Installation, Operating & Maintenance Instructions

Butterfly Pressure Control Valve
with DeviceNet interface

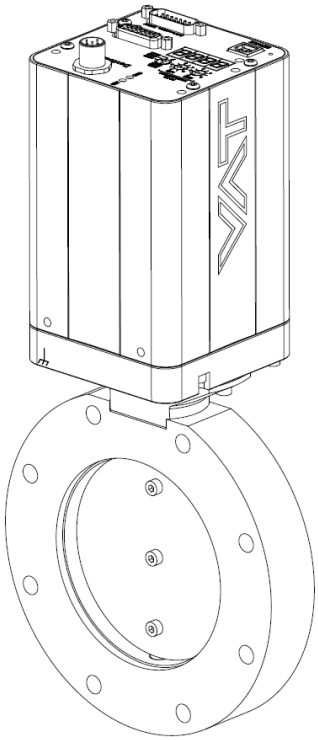
Series 613
DN 25-50 mm (I.D. 1“ - 2")

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

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

SPS = Sensor Power Supply PFO = Power Failure Option

configured with firmware : **F01.0C.28.xx** and DeviceNet FW: **966219**



Sample picture

Imprint

Manufacturer VAT Vakuumventile AG, CH-9469 Haag, Switzerland

Website: www.vatvalve.com
Phone: +41 81 771 61 61
Fax: +41 81 771 48 30
Email: CH@vatvalve.com

Publisher VAT Vakuumventile AG, CH-9469 Haag, Switzerland

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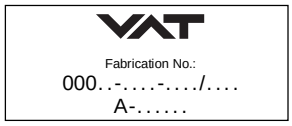
Contents

1 Description of product

1.1 Identification of product

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



← Fabrication number
← Order number

1.2 Use of product

This product is a 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.

1.3 Used abbreviations

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

1.4 Related documents

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

1.5 Important information

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

Example:

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

1.6 Technical data

1.6.1 Control and actuating unit

Description		
Power supply input [1]	connector	D-Sub, DA-15, male
	supply voltage	+24 VDC (±10%) @ 0.5 V pk-pk max.
Power consumption	(control / drive)	40 W (max.) with optional SPS + 40 W with optional PFO + 10 W [4] 3 W max. (from DeviceNet® to DeviceNet® Interface board of valve)
Ambient	temperature	0 °C to +50 °C max. (<35 °C recommended)
	humidity	0 to 95% RH, non-condensing
Interface	remote	DeviceNet
	service port	USB-B (USB 2.0)
Digital inputs [3]	input 1 input 2	open valve (adjustable with CPA) close valve (adjustable with CPA)
	voltage control contact control	12 … 24V / 4 … 8 mA 24V / 8 mA
Digital outputs [3]	output 1 output 2	valve closed (adjustable with CPA) valve opened (adjustable with CPA)
	load	max. 70 V / 0.1 A
Sensor [2]	connector	D-Sub, DA-15, female
	number of inputs	2
	signal voltage	0 … 10V DC with linear pressure
	signal voltage range	-10 … +10 V
	input resistance	100 kΩ
	ADC resolution	0.1 mV
	sampling rate	2 ms
	power supply (output) [2]	+24 VDC / 1.5 A max. or ±15 VDC / 1.2 A max. (with SPS option)
Position resolution		5000 (90° angle)
Actuator		stepper motor, servo control
Actuator backlash		< 0.02°
Pressure control accuracy		5 mV or 0.1% of setpoint, the higher value applies
Ingress Protection		IP 40

PFO [4] battery pack [613 . . - . . **C** . - . . . . / 613 . . - . . **H** . - . . . .] Charging time Durability	 1 minutes max. up to 10 years @ 25°C ambient; refer to «Durability of power fail battery» for details
Utilizable valve torque	2.5 Nm

[1] Internal overcurrent protection by a PTC device.
[2] Refer to chapter «Sensor supply concepts» for details. Complete power consumption of the valve depends on sensor supply concept and sensor power consumption
[3] Refer to chapter «Schematics» for details.
[4] PFO = Power Failure Option. Refer to chapter «Behavior in case of power failure» for details

1.6.2 DeviceNet:

Description		
Connector		microstyle, 5-pin, male
Communication	protocol	DeviceNet, group 2 slave only
	data rate	125, 250, 500 kbaud by switch or network programmable
	MAC ID	address 00 - 63 by switch or network programmable
	profile	“Process Control Device” profile (ODVA)
	device type	Process Control Device
Supply voltage	transceiver at microstyle connector	24 Vnom, 11 … 25V; max. 0.5 W

1.6.3 Valve unit

Description				
Pressure range at 20°C (unheated on delivery) - Aluminum (613 . . - . **A**. . - . . . .) - Aluminum hard anodized (613 . . - . **H**. . - . . . .) - Aluminum nickel coated (613 . . - . **I**. . - . . . .) - Stainless steel (613 . . - . **E**. . - . . . .)		 1×10^{-8} mbar to 1.2 bar (abs) 1×10^{-6} mbar to 1.2 bar (abs) 1×10^{-8} mbar to 1.2 bar (abs) 1×10^{-8} mbar to 1.2 bar (abs)		
Leak valve body, valve seat at 20°C (unheated on delivery) - Aluminum (613 . . - . **A**. . - . . . .) - Aluminum hard anodized (613 . . - . **H**. . - . . . .) - Aluminum nickel coated (613 . . - . **I**. . - . . . .) - Stainless steel (613 . . - . **E**. . - . . . .)		 1×10^{-9} mbar l/s 1×10^{-5} mbar l/s 1×10^{-9} mbar l/s 1×10^{-9} mbar l/s		
Cycles until first service (unheated and under clean conditions)		2'000'000		
Admissible operating temperature • Valve body • Ambient		Temperature of valve body and valve plate should be kept on about same level 10°C to 150°C ≤ 50°C		
Mounting position		any		
Process side materials	body / plate	Aluminum - EN AW-6082 (3.2315) (**A, H, I**) Stainless steel: AISI 316L (1.4404 or 1.4435) (**E**)		
	shaft / plate screws	Stainless steel AISI 316L (1.4404 or 1.4435)		
	shaft bearing	Iglidur® X		
Seals rotary feed through	atmosphere side	FKM (e.g. Viton®)		
	vacuum side	FKM (e.g. Viton®)		
DN (nominal I. D.) [mm] [inch]		**25** **1"**	**40** **1½"**	**50** **2"**
Max. differential pressure on plate (close position) [mbar]		1000	1000	1000
Typical closing or opening time	Aluminum [s]	0.09	0.09	0.09
	Steel [s]	0.09	0.09	0.09
Min. controllable conductance (N_2 molecular flow) [ls^{-1}]		0.15	0.25	0.3
Max. conductance (N_2 molecular flow) [ls^{-1}]		22	80	150
Weight (approx.) Aluminum valve	Aluminum [kg]	2.2	2.3	2.6
	Aluminum [lbs]	4.9	5.1	5.8
Weight (approx.) Stainless steel valve	Steel [kg]	2.7	2.8	3.2
	Steel [lbs]	6.0	6.2	7.1
Dimensions	Refer to dimensional drawing of specific valve ordering number available on request			

2 Safety

2.1 Compulsory reading material

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

NOTICE

Lack of knowledge

Failing to read this manual may result in property damage.

Firstly, read manual.

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

2.2 Danger levels

DANGER

High risk

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

WARNING

Medium risk

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

CAUTION

Low risk

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

NOTICE

Command

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

2.3 Personnel qualifications

⚠ WARNING

Unqualified personnel

Inappropriate handling may cause serious injury or property damage.

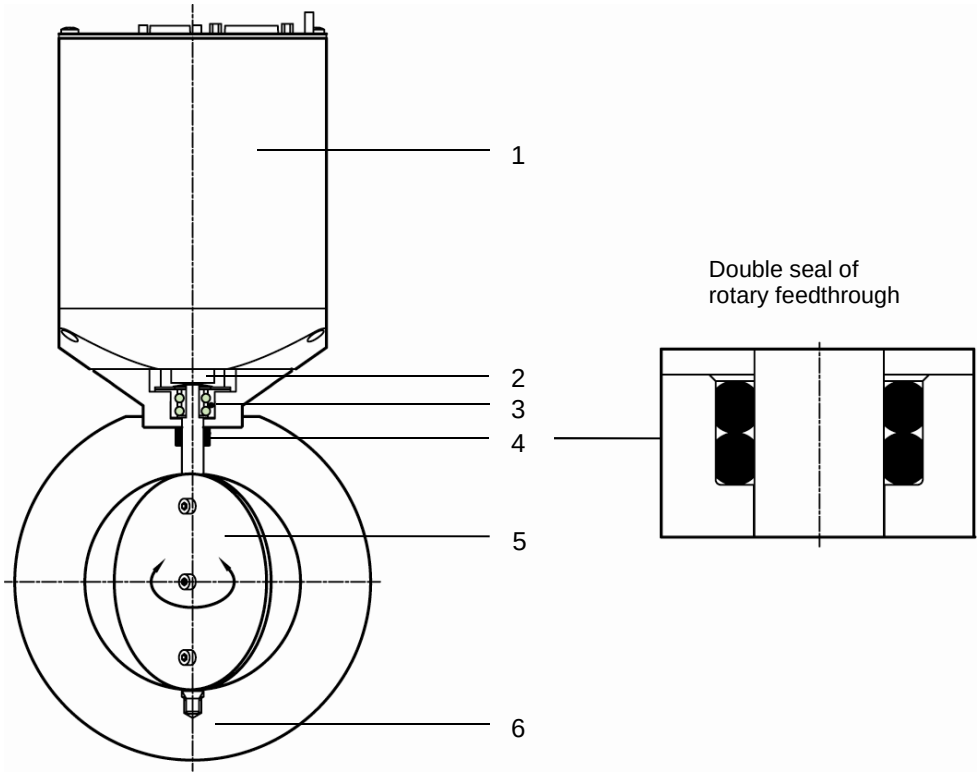
Only qualified personnel are allowed to carry out the described work.

2.4 Safety labels

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

3 Design and Function

3.1 Design



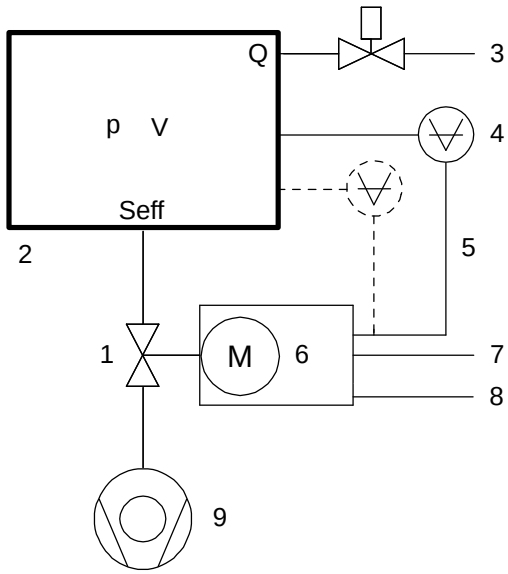
1	Integrated controller	4	Double seal
2	Coupling	5	Plate
3	Bearing	6	Valve body

3.2 Function

The valve plate (5) acts as a throttling element and varies the conductance of the valve opening.
The integrated controller (1) calculates the required plate position to achieve the setpoint pressure.
See also principle drawing on chapter: «Connection Overview».
Actuation is performed by a stepper motor. An encoder monitors the position. This principle ensures very fast and accurate process pressure control even in demanding contaminating processes.

3.2.1 Pressure control system overview and function

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



Example: Downstream control

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

S_{eff} Q / p
S_{eff} effective pump speed (ls^{-1})
Q Gas flow (mbar)
p Pressure (mbar)

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

3.2.1.1 Way of operation

The controller compares the actual pressure in the process chamber given by the pressure sensor with the preset pressure. The controller uses the difference between actual and set pressure to calculate the correct position of the control valve. The controller drives the control valve into the correct position and the actual pressure again equals the set pressure.
This control operation is performed continuously. Pressure changes in the process chamber due to leaks, desorption, and gas flow, reaction products, variations in pumping speed etc. are always corrected at once.

3.2.1.2 Pressure control

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

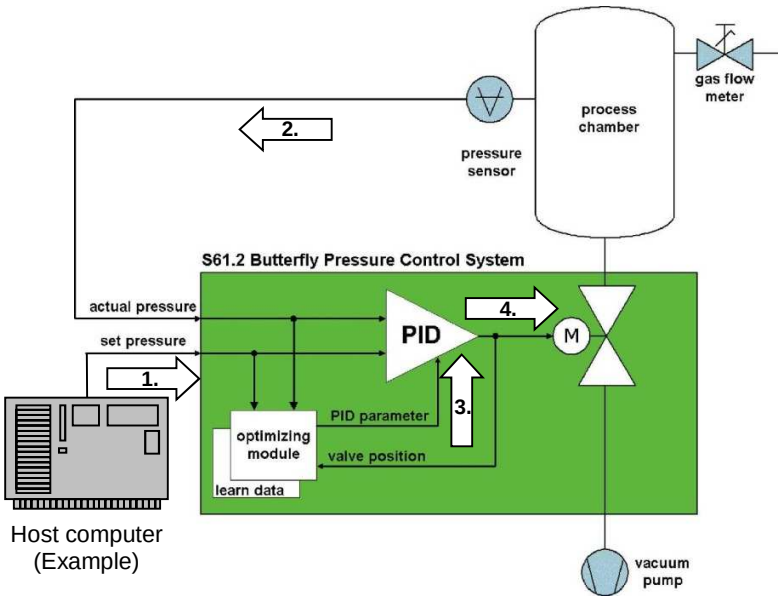
1. Downstream control (standard):
   The pressure is controlled by changing the conductance of a control valve between pump and process chamber. This changes the effective pumping speed at the process chamber. Pressure and gas flow can be independently controlled over a wide range.

2. Upstream control:
   The pressure is controlled by changing the gas flow into the process chamber, while the pumping speed remains constant.

3.2.1.3 Adaptive controller (standard)

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

3.2.2 Principle of a pressure control system



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

4 Installation

⚠ WARNING

Unqualified personnel

Inappropriate handling may cause serious injury or property damage.

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

4.1 Unpacking

NOTICE

Physical overstraining at controller

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

Do not place the valve on the controller.

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

4.2 Installation into the system

⚠ WARNING

Valve opening

Risk of serious injury.

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

NOTICE

Sealing surfaces

Sealing surfaces of valve and vacuum system could be damage in case of incorrect handling.

Only qualified personal are allowed to install the valve into the vacuum system.

NOTICE

Wrong connection

Wrong connection may result in damage of controller or power supply.

Connect all cables exactly as shown in the following descriptions and schematics.

NOTICE

Burned connector pins (spark)

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

Do not plug or unplug connectors under power.

NOTICE

Contamination

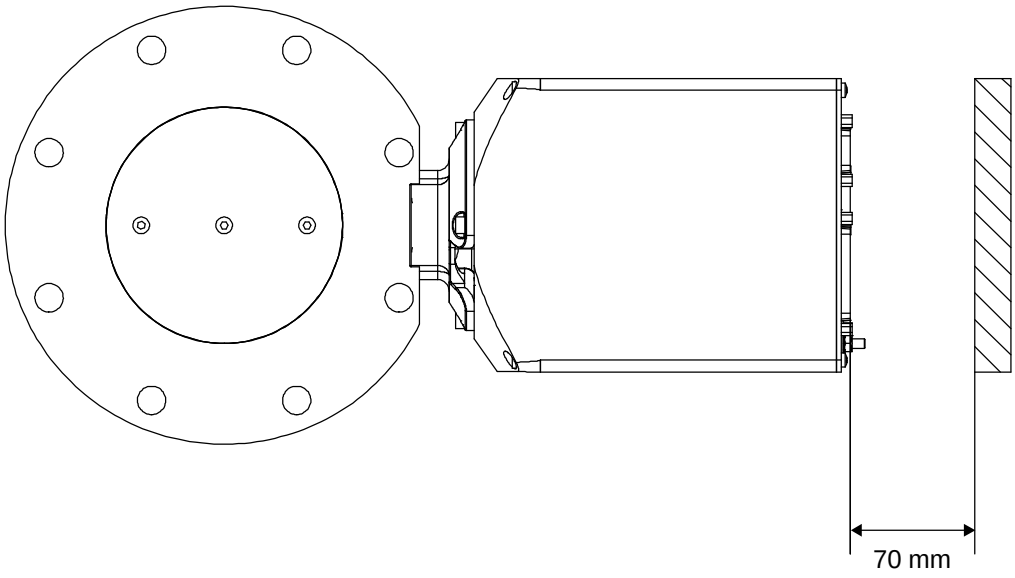
Gate and other parts of the valve must be protected from contamination.

Always wear clean room gloves when handling the valve.

Mount valve to a clean system only.

4.2.1 Installation space condition

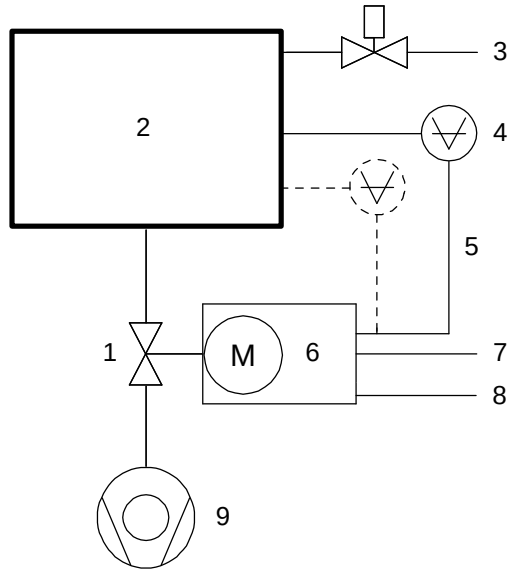
Install the valve with integrated controller with space for dismantling and air circulation as shown in figure below.



