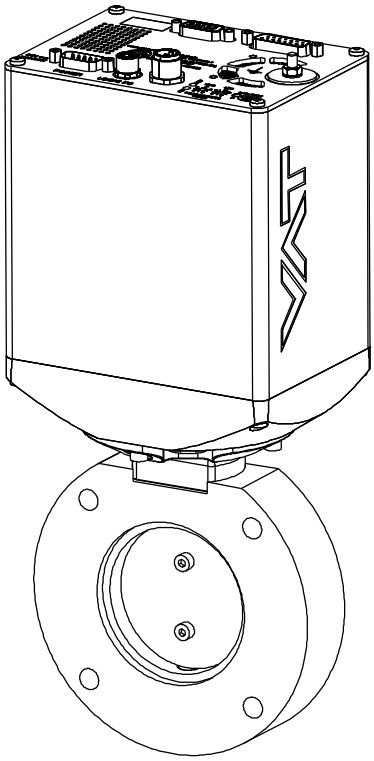
Butterfly Pressure Control Valve
with DeviceNet interface


sample picture

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

612 . . - . . GP -	(1 sensor input)
612 . . - . . GQ -	(2 sensor inputs)
612 . . - . . AP -	(1 sensor input / ±15V SPS)
612 . . - . . AQ -	(2 sensor inputs / ±15V SPS)
612 . . - . . HP -	(1 sensor input / PFO)
612 . . - . . HQ -	(2 sensor inputs / PFO)
612 . . - . . CP -	(1 sensor input / ±15V SPS / PFO)
612 . . - . . CQ -	(2 sensor inputs / ±15V SPS / PFO)

SPS = Sensor Power Supply PFO = Power Failure Option

configured with firmware **612P.1E.00** and (DeviceNet® 264420)

The fabrication number is indicated on each product as per the label below (or similar):

VAT
made in Switzerland
Fabrication No.:
612 ..–....–..../....
A–.....

← Fabrication number

Explanation of symbols:

Read declaration carefully before you start any other action!

Attention!

Loaded springs and/or air cushions are potential hazards!

Disconnect electrical power and compressed air lines. Do not touch parts under voltage!

Keep body parts and objects away from the valve opening!

Hot surfaces; do not touch!

Wear gloves!

Read these **«Installation, Operating & Maintenance Instructions»** and the enclosed **«General Safety Instructions»** carefully before you start any other action!

Imprint

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Contents:

1 Use of product

This product is a Butterfly control valve for downstream pressure control in vacuum systems.

Use product for clean and dry indoor vacuum applications under the conditions indicated in chapter «Technical data» only! Other applications are only allowed with the written permission of VAT.

1.1 Technical data

Control and actuating unit	
Power input [1] **(α)** [612 . . - . . **A** . - . . . . / 612 . . - . . **G** . - . . . .] [612 . . - . . **C** . - . . . . / 612 . . - . . **H** . - . . . .]	+24 VDC (±10%) @ 0.5 V pk-pk max. [connector: POWER] 38 W max. (operation of valve with max. load) without PFO [4] 38 W plus 10 W for PFO [4]
Sensor power supply [2] **(β)** [612 . . - . . **A** . - . . . . / 612 . . - . . **C** . - . . . .] Input Output	 +24 VDC / 1500 mA max. [connector: POWER] ±15 VDC (±5%) / 1000 mA max. [connector: SENSOR]
Sensor power supply [2] **(β)** [612 . . - . . **G** . - . . . . / 612 . . - . . **H** . - . . . .] Input Output	 + 24 VDC resp. ± 15 VDC [connector: POWER] same as input but: [connector: SENSOR] 2.0 A max. at ± 15 VDC 1.5 A max. at + 24 VDC

Calculation of complete power consumption:

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

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

Control and actuating unit (continuation)			
Sensor input Signal input ADC resolution Sampling time		0-10 VDC / Ri>100 kΩ 0.23 mV 10 ms	[connector: SENSOR]
Power input (DeviceNet®)		3 W max. (from DeviceNet®)	[DeviceNet® connector]
LOGIC I/O (configurable)		1 digital input 1 digital output	[connector: LOGIC I/O]
PFO [4] battery pack [612 . . - . . **W** . - . . . . / 612 . . - . . **U** . - . . . .] Charging time Durability		2 minutes max. up to 10 years @ 25°C ambient; refer to «Durability of power fail battery» for details	
Ambient temperature		0 °C to +50 °C max. (<35 °C recommended)	
Pressure control accuracy		5 mV or 0.1% of setpoint, whichever is greater	
Position resolution / position control capability		20000	
Actuating time	closing	0.3 s typ.	
	opening	0.3 s typ.	
Utilizable valve torque		2.5 Nm	

1) Internal overcurrent protection by a PTC device.
2) Refer to chapter «Sensor supply concepts» for details.
3) Refer to chapter «Schematics» for details.
4) PFO = Power Failure Option. Refer to «Behavior in case of power failure» for details.

1.1.1 Valve unit

Valve unit		
Pressure range at 20°C		
- Aluminum	(612 . . - . **A** . . - . . . .)	1 x 10E-8 mbar to 1.2 bar (abs)
- Aluminum hard anodized	(612 . . - . **H** . . - . . . .)	1 x 10E-6 mbar to 1.2 bar (abs)
- Aluminum nickel coated	(612 . . - . **I** . . - . . . .)	1 x 10E-8 mbar to 1.2 bar (abs)
- Stainless steel	(612 . . - . **E** . . - . . . .)	1 x 10E-8 mbar to 1.2 bar (abs)
Leak rate to outside at 20°C		
- Aluminum	(612 . . - . **A** . . - . . . .)	1 x 10E-9 mbar l/s
- Aluminum hard anodized	(612 . . - . **H** . . - . . . .)	1 x 10E-5 mbar l/s
- Aluminum nickel coated	(612 . . - . **I** . . - . . . .)	1 x 10E-9 mbar l/s
- Stainless steel	(612 . . - . **E** . . - . . . .)	1 x 10E-9 mbar l/s
Cycles until first service		2’000’000
Admissible operating temperature		10°C to +150°C
Mounting position		Any. Control unit for ISO-KF version needs support when mounted on horizontal piping and control unit does not hang.
Wetted materials		
- Body, plate	(612 . . - . **A** . . - . . . .)	Aluminum 3.2315 (AA6082)
- Body, plate	(612 . . - . **H** . . - . . . .)	Aluminum 3.2315 (AA6082) hard anodized
- Body, plate	(612 . . - . **I** . . - . . . .)	Aluminum 3.2315 (AA6082) nickel coated
- Body, plate	(612 . . - . **E** . . - . . . .)	Stainless steel 316L (1.4404 or 1.4435)
- Shaft		Stainless steel 316L (1.4404 or 1.4435)
- Plate screws		Stainless steel 316L (A4)
- Shaft seal		FKM (e.g. Viton®). Other materials available. Seal materials are declared on dimensional drawing of specific valve ordering number.
- Slide bearing for shaft		iglidur® X

Valve unit (continuation)					
	DN 63 **2½"** (612**36** - ....)	**DN 80** **3"** (612**38** - ....)	**DN 100** **4"** (612**40** - ....)	**DN 160** **6"** (612**44** - ....)	**DN 200** **8"** (612**46** - ....)
Max. differential pressure on plate	1000 mbar	1000 mbar	800 mbar	300 mbar	150 mbar
Min. controllable conductance (C_{min}) [N_2 molecular flow] Conductance in open position [N_2 molecular flow]	0.45 l/s 360 l/s	0.65 l/s 850 l/s	0.85 l/s 1400 l/s	1.7 l/s 3800 l/s	2.8 l/s 7800 l/s
	DN 250 **10"** (612**48** - ....)				
Max. differential pressure on plate	100mbar				
Min. controllable conductance (C_{min}) (N_2 molecular flow) Conductance in open position [N_2 molecular flow]	5 l/s 15000 l/s				
Dimensions	Refer to dimensional drawing of specific valve ordering number (available on request)				

2 Installation

2.1 Unpacking

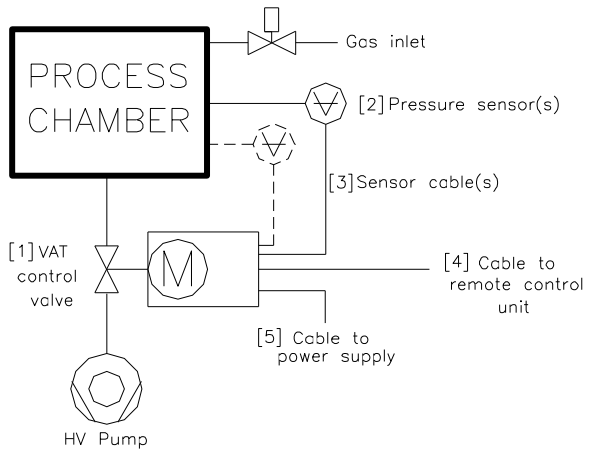
Valves DN63 / 2½" and larger must not be lifted solely by the actuator.

2.2 Installation into the system

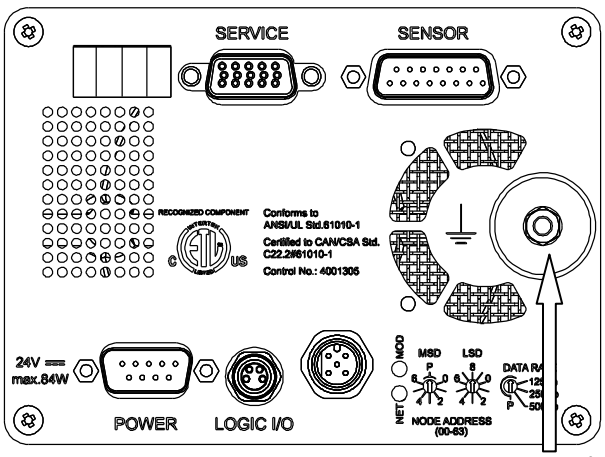
Fingers and objects must be kept out of the valve opening and away from moving parts.
The valve plate may start to move just after power is supplied.

Do not connect or disconnect sensor cable when device is under power.

Connection overview



Connectors at controller panel



1. Install valve [1] into the vacuum system.
   Caution: Do not tighten the flange screws stronger than indicated under «Tightening torque».
   Caution: Do not admit higher forces to the valve than indicated under «Admissible forces».
   Note: Make sure that enough space is kept free to do preventive maintenance work. The required space is indicated on the dimensional drawing.
   Note: Control unit of valves with ISO-KF flanges (612 . . **– K** . . .) needs support when mounted on horizontal piping and control unit does not hang.

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

3. Install sensor(s) [2] according to the recommendations of the sensor manufacturer and directives given under «Requirements to sensor connection».

4. Connect pressure sensor cable [3] to sensor(s) and then to valve (connector: SENSOR). Refer to chapter «Electrical connection» for correct wiring.
   Note: Input for second sensor is available on 612 . . - . . . **Q** - . . . . version only.

5. Connect valve to DeviceNet [4] (DeviceNet connector). Refer to «DeviceNet schematics» for correct wiring.

6. Connect power supply [5] to valve (connector: POWER). Refer to chapter «Electrical connection» for correct wiring.
   Note: To provide power to the valve motor pins 4 and 8 must be bridged, otherwise motor interlock is active and the valve enters the safety mode and is not operative. Refer also to «Safety mode».

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

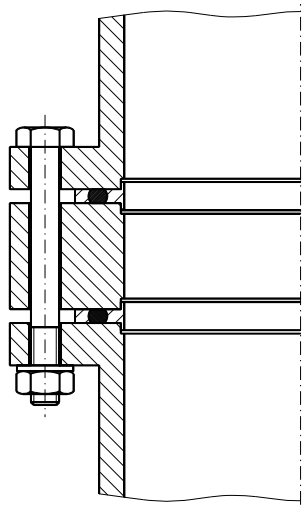
8. Perform «Setup procedure» to prepare valve for operation.
   Note: Without performing the setup procedure the valve will not be able to do pressure control.

2.3 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.

2.3.1 Mounting with centering rings

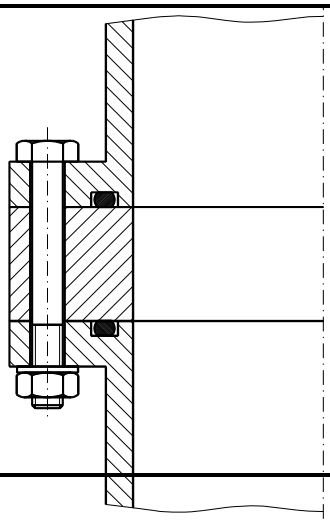
Valve size		max. tightening torque (Nm)	max. tightening torque (lbs . ft)
mm	inch	ISO-F	ISO-F
63	2½	8-10	6-8
80	3	8-10	6-8
100	4	8-10	6-8
160	6	13-15	9-11
200	8	13-15	9-11
250	10	13-15	9-11



Refer to «Spare parts and accessories» for centering rings ordering numbers.

