchange data between learn banks and between valves.



	Valve Learn Bank 1	Valve Learn Bank 2	Valve Learn Bank 3	Valve Learn Bank 4
Status	Available	Not used	Not used	Not used
Warning Info	0	0	0	0
Type	Standard	Standard	Standard	Standard
Lowest Measured Position	6 %	0 %	0 %	0 %
Time constant SFS	5.713 s	0 s	0 s	0 s

5.3.3.3 Tuning

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



Gain Factor adjustment

The Gain Factor effects: **Stability, Response time**

Adjustment range is from 0.0001 to 100.0

- 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 0.1 should lead to good results. Otherwise you may need to improve sensor connection. Refer to «Requirements to sensor connection».

Sensor Delay adjustment

Sensor Delay adjustment effects: **Stability**

Adjustment range is from 0.0 to 1.0sec

Pipes and orifices for sensor attachment delay response time and so badly impact pressure control stability.
By adapting this parameter to the approximate delay time stability problems can be reduced. But control response time will be slowed down by this measure.

Whenever possible sensors should be attached to the chamber according to «Requirements to sensor connection». This is the most effective measure against stability issues. If your gauge attachment fulfills these criteria do not use this parameter.

Adjustment procedure:

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

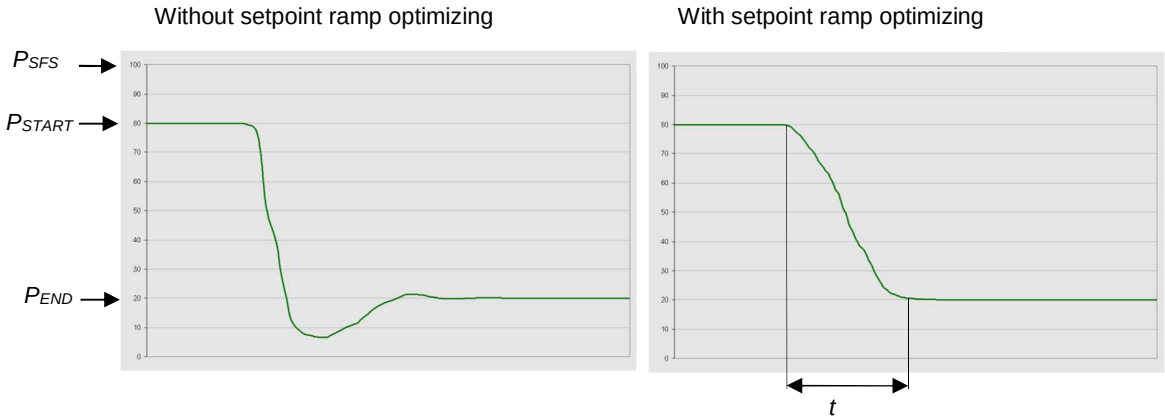
Setpoint Ramp adjustment

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

Note: The ramp is described in detail in capital Pressure Ramp**.**

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

Pressure chart



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

t	-	Setpoint Ramp
P_{SFS}	-	Pressure at Sensor full scale
P_{START}	-	Pressure at start of controlling a pressure step
P_{END}	-	Certain pressure, which should be regulated

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.

Pressure Control Speed adjustment

Valve speed effects: **Response time**

Adjustment range is from 0.001 to 1.0
Default value is 1.0

Location: CPA/Navigation/Parameters: Pressure Control.Pressure Control Speed

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 maximum Pressure Control 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 Pressure Control Speed until required response is achieved.

Required information for support:

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

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

5.3.4 PI algorithm

This control algorithm may be used for downstream or upstream pressure control depending on configuration.

5.3.4.1 Control Parameter

Location: CPA/Navigation/Parameters: Pressure Control.Controller x,Control Settings

Parameter	Description
P-Gain	The **P-Gain** is the proportional factor of the fixed control algorithm. A higher P-Gain results in faster response, higher over- / undershoot of pressure.
I-Gain	The **I-Gain** is the integral factor. The **I-Gain** helps to reach the target pressure exactly.
Pressure Scale	Linear Logarithmic Recommended if the pressure control extends over several decades. In most cases, the sensor used is a logarithmic sensor anyway.
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.

5.3.4.2 Tuning

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

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

Introduction

PI controller mode is used if for any reason (e.g. too long system time constant) the adaptive control mode does not provide satisfying control performance.
In PI controller mode the parameters P-Gain and I-Gain have to be set according to the systems characteristics. The best set of parameters can be found by using the empiric method below.

Pressure and gas flow for optimization

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

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

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

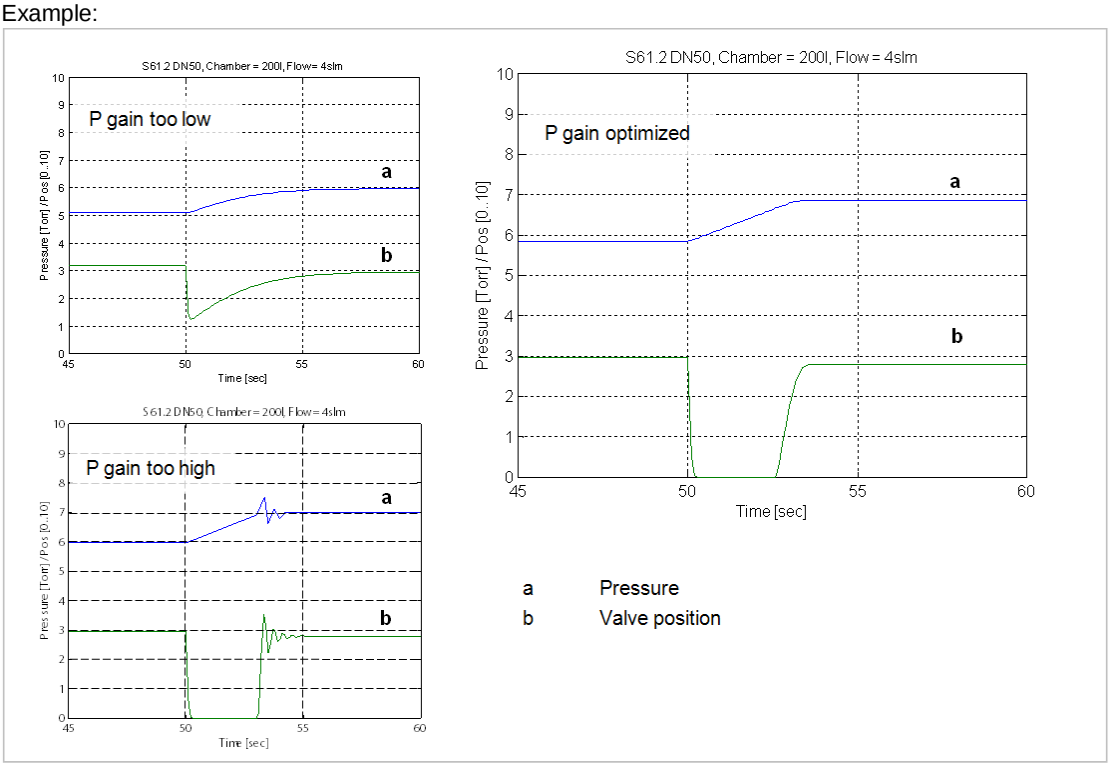
Pressure set points and gas flow for optimization:
SP1 = 7 Torr
SP2 = 6 Torr
Gas flow = 4 slm

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:

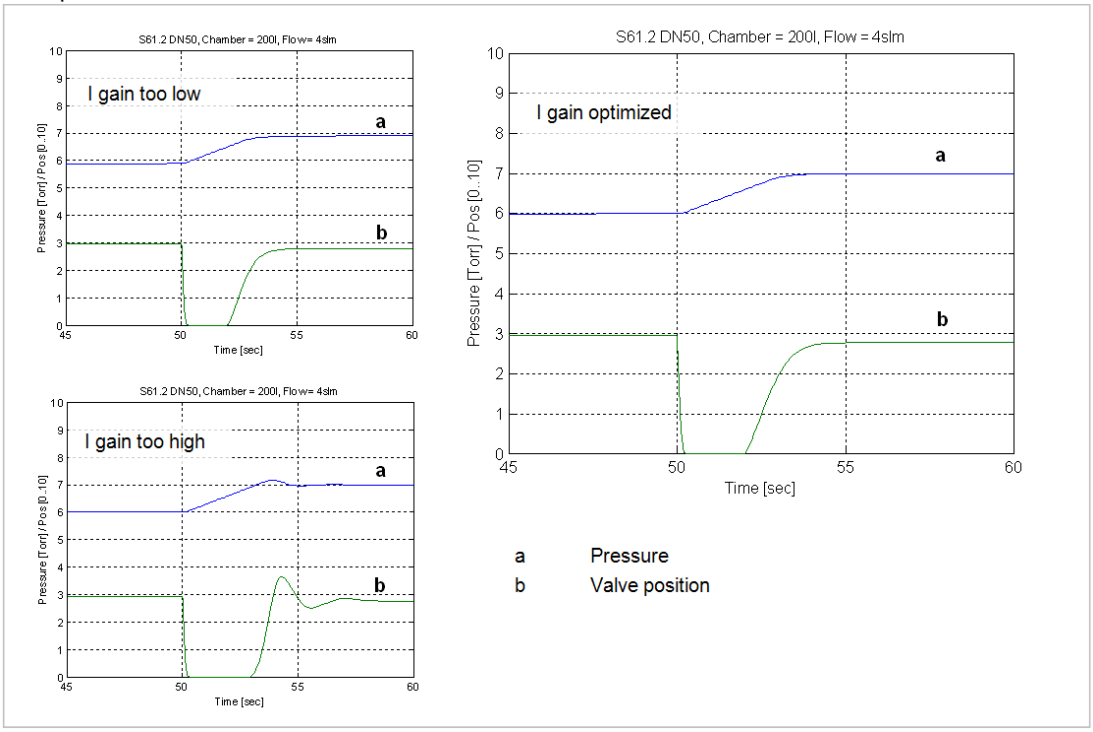


Optimizing I-Gain

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

Start with P-Gain set to half of the value found when optimizing P-Gain and set I-Gain to 1.0.
Keep the P-Gain constant.
Set chamber pressure to SP2, wait until the pressure is stable. Set pressure to SP1. If the transition from SP2 to SP1 results in a significant pressure over shoot or if the valve position does not stabilize, I-Gain is too high. If the transition results in a slow asymptotical pressure rise and there is still a constant deviation to SP2, the I-Gain is too low.
The optimal value for I-Gain is found if the transition from SP2 to SP1 result in just a slight pressure over shoot, a stable valve position and the actual pressure matches SP2 exactly.