Sample picture

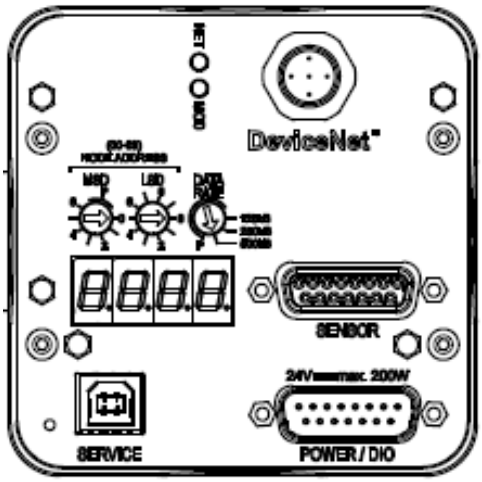
4.2.2 Connection overview

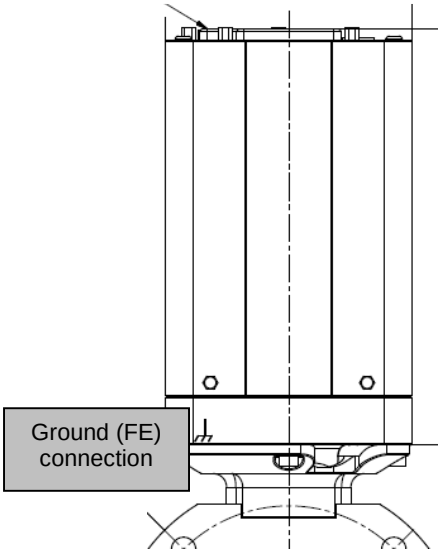
System:



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

Controller:





4.2.3 Installation procedure

All numbers in brackets refer to chapter: «Connection overview».

1. Remove protective covers from body flanges.

2. Install [1] valve into the vacuum system. Refer to chapter «Installation» in valve manual.

- 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 (613 . . – **K** . . .) needs support when mounted on horizontal piping and control unit does not hang.

3. Install the ground connection cable at controller. Refer to chapter «Electrical connection».

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

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

All 613-valves support supports 2 sensor(s).

6. Connect valve with cable [7] to remote control unit (connector: INTERFACE). Refer to chapter «DeviceNet connection» for correct wiring.

7. Connect power supply cable [8] to valve (connector: POWER). Refer to chapter «Electrical connection» for correct wiring.

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

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

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

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

4.3 Tightening torque

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.

4.3.1 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.

4.4 Admissible forces

NOTICE

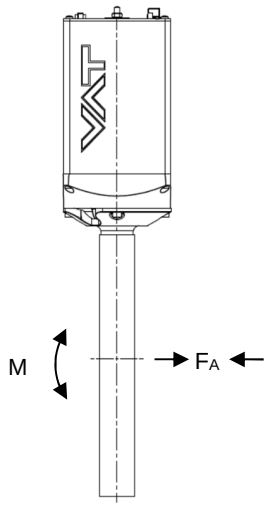
Force at valve body

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.
25	1	70	16	3	3.2
40	1½	100	22	6	4.5
50	2	150	34	11	8



4.4.1 Admissible forces at controller

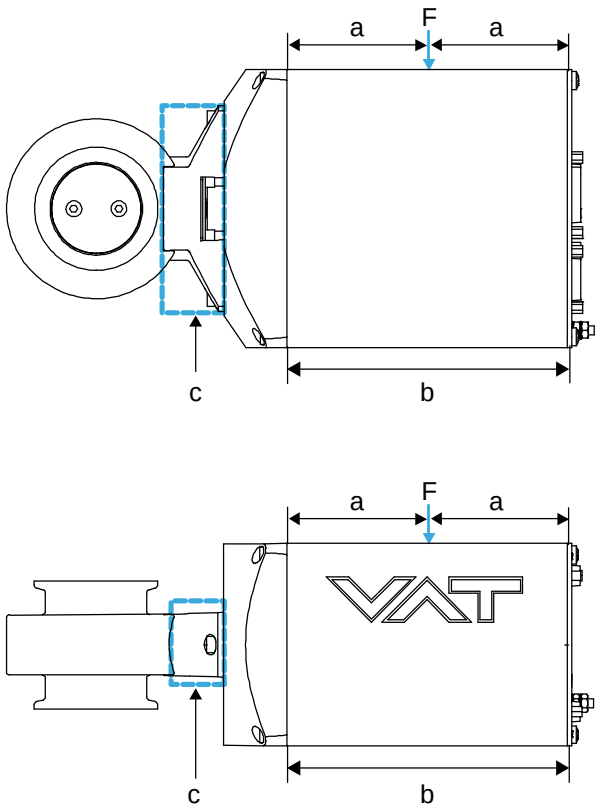
NOTICE

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 aluminium part of controller (b / 2)
400 N	

4.4.2 Heated condition

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

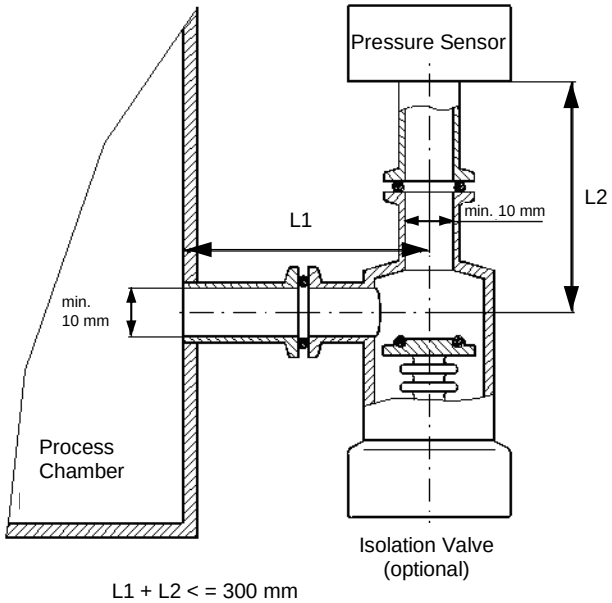
This valve may be operated in the temperature range mentioned in chapter «Technical data».

4.4.3 Requirements to sensor connection

To achieve fast and accurate pressure control a fast sensor response is required. Sensor response time: < 50ms. The sensor is normally connected to the chamber by a pipe. To maintain that the response time is not degraded by this connection it needs to meet the following requirements:

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

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



L1 + L2 < = 300 mm

4.5 Electrical connection

NOTICE

Wrong connection

Wrong connection may result in damage of controller or power supply.

Connect all cables exactly as shown in the following descriptions and schematics.

NOTICE

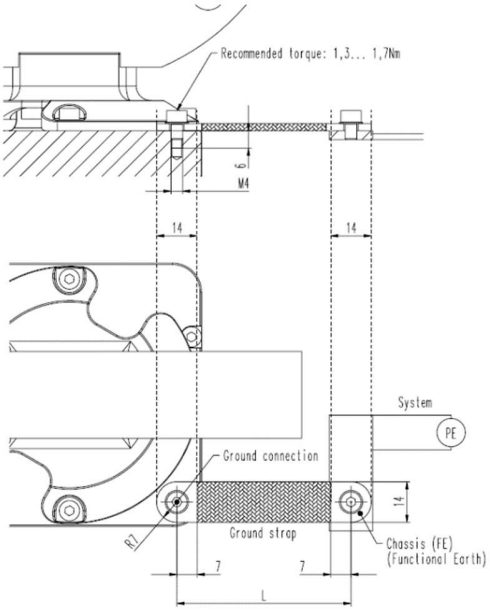
Burned connector pins (spark)

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

Do not plug or unplug connectors under power.

4.5.1 Ground connection

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



- 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)

- If ground connection cable instead of ground strap is used it should be min. AWG 12 (4 mm^2). EMC conformance may not be achieved by this method.

4.5.2 Power and Sensor supply concepts

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

Concepts:

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

This concept is only possible when SPS retrofit is installed.

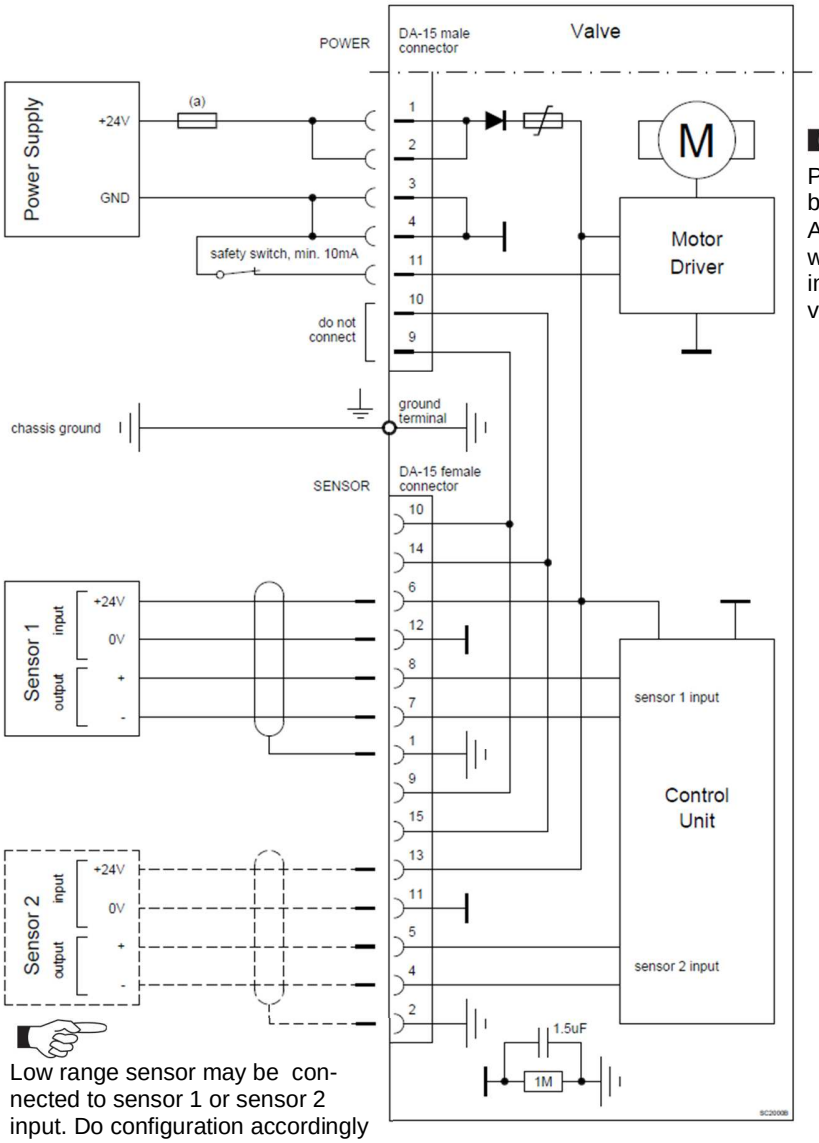
Valve versions:

- 613. . - . . **G** . - . . . . and 613 . . - . . **H** . - . . . . SPS module not included
- 613 . . - . . **A** . - . . . . and 613 . . - . . **C** . - . . . . SPS module included

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

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

[613 . . - . . **G** . - . . . . / 613 . . - . . **H** . - . . . . versions recommended]



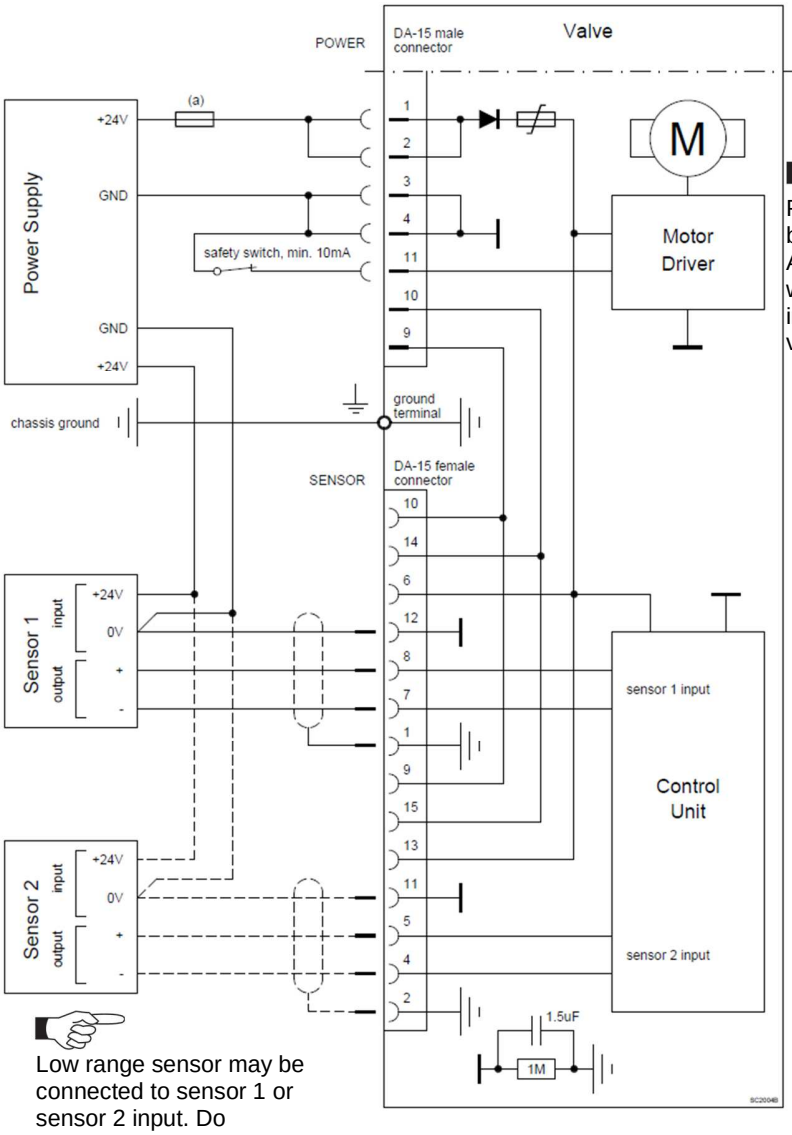
Pins 4 and 11 must be bridged for operation. An optional switch would allow for motor interlock to prevent valve from moving.

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

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

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

[613 . . - . . **G** . - . . . . / 613 . . - . . **H** . - . . . . versions recommended]



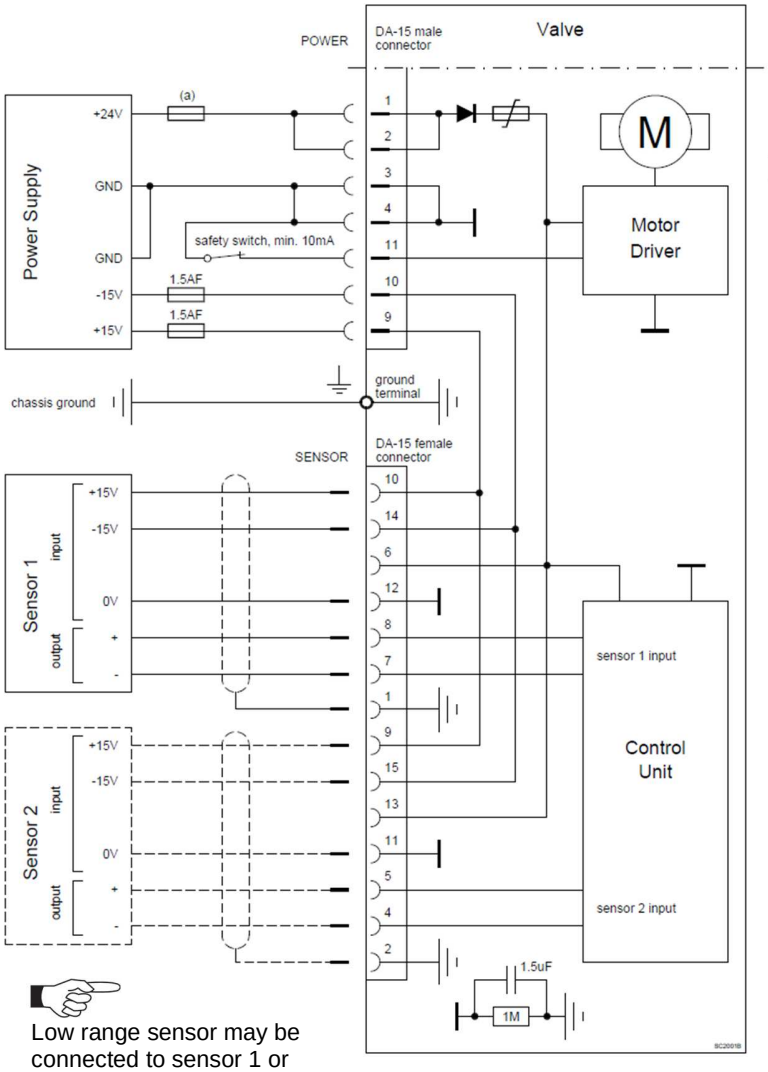
Pins 4 and 11 must be bridged for operation. An optional switch would allow for motor interlock to prevent valve from moving.