2.3.2 Mounting with O-ring in grooves

Valve size		max. tightening torque (Nm)			max. tightening torque (lbs . ft)		
mm	inch	ISO-F	JIS	ASA	ISO-F	JIS	ASA
63	2½	20-23	35-40	35-40	15-17	26-30	26-30
80	3	20-23	35-40	35-40	15-17	26-30	26-30
100	4	20-23	35-40	35-40	15-17	26-30	26-30
160	6	40-45	35-40	35-40	30-35	26-30	26-30
200	8	40-45	65-70	80-90	30-35	48-52	59-67
250	10	40-45	65-70	80-90	30-35	48-52	59-67



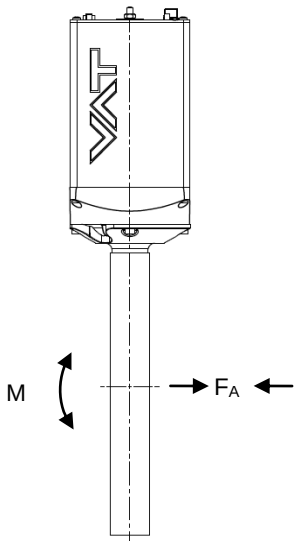
Note: Make sure that screws in use are capable to withstand applied torques.

2.4 Admissible forces

2.4.1 Admissible forces for valve body

Forces from the weight of other components can lead to deformation of the valve body and to malfunction of the valve. The stress has to be relieved by suitable means. The following forces are admissible:

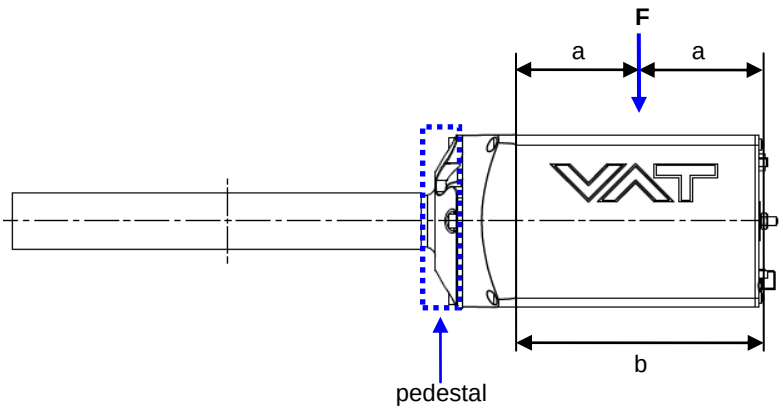
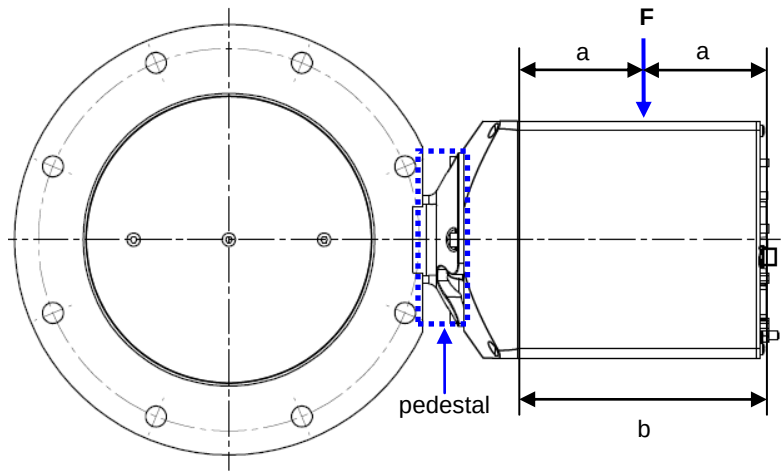
Valve size		Axial tensile or compressive force «F_A»		Bending moment «M»		
mm	inch	N	lb.	Nm	lbf.	
63	2½	800	176	32	24	
80	3	850	187	35	26.5	
100	4	1000	220	40	30	
160	6	1200	264	60	45	
200	8	1200	264	60	45	
250	10	1200	264	60	45	



2.4.2 Admissible forces at controller

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

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

2.5 Requirements to sensor connection

To achieve fast and accurate pressure control a fast sensor response is required.

Sensor response time: < 50ms

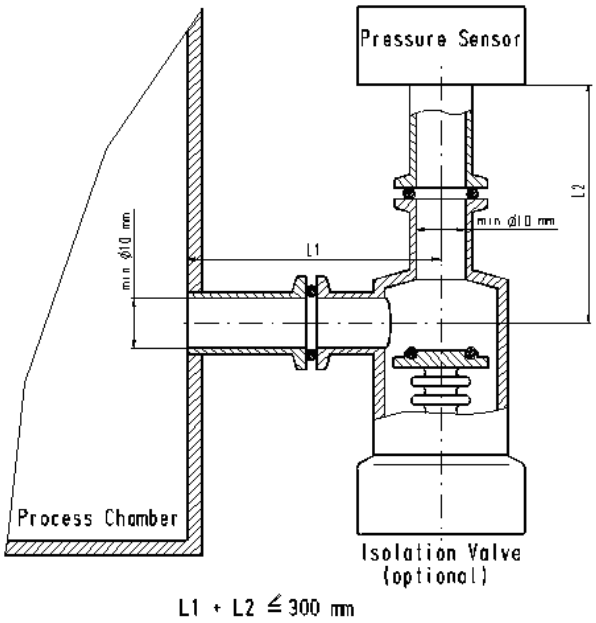
The sensor is normally connected to the chamber by a pipe. To maintain that the response time is not degraded by this connection it needs to meet the following requirements:

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.

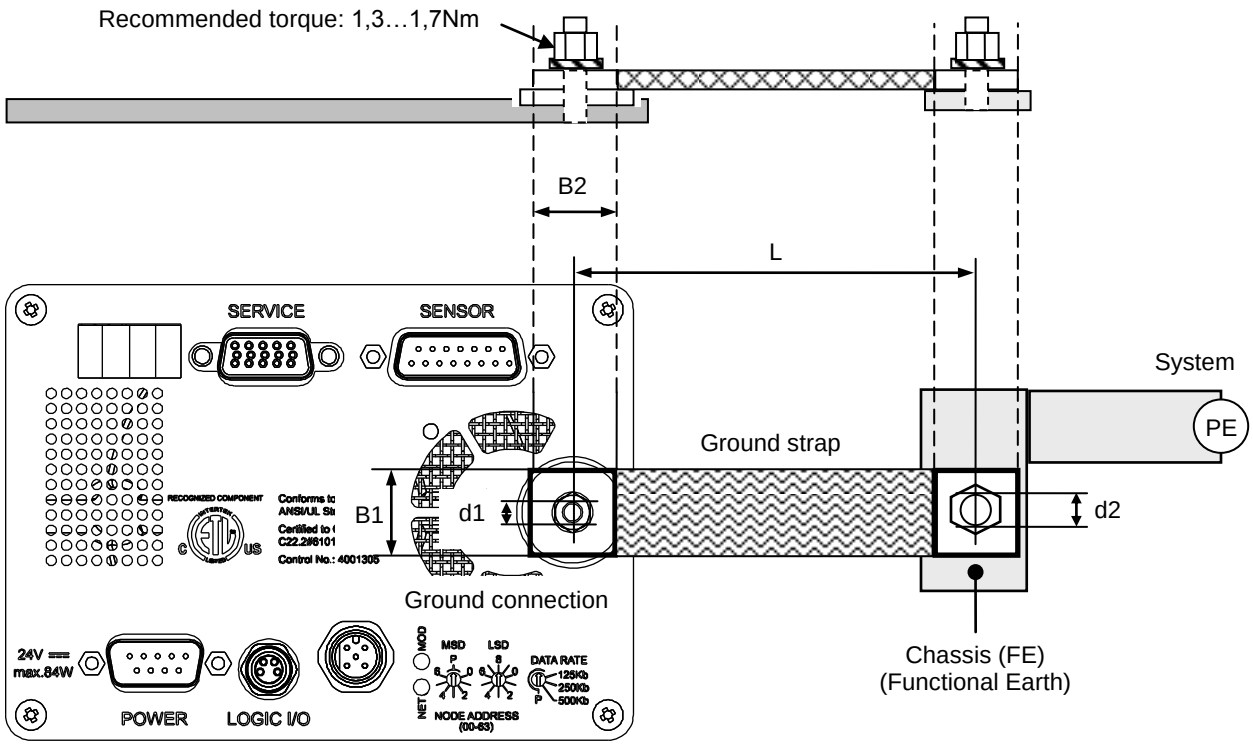


2.6 Electrical connection

2.6.1 Ground connection

Recommendation for ground strap between controller and system (chassis)

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



Valve controller

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

Note: 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.

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

2.6.2 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 feed through to SENSOR connector to supply 24 VDC sensors. Refer to chapter «2.6.3 Power and sensor connection (+24 VDC sensors)» for schematic and correct wiring.
- External ±15 VDC supplied to POWER connector is feed through to SENSOR connector to supply ±15 VDC sensors. Refer to chapter «2.6.4 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 «2.6.5 Power and sensor connection (±15 VDC sensors) with optional SPS module» for schematic and correct wiring.

Valve versions:

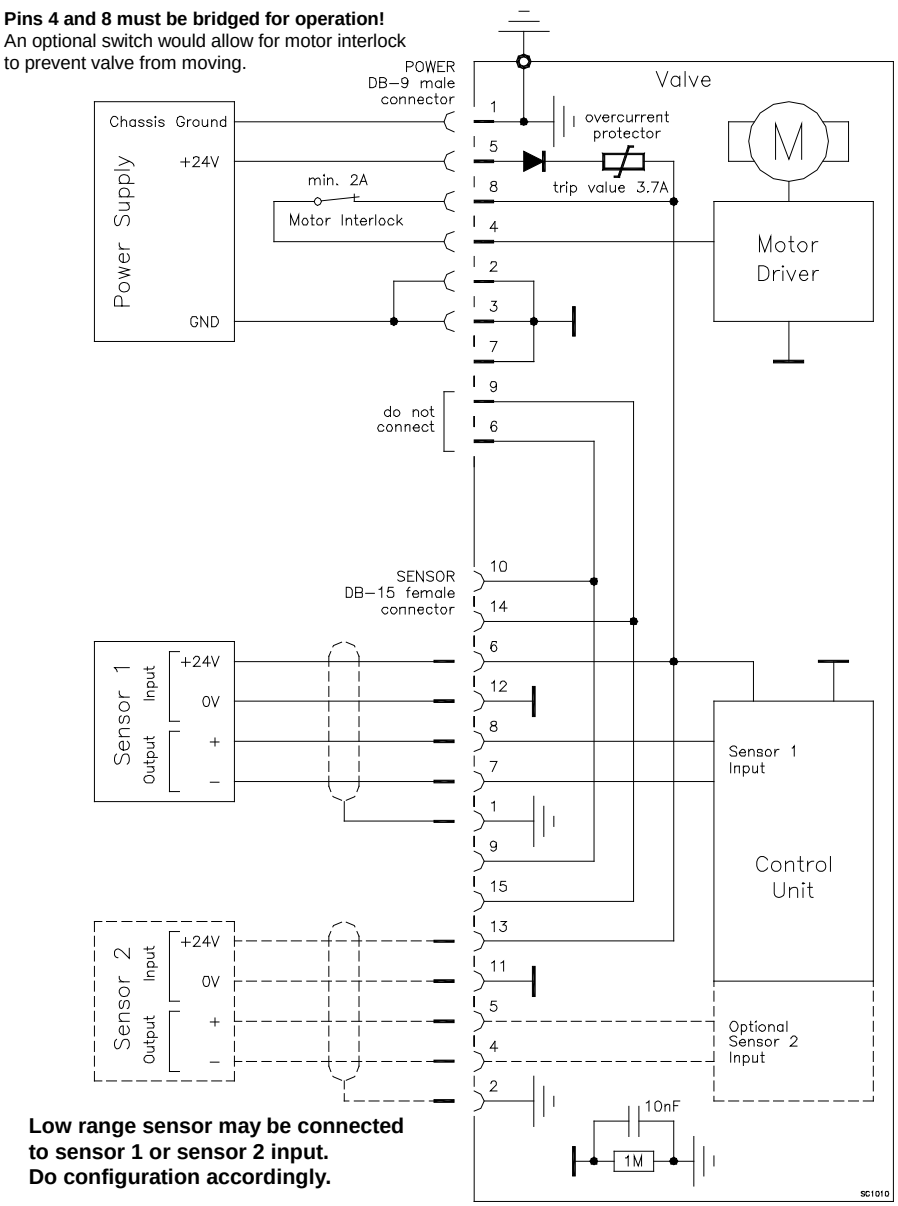
- 612 . . - . . **G** . - . . . . / 612 . . - . . **H** . - . . . . SPS module not included
- 612 . . - . . **A** . - . . . . / 612 . . - . . **C** . - . . . . SPS module included