Example:



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

Required information for support:

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

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

5.3.4.3 Soft Pump/Vent algorithm

This control algorithm may be used to control pressure ramps during pump down or venting the chamber. This is a modified PI controller that has been optimized to start up very gently when the valve is opened.

5.3.4.4 Control Parameter

Location: CPA/Navigation/Parameters: Pressure Control.Controller x,Control Settings

Parameter	Description
P-Gain	The **P-Gain** is the proportional factor of the fixed control algorithm. A higher P-Gain results in faster response, higher over- / undershoot of pressure.
I-Gain	The **I-Gain** is the integral factor. The **I-Gain** helps to reach the target pressure exactly.
Pressure Scale	Linear Logarithmic Recommended if the pressure control extends over several decades. In most cases, the sensor used is a logarithmic sensor anyway.
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.
Ramp	Only the ramp makes the soft pump or soft vent… See chapter «Pressure Ramp»

5.3.4.5 Tuning

Optimizing P-Gain

Start optimization with P-Gain set to 0.1 and I-Gain set to 0.0.
The control 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
- Send the pressure set point to the valve controller.

While pumping/venting the chamber pressure and valve position should be data logged to compare the actual curve with the ideal straight pump/venting line.
If the pressure follows the ideal pump/venting line with significant delay, the P-Gain is too low.
If the pressure oscillates around the ideal pump/venting line or if the valve position oscillates, P-Gain is too high.

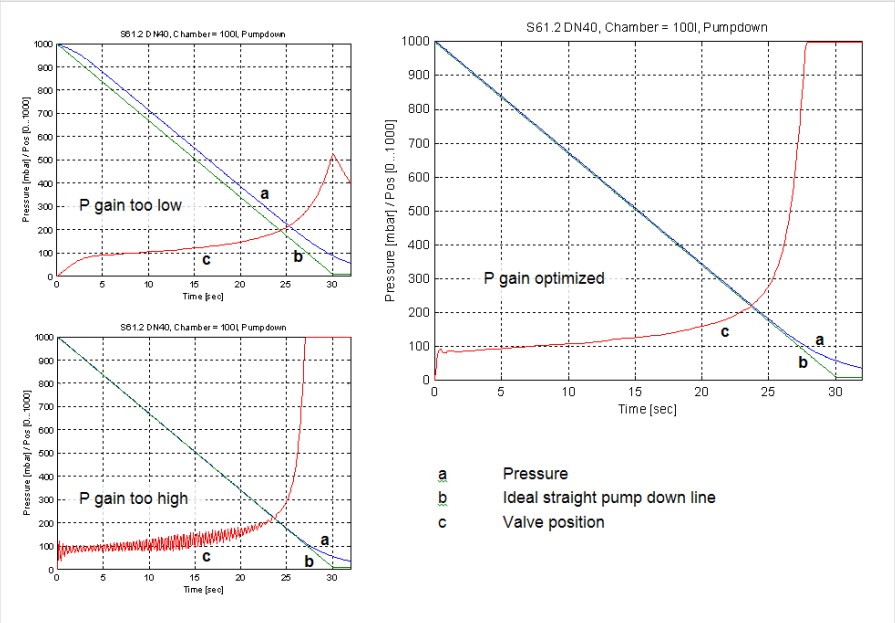
P-Gain is optimized if the pressure follows the ideal pump down line closely and the valve position is not oscillating at all.

Optimizing I-Gain

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.
If the pressure follows the ideal pump/venting line with significant delay, the I-Gain is too low.
If the pressure oscillates around the ideal pump/venting line or if the valve position oscillates, I-Gain is too high.

I-Gain is optimized if the pressure follows the ideal pump down line closely and the valve position is not oscillating at all.

Example:



Optimizing I-Gain

I-Gain is responsible to reach the setpoint. If reaching setpoint is not important (e.g. setpoint is 0) leave the I-Gain at 0. Otherwise start with P-Gain set to half of the value found when optimizing P-Gain and set I-Gain to 0.1. Keep the P-Gain constant. Start again the pump down. Check how the pressure reaches the setpoint:
If the setpoint is reached too slowly increase I-Gain
If there is an undershoot increase I-Gain

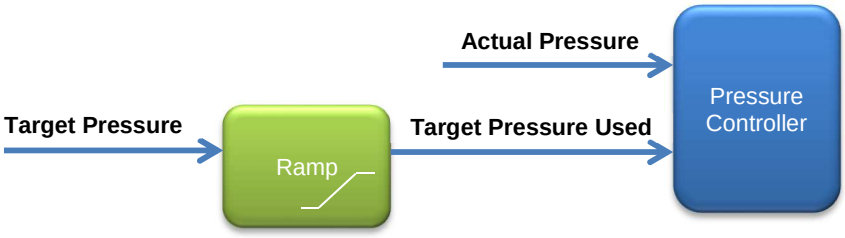
Required information for support:

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

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

5.3.5 Pressure Ramp

Basically, the pressure ramp is used to limit the rate of pressure change.



5.3.5.1 Configuration

Location: CPA/Navigation/Parameters: Pressure Control.Controller x.Ramp

Parameter	Description
Enable	Activate / Deactivate pressure target ramp
Mode	**0**:Use ***Ramp Time*** **1**:Use ***Ramp Slope*** See description below
Time	Target reach time in seconds (Used if **Mode** = 0)
Slope	Limit the rate of pressure change in pressure per seconds (Used if **Mode** = 1)
Type	**0**:Linear **1**:Logarithmic **2**:Exponential
Start Value	**0**:Previous Ramp Value **1**:Actual Pressure Value

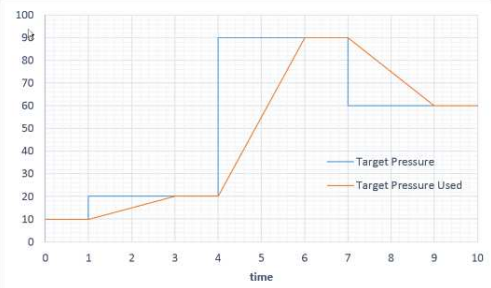
5.3.5.2 Mode

Time

Unit: seconds

Time is constant, slope varies

Example: 2 sec

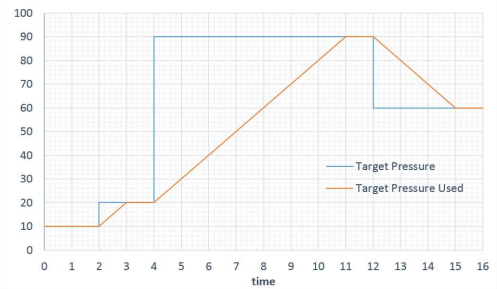


Slope

Unit: Pressure / seconds

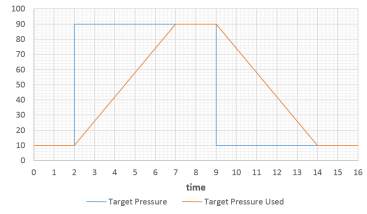
Slope is constant, time varies

Example: 10mTorr/second

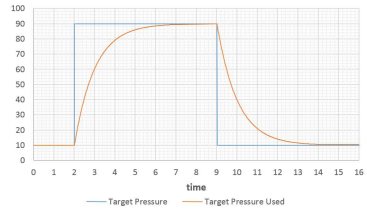


5.3.5.3 Type

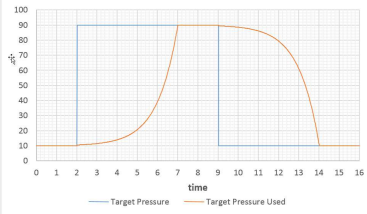
Linear



Logarithmic



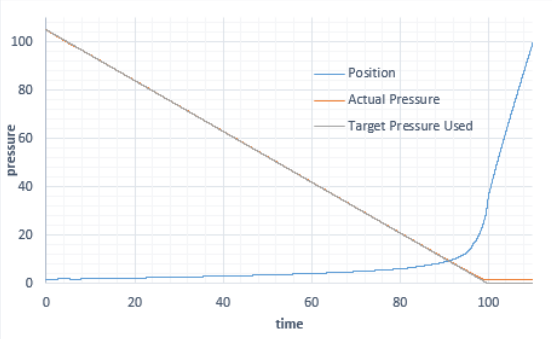
Exponential



5.3.5.4 Applications Examples

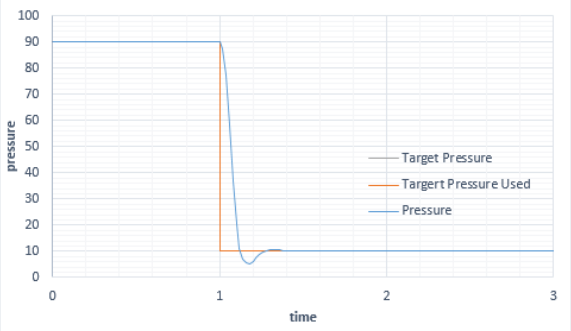
Soft pump

Ramp Mode = Time
Ramp Time = 100 sec
Ramp Type = Linear
Target Pressure = 0

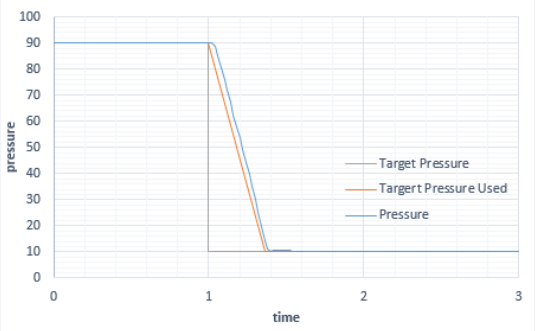


Minimize pressure over- or undershoots

New Target Pressure without pressure ramp

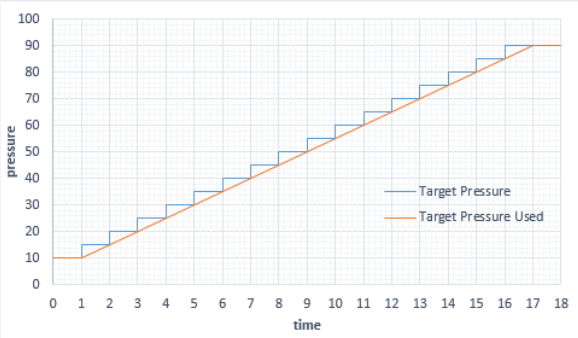


New Target Pressure with pressure ramp



Smoothing a staircase

Pressure ramp with new target pressure to the valve every second is smoothed by a 1 sec internal ramp
Ramp Time = 1sec



