

Installation, Operating & Maintenance Instructions



Pendulum control & isolation valve with EtherCAT® interface

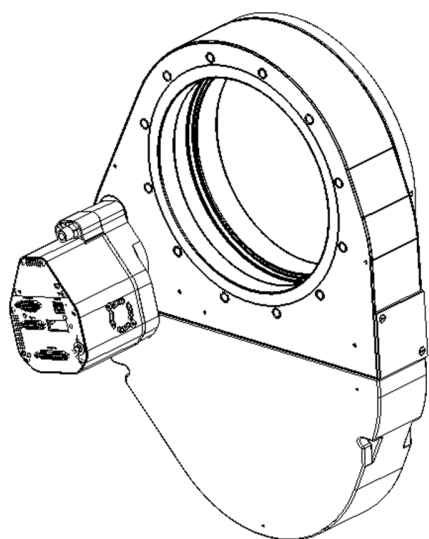
Series 653 DN 100-250 mm (I.D. 4" - 10")

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

653GX -	(2 sensor inputs / analog outputs)
653AX -	(2 sensor inputs / analog outputs / ±15V SPS)
653HX -	(2 sensor inputs / analog outputs / PFO)
653CX -	(2 sensor inputs / analog outputs / ±15V SPS / PFO)

SPS = Sensor Power Supply PFO = Power Failure Option

Configured with firmware : F01.0C.28.xx



Sample picture

Imprint

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1 Description of product

1.1 Identification of product

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



1.2 Use of product

This product is a throttling pendulum valve with isolation functionality. It is intended to use for downstream pressure control applications.
 Use product for clean and dry vacuum applications only. Other applications are only allowed with the written permission of VAT.

1.3 Used abbreviations

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

1.4 Related documents

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

1.5 Important information

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

Example:

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

1.6 Technical data

1.6.1 Control and actuating unit

Description	
Power input ¹⁾ (α) [653 A / 653 H] [653 C / 653 H]	+24 VDC ($\pm 10\%$) @ 0.5 V pk-pk max. connector: POWER 70 W max. (operation of valve with max. load) without PFO ³⁾ with optional SPS + 40 W with optional PFO + 10 W ³⁾
Sensor power supply ²⁾ (β) [653 A / 653 C] input output	+24 VDC / 1500 mA max. connector: POWER ± 15 VDC ($\pm 5\%$) / 1200 mA max. connector: SENSOR
Sensor power supply ²⁾ (β) [653 G / 653 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
Actuator type	Stepper motor with servo control
Ingress Protection	IP30

¹⁾ Internal overcurrent protection by a PTC device.

²⁾ Refer to chapter «Sensor supply concepts» for details.

³⁾ PFO = Power Failure Option. Refer to «Behavior in case of power failure» for details.



Calculation of complete power consumption:

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

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

Control and actuating unit (continuation)		
Sensor input Signal input voltage ADC resolution Sampling time	-10 ... +10 V / $R_i = 100 \text{ k}\Omega$ 0.1 mV 2 ms	connector: SENSOR
Digital inputs (power connector) input 1 input 2 voltage control contact control	interlock open (adjustable with CPA) interlock close (adjustable with CPA) 12 ... 24V / 4 ... 8 mA 24V / 8 mA	connector: POWER connector: POWER
Digital outputs (power connector) output 1 output 2 load	valve closed (adjustable with CPA) valve opened (adjustable with CPA) max. 70 V / 0.1 A	connector: POWER connector: POWER
Digital inputs ⁴⁾ voltage control contact control	5 ... 24V / 2 ... 10 mA 3.3V / 2 mA	connector: INTERFACE
Digital outputs ⁴⁾ Input voltage Input current	max. 70 V max. 0.1 A	connector: INTERFACE
Analog outputs ⁴⁾	0-10 VDC / 1 mA max.	connector: INTERFACE
PFO ⁵⁾ battery pack [653 C / 653 H] charging time durability	2 minutes max. up to 10 years @ 25°C ambient; refer to «Durability of power fail battery» for details	
Compressed air supply	4 - 7 bar / 55 - 100 psi (above ATM)	
Ambient temperature	0 °C to +50 °C max. (<35 °C recommended)	
Pressure control accuracy	5 mV or 0.1% of setpoint, whichever is greater	

	DN 100 4" (65340 -)	DN 160 6" (65344 -)	DN 200 8" (65346 -)	DN 250 10" (65348 -)
Position resolution / position control capability	58000 steps (full stroke)			
Closing time throttling only (full stroke)	0.7 s typ. 0.4 s typ.	0.8 s typ. 0.45 s typ.	0.9 s typ. 0.5 s typ.	0.9 s typ. 0.5 s typ.
Opening time throttling only (full stroke)	0.7 s typ. 0.4 s typ.	0.8 s typ. 0.45 s typ.	0.9 s typ. 0.5 s typ.	0.9 s typ. 0.5 s typ.
Closing time throttling & isolation (full stroke)	3 s typ.	3 s typ.	3 s typ.	3 s typ.
Opening time throttling & isolation (full stroke)	4 s typ.	4 s typ.	4 s typ.	4 s typ.

4) Refer to chapter «Schematics» for details.

5) PFO = Power Failure Option. Refer to chapter «Behavior in case of power failure» for details.

1.6.2 Valve unit

Description	
Pressure range at 20°C - Aluminum (653 A) - Aluminum hard anodized (653 H) - Aluminum nickel coated (653 I)	1 x 10E-8 mbar to 1.2 bar (abs) 1 x 10E-6 mbar to 1.2 bar (abs) 1 x 10E-8 mbar to 1.2 bar (abs)
Leak rate to outside at 20°C - Aluminum (653 A) - Aluminum hard anodized (653 H) - Aluminum nickel coated (653 I)	1 x 10E-9 mbar l/s 1 x 10E-5 mbar l/s 1 x 10E-9 mbar l/s
Leak rate valve seat at 20°C - Aluminum (653 A) - Aluminum hard anodized (653 H) - Aluminum nickel coated (653 I)	1 x 10E-9 mbar l/s 1 x 10E-4 mbar l/s 1 x 10E-9 mbar l/s
Cycles until first service - Isolation cycles (open - closed - open) - Throttling cycles (open - max. throttle - open)	200'000 (unheated and under clean conditions) 1'000'000 (unheated and under clean conditions)
Admissible operating temperature	+10°C to +120°C
Mounting position	horizontally only
Wetted materials - Body (653 A) - Body (653 H) - Body (653 I) - Pendulum plate (653 A) - Pendulum plate (653 H) - Pendulum plate (653 I) - Sealing ring (653 A) - Sealing ring (653 H) - Sealing ring (653 I)	Aluminum 3.3211 (AA6061) Aluminum 3.3211 (AA6061) hard anodized Aluminum 3.3211 (AA6061) nickel coated Aluminum 3.3211 (AA6061) Aluminum 3.3211 (AA6061) hard anodized Aluminum 3.3211 (AA6061) nickel coated Aluminum 3.3211 (AA6061), 1.4306 (304L) Aluminum 3.3211 (AA6061) hard anodized, 1.4306 (304L) Aluminum 3.3211 (AA6061) nickel coated, 1.4306 (304L)
- Other parts	Stainless steel 316L (1.4404 or 1.4435), 1.4122, 1.4310 (301), 1.4303 (304), 1.4571, A2 (304)
- Seals	Viton® (standard). Other materials available. Seal materials are declared on dimensional drawing of specific valve ordering number.

Description				
	DN 100 4" (65340 -)	DN 160 6" (65344 -)	DN 200 8" (65346 -)	DN 250 10" (65348 -)
Max. differential pressure on plate during isolation	1200 mbar in either direction	1200 mbar in either direction	1200 mbar in either direction	1200 mbar in either direction
Max. differential pressure on plate during opening and throttling	30 mbar	10 mbar	5 mbar	5 mbar
Min. controllable conductance (N ₂ molecular flow)	Typ. 2 l/s	Typ. 4 l/s	Typ. 7 l/s	Typ. 10 l/s
Dimensions	Refer to dimensional drawing of specific valve ordering number (available on request)			

2 Safety

2.1 Compulsory reading material

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

	NOTICE
	<p>Lack of knowledge Failing to read this manual may result in property damage. Firstly, read manual.</p>



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

2.2 Danger levels


	⚠ DANGER
	<p>High risk Indicates a hazardous situation which, if not avoided, will result in death or serious injury.</p>

	⚠ WARNING
	<p>Medium risk Indicates a hazardous situation which, if not avoided, could result in death or serious injury.</p>


	⚠ CAUTION
	<p>Low risk Indicates a hazardous situation which, if not avoided, may result in minor or moderate injury.</p>

	NOTICE
	<p>Command Indicates a hazardous situation which, if not avoided, may result in property damage.</p>

2.3 Personnel qualifications

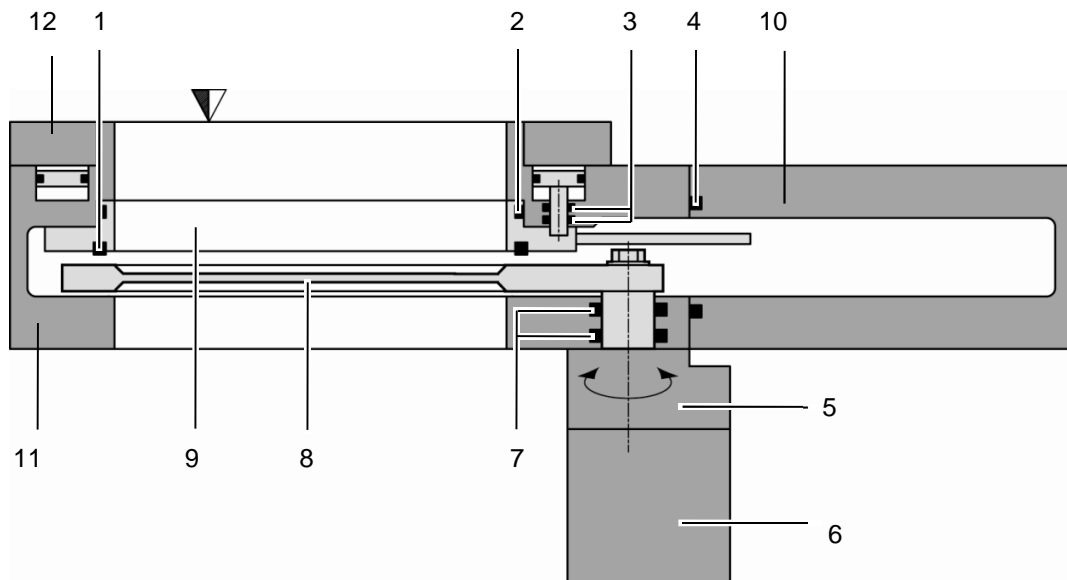
	⚠ WARNING	
	Unqualified personnel Inappropriate handling may cause serious injury or property damage. Only qualified personnel are allowed to carry out the described work.	

2.4 Safety labels

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

3 Design and Function

3.1 Design

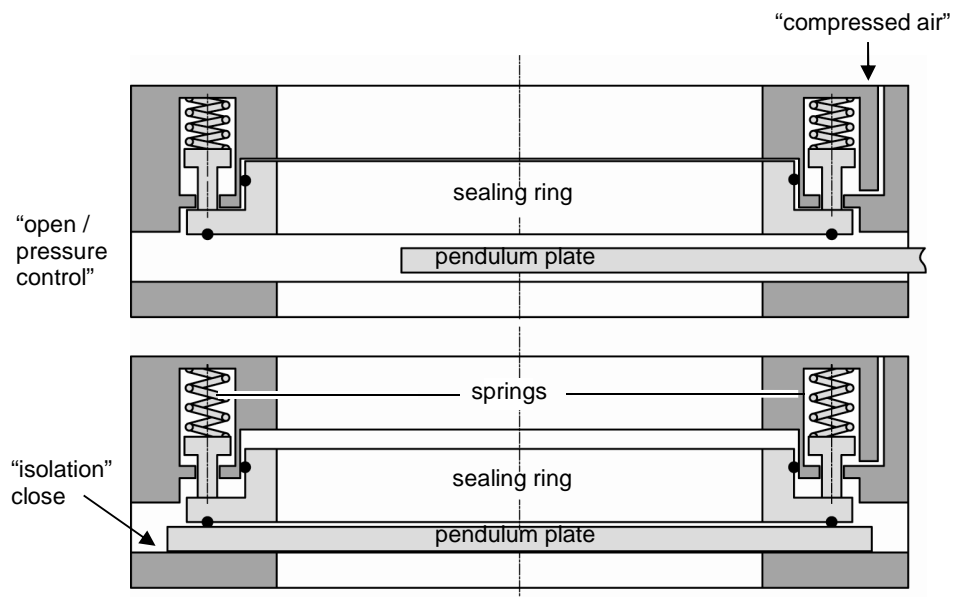


- | | | | |
|---|--------------------------|----|---------------------------|
| 1 | Plate seal | 7 | Rotary feed through seals |
| 2 | Body seal | 8 | Pendulum plate |
| 3 | Shaft feed through seals | 9 | Sealing ring |
| 4 | Bonnet seal | 10 | Bonnet |
| 5 | Actuator | 11 | Body |
| 6 | Integrated controller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

3.2 Function

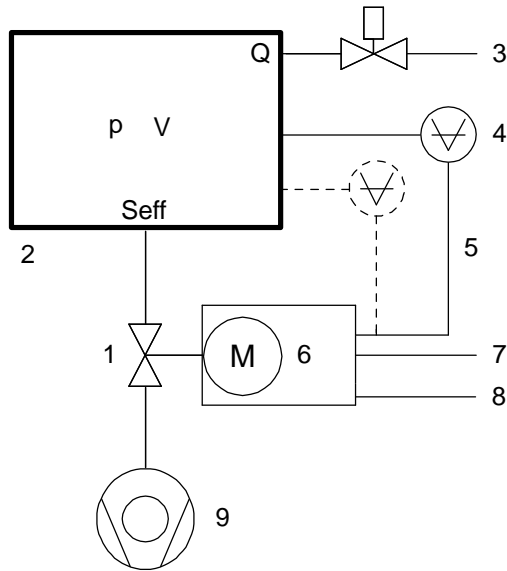
The valve plate acts, due to its pendulum motion, as a throttling element and varies the conductance of the valve opening. The integrated controller calculates the required plate position to achieve the set point pressure. Actuation is performed by a stepper motor. An encoder monitors the position. This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

For opening or control the “sealing ring” is lifted pneumatically by “compressed air”, afterwards the “pendulum plate” moves to open or do pressure control. For leak tight closing, the “sealing ring” moves downwards and press the pendulum plate to valve body for “isolation”. Closing is performed by “springs”.



3.2.1 Pressure control system overview and function

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



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

$S_{eff} = Q / p$
 S_{eff} effective pump speed ($l s^{-1}$)
 Q Gas flow ($mbar l s^{-1}$)
 p Pressure (mbar)

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

Example: Downstream control

3.2.1.1 Way of operation

The controller compares the actual pressure in the process chamber given by the pressure sensor with the preset pressure. The controller uses the difference between actual and set pressure to calculate the correct position of the control valve. The controller drives the control valve into the correct position and the actual pressure again equals the set pressure.

This control operation is performed continuously. Pressure changes in the process chamber due to leaks, desorption, and gas flow, reaction products, variations in pumping speed etc. are always corrected at once.

3.2.1.2 Pressure control

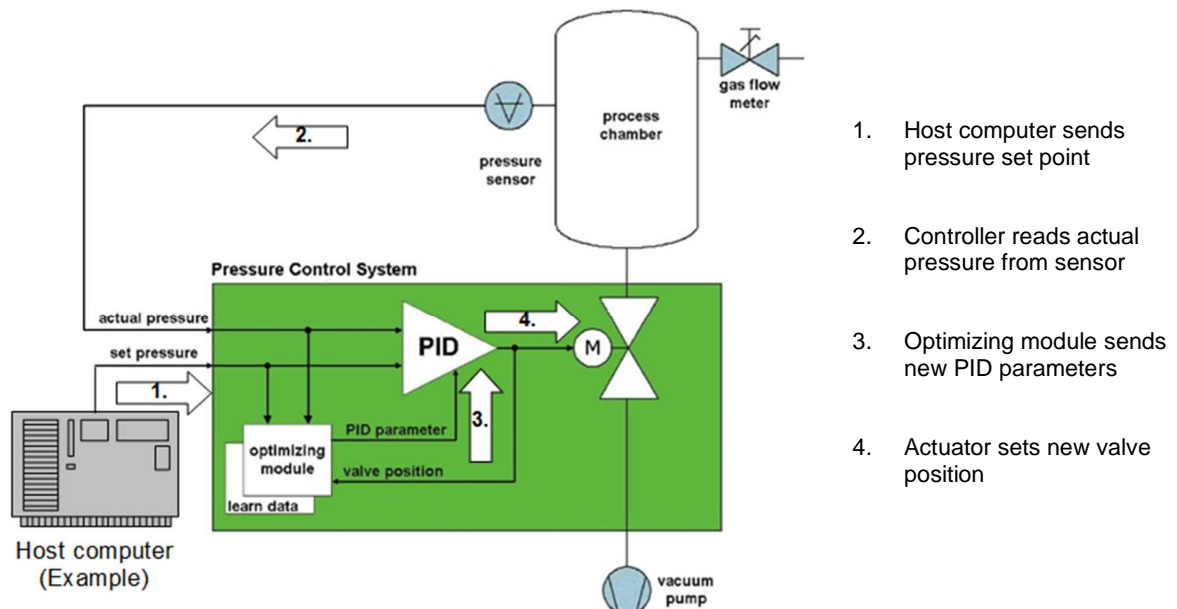
In a vacuum system which is pumped and into which gas is admitted at the same time, the pressure can be controlled in two ways:

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

3.2.1.3 Adaptive controller (standard)

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

3.2.2 Principle of a pressure control system



4 Installation

	WARNING
	<p>Unqualified personnel Inappropriate handling may cause serious injury or property damage. Only qualified personnel are allowed to carry out the described work.</p>

4.1 Unpacking

	NOTICE
	<p>Physical overstraining at controller Inappropriate handling with the valve may cause in damage of controller. Do not place the valve on the controller.</p>

	CAUTION
	<p>Valve is a heavy component Physical overstraining. Use a crane to lift valves DN 200 (8") and larger.</p>









- Make sure that the supplied products are in accordance with your order.
- Inspect the quality of the supplied products visually. If it does not meet your requirements, please contact VAT immediately.
- Store the original packaging material. It may be useful if products must be returned to VAT.