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

2.6.3 Power and sensor connection (+24 VDC sensors)

[612 . . - . . **G** . - . . . . / 612 . . - . . **H** . - . . . . versions recommended]

2.6.3.1 Sensor power wiring via controller

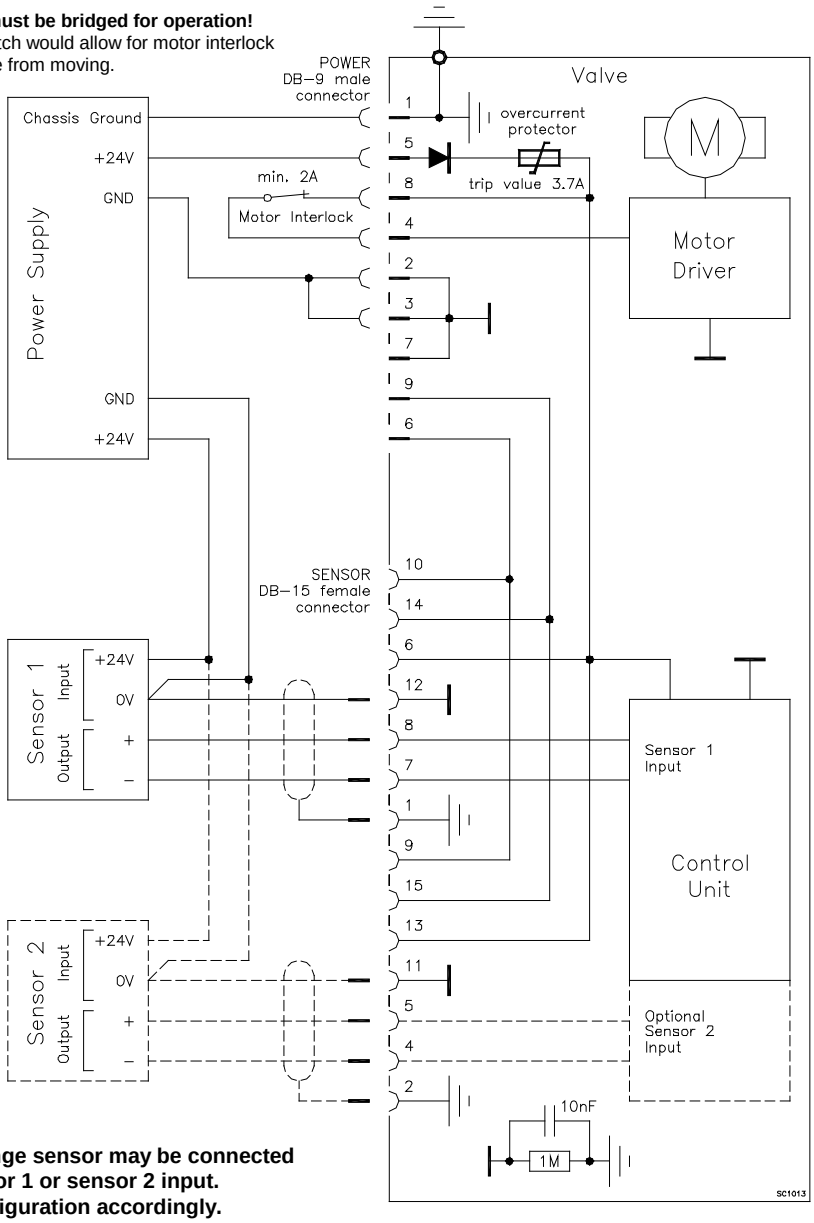


Note:

- Use shielded sensor cable(s). Keep cable as short as possible, but locate it away from noise sources.
- Connect the +24 VDC sensors at DB–15 female sensor connector exactly as shown in the drawing above. Do not connect other pins that may damage sensors, power supply or controller!
- Connector: Use only screws with 4-40UNC thread for fastening the connectors!

2.6.3.2 Sensor power wiring external

Pins 4 and 8 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.

Note:

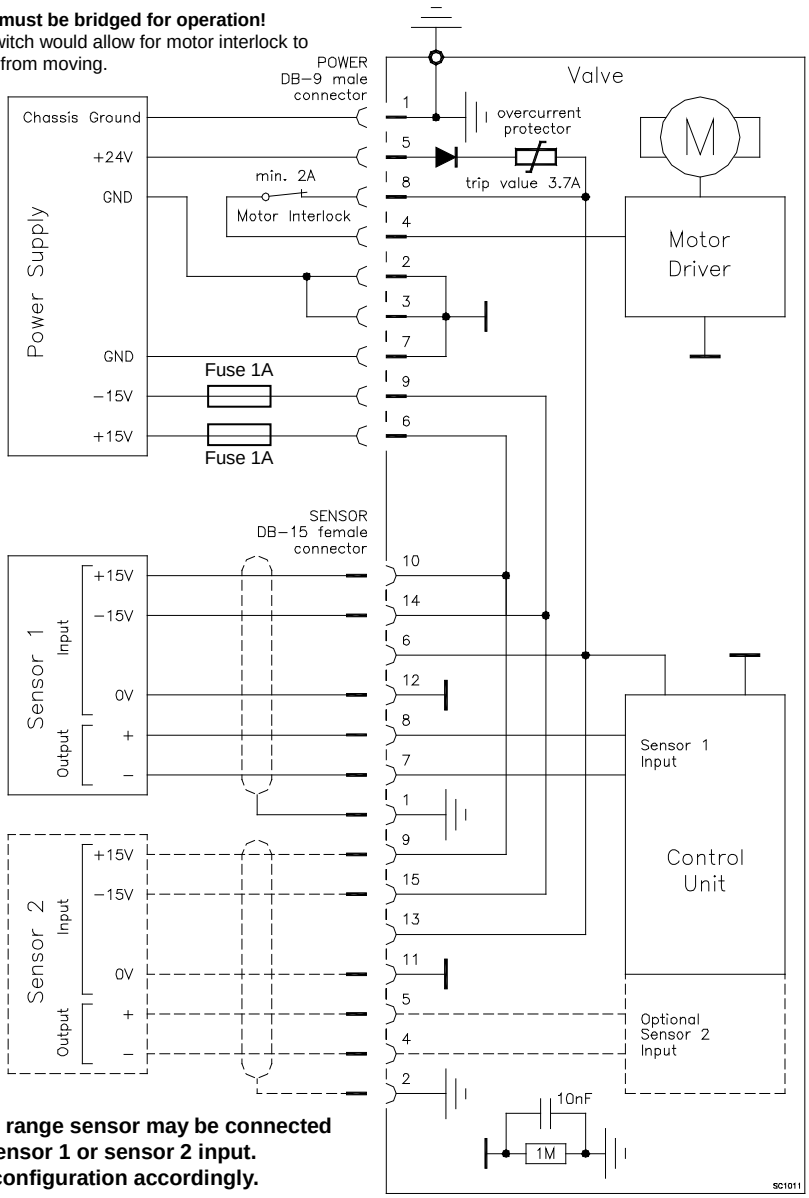
- Use shielded sensor cable(s). Keep cable as short as possible, but locate it away from noise sources.
- Connect the +24 VDC sensors at DB–15 female sensor connector exactly as shown in the drawing above. Do not connect other pins that may damage sensors, power supply or controller!
- Connector: Use only screws with 4-40UNC thread for fastening the connectors!

2.6.4 Power and sensor connection (±15 VDC sensors) without optional SPS module

[612 . . - . . **G** . - . . . . / 612 . . - . . **H** . - . . . . versions only]

2.6.4.1 Sensor power wiring via controller

Pins 4 and 8 must be bridged for operation!
An optional switch would allow for motor interlock to prevent valve from moving.



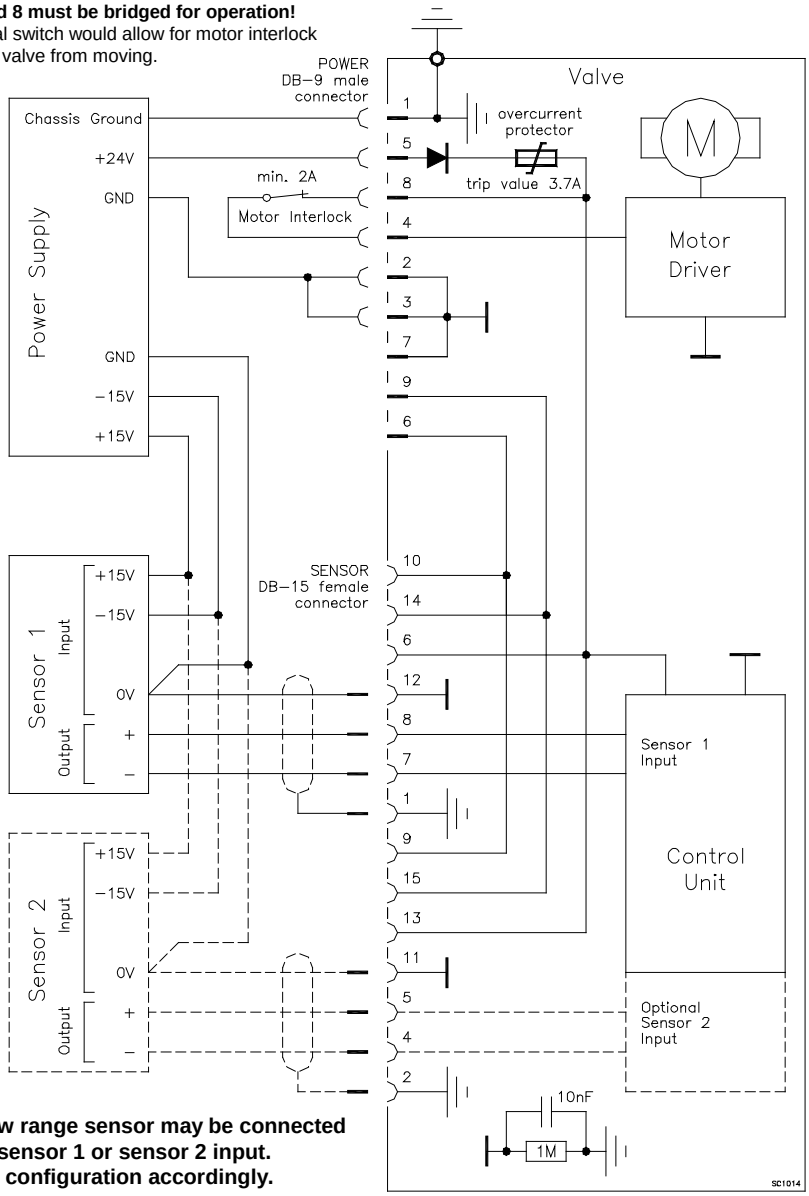
Low range sensor may be connected to sensor 1 or sensor 2 input.
Do configuration accordingly.

Note:

- Use shielded sensor cable(s). Keep cable as short as possible, but locate it away from noise sources.
- Connect the ±15 VDC sensors at DB–15 female sensor connector exactly as shown in the drawing above. Do not connect other pins that may damage sensors, power supply or controller!
- Connector: Use only screws with 4-40UNC thread for fastening the connectors!

2.6.4.2 Sensor power wiring external

Pins 4 and 8 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.