5.3.6 Profile Ramp

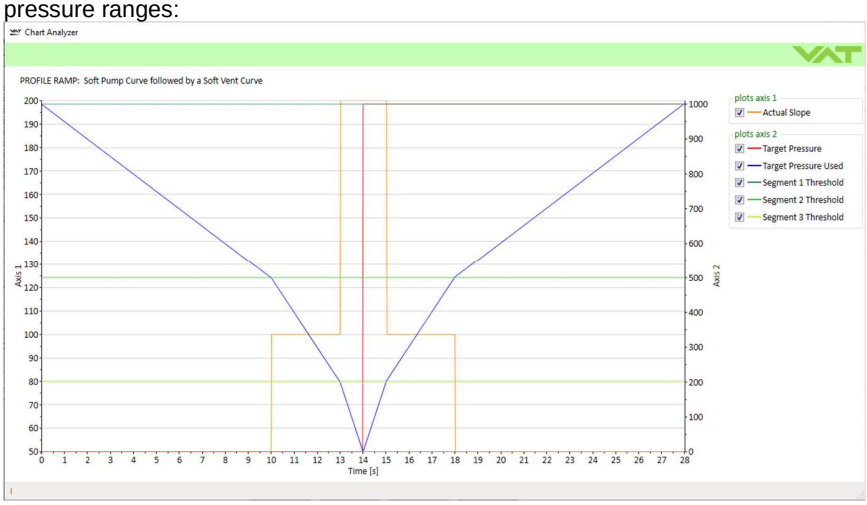
Profile Ramp is a **Target Pressure** ramp that depends on pressure ranges (segments).
It is mainly used to create soft pumping or soft venting profiles.

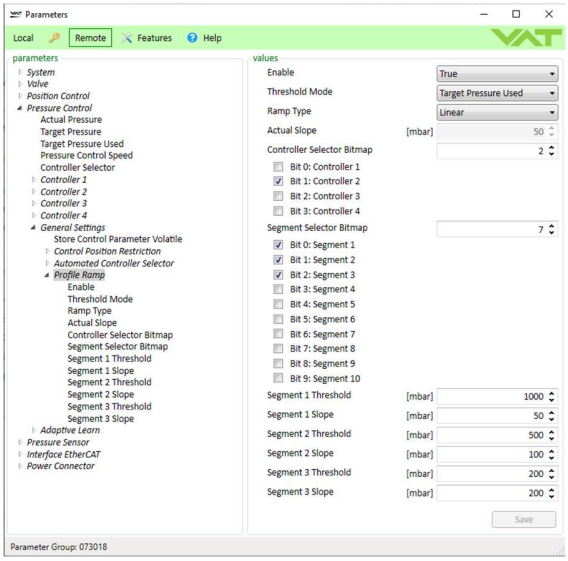
To design a profile, the segments (pressure ranges) must be defined.
A segment is defined by the pressure **Threshold** and the **Slope**.
It is possible to define up to 10 segments.

Example: Ramp Profile with 3 segments

Segment Nr	**Threshold** mBar*	Resulting Segment mBar*	**Slope** mBar*/sec
1	1000	500 to 1000	50
2	500	200 to 500	100
3	200	0 to 200	200

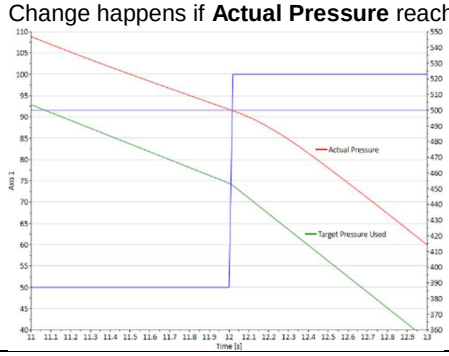
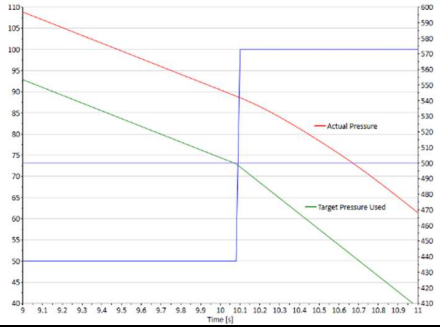
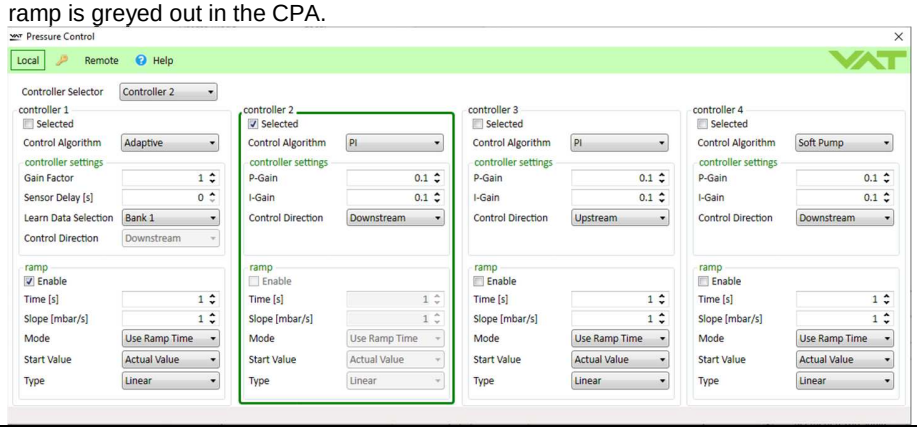
Result is a Target Pressure Ramp (**Target Pressure Used**) with different slopes depending on pressure ranges:

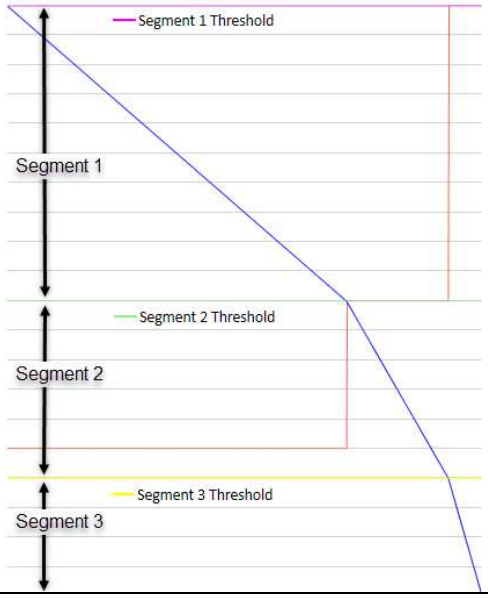




Parameters:

Location: CPA/Navigation/Parameters: Pressure Control.General Settings.Profile Ramp

Parameter	Description
Enable	Switches on/off the function
Threshold Mode	Defines which pressure the threshold refers to
	Actual Pressure — Change happens if **Actual Pressure** reaches the **Threshold** 
	Target Pressure Used — Change happens if **Target Pressure Used** reaches the **Threshold** 
Ramp Type	Defines the shape of the ramp Linear Logarithmic Exponential
Actual Slope	Show the actual use slope during pressure control in mBar*/sec.
Controller Selector Bitmap	Determines which Controller uses the profile ramp. When a Controller is selected, the ramp is no longer used in the controller itself. Therefore the ramp is greyed out in the CPA. 
Segment Selector Bitmap	Defines which segments is used for the Profile Ramp.

Segment x Threshold	This is the upper limit of the segment. The lower limit is defined by the next lower **Threshold**, or the lower limit is 0 if there is no lower **Threshold**. If the value exceeds the top threshold, the slope value of the top segment is used (Segment 1 in below example) 
Segment x Slope	Defines the slope (mBar*/sec) in the segment

** Unit adjustable*

5.3.7 Automated Controller Selector

With the 4 Controllers it is possible to define different pressure control settings.
The Automated Controller Selector can select one of the 4 Controllers depending on Target Pressure (***Mode***: *Threshold*) or Up-Down Control (***Mode***: *Pressure Direction*)

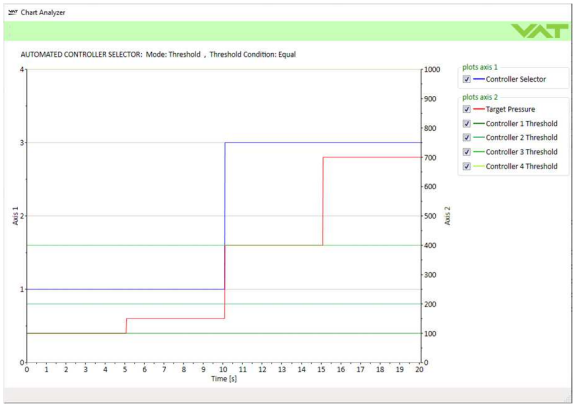
Mode: *Threshold*
Threshold Condition: *Lower or Equal*

Controller Selector *changes when the* ***Target Pressure*** *exceeds or falls below a* ***Threshold*** *value*

Mode		Threshold
Controller Selector Bitmap		15
Bit 0: Controller 1		
Bit 1: Controller 2		
Bit 2: Controller 3		
Bit 3: Controller 4		
Threshold Condition		Lower or Equal
Controller 1 Threshold	[mbar]	100
Controller 2 Threshold	[mbar]	200
Controller 3 Threshold	[mbar]	400
Controller 4 Threshold	[mbar]	1000

Threshold Condition: *Equal*

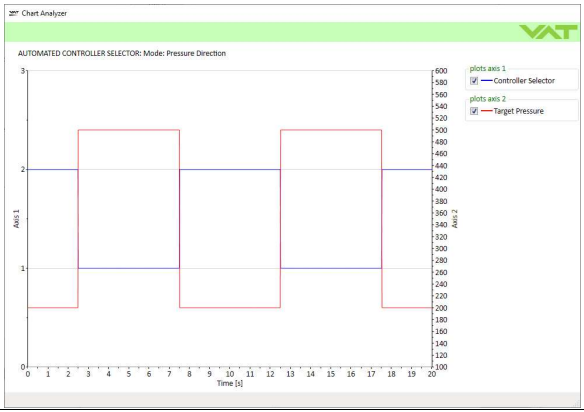
Controller Selector changes only when the ***Target Pressure*** is equal to a ***Threshold*** value