1. Open the transport case and remove inside packing material as far as necessary.
2. Attach lifting device for valves DN 200 (8") and larger. For attachment refer to dimensional drawing of valve.
3. Lift the valve carefully and place it on a clean place.



Do not remove protective foils from valve opening

4.2 Installation into the system

	<p style="text-align: center;">⚠ WARNING</p> <p>Valve opening Risk of serious injury. Human body parts must be kept out of the valve opening and away from moving parts. Do not connect the controller to power before the valve is installed complete into the system.</p>
	<p style="text-align: center;">⚠ WARNING</p> <p>Valve in open position Risk of injury when compressed air is connected to the valve. Connect compressed air only when: – valve is installed in the vacuum system – moving parts cannot be touched</p>
	<p style="text-align: center;">NOTICE</p> <p>Sealing surfaces Sealing surfaces of valve and vacuum system could be damage in case of incorrect handling. Only qualified personal are allowed to install the valve into the vacuum system.</p>
	<p style="text-align: center;">NOTICE</p> <p>Wrong connection Wrong connection may result in damage of controller or power supply. Connect all cables exactly as shown in the following descriptions and schematics.</p>
	<p style="text-align: center;">NOTICE</p> <p>Burned connector pins (spark) Connector pins or electronic parts could damage, if plugged and unplugged under power. Do not plug or unplug connectors under power.</p>
	<p style="text-align: center;">NOTICE</p> <p>Contamination Gate and other parts of the valve must be protected from contamination. Always wear clean room gloves when handling the valve.</p>

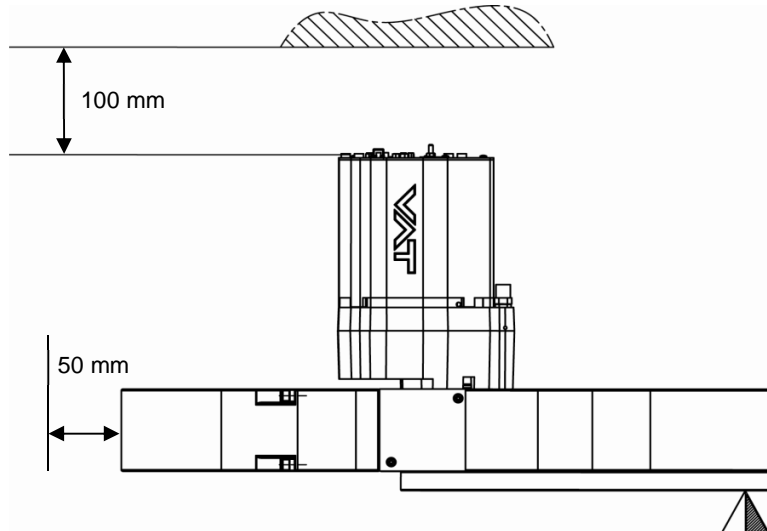


Mount valve to a clean system only.

4.2.1 Installation space condition

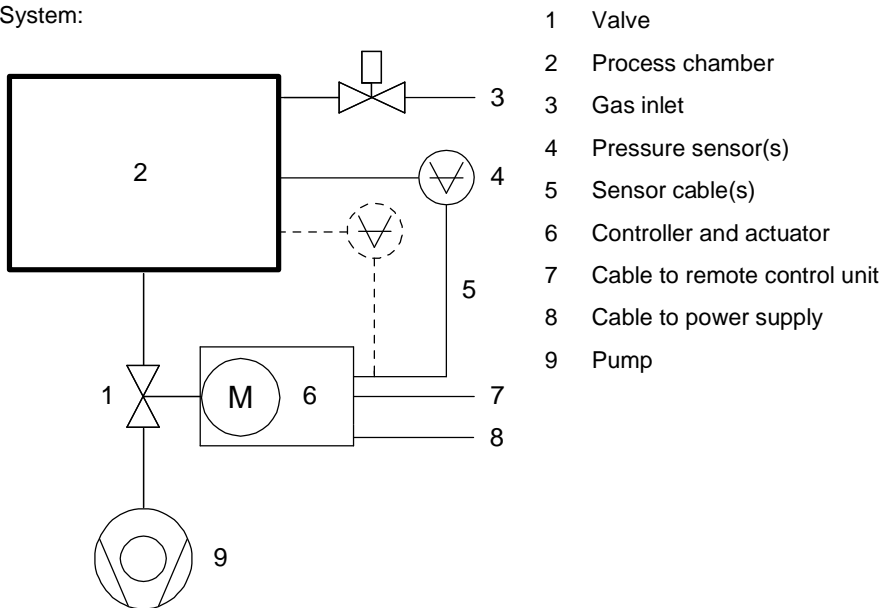


Install the valve with integrated controller with space for dismantling and air circulation as shown in figure below.



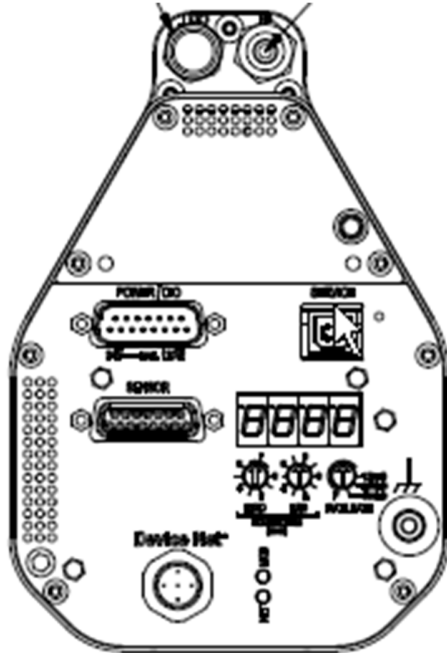
4.2.2 Connection overview

System:



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

Controller:



4.2.3 Installation procedure

1. Install valve [1] into the vacuum system. Valve seat side should face process chamber. The valve seat side is indicated by the symbol "∇" on the valve flange.



- Do not tighten the flange screws stronger than indicated under «Tightening torque».
- Do not admit higher forces to the valve than indicated under «Admissible forces».
- Make sure that enough space is kept free to do preventive maintenance work. The required space is indicated on the dimensional drawing.

2. Connect compressed air supply to connection labeled 'IN' located at actuator, see Figure 1 below. Connect compressed air return line connection labeled 'OUT' located at actuator, see Figure 1 below.



- Compressed air pressure must be in the range of: **4 - 7 bar / 55 - 100 psi (above ATM)**.
- Use only clean, dry or slightly oiled air. IN / OUT connections are 1/8" ISO/NPT internal threads.

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

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

5. Connect sensor cable [3] to sensor(s) and then to valve (connector: SENSOR). Refer to chapter «Electrical connection» for correct wiring.

6. Connect valve to DevicNet [4] (connector: INTERFACE). Refer to «Function and Wiring» for correct wiring.

7. Connect power supply [5] to valve (connector: POWER). Refer to chapter «Electrical connection» for correct wiring.



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

8. This valve has a double sealed rotary feedthrough and optionally an intermediate pumping port for the actuator shaft. This port (1/8" ISO/NPT) could be connected to the vacuum line, see Figure 3 below.

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

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



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

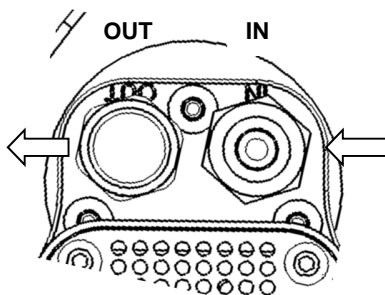


Fig. 1



Fig. 2

4.2.4 Tightening torque

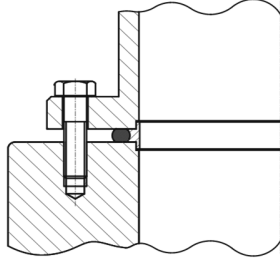


The torque values below are dependent on many factors, such as materials involved, surface quality, surface treatment, and lubrication.

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

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

4.2.5 Mounting with centering rings

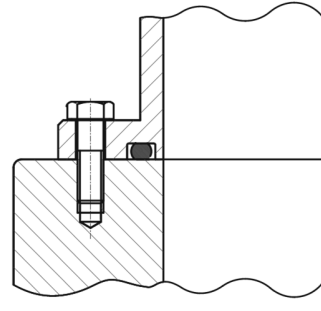
Valve size	ISO-F	ISO-F	
	max. tightening torque (Nm)	max. tightening torque (lbs . ft)	
DN100 / 4" 65340 -	8-10	6-8	
DN160 / 6" 65344 -	13-15	9-11	
DN200 / 8" 65346 -	13-15	9-11	
DN250 / 10" 65348 -	17-20	13-15	
	hole depth (mm)	hole depth (inch)	
DN100 / 4" 65340 -	12	0.47	
DN160 / 6" 65344 -	14	0.55	
DN200 / 8" 65346 -	15	0.59	
DN250 / 10" 65348 -	16	0.63	




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

4.2.6 Mounting with O-ring in grooves

Valve size	ISO-F	JIS	ASA-LP	ISO-F	JIS	ASA-LP
	max. tightening torque (Nm)			max. tightening torque (lbs . ft)		
DN100 / 4" 65340 -	20-23	35-40	35-40	15-17	26-30	26-30
DN160 / 6" 65344 -	35-40	35-40	35-40	26-30	26-30	26-30
DN200 / 8" 65346 -	35-40	35-40	80-90	26-30	26-30	59-67
DN250 / 10" 65348 -	35-41	65-70	80-90	26-30	48-52	59-67
	hole depth (mm)			hole depth (inch)		
DN100 / 4" 65340 -	12	12	12	0.47	0.47	0.47
DN160 / 6" 65344 -	14	14	14	0.55	0.55	0.55
DN200 / 8" 65346 -	15	15	14	0.59	0.59	0.59
DN250 / 10" 65348 -	16	16	16	0.63	0.63	0.63



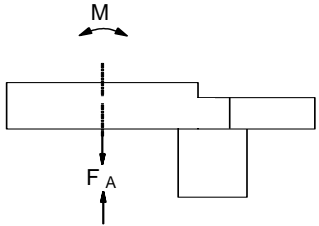
4.2.7 Admissible forces

NOTICE	
	<p>Force at valve body</p> <p>Forces from evacuating the system, from the weight of other components, and from baking can lead to deformation and malfunctioning of the valve.</p> <p>Do not higher force the valve body as specified.</p>



The following forces are admissible.

Valve size	Axial tensile or compressive force «F _A »		Bending moment «M»	
	N	lb.	Nm	lbf.
DN100 / 4" 65340 -	1000	220	40	30
DN160 / 6" 65344 -	2000	440	80	60
DN200 / 8" 65346 -	2000	440	80	60
DN250 / 10" 65348 -	2500	550	100	75
<p>For a combination of both forces (F_A and M) the values are invalid.</p> <p>Verify that the depth of the mounting screws is min. 1 x thread diameter.</p> <p>Please contact VAT for more information.</p>				

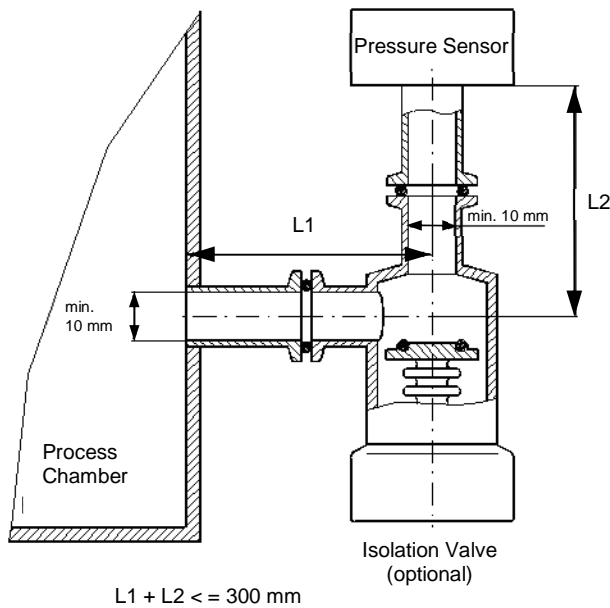


4.2.8 Requirements to sensor connection

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

- Inner diameter of connection pipe: $\geq 10 \text{ mm}$
- Length of connection pipe: $\leq 300 \text{ mm}$

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



4.3 Electrical connection

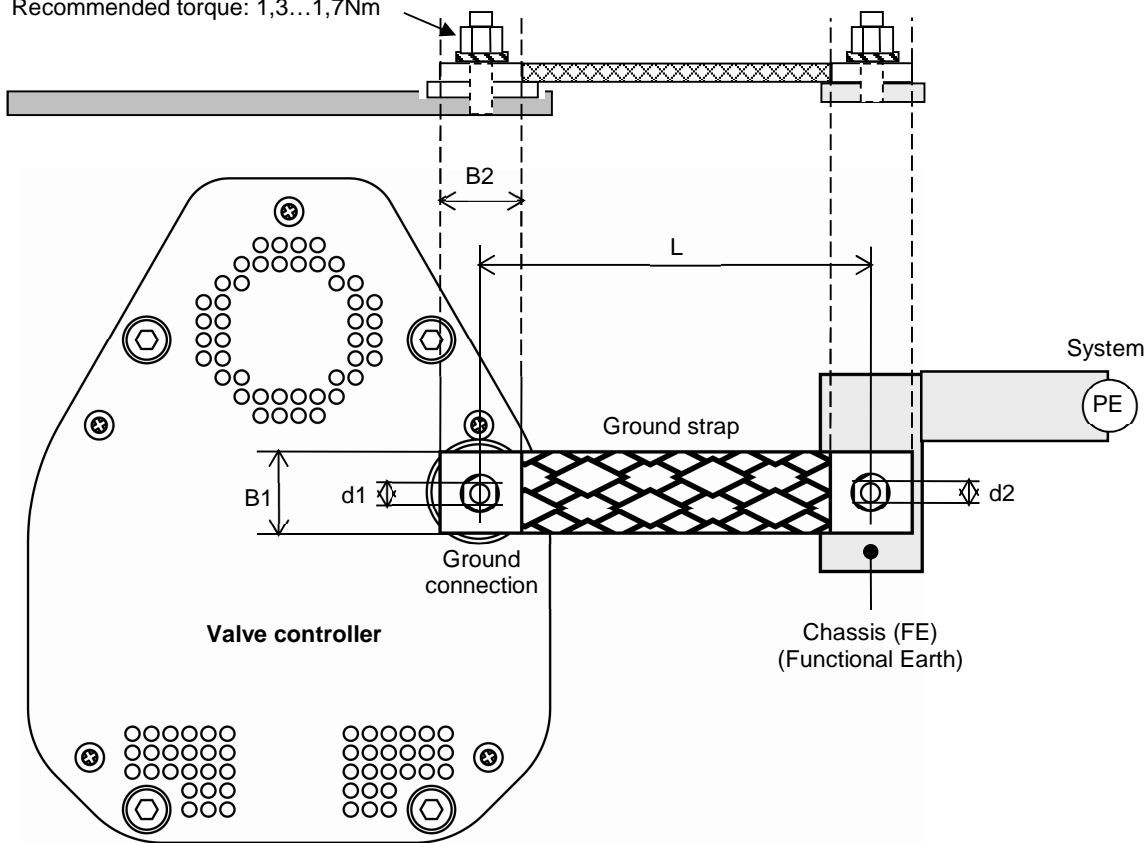
	NOTICE
<p>Wrong connection</p> <p>Wrong connection may result in damage of controller or power supply. Connect all cables exactly as shown in the following descriptions and schematics.</p>	
	NOTICE
<p>Burned connector pins (spark)</p> <p>Connector pins or electronic parts could damage, if plugged and unplugged under power. Do not plug or unplug connectors under power.</p>	

4.3.1 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

Recommended torque: 1,3...1,7Nm



sample picture



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

The connection point at chassis (FE) must be blank metal (not coated).
It is also possible to connect the ground strap at system chamber if it is well connected to PE.

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

4.3.2 Power and Sensor supply concepts

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

Concepts:

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



This concept is only possible when SPS retrofit is installed.