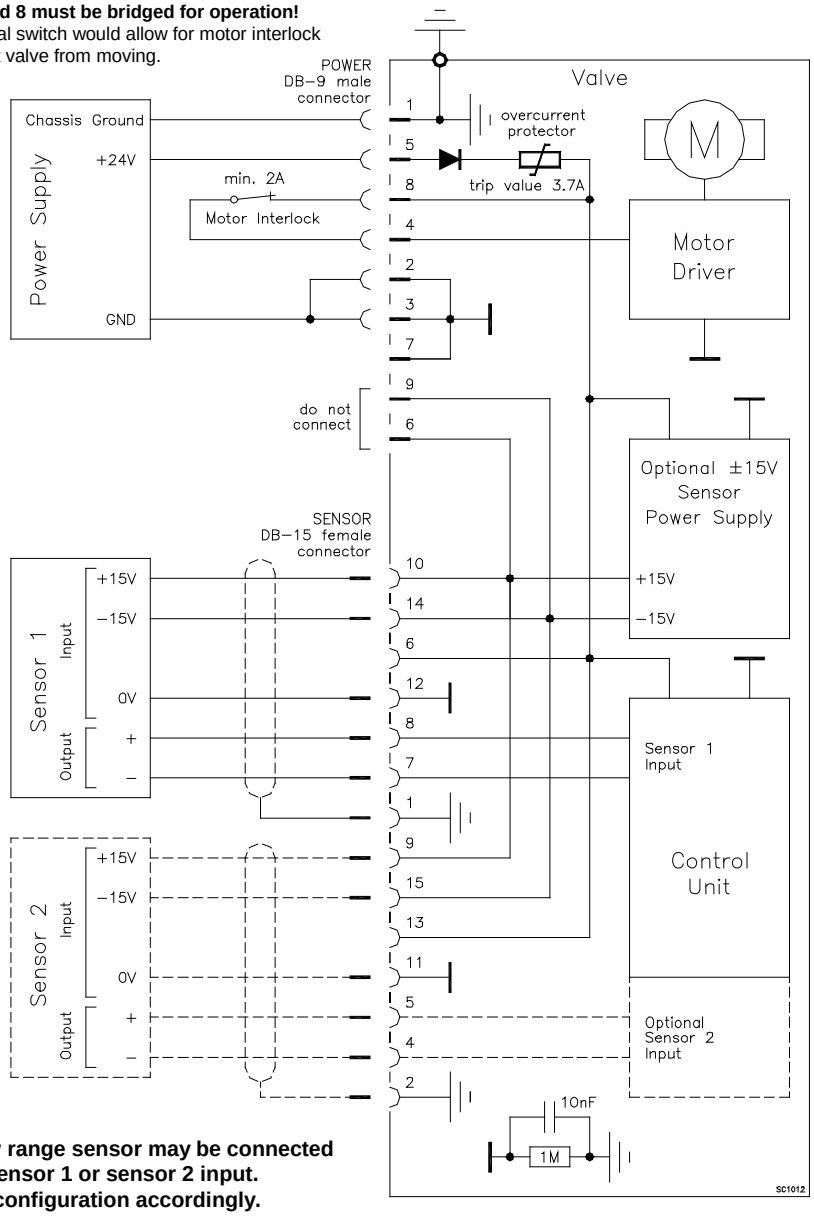
Note:

- Use shielded sensor cable(s). Keep cable as short as possible, but locate it away from noise sources.
- Connect the ±15 VDC sensors at DB–15 female sensor connector exactly as shown in the drawing above. Do not connect other pins that may damage sensors, power supply or controller!
- Connector: Use only screws with 4-40UNC thread for fastening the connectors!

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

[612 . . - . . **A** . - . . . . / 612 . . - . . **C** . - . . . . versions only]

Pins 4 and 8 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.

Note:

- Use shielded sensor cable(s). Keep cable as short as possible, but locate it away from noise sources.
- Connect the ±15 VDC sensors at DB–15 female sensor connector exactly as shown in the drawing above. Do not connect other pins that may damage sensors, power supply or controller!
- Connector: Use only screws with 4-40UNC thread for fastening the connectors!

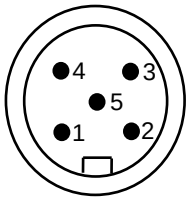
2.6.6 DeviceNet® connection

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

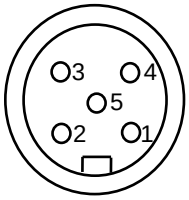
At valve controller	DeviceNet cable		
PIN	Name	Wire color	Description
1 ←	Drain	Bare	Shield
2 ←	V+	Red	DeviceNet® power supply +
3 ←	V-	Black	DeviceNet® power supply -
4 ←	CAN_H	White	DeviceNet® signal
5 ←	CAN_L	Blue	DeviceNet® signal

Note: The DeviceNet® interface is galvanic isolated from control unit.

Micro Connector Pinout



Male (pins) at
valve controller



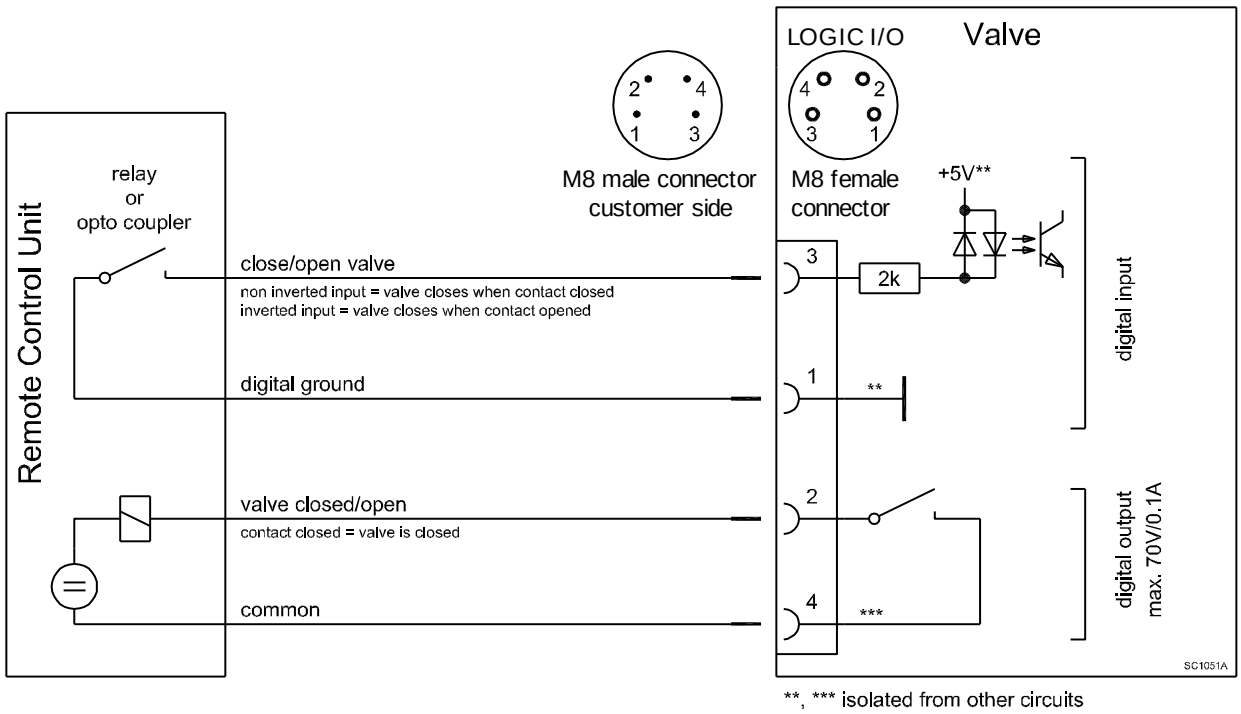
Female (sockets)
at DeviceNet cable

2.6.7 LOGIC I/O

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

Active **digital input** has:

- **higher priority than DeviceNet** commands
- **higher priority than Local** commands



Note: Do not connect other pins than indicated in the schematics above! Example for connector: Type «Binder M8 male, 4-pole, shielded (recommended)» (99-3363-00-04).

2.6.8 Digital input

Pin	Signal type	Description
3	Digital input	This function will close / 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 adjusted in local operation via service port with CV, CPA or Hyper terminal. Refer to chapter: «LOGIC I/O configuration».
1	Digital ground	Ground for digital input. Connect switch to ground. See also chapter: «2.6.7 LOGIC I/O».

Note: The digital input is digitally filtered. Filter delay is 50ms. This means that digital signal must be applied for at least 50ms to be effective. Refer to chapter: «2.6.7 LOGIC I/O» for details about input circuit.

2.6.9 Digital output

Pin	Signal type	Description
2	Digital output	This function will indicate that the valve is closed or open. If the function “ON” is configured the output is continous on.
4	Digital common	Common for all digital output. Connect + or – terminal of source with common. See also chapter: «2.6.7 LOGIC I/O».

2.6.10 Service port connection

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

Connector: Use only screws with 4-40UNC thread for fastening the service port connector!

3 Operation

	**⚠ CAUTION** **Valve opening** Fingers and objects must be kept out of the valve opening and away from moving parts. Risk of injury. Do not connect the controller to power before the valve isn’t installed complete into the system.

3.1 Introduction

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.

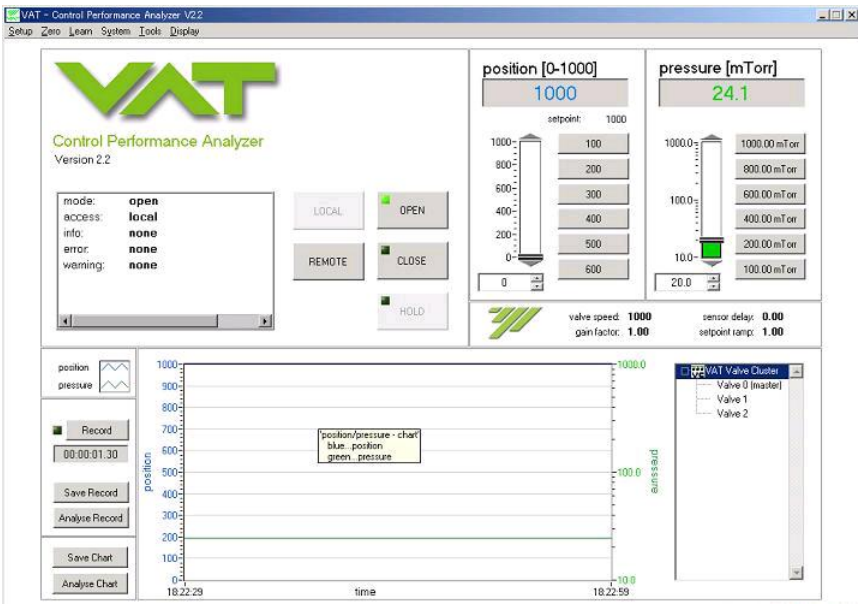
3.1.1 Local operation

Local operation means that the valve is operated via the service port using a computer or the Service Box 2. When using a computer, a service cable and a software from VAT are required. You can either download our freeware 'Control View' from www.vatvalve.com or purchase our 'Control Performance Analyzer'.
These software are beneficial especially for setup, testing and maintenance.

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

‘Control view’ supports:
- parameter setup
- manual control
- numeric monitoring
- basic diagnostic

'Control Performance Analyzer' supports:
- parameter setup
- manual control
- sequence control
- numeric and graphical monitoring
- data recording
- data analysis
- advanced diagnostic



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

Refer to «Spare parts / Accessories» for ordering numbers of service cable, software and Service Box 2.

3.1.2 Remote operation

This product is equipped with a DeviceNet interface to allow for remote operation. See section «DeviceNet Interface» for details. ‘Control View’ software, 'Control Performance Analyzer' software or 'Service Box 2' may be used for monitoring during remote control.
Note: In case ‘Control View’ or ‘Control Performance Analyzer’ software is connected to valve make sure ‘REMOTE’ button is pushed to enable for remote operation. In case Service Box 2 is connected to valve make sure the LED on button ‘LOCAL’ is OFF for remote operation.

3.1.3 Safety mode

By means of an external switch (see connection diagrams «Electrical connection») the motor power supply can be interrupted. In this case the valve enters the ‘safety mode’. This motor interlock prevents the valve from moving (e.g. maintenance work). Data reading from the control unit remains possible.
When motor interlock is active during power up the valve directly enters the ‘safety mode’ and is not able to synchronize. Display shows ‘D C’ or ‘D999’. In this case synchronization cycle will be done when motor interlock is deactivated. Then Display shows ‘INIT’ for a moment followed by ‘SYNC’.
When ‘safety mode’ is entered from operation (i.e. pressure control mode), the unit will automatically switch to position control mode and remain at current position. Once motor interlock is deactivated the unit remains in position control mode.

3.1.4 Service indication

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

3.2 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».