Mode		Threshold
Controller Selector Bitmap		15
Bit 0: Controller 1		
Bit 1: Controller 2		
Bit 2: Controller 3		
Bit 3: Controller 4		
Threshold Condition		Equal
Controller 1 Threshold	[mbar]	100
Controller 2 Threshold	[mbar]	200
Controller 3 Threshold	[mbar]	400
Controller 4 Threshold	[mbar]	1000

Mode: *Pressure Direction*
Controller Pressure Rising: *Controller 1*
Controller Pressure Falling: *Controller 2*

Controller Selector changes depending on whether ***Target Pressure*** is rising or falling



Mode	Pressure Direction
Controller Pressure Rising	Controller 1
Controller Pressure Falling	Controller 2

Parameter:

Location: CPA/Navigation/Parameters: Pressure Control.General Settings.Automated Controller Selector

Parameter	Description
Enable	Switches on/off the function
Mode	*Threshold* *Pressure Direction*
Controller Selector Bitmap	Used if ***Mode*** = *Threshold* Defines which controllers are automatically selected
Threshold Condition	Used if ***Mode*** = *Threshold* *Lower or Equal* *Equal* The Thresholds are related to ***Target Pressure***
Controller 1 Threshold ***Controller 2 Threshold*** ***Controller 3 Threshold*** ***Controller 4 Threshold***	Used if ***Mode*** = *Threshold* The Thresholds are related to ***Target Pressure***
Controller Pressure Rising ***Controller Pressure Falling***	Used if ***Mode*** = *Pressure Direction* Select one Controller for up control and one for down control *Controller 1* *Controller 2* *Controller 3* *Controller 4*

5.3.8 Control Position Restriction

Location: CPA/Navigation/Parameters: Pressure Control.General Settings.Control Position Restriction

Parameter	Description
Enable	False True
Minimum Control Position	Defines the lowest position during pressure control
Maximum Control Position	Defines the highest position during pressure control
Restriction Active	False True

5.3.9 Store Control Parameter Volatile

Used when the control parameters are changed frequently during the process and it is not useful to store the value in the non-volatile memory each time (the lifetime of the non-volatile value is 1 million memory cycles).

Only effective on the interface, the settings via CPA are always stored in non-volatile memory

Location: CPA/Navigation/Parameters: Pressure Control.General Settings

Parameter	Description
Store Control Parameter Volatile	False True

5.4 Position Control

5.4.1 Parameter

Location: CPA/Navigation/Parameters: Position Control

Parameter	Description
Actual Position	Position of the valve plate Range depends on Position Scaling setting (on Interface and CPA)
Target Position	Desired position of the valve plate Range depends on Position Scaling setting (on Interface and CPA)
Position Control Speed	Speed of the valve in Control Mode Position 0.001 .. 1.0 (Full speed)
Ramp	See below

5.4.2 Position Ramp

5.4.2.1 Configuration

Location: CPA/Navigation/Parameters: Position Control.Ramp

Parameter	Description
Enable	Activate / Deactivate position ramp
Mode	**0**:Use ***Ramp Time*** **1**:Use ***Ramp Slope*** See description below
Time	Target reach time in seconds (Used if **Mode** = 0)
Slope	Limit the rate of position change per second (Used if **Mode** = 1)
Type	**0**:Linear **1**:Logarithmic **2**:Exponential

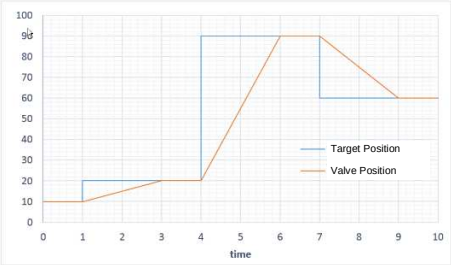
5.4.2.2 Mode

Time

Unit: seconds

Time is constant, slope varies

Example: 2 sec

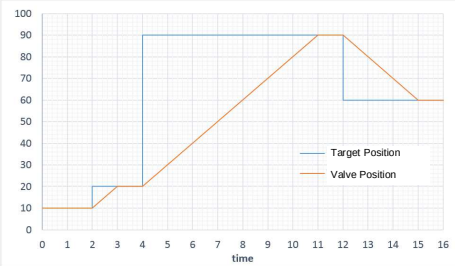


Slope

Unit: %* / seconds

Slope is constant, time varies

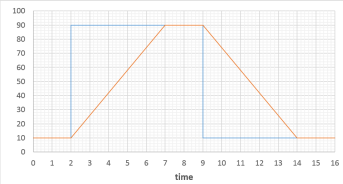
Example: 10% / sec



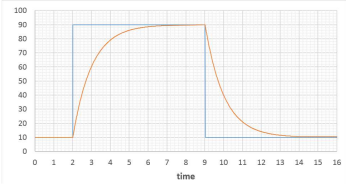
** Unit adjustable*

5.4.2.3 Type

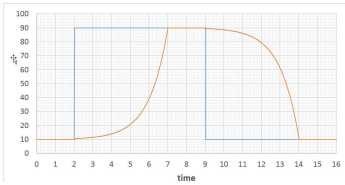
Linear



Logarithmic



Exponential



5.5 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 product data sheet.

⚠ WARNING

O-ring sticking

Due to the sticking properties of elastomer O-rings at high temperature, operator/ integrator must ensure the vacuum product settled at the same temperature prior to opening as it was when it was closed otherwise there is a risk of damage to the O-ring.

6 Trouble shooting

6.1 Warnings

A warning does not lead to an interruption of valve operation.

Location: CPA/Parameters: System.Services

Parameter	Description		
Warning Bitmap	Bit	Hex	Description
	0	1	No learn data available for adaptive control
	1	2	Position indicator signal of the external isolation valve incorrect.
	2	4	No Sensor Active
	3	8	PFO Not Ready
	4	16	Cluster Slave Offline
	6	40	Fieldbus Data Not Valid
	8	256	Compressed Air Not Falling when valve close
	9	512	Compressed Air Too Low
	10	1024	Compressed Air Too High
	12	4096	Fan stall alarm

Failure	Check	Action
Display does not light up	- 24 V power supply	- Connect valve to power supply according to 'Power, ground and sensor connection' and make sure that power supply is working.
Remote operation does not work	- Local operation via service port active	- Switch to remote or locked operation Refer to 'Remote and local operation'
	- Safety mode active Check for S on display	- Check 'Drive Power Enable Switch' Refer to 'Power, ground and sensor connection'
	- Interlock mode active Check for I on display	- Check Digital Input Refer to 'Power connector IO' → 'Digital Input'
POSITION CONTROL does not work	- Safety mode active Check for S on display	- Check 'Drive Power Enable Switch' Refer to 'Power, ground and sensor connection'
	- Interlock mode active Check for I on display	- Check Digital Input Refer to 'Power connector IO' → 'Digital Input'
	- POSITION CONTROL selected, check for A on display?	- Select POSITION CONTROL mode. Refer to 'Control Mode' in 'EtherCAT' interface
Pressure reading is wrong Pressure reading is negative	- Sensor connection	- Refer to 'Power, ground and sensor connection'
	- ZERO done?	- Perform ZERO when base pressure is reached. Refer to 'Pressure Sensor' → 'Zero Adjust'
	- Does sensor power supply provide enough power for sensor(s)?	- Verify sensor supply voltage.
ZERO does not work	- ZERO disabled?	- Enable ZERO. Refer to 'Pressure Sensor' → 'Zero Adjust'
	- Sensor voltage shifting?	- Wait until sensor does not shift any more before Performing ZERO.
Pressure is not '0' after ZERO	- System pumped to base pressure?	- OPEN VALVE and bring chamber to base pressure before performing ZERO.
	- Sensor offset voltage exceeds ±1.4V	- Adjust the offset direct at the sensor - Check function of the sensor.
PRESSURE CONTROL does not work	- PRESSURE CONTROL selected, check for P on display?	- Select PRESSURE CONTROL mode. Refer to 'Control Mode' in 'EtherCAT' interface
	- LEARN done?	- Perform LEARN. Refer to 'Pressure control' → 'Adaptive algorithm' → 'Learn'
	- Sensor signal ok?	- Refer to 'Pressure Sensor'
	- Pressure control setup done	- Refer to 'Pressure control'
PRESSURE CONTROL not optimal	- LEARN successfully done?	- Perform LEARN. Check 'Status' and 'Warning Info' in 'Pressure control' → 'Adaptive algorithm' → 'Learn'
	- ZERO performed before LEARN?	- Perform ZERO then repeat LEARN. Refer to 'Pressure Sensor' → 'Zero Adjust'
	- Was gas flow stable during LEARN?	- Repeat LEARN with stable gas flow. Refer to 'Pressure control' → 'Adaptive algorithm' → 'Learn'
	- Tuning done?	- Tune valve for application. Refer to the tuning sections in 'Pressure Control'
	- 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.

6.2 Errors

If valve is in Control Mode Error, movement is no longer possible.

The following parameters provide information about the cause of the error:

Location: CPA/Parameters: System.Services

Parameter	Description
Error Bitmap	Information about the types of errors. Details below.
Error Number	Information about the error component. Details below. Also shown on the controller display when active.
Error Code	Information about the different error states. Details below. Also shown on the controller display when active.