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

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

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

[613 . . - . . **G** . - . . . . / 613 . . - . . **H** . - . . . . versions recommended]



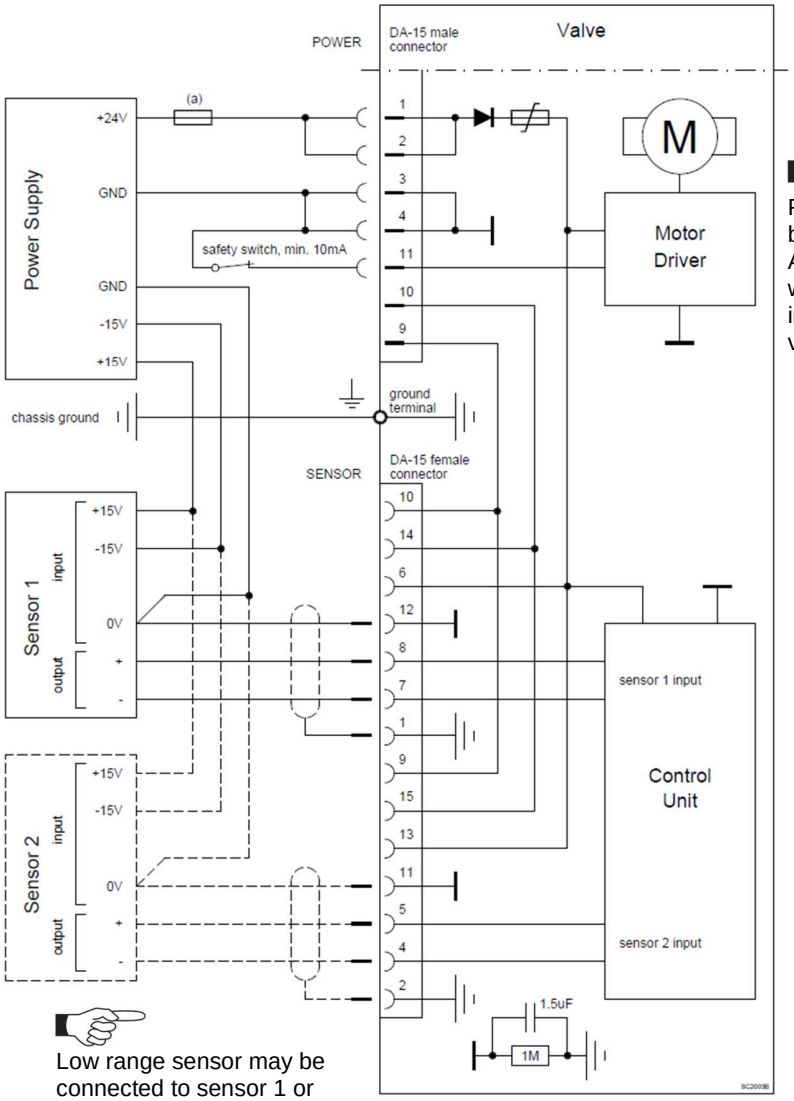
Pins 4 and 11 must be bridged for operation. An optional switch would allow for motor interlock to prevent valve from moving.

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

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

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

[613 . . - . . **G** . - . . . . / 613 . . - . . **H** . - . . . . versions recommended]



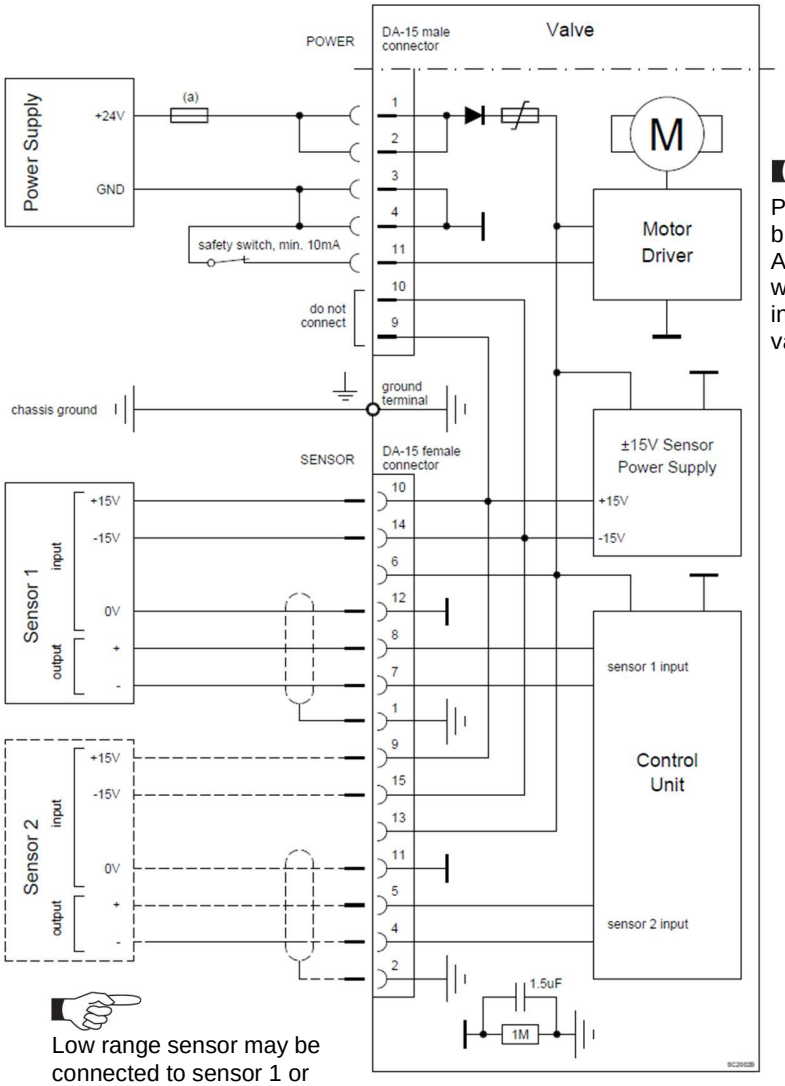
Pins 4 and 11 must be bridged for operation. An optional switch would allow for motor interlock to prevent valve from moving.

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

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

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

[613 . . - . . **A** . - . . . . / 613 . . - . . **C** . - . . . . versions only]



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

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

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

4.5.3 Digital Input/Output and Analog Output connections

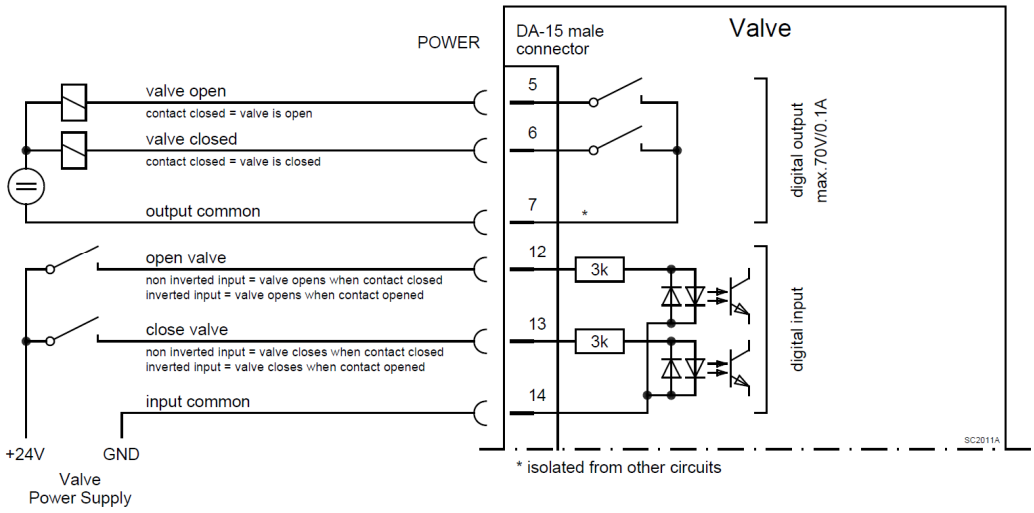
This interface allows for remote operation by means of a command set based on the DeviceNet protocol. In addition there are 2 digital inputs and 2 digital outputs. Digital inputs may be operated either by switches or by voltage sources.

Digital inputs on the **POWER and INTERFACE connector** have the **same priority**.

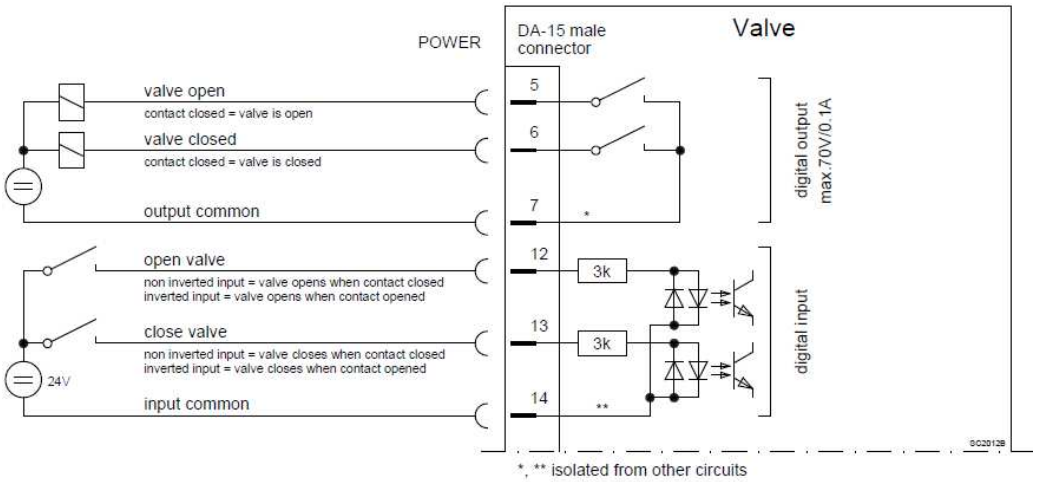
Active **digital inputs** have **higher priority than DeviceNet** commands.

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

4.5.3.1 Power connector: Configuration with switches for digital inputs



4.5.3.2 Power connector: Configuration with voltage source for digital inputs



4.5.3.3 Digital inputs

Pin	Function	Signal type	Description	Priority
13	**CLOSE VALVE**	Digital input [1)]	This function will close the valve. Valve will be in interlock mode as long as function is activated. After deactivation of function it will remain effective until - OPEN valve digital input is active - converse DEVICENET control command have been received The function is activated when optocoupler is 'on' in **non inverted** configuration. The function is activated when optocoupler is 'off' in **inverted** configuration. Configuration can be done in local operation via service port or in remote operation.	1 [2)]
12	**OPEN VALVE**	Digital input [1)]	This function will open the valve. Valve will be in interlock mode as long as function is activated. After deactivation of function it will remain effective until converse DEVICENET control command have been received. The function is activated when optocoupler is 'on' in **non inverted** configuration. The function is activated when optocoupler is 'off' in **inverted** configuration. Configuration can be done in local operation via service port or in remote operation.	2 [2)]
14	**DIGITAL input COMMON**	Digital common	Common for all digital inputs. Common is used when digital inputs are driven by voltage sources. Connect + or – terminal of source with common (optocoupler inputs are capable of bidirectional operation). See also « Function and Wiring» configuration b).	

1) Highest priority is 1. Functions with lower priorities will not be effective as long as higher priority functions are active. These digital inputs have higher priority than all DEVICENET commands. DEVICENET commands will not be accepted while digital inputs are active.

4.5.3.4 Digital output

Pin	Function	Signal type	Description
6	**VALVE CLOSED**	Digital output	This function will indicate that the valve is closed. If the function "ON" is configured the output is continuous on. Configuration can be done in local operation via service port or in remote operation.
5	**VALVE OPENED**	Digital output	This function will indicate that the valve is open. If the function "ON" is configured the output is continuous on. Configuration can be done in local operation via service port or in remote operation.
7	**OUTPUT COMMON**	Digital common	Common for all digital output. Connect + or – terminal of source with common

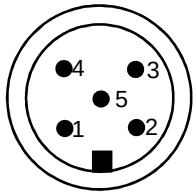
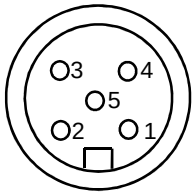
4.5.4 DeviceNet® interface connection

Connector type: Micro-style male (5 pin), connector is shown on panel refer to chapter «Installation into the system».

At valve controller	DeviceNet® cable		
PIN	Name	Wire color	Description
1 ⟷	Drain	Bare	Shield
2 ⟷	V+	Red	DeviceNet® power supply +
3 ⟷	V-	Black	DeviceNet® power supply -
4 ⟷	CAN_H	White	DeviceNet® signal
5 ⟷	CAN_L	Blue	DeviceNet® signal

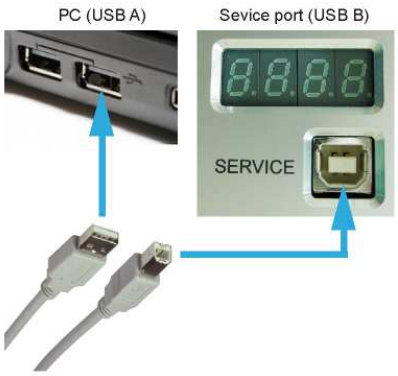
The DeviceNet® interface is galvanic isolated from control unit.

4.5.4.1 Micro Connector Pinout

Male (pins) at valve controller	Female (sockets) at DeviceNet® cable
	

4.5.5 Service port connection

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



You can use our Software 'Control Performance Analyzer' 4.0 for Local operation, which is integrated in the IC2 controller. Refer to chapter: ‘Local operation’ for detail information.

4.6 Initial operation

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

Setup step		Description
1	**Power up**	Turn on external + 24VDC power supply (and external ±15 VDC for sensor power supply if required).
2	**Scaling of Pressure and Position Values**	Refer to chapter «Scaling of Pressure and Position Values» for details.
3	**Valve configuration**	Refer to chapter «Valve configuration» for details.
4	**Interface configuration**	Refer to chapter «DeviceNet interface configuration» for details.
5	**Sensor configuration**	Basic configurations of the valve must be adapted according to application needs. Refer to chapter «Sensor configuration» for details.
6	**Zero Adjust**	Compensation of the sensor offset voltage. Refer to chapter «Sensor configuration» for details.
7a	**Learn**	*For adaptive pressure controller only*. Determination of the vacuum system characteristic to accommodate the PID controller. Refer to chapter «LEARN adaptive» for details.
7b	**Pressure Control Configuration**	Adaption of pressure controller to the vacuum system characteristic. Refer to chapter: «Pressure Control» for details.

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

4.7 Valve configuration

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

- **After power up**, default is ‘close‘.
- **Power failure**, default is ‘not defined‘. Only for versions that have Power Fail Option equipped [613 . . - . . **C** . - . . . . or 613 . . - . . **H** . - . . . .].
- **Network failure**, for default settings refer to individual product data sheet.

Local operation: (‘Control Performance Analyzer’)	**Remote operation**: (Refer to chapter «Setup commands» for details)
With CPA: • Do valve configuration in menu ‘Valve / Setup’.	1. Send VALVE CONFIGURATION

4.7.1 Homing Start Option

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

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

Parameter location:

CPA	DEVICENET
Valve->Homing	Refer to DEVICENET-setup command for detail

4.7.2 Power Failure Option

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

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

Parameter location:

CPA	DEVICENET
Power Fail Option	Refer to DEVICENET-setup command for detail

4.7.3 Digital I/O

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

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

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

Parameter location:

CPA	DEVICENET
Power Connector IO	Refer to DEVICENET-setup command for detail

4.8 DeviceNet Interface configuration

4.8.1 Interface® configuration (DeviceNet®)

MSD and LSD switches are arranged in unusal order. Make sure to select the correct node number.

DeviceNet® node number and baudrate for valve must be selected. DeviceNet® parameters must be adapted according to application needs.

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

Operation via DeviceNet® is sophisticated and requires specific knowledge and training about it and its tools.
VAT offers valve-related but not general DeviceNet® support. Contact us under: devicenet-support@vat.ch

1. The **node number** is the device address and can be selected by two rotary switches which are on the panel. Set the most significant digit (MSD) with the middle switch and the least significant digit (LSD) with the left switch. For example, to set the address to 13, set the MSD to 1 and the LSD to 3. (Factory default is 00).

In case a valid node number (0-63) is selected the number will be used at start of system as MAC-Id of the device and stored in the device memory. In this case node number is not selectable by DeviceNet® service.
If an invalid node number is selected (> 63) node number will be read from the device memory and node number is settable by DeviceNet®. with these tools and interfaces you need to consult the vendor.

2. The **baudrate** can be selected by a rotary switch which is also on the panel.

If a valid baudrate is selected (125kBaud, 250kBaud, 500kBaud), the rate will be used and stored in the device memory as actual baudrate (Factory default is 500kb). In this case baudrate is not selectable by DeviceNet® service.
If an invalid baudrate is selected, the baudrate will be read from the device memory and the rate is settable by DeviceNet®.

3. **Pressure range** for DeviceNet® communication must be selected. Default is 0 -10'000.

Local operation: ('Control Performance Analyzer'')	**Remote operation**: (Refer to chapter «Explicit messaging setup commands» for details)
It's not possible to do pressure value range configuration in local operation.	1. Select DATA TYPE
	2. Select GAIN

4. **DeviceNet®** offers many **parameters** that may be set. Many of them are not directly used to operate the valve but are part of the DeviceNet® profile. You may set all parameters via electronic data sheet (EDS) or via explicit messaging. Setup steps 3 to 5 describe all valve specific parameters that require a setup to enable for valve operation.

The Electronic Data Sheet (EDS) allows the configuration of DeviceNet® components with a general configuration tool. The EDS contains general data regarding device, selection of operation mode, assignment of I/O data to the corresponding I/O message connections (Polling, Bit Strobe, Change of State) and description of device parameters. The parameters of a device are described in a form which is defined by DeviceNet® and visualized by a configuration tool.