Valve versions:

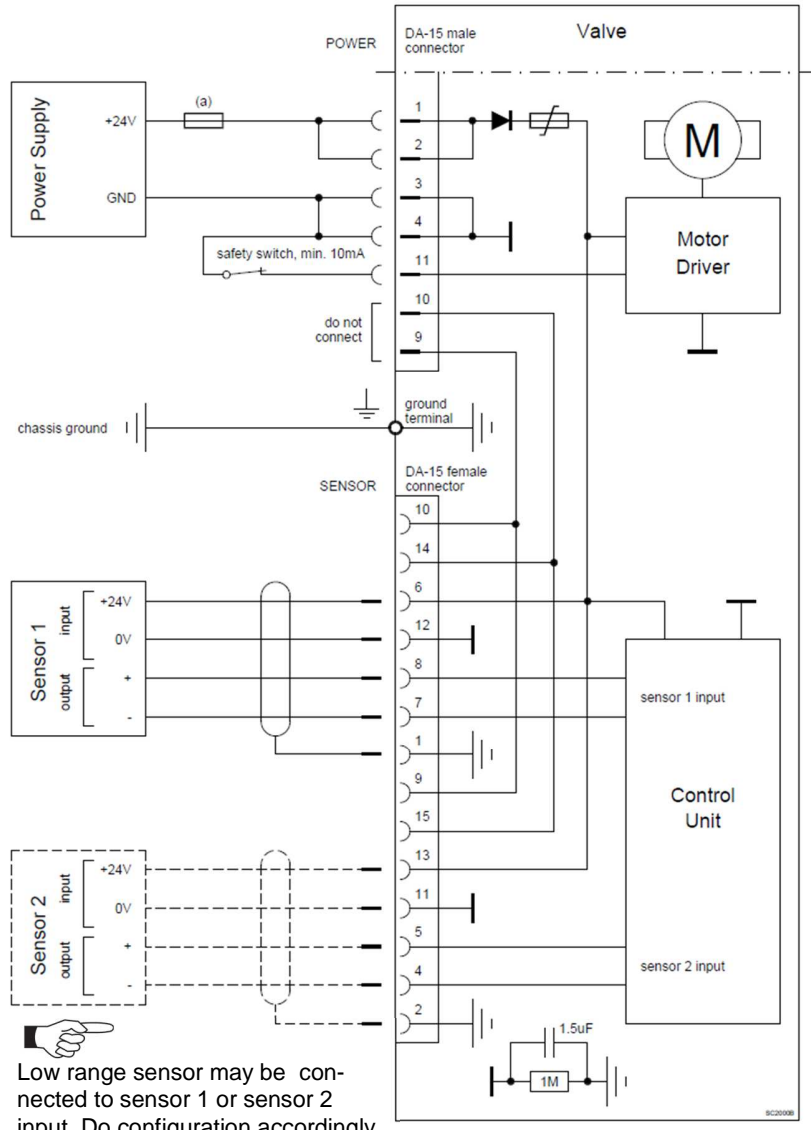
- 653 **G** and 653 **H** SPS module not included
- 653 **A** and 653 **C** SPS module included



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

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

[653 G / 653 H versions recommended]



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

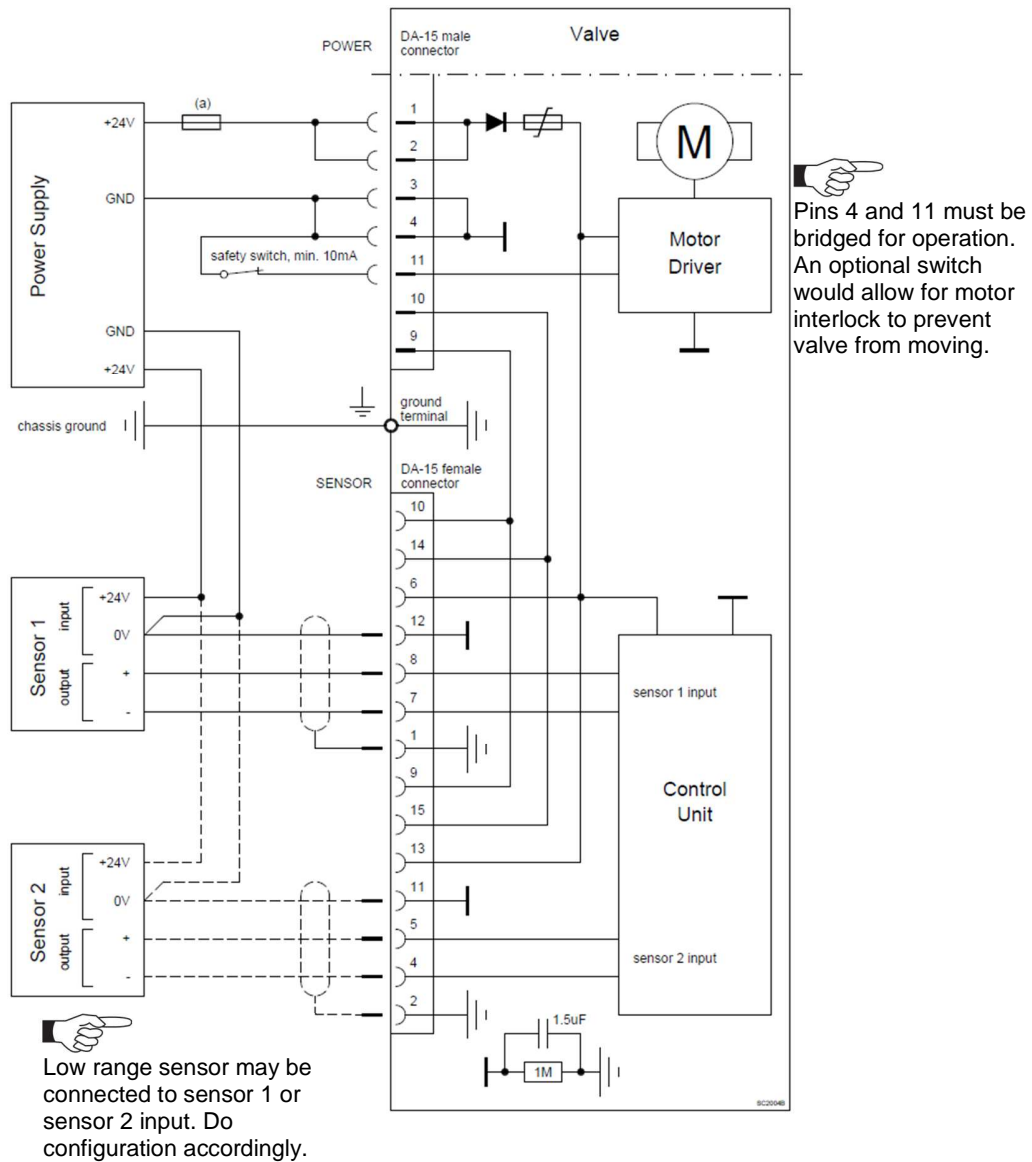
Low range sensor may be connected to sensor 1 or sensor 2 input. Do configuration accordingly



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

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

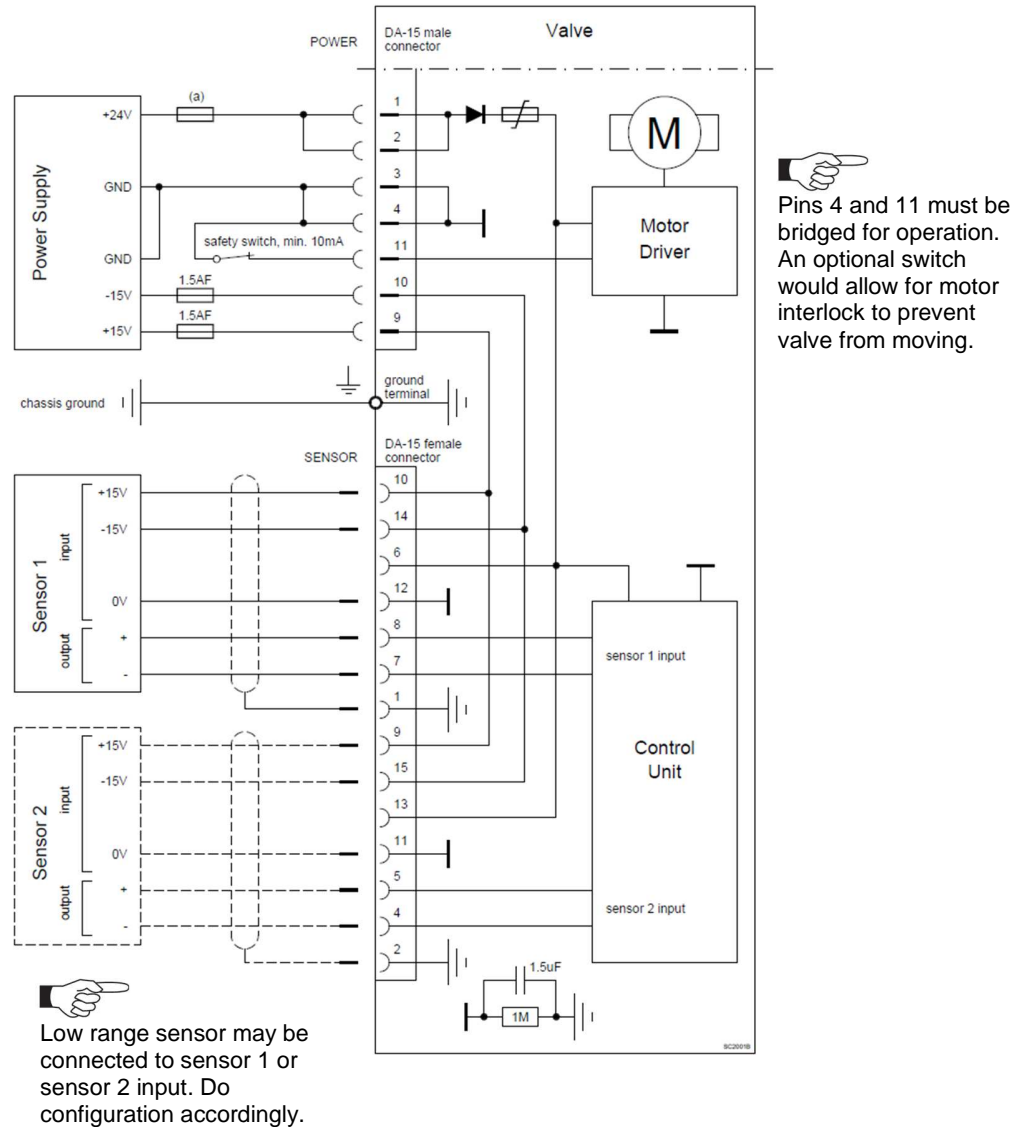
[653 G / 653 H versions recommended]



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

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

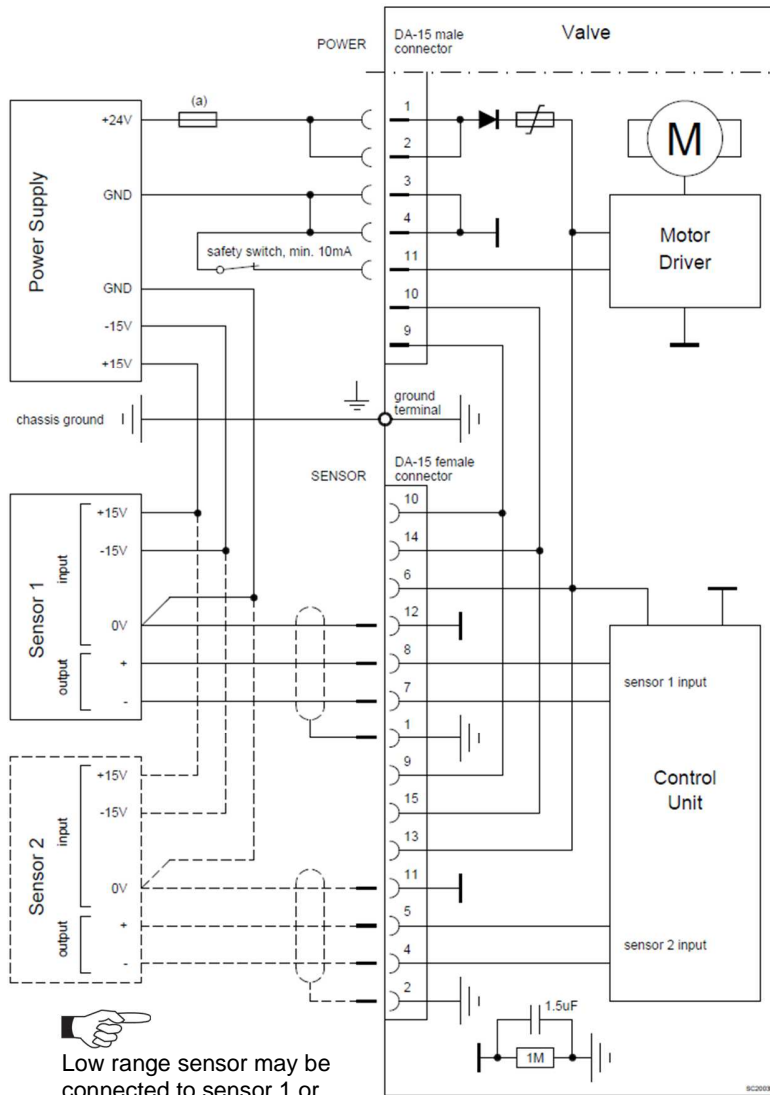
[653 G / 653 H versions recommended]



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

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

[653 G / 653 H versions recommended]



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

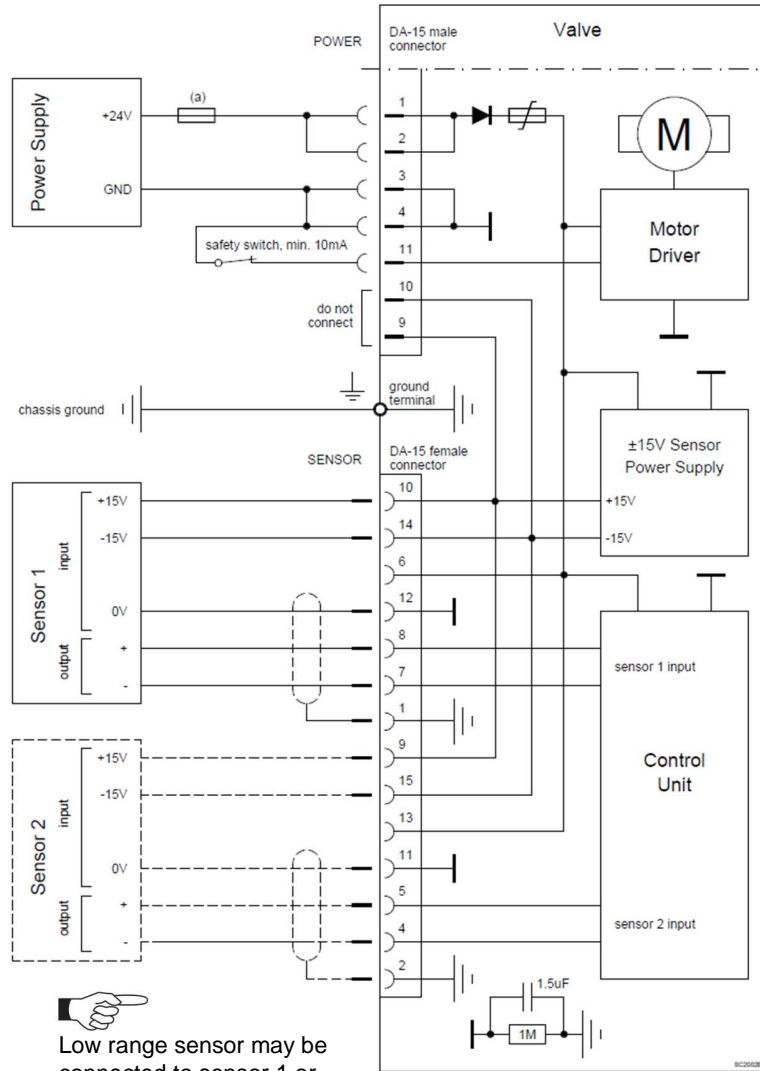
Low range sensor may be connected to sensor 1 or sensor 2 input. Do configuration accordingly.



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

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

[653 A / 653 C versions only]



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

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



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

4.3.3 Digital Input/Output connections

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

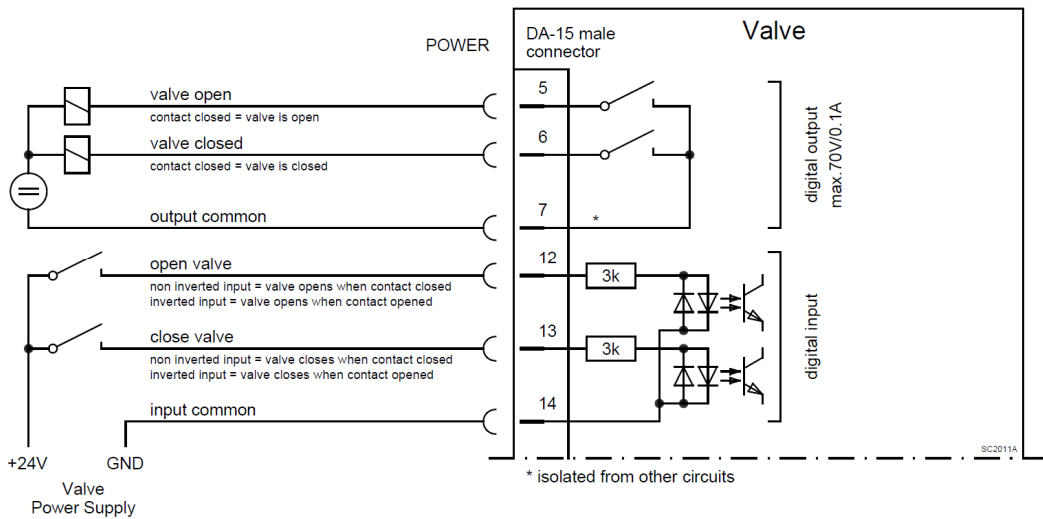


Active **digital inputs** have **higher priority than EtherCAT** commands.

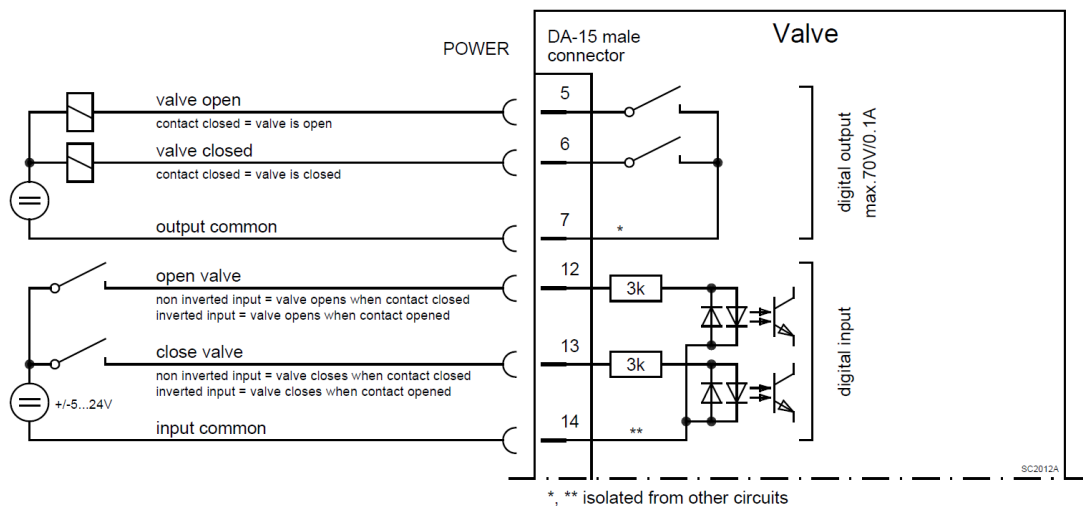


Do not connect other pins than indicated in the schematics above!
Use only screws with 4-40UNC thread for fastening the DA-15 connector!