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

The following information is required for VAT to analyze the error case:

- Diagnostic File: CPA → Tools → Diagnostic File
- Load Error Data: CPA → Tools → Trace Log → Mode Load Error Data → Start

6.2.1 Error Recovery

To leave the error state, the ***Error Recovery*** or ***Restart Controller*** can be used***:***

Location: CPA/Parameters: System.Services

Parameter	Description
Restart Controller	Emulates a power cycle of the valve
Error Recovery	Attempts to reset the Control Mode Error without restarting the valves

Create a diagnostic file before recovery or restart if the error is to be analyzed by VAT

6.2.2 Error Bitmap

Parameter	Description		
Error Bitmap	Bit	Hex	Description
	0	1	Homing Position Error
	1	2	Homing Not Running
	2	4	Homing Error State
	3	8	Operation Position Error
	4	10	Operation Not Running
	5	20	Operation Error State
	12	1000	Other Component
	30	40000000	General
	31	80000000	Internal

6.2.3 Error Number

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

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

6.2.4 Error Code

[1)] Mechanical movement problem:

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

Code	Description	Solution
1	No valve connected	Connect valve controller to the valve
2	Nonvolatile memory failure	Replace valve controller
3	Analog digital converter of sensor input failure	Replace valve controller
4	Initialization of motion controller failed	Wrong motion controller firmware version → Update motion controller firmware
5	Encoder index pulse not found	• [1)] • Encoder failure • O-ring sticking
6	Initialization of interface module failed	• Fieldbus: Valve firmware does not support interface type → Update valve firmware • Wrong interface firmware version → Update interface firmware
7	Initialization of external drive EEProm failed	Check cables
10	Closing position can't be reached	[1)]
11	Homing position can't be reached	• [1)] • Plate not mounted
12	Motion controller: Internal voltage error	Check power supply
13	Motion controller: Internal error temperature	Check for a heat accumulation
14	Motion controller: Unexpected behavior	Contact vat support • Axis inverted • Encoder not connected • Break not released
15	Motion controller: Target position can't be reached	• [1)] • Current Settings
16	Motion controller: Position minimal conductance cannot be reached	• [1)] • Check Plate and Seal ring • Check Parameter "Isolation Position Enter [r]"
17	Motion controller: Position to push back the Differential Plate cannot be reached	• [1)] • Check Different Plate • Check Parameter "Differential Plate Push Back Position [r]"
18	Motion controller: Minimal isolation position cannot be reached	• [1)] • Check Plate and Seal ring • Check Parameter "Isolation Position [r]"
20	Break slippery detected	Replace actuator

Code	Description	Solution
30	SFV: Motion controller failure in master-slave communication	Contact vat support
40	Compressed air error	Check compressed air
42	Power supply, low voltage detected	Check if power supply is ok and is able to deliver needed power
96	SFV: Position deviation axis1 to axis2 at homing procedure	• [1)] • O-ring sticking
97	SFV: Position deviation axis1 to axis2 at operating	[1)]
98	Position error during closing procedure	[1)]
99	Position error at operating	[1)]
200	Valve configuration error, not possible to operate the valve with these configuration	Contact VAT support
701	Wrong ident code axis 1	Check wiring
702	Wrong ident code axis 2	
703	Wrong ident code axis 2 AND axis 1	
704	Wrong ident code axis 3	
705	Wrong ident code axis 3 AND axis 1	
706	Wrong ident code axis 3 AND axis 2	
707	Wrong ident code axis 3 AND axis 2 AND axis 1	
707	Do not operating mode active	

6.3 Troubleshooting List

Failure	Check	Action
Display does not light up	- 24 V power supply	- Connect valve to power supply according to 'Power, ground and sensor connection' and make sure that power supply is working.
Remote operation does not work	- Local operation via service port active	- Switch to remote or locked operation Refer to 'Remote and local operation'
	- Safety mode active Check for S on display	- Check 'Drive Power Enable Switch' Refer to 'Power, ground and sensor connection'
	- Interlock mode active Check for I on display	- Check Digital Input Refer to 'Power connector IO' → 'Digital Input'
POSITION CONTROL does not work	- Safety mode active Check for S on display	- Check 'Drive Power Enable Switch' Refer to 'Power, ground and sensor connection'
	- Interlock mode active Check for I on display	- Check Digital Input Refer to 'Power connector IO' → 'Digital Input'
	- POSITION CONTROL selected, check for A on display?	- Select POSITION CONTROL mode. Refer to 'Control Mode' in 'EtherCAT' interface
Pressure reading is wrong Pressure reading is negative	- Sensor connection	- Refer to 'Power, ground and sensor connection'
	- ZERO done?	- Perform ZERO when base pressure is reached. Refer to 'Pressure Sensor' → 'Zero Adjust'
	- Does sensor power supply provide enough power for sensor(s)?	- Verify sensor supply voltage.
ZERO does not work	- ZERO disabled?	- Enable ZERO. Refer to 'Pressure Sensor' → 'Zero Adjust'
	- Sensor voltage shifting?	- Wait until sensor does not shift any more before Performing ZERO.
Pressure is not '0' after ZERO	- System pumped to base pressure?	- OPEN VALVE and bring chamber to base pressure before performing ZERO.
	- Sensor offset voltage exceeds ±1.4V	- Adjust the offset direct at the sensor - Check function of the sensor.
PRESSURE CONTROL does not work	- PRESSURE CONTROL selected, check for P on display?	- Select PRESSURE CONTROL mode. Refer to 'Control Mode' in 'EtherCAT' interface
	- LEARN done?	- Perform LEARN. Refer to 'Pressure control' → 'Adaptive algorithm' → 'Learn'
	- Sensor signal ok?	- Refer to 'Pressure Sensor'
	- Pressure control setup done	- Refer to 'Pressure control'
PRESSURE CONTROL not optimal	- LEARN successfully done?	- Perform LEARN. Check 'Status' and 'Warning Info' in 'Pressure control' → 'Adaptive algorithm' → 'Learn'
	- ZERO performed before LEARN?	- Perform ZERO then repeat LEARN. Refer to 'Pressure Sensor' → 'Zero Adjust'
	- Was gas flow stable during LEARN?	- Repeat LEARN with stable gas flow. Refer to 'Pressure control' → 'Adaptive algorithm' → 'Learn'
	- Tuning done?	- Tune valve for application. Refer to the tuning sections in 'Pressure Control'
	- 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.

7 Maintenance

⚠ WARNING

Unqualified personnel

Inappropriate handling may cause serious injury or property damage.

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

⚠ WARNING

Valve opening

Risk of serious injury.

Human body parts must be kept out of the valve opening and away from moving parts. Disconnect power on controller before doing any work.

⚠ CAUTION

Hot valve

Heated valve may result in minor or moderate injury.

Do not touch valve and heating device during operation. Once heating is switched off (valve and system) await until the valve is cooled down complete before doing any work.

NOTICE

Contamination

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

Always wear clean room gloves when handling the valve.

7.1 Maintenance intervals

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

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

7.2 Maintenance procedures

Two maintenance procedures are defined for this valve. This are:

- Replacement of shaft feedthrough seals and valve cleaning. Refer to chapter: «Replacement of rotary feedthrough».
- Replacement of Option board. Refer to chapter: «Replacement of Option board»

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

VAT can give the following recommendations for preventive maintenance:

Replacement of	unheated [1)]	heated ≤ 80 °C [1)]	heated > 80 °C [1)]
Rotary feedthrough seals	2'000'000 cycles	6 months but max. 2'000'000 cycles	3 months but max. 2'000'000 cycles
Plate O-ring / Plate vulcanized	250'000 closing / opening	6 months but max. 250'000 cycles	3 months but max. 250'000 cycles
Plate O-ring / Plate vulcanized DN 63 - 100 mm	100'000 closing / opening	6 months but max. 100'000 cycles	3 months but max. 100'000 cycles

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

Below pictures are sample pictures. Although there may be different variants of the valve, the assembly procedure stays the same for all these variants with the differences shown in the table below.

ISO K (DN 40-50)

ISO_F (DN 63-100)

Plate with O-ring

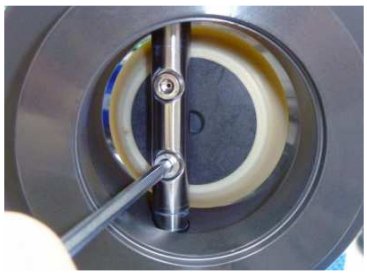


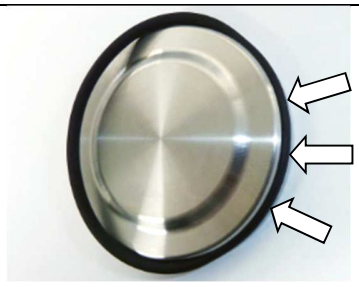
Plate vulcanized

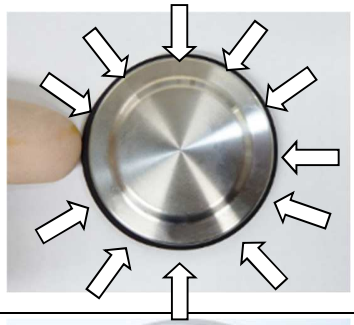
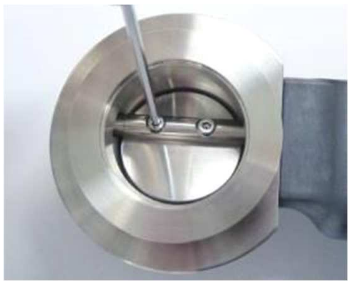
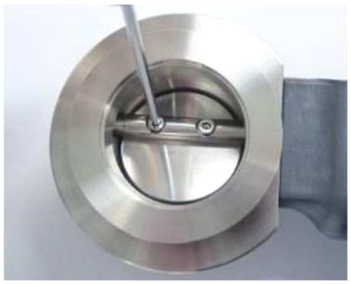
7.2.1 Replacement of vulcanized plate or plate with O-ring

Required tools

- Allen wrench 3mm for DN 40-63mm
- Allen wrench 4mm for DN 80-100mm
- O-ring removal tool (see chapter Accessories)
- Vacuum grease (see chapter spare parts)
- Cleanroom wipes

Description		Required tool
1. Vent vacuum system on both sides of the valve. 2. Move the plate to position 30% open. 3. Disconnect electrical POWER connector at valve and remove valve from vacuum system. **Attention!** Electrical power is needed for plate adjustment Take care to the sealing surface!		
4. Unfasten and remove the 2 or 3 fastening screws		• Allen wrench 3mm for DN 40-63mm • Allen wrench 4mm for DN 80-100mm
5. Push the plate a little down		
6. Remove the plate on the other side of shaft		

Description		Required tool
7. For vulcanized plates, please skip steps 8-12 for O-ring replacement and use a new vulcanized plate instead. Lubricate the new vulcanized plate with 0.025g / 0.0125 ml vacuum grease. Pay attention that grease is distributed constantly over the whole seal circumference		Vacuum grease
8. For plate O-ring exchange, skip step 7 and remove the plate O-ring instead Replace the plate if necessary		O-ring removal tool
9. Clean the plate and O-ring groove Check the O-ring groove. If there are any scratches in groove, use a new plate. Refer to spare parts for new plate.		Cleanroom wipes soaked with isopropyl alcohol
10. Lubricate the new O-ring with 0.025g / 0.0125 ml vacuum grease Pay attention that grease is distributed constantly over the whole circumference For new O-ring refer to chapter spare parts.		Vacuum grease
11. Place the new O-ring at O-ring groove at one side first. Then move the O-ring in the O-ring groove fully around including the other side		