5. If **Poll** or **Change of State / Cycling** connection is used for remote operation it's required to preset the correct assemblies. Default values are: poll output assembly = 8, poll input assembly = 3, change of state / cycling input assembly = 3

Assembly object change procedure:

<table>
<tr><td>Local operation:
(Control Performance Analyzer)</td><td>Remote operation:
(Refer to chapter «Explicit messaging setup commands» for details)</td></tr>
<tr><td rowspan="3">Note: It's not possible to make assembly object configuration in local operation.</td><td>1. Select
POLL CONNECTION OUTPUT
assembly</td></tr>
<tr><td>2. Select
POLL CONNECTION INPUT
assembly</td></tr>
<tr><td>3. Reestablish poll I/O connection</td></tr>
</table>

4.9 Sensor configuration

4.9.1 Sensor configuration

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

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

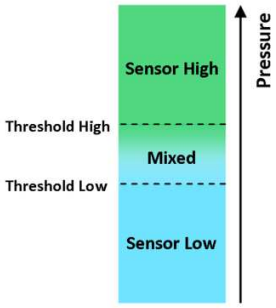
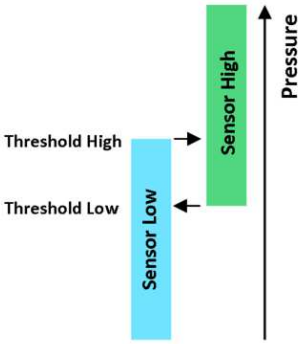
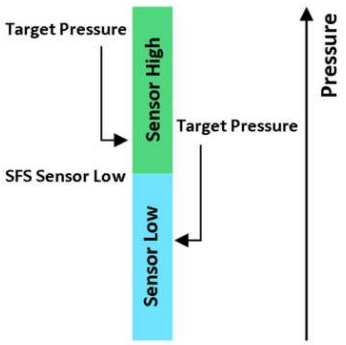
Parameter location:

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

4.9.2 Sensor crossover (2 sensor operation mode)

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

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

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

Parameter location:

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

4.9.3 Zero Adjust

Zero Adjust allows for the compensation of the sensor offset voltage.
When Zero Adjust is performed the current value at the sensor input is equated to Zero.Adjust Target Pressure.
In case of a 2 sensor system both sensor inputs will be adjusted.
Note: A maximum offset voltage of +/- 1.4 V can be compensated.
To execute a zero adjust, the zero adjust have to be enabled (see chapter above).

Parameter	Description
Zero Adjust.Sensor Selection	Select the sensor for the zero adjust: • Sensor 1 + 2 • Sensor 1 • Sensor 2
Zero Adjust.Target Pressure	Normally this parameter is set to 0 in case the process chamber is fully evacuated (which means pressure value is nearly 0). If not you can align the sensor value to a known pressure. In this case set **Target Pressure** to the current pressure. Note: Target Pressure is in the unit of pressure, see chapter «Scaling of Pressure and Position Values»
Zero Adjust.Execute	Start the zero adjust by set **Execute** to 1 At this moment offset value will be calculated and Sensor x.Value = Target Pressure. The resulting offset value can be read on parameter Sensor x.Offset Value [SFS] Clear the offset values by setting **Execute** to 2 The result of clearing the zero adjust: Sensor x.Offset Value [SFS] = 0.0
Sensor 1.Enable **Sensor 2.Enable**	0: It's not possible to execute a zero adjust. A present offset value is ignored. 1: It's possible to execute a zero adjust. A present offset value is respected.
Sensor 1.Offset Value [SFS] **Sensor 2.Offset Value [SFS]**	Value which will be subtracted from measured sensor value The value is related to sensor full scale (0.1 means 10% of sensor full scale)

Parameter location:

CPA	DEVICENET
Pressure Sensor->Zero Adjust Pressure Sensor->Sensor 1->Zero Adjust Pressure Sensor->Sensor 2->Zero Adjust	Refer to "DEVICENET setup commands" for details.

Performing a zero adjust:

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

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

pressure reading is the result.

4.10 Learn (adaptive control algorithm)

DeviceNet:

LEARN adapts the PID controller of the valve to the vacuum system and its operating conditions. The DeviceNet® term for learn is “calibration service”. LEARN must be executed only once during system setup.
The LEARN routine determines the characteristic of the vacuum system. Based on this, the PID controller is able to run fast and accurate pressure control cycles.
This characteristic depends on various parameters such as chamber volume, conductance and flow regime. Therefore it must be performed with a specific gas flow according to instruction below.
The result of LEARN is a pressure versus valve position data table. This table is used to adapt the PID parameters. The data table is stored in the device memory which is power fail save. The data table can be up-/downloaded via ‘Control Performance Analyzer’ software or remote interface. Due to encoding the data may not be interpreted directly.
By an OPEN VALVE, CLOSE VALVE, POSITION CONTROL or PRESSURE CONTROL command the routine will be interrupted.

Local operation: (‘Control View’ resp. ‘Control Performance Analyzer’)	**Remote operation**: (Refer to chapter « Explicit messaging control commands» resp. « Explicit messaging setup commands» for details)
Go to ‘Learn / LEARN’ menu and follow instructions. **Note:** Gasflow calculation according to recommendation below is done automatically based on inputs.	1. Send EXECUTING (if not yet selected)
	2. Select SETPOINT TYPE = position control
	3. Select CONTROL MODE for position = open valve
	4. Set specific gas flow according to calculation below and wait until flow is stable. Autolearn does not need to be performed with the process gas. Instead N_2 or Ar may be used.
	5. Set LEARN PRESSURE LIMIT to p_{max} (max. pressure to control during process)
	6. Send LEARN

- 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:

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.

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

Parameter location:

CPA	DEVICENET
Pressure Control->Adaptive Learn	Refer to "DEVICENET setup commands" for details.

Execute a learn procedure:

1. Set specific gas flow according to calculation below and wait until flow is stable. Learn does not need to be performed with the process gas. Instead N_2 or Ar may be used.
2. Set parameter **Bank Selection**, if only one learn is used take Bank 1. Be sure that the pressure controller also selects this learn bank!
3. Set parameter **Open Speed**. If it's critical for the chamber, if the pressure falls rapidly while opening the valve, reduce the open speed.
4. Set parameter **Controller Mode** = **LEARN**.
5. Wait till **Controller Mode** leave to **LEARN** state → Learn procedure is finished
6. Check if the learn was successful by checking if **Status** shows value 2 (=Completed Successfully). In best case **Warning Info** shows no warning.

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

Gasflow calculation for LEARN:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

4.11 Pressure Control

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

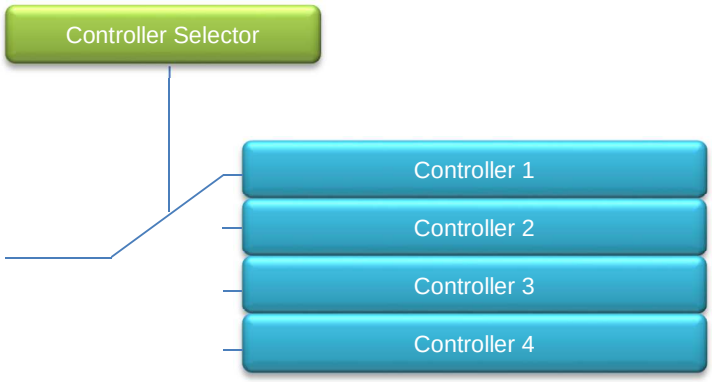
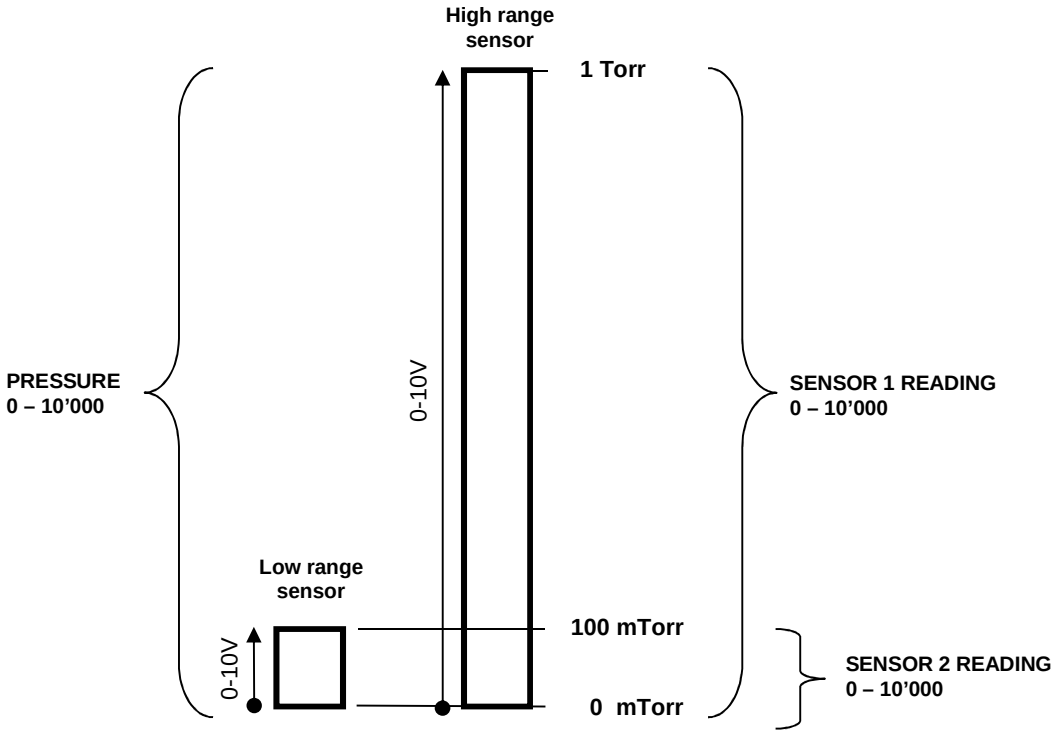


Figure 1: The Controller Selector selects the controller.

4.11.1 Pressure control operation with 2 sensors

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

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



4.11.2 Control parameters

This chapter describes the functionality of Controller 1 to Controller 4.

4.11.2.1 Control algorithm

Parameter location:

CPA	
Pressure Control Pressure Control->Pressure Controller 1 Pressure Control->Pressure Controller 2 Pressure Control->Pressure Controller 3 Pressure Control->Pressure Controller 4	

The main parameter of a controller unit is its **Control Algorithm**. There are different control algorithms implemented in the firmware of the valve. The user can select the control algorithm which fits his demands.

Control Algorithm	Description
Adaptive	This is the most dynamic control algorithm. Before using adaptive control algorithm, a special procedure called “learn” must be executed first (see chapter x). The valve will observe the behavior of the vacuum system by moving the valve to different positions. During the learn procedure the valve performs an internal parameter estimation correspondent to the vacuum system. Note: The adaptive pressure control work at its best if the conditions (mainly gas flow) are close the conditions at the learn procedure.
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	Is a modified PI control algorithm to pump down from atmospheric pressure. This control algorithm has been optimized to prevent that the pressure in the chamber is falling too fast (reduce occurrence of undershoots).

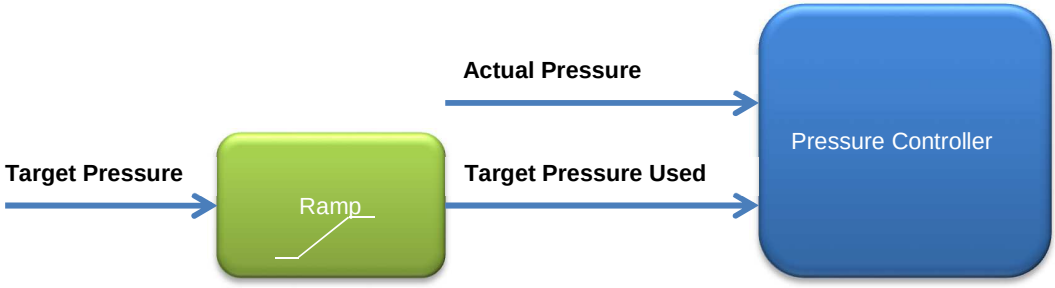
4.11.2.2 Control Algorithm

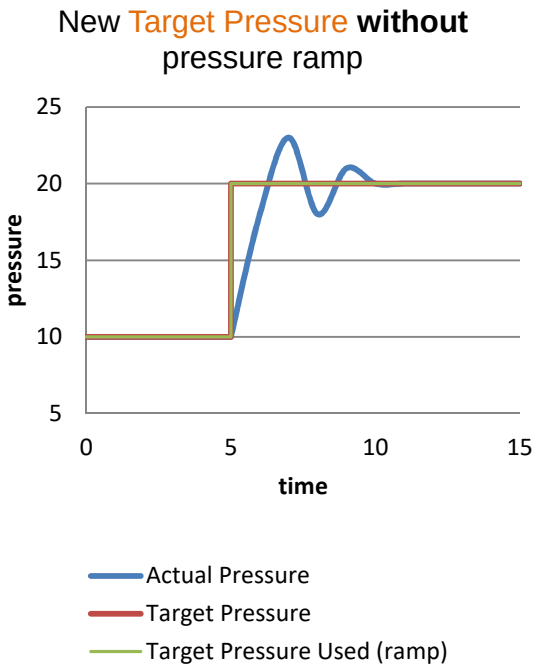
Depending on the Control Algorithm setting there are different parameters available to adjust the algorithm:

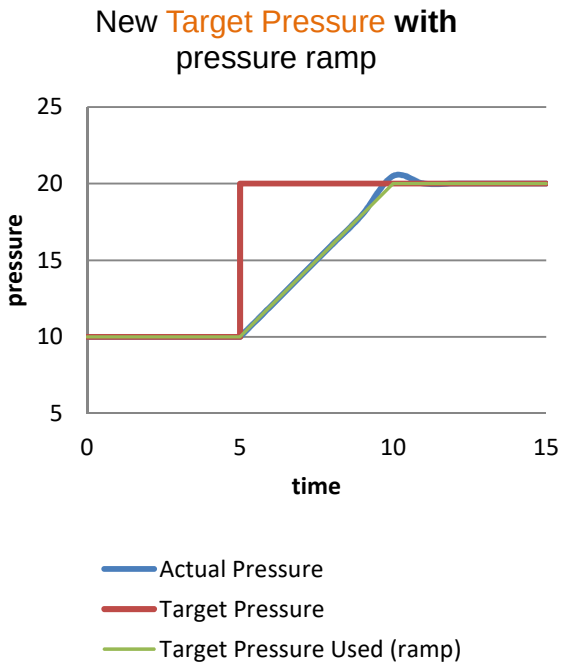
	Parameter	Description
Adaptive	**Gain Factor**	*The* **Gain Factor** *is a control parameter to adapt the performance of the pressure control algorithm. A higher gain results in a faster response, higher over- / undershoots of pressure. A lower gain results in slower response, lower over- / undershoot of pressure.*
	Sensor Delay	*The* **Sensor Delay** *is a control parameter to compensate delays during the pressure detection. Pipes and orifices for sensor attachment can cause delays in response time and could impact badly the pressure control stability. By adapting this parameter to the approximate delay time stability problems can be reduced. But control response time will be slowed down by this measure.*
	Learn Data Selection	*There are up to 4 different learn data sets available. Select which Learn Data set the adaptive controller shall use for pressure control.*
PI	**P-Gain**	*The* **P-Gain** *is the proportional factor of the fixed control algorithm. A higher P-Gain results in faster response, higher over- / undershoot of pressure.*
	I-Gain	*The* **I-Gain** *is the integral factor. The* **I-Gain** *helps to reach the target pressure exactly.*
	Direction	*The* **Control Direction** *defines the type of application, if the valve is mounted in downstream or upstream. Downstream means the valve is after the chamber and before the pump. Upstream, valve is mounted before chamber and pump.*
Soft Pump	**P-Gain**	The P-Gain is the proportional factor of the fixed control algorithm. A higher P-Gain results in faster response, higher over- / undershoots of pressure.
	I-Gain	*The* **I-Gain** *is the integral factor. The* **I-Gain** *helps to reach the target pressure exactly.*

4.11.2.3 Pressure ramp

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

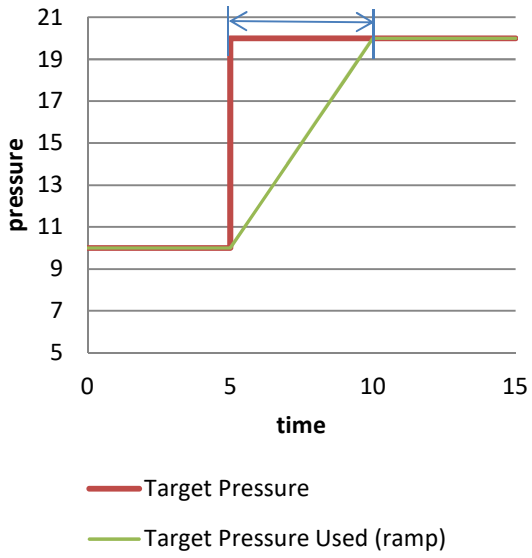




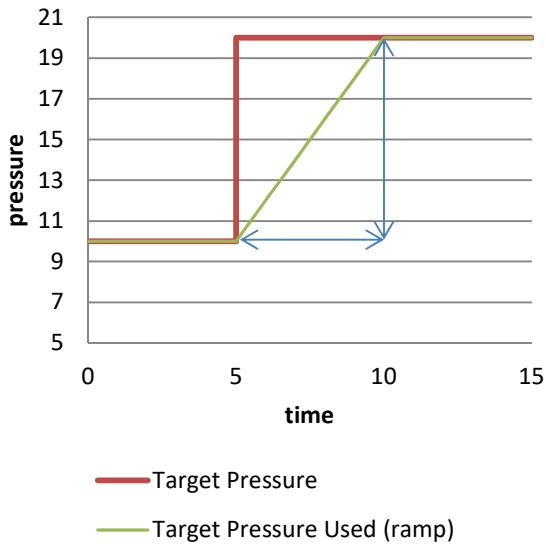


4.11.2.4 Pressure ramp configuration

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

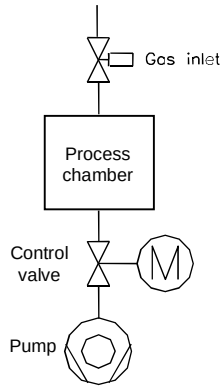
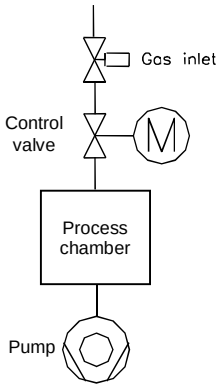


Slope Mode (Ramp Mode = Slope)
After setting a new **Target Pressure, Target Pressure Used** will converge the **Target Pressure** in the slope defines in parameter **Ramp Slope**. **Ramp Slope** is a value in the unit [pressure / seconds]



4.11.3 Choose correct control algorithm

Select the configuration what your application needs.