3.3 Behaviour during power up

Valve position before power up:	**Reaction of valve:**	
	Valve power up configuration = closed (defaullt)	Valve power up configuration = open
Any	Valve runs a synchronization cycle (close-open-close) to detect the limit stops. This cycle is performed with reduced torque (2Nm). Display shows configuration of product until synchronization cycle is done. Refer also to chapter «Display information».	
	Valve position after power up is closed	Valve position after power up is open

3.4 Behavior in case of power failure

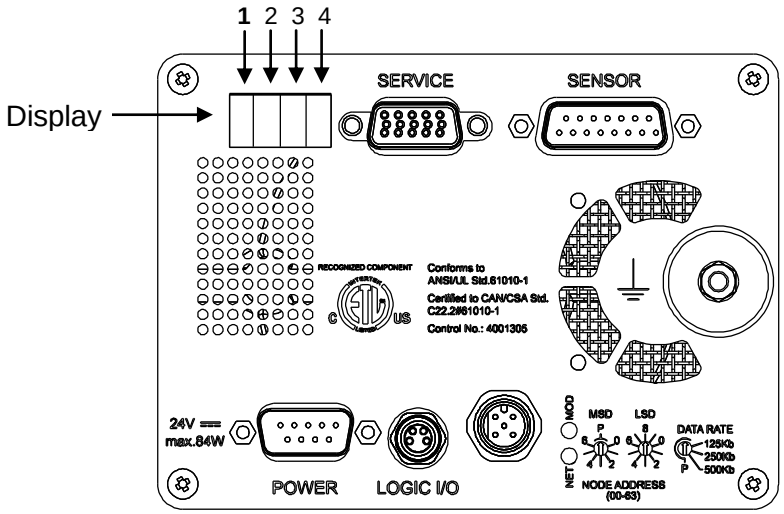
Valve position before power failure:	**Reaction of valve:**	
	Without Power Failure Option (PFO) 612 . . - . . **G** . - . . . . 612 . . - . . **A** . - . . . . 612 . . - . . **T** . - . . . . 612 . . - . . **V** . -	With Power Failure Option (PFO) 612 . . - . . **H** . - . . . . 612 . . - . . **C** . - . . . . 612 . . - . . **U** . - . . . . 612 . . - . . **W** . - . . . .
Any	Valve remains at current position.	Valve will close or open depending on valve configuration *). Default is not defined. Display indicates **F**.

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

All parameters are stored in a power fail save memory.

3.5 Display information

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



Power up:

Description	Digit 1	Digit 2	Digit 3	Digit 4
At first all dots are illuminated then configuration is displayed: • Firmware version [e.g. 1E00] (1st information for about 2s) • Controller configuration (2nd information for about 2s) **SYNC** indicates that power up synchronization is running. In case **D999** is displayed, motor interlock is active. Refer to «Safety mode» for details.	**1**	**E**	**0**	**0**
		4 = DeviceNet® Interface	**0** = basic **1** = with SPS[1)] **2** = with PFO[2)] **3** = with SPS[1)] and PFO[2)]	**1** = 1 sensor version **2** = 2 sensor version
	S	**Y**	**N**	**C**

1) SPS = optional ±15 VDC Sensor Power Supply module

2) PFO = Power Failure Option

Operation:

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

Fatal error:

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

3.6 Setup procedure

To enable this valve for **pressure control** setup **steps 1 to 6 must be performed**.
In case position control is required only it’s sufficient to perform steps 1 to 3.

Setup step		Description
1	**Power up**	Turn on external + 24VDC power supply (and external ±15 VDC for sensor power supply if required). Refer to chapter «Behavior during power up» for details.
2	**DeviceNet® configuration**	DeviceNet® node number and baudrate for valve must be selected. DeviceNet® parameters must be adapted according to application needs. Refer to chapter «DeviceNet® configuration» for details.
3	**LOGIC I/O configuration**	Configuration for LOGIC I/O. Refer to chapter «LOGIC I/O configuration» for details.
4	**Valve and sensor configuration**	Basic configurations of the valve must be adapted according to application needs. Refer to chapter «Valve and sensor configuration» for details.
5	**ZERO**	Compensation of the sensor offset voltage. Refer to chapter «ZERO» for details.
6	**LEARN**	Determination of the vacuum system characteristic to accommodate the PID controller. Refer to chapter «LEARN» for details. **Note:** Without LEARN the valve is not able to run pressure control

3.6.1 DeviceNet® configuration

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.

Note: 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).

   Note: 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®.

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

   Note: 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 View’, ‘Control Performance Analyzer’ or ‘Service Box 2‘)	**Remote operation**: (Refer to chapter «Explicit messaging setup commands» for details)
Note: 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:

Local operation: (‘Control View’, ‘Control Performance Analyzer’ or ‘Service Box 2‘)	**Remote operation**: (Refer to chapter «Explicit messaging setup commands» for details)
Note: It’s not possible to make assembly object configuration in local operation.	1. Select POLL CONNECTION OUTPUT assembly
	2. Select POLL CONNECTION INPUT assembly
	3. Select CHANGE OF STATE / CYCLING INPUT assembly
	4. Reestablish poll I/O connection

3.6.2 Valve and sensor configuration

Basic valve configuration must be adapted according to application needs.

- Definition of valve plate position (CLOSE or OPEN) after power up sequence. Default is ‘close‘.
- Definition of valve plate position (CLOSE or OPEN) in case of a power failure. Default is ‘not defined‘.
  Only for versions that have Power Fail Option equipped [612 . . - . . **C** . - . . . . or 612 . . - . . **H** . - . . . .].
- ZERO function. This may be ‘disabled’ or ‘enabled’. Default is ‘enabled‘. Refer also to «ZERO (setup step 4)».
- Sensor configuration for 2 sensor version [612 . . - . . . **Q** - . . . .].
  Refer also to «Pressure control operation with 2 sensors».

Local operation: (‘Control View’, ‘Control Performance Analyzer’ or ‘Service Box 2‘)	**Remote operation**: (Refer to chapter «Explicit messaging setup commands» for details)
1. Do power up configuration in menu ‘Setup / Valve’.	1. Select POWER UP CONFIGURATION
2. Do power fail configuration in menu ‘Setup / Valve’.	2. Select POWER FAIL CONFIGURATION
3. Enable or disable ZERO function in menu ‘Setup / Sensor’.	3. Select ZERO CONTROL
4. Do 2 sensor configuration in menu ‘Setup / Sensor’.	4. Select SENSOR MODE
	5. Select SENSOR RATIO

3.6.3 ZERO

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

Local operation: (‘Control View’, ‘Control Performance Analyzer’ or ‘Service Box 2‘)	**Remote operation**: (Refer to chapter «Explicit messaging control commands» resp. «Explicit messaging setup commands» for details)
Go to menu ‘Zero / ZERO’ and follow instructions.	1. Send EXECUTING (if not yet selected)
	2. Select SETPOINT TYPE = position control
	3. Select CONTROL MODE for position = open valve
	4. Wait until process chamber is evacuated and sensor signal is not shifting anymore.
	5. Send ZERO

Note: Do not perform ZERO as long as pressure gauge voltage is shifting otherwise incorrect pressure reading is the result. Refer to manual of sensor manufacturer for warm up time.

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

3.6.4 LEARN

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

Note: Sensor signal must not shift during LEARN. Wait until sensor signal is stable before LEARN is performed.

Note: 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.

Note: 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]

Note: 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.

$$q_L = \frac{p_{max} \bullet C_R}{2000}$$

q_L gasflow for learn [**Pa m³/s**]
p_{max} max. pressure to control [**Pa**]
C_R required lower conductance [l/s]

$$q_L = \frac{p_{max} \bullet C_R}{2}$$

q_L gasflow for learn [**mbar l/s**]
p_{max} max. pressure to control [**mbar**]
C_R required lower conductance [l/s]

$$q_L = 39.4 \bullet p_{max} \bullet C_R$$

q_L gasflow for learn [**sccm**]
p_{max} max. pressure to control [**Torr**]
C_R required lower conductance [l/s]

3.7 Close valve

Local operation: (‘Control View’, ‘Control Performance Analyzer’ or ‘Service Box 2‘)	**Remote operation**: (Refer to chapter «Explicit messaging control commands» for details)
Push CLOSE button	1. Send EXECUTING (if not yet selected)
	2. Send SETPOINT TYPE = position control
	3. Send CONTROL MODE for position = close valve

3.8 Open valve

Local operation: (‘Control View’, ‘Control Performance Analyzer’ or ‘Service Box 2‘)	**Remote operation**: (Refer to chapter «Explicit messaging control commands» for details)
Push OPEN button	1. Send EXECUTING (if not yet selected)
	2. Send SETPOINT TYPE = position control
	3. Send CONTROL MODE for position = open valve

3.9 Position control

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

Local operation: (‘Control View’, ‘Control Performance Analyzer’ or ‘Service Box 2‘)	**Remote operation**: (Refer to chapter «Explicit messaging control commands» for details)
Select or enter position setpoint	1. Send EXECUTING (if not yet selected)
	2. Send SETPOINT TYPE = position control
	3. Send CONTROL MODE for position = control mode
	4. Send POSITION SETPOINT

3.10 Pressure control

To prepare valve for PRESSURE CONTROL perform complete **«Setup procedure»**.

The valve has parameters that may be modified to tune pressure control performance.
Refer to **«Tuning of control performance»**.

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

Local operation: (‘Control View’ resp. ‘Control Performance Analyzer’)	**Remote operation**: (Refer to chapter «Explicit messaging control commands» for details)
Select or enter pressure setpoint	1. Send EXECUTING (if not yet selected)
	2. Send SETPOINT TYPE = pressure control
	3. Send CONTROL MODE for pressure = control mode
	4. Send PRESSURE SETPOINT

3.10.1 Pressure control operation with 2 sensors

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

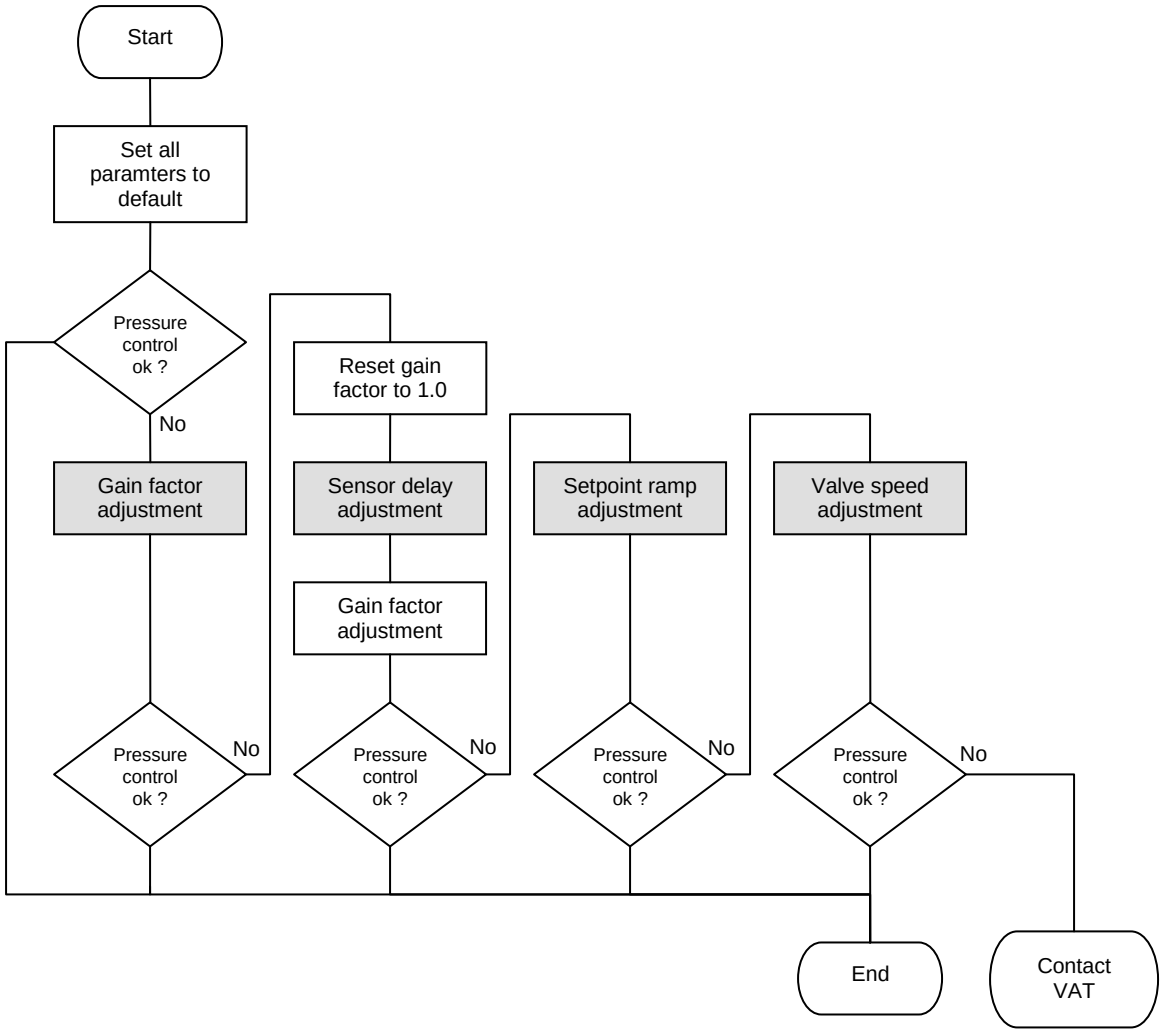
If 2 sensor operation is enabled, changeover between the sensors is done automatically during pressure control. For configuration refer to chapter «Setup procedure». We recommend a ratio of 10:1 between the pressure gauges. Max. ratio is 100:1. High range respectively low range pressure gauge may be 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 «Explicit messaging inquiry commands SENSOR 1 READING and SENSOR 2 READING».