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



4.3.3.2 Power connector: Configuration with voltage source for digital inputs “Interlock”



4.3.3.3 Digital inputs

Pin	Function	Signal type	Description	Priority
13	CLOSE VALVE	Digital input ¹⁾	<p>This function will close the valve. Valve will be in this mode as long as function is activated. After deactivation of function it will remain effective until</p> <ul style="list-style-type: none"> - OPEN valve digital input is active - converse EtherCAT control command have been received <p>The function is activated when optocoupler is 'on' in non inverted configuration. The function is activated when optocoupler is 'off' in inverted configuration.</p> <p>Configuration can be done in local operation via service port or in remote operation.</p>	1 ²⁾
12	OPEN VALVE	Digital input ¹⁾	<p>This function will open the valve. Valve will be in this mode as long as function is activated. After deactivation of function it will remain effective until converse EtherCAT control command have been received.</p> <p>The function is activated when optocoupler is 'on' in non inverted configuration. The function is activated when optocoupler is 'off' in inverted configuration.</p> <p>Configuration can be done in local operation via service port or in remote operation.</p>	2 ²⁾
14	DIGITAL INPUT GROUND	Digital ground	Ground for all digital inputs. Ground is used when digital inputs are operated by switches. Connect switches to ground.	

- 1) All digital inputs are digitally filtered. Filter delay is 50ms. This means that digital signals must be applied for at least 50ms to be effective. Refer to « Function and Wiring » for details about input circuit.
- 2) Highest priority is 1. Functions with lower priorities will not be effective as long as higher priority functions are active. These digital inputs have higher priority than all EtherCT commands. EtherCAT commands will not be accepted while digital inputs are active.

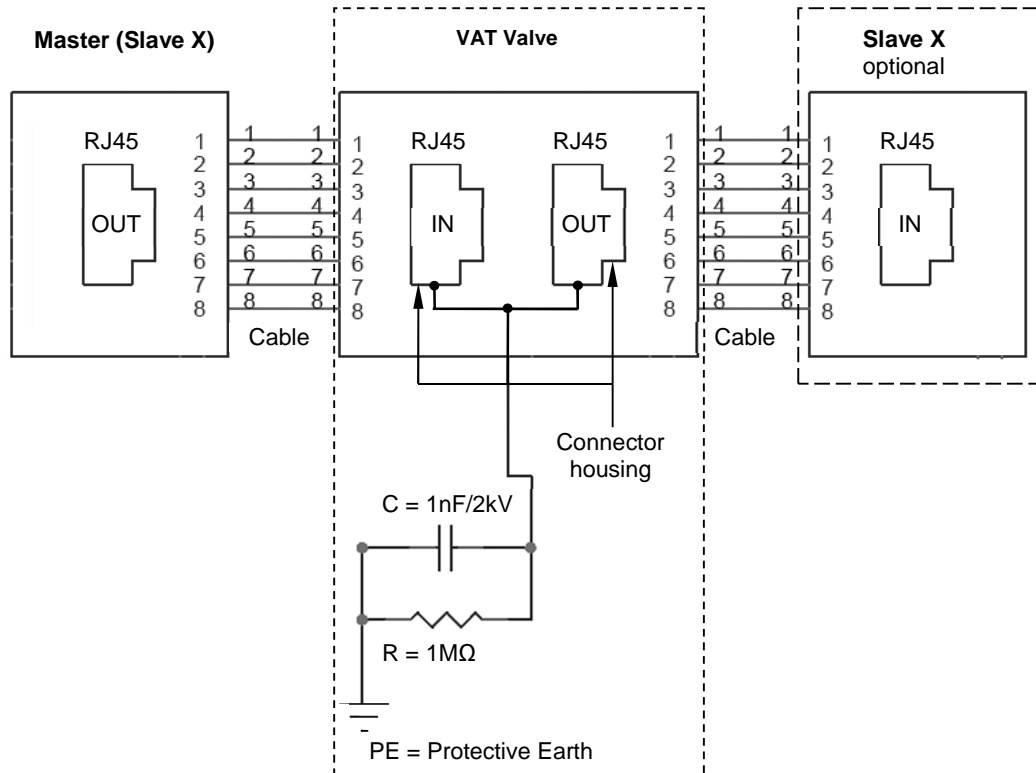
4.3.3.4 Digital output

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

4.3.4 EtherCAT interface connection

The EtherCAT interface is galvanic isolated from control unit.

4.3.4.1 EtherCAT installation (example)



4.3.4.2 EtherCAT network and cable

- **Connector type: RJ45 standard connector**
- **Cable: CAT5, 6 or 7 STP (shielded twisted pair), not crossover**

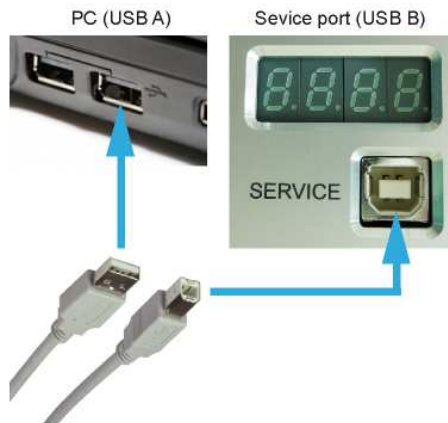


Cable length between Master and Slaves max. 100 m.

For all detail information about EtherCAT refer to EtherCAT homepage:
<http://www.ethercat.org/>

4.3.5 Service port connection

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



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

4.4 Initial operation



To enable the valve cluster for **pressure control** setup **steps 1 to 6 must be performed**. In case position control is required only it's sufficient to perform steps 1 to 4.

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



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

4.5 Scaling of Pressure and Position Values

The scaling for pressure and position values can be configured.

- The position scaler defines the unit/range of all position values: Target Position, Actual Position, ...
- The pressure scaler defines the unit/range of all pressure values: Target Pressure, Actual Pressure, ...

In case of EtherCAT sensors are used (EtherCAT master sends the actual pressure value of the sensor via EtherCAT to the valve), there are two additional scalers for digital sensor inputs.

Overall there are six individual scalers:

EtherCAT	Position Scaler	
	Pressure Scaler	
	Digital Sensor Input 1 Scaler	Only used for EtherCAT sensors
	Digital Sensor Input 2 Scaler	Only used for EtherCAT sensors
Service (CPA over USB)	Position Scaler	
	Pressure Scaler	

Parameter location EtherCAT scaler

CPA	EtherCAT
Interface EtherCAT->Scaling	Objects 2610
<p>Note: The scalers “Digital Sensor 1 Input” and “Digital Sensor 2 Input” are only visible if a sensor is configured as EtherCAT sensor. For more information how to configure an EtherCAT sensor see chapter «Sensor configuration».</p>	

Parameter location Service (CPA over USB) scaler

CPA	EtherCAT
	-(no access)

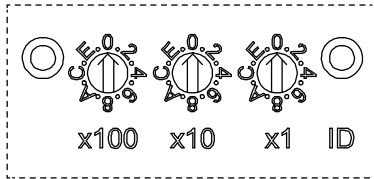
4.6 EtherCAT configuration

4.6.1 Device identification value

The Device Identification value (ID) is set by three hexadecimal rotary switches. That means the supported address range is 0-0xFFFF in hexadecimal or 0-4095 in decimal.



The Device Identification value is read once after power on.



Example: 0

4.6.2 Connection Loss Reaction

Connection Loss reaction defines what the valve is doing in case the EtherCAT connection get lost.

Parameter	Description
Enable	'True' enables the connection loss reaction, in case of 'False' there is no reaction on a connection loss
State	Current connection loss state
Functionality	Defines the functionality in case of connection loss. This can be "open" or "close".

Parameter location

CPA	EtherCAT
Interface EtherCAT->Connection Loss Reaction	Objects 2601:03 and 2601:04

4.7 Valve configuration

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

- **After power up**, default is 'close'.
- **Power failure**, default is 'not defined'. Only for versions that have Power Fail Option equipped [653 . . . **C** or 653 **H**].
- **Network failure**, for default settings refer to individual product data sheet.

4.7.1 Homing Start Option

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

Parameter	Description														
Start Condition	Homing start option defines when the valve performs the homing procedure. <table border="0"> <tr> <td>Standard</td> <td>Do homing after restart if valve is not in sealed state</td> </tr> <tr> <td>Open Command</td> <td>Do homing on an open command</td> </tr> <tr> <td>Move Command</td> <td>Do homing on any move command</td> </tr> <tr> <td>At Startup</td> <td>Do homing after restart</td> </tr> <tr> <td>Homing Command</td> <td>Do homing on homing command</td> </tr> <tr> <td>Move</td> <td>Settings from move commands, without homing in close position by close command</td> </tr> <tr> <td>Command/Standard</td> <td></td> </tr> </table>	Standard	Do homing after restart if valve is not in sealed state	Open Command	Do homing on an open command	Move Command	Do homing on any move command	At Startup	Do homing after restart	Homing Command	Do homing on homing command	Move	Settings from move commands, without homing in close position by close command	Command/Standard	
Standard	Do homing after restart if valve is not in sealed state														
Open Command	Do homing on an open command														
Move Command	Do homing on any move command														
At Startup	Do homing after restart														
Homing Command	Do homing on homing command														
Move	Settings from move commands, without homing in close position by close command														
Command/Standard															
End Control Mode	This control mode is set after a successful homing.														
End Position	In case the "End Control Mode" is set to "Position", this parameter defines which position is set after successful homing.														

Parameter location:

CPA	EtherCAT
Valve->Homing	Objects 2120

4.7.2 Power Failure Option

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

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

Parameter location:

CPA	EtherCAT
Power Fail Option	Object 2E00

4.7.3 Digital I/O

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

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

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

Parameter location:

CPA	EtherCAT
Power Connector IO	Objects 2C01, 2C02, 2C03, 2C04

4.8 Sensor configuration

Basic sensor configuration must be adapted according to application needs.

- ZERO function: This may be 'disabled' or 'enabled'. Default is 'enabled'. Refer also to chapter «ZERO ADJUST».
- Sensor configuration with 2 sensor version [653 X -]. Refer also to chapter: «Pressure control operation with 2 sensors».

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

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

“Sensor Crossover” defines the behavior when the actual pressure is around the upper limit of the low range sensor and define what sensor signal is used for building the Actual Pressure.

Parameter	Description
Crossover Mode	<p>Execution method of the transient area from one sensor to the other:</p> <ul style="list-style-type: none"> 0: Soft Switch Actual Pressure is a summation of the pressure value of sensor 1 and sensor 2. 1: Hard Switch Actual Pressure is the value of sensor 1 or sensor 2 2: Target Pressure During pressure control: If Target Pressure falls into low range sensor, the low sensor is used for Actual Pressure. In other case the high range sensor is used. During position control: 'Soft Switch' is used.
Threshold High [SFS low sensor] Threshold Low [SFS low sensor]	<p>Defines the crossover area in Crossover Mode 'Soft Switch' and 'Hard Switch'.</p> <p>Example: Threshold High = 1.0 [SFS of low sensor] Threshold Low = 0.9 [SFS of low sensor]</p> <p><u>Soft switch:</u> At pressure $\leq 0.9 \cdot \text{SFS low sensor}$: Actual Pressure = Sensor low pressure At pressure $0.95 \cdot \text{SFS low sensor}$: Actual Pressure = 50% * Sensor low pressure + 50% sensor high pressure At pressure $\geq 1.0 \cdot \text{SFS low sensor}$: Actual Pressure = Sensor high pressure</p> <p><u>Hard switch:</u> At pressure increase over $1.0 \cdot \text{SFS low sensor}$: Actual Pressure = Sensor high pressure after Delay At pressure decrease under $0.9 \cdot \text{SFS low sensor}$: Actual Pressure = Sensor low pressure after Delay</p>
Delay	Switch over delay in Crossover Mode 'Hard Switch', see example above.



ONLY USED FOR ETHERCAT SENSORS!

For EtherCAT sensors the range/scaling for the PDO object "Pressure Input Digital Sensor 1" and "Pressure Input Digital Sensor 2" is needed. For example the EtherCAT sensor is configured to deliver pressure value in the unit of Pascal, it's possible to also select the unit Pascal for Pressure Input Digital Sensor scaler so the EtherCAT master can directly transfer the sensor data to the valve.

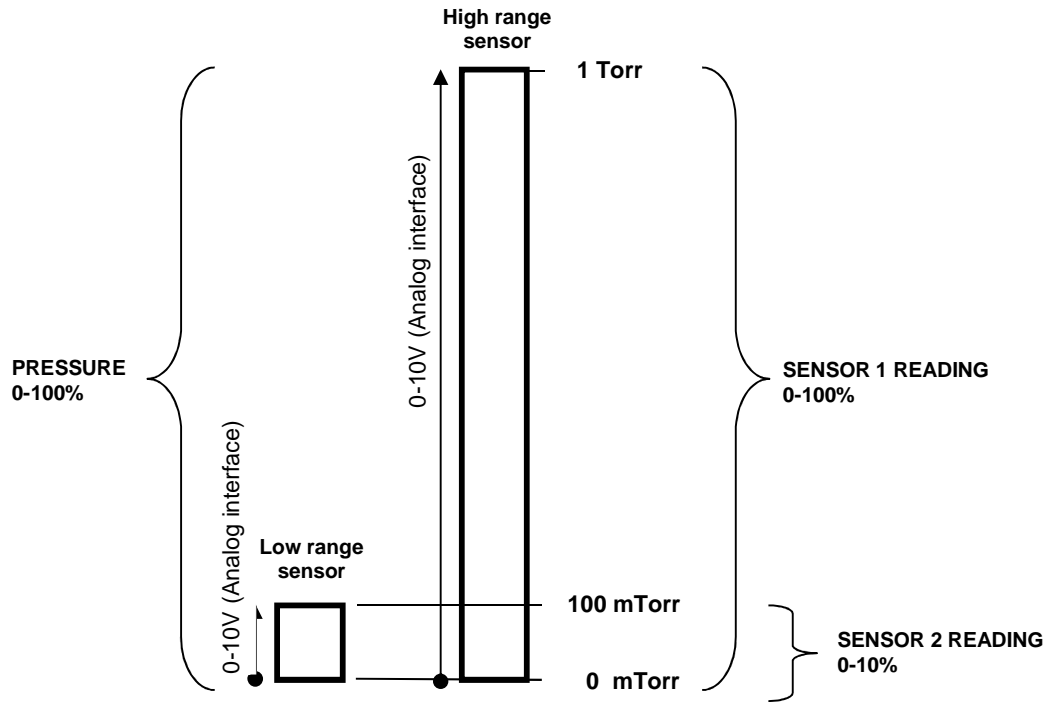
Parameter	Description
Pressure Unit	<p>Choose the unit of the pressure value sent to "Pressure Input Digital Sensor 1" or "Pressure Input Digital Sensor 2". Following units are available:</p> <ul style="list-style-type: none"> • Pa • kPa • bar • mbar • Torr • mTorr • psi • user specific (see parameter below)
Value Sensor x Upper Limit Data Value Value Sensor x Lower Limit Data Value	<p>Only used if Pressure Unit is set to 'user specific'.</p> <p>Defines the range for the pressure value sent to the digital pressure input. ('Pressure Input Digital Sensor 1' or 'Pressure Input Digital Sensor 2')</p> <p>The value corresponds to Range.Upper Limit Data Value and Range.Lower Limit Data Value</p> <p>For Example: 250mTorr sensor but digital value from sensor has range of 0 ... 10000</p> <p>Settings: Range.Upper Limit Data Value = 250.0 mTorr Range.Lower Limit Data Value = 0.0 mTorr Value Sensor x Upper Limit Data Value = 10000.0 Value Sensor x Lower Limit Data Value = 0.0</p> <p>So for example digital value of 5000 results in a pressure value of 125.0 mTorr</p> <p>Note: If digital value is equal to the range of the sensor both data values have the same values: Value Sensor x Upper Limit Data Value = 250.0 Value Sensor x Lower Limit Data Value = 0 Range.Upper Limit Data Value = 250.0 mTorr Range.Lower Limit Data Value = 0.0 mTorr</p>

Parameter location:

CPA	EtherCAT
Pressure Sensor->Sensor 1	2401
Pressure Sensor->Sensor 2	2401
Pressure Sensor->Crossover	2405
Interface EtherCAT->Scaling->Digital Sensor 1 Input	2610:09, 2610:0A, 2610:0B
Interface EtherCAT->Scaling->Digital Sensor 2 Input	2610:0D, 2610:0E, 2610:0F

Example:

Configure an application with two sensors, a 1 Torr sensor on sensor input 1 and a 100 mTorr sensor on sensor input 2



Analog sensors:

<p> Sensor 1.Available = 1 Sensor 1.Enable = 1 Sensor 1.Range.Data Unit = Torr Sensor 1.Range.Upper Limit Data Value = 1.0 Sensor 1.Range.Lower Limit Data Value = 0.0 Sensor 1.Range.Upper Limit Voltage Value = 10.0 Sensor 1.Range.Lower Limit Voltage Value = 0.0 Sensor 1.Range.Scale = Linear Sensor 1.Input Source = Analog </p>	<p> Sensor 2.Available = 1 Sensor 2.Enable = 1 Sensor 2.Range.Data Unit = mTorr Sensor 2.Range.Upper Limit Data Value = 100.0 Sensor 2.Range.Lower Limit Data Value = 0.0 Sensor 2.Range.Upper Limit Voltage Value = 10.0 Sensor 2.Range.Lower Limit Voltage Value = 0.0 Sensor 2.Range.Scale = Linear Sensor 2.Input Source = Analog </p>
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EtherCAT sensors:

<p> Sensor 1.Available = 1 Sensor 1.Enable = 1 Sensor 1.Range.Data Unit = Torr Sensor 1.Range.Upper Limit Data Value = 1.0 Sensor 1.Range.Lower Limit Data Value = 0.0 Sensor 1.Range.Scale = Linear Sensor 1.Input Source = Digital </p> <p> Assumption: EtherCAT sensor delivers values in the unit of Torr. Configure the scaler for "Pressure Input Digital Sensor 1" (PDO object) that the EtherCAT master can directly transfer the signal to the valve: </p> <p> Digital Sensor 1 Input.Pressure Unit = Torr </p>	<p> Sensor 2.Available = 1 Sensor 2.Enable = 1 Sensor 2.Range.Data Unit = mTorr Sensor 2.Range.Upper Limit Data Value = 100.0 Sensor 2.Range.Lower Limit Data Value = 0.0 Sensor 2.Range.Scale = Linear Sensor 2.Input Source = Digital </p> <p> Assumption: EtherCAT sensor delivers values in the unit of Torr. Configure the scaler for "Pressure Input Digital Sensor 2" (PDO object) that the EtherCAT master can directly transfer the signal to the valve: </p> <p> Digital Sensor 2 Input.Pressure Unit = Torr </p>
--	---

4.8.1 Zero Adjust

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

When Zero Adjust is performed the current value at the sensor input is equated to Zero.Adjust Target Pressure.