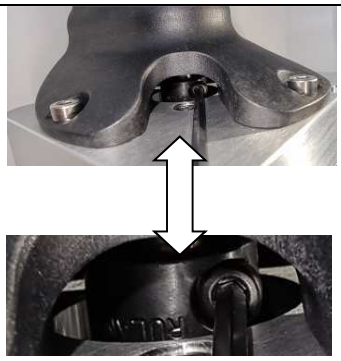
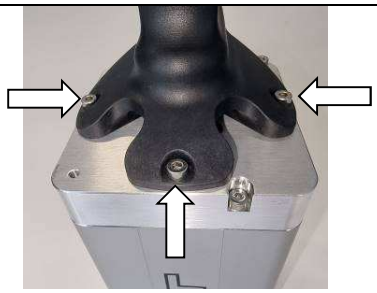
Description		Required tool
12. Push in the O-ring equally around the plate into O-ring groove. Ensure it is fully and symmetrically inserted.		
13. Place the plate on the shaft in the valve body		
14. Tighten plate screws to block. 15. Loosen the plate screws a quarter turn counter clockwise. Plate is now movable on shaft and ready to sliding into valve seat.		• Allen wrench 3mm for DN 40-63mm • Allen wrench 4mm for DN 80-100mm
16. Connect electrical POWER connection at valve **Attention!** Valve does synchronize automatically and moves the plate into sit of valve body (close position). 17. Disconnect electrical POWER connection	**Attention!**  Keep fingers out of the valve opening during plate movement!	
18. Fasten the plate screws with • 2 Nm for DN 40- 63 mm • 4 Nm for DN 80 – 100 mm If some grease on plate surface or valve body clean it with cleanroom wipes		• Allen wrench 3mm for DN 40-63mm • Allen wrench 4mm for DN 80-100mm • Cleanroom wipes

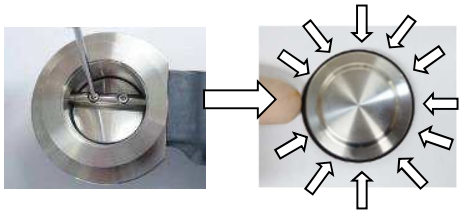
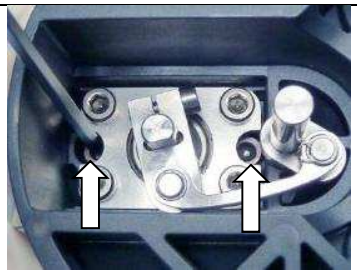
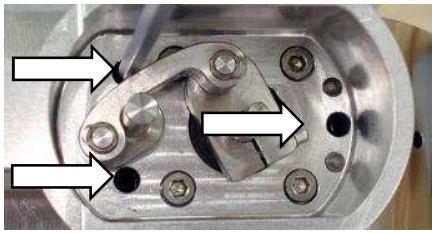
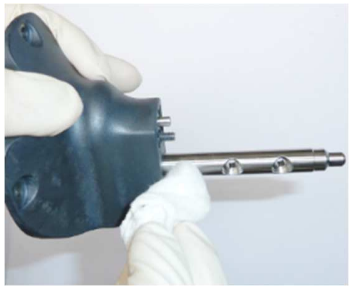
Description		Required tool
19. Reinstall valve into vacuum system according to chapter «Installation» of valve manual		

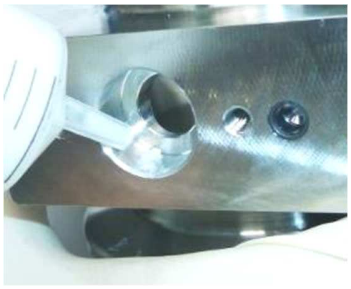
7.2.2 Replacement of shaft feed through seals and valve cleaning

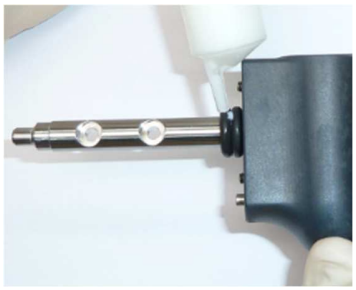
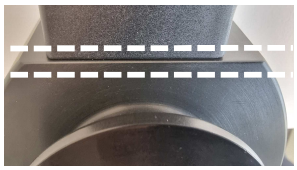
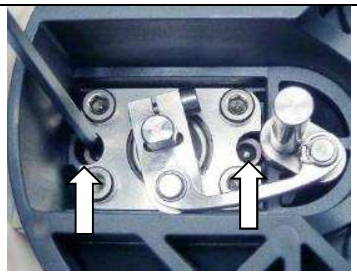
Required tools

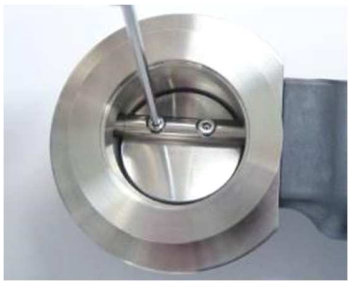
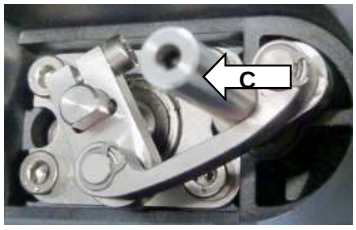
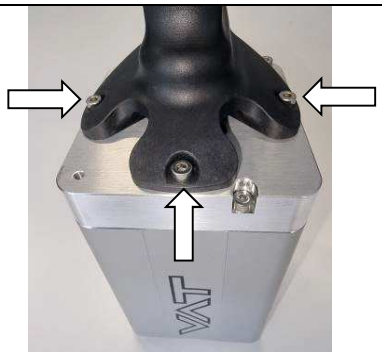
- Allen wrench 2mm / 2.5mm
- Allen wrench 3mm
- O-ring removal tool (see chapter Accessories)
- Isopropyl alcohol
- Cleanroom wipes
- Vacuum grease (see chapter spare parts)

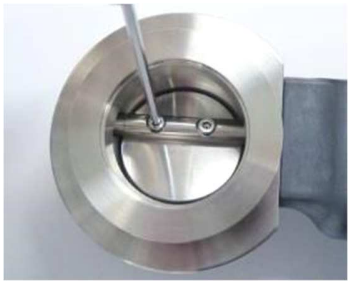
Description		Required tool
1. Vent vacuum system on both sides of the valve. 2. Move the plate to position 50% open. 3. Disconnect electrical POWER connector at valve and remove valve from vacuum system. **Attention!** Electrical power is needed for plate adjustment. Take care to the sealing surface!		
4. Loosen clamp coupling screw		Allen wrench: 2.5 mm
5. Unfasten and remove the 3 fastening screws		Allen wrench: 3mm
6. Remove control and actuating unit from mechanical valve unit If clamp coupling is separated, assemble them at control and actuating unit.		

Description		Required tool
7. For removing the plate and exchanging the plate or O-ring we refer to Steps 4-7 or 4-12 12 of the previous chapter 7.2.1 Replacement of vulcanized plate or plate with O-ring		
8. Unfasten the two (DN40-63) or three (DN80-100) - screws completely	 	• Allen wrench 3mm for DN 40-63mm • Allen wrench 4mm for DN 80-100mm
9. Remove mechanical unit from valve body		
10. Clean shaft		Cleanroom wipes soaked with isopropyl alcohol

Description		Required tool
11. Remove both O-rings Check and if required use new O-rings.		Soft tool
12. Clean shaft feed through and the valve body		Cleanroom wipes soaked with isopropyl alcohol
13. Lubricate seal contact surface of valve body with a slight film of 0.025g = 0.0125 ml vacuum grease		Vacuum grease
14. Lubricate seal contact surface of shaft with a slight film of 0.025g = 0.0125 ml vacuum grease		Vacuum grease
15. Lubricate each O-ring with a slight film of 0.025g = 0.0125 ml vacuum grease.		Vacuum grease

Description		Required tool
16. Slide both O-rings onto shaft till the end 17. Deposit the following amount of vacuum grease between the O-rings: 0.075 g = 0.04 ml for DN 40 and DN 50 0.1 g = 0.05 ml for DN 63, 80,100 18. Clean shaft from vacuum grease Make sure there is no residuals from vacuum grease on the shaft.		Vacuum grease Cleanroom wipes
19. Install mechanical unit into valve body, see picture Make sure the pedestal is aligned to be parallel with the valve body	 	
20. Fasten and tighten the mounting screws • 2x with 2.5 Nm for DN 40-63mm • 3x with 4 Nm for DN 80-100mm		• Allen wrench 3mm for DN 40-63mm • Allen wrench 4mm for DN 80-100mm
21. Place the plate on the shaft in the valve body		

Description		Required tool
22. Tighten plate screws to block. 23. Loosen the plat screws a quarter turn counter clockwise so that plate is still movable at shaft.		• Allen wrench 3mm for DN 40-63mm • Allen wrench 4mm for DN 80-100mm
24. Clean the actuating lever Make sure that there is no grease at actuating lever axis (**C**)		
25. Assemble valve unit with control and actuating. Push axis (**C**) into clamp coupling		
26. Tighten mounting screws adequately		Allen wrench: 3mm

Description		Required tool
27. Tighten clamp steel coupling with 1.1 Nm	 	Allen wrench: 2.5 mm
28. Connect electrical POWER connection at valve **Attention!** Valve does synchronize automatically and moves the plate into sit of valve body (close position). 29. Disconnect electrical POWER connection	**Attention!**  Keep fingers out of the valve opening during plate movement!	
30. Fasten the plate screws with • 2 Nm for DN 40- 63 mm • 4 Nm for DN 80 – 100 mm If some grease on plate surface or valve body clean it with cleanroom wipes .		• Allen wrench 3mm for DN 40-63mm • Allen wrench 4mm for DN 80-100mm • Cleanroom wipes
31. Reinstall valve into vacuum system according to chapter «Installation».		

7.2.3 Replacement of Option board

NOTICE

Electrostatic discharge

Electronic components could be damage.

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

NOTICE

Burned connector pins (spark)

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

Do not plug or unplug connectors under power.