Note: Make sure that both sensors are calibrated.

Note: Do not close optional gauge isolation valves during the transition phase between the sensors.

3.10.2 Tuning of control performance

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



Required information for support:

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

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

3.10.2.1 Gain factor adjustment

The gain factor effects:

- **Stability**
- **Response time**

Default value is 1. Adjustment range is from 0.0001 to 7.5.

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

Adjustment procedure:

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

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

Local operation: (‘Control View’, ‘Control Performance Analyzer’ or ‘Service Box 2‘)	**Remote operation**: (Refer to chapter «Explicit messaging setup commands» for details)
Set gain factor in menu ‘Setup / Control Parameter’	Select PID CONTROLLER GAIN FACTOR

3.10.2.2 Sensor delay adjustment

Sensor delay adjustment effects:

- **Stability**

Default value is 0. 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.

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

Adjustment procedure:

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

Local operation: (‘Control View’, ‘Control Performance Analyzer’ or ‘Service Box 2‘)	**Remote operation**: (Refer to chapter «Explicit messaging setup commands» for details)
Go to ‘Setup / Controller’ menu. Select sensor delay.	Select PID CONTROLLER SENSOR DELAY

3.10.2.3 Setpoint ramp adjustment

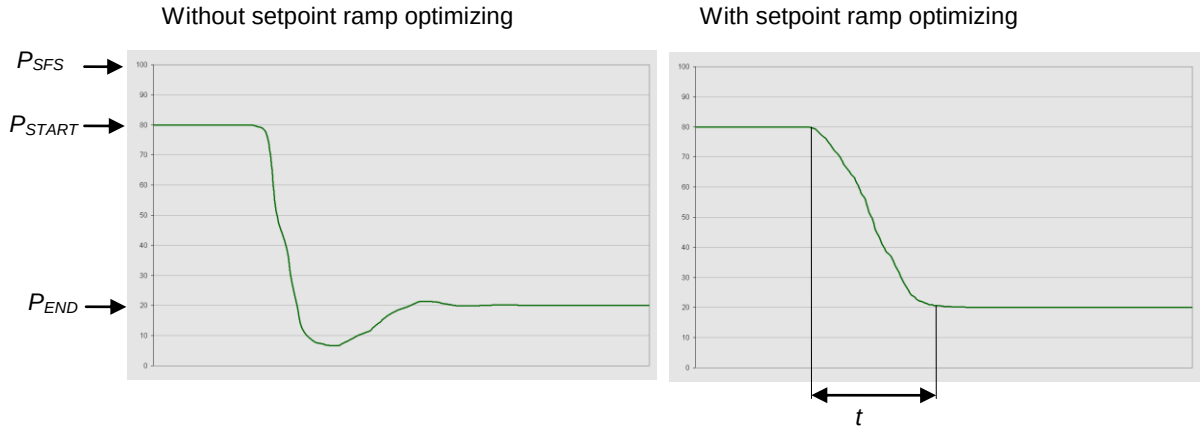
Setpoint ramp effects:

- **Undershoot of pressure**
- **Response time**

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

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

Pressure chart



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

t = 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.

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

Local operation: (‘Control View’, ‘Control Performance Analyzer’ or ‘Service Box 2‘)	**Remote operation**: (Refer to chapter «Explicit messaging setup commands» for details)
Go to ‘Setup / Control Parameter’ menu. Select setpoint ramp.	Select PID CONTROLLER SETPOINT RAMP

3.10.2.4 Valve speed adjustment

Valve speed effects:

- **Response time**

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

This parameter effects valve plate actuating speed.
Speed adjustment is effective for PRESSURE CONTROL and POSITION CONTROL.
Note: 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.
Note: OPEN and CLOSE are always done with max. speed.

Adjustment procedure:

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

Local operation: (‘Control View’, ‘Control Performance Analyzer’ or ‘Service Box 2‘)	**Remote operation**: (Refer to chapter «Explicit messaging setup commands» for details)
Go to ‘Setup / Control Parameter’ menu. Select valve speed.	Select VALVE SPEED

3.11 DeviceNet® interface

3.11.1 Assembly objects

Note: 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	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	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)»

3.11.2 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.

3.11.2.1 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							

MODE (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

3.11.2.2 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	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Manufacturer specific alarm present	1	0	0	0	0	1	0	0
Manufacturer specific warning present	1	1	0	0	0	0	0	0
No warning, no error present	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)	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

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)	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

3.11.3 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. **Note:** EXECUTING must to be selected to enable for all executing commands such as control mode, close valve and open valve. **Note:** 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. **Note:** 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. **Note:** To perform either position or pressure control also correct MODE must be selected.					
MODE (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 mode for pressure resp. position control. By means of instance ID either pressure or position must be addressed. **Note:** To activate either pressure or position control you must select correct SETPOINT TYPE separately.					

Note: 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.						

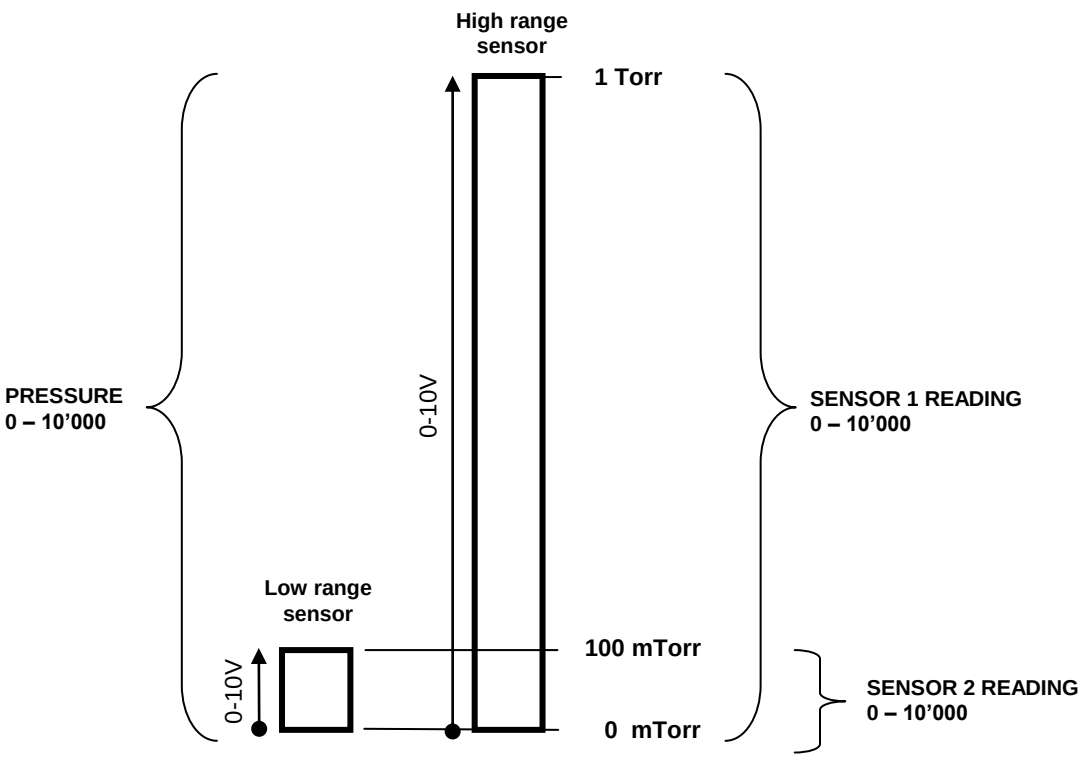
Note: Unless otherwise specified all values in the table above are in decimal notification. Hexadecimal values are indicated by the letter ‚h‘ (e.g. 31h)

3.11.4 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).						

Note: 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».

Command (DeviceNet® term if deviant)	Service Code		Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description						
LEARN STATUS (calibration state)	Get	14	51	1	106	2	

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

Note: 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.						

Note: 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					

EXCEPTION DETAIL ALARM

EXCEPTION DETAIL WARNING

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	Sensor ratio exceeded	PFO not ready	Compressed air failure	Learn data set invalid	Service request
Manufacturer Exception Detail Byte #2	Reserved	Reserved	Reserved	Reserved	Reserved	ADC not responding	Reserved	Reserved
Manufacturer Exception Detail Byte #3	Reserved	Reserved	Reserved	Wrong controller mode	Local 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[1)]	E22[1)]	E21[1)]	E20[1)]
Manufacturer Exception Detail Byte #6	Reserved	Reserved	Reserved	Reserved	Setpoint invalid (safe state)	IO data missing (safe state)	Setpoint type invalid (safe state)	Control mode invalid (safe state)

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

Note: 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.						
ISOLATION CYCLE COUNTER	Get	14	100	1	106	4	
	This command returns the number of isolation cycles. Data type is unsigned long integer. Each closing of the sealing ring counts as one cycle.						

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

3.11.5 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, “high byte first” notation). e.g.: Gain = 0.1 pressure value range results in 0-1’000 (3Dh CCh CCh CCh) Gain = 1 pressure value range results in 0-10’000 (3Fh 80h 00h 00h) Gain = 3.2767 pressure value range results in 0-32’767 (40h 51h B5h 73h)						
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	2	100	1	X
	Get	14	5	2	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	2	101	1	X
	Get	14	5	2	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						

Note: 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	Set	16	5	4	101	1	X
	Get	14	5	4	101	1	
	X: input assembly object number (**3**, **4**, **5**, **13**, **14**, **100**, **101**) This command configures resp. reads the input assembly for change of state / cycling.						
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 [612 . . - . . **C** . - . . . . or 612 . . - . . **H** . - . . . . or 612 . . - . . **U** . - . . . . or 612 . . - . . **W** . - . . . .].						

Note: 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. **Note:** Sensor modes 2, 3 and 4 are possible with 2 sensor hardware [612 . . - . . . **Q** - . . . .] only. **Note:** 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. **Note:** Refer to «ZERO (setup step 4)» for correct zero procedure.						

Note: 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. **Note:** 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. **Note:** 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.						

Note: 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. **Note:** 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. **Note:** 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. **Note:** 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. **Note:** Refer to «Valve speed adjustment» for details.						

Note: 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 Trouble shooting

Failure	Check	Action
No dots lighted on display	- 24 V power supply ok?	- Connect valve to power supply according to «Electrical connection» and make sure that power supply is working.
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 (DeviceNet®) 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.
Display shows «**E 20**» (**fatal error** - limit stop of valve unit not detected)	- Clamp coupling screw not fastened?	- Tighten screw. See chapter «Tightening torque» for details.
Display shows «**E 21**» (**fatal error** - rotation angle of valve plate limited during power up)	- Valve plate centric adjusted?	- Adjust valve plate according to «Maintenance procedures».
	- Valve unit heavy contaminated?	- Clean valve unit according to «Maintenance procedures».
	- Valve plate mechanically obstructed?	- Resolve obstruction.
Display shows «**E 22**» (**fatal error** - rotation angle of valve plate limited during operation)	- Valve unit heavy contaminated?	- Clean valve unit according to «Maintenance procedures».
	- Valve plate mechanically obstructed?	- Resolve obstruction.
Display shows «**E 40**» (**fatal error** - motor driver failure detected)		- Replace control and actuating unit according to «Maintenance procedures».
Display shows «**D999**»	- Motor power supplied?	- 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.
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.

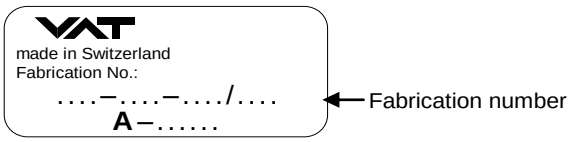
Failure	Check	Action
Pressure reading is wrong or pressure reading is negative	- Sensor(s) connected?	- Refer to «Electrical connection».
	- 2 sensor version present at valve controller?	- Check valve version on page 1. Verify configuration. Refer to «Setup procedure». - Refer to «Pressure control operation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

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

5 Maintenance & repairs

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 or repairs, please contact VAT. It has to be individually decided whether the maintenance/repair can be performed by the customer or has to be carried out by VAT. The fabrication number on the valve



has always to be specified.

All supplies (e. g. compressed air, electrical power) must be disconnected for removal/installation of the valve from/into the system.

Even with disconnected supply, loaded springs and/or air cushions in cylinders can be potential hazards.

Keep fingers and objects away from the valve opening!

Products returned to VAT must be free of harmful substances such as e.g. toxical, caustic or micro-biological ones. If products are radioactively contaminated, fill in the VAT form «Contamination and Radiation Report» and send it with the product. The form is available at VAT. The maximum values indicated in the form must not be exceeded.

5.1 Maintenance procedures

Keep fingers out of the valve during maintenance work.

Use cleanroom gloves during maintenance work.

One **p r e v e n t i v e m a i n t e n a n c e** procedure is defined for this product. This is:

Replacement of shaft feedthrough seals and valve cleaning.