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

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

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

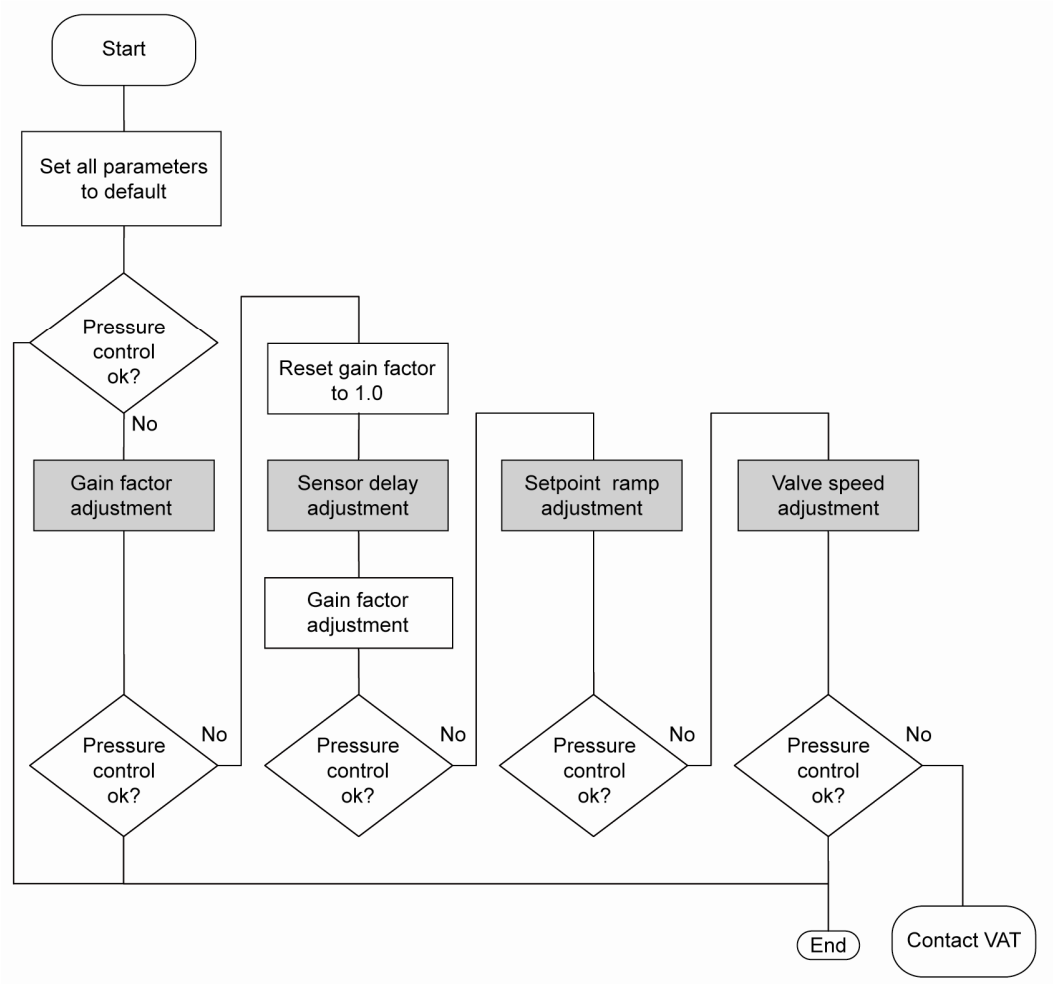
q_L	gasflow for learn [mbarl/s]
p_{SFS}	sensor full scale pressure [mbar]
Tv*	Vacuum time constant [sec]
CV	Chamber Volume [l]

4.11.4 Tuning of control performance

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

4.11.4.1 Tuning of control performance with adaptive pressure controller

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



Gain factor adjustment

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

Adjustment range is from 0.0001 to 7.5.

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

Adjustment procedure:

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

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

Sensor delay adjustment

Sensor delay adjustment effects: **Stability**

Adjustment range is from 0 to 1.0s.

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

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

Adjustment procedure:

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

Setpoint ramp adjustment

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

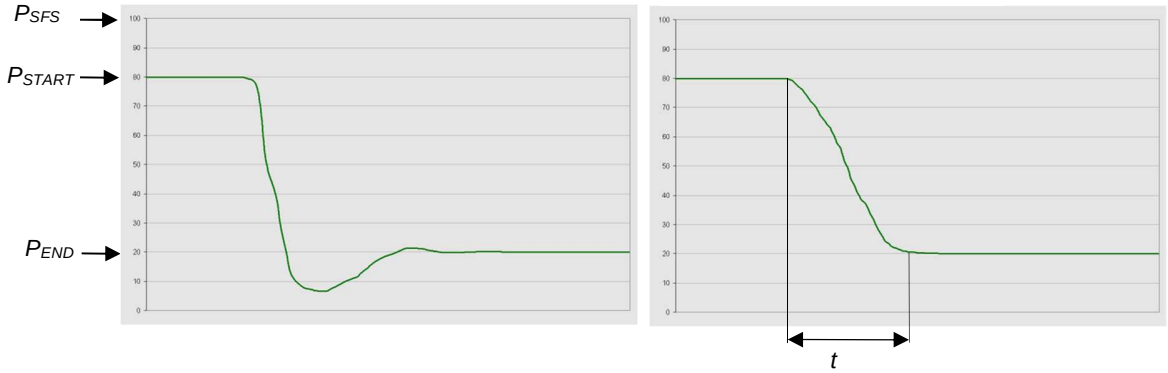
Adjustment range for Setpoint Ramp is from 0 to 10 s.

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

Pressure chart

Without setpoint ramp optimizing

With setpoint ramp optimizing



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

t = Setpoint Ramp

Adjustment procedure:

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

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

Valve speed adjustment

Valve speed effects: **Response time**

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

This parameter effects valve plate actuating speed.
Speed adjustment is effective for PRESSURE CONTROL and POSITION CONTROL.

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

Adjustment procedure:

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

Required information for support:

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

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

4.11.4.2 Tuning of control performance with fixed PI pressure controller

Optimizing P gain and I gain

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

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

Introduction

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

1. Optimizing P gain and I gain

1.1 Pressure and gas flow for optimization

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

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

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

Pressure set points and gas flow for optimization:

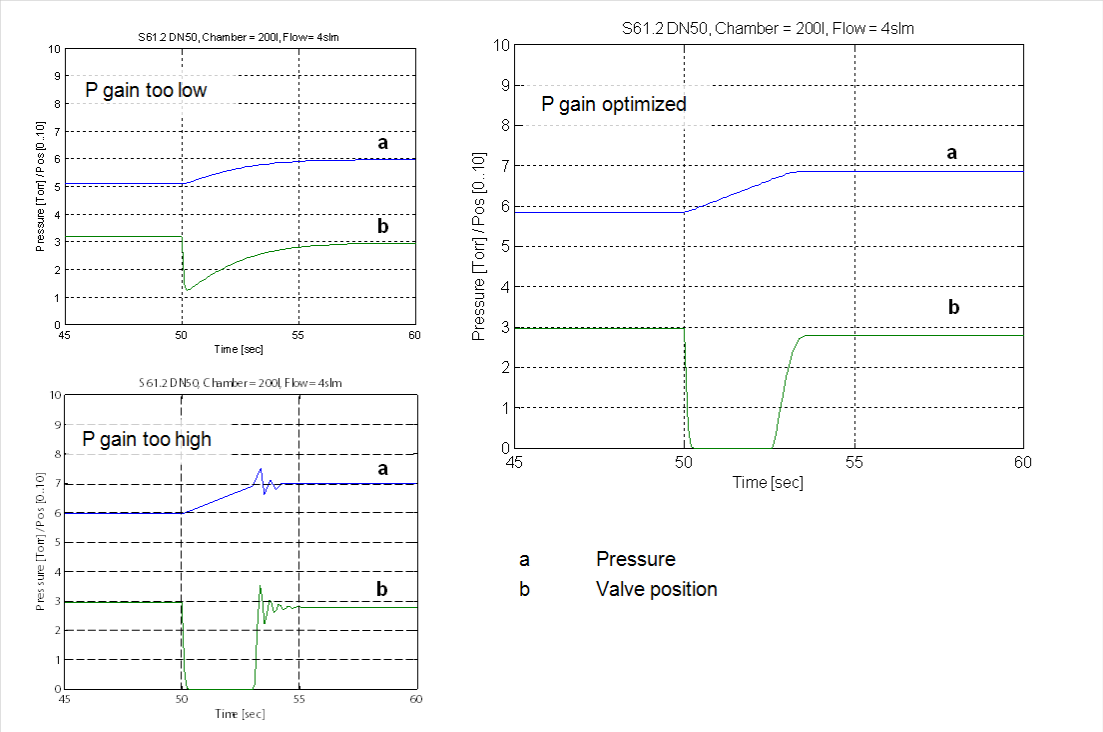
SP1	=	7 Torr
SP2	=	6 Torr
Gas flow	=	4 slm

1.2 Optimizing P gain

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

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

Example:

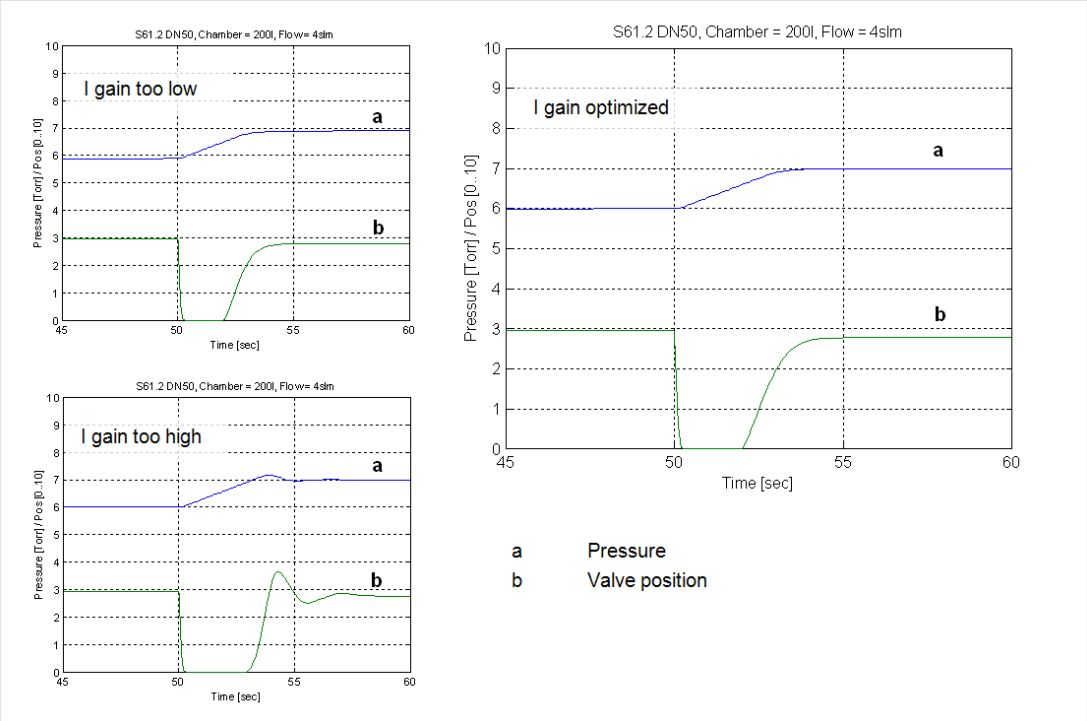


1.3 Optimizing I gain

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

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

Example:



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

Required information for support:

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

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

4.11.4.3 Tuning of control performance with soft pump pressure controller

Optimizing P gain

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

Introduction

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

1. Optimizing P gain

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

1.1 Basic settings

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

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

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

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

1.2 Optimizing P gain

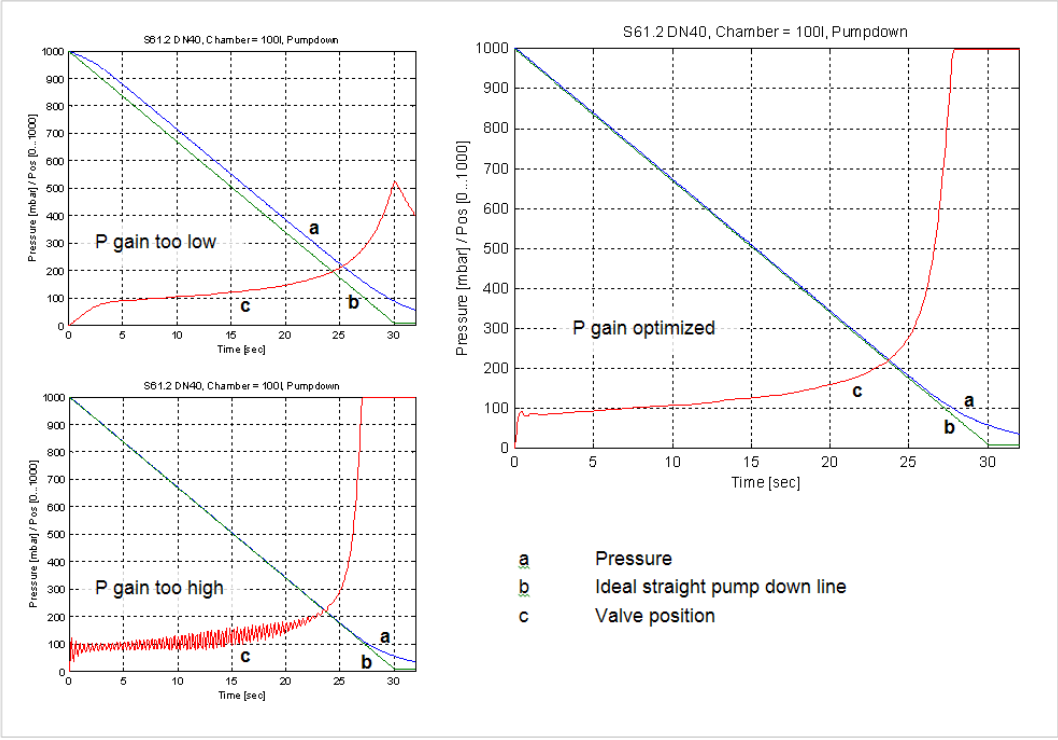
WE start by setting the P gain to 1.0 as a trial value and adjust according to the response.
The pump down routine has to be controlled as follows:

Move control valve into close position
Start pump down by opening the pump isolation valve or starting the pump and sending the first pressure set point to the valve controller. With the example above, the first pressure set point is 510 Torr.
At each new interval (exceeding 10 sec) send the new pressure set point.
Repeat until process pressure is achieved.

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

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

Example:



Required information for support:

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

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

4.12 DeviceNet interface commands

4.12.1 Assembly objects

Factory default assemblies are: Input assembly 3 / Output assembly 8

Number	Type	Composition [2]	[number of data bytes] [1]
3	Input	EXCEPTION STATUS PRESSURE POSITION	[1] [2] or [4] [2] or [4]
4	Input	EXCEPTION STATUS PRESSURE SETPOINT [3]	[1] [2] or [4] [2] or [4]
5	Input	EXCEPTION STATUS PRESSURE SETPOINT [3] POSITION	[1] [2] or [4] [2] or [4] [2] or [4]
7	Output	SETPOINT [3] SETPOINT TYPE	[2] [1]
8	Output	CONTROL MODE SETPOINT [3] SETPOINT TYPE	[1] [2] or [4] [1]
13 (Dh)	Input	EXCEPTION STATUS EXCEPTION DETAIL ALARM EXCEPTION DETAIL WARNING	[1] [15] [15]
14 (Eh)	Input	EXCEPTION STATUS PRESSURE POSITION VALVE CLOSED / OPEN CHECK [4]	[1] [2] or [4] [2] or [4] [1]
100 (64h)	Input	EXCEPTION STATUS PRESSURE POSITION DEVICE STATUS 2 ACCESS MODE	[1] [2] or [4] [2] or [4] [1] [1]
101 (65h)	Input	EXCEPTION STATUS PRESSURE POSITION VALVE CLOSED / OPEN CHECK [4] DEVICE STATUS 2	[1] [2] or [4] [2] or [4] [1] [1]
102 (66h)	Output	CONTROL MODE SETPOINT [3] SETPOINT TYPE LEARN [5] LEARN PRESSURE LIMIT ZERO [5]	[1] [2] or [4] [1] [1] [2] or [4] [1]

1) Depending on DATA TYPE configuration (signed integer or floating point) the length may vary. DATA TYPE may be changed via Explicit Messaging refer to «Explicit messaging setup commands» for details or via EDS file.
2) For data format details refer to «Explicit messaging commands».
3) PRESSURE SETPOINT or POSITION SETPOINT depending on related SETPOINT TYPE
4) 0 = Valve is neither closed nor open, 1 = Valve is CLOSED, 2 = Valve is OPEN
5) To activate ZERO or LEARN use 1 as data else 0. Apply always correct procedures as described in «ZERO (setup step 4)» or «LEARN (setup step 5)»

4.12.2 Assembly object bit map

This is an example based on output assembly 8 and input assembly 3 to illustrate bit map.
DATA TYPE in this example is signed integer.

4.12.2.1 Output assembly

Assembly	Type	Byte	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
8	Output	1	MODE							
		2	SETPOINT low byte							
		3	SETPOINT high byte							
		4	SETPOINT TYPE							

CONTROL MODE may be set to one out of below selections, see also «Explicit messaging control commands»:

Description	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Control valve	0	0	0	0	0	0	0	0
Close valve	0	0	0	0	0	0	0	1
Open valve	0	0	0	0	0	0	1	0
Hold valve	0	0	0	0	0	0	1	1

SETPOINT may be set to any value between the lowest and the highest value. Depending on SETPOINT TYPE it reflects position or pressure setpoint , see also «Explicit messaging control commands».