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

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

It is available in 3 versions. These are:

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

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

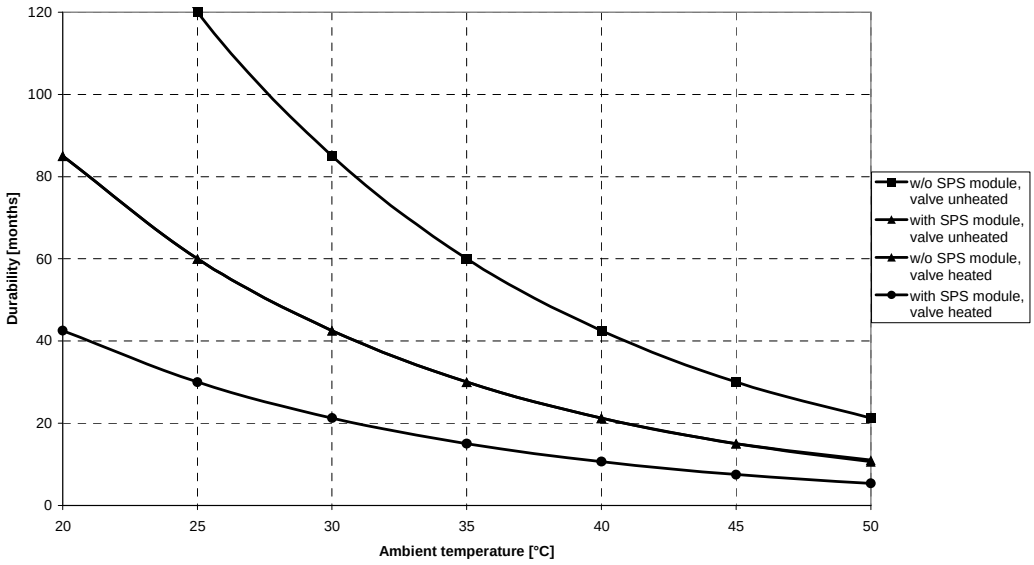
If you need any further information, please contact one of our service centers. You can find the addresses on our website: www.vatvalve.com.

7.2.3.1 Durability of power fail battery

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

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

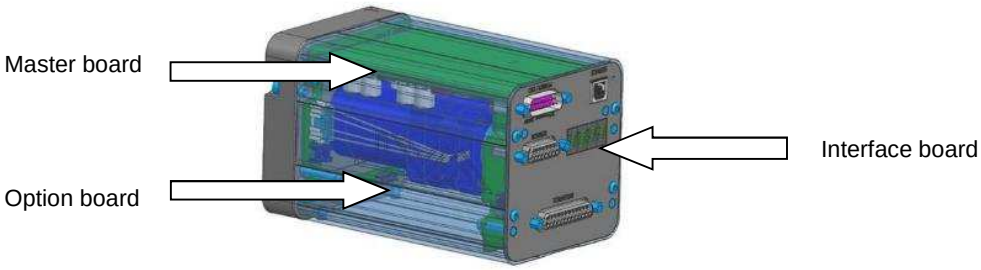
Therefore please determine the equivalent maintenance period for replacing the Ultra Cap battery (Option board).



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

7.2.3.2 Retrofit / replacement procedure

View on control and actuating unit:

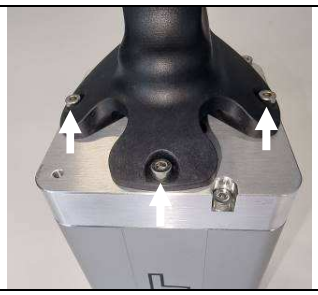


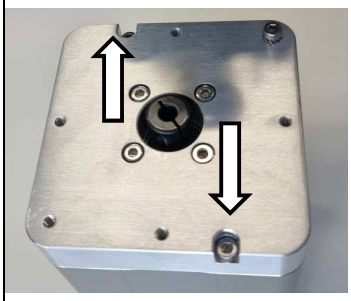
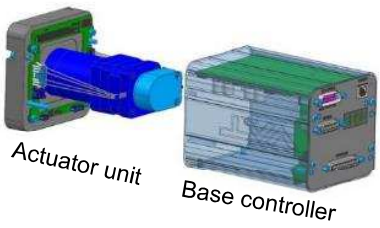
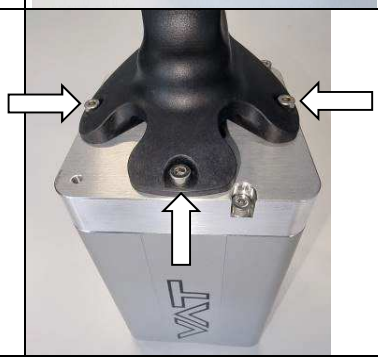
All boards have a fixed position into control and actuating unit. It is not possible to fit a board in other position as shown in picture above! Do not try out other positions, which maybe destroy the socket of boards!

Required tools

- Allen Wrench 2 mm / 2.5mm
- Allen Wrench 3 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.

Description		Required tool
1. Vent vacuum system on both sides of the valve. 2. Move the plate to position 30% open. 3. Disconnect electrical POWER connector at valve and remove valve from vacuum system. **Attention!** Electrical power is needed for plate adjustment. Take care to the sealing surface!		Depending on flange screws
4. Unfasten clamp coupling		Allen wrench: 2.5 mm
5. Unfasten the 3 connection bolts and separate valve body from controller		Allen wrench 3 mm

Description		Required tool
6. Replacement of the option board / whole controller Unfasten the two bolts from bottom side and dismount the controller from the actuator unit. The SPS/PFO option board has to be mounted/ dismounted from bottom side of the controller. The Controller and Interface board are fix connected and shall not be dismounted. you have to work on an ESD-protected working space If you need any further information, please contact one of our service centers. You can find the addresses on our website: www.vatvalve.com	 	.
7. Assemble valve unit with control and actuating. Push axis (C) into clamp coupling		
8. Tighten mounting screws adequately		Allen wrench 3mm

Description		Required tool
9. Tighten clamp of steal coupling with 1.1 Nm	 	Allen wrench: 2.5 mm

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.

8.1 FPR Service

The VAT customer service can refurbish the product or individual components for you. Wear-sensitive parts are replaced, and the guarantee on the replaced parts is extended.

a) Select the desired Fixed Price Refurbishment service from our comprehensive service program for the refurbishment.
b) Contact your assigned sales person or the nearest VAT service center to learn about the options for the product in question. www.vatvalve.com.

9 Dismounting and Storage

⚠ WARNING

Unqualified personnel

Inappropriate handling may cause serious injury or property damage.

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

9.1 Dismounting

NOTICE

Contamination

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

Always wear clean room gloves when handling the valve.

NOTICE

Valve in open position

Valve body may become damaged if valve gate is in open position.

Move valve gate to the closed position before dismounting the valve.

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

9.2 Storage

NOTICE

Wrong storage

Inappropriate temperatures and humidity may cause damage to the product.

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

NOTICE

Inappropriate packaging

Product may get damaged if inappropriate packaging material is used.

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

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

10 Packaging and Transport

⚠ WARNING

Unqualified personnel

Inappropriate handling may cause serious injury or property damage.

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

⚠ WARNING

Harmful substances

Risk of injury in case of contact with harmful substances.

Remove harmful substances (e. g. toxic, caustic or microbiological ones) from valve before you return the valve to VAT.

NOTICE

Inappropriate packaging

Product may get damaged if inappropriate packaging material is used.

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

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

10.1 Packaging

NOTICE

Valve in open position

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

Make sure that the valve is closed.

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

VAT disclaims any liability for damages resulting from inappropriate packaging.

10.2 Transport

NOTICE

Inappropriate packaging

Product may get damaged if inappropriate packaging material is used.

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

VAT disclaims any liability for damages resulting from inappropriate packaging.

11 Disposal

Observe the local regulations for disposal

⚠ WARNING

Harmful substances

Environmental pollution.

Discard products and parts according to the local regulations.

⚠ WARNING

Unqualified personnel

Inappropriate handling may cause serious injury or property damage.

Only qualified personnel are allowed to carry out the disposal.

⚠ CAUTION

Risk of damage

Indicates a hazardous situation which, if not avoided, may result in minor or moderate injury. A large number of diverse materials are used in the product. Some of them could cause human and machine damage in the case of improper handling.

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

NOTICE

Improper disposal

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

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

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

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

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

12 Spare parts

NOTICE

Non-original spare parts

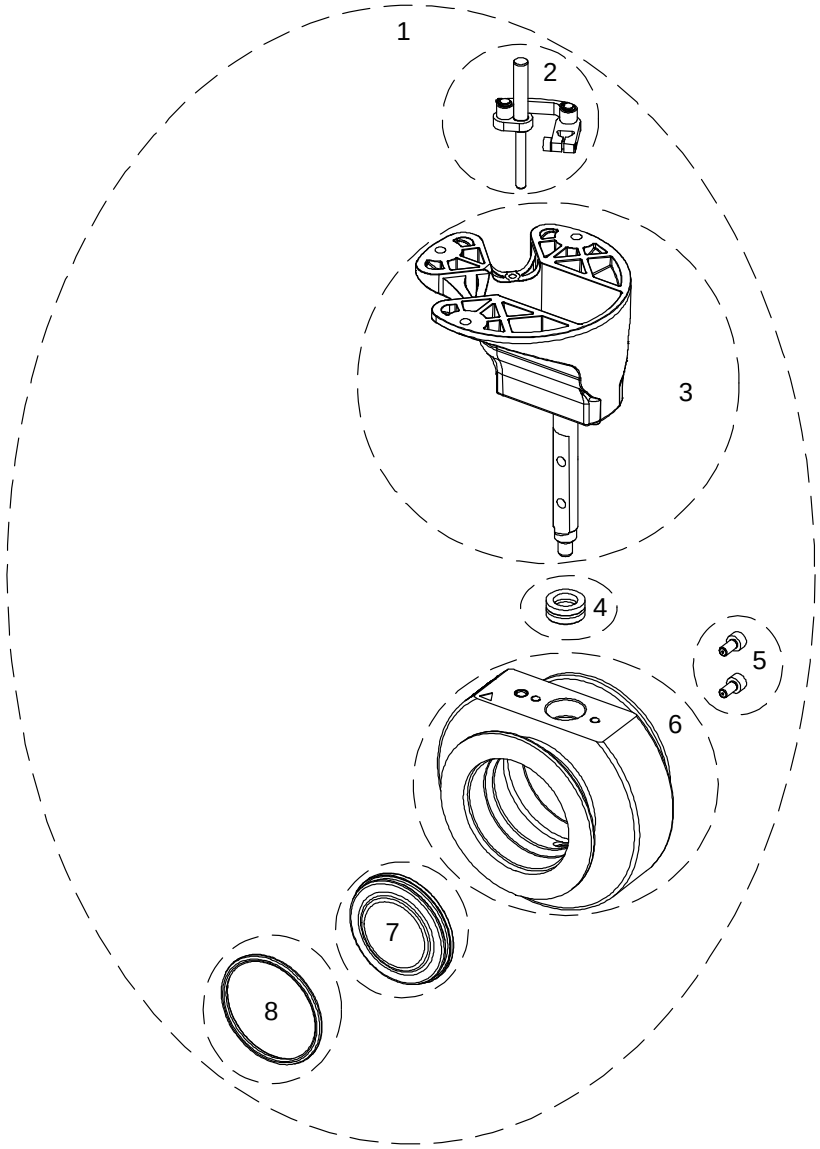
Non-original spare parts may cause damage to the product.