In case of a 2 sensor system both sensor inputs will be adjusted.

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

To execute a zero adjust, the zero adjust have to be enabled (see chapter above).

Parameter	Description
Zero Adjust.Sensor Selection	Select the sensor for the zero adjust: <ul style="list-style-type: none"> • Sensor 1 + 2 • Sensor 1 • Sensor 2
Zero Adjust.Target Pressure	Normally this parameter is set to 0 in case the process chamber is fully evacuated (which means pressure value is nearly 0). If not you can align the sensor value to a known pressure. In this case set Target Pressure to the current pressure. Note: Target Pressure is in the unit of pressure, see chapter «Scaling of Pressure and Position Values»
Zero Adjust.Execute	Start the zero adjust by set Execute to 1 At this moment offset value will be calculated and Sensor x.Value = Target Pressure. The resulting offset value can be read on parameter Sensor x.Offset Value [SFS] Clear the offset values by setting Execute to 2 The result of clearing the zero adjust: Sensor x.Offset Value [SFS] = 0.0
Sensor 1.Enable Sensor 2.Enable	0: It's not possible to execute a zero adjust. A present offset value is ignored. 1: It's possible to execute a zero adjust. A present offset value is respected.
Sensor 1.Offset Value [SFS] Sensor 2.Offset Value [SFS]	Value which will be subtracted from measured sensor value The value is related to sensor full scale (0.1 means 10% of sensor full scale)

Parameter location:

CPA	EtherCAT
Pressure Sensor->Zero Adjust	2400
Pressure Sensor->Sensor 1->Zero Adjust	2401:0A
Pressure Sensor->Sensor 2->Zero Adjust	2402:0A
Pressure Sensor->Sensor 1->Zero Adjust	2401:0B
Pressure Sensor->Sensor 2->Zero Adjust	2402:0B

Performing a zero adjust:

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

For EtherCAT it's also possible to execute the zero adjust with the object «GENERAL CONTROL SETPOINT» of the PDO communication. In both case (perform the zero adjust **with Sensor Selection, Execute** and **Execute** or **GENERAL CONTROL SETPOINT**) the result is the same:

1. Wait until process chamber is evacuated and sensor signal is not shifting anymore. Do not perform Zero Adjust as long as pressure gauge voltage is shifting otherwise incorrect pressure reading is the result. Refer to manual of sensor manufacturer for warm up time.
2. In «OUTPUT Buffer» > «GENERAL CONTROL SETPOINT» set Bit 0 (rising edge).
3. Wait until Bit1 of «GENERAL STATUS» is set (see INPUT Buffer).



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

4.9 Learn (adaptive control algorithm)

LEARN adapts the PID controller of the valve to the vacuum system and its operating conditions. LEARN must be executed only once during system setup. The LEARN routine determines the characteristic of the vacuum system. Based on this, the PID controller is able to run fast and accurate pressure control cycles. This characteristic depends on various parameters such as chamber volume, conductance and flow regime. Therefore it must be performed with a specific gas flow according to instruction below.

The result of LEARN is a pressure versus valve position data table. This table is used to adapt the PID parameters. The data table is stored in the device memory which is power fail save. The data table can be up-/downloaded via 'Control Performance Analyzer' software or remote interface. Due to encoding the data may not be interpreted directly.

By an OPEN VALVE, CLOSE VALVE, POSITION CONTROL or PRESSURE CONTROL command the routine will be interrupted.

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

Parameter location:

CPA	EtherCAT
Pressure Control->Adaptive Learn	2350

Execute a learn procedure:

1. Set specific gas flow according to calculation below and wait until flow is stable. Learn does not need to be performed with the process gas. Instead N₂ or Ar may be used.
2. Set parameter **Bank Selection**, if only one learn is used take Bank 1. Be sure that the pressure controller also selects this learn bank!
3. Set parameter **Open Speed**. If it's critical for the chamber, if the pressure falls rapidly while opening the valve, reduce the open speed.
4. Set parameter **Controller Mode = LEARN**.
5. Wait till **Controller Mode** leave to **LEARN** state → Learn procedure is finished
6. Check if the learn was successful by checking if **Status** shows value 2 (=Completed Successfully). In best case **Warning Info** shows no warning.



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

Gasflow calculation for LEARN:


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

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

- 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.

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

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**]

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

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

- Out of these calculated conductance values choose the lowest.

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

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



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

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

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

q_L gasflow for learn [**Pa m³/s**]
 p_{SFS} sensor full scale pressure [**Pa**]
 C_{min} min. controllable conductance of valve [l/s], (refer to «Technical data»)

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

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

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

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

4.10 Pressure Control

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

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

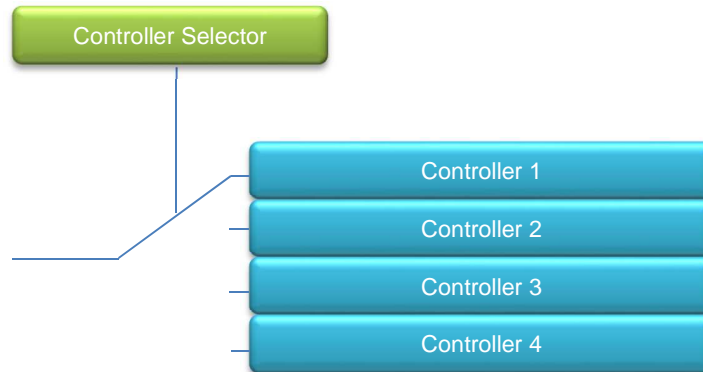


Figure 1: The Controller Selector selects the controller.

4.10.1 Pressure control operation with 2 sensors

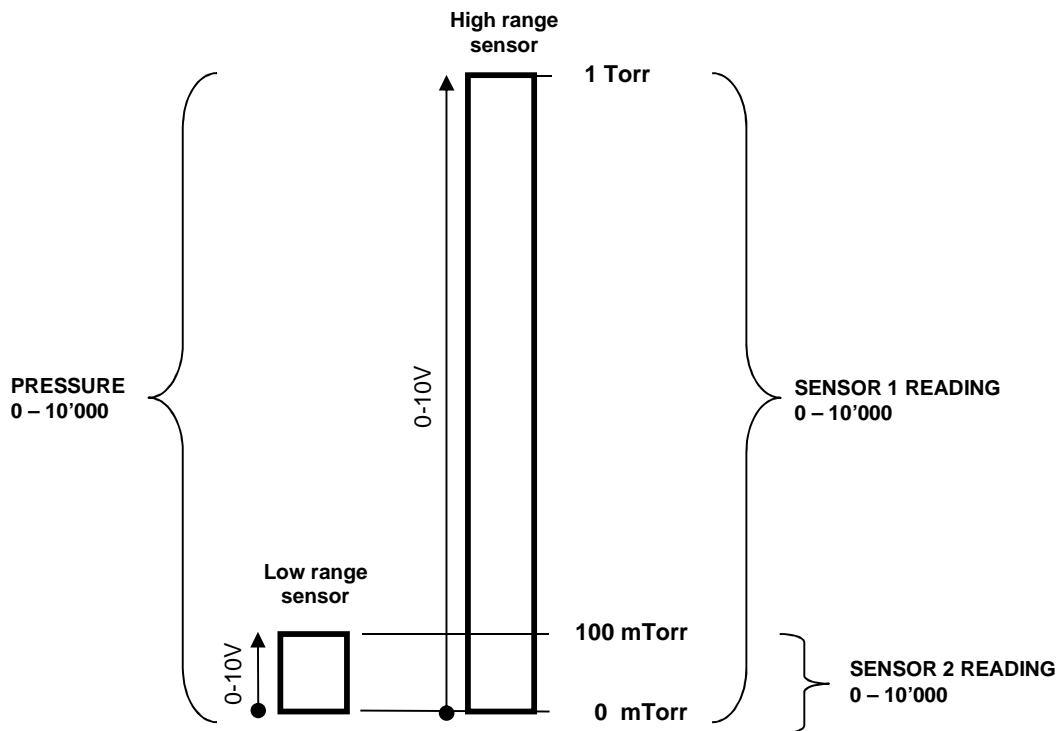
If 2 sensor operation is enabled, changeover between the sensors is done automatically during pressure control. For configuration refer to chapter «Setup procedure». We recommend a ratio of 10:1 between the pressure gauges. Max. ratio is 100:1. High range respectively low range pressure gauge may be either connected to sensor 1 or sensor 2 input. It's required to do correct sensor configuration.

Between 90 and 100% of the low range sensor full scale, the low range sensor is phased out while high range sensor is phased in during pressure rise. During pressure decrease the high range sensor is phased out while low range sensor is phased in. This maintains a functional response behavior in case of small calibration errors between the two sensors. The PRESSURE output in this range is a blend between both sensors.

For monitoring purpose each sensor signal may be read out individually. Refer to «inquiry commands SENSOR 1 READING and SENSOR 2 READING»



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



4.10.2 Control parameters

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

4.10.2.1 Control algorithm

Parameter location:

CPA	EtherCAT
Pressure Control Pressure Control->Pressure Controller 1 Pressure Control->Pressure Controller 2 Pressure Control->Pressure Controller 3 Pressure Control->Pressure Controller 4	2199

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

Control Algorithm	Description
<i>Adaptive</i>	This is the most dynamic control algorithm. Before using adaptive control algorithm, a special procedure called "learn" must be executed first (see chapter x). The valve will observe the behavior of the vacuum system by moving the valve to different positions. During the learn procedure the valve performs an internal parameter estimation correspondent to the vacuum system. Note: The adaptive pressure control work at its best if the conditions (mainly gas flow) are close the conditions at the learn procedure.
<i>PI</i>	This is a solid algorithm for pressure control. The performance will be behind the adaptive control algorithm. But if the condition varies a lot, it's possible that the adaptive control algorithm does not work properly so the PI algorithm provides the best result.
<i>Soft Pump</i>	Is a modified PI control algorithm to pump down from atmospheric pressure. This control algorithm has been optimized to prevent that the pressure in the chamber is falling too fast (reduce occurrence of undershoots).

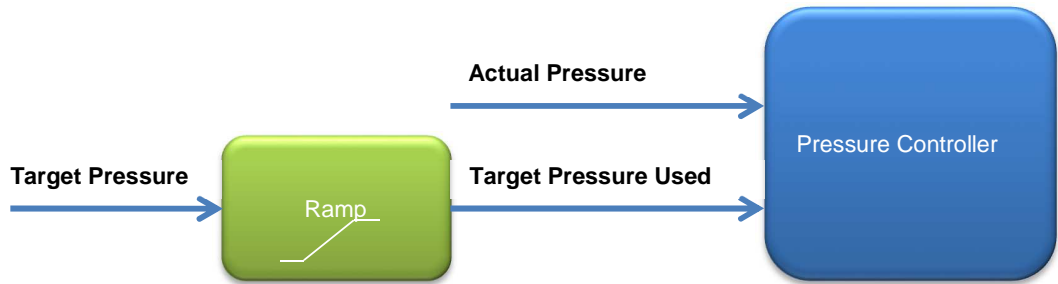
4.10.2.2 Control parameter

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

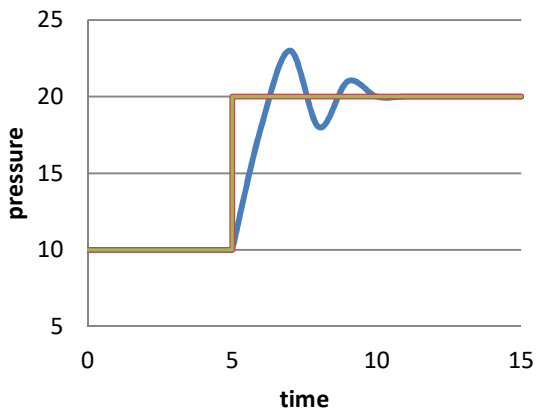
	Parameter	Description
Adaptive	Gain Factor	<i>The Gain Factor is a control parameter to adapt the performance of the pressure control algorithm. A higher gain results in a faster response, higher over- / undershoots of pressure. A lower gain results in slower response, lower over- / undershoot of pressure.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

4.10.2.3 Pressure ramp

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

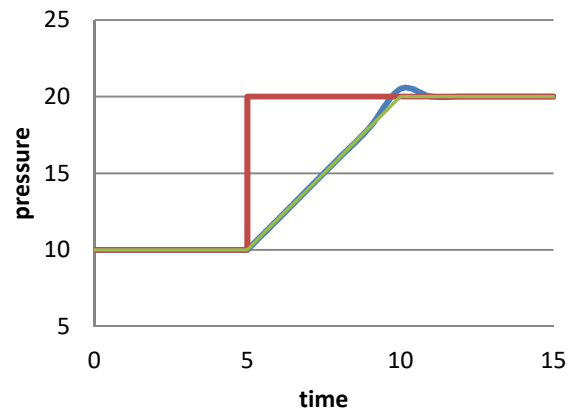


New **Target Pressure without** pressure ramp



- Actual Pressure
- Target Pressure
- Target Pressure Used (ramp)

New **Target Pressure with** pressure ramp



- Actual Pressure
- Target Pressure
- Target Pressure Used (ramp)

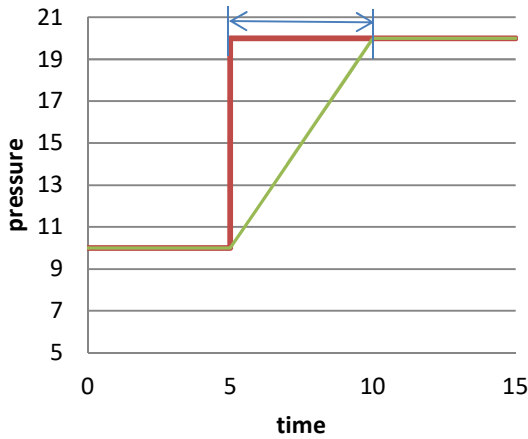
4.10.2.4 Pressure ramp configuration

Time Mode (Ramp Mode = Time)

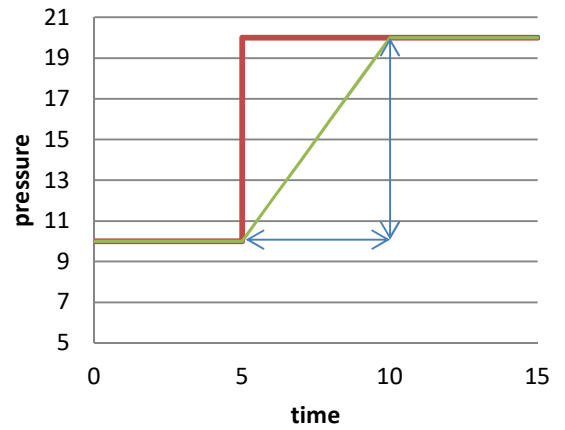
The time within **Target Pressure Used** (ramp) reaches a new **Target Pressure** is defined in parameter value **Ramp Time**. **Ramp Time** is a value in the unit [seconds].

Slope Mode (Ramp Mode = Slope)

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



— Target Pressure
— Target Pressure Used (ramp)



— Target Pressure
— Target Pressure Used (ramp)

4.10.3 Choose correct control algorithm

Select the configuration what your application needs.

System Configuration	Constant gas flow available		Constant gas flow not available
	Tv* <= 500 sec	Tv* > 500 sec	
<p>Downstream</p>	<p>Adaptive pressure controller</p>	<p>Fixed pressure controller</p>	
<p>Upstream</p>	<p>Fixed pressure controller</p>		
<p>Soft Pump</p>	<p>Soft Pump</p>		



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

$$T_v = \frac{P_{SFS} \cdot CV}{q_L}$$

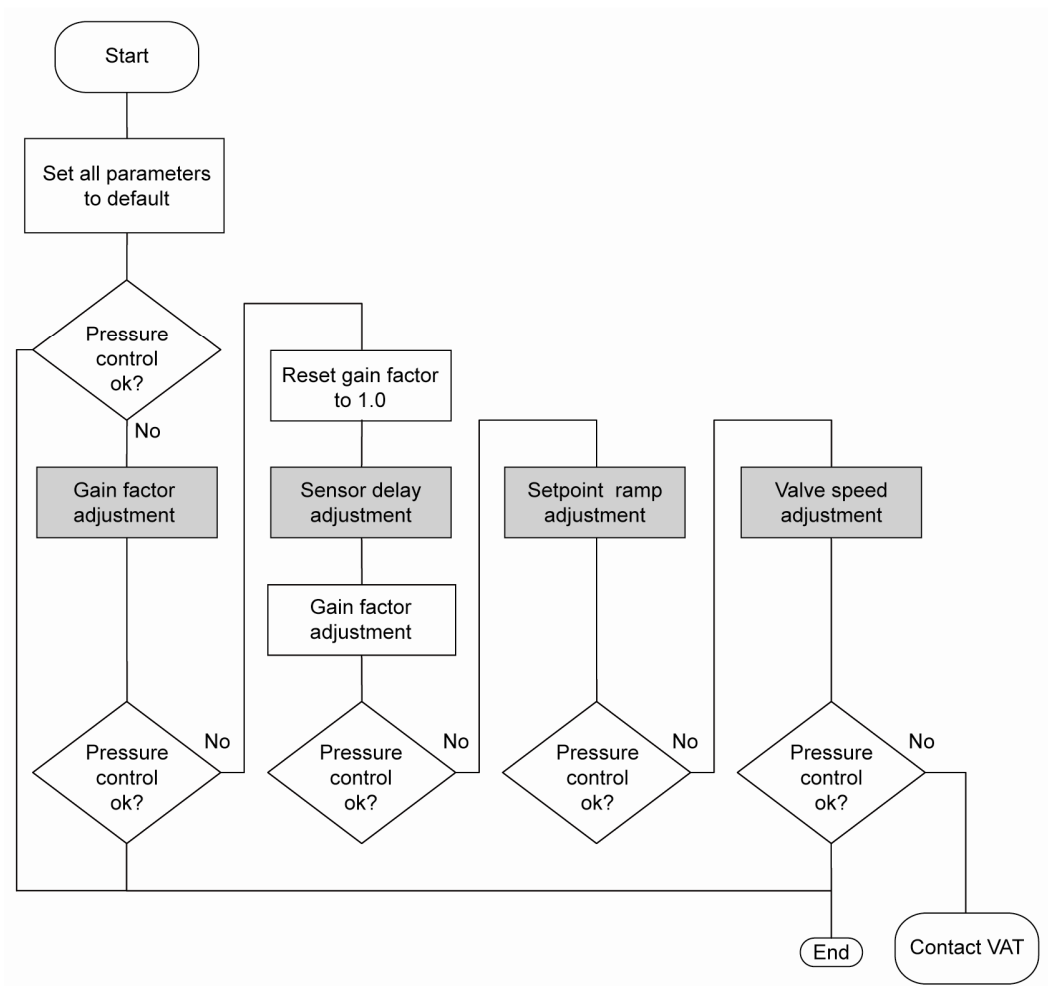
- q_L** gasflow for learn [mbar/s]
- p_{SFS}** sensor full scale pressure [mbar]
- Tv*** Vacuum time constant [sec]
- CV** Chamber Volume [l]

4.10.4 Tuning of control performance

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

4.10.4.1 Tuning of control performance with adaptive pressure controller

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



Gain factor adjustment

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

Adjustment range is from 0.0001 to 7.5.