Description		Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Lowest value (0)	low byte	0	0	0	0	0	0	0	0
	high byte	0	0	0	0	0	0	0	0
Highest value (10000)	low byte	0	0	0	1	0	0	0	0
	high byte	0	0	1	0	0	1	1	1

SETPOINT TYPE may be set to one out of below selections, see also «Explicit messaging control commands».

Description	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Pressure control	0	0	0	0	0	0	0	0
Position control	0	0	0	0	0	0	0	1

4.12.2.2 Input assembly

Instance	Type	Byte	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
3	Input	1	EXCEPTION STATUS							
		2	PRESSURE low byte							
		3	PRESSURE high byte							
		4	POSITION low byte							
		5	POSITION high byte							

EXCEPTION STATUS will respond with one out of below selections, see also «Explicit messaging inquiry commands».

Description	Value	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Manufacturer specific alarm present	84h	1	0	0	0	0	1	0	0
Manufacturer specific warning present	C0h	1	1	0	0	0	0	0	0
No warning, no error present	80h	1	0	0	0	0	0	0	0

PRESSURE will respond with any value between the lowest and the highest value, see also «Explicit messaging inquiry commands»:

Description			Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Lowest value 0 0000h	low byte	00h	0	0	0	0	0	0	0	0
	high byte	00h	0	0	0	0	0	0	0	0
Highest value 10000 2710h	low byte	10h	0	0	0	1	0	0	0	0
	high byte	27h	0	0	1	0	0	1	1	1

POSITION will respond with any value between the lowest and the highest value, see also «Explicit messaging inquiry commands»:

Description			Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Lowest value 0 0000h	low byte	00h	0	0	0	0	0	0	0	0
	high byte	00h	0	0	0	0	0	0	0	0
Highest value 10000 2710h	low byte	10h	0	0	0	1	0	0	0	0
	high byte	27h	0	0	1	0	0	1	1	1

4.12.3 Explicit messaging control commands

Command (DeviceNet® term if deviant)	Service Code	Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description					
EXECUTING	6	48	1	3		
	This command changes the valve to executing state. EXECUTING must to be selected to enable for all executing commands such as control mode, close valve and open valve. **If valve is already in executing state and anew EXECUTING command is sent DeviceNet® will return an error message.**					
IDLE	7	48	1	3		
	This command changes the valve to idle state.					
RESET	5	1	1	0		
	This command resets the DeviceNet® interface.					
FACTORY RESET	5	1	1	1		
	This command resets the DeviceNet® interface to factory default settings. All previously done configurations will be overwritten.					
SETPOINT TYPE	Set 16	51	0	8	1	Y
	Get 14	51	0	8	1	
	Y: **0** pressure control **1** position control This command selects / returns current setpoint type. It toggles valve operation mode between position and pressure control. To perform either position or pressure control also correct CONTROL MODE must be selected.					
CONTROL MODE	Set 16	51	1 (pressure) 2 (position)	5	1	Y
	Get 14	51	1 (pressure) 2 (position)	5	1	
	Y: **0** control mode (pressure resp. position control) **1** close valve (valve will close) **2** open valve (valve will open) **3** hold (stops the valve at the current position) **4** safe state (valve will close) This command preselects / returns the control mode for pressure resp. position control. By means of instance ID either pressure or position must be addressed. To activate either pressure or position control you must select correct SETPOINT TYPE separately.					

Unless otherwise specified all values in the table above are in decimal notification. Hexadecimal values are indicated by the letter ‘h‘ (e.g. 31h)

Command (DeviceNet® term if deviant)	Service Code		Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description						
POSITION SETPOINT	Set	16	51	2	6	2 or 4	Y
	Get	14	51	2	6	2 or 4	
	Y: position setpoint according to selected DATA TYPE, **0** (closed) … **10'000** (open) This command transfers/reads the position setpoint to/from the valve.						
PRESSURE SETPOINT	Set	16	51	1	6	2 or 4	Y
	Get	14	51	1	6	2 or 4	
	Y: pressure setpoint 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 setpoint to/from the valve.						
ASSEMBLY OBJECTS	Set	16	4	7 8 102	3	X	Y
	Get	14	4	3 4 5 13 14 100 101	3	X	
	X, Y: depending on respective assembly object, refer to «Assembly objects» for details. Instance ID = assembly object number. This command writes/reads the respective assembly object.						

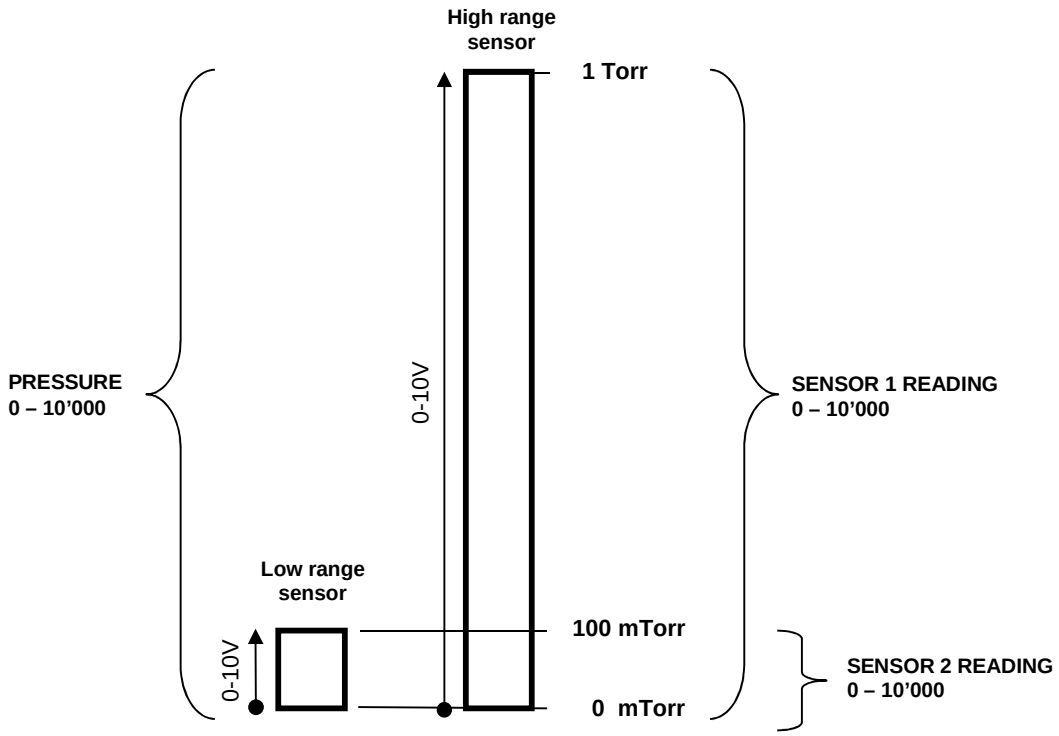
Unless otherwise specified all values in the table above are in decimal notification. Hexadecimal values are indicated by the letter 'h' (e.g. 31h)

4.12.4 Explicit messaging inquiry commands

Command (DeviceNet® term if deviant)	Service Code		Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description						
VALVE CLOSED CHECK (discrete input 1)	Get	14	8	1	3	1	
	This command returns: **0** valve is not closed **1** valve is closed						
VALVE OPEN CHECK (discrete input 2)	Get	14	8	2	3	1	
	This command returns: **0** valve is not open **1** valve is open						
POSITION	Get	14	49	3	6	2 or 4	
	This command returns the current valve position according to selected DATA TYPE. Position range is **0** (closed) … **10'000** (open).						
PRESSURE	Get	14	49	1	6	2 or 4	
	This command returns the actual pressure 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 and picture on the following page for details.						
SENSOR 1 READING	Get	14	100	1	108	2 or 4	
	This function returns direct reading from sensor 1 according to selected DATA TYPE. 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 or 4	
	This function returns direct reading from sensor 2 according to selected DATA TYPE. 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 VALUE (Sensor 1 offset A)	Get	14	49	1	12	2 or 4	
			100	1	110		
	These commands return the offset voltage (adjusted by ZERO) of the sensor 1 according to selected DATA TYPE. Both commands are identical. Value range is **-1400** … **+1400** (-1.40V … +1.40V).						
SENSOR 2 OFFSET VALUE (Sensor 2 offset A)	Get	14	100	1	111	2 or 4	
	This command returns the offset voltage (adjusted by ZERO) of the sensor 2 according to selected DATA TYPE. Value range is **-1400** … **+1400** (-1.40V … +1.40V).						

Unless otherwise specified all values in the table above are in decimal notification. Hexadecimal values are indicated by the letter 'h' (e.g. 31h)

Example of PRESSURE and SENSOR READING allocation:



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

<table>
<tr><th rowspan="2">Command
(DeviceNet® term
if deviant)</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">LEARN STATUS
(calibration state)</td><td>Get</td><td>14</td><td>51</td><td>1</td><td>106</td><td>2</td><td></td></tr>
<tr><td colspan="7">This command returns the status of the LEARN procedure. The status is binary coded.

Bit — Explanation:

(LSB) 0 — 0 = LEARN not running
1 = LEARN running

1 — 0 = LEARN data set present
1 = LEARN data set not present

2 — 0 = ok
1 = LEARN terminated by user

3 — 0 = ok
1 = pressure in position OPEN
> 50% sensor full scale (of high range sensor in case of a 2 sensor system)
or
> LEARN PRESSURE LIMIT

4 — 0 = ok
1 = pressure in position 0
< 10% sensor full scale (of low range sensor in case of a 2 sensor system)

5 — 0 = ok
1 = pressure falling during LEARN

6 — 0 = ok
1 = sensor not stable during LEARN

7 — reserved

8 — reserved

9 — reserved

10 — 0 = ok
1 = LEARN terminated by controller

11 — 0 = ok
1 = pressure in position OPEN negativ

12 — reserved

13 — reserved

14 — reserved

15 — reserved

(MSB) 16 — reserved</td></tr>
</table>

Unless otherwise specified all values in the table above are in decimal notification. Hexadecimal values are indicated by the letter ‘h‘ (e.g. 31h)

Command (DeviceNet® term if deviant)	Service Code	Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description					
DEVICE STATUS 1	Get 14	48	1	11	1	Y
	Y: **1** self test **2** idle **3** self test exception **4** executing **5** abort This command returns the device status.					
DEVICE STATUS 2	Get 14	100	1	103	1	
	This command returns the device status. **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)					
EXCEPTION STATUS (status)	Get 14	48	1	12	1	
	This command returns the exception status. Bit Explanation: (LSB) 0 **0** (reserved) 1 **0** (reserved) 2 This bit is set to 1 in case of a manufacturer specific alarm. 3 **0** (reserved) 4 **0** (reserved) 5 **0** (reserved) 6 This bit is set to 1 in case of a manufacturer specific warning. (MSB) 7 **1** The exception status byte only indicates that alarms or warnings are present. In order to find out which alarm or warning is present, you must read EXCEPTION DETAIL ALARM resp. EXCEPTION DETAIL WARNING.					
EXCEPTION DETAIL ALARM **EXCEPTION DETAIL WARNING**	Get 14	48	1	13 14	15	
	With Attribute ID = 13 EXCEPTION DETAIL ALARM bytes will be returned. With Attribute ID = 14 EXCEPTION DETAIL WARNING bytes will be returned. For meaning see table on next page.					

Unless otherwise specified all values in the table above are in decimal notification. Hexadecimal values are indicated by the letter ‘h‘ (e.g. 31h)

Command (DeviceNet® term if deviant)	Service Code	Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description					

Table with EXCEPTION DETAIL ALARM resp. EXCEPTION DETAIL WARNING bits.
0 OK
1 Exception / Failure / Error (except for detail size bytes)

Data Component	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PCV Common Exception Detail Size	0	0	0	0	0	0	1	0
PCV Common Exception Detail Byte #0	0	0	0	0	0	0	0	0
PCV Common Exception Detail Byte #1	0	0	0	0	0	0	0	0
PCV Device Exception Detail Size	0	0	0	0	0	1	0	0
PCV Device Exception Detail Byte #0	0	0	0	0	0	0	0	0
PCV Device Exception Detail Byte #1	0	0	0	0	0	0	0	0
PCV Device Exception Detail Byte #2	0	0	0	0	0	0	0	0
PCV Device Exception Detail Byte #3	0	0	0	0	0	0	0	0
Manufacturer Exception Detail Size	0	0	0	0	0	1	1	0
Manufacturer Exception Detail Byte #1	Reserved	Reserved	Isolation valve position failure	Reserved	PFO not ready	Compressed air failure	Learn data set invalid	Reserved
Manufacturer Exception Detail Byte #2	Reserved	Reserved	Reserved	Reserved	Reserved	ADC not responding	Reserved	Reserved
Manufacturer Exception Detail Byte #3	Reserved	Reserved	Reserved	~~Wrong Device Status 2~~	~~Wrong Access Mode~~	~~ZERO disabled~~	~~Optional hardware missing~~	No sensor
Manufacturer Exception Detail Byte #4	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	PFO off	Simulation active
Manufacturer Exception Detail Byte #5	Reserved	Reserved	Reserved	Reserved	E40	E22	E21	E20
Manufacturer Exception Detail Byte #6	Reserved	Reserved	Reserved	Valve power OFF or internal com. error	Setpoint invalid (safe state)	IO data missing (safe state)	Setpoint type invalid (safe state)	Control mode invalid (safe state)

EXCEPTION DETAIL ALARM

EXCEPTION DETAIL WARNING

1) Refer to «Trouble shooting» for details on these fatal errors.

Unless otherwise specified all values in the table above are in decimal notification. Hexadecimal values are indicated by the letter ‘h‘ (e.g. 31h)

Command (DeviceNet® term if deviant)	Service Code		Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description						
THROTTLE CYCLE COUNTER	Get	14	100	1	101	4	
	This command returns the number of throttle cycles. 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.						

Unless otherwise specified all values in the table above are in decimal notification. Hexadecimal values are indicated by the letter ‘h‘ (e.g. 31h)

4.12.5 Explicit messaging setup commands

Command (DeviceNet® term if deviant)	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	49	1	3	1	
	X: **195** signed integer **202** floating point This command defines the data type for PRESSURE, SENSOR READING, OFFSET and POSITION.						
GAIN PRESSURE	Set	16	49	1	14	4	X
	Get	14	49	1	14	4	
	X: gain, max. value is **3.2767**, data type is floating point This command selects the gain for PRESSURE and allows for scaling. Default value is 1 (3Fh 80h 00h 00h). e.g.: Gain = 0.1 pressure value range results in 0-1'000 Gain = 1 pressure value range results in 0-10'000 Gain = 3.2767 pressure value range results in 0-32'767						
GAIN POSITION	Set	16	49	3	14	4	X
	Get	14	49	3	14	4	
	X: gain, max. value is **3.2767**, data type is floating point This command selects the gain for POSITION and allows for scaling. Default value is 1 (3Fh 80h 00h 00h, "high byte first" notation). e.g.: Gain = 0.1 position value range results in 0-1'000 (3Dh CCh CCh CCh) Gain = 1 position value range results in 0-10'000 (3Fh 80h 00h 00h) Gain = 3.2767 position value range results in 0-32'767 (40h 51h B5h 73h)						
POLL OUTPUT	Set	16	5	**0**	100	1	X
	Get	14	5	**0**	100	1	
	X: output assembly object number (**7**, **8**, **102**) This command configures resp. reads the output assembly for poll connection.						
POLL INPUT	Set	16	5	**0**	101	1	X
	Get	14	5	**0**	101	1	
	X: input assembly object number (**3**, **4**, **5**, **13**, **14**, **100**, **101**) This command configures resp. reads the input assembly for polling.						
BIT STROBE INPUT	Not implemented						

Unless otherwise specified all values in the table above are in decimal notification. Hexadecimal values are indicated by the letter 'h' (e.g. 31h)

Command (DeviceNet® term if deviant)	Service Code		Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
CHANGE OF STATE / CYCLING INPUT							
	Not implemented						
ACCESS MODE	Set	16	100	1	107	1	X
	Get	14	100	1	107	1	
	X: **0** Local (operation via service port) **1** Remote (operation via DeviceNet®) **2** Locked (in remote mode) This command controls / returns the access mode of the valve.						
POWER UP CONFIGURATION	Set	16	100	1	112	1	X
	Get	14	100	1	112	1	
	X: **0** closed **1** open This command controls / returns the valve position after power up.						
POWER FAIL CONFIGURATION	Set	16	100	1	113	1	X
	Get	14	100	1	113	1	
	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 [950 . . - . . **C** . - . . . . or 950 . . - . . **H** . - . . . . or 950 . . - . . **U** . - . . . . or 950 . . - . . **W** . - . . . .].						

Unless otherwise specified all values in the table above are in decimal notification. Hexadecimal values are indicated by the letter ‘h‘ (e.g. 31h)

Command (DeviceNet® term if deviant)	Service Code		Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
SENSOR MODE	Set	16	49	1	101	1	X
	Get	14	49	1	101	1	
	X: **0** no sensor **1** 1 sensor operation (sensor 1 input) **2** 2 sensor operation with automatic changeover (low range = sensor 2 input, high range = sensor 1 input) **3** 1 sensor operation (sensor 2 input) **4** 2 sensor operation with automatic changeover (low range = sensor 1 input, high range = sensor 2 input) This command controls / returns the sensor mode for pressure control. Sensor modes 2, 3 and 4 are possible with 2 sensor hardware [950 . . - . . . **Q** - . . . .] only. For applications where the high range sensor is used for 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.						
SENSOR RATIO	Set	16	49	1	103	2 or 4	X
	Get	14	49	1	103	2 or 4	
	X: sensor ratio according to selected DATA TYPE, range is **100** … **10'000** This command defines the sensor ratio for 2 sensor operation. Sensor ratio = high range sensor full scale / low range sensor full scale * 100.						
ZERO CONTROL	Set	16	49	1	102	1	X
	Get	14	49	1	102	1	
	X: **0** Disable **1** Enable This command enables resp. disables the ZERO command. In case it is disabled ZERO does not work.						
ZERO	75		49	1			
	This command initiates ZERO. Refer to «ZERO (setup step 4)» for correct zero procedure.						