Use original spare parts from VAT only.

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

12.1 ISO-KF for DNs 40 - 63mm

12.1.1 Drawing



1	Body with mechanism	5	Plate screws
2	Lever complete	6	Body complete
3	Adapter flange, rod with bearing	7	Plate
4	Rotary feedthrough seals	8	Plate O-ring

All “Item“ refer to chapter «Drawing»

12.1.2 ISO-KF valve unit – aluminum hard anodized, without heating

Item	Description		
	Valve size **Product ordering number**	**DN 40 / 1½”** **61632 - KH . .** **ISO-KF**	**DN 50 / 2”** **61634 - KH . .** **ISO-KF**
1	Spare parts kit body with mechanism	462173	453946
2	Spare parts kit lever complete	511515	
3	Spare parts kit, adapter flange rod with bearing	453094	453106
5	Plate screws	2 × 428946	
6	Body complete	443116	443180
8	Spare parts kit plate.	433800	431309

12.1.3 ISO-KF valve unit – stainless steel, without heating

Item	Description		
	Valve size **Product ordering number**	**DN 40 / 1½”** **61632 - KE . .** **ISO-KF**	**DN 50 / 2”** **61634 - KE . .** **ISO-KF**
1	Spare parts kit body with mechanism	462153	453945
2	Spare parts kit lever complete	511515	
3	Spare parts kit, adapter flange rod with bearing	453094	453106
5	Plate screws	2 × 428946	
6	Body complete	443048	443093
8	Spare parts kit plate.	428257	428118

12.1.4 Seals and grease

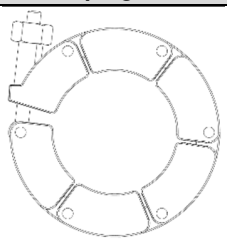
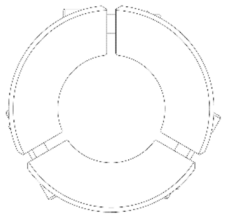
Item	Description		
4	Vacuum seal kit (VITON ®) rotary feed through	237235	
	Vacuum grease (2ml syringe)	206792	
		DN 40 / 1½”	**DN 50 / 2”**
8	Vacuum seal kit (VITON ®) for plate	327291	365577

For versions such as:

- other valve sizes
- heated valves
- valves made of hard anodized aluminum
- valves made of nickel coated aluminum

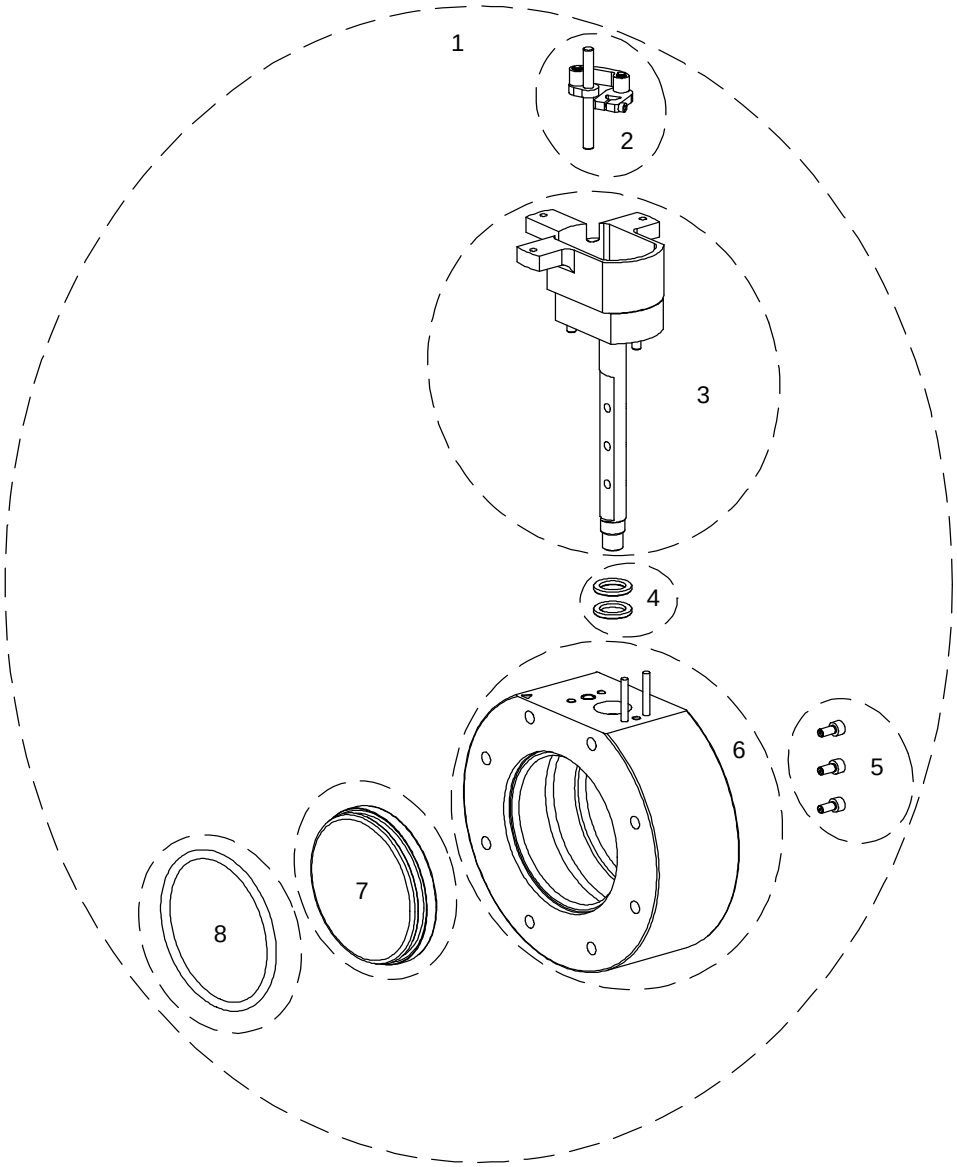
spare parts ordering numbers are available on request.

12.1.5 Clamping connections for ISO-KF

Valve size	Clamping chain	Clamping device
		
DN40 / 1½ “	31032-KASA-0001	31032-KASE-0001
DN50 / 2“	31034-KASA-0001	31034-KASE-0001

12.2 ISO-F for DNs 80 - 100mm

12.2.1 Drawing



Sample picture

1	Body with mechanism	5	Plate screws
2	Lever complete	6	Body complete
3	Adapter flange, rod with bearing	7	Plate
4	Rotary feedthrough seals	8	Plate O-ring

All “Item“ refer to chapter «Drawing»

12.2.2 ISO-F valve unit – aluminum hard anodized, without heating

Item	Description			
	Valve size Product ordering number	**DN 63 / 2½” 61636 - PH . . - . . . .**	**DN 80 / 3” 61638 - PH . . - . . . .**	**DN 100 / 4” 61640 - PH . . - . . . .**
1	Spare parts kit body with mechanism compl.	496935	497018	489207
2	Spare parts kit lever compl.	350045		
3	Spare parts kit shaft kit	471253	471254	471255
6	Body compl.	407250	449825	367045
7	Spare parts kit plate compl.	377974	377321	358337
	Plate screw (3pcs)	355662	361781	

12.2.3 ISO-F valve unit – stainless steel, without heating

Item	Description			
	Valve size Product ordering number	**DN 63 / 2½” 61636 - PE . . - . . . .**	**DN 80 / 3” 61638 - PE . . - . . . .**	**DN 100 / 4” 61640 - PE . . - . . . .**
1	Spare parts kit body with mechanism compl.	486575	497020	487017
2	Spare parts kit lever compl.	350045		
3	Spare parts kit shaft kit	471253	471254	471255
6	Body compl.	384963	394352	356034
7	Spare parts kit plate compl.	354547	363311	326557
	Plate screw (3 pcs)	355662	361781	

12.2.4 Seals and grease

Item	Description			
	Valve size	**All sizes**		
4	Rotary feed through seals (VITON ®) (2 pcs)	323642		
		DN 63 / 2½”	**DN 80 / 3”**	**DN 100 / 4”**
8	Plate seal (VITON ®)	380402	234889	365579
	Vacuum grease (4g syringe)	206792		
	Vacuum grease (10g syringe)	206793		

For versions such as:

- other valve sizes
- heated valves
- valves made of hard anodized aluminum
- valves made of nickel coated aluminum

spare parts ordering numbers are available on request.

12.3 Control unit and Accessories

12.3.1 Control and actuating unit

Description	Part number
Control and actuating unit	Too many to list. Please contact VAT.
Option board with SPS module (±15 VDC Sensor Power Supply)	858530
Option board with PFO module (Power Failure Option)	858529
Option board with SPS and PFO module	840512

12.3.2 Accessories

Description	Part number
24 VDC power supply unit (input: 100 – 240 VAC)	891528 (D-Sub15 connector)
Adapter cable for power supply with D-Sub9 connector	(735567) (D-Sub15 to D-Sub9)
Plug D-sub 15 pin female with 4-40UNC screws for the power input and Logic interface (plug only)	81177-R1
Service cable (PC to valve Service connector)	809474 (USB A–B male-male)
Special Allen wrench (SW3) for disassembly and assembly	244873
O-ring removal tool	234859

12.3.3 Centering ring with VITON ® O-ring

Description						
Valve size Product ordering number		DN 40 / 1½”	DN 50 / 2”	DN 63 / 2½”	DN 80 / 3”	DN 100 / 4”
Centering ring with VITON ® O-ring (for ISO-KF and ISO-F installation only)	Aluminum	31032-KAZV	32036-QAZV	32038-QAZV	32040-QAZV	32040-QAZV
	Stainless steel	31032-KEZV	32036-QEZV	32038-QEZV	32040-QEZV	32040-QEZV

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