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

A critical factor influencing the maintenance period is the lifetime of the vacuum grease, being limited under increased temperature. In this case grease will separate to PTFE and oil. The oil may flow and contaminate the valve parts.

VAT can give the following **recommendations for preventive maintenance**:

	unheated *)	heated ≤ 80°C *)	heated > 80°C *)
shaft feedthrough seals	2’000’000 cycles	6 months but max. 2’000’000 cycles	3 months but max. 2’000’000 cycles

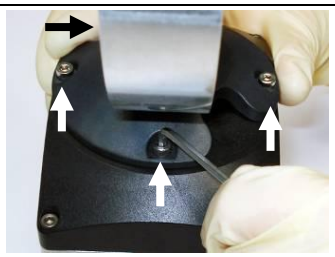
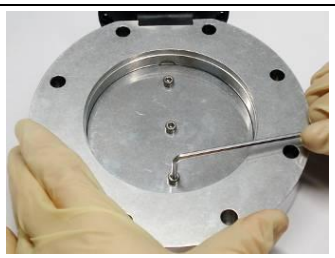
*) These figures are reference values for clean conditions under various temperatures. These values do not include any impact of the process. Therefore preventive maintenance schedule has finally to be checked for the actual process conditions.

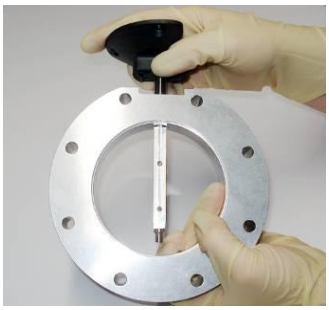
Furthermore the following maintenance procedures are described:

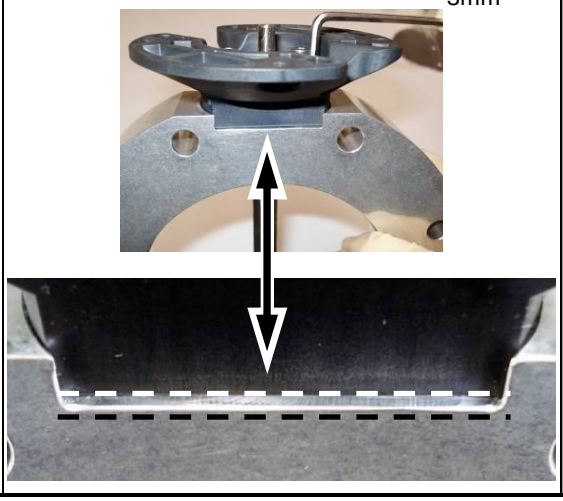
Replacement of **plate**

Replacement of **control and actuating unit** or **valve unit**

Replacement of **valve body** or **mechanical unit**

	Description		Required tool
Remove valve from system	1. **Note:** Make sure that the valve is in closed position 2. 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. **Note:** Take care not to damage the sealing surface! **Attention!** Do not move the plate by hands when control and actuating unit is installed.		Depending on flange screws
Remove control and actuating unit from valve unit	3. Unfasten clamp coupling		Allen Wrench 2mm
	4. Unfasten the 2 connection bolts and separate both parts. **Note:** Valve size DN 160 (6”) and bigger require a shortened wrench. For ordering number refer to «Spare parts and accessories». 12 mm 		Allen Wrench 3mm
Remove plate	5. Unfasten screws and remove plate from shaft.		Allen Wrench 3mm
Remove and clean mechanical unit	6. Unfasten alternately the 2 mounting screws little by little. **Note:** 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 3mm

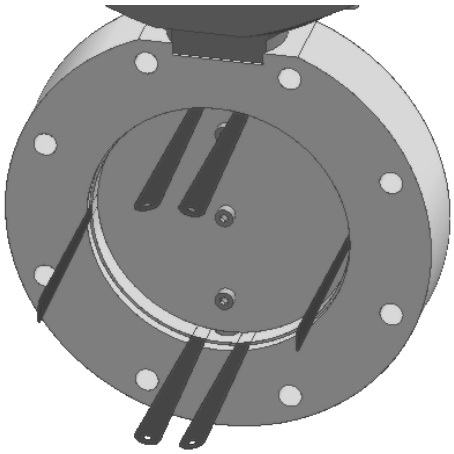
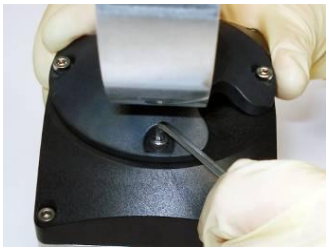
Description			Required tool				
	7. Remove mechanical unit and clean shaft.						
Seal removal and valve cleaning	8. Remove o-rings. 9. Clean shaft feedthrough and valve body.		Lint and dust free cloth soaked with isopropyl alcohol				
Lubricate and install seals	10. Lubricate seal contact surface of valve body with a slight film of vacuum grease (0.025 ml). 11. Lubricate each o-ring with a slight film of vacuum grease (0.0125 ml).		Vacuum grease				
	12. Lubricate seal contact surface of shaft with a slight film of vacuum grease (0.0125 ml). 13. Slide both o-rings onto shaft till the end. 14. Deposit 0.0375 ml vacuum grease between the o-rings 15. Clean shaft from vacuum grease.		Vacuum grease				

Description			Required tool				
Mount mechanical unit to valve body	16. Assemble mechanical unit in reverse order as disassembled (steps 7 to 6). 17. Align pedestal parallel to valve body and tighten the 2 mounting screws with 2 Nm.		Allen Wrench 3mm				

<table>
<tr><th colspan="2">Description</th><th>Required tool</th></tr>
<tr><td>Assemble and adjust plate</td><td>18. Place the plate on shaft and fasten the screws a little.

19. Center plate with feeler gauge as shown
<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>0.06</td></tr><tr><td>200</td><td>0.08</td></tr><tr><td>250</td><td>0.1</td></tr></table>
20. Tighten plate screws with 2 Nm.</td><td>Allen Wrench 3mm

Adequate feeler gauge

  </td></tr>
<tr><td rowspan="2">Mount control and actuating unit to valve unit</td><td>21. Assemble control and actuating unit to valve unit. Tighten mounting screws adequately.</td><td>  </td><td>Allen Wrench 3mm</td></tr>
<tr><td>22. Tighten clamp coupling with 1.1 Nm.</td><td>  </td><td>Allen Wrench 2mm</td></tr>
<tr><td>Install valve into system</td><td>23. Reinstall valve into vacuum system according to chapter «Installation».</td><td></td><td></td></tr>
</table>

5.2 Option board

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:
- ±15VDC 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

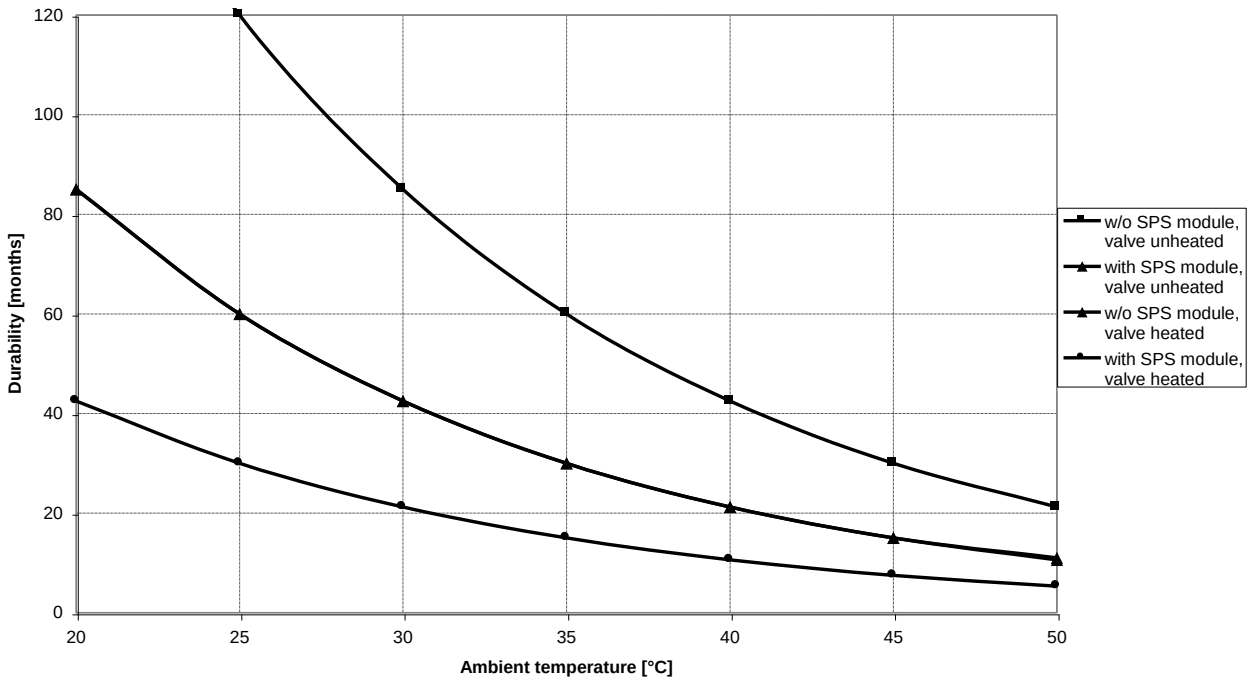
The modules may be retrofitted or replaced easily. The battery lifetime of the PFO module depends on the ambient temperature (see below). To assure PFO function the option board must be replaced after battery life has expired. For ordering number of the modules refer to «Spare parts and accessories».

5.2.1 Durability of power fail battery

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

If the SPS is not fully loaded (< 1 A) or heating temperature of valve body is lower than 150 degree 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 UltraCap battery (Option board).



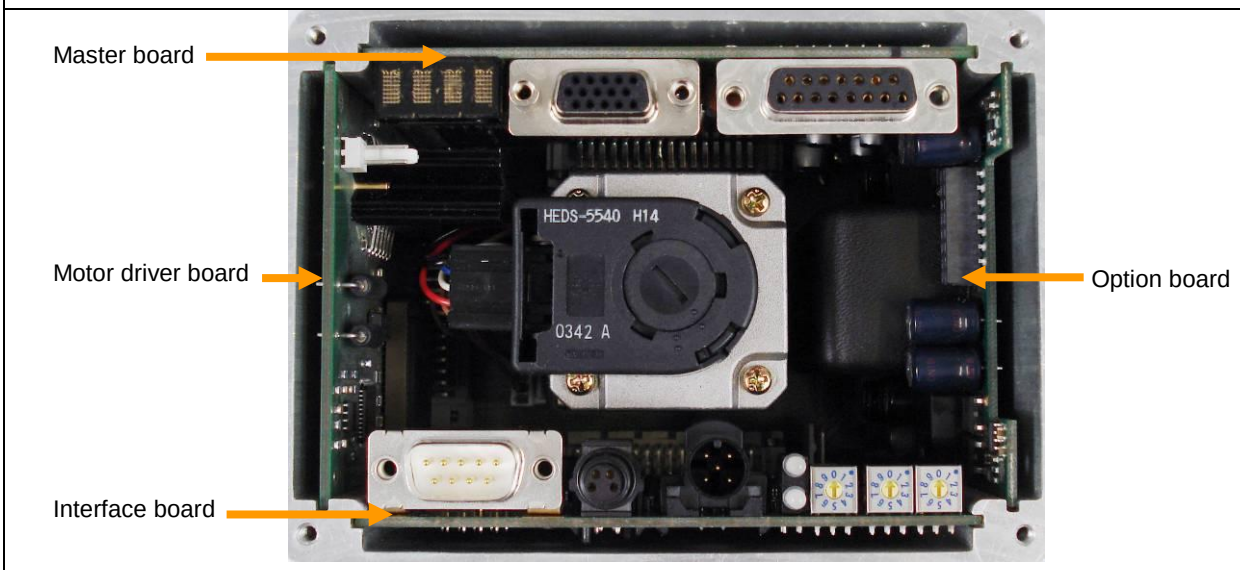
Note: This graph shows estimated life of UltraCap PFO for reference and not as guaranteed value.

5.2.2 Retrofit / replacement procedure

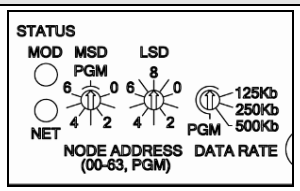
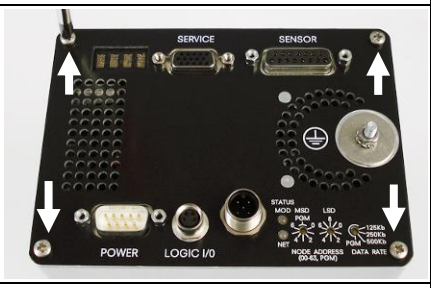
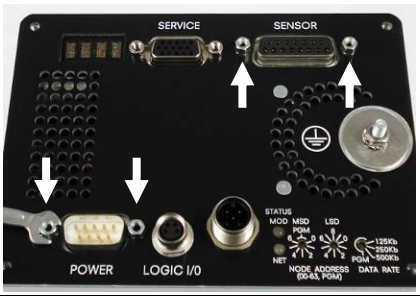
ESD Precaution!