Unless otherwise specified all values in the table above are in decimal notification. Hexadecimal values are indicated by the letter 'h' (e.g. 31h)

Command (DeviceNet® term if deviant)	**Service Code**		**Class ID**	**Instance ID**	**Attribute ID**	**Service data length** (number of bytes)	**Service data field**
LEARN PRESSURE LIMIT (calibration scale)	Set	16	51	1	100	2 or 4	Y
	Get	14	51	1	100		
	Y: 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. Refer to «LEARN (setup step 5)» for correct learn pressure limit setting.						
LEARN (calibration service)	100		51	1	0		
	This command starts LEARN. With MODE commands open valve or close valve the routine may be interrupted. Without LEARN the PID controller is not able to perform pressure control. Refer to «LEARN (setup step 5)» for correct learn gas flow and procedure.						
DOWNLOAD LEARN DATA	51		48	1		11	XY
	X: index (**000** .. **103**, whereas these indices must be ASCII coded, e.g. 000 = 30h 30h 30h, 001 = 30h 30h 31h, etc.) Y 8 data bytes ASCII coded (e.g. 30h 32h 33h 33h 33h 30h 33h 36h) Example of XY: 30h 30h 30h 30h 32h 33h 33h 33h 30h 33h 36h (11 bytes in total) This command loads the learn data sets from the host down to the valve. There are a total number of 104 data sets. Each data set needs to be downloaded separately.						
UPLOAD LEARN DATA	50		48	1		3	X
	X: index (**000** .. **103**, whereas these indices must be ASCII coded, e.g. 000 = 30h 30h 30h, 001 = 30h 30h 31h, etc.) 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. Each answer consists of 11 bytes. Whereas the leading 3 bytes are the data set index followed by 8 data bytes. Data are ASCII coded.						

Unless otherwise specified all values in the table above are in decimal notification. Hexadecimal values are indicated by the letter 'h' (e.g. 31h)

Command (DeviceNet® term if deviant)	Service Code		Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
PID CONTROLLER GAIN FACTOR	Set	16	51	1	105	1	X
	Get	14	51	1	105	1	
	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 This command selects/returns the gain factor for the PID controller. Refer to «Gain factor adjustment» for details.						
PID CONTROLLER SENSOR DELAY	Set	16	51	1	107	1	X
	Get	14	51	1	107	1	
	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 This command selects/returns the sensor delay for the PID controller. Refer to «Sensor delay adjustment» for details.						
PID CONTROLLER SETPOINT RAMP	Set	16	51	1	108	1	X
	Get	14	51	1	108	1	
	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 This command selects/returns the setpoint ramp for the PID controller. Refer to «Setpoint ramp adjustment» for details.						
VALVE SPEED	Set	16	51	2	101	2	X
	Get	14	51	2	101	2	
	X: valve speed, **1** … **1000** (1 = min. speed, 1000 = max. speed), This command selects/returns the actuating speed for the valve plate. Data type is unsigned integer. Speed selection is effective for pressure control and position control. Open valve and close valve are always done with max. speed. Refer to «Valve speed adjustment» for details.						

Unless otherwise specified all values in the table above are in decimal notification. Hexadecimal values are indicated by the letter ‘h‘ (e.g. 31h)

5 Operation

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

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

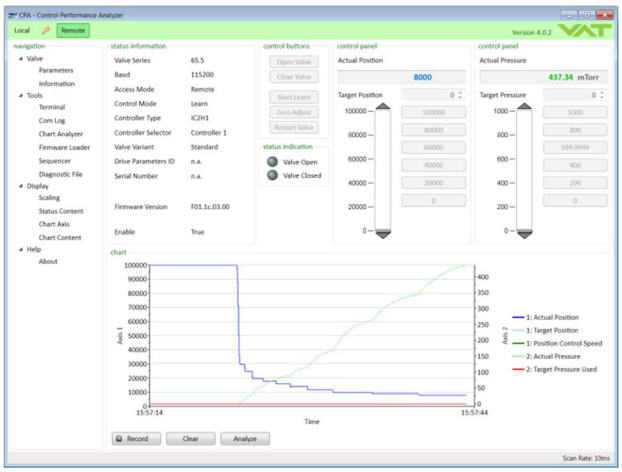
5.1 Normal operation

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

5.1.1 Remote operation

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

'Control Performance Analyzer' 4.0 software



sample picture

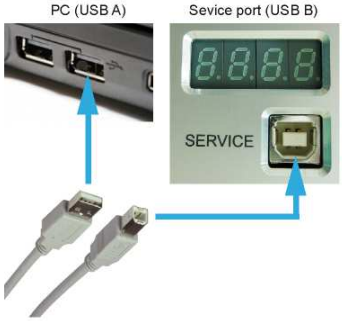
In case ‘Control Performance Analyzer’ is used, make sure ‘Remote’ button is pushed to enable for remote operation.

5.1.2 Local operation

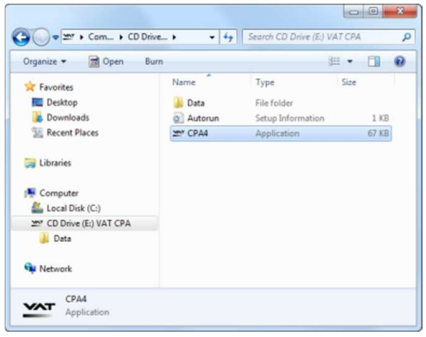
Local operation means that the valve is operated via the service port using a computer.
You can use our software 'Control Performance Analyzer' for Local operation, which is integrated in the controller. The software is beneficial especially for setup, testing and maintenance.

How to start:

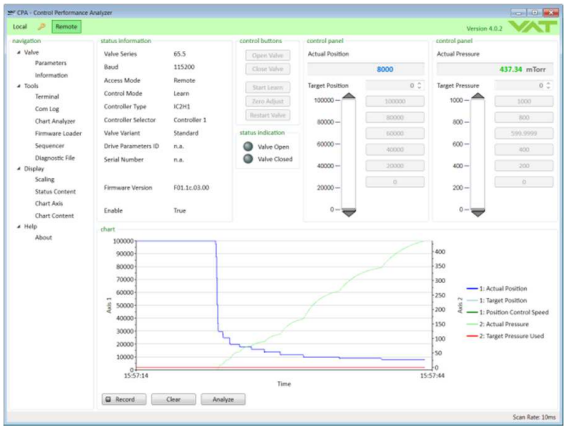
1. Connect service cable (USB A–B cable male-male) between PC and valve:



A drive opens:



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



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

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

5.2 Close valve

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

5.3 Open valve

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

5.4 Position control

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

Local operation: ('Control Performance Analyzer')	**Remote operation**: (Refer to chapter «OUTPUT Buffer» > «POSITION SETPOINT» for details)
Select or enter position setpoint	1. In «OUTPUT Buffer» > « POSITION SETPOINT» 2. Select a valid value 3. In «OUTPUT Buffer» > «CONTROL MODE SETPOINT» 4. Select [Position] (value = 2)

5.5 Pressure control

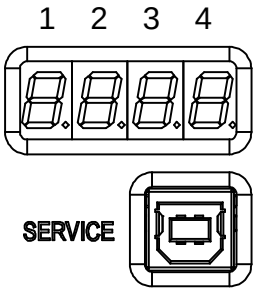
To prepare valve for PRESSURE CONTROL perform complete «Setup procedure». The valve has parameters that may be modified to tune pressure control performance. Refer to «Tuning of control performance».

The included PID controller controls the chamber pressure according to the pressure setpoint by means of the valve position. The PID controller works with an adaptive algorithm to achieve best results under altering conditions (gasflow, gas type).

Local operation: with 'Control Performance Analyzer' 4.0, refer to chapter: «Local operation»	**Remote operation**:
1. Open the CPA 4.0 2. Click [Local] 3. Click [Parameters] 4. Click [Pressure Control] and do the settings 5. Click [Save]	Refer to "DeviceNet control commands" for details.

5.6 Display information

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



5.6.1 Power up

Description	Digit 1	Digit 2	Digit 3	Digit 4
● 1st Power On: All dots are illuminated	#	#	#	#
● 2st information for about 3s Valve type [e.g.]		**6**	**7**	**0**
● 3st information for about 3s: Firmware generation and Firmware Type [e.g. **01.0C**]	**0**	**1**	**0**	**C**
● 4st information for about 3s: Firmware version and firmware revision [e.g. **07.00**]	**0**	**7**	**0**	**0**
● 5nd information for about 3s: Controller configuration. [e.g. **11.00**] Refer to «Safety mode» for details.	**Controller Type** (1=EC2)	**Inteface Type** (1=RS232/RS485, 2=EtherCAT, 3=DeviceNet) 5=Logic	**Option Type**	
			0	**0** (none)
			0	**1** (SPS)
			0	**2** (PFO)
			0	**3** (Cluster)
			0	**4** (SPS & PFO)
			0	**5** (SPS & Cluster)
			0	**6** (PFO & Cluster)
			0	**7** (SPS & PFO & Cluster
'Ho' indicates power up homing is running	**H**	**o**		

5.6.2 Operation

Description / Mode	Digit 1	Digit 2	Digit 3	Digit 4
Start up (Init)	**I**	**n**	**-**	**-**
Start up (init) leak tight	**I**	**n**	**-**	**C**
Valve closed (leak tight)	**C**	-	-	**C**
Valve open	**O**	**0…100** = valve position (0 = minimal conductance 100 = max. open)		
PRESSURE CONTROL mode	**P**			
POSITION CONTROL mode (e.g. **A..0** = min. conductance)	**A**			
Closed / open interlock (Valve closed / open by digital input)	**I**			
HOLD (position frozen) activated	**H**			
LEARN running	**L**			
Safety mode established. Refer to «Safety mode» for details.	**S**			
Power failure	**F**			

5.6.3 Error

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

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

5.6.4 Safety mode

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

5.7 Operation during power up

Valve position before power up:	**Reaction of valve:**	
	Valve power up configuration = closed (default)	Valve power up configuration = open
Closed (isolated)	Valve remains closed. Display shows 'C C'. Homing will be done when first movement command is received.	Valve runs to maximum throttle position to detect the limit stops to do homing. Display shows configuration of product resp. 'Ho' until homing is done. Valve position after power up is 'A. 0' min. conductance.
All other than closed (not isolated)	Valve runs to max. throttle position to detect limit stop for homing. Display shows configuration of product resp. 'Ho' until homing is done, and afterwards to close position. Display shows 'C C'.	
	Valve position after power up is closed	Valve position after power up is open

Refer also to chapter: «Display information».

5.8 Behavior in case of power failure

Valve position before power failure:	**Reaction of valve:**	
	Without Power Failure Option (PFO) 613 . . - . . **G** . - .... / 613 . . - . . **A** . -	With Power Failure Option (PFO) 613 . . - . . **H** . - .... / 613 . . - . . **C** . - ....
Closed (isolated)	Valve remains closed.	Valve will close or open depending on valve configuration [1]. Default is not defined. Display indicates **F**.
Valve open or in any intermediate position	The plate remains at the current position.	

[1] Provided the battery pack of the VAT controller is charged. Charging time after power up is 1 minutes maximum.

All parameters are stored in a power fail save memory.

For PFO retrofit and other options refer to chapter: «Spare parts».

5.9 Operation under increased temperature

⚠ CAUTION

Hot valve

Heated valve may result in minor or moderate injury.

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

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

6 Trouble shooting

6.1 General

Failure	Check	Action
No dots lighted on display	- 24 V power supply ok?	- Connect valve to power supply according to «Electrical connection» and make sure that power supply is working.
Module Status LED is off	- DeviceNet® power supply ok?	- Connect valve to DeviceNet® according to «DeviceNet® connection» and make sure that power is provided.
Module Status LED is flashing green		- The controller needs commissioning due to missing, incomplete or incorrect configuration.
Module Status LED is flashing red (**recoverable fault**)	- Refer to ODVA specification volume II, release 2.0 (incl. errata 1) «IDENTITY OBJECT, figure 6.2, state event matrix for identity object»	- Refer to ODVA specification volume II, release 2.0 (incl. errata 1) «IDENTITY OBJECT, figure 6.2, state event matrix for identity object»
Module Status LED is red (**unrecoverable fault**)	- Refer to ODVA specification volume II, release 2.0 (incl. errata 1) «IDENTITY OBJECT, figure 6.2, state event matrix for identity object»	- Refer to ODVA specification volume II, release 2.0 (incl. errata 1) «IDENTITY OBJECT, figure 6.2, state event matrix for identity object»
Network Status LED is off (**Device is not on line**)	- DeviceNet® power supply ok?	- Connect valve to DeviceNet® according to «DeviceNet® connection» and make sure that power is provided.
Network Status LED is flashing green (**on line but no connections in the established state**)		- Allocate device to master
Network Status LED is flashing red (**time out**)	- Are I/O connections in the time out state?	- Reestablish I/O connections.
Network Status LED is red		- Failed communication device. The device has detected an error that has rendered it incapable of communicating on the network.
Controller does not respond to DeviceNet® commands	- Node number and baudrate correct?	- Proceed according to «Setup procedure, DeviceNet® CONFIGURATION».
Controller does either not respond or respond in an unexpected way to DeviceNet® commands	- Configuration correct?	- Send FACTORY RESET and redo complete configuration. Refer to «Explicit messaging control commands, FACTORY RESET» and «Setup procedure, DeviceNet® configuration» for details.
Read back from contoller is wrong during polling	- Check poll rate	- Refer to «Setup procedure, DeviceNet® configuration» for details.

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

Failure	Check	Action
Display shows «**I100**» Interlock open mode active	-	- Refer to «Logic I/O connector» for details.)
- Display shows «**S** »	- Motor power supplied/Safety Switch?	- Provide power to motor to allow for operation. - Refer to «Electrical connection» for details.
- CLOSE VALVE does not work	- Safety mode active, check for D on display?	- Provide power to motor to allow for operation. - Refer to «Electrical connection» for details.
- OPEN VALVE does not work	- Safety mode active, check for D on display?	- Provide power to motor to allow for operation. - Refer to «Electrical connection» for details.

Failure	Check	Action
DeviceNet «**E 20**» (**homing failure, no end position found**)	- Clamp coupling screw not fastened?	- Tighten screw. See chapter «Tightening torque» for details.
DeviceNet «**E 21**» (**valve blocked during homing operation**)	- Valve plate centric adjusted? - Valve unit heavy contaminated? - Valve plate mechanically obstructed?	- Adjust valve plate according to «Maintenance procedures». - Clean valve unit according to «Maintenance procedures». - Resolve obstruction.
DeviceNet «**E 22**» (**plate blocked during operation**)	- Valve unit heavy contaminated? - Valve plate mechanically obstructed?	- Clean valve unit according to «Maintenance procedures». - Resolve obstruction.
DeviceNet «**E 40**» (**motor driver failure**)		- Replace control and actuating unit according to «Maintenance procedures».

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

6.2 Errors

6.2.1 Controller Display

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

6.2.2 Error numbers

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

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

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

6.2.3 Error code

Error Code *u*	*v*	*w*	Description	Solution
		1	No valve connected	Connect valve controller to the valve
		2	Non volatile memory failure	Replace valve controller
		3	Analog digital converter of sensor input failure	Replace valve controller
		4	Initialization of motion controller failed	• Wrong motion controller firmware version → Update motion controller firmware
		5	Encoder index not found	• Encoder failure • O-Ring sticking • 1)
		6	Initialization of interface module failed	• Fieldbus: Valve firmware does not support interface type → Update valve firmware • Wrong interface firmware version → Update interface firmware
	1	0	Closing position can't be reached	• 1)
	1	1	Homing position can't be reached	• 1)
	1	2	Motion controller: Internal voltage error	• Check power supply
	1	3	Motion controller: Internal error temperature	• Check for a heat accumulation
	1	4	Motion controller: Unexpected behavior	Contact vat support
	1	5	Motion controller: Target position can't be reached	• 1)
	1	6	Motion controller: Position minimal conductance cannot be reached	• 1) • Check Plate and Seal ring • Check Parameter "Isolation Position Enter [r]"
	1	7	Motion controller: Position to push back the	• 1)

			Differential Plate cannot be reached	• Check Different Plate • Check Parameter “Differential Plate Push Back Position [r]”
	1	8	Motion controller: Minimal isolation position cannot be reached	• 1) • Check Plate and Seal ring • Check Parameter “Isolation Position [r]”
	2	0	Break slippery detected	Replace actuator
	3	0	SFV: Motion controller failure in master-slave communication	Contact vat support
	9	6	SFV: Position deviation axis1 to axis2 at homing procedure	• O-Ring sticking • 1)
	9	7	SFV: Position deviation axis1 to axis2 at operating	1)
	9	8	Position error during closing procedure	1)
	9	9	Position error at operating	1)

1) Mechanical movement problem:
- Check for differential pressure
- Remove foreign object in movement area
- Eliminate tight movement
- Repair mechanical failure

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

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:

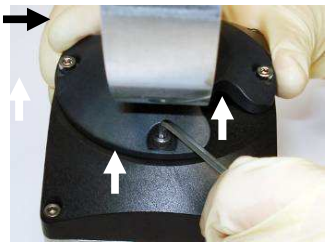
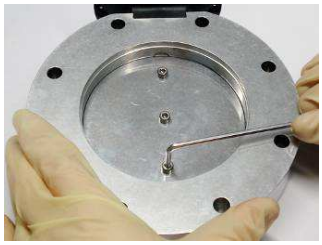
Replacement of	unheated [1)]	heated ≤ 80 °C [1)]	heated > 80 °C [1)]
Rotary feedthrough seals	2'000'000 cycles	6 months but max. 2'000'000 cycles	3 months but max. 2'000'000 cycles

[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.