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

Adjustment procedure:

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



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

Sensor delay adjustment

Sensor delay adjustment effects: **Stability**

Adjustment range is from 0 to 1.0s.

Pipes and orifices for sensor attachment delay response time and so badly impact pressure control stability.

By adapting this parameter to the approximate delay time stability problems can be reduced. But control response time will be slowed down by this measure.



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

Adjustment procedure:

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

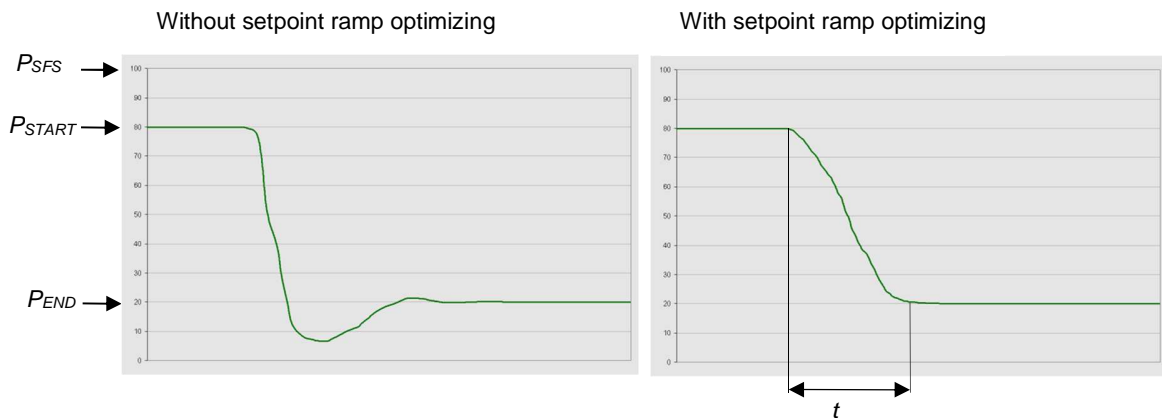
Setpoint ramp adjustment

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

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

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

Pressure chart



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

$$t = \text{Setpoint Ramp}$$

Adjustment procedure:

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



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

Valve speed adjustment

Valve speed effects: **Response time**

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

This parameter effects valve plate actuating speed.

Speed adjustment is effective for PRESSURE CONTROL and POSITION CONTROL.



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

Adjustment procedure:

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

Required information for support:

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

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

4.10.4.2 Tuning of control performance with fixed PI pressure controller

Optimizing P gain and I gain

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



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

Introduction

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

1. Optimizing P gain and I gain

1.1 Pressure and gas flow for optimization

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

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

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

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

1.2 Optimizing P gain

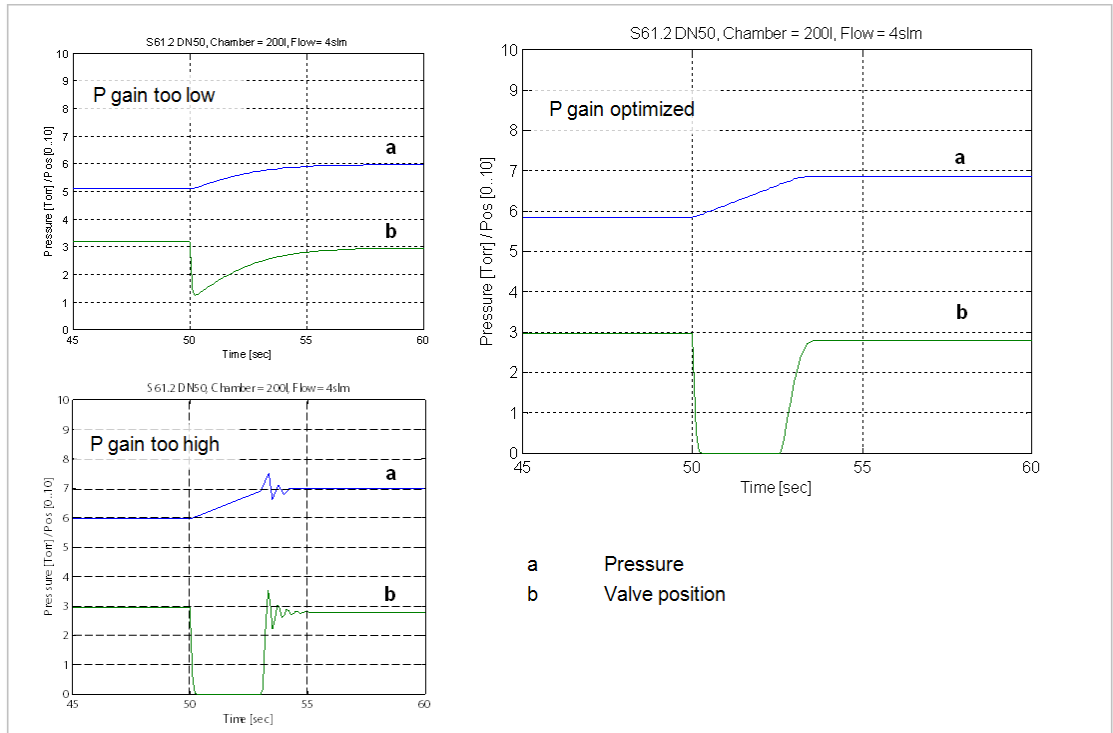
While optimizing P gain, the gas flow determined above has to be constant all the time.

Start optimization with P gain set to 1.0 and I gain set to 0.0.

Set chamber pressure to SP2, wait until the pressure is stable. Set pressure to SP1. If the transition from SP2 to SP1 results in a significant pressure over shoot or even does not stabilize at all, the P gain is too high. If there is no over shoot and the pressure reaches SP1 asymptotically and very slow, P gain is too low.

The optimal P gain value is found if the transition from SP2 to SP1 results in a slight pressure over shoot. It does not matter if there is still a deviation between SP1 and actual pressure.

Example:



1.3 Optimizing I gain

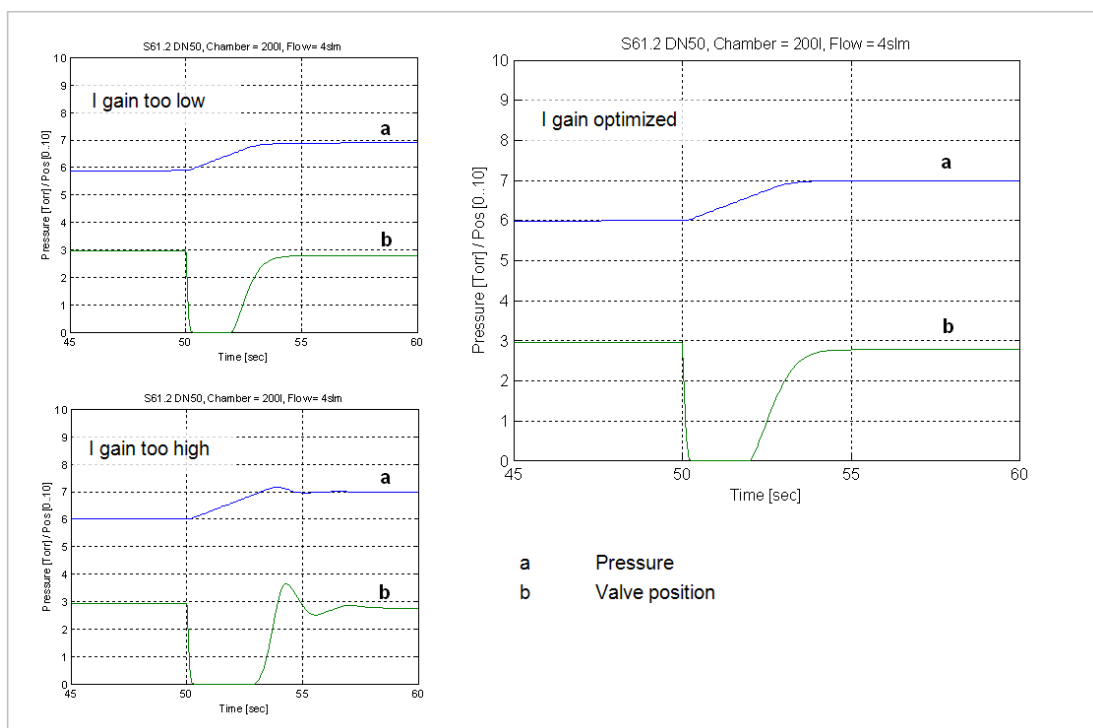
While optimizing I gain, the gas flow determined above has to be constant all the time.

Start with P gain set to half of the value found when optimizing P gain and set I gain to 1.0. Keep the P gain constant.

Set chamber pressure to SP2, wait until the pressure is stable. Set pressure to SP1. If the transition from SP2 to SP1 results in a significant pressure over shoot or if the valve position does not stabilize, I gain is too high. If the transition results in a slow asymptotical pressure rise and there is still a constant deviation to SP2, the I gain is too low.

The optimal value for I gain is found if the transition from SP2 to SP1 result in just a slight pressure over shoot, a stable valve position and the actual pressure matches SP2 exactly.

Example:



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

Required information for support:

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

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

4.10.4.3 Tuning of control performance with soft pump pressure controller

Optimizing P gain

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

Introduction

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

1. Optimizing P gain

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

1.1 Basic settings

The pump down characteristic is determined by start pressure, end pressure and pump down time. This straight line from start pressure to end pressure.

The VAT soft pump controller requires a pump down time shorter than 10 sec. for good control results. If the required pump down time is longer than 10 sec., the pump down curve has to be partitioned into sections shorter than 10 sec. with corresponding end pressure.

Example:

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

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

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

1.2 Optimizing P gain

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

Move control valve into close position

Start pump down by opening the pump isolation valve or starting the pump and sending the first pressure set point to the valve controller. With the example above, the first pressure set point is 510 Torr.

At each new interval (exceeding 10 sec) send the new pressure set point.

Repeat until process pressure is achieved.

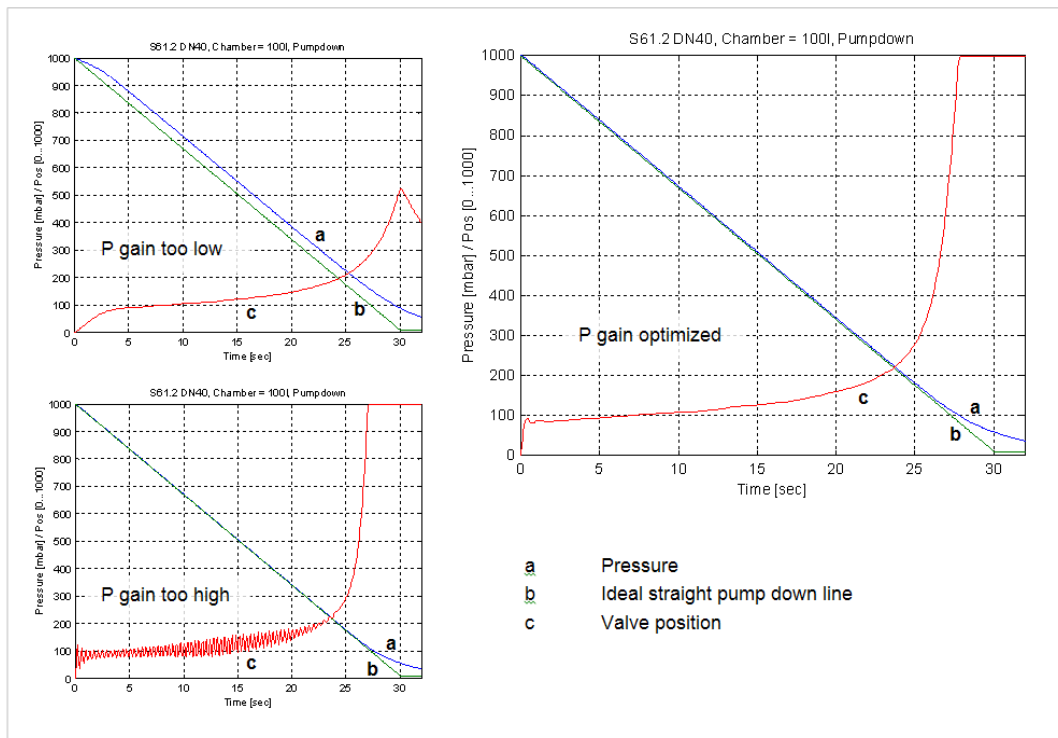
While pumping down chamber pressure and valve position should be data logged to compare the actual pump down curve with the ideal straight pump down line.

If the pressure follows the ideal pump down line with significant delay, the P gain is too low.

If the pressure oscillates around the ideal pump down line or if the valve position oscillates, P gain is too high.

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

Example:



Required information for support:

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

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

4.11 EtherCAT interface (Process data – cyclic communication)

4.11.1 RxPDO Output mappings

The EtherCAT process data mapping is done automatically corresponding to the following list and respectively to the sync manager information.

Mapping object	Mapping content
0x1600	SINT32 Target Pressure SINT32 Target Position SINT32 Pressure Input Digital Sensor 1 SINT32 Pressure Input Digital Sensor 2 SINT8 Control Mode UINT16 General Control Setpoint FLOAT Pressure Ramp Time
0x1601 (default)	FLOAT Target Pressure FLOAT Target Position FLOAT Pressure Input Digital Sensor 1 FLOAT Pressure Input Digital Sensor 2 SINT8 Control Mode UINT16 General Control Setpoint FLOAT Pressure Ramp Time
0x1602	SINT32 Target Pressure SINT32 Target Position SINT32 Pressure Input Digital Sensor 1 SINT32 Pressure Input Digital Sensor 2 SINT8 Control Mode UINT16 General Control Setpoint
0x1603	FLOAT Target Pressure FLOAT Target Position FLOAT Pressure Input Digital Sensor 1 FLOAT Pressure Input Digital Sensor 2 SINT8 Control Mode UINT16 General Control Setpoint
0x1604	SINT32 Target Position SINT8 Control Mode UINT16 General Control Setpoint
0x1605	FLOAT Target Position SINT8 Control Mode UINT16 General Control Setpoint
0x16FF	Configurable mapping object

Signal Type	Name	Byte Length	Data Type	Valid Range	Description
Signal	TARGET PRESSURE	4	floating point (default) or signed integer	Value in [mBAR] (default), adjustable ¹⁾	In case of the valve is in pressure mode (CONTROL MODE = Pressure (5)), the signal is used as setpoint value.
Signal	TARGET POSITION	4	floating point (default) or signed integer	0..100 (default), adjustable ¹⁾	In case of the valve is in position mode (CONTROL MODE = Position (2)), the signal is used as setpoint value. Minimum Position: Valve is moved to minimum control position but is not isolated/sealed if the valve has an isolation / sealing functionality (e.g. series 655).
Signal	PRESSURE INPUT DIGITAL SENSOR 1	4	floating point (default) or signed integer	Value in [mBAR] (default), adjustable ¹⁾	Is used as "external digital" pressure sensor signal instead of the analog pressure sensor signal that is hard wired / connected to the valve via the sensor connector.
Signal	PRESSURE INPUT DIGITAL SENSOR 2	4	floating point (default) or signed integer	Value in [mBAR] (default), adjustable ¹⁾	Is used as "external digital" pressure sensor signal instead of the analog pressure sensor signal that is hard wired / connected to the valve via the sensor connector.
Signal	CONTROL MODE	1	unsigned integer	1...7	1 = Homing 2 = Position: Position control mode 3 = Close: The valve is closed ²⁾ 4 = Open: The valve is opened 5 = Pressure: Pressure control mode 6 = Hold: Valve is kept in current position 7 = Learn: Valve starts the internal learn procedure
Bitmap	GENERAL CONTROL	2	boolean array	-	-
Signal	PRESSURE RAMP TIME	1	Floating point	0...10E6	Time in ms

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

GENERAL CONTROL SETPOINT bitmap table:

Bit		Description												
0	ZERO ADJUST	0 = No Operation 1 = ZERO adjust, the actual pressure signal is set to internal pressure 0. The valid range for adjustment is limited to -1.4V...+1.4! Otherwise the sensor must be adjusted!												
1	NOT USED (reserved)	-												
2	PING PONG TX BIT	PING PONG TX BIT transmitted from the master (PLC), is used to check the loop "master PLC - VAT station".												
3	NOT USED (reserved)	-												
4	ACCESS MODE LOCKED	<table border="1"> <thead> <tr> <th>Start mode</th> <th>Access mode locked bit</th> <th>End mode</th> </tr> </thead> <tbody> <tr> <td>local</td> <td>Set bit: 0→1</td> <td>locked</td> </tr> <tr> <td>locked</td> <td>Reset bit: 1→0</td> <td>remote</td> </tr> <tr> <td>remote</td> <td>Set bit: 0→1</td> <td>locked</td> </tr> </tbody> </table>	Start mode	Access mode locked bit	End mode	local	Set bit: 0→1	locked	locked	Reset bit: 1→0	remote	remote	Set bit: 0→1	locked
		Start mode	Access mode locked bit	End mode										
		local	Set bit: 0→1	locked										
		locked	Reset bit: 1→0	remote										
remote	Set bit: 0→1	locked												
Example:														
1. from local to locked - 1st step : set bit (0→1)														
2. from local to remote - 1st step : set bit (0→1) - 2nd step: reset bit (1→0)														
3. from remote to locked - 1st step : set bit (0→1)														
4. from locked to remote - 1st step : reset bit (1→0)														
5-15	NOT USED (reserved)	-												

4.11.2 TxPDO Input mappings

The EtherCAT process data mapping is done automatically corresponding to the following list and respectively to the sync manager information.