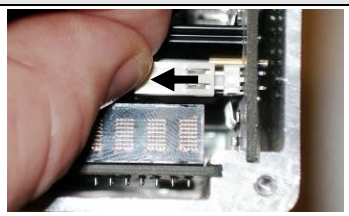
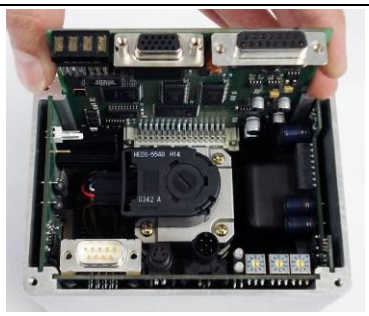
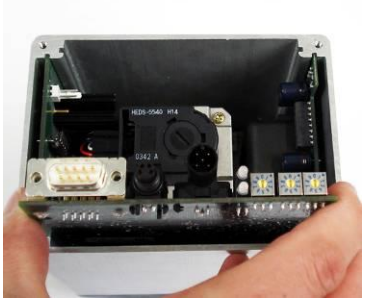
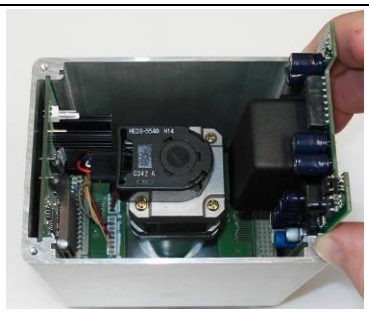
All work on the control and actuating unit has to be done under ESD protected environment to prevent electronic components from damage!

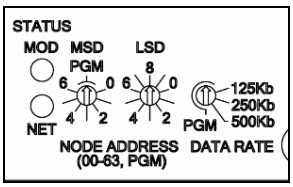
Top view on control and actuating unit with panel removed:



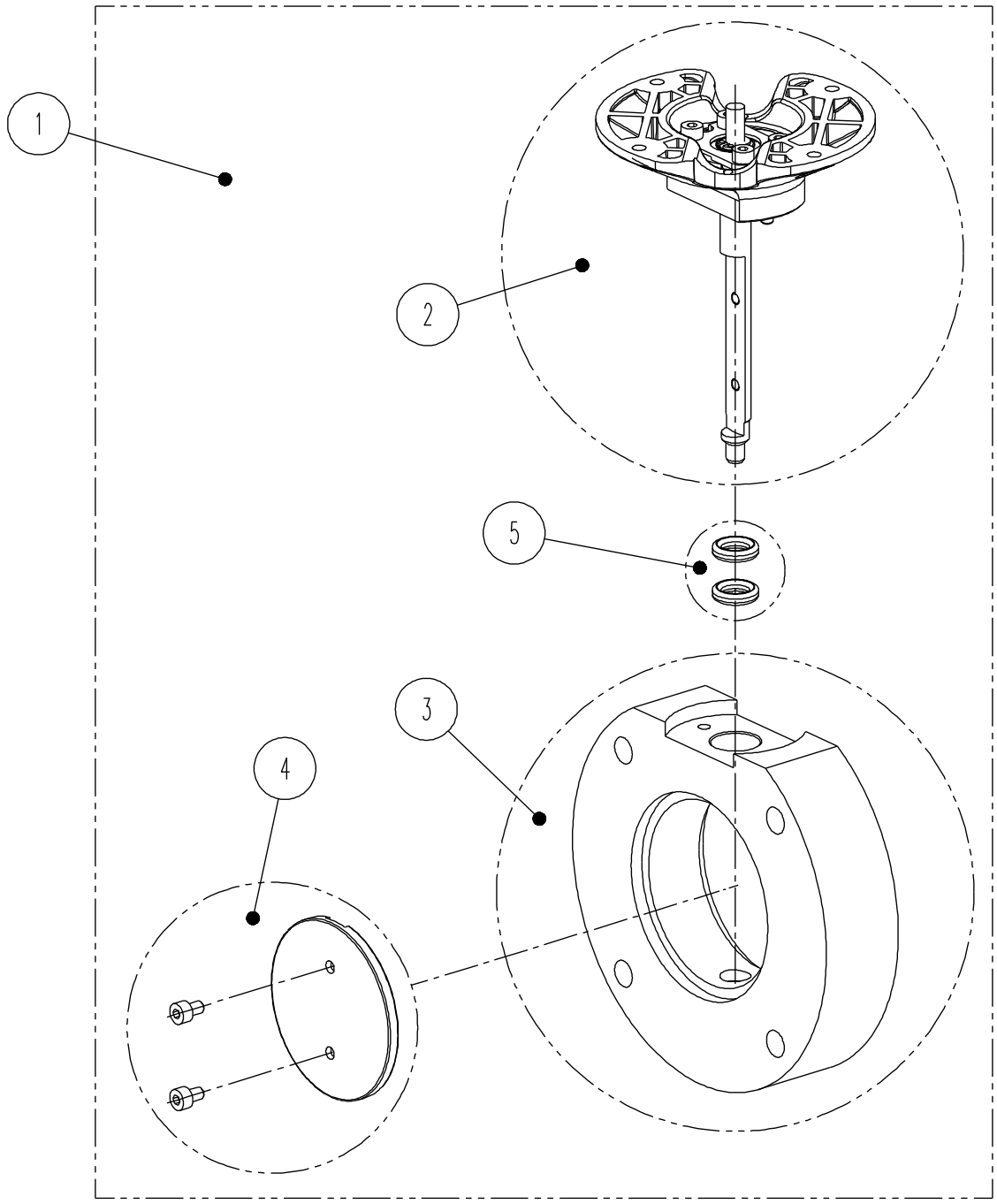
Note: All boards have a fixed position into control and actuating unit. It is not possible to fit a board in other position as shown in picture above. Do not try out other positions, that may be destroy the socket of boards!

Description		Required tool
1. Write down the «NODE ADDRESS» and «DATA RATE» in case of Interface board replacement.		Ballpoint
2. Remove panel screws.		Pozidriv screw driver size 1
3. Remove female screw locks from SENSOR and POWER connectors.		Open end wrench 4.5 mm
4. Loosen and remove the LOCIC connector screw		Open end wrench 10mm
5. Lift panel carefully.		

Description		Required tool
6. Disconnect fan cable from board.		
7. Remove or replace master board.		
8. Remove or replace interface board.		
9. Remove or replace option board.		
10. Insert all boards in reverse order as they disassembled at correct positions (see steps 9…7).		
11. Reconnect fan cable to motor driver board (see step 6).		

Description		Required tool
12. Place and reassemble the controller panel (see steps 5…2) 13. Tighten panel screws with 1.1Nm (see step 2)		
14. In case of replacement Interface board, adjust the «NODE ADDRESS» and «DATA RATE» on new Interface board that you wrote down on step 1.		

6 Drawing



Example picture

7 Spare parts

Please specify the **fabrication number of the valve** (see yellow label on valve) when ordering spare parts. This is to ensure that the appropriate spare parts are supplied.

7.1 Control and actuating unit

Item	Description	
	Valve size **Product ordering number**	**All sizes** **612 . . - . . . .**
	Control and actuating unit	On request *)
	Option board with SPS module (±15VDC sensor power supply)	378000
	Option board with PFO module (power failure option)	378002
	Option board with SPS and PFO module	376837

*) Too many to list. Depends on configuration, please contact VAT.

7.2 Seals and grease

Item	Description		
	Valve size **Product ordering number**		**All sizes** **612 . . - . . . .**
5	Vacuum seal kit	Viton	237235
		Others	on request
	Vacuum grease (2ml syringe)		206792

7.3 ISO-F valve unit - aluminum blank, without heating

Item	Description						
	Valve size **Product ordering number**	**DN 63 / 2½”** **61236 - PA . .**	**DN 80 / 3”** **61238 - PA . .**	**DN 100 / 4”** **61240 - PA . .**	**DN 160 / 6”** **61244 - PA . .**	**DN 200 / 8”** **61246 - PA . .**	**DN 250 / 10”** **61248 - PA . .**
1	Spare parts kit valve unit	490143	489471	490093	489026	491729	489827
2	Spare parts kit mechanical unit	490144	489464	490094	489022	491728	489910
3	Spare parts kit valve body	232273	232274	232275	243026	237716	241204
4	Spare parts kit plate	232278	232279	232280	243028	237725	252046
	Plate screws	353386 (2 pcs required)	353386 (3 pcs required)	353386 (3 pcs required)	353386 (3 pcs required)	353386 (3 pcs required)	353386 (3 pcs required)

For versions such as

- other valve sizes
- heated valves
- valves made of hardanodized aluminum
- valves made of nickel coated aluminum
- valves made of stainless steel
- valves with JIS, ASA or CF-F flanges

spare part ordering numbers are available on request.

7.4 Accessories

Item	Description	Part number
	24 VDC power supply unit (input: 100 – 240 VAC)	249775
	‘Control Performance Analyzer’ package for Windows® consisting of software and cable	600SP-99LB-000
	‘Control View’ software for Windows®	248126 free download from www.vatvalve.com or available on order against charge
	Service cable (PC to valve connection)	230327 free wiring information available for download from www.vatvalve.com
	Connector kit consisting of: •DB-9 female POWER plug •DB-15 male SENSOR plug •DB-25 male INTERFACE plug	242411
	Service Box 2	601BS-29NN-000
	Control panel (rack-mount version of Service Box 2)	602BS-29LE-000
	Special Allen wrench (SW3) for disassembly and assembly	244873
	Special tool kit for disassembly and assembly: • Special Allen wrench (SW3) • Allen wrench (SW2) • Feeler gauges: 0.04, 0.06 and 0.08mm each 6 pcs.	257820

7.4.1 Centering ring with Viton o-ring

Description						
Valve size **Product ordering number**		**DN 63 / 2½”** **61236 - . . . .**	**DN 80 / 3”** **61238 - . . . .**	**DN 100 / 4”** **61240 - . . . .**	**DN 160 / 6”** **61244 - . . . .**	**DN 200 / 8”** **61246 - . . . .**
Centering ring with Viton o-ring (ISO-F installation only)	Aluminum	32036-QAZV	32038-QAZV	32040-QAZV	32044-QAZV	32046-QAZV
	Stainless steel	32036-QEZV	32038-QEZV	32040-QEZV	32044-QEZV	32046-QEZV

Description						
Valve size **Product ordering number**		**DN 250 / 10”** **61248 - . . . .**				
Centering ring with Viton o-ring (for ISO-F installation only)	Aluminum	32048-QAZV				
	Stainless steel	32048-QEZV				

8 Warranty

Each product sold by VAT Vakuumventile AG (VAT) is warranted to be free from the manufacturing defects that adversely affect the normal functioning thereof during the warranty period stated in VAT's «Terms of Sale» immediately following delivery thereof by VAT, provided that the same is properly operated under conditions of normal use and that regular, periodic maintenance and service is performed or replacements made, in accordance with the instructions provided by VAT. The foregoing warranty shall not apply to any product or component that has been repaired or altered by anyone other than an authorized VAT representative or that has been subject to improper installation or abuse, misuse, negligence or accident. VAT shall not be liable for any damage, loss, or expense, whether consequential, special, incidental, direct or otherwise, caused by, arising out of or connected with the manufacture, delivery (including any delay in or failure to deliver), packaging, storage or use of any product sold or delivered by VAT shall fail to conform to the foregoing warranty or to the description thereof contained herein, the purchaser thereof, as its exclusive remedy, shall upon prompt notice to VAT of any such defect or failure and upon the return of the product, part or component in question to VAT at its factory, with transportation charges prepaid, and upon VAT's inspection confirming the existence of any defect inconsistent with said warranty or any such failure, be entitled to have such defect or failure cured at VAT's factory and at no charge therefor, by replacement or repair of said product, as VAT may elect. VAT MAKES NO WARRANTY OR REPRESENTATION OF ANY KIND, EXPRESS OR IMPLIED, (INCLUDING NO WARRANTY OR MERCHANTABILITY), EXCEPT FOR THE FOREGOING WARRANTY AND THE WARRANTY THAT EACH PRODUCT SHALL CONFORM TO THE DESCRIPTION THEREOF CONTAINED HEREIN, and no warranty shall be implied by law.

Furthermore, the «Terms of sale» at the back of the price list are applicable.