7.2.1 Replacement of shaft feedthrough seals and valve cleaning

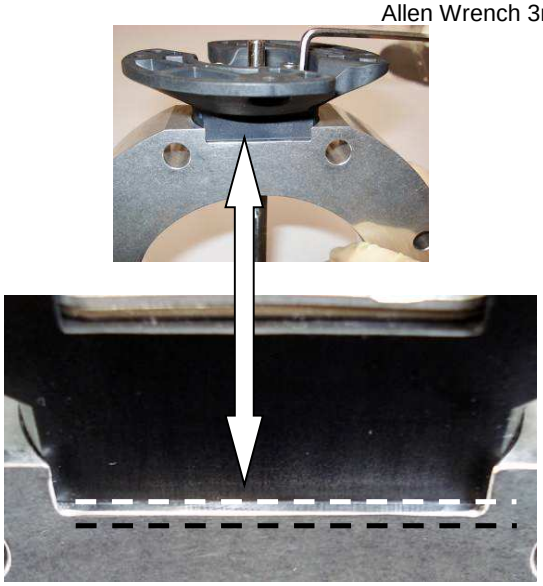
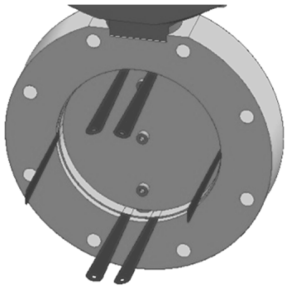
7.2.1.1 Required tools

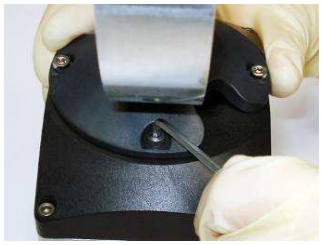
- Allen Wrench 2 mm / 2.5mm
- Allen Wrench 3 mm
- Feeler gauge
- Clean room wipes, isopropyl alcohol
- Vacuum grease

Description		Required tool
Make sure that the valve is in closed position 1. Vent vacuum system, disconnect electrical connections and remove valve from vacuum system. If you only replace control and actuating unit, the valve can remain in the system. Take care not to damage sealing surface! **Attention!** Do not move the plate by hands when control an actuating unit is installed.		Depending on flange screws
2. Unfasten clamp coupling		Allen Wrench: elastic coupling 2 mm steel coupling 2.5 mm
3. Unfasten the 4 connection bolts and separate both parts. Valve size DN 160 (6”) and bigger require a shortened wrench. For ordering number refer to «Spare parts and accessories». 12 mm 		Allen Wrench 3 mm
4. Unfasten screws and remove plate from shaft.		Allen Wrench 3 mm

Description		Required tool
5. Unfasten alternately the 2 mounting screws little by little. If only one screw is fasten / unfasten, the mechanical unit will be damaged. Max. difference should be less than 1 turn or 0.5 turn of the screws.		Allen Wrench 3 mm
6. Remove mechanical unit and clean shaft.		
7. Remove o-rings. 8. Clean shaft feedthrough and valve body.		Clean room wipes, isopropyl alcohol
9. Lubricate seal contact surface of valve body with a slight film of vacuum grease (0.025 ml). 10. Lubricate each o-ring with a slight film of vacuum grease (0.0125 ml).		Vacuum grease
11. Lubricate seal contact surface of shaft with a slight film of vacuum grease (0.0125 ml). 12. Slide both o-rings onto shaft till the end. 13. Deposit 0.0375 ml vacuum grease between the o-rings 14. Clean shaft from vacuum grease.		Vacuum grease Clean room wipes

<table>
<tr><th>Description</th><th>Required tool</th></tr>
<tr><td>15. Assemble mechanical unit in reverse order as disassembled (steps 6 to 5).

16. Align pedestal parallel to valve body and tighten the 2 mounting screws with 2.5 Nm.</td><td>Allen Wrench 3mm
  </td></tr>
<tr><td>17. Center plate.
<table><tr><th>Size</th><th>Feeler gauge mm</th></tr><tr><td>63</td><td>0.04</td></tr><tr><td>80</td><td>0.06</td></tr><tr><td>100</td><td>0.06</td></tr><tr><td>160</td><td>0.08</td></tr><tr><td>200</td><td>0.08</td></tr><tr><td>250</td><td>0.10</td></tr><tr><td>320</td><td>0.12</td></tr></table>18. Tighten plate screws with 2.5 Nm.</td><td>Actuator side
  </td><td>Allen Wrench 3 mm

Adequate feeler gauge</td></tr>
<tr><td>19. Assemble control and actuating unit to valve unit. Tighten mounting screws adequately.</td><td>  </td><td>Allen Wrench mm</td></tr>
<tr><td>20. Tighten clamp coupling:
with elastic coupling 1.1 Nm
with steel coupling 2.2 Nm</td><td>  </td><td>Allen Wrench:

elastic coupling 2 mm

steel coupling 2.5 mm</td></tr>
</table>

Description		Required tool
21. Reinstall valve into vacuum system according to chapter «Installation».		

7.2.2 Replacement of Option board

NOTICE

Electrostatic discharge

Electronic components could be damage.

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

NOTICE

Burned connector pins (spark)

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

Do not plug or unplug connectors under power.

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

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

It is available in 3 versions. These are:

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

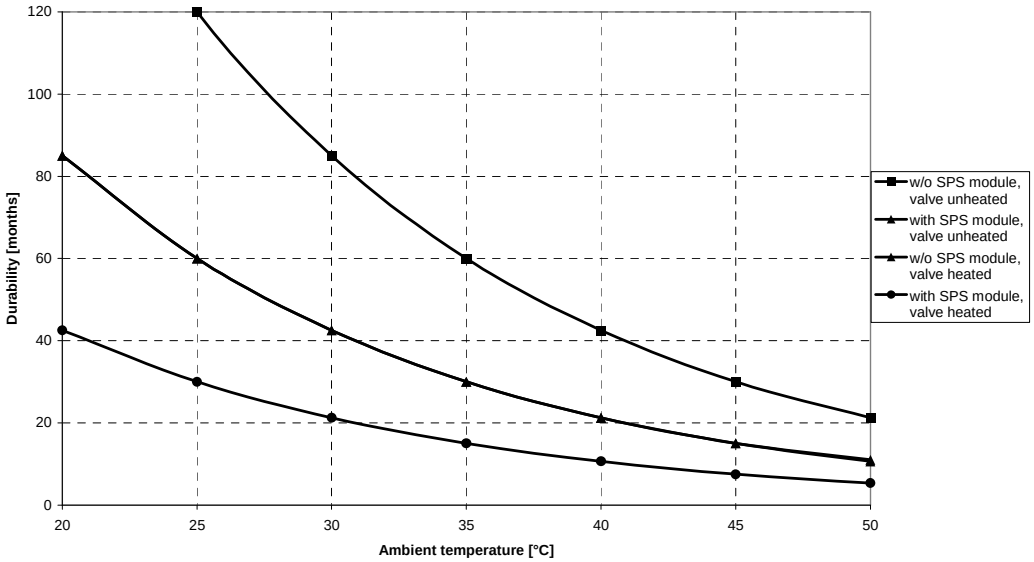
The modules may be retrofitted or replaced easily. The battery lifetime of the PFO module depends on the ambient temperature (see below). To assure PFO function the option board must be replaced after battery life has expired. For ordering number of the modules refer to chapter «Spare parts».

7.2.2.1 Durability of power fail battery

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

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

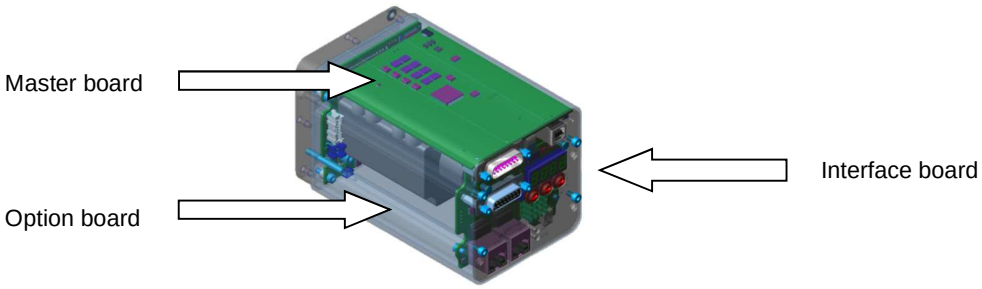
Therefore please determine the equivalent maintenance period for replacing the Ultra Cap battery (Option board).



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

7.2.2.2 Retrofit / replacement procedure

View on control and actuating unit:

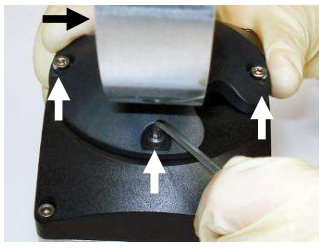


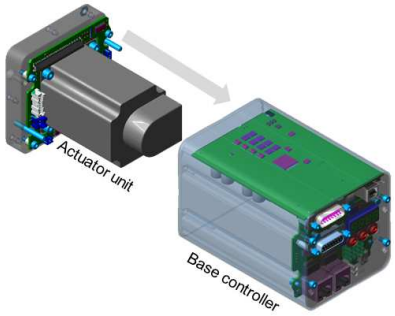
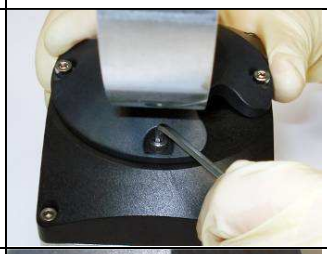
All boards have a fixed position into control and actuating unit. It is not possible to fit a board in other position as shown in picture above! Do not try out other positions, which maybe destroy the socket of boards!

7.2.2.3 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
Make sure that the valve is in closed position 1. Vent vacuum system, disconnect electrical connections and remove valve from vacuum system. If you only replace control and actuating unit, the valve can remain in the system. Take care not to damage sealing surface! **Attention!** Do not move the plate by hands when control an actuating unit is installed.		Depending on flange screws
2. Unfasten clamp coupling		Allen Wrench: steel coupling 2.5 mm
3. Unfasten the 4 connection bolts and separate both parts. Valve size DN 160 (6”) and bigger require a shortened wrench. For ordering number refer to «Spare parts and accessories». 12 mm 		Allen Wrench 3 mm

Description		Required tool
4. Replacement of the option board / whole controller Unfasten the two bolts from bottom side and 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		.
5. Assemble control and actuating unit to valve unit. Tighten mounting screws adequately.		Allen Wrench mm
6. Tighten clamp coupling: • with elastic coupling 1.1 Nm • with steel coupling 2.2 Nm		Allen Wrench: steel coupling 2.5 mm
7. Reinstall valve into vacuum system according to chapter «Installation		

8 Repairs

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

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

9 Dismounting and Storage

⚠ WARNING

Unqualified personnel

Inappropriate handling may cause serious injury or property damage.

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

9.1 Dismounting

NOTICE

Contamination

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

Always wear clean room gloves when handling the valve.

NOTICE

Valve in open position

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

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

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

9.2 Storage

NOTICE

Wrong storage

Inappropriate temperatures and humidity may cause damage to the product.

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

NOTICE

Inappropriate packaging

Product may get damaged if inappropriate packaging material is used.

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

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

10 Packaging and Transport

⚠ WARNING

Unqualified personnel

Inappropriate handling may cause serious injury or property damage.

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

⚠ WARNING

Harmful substances

Risk of injury in case of contact with harmful substances.

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

NOTICE

Inappropriate packaging

Product may get damaged if inappropriate packaging material is used.

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

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

10.1 Packaging

NOTICE

Valve in open position

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

Make sure that the valve is closed.

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

VAT disclaims any liability for damages resulting from inappropriate packaging.

10.2 Transport

NOTICE

Inappropriate packaging

Product may get damaged if inappropriate packaging material is used.

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

VAT disclaims any liability for damages resulting from inappropriate packaging.

11 Disposal

Observe the local regulations for disposal

⚠ WARNING

Harmful substances

Environmental pollution.

Discard products and parts according to the local regulations.

⚠ WARNING

Unqualified personnel

Inappropriate handling may cause serious injury or property damage.

Only qualified personnel are allowed to carry out the disposal.

⚠ CAUTION

Risk of damage

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

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

NOTICE

Improper disposal

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

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

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

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

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

12 Spare parts

NOTICE

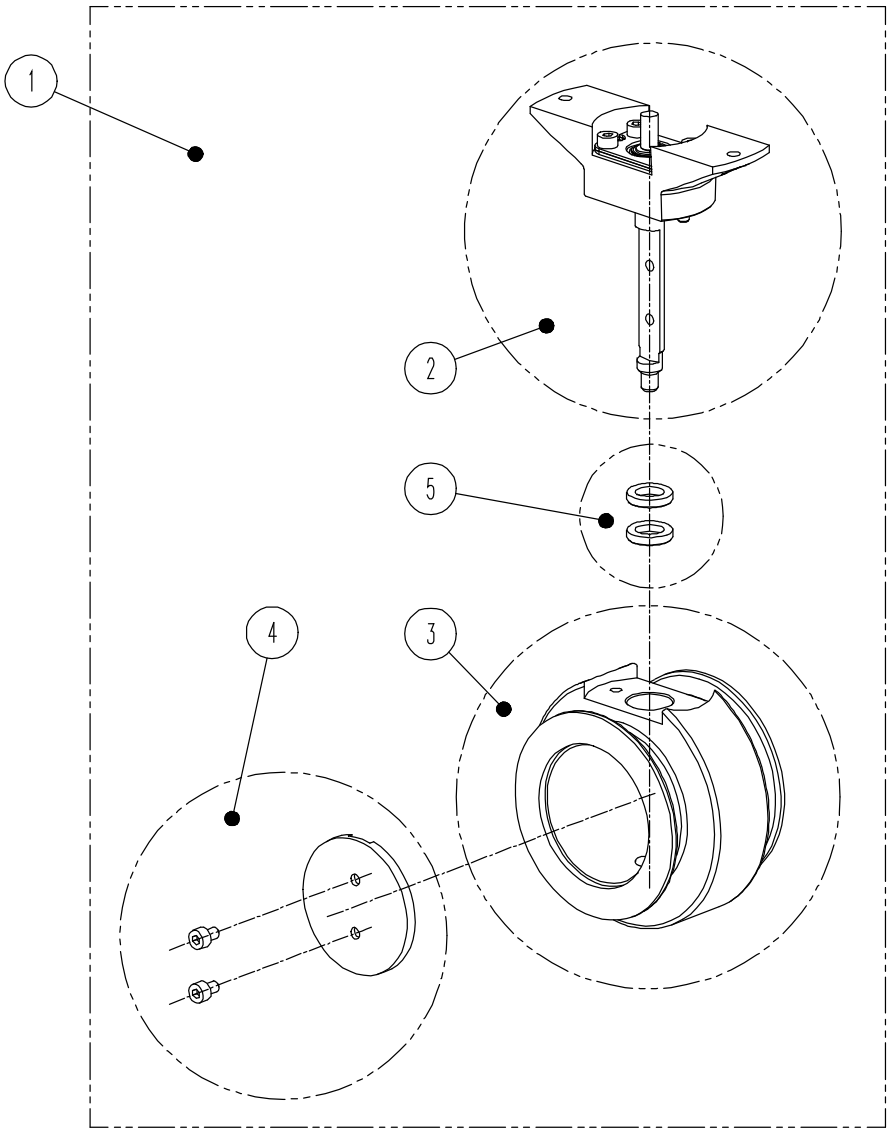
Non-original spare parts

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

Use original spare parts from VAT only.

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

12.1 Drawing



Sample picture

1 Body with mechanism
2 Shaft kit
3 Valve body
4 Plate kit
5 Shaft feed through seals

All “Item“ refer to chapter «Drawing»

12.1.1 ISO-KF valve unit - aluminum blank, without heating

Item	Description			
	Valve size Product ordering number	**DN 25 / 1” 61328 - KA . . ISO-KF**	**DN 40 / 1½” 61332 - KA . . ISO-KF**	**DN 50 / 2” 61334 - KA . . ISO-KF**
1	Spare parts kit valve unit	488956	485726	486738
2	Spare parts kit mechanical unit	488946	471287	471292
3	Spare parts kit valve body	240574	232271	232272
4	Spare parts kit plate	253255	232276	232277
	Plate screws	361960 (2 pcs required)	353386 (2 pcs required)	353386 (2 pcs required)

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

Item	Description			
	Valve size Product ordering number	**DN 25 / 1” 61328 - KE . . ISO-KF**	**DN 40 / 1½” 61332 - KE . . ISO-KF**	**DN 50 / 2” 61334 - KE . . ISO-KF**
1	Spare parts kit valve unit	489057	486772	485723
2	Spare parts kit mechanical unit	488946	471287	471292
3	Spare parts kit valve body	342558	243089	237850
4	Spare parts kit plate	342563	243090	239549
	Plate screws	361960 (2 pcs required)	353386 (2 pcs required)	353386 (2 pcs required)

12.1.3 Seals and grease

Item	Description		
	Valve size Product ordering number		**All sizes 613 . . - . . . .**
5	Vacuum seal kit	Viton	237235 (2x N-5100-204)
		Others	on request
	Vacuum grease syringe		206792 (2ml), 206793 (5ml)

For versions such as:

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

spare parts ordering numbers are available on request.

12.1.4 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

12.1.5 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)
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

12.1.5.1 Centering ring with Viton o-ring

Description				
Valve size **Product ordering number**		**DN 25 / 1** **61328 - . . . .**	**DN 40 / 1½”** **61332 - . . . .**	**DN 50 / 2”** **61334 - . . . .**
Centering ring with Viton o-ring (for ISO-KF and ISO-F installation only)	Aluminum	31028-KAZV-0001	31032-KAZV--0001	32034-KAZV-0001
	Stainless steel	31028-KEZV-0001	31032-KEZV-0001	32034-KEZV-0001

13 Appendix

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