Mapping object	Mapping content
0x1A00	SINT32 Actual Pressure SINT32 Pressure Sensor 1 SINT32 Pressure Sensor 2 SINT32 Actual Position SINT8 Control Mode UINT16 Error Number UINT16 General Status UINT16 General Warnings UINT32 Extended Warnings
0x1A01 <i>(default)</i>	FLOAT Actual Pressure FLOAT Pressure Sensor 1 FLOAT Pressure Sensor 2 FLOAT Actual Position SINT8 Control Mode UINT16 Error Number UINT16 General Status UINT16 General Warnings UINT32 Extended Warnings
0x1A02	SINT32 Actual Position SINT8 Control Mode UINT16 Error Number UINT16 General Status UINT16 General Warnings UINT32 Extended Warnings
0x1A03	FLOAT Actual Position SINT8 Control Mode UINT16 Error Number UINT16 General Status UINT16 General Warnings UINT32 Extended Warnings
0x1AFF	Configurable mapping object

Signal Type	Name	Byte Length	Data Type	Valid Range	Description
Signal	ACTUAL PRESSURE	4	signed integer (default) or floating point	Value in [mBAR] (default), adjustable ¹⁾	
Signal	PRESSURE SENSOR 1	4	signed integer (default) or floating point	Value in [mBAR] (default), adjustable ¹⁾	
Signal	PRESSURE SENSOR 2	4	signed integer (default) or floating point	Value in [mBAR] (default), adjustable ¹⁾	
Signal	ACTUAL POSITION	4	signed integer (default) or floating point	0..100 (default), adjustable ¹⁾	Note: Minimum value for ACTUAL POSITION do not mean that the valve is sealed (if sealing functionality is available). For this refer to the bit SEALING STATE in General Status .
Signal	CONTROL MODE	1	unsigned integer	0...14	0 = init 1 = homing 2 = position 3 = close 4 = open 5 = pressure 6 = hold 7 = learn 8 = interlock open 9 = interlock close 12 = power failure 13 = safety 14 = fatal error
Signal	ERROR NUMBER	2	unsigned integer	200...888	To adjust range refer to chapter: «Errors»
Bitmap	GENERAL STATUS	2	boolean array		See bitmap table below
Bitmap	GENERAL WARNING	2	boolean array		See bitmap table below
Bitmap	EXTENDED WARNING	2	boolean array		See bitmap table below

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

GENERAL STATUS bitmap table:

Bit		Description															
0	FIELD BUS DATA VALID	0 = Valve is not in the EtherCAT state OPERATIONAL or the process data output watchdog (SyncManager2) is disabled 1 = Valve is in the EtherCAT state OPERATIONAL and the process data output watchdog (SyncManager2) is enabled															
1	ZERO ADJUST EXECUTED	ZERO ADJUST successful executed, active for 2 seconds															
2	PING PONG RX-BIT	PING PONG RX BIT, is inverted and transmitted back to the fieldbus master (PLC)															
3	PRESSURE SIMULATION	0 = off 1 = on															
4	TARGET PRESSURE REACHED	0 = The actual pressure is not within 2% of the pressure setpoint 1 = The actual pressure is within 2% of the pressure setpoint															
5-6	NOT USED (reserved)	-															
7-8	ACCESS MODE	<table border="0"> <tr> <td>bit</td> <td>bit</td> <td></td> </tr> <tr> <td>8</td> <td>7</td> <td></td> </tr> <tr> <td>0</td> <td>0</td> <td>= LOCAL</td> </tr> <tr> <td>0</td> <td>1</td> <td>= REMOTE</td> </tr> <tr> <td>1</td> <td>0</td> <td>= LOCKED</td> </tr> </table>	bit	bit		8	7		0	0	= LOCAL	0	1	= REMOTE	1	0	= LOCKED
bit	bit																
8	7																
0	0	= LOCAL															
0	1	= REMOTE															
1	0	= LOCKED															
9	WARNINGS ACTIVE	0 = No WARNINGS 1 = At least one WARNING of the warning bitmaps is active (GENERAL WARNING bitmap and EXTENDED WARNING bitmap)															
10	SEALING STATE	Only valid if a sealing functionality is available. 0 = valve is not sealed 1 = valve is sealed															
11	INTERLOCK ACTIVE	Is set if an interlock input is active															
12-15	NOT USED (reserved)	-															

GENERAL WARNING bitmap table:

Bit		Description
0	NOT USED (reserved)	-
1	LEARN DATA SET	Learn data not present. Learn required for adaptive pressure control. Just active if adaptive pressure control algorithm is chosen.
2	NOT USED (reserved)	-
3	POWER FAILURE BATTERY	Not ready, voltage too low. Just active if power failure is available.
4-15	NOT USED (reserved)	-

EXTENDED WARNING bitmap table:

Bit		Description
0	REMOTE CONTROL NOT POSSIBLE	Remote control not possible, access mode local is active, change to access mode remote or access mode locked
1	ACTUAL CONTROL MODE SETPOINT NOT ALLOWED	Not possible to switch the actual control mode to CONTROL MODE SETPOINT <ul style="list-style-type: none"> • Control mode is interlock or fatal error • CONTROL MODE SETPOINT is 5 (pressure) or 7 (learn) and no sensor is selected (sensor mode configuration)
2	ZERO DISABLED	Using zero function not possible
3	PFO DEACTIVATED	Power Failure Option is deactivated
4	NOT USED (reserved)	-
5	OUT OF RANGE: PRESSURE SETPOINT	Value of PRESSURE SETPOINT is out of range
6	OUT OF RANGE: POSITION SETPOINT	Value of POSITION SETPOINT is out of range
7-9	NOT USED (reserved)	-
10	OUT OF RANGE: CONTROL MODE SETPOINT	Value of CONTROL MODE SETPOINT is out of range
11	OUT OF RANGE: GENERAL CONTROL SETPOINT	Value of GENERAL CONTROL SETPOINT is out of range
12-15	NOT USED (reserved)	-

4.12 EtherCAT interface (Parameter data – acyclic communication)

4.12.1 Standard Object Entries

Index	SI	Name	Data Type	Access	NV	Unit	Min	Max	Description
1000		Device Type	UINT32	RO					0000 0000h (No profile)
1008		Manufacturer Device Name	Visible String	RO					
1009		Manufacturer Hardware Version	Visible String	RO					x.y.z
100A		Manufacturer Software Version	Visible String	RO					w.x.y.z w = Valve Firmware Version mit Firmware-Generation (0,1,..) und -Typ (Customer, Basis, Production), for example 01C15 means firmware generation 01, customer firmware, firmware version 15 x = Valve Firmware Revision y = EtherCAT Stack Firmware z = Drive Firmware(n) Example: 01C15.16.17.18
100B		Manufacturer Bootloader Version	Visible String	RO					
1018		Identity Object	UINT8	RO					
	01	Vendor Id	UINT32	RO					0x0549 for VAT Vakuumventile AG
	02	Product Code	UINT32	RO					
	03	Revision Number	UINT32	RO					
	04	Serial Number	UINT32	RO					
1600		RxPDO Mapping Outputs Integer 1	UINT8	RO					See ESI file for content
1601		RxPDO Mapping Outputs Float 1	UINT8	RO					See ESI file for content
1602		RxPDO Mapping Outputs Integer 2	UINT8	RO					See ESI file for content
1603		RxPDO Mapping Outputs Float 2	UINT8	RO					See ESI file for content
1604		RxPDO Mapping Outputs Integer 3	UINT8	RO					See ESI file for content
1605		RxPDO Mapping Outputs Float 3	UINT8	RO					See ESI file for content
16FF		RxPDO Mapping Outputs User	UINT8	RO					User mapping
1A00		TxPDO Mapping Inputs Integer 1	UINT8	RO					See ESI file for content
1A01		TxPDO Mapping Inputs Float 1	UINT8	RO					See ESI file for content
1A02		TxPDO Mapping Inputs Integer 2	UINT8	RO					See ESI file for content
1A03		TxPDO Mapping Inputs Float 2	UINT8	RO					See ESI file for content
1AFF		TxPDO Mapping Inputs User	UINT8	RO					User mapping
1C00		Sync Manager Communication Type	UINT8	RO					
	01	CommunicationTypeSyncManager0	UINT8	RO					
	02	CommunicationTypeSyncManager1	UINT8	RO					
	03	CommunicationTypeSyncManager2	UINT8	RO					
	04	CommunicationTypeSyncManager3	UINT8	RO					
1C10		Sync Manager 0 PDO Assignment	UINT8	RO					
1C11		Sync Manager 1 PDO Assignment	UINT8	RO					
1C12		Sync Manager 2 PDO Assignment	UINT8	RW					

Index	SI	Name	Data Type	Access	NV	Unit	Min	Max	Description
	01	SubIndex 001	UINT16	RW					
1C13		Sync Manager 3 PDO Assignment	UINT8	RW					
	01	SubIndex 001	UINT16	RW					
1C32		Sync Manager 2 Synchronization	UINT8	RO					
	01	Synchronization Type	UINT16	RO					
	02	Cycle Time	UINT32	RO					
	04	Synchronization Types Supported	UINT16	RO					
1C33		Sync Manager 3 Synchronization	UINT8	RO					
	01	Synchronization Type	UINT16	RO					
	02	Cycle Time	UINT32	RO					
	04	Synchronization Types Supported	UINT16	RO					
	20	Sync Error	BOOL	R					

4.13.1 Manufacturer specific IC compatible object entries

Index	SI	Object Name	Name	Data Type	Valid Range	Access	Description
20E6	00	SENSOR OPERATION MODE	Current SENSOR OPERATION MODE	UINT8	0..4	RW	<p>0 = no sensor 1 = 1 sensor operation (sensor 1 input) 2 = 2 sensor operation (low range = sensor 2 input, high range = sensor 1 input) , Soft Switch Crossover Mode 3 = 1 sensor operation (sensor 2 input) 4 = 2 sensor operation (low range = sensor 1 input, high range = sensor 2 input) , Soft Switch Crossover Mode Refer to chapter: «Valve and sensor configuration»</p>
20E7	00	SENSOR FULL SCALE RATIO	Current SENSOR FULL SCALE RATIO	FLOAT	1.0..100.0	RW	Refer to chapter: «Valve and sensor configuration»
2118	00	MAXIMUM LEARN PRESSURE	Max. learn pressure in ‰ of the internal pressure upper scale value (1'000'000)	UINT16	0...1000	RW	The pressure range settings (see chapter «EtherCAT configuration» - 2. Range of pressure and position values) does not influence that parameter. The «MAXIMUM LEARN PRESSURE» is always related to the constant internal upper scale value of 1'000'000.
2119	00	LEARN STATE	Current LEARN status information	UINT16	-	RO	See table below
2190	00	VALVE SPEED	Valve speed	UINT16	0...1000	RW	Default is: 1000.
2199	00	PRESSURE CONTROL ALGORITHM	Pressure control algorithm of the pressure controller	UINT8	0...3	RW	<p>0 = adaptive downstream (default) 1 = Fixed 1 2 = Fixed 2 3 = soft pump Refer to chapter: «Pressure control configuration»</p>
219A	00	SENSOR DELAY (ADAPTIVE DOWNSTREAM)	Sensor delay (Adaptive downstream)	FLOAT	0.00...1.00	RW	In seconds. Default is: 0.00
219B	00	RAMP TIME (ADAPTIVE DOWNSTREAM)	Ramp time (Adaptive downstream)	FLOAT	0.00... 1'000'000.0	RW	In seconds. Default is: 0.00
219C	00	RAMP MODE (ADAPTIVE DOWNSTREAM)	Ramp mode (Adaptive downstream)	UINT8	0...1	RW	<p>0 = Constant Time 1 = Constant Slope Default is: 0</p>
219E	00	GAIN FACTOR (ADAPTIVE DOWNSTREAM)	Gain factor (Adaptive downstream)	FLOAT	0.0001... 7.5	RW	Default is: 1
21A5	00	RAMP TIME (FIXED 1)	Ramp time (Fixed 1)	FLOAT	0.00... 1'000'000.0	RW	In seconds. Default is: 0.00

Index	SI	Object Name	Name	Data Type	Valid Range	Access	Description
21A6	00	RAMP MODE (FIXED 1)	Ramp mode (Fixed 1)	UINT8	0...1	RW	0 = Constant Time 1 = Constant Slope Default is: 0
21A7	00	CONTROL DIRECTION (FIXED 1)	Control direction (Fixed 1)	UINT8	0...1	RW	0 = downstream 1 = upstream Default is: 0
21A8	00	P-GAIN (FIXED 1)	P-Gain (Fixed 1)	FLOAT	0.001... 100.0	RW	Default is: 0.018
21A9	00	I-GAIN (FIXED 1)	I-Gain (Fixed 1)	FLOAT	0.000... 100.0	RW	Default is: 0.018
21AF	00	RAMP TIME (FIXED 2)	Ramp time (Fixed 2)	FLOAT	0.00... 1'000'000.0	RW	In seconds. Default is: 0.00
21B0	00	RAMP MODE (FIXED 2)	Ramp mode (Fixed 2)	UINT8	0...1	RW	0 = Constant Time 1 = Constant Slope Default is: 0
21B1	00	CONTROL DIRECTION (FIXED 2)	Control direction (Fixed 2)	UINT8	0...1	RW	0 = downstream 1 = upstream Default is: 0
21B2	00	P-GAIN (FIXED 2)	P-Gain (Fixed 2)	FLOAT	0.001... 100.0	RW	Default is: 0.018
21B3	00	I-GAIN (FIXED 2)	I-Gain (Fixed 2)	FLOAT2	0.000... 100.0	RW	Default is: 0.018
21B9	00	RAMP TIME (SOFT PUMP)	Ramp time (Soft pump)	FLOAT	0.00... 1'000'000.0	RW	In seconds. Default is: 0.00
21BA	00	RAMP MODE (SOFT PUMP)	Ramp mode (Soft pump)	UINT8	0...1	RW	0 = Constant Time 1 = Constant Slope Default is: 0
21BC	00	P-GAIN (SOFT PUMP)	P-Gain (Soft pump)	FLOAT	0.001... 100.0	RW	Default is: 0.018
2258	00	RESET NODE	Set node	UINT8	0...1	RW	Default is: 0

4.13.3 Manufacturer specific object entries

List of abbreviations:

RO: Read Only
 RW: Read Write
 NV: Non Volatile
 V: Volatile
 SI: Sub Index

Index	SI	Name	Data Type	Access	PDO Mapping	NV	Unit	Min	Max	Def	Description
2002		Control Mode	SINT8	RW	TX/RX	V		0	14		0: Init 1: Homing 2: Position 3: Close 4: Open 5: Pressure Control 6: Hold 7: Learn 8: Interlock Open 9: Interlock Close 12: Power Failure 13: Safety 14: Error
200B		Access Mode	SINT8	RW	TX	V		0	2		0: Local 1: Remote 2: Remote Locked
2010		Identification	REC								
	01	Serial Number	STRING	RO		NV					
	02	Valve Series	UINT16	RO		NV		0	980		Example 655: S65.5
	03	Valve Variant	UINT16	RO		NV		0	100		0: Standard 1: Differential Plate 2: Face Seal 3: Aluminium 4: Stainless Steel 5: Single Drive 100: Toblerone
	04	Nominal Diameter	UINT16	RO		NV		20	62		20: DN10 24: DN16 28: DN25 32: DN40 34: DN50 36: DN63 38: DN80 39: DN88 40: DN100 44: DN160 46: DN200 48: DN250 50: DN320 51: DN350 52: DN400 54: DN500 56: DN630 58: DN800 60: DN1000 62: DN1250
	08	Controller Type	UINT16	RO		NV		1	5		1: IC2H1 2: IC2H2 3: IC2H3 4: IC2H4 5: IC2H5
	09	Interface Type	UINT16	RO		NV		1	5		1: RS232/RS485 2: EtherCAT 3: DeviceNET 4: Onboard 5: Logic
	0A	Option Type	UINT16	RO		NV		0	11		0: Not Available 1: SPS 2: PFO 3: Cluster 4: SPS + PFO 5: SPS + Cluster 6: PFO + Cluster 7: SPS + PFO + Cluster 8: sPFO 9: SPS + sPFO 10: sPFO + Cluster 11: SPS + sPFO + Cluster
	0C	Configuration Parameters ID	STRING	RO		NV					
	0D	Drive Parameters ID	STRING	RO		NV					
	0E	Firmware ID	STRING	RO		V					

	0F	Firmware Version	STRING	RO		V					
	10	CPA Version	STRING	RO		V					
	11	Interface Firmware Version	STRING	RO		V					
	12	Motion Controller 1 Firmware Version	STRING	RO		V					
	13	Motion Controller 2 Firmware Version	STRING	RO		V					
2020		Statistics	REC								
	01	Start Counter Up	UINT32	RO	TX	NV			0		
	02	Total Time Powered	UINT32	RO	TX	NV	sec		0		Stored every 15 minutes
	03	Time Since Power On	UINT32	RO	TX	NV	sec		0		
2030		Warning/Error	REC								
	01	Warning Bitmap	UINT32	RO	TX	V					See relevant chapter
	02	Error Bitmap	UINT32	RO	TX	V					See relevant chapter
	03	Error Number	UINT16	RO	TX	V					See relevant chapter
	04	Error Code	UINT16	RO	TX	V					See relevant chapter
2050		Services	REC								
	01	Restart Controller	BOOL	RW		V					Set to 1 to start the service
	02	Store User Parameters	BOOL	RW		V					
	03	Restore User Parameters	BOOL	RW		V					
	05	Restore Factory Parameters	BOOL	RW		V					
	06	Configuration Lock Mode	BOOL	RW		NV			0		If active the valve does not accept set commands for parameters which are stored in non-volatile memory: the valve configuration is locked. 0 :not locked (do unlock) 1 :locked (do lock)
	07	Internal Services	UINT32	RW		V					
2111		Isolation State	BOOL	RO	TX	NV		0	1		0 :Not Isolated 1 :Isolated



2112		Position State	UINT8	RO	TX	V		0	2		Indication of valve position 0: Intermediate 1: Closed 2: Open
2120		Homing	REC								
	01	Start Condition	UINT8	RW		NV		0	5	0	0: Standard Do homing after restart if valve is not in isolated state 1: Open Command Do homing on an open command 2: Move Command Do homing on any move command 3: At Startup Do homing after restart 4: Homing Command Do homing on homing command 5: Move Command/Standard Settings from move commands, without homing in close position by close command
	02	Mode	UINT8	RW		NV		0	1	0	Not supported yet
	03	End Control Mode	SINT8	RW		NV		2	5	2	Control Mode after homing 2: Position 3: Close 4: Open 5: Pressure Control
	04	End Position	FLOAT	RW		NV	[pos]*	0.0*	100.0*	0.0	Position after homing if End Control Mode is 2 (Position)
	05	Status	SINT16	RO	TX	V		0	3		0: Not Started 1: In Progress 2: Completed Successfully 3: Error Occurred
2121		Position Restriction	REC								Position restriction of the valve movement.
	01	Enable	BOOL	RW	TX/RX	NV		0	1	0	
	03	Maximum Control Position	FLOAT	RW	TX/RX	NV	[pos]*	0.0*	100.0*	100.0*	With an enabled Position Restriction the valve will not move above this position
	04	Restriction Active	BOOL	RO	TX/RX	V		0	1		Indicates if currently a position restriction is active
2122		Position Ramp	REC								
	01	Enable	BOOL	RW		NV		0	1	0	Activate/Deactivate position target ramp.
	02	Time	FLOAT	RW		NV		0	1E+7	0	
	03	Slope	FLOAT	RW		NV		0	1E+8	0	
	04	Mode	UINT8	RW		NV		0	1	0	0: Use Ramp Time 1: Use Ramp Slope
	05	Type	UINT8	RW		NV		0	2	0	0: Linear

											1:Logarithmic 2:Exponential
2130		Cycle Counter	REC								
	01	Control Cycles	UINT32	RW	TX	NV				0	The valve movement is summarized. The distance open -> close -> open is 1 Control Cycle. This value can be manipulated by the customer.
	02	Control Cycles Total	UINT32	RO	TX	NV				0	See Control Cycles. This value is the number of Control Cycles in valve lifespan.
	03	Isolation Cycles	UINT32	RW	TX	NV				0	A Isolation Cycle is done if the valve has reached the isolated state. This value can be manipulated by the customer.
	04	Isolation Cycles Total	UINT32	RO	TX	NV				0	See Isolation Cycles. This value is the number of Isolation Cycles in valve lifespan.
2132		SFV Axis Initialization Mode	BOOL	RW		NV				0	Series 67.0 specific object, not available for other valve series. Set to 1 to ignore position deviation of the two axis.
2160		External Isolation	REC								Only used if an external isolation valve is available
	01	Follow Valve	BOOL	RW		NV		0	1	1	0: Isolation valve handled by using Target State object 1: Isolation valve automatically handled by valve. In case the valve gets close the external isolation valve gets close too.
	02	Plate Position Isolated	FLOAT	RW		NV	[pos]*	0.0*	100.0*	25.0*	Only active if Follow Valve is true. Valve position when the Control Mode is set to close.
	03	Target State	BOOL	RO	TX	V		0	1		If Follow Valve value is 0 than this parameter is settable. 0: Open, external isolation valve will open 1: Close, external isolation valve will close
	04	State	BOOL	RO	TX	V		0	1		0: Not Isolated (external isolation valve is not close) 1: Isolated (external isolation valve is close)
	05	Indicator Open	BOOL	RO	TX	V		0	1		
	06	Indicator Close	BOOL	RO	TX	V		0	1		
	07	Warning	BOOL	RO	TX	V		0	1	0	Set if external isolation valve is not follows on Target State .
	08	Isolation Cycles	UINT32	RW	TX	NV					Counter for the external isolation valve. This value can be manipulated by the customer.
	09	Isolation Cycles Total	UINT32	RO	TX	NV					See Isolation Cycle. This value is the number of Isolation Cycle in valve lifespan.
21C0		Drive Parameter A1	REC								
	01	Maximal Speed	FLOAT	RW		NV	r/s	0	100	***	
	02	Maximal Acceleration	FLOAT	RW		NV	r/s2	0	1000	***	
	03	Maximal Deceleration	FLOAT	RW		NV	r/s2	0	1000	***	
	04	Jerk Limit	FLOAT	RW		NV	r/s3	0	10000	***	Value 0 means not jerk limitation
	05	Home Offset	FLOAT	RW		NV	r	-100	100	***	
	06	Range of Movement	FLOAT	RW		NV	r	0	10000	***	
	08	Maximum Current	FLOAT	RW		NV	Amper e	0	8	***	

	09	Isolation Current	FLOAT	RW		NV	Amper e	0	8	***	Torque producing current, vector of the two phase currents
21D0		Drive Parameter A2	REC								
	01	Maximal Speed	FLOAT	RW		NV	r/s	0	100	***	
	02	Maximal Acceleration	FLOAT	RW		NV	r/s2	0	1000	***	
	03	Maximal Deceleration	FLOAT	RW		NV	r/s2	0	1000	***	
	04	Jerk Limit	FLOAT	RW		NV	r/s3	0	10000	***	Value 0 means not jerk limitation
	05	Home Offset	FLOAT	RW		NV	r	-100	100	***	
	06	Range of Movement	FLOAT	RW		NV	r	0	10000	***	
	08	Maximum Current	FLOAT	RW		NV	Amper e	0	8	***	
	09	Isolation Current	FLOAT	RW		NV	Amper e	0	8	***	
2200		Position Control	REC								
	01	Actual Position	FLOAT	RO	TX	V	[pos]*	0.0*	100.0*		
	02	Target Position	FLOAT	RW	TX/RX	V	[pos]*	0.0*	100.0*		
	03	Position Control Speed	FLOAT	RW	TX/RX	NV		0.00 1	1.0	1.0	Speed valid in Control Mode = Position, 1.0 equals to full speed
2300		Pressure Control	REC								
	01	Actual Pressure	FLOAT	RO	TX	V	mbar*				
	02	Target Pressure	FLOAT	RW	TX/RX	V	mbar*	0.0	SFS		
	03	Target Pressure Used	FLOAT	RO	TX	V	mbar*	0.0	SFS		This value is set as pressure controller input. It differs to the Target Pressure if a pressure ramp (see object 2311-2314) is used.
	04	Pressure Control Speed	FLOAT	RW	TX/RX	NV **		0.00 1	1.0	1.0	Speed valid in Control Mode = Pressure, 1.0 equals to full speed
2310		Pressure Controller Selector	UINT8	RW	TX/RX	NV **		1	4	1	Active Controller in Control Mode = Pressure 1:Controller 1 2:Controller 2 3:Controller 3 4:Controller 4
2311		Pressure Controller 1	REC								
	01	Control Algorithm	UINT8	RW	TX/RX	NV **		0	2	0	0:Adaptive 1:PI 2:Soft Pump
	02	P-Gain	FLOAT	RW	TX/RX	NV **		0.00 1	100.0	0.1	Used for Control Algorithm PI and Soft Pump
	03	I-Gain	FLOAT	RW	TX/RX	NV **		0.0	100.0	0.1	Used for Control Algorithm PI and Soft Pump
	04	Gain Factor	FLOAT	RW	TX/RX	NV **		0.00 01	100.0	1.0	Used for Control Algorithm Adaptive

	05	Sensor Delay	FLOAT	RW	TX/RX	NV **	sec	0.0	1.0	0.0	Used for Control Algorithm Adaptive
	06	Learn Data Selection	UINT8	RW	TX/RX	NV **		0	3	0	Used for Control Algorithm Adaptive 0:Bank 1 1:Bank 2 2:Bank 3 3:Bank 4
	07	Control Direction	UINT8	RW	TX/RX	NV **		0	1	0	Used for Control Algorithm PI and Soft Pump 0:Downstream 1:Upstream
	08	Position Filter Time	FLOAT	RW	TX/RX	NV **	sec	0	10	0.0	(advanced optimization)
	0A	Ramp Enable	BOOL	RW	TX/RX	NV **		0	1	1	Activate/Deactivate pressure target ramp. The effective target pressure can be read in Object 2300:03 Target Pressure Used
	0B	Ramp Time	FLOAT	RW	TX/RX	NV **	sec	0.0	1000000.0	1.0	Target reach time
	0C	Ramp Slope	FLOAT	RW	TX/RX	NV **	mbar*/ sec	0.0	SFS	1.333 224	
	0D	Ramp Mode	UINT8	RW	TX/RX	NV **		0	1	0	0:Use Ramp Time 1:Use Ramp Slope
	0E	Ramp Start Value	UINT8	RW	TX/RX	NV **		0	1	1	0: Previous Ramp Value 1: Actual Pressure Value
	0F	Ramp Type	UINT8	RW	TX/RX	NV **					Not supported yet
	14	P-Gain Limit	FLOAT	RW	TX/RX	NV **		0	1000	0.0	Used for Control Algorithm Adaptive (advanced optimization)
	15	Flow Factor Filter Time	FLOAT	RW	TX/RX	NV **		0	10	0.4	Used for Control Algorithm Adaptive (advanced optimization)
	16	Flow Factor Filter Order	UINT8	RW	TX/RX	NV **		1	6	2	Used for Control Algorithm Adaptive (advanced optimization)
2312		Pressure Controller 2	REC								
	01	Control Algorithm	UINT8	RW	TX/RX	NV **		0	2	1	0:Adaptive 1:PI 2:Soft Pump
	02	P-Gain	FLOAT	RW	TX/RX	NV **		0.00 1	100.0	0.1	Used for Control Algorithm PI and Soft Pump
	03	I-Gain	FLOAT	RW	TX/RX	NV **		0.0	100.0	0.1	Used for Control Algorithm PI and Soft Pump
	04	Gain Factor	FLOAT	RW	TX/RX	NV **		0.00 01	100.0	1.0	Used for Control Algorithm Adaptive
	05	Sensor Delay	FLOAT	RW	TX/RX	NV **	sec	0.0	1.0	0.0	Used for Control Algorithm Adaptive
	06	Learn Data Selection	UINT8	RW	TX/RX	NV **		0	3	0	Used for Control Algorithm Adaptive 0:Bank 1 1:Bank 2 2:Bank 3 3:Bank 4



	07	Control Direction	UINT8	RW	TX/RX	NV**		0	1	0	Used for Control Algorithm PI and Soft Pump 0:Downstream 1:Upstream
	08	Position Filter Time	FLOAT	RW	TX/RX	NV**	sec	0	10	0.0	(advanced optimization)
	0A	Ramp Enable	BOOL	RW	TX/RX	NV**		0	1	1	Activate/Deactivate pressure target ramp. The effective target pressure can be read in Object 2300:03 Target Pressure Used
	0B	Ramp Time	FLOAT	RW	TX/RX	NV**	sec	0.0	1000000.0	1.0	Target reach time
	0C	Ramp Slope	FLOAT	RW	TX/RX	NV**	mbar*/sec	0.0	SFS	1.333224	
	0D	Ramp Mode	UINT8	RW	TX/RX	NV**		0	1	0	0:Use Ramp Time 1:Use Ramp Slope
	0E	Ramp Start Value	UINT8	RW	TX/RX	NV**		0	1	1	0: Previous Ramp Value 1: Actual Pressure Value
	0F	Ramp Type	UINT8	RW	TX/RX	NV**					Not supported yet
	14	P-Gain Limit	FLOAT	RW	TX/RX	NV**		0	1000	0.0	Used for Control Algorithm Adaptive (advanced optimization)
	15	Flow Factor Filter Time	FLOAT	RW	TX/RX	NV**		0	10	0.4	Used for Control Algorithm Adaptive (advanced optimization)
	16	Flow Factor Filter Order	UINT8	RW	TX/RX	NV**		1	6	2	Used for Control Algorithm Adaptive (advanced optimization)
2313		Pressure Controller 3	REC								
	01	Control Algorithm	UINT8	RW	TX/RX	NV**		0	2	1	0:Adaptive 1:PI 2:Soft Pump
	02	P-Gain	FLOAT	RW	TX/RX	NV**		0.001	100.0	0.1	Used for Control Algorithm PI and Soft Pump
	03	I-Gain	FLOAT	RW	TX/RX	NV**		0.0	100.0	0.1	Used for Control Algorithm PI and Soft Pump
	04	Gain Factor	FLOAT	RW	TX/RX	NV**		0.0001	100.0	1.0	Used for Control Algorithm Adaptive
	05	Sensor Delay	FLOAT	RW	TX/RX	NV**	sec	0.0	1.0	0.0	Used for Control Algorithm Adaptive
	06	Learn Data Selection	UINT8	RW	TX/RX	NV**		0	3	0	Used for Control Algorithm Adaptive 0:Bank 1 1:Bank 2 2:Bank 3 3:Bank 4
	07	Control Direction	UINT8	RW	TX/RX	NV**		0	1	1	Used for Control Algorithm PI and Soft Pump 0:Downstream 1:Upstream
	08	Position Filter Time	FLOAT	RW	TX/RX	NV**	sec	0	10	0.0	(advanced optimization)

	0A	Ramp Enable	BOOL	RW	TX/RX	NV **		0	1	1	Activate/Deactivate pressure target ramp. The effective target pressure can be read in Object 2300:03 Target Pressure Used
	0B	Ramp Time	FLOAT	RW	TX/RX	NV **	sec	0.0	1000000. 0	1.0	Target reach time
	0C	Ramp Slope	FLOAT	RW	TX/RX	NV **	mbar*/ sec	0.0	SFS	1.333 224	
	0D	Ramp Mode	UINT8	RW	TX/RX	NV **		0	1	0	0: Use Ramp Time 1: Use Ramp Slope
	0E	Ramp Start Value	UINT8	RW	TX/RX	NV **		0	1	1	0: Previous Ramp Value 1: Actual Pressure Value
	0F	Ramp Type	UINT8	RW	TX/RX	NV **				0	Not supported yet
	14	P-Gain Limit	FLOAT	RW	TX/RX	NV **		0	1000	0.0	Used for Control Algorithm Adaptive (advanced optimization)
	15	Flow Factor Filter Time	FLOAT	RW	TX/RX	NV **		0	10	0.4	Used for Control Algorithm Adaptive (advanced optimization)
	16	Flow Factor Filter Order	UINT8	RW	TX/RX	NV **		1	6	2	Used for Control Algorithm Adaptive (advanced optimization)
2314		Pressure Controller 4	REC								
	01	Control Algorithm	UINT8	RW	TX/RX	NV **		0	2	2	0: Adaptive 1: PI 2: Soft Pump
	02	P-Gain	FLOAT	RW	TX/RX	NV **		0.00 1	100.0	0.1	Used for Control Algorithm PI and Soft Pump
	03	I-Gain	FLOAT	RW	TX/RX	NV **		0.0	100.0	0.1	Used for Control Algorithm PI and Soft Pump
	04	Gain Factor	FLOAT	RW	TX/RX	NV **		0.00 01	100.0	1.0	Used for Control Algorithm Adaptive
	05	Sensor Delay	FLOAT	RW	TX/RX	NV **	sec	0.0	1.0	0.0	Used for Control Algorithm Adaptive
	06	Learn Data Selection	UINT8	RW	TX/RX	NV **		0	3	0	Used for Control Algorithm Adaptive 0: Bank 1 1: Bank 2 2: Bank 3 3: Bank 4
	07	Control Direction	UINT8	RW	TX/RX	NV **		0	1	1	Used for Control Algorithm PI and Soft Pump 0: Downstream 1: Upstream
	08	Position Filter Time	FLOAT	RW	TX/RX	NV **	sec	0	10	0	(advanced optimization)
	0A	Ramp Enable	BOOL	RW	TX/RX	NV **		0	1	1	Activate/Deactivate pressure target ramp. The effective target pressure can be read in Object 2300:03 Target Pressure Used
	0B	Ramp Time	FLOAT	RW	TX/RX	NV **	sec	0.0	1000000. 0	1.0	Target reach time
	0C	Ramp Slope	FLOAT	RW	TX/RX	NV **	mbar*/ sec	0.0	SFS	1.333 224	



	0D	Ramp Mode	UINT8	RW	TX/RX	NV **		0	1	0	0: Use Ramp Time 1: Use Ramp Slope
	0E	Ramp Start Value	UINT8	RW	TX/RX	NV **		0	1	1	0: Previous Ramp Value 1: Actual Pressure Value
	0F	Ramp Type	UINT8	RW	TX/RX	NV **					Not supported yet
	14	P-Gain Limit	FLOAT	RW	TX/RX	NV **		0	1000	0	Used for Control Algorithm Adaptive (advanced optimization)
	15	Flow Factor Filter Time	FLOAT	RW	TX/RX	NV **		0	10	0.4	Used for Control Algorithm Adaptive (advanced optimization)
	16	Flow Factor Filter Order	UINT8	RW	TX/RX	NV **		1	6	2	Used for Control Algorithm Adaptive (advanced optimization)
2330		Store Control Parameter Volatile	BOOL	RW		NV		0	1	0	0: Store in NV Memory 1: Do Not Store in NV Memory
2331		Pressure Control Position Restriction	REC								Limit the valve movement in Control Mode Pressure
	01	Enable	BOOL	RW	TX/RX	NV		0	1	0	
	02	Minimum Control Position	FLOAT	RW	TX/RX	NV	[pos]*	0.0*	100.0*	0.0*	
	03	Maximum Control Position	FLOAT	RW	TX/RX	NV	[pos]*	0.0*	100.0*	100.0*	
2350		Adaptive Learn	REC								
	02	Type	SINT8	RW		NV		0	0	0	0:Standard
	03	Bank Selection	SINT8	RW		NV		0	3	0	Select a learn bank to save the data for the following learn procedure 0: Bank 1 1: Bank 2 2: Bank 3 3: Bank 4
	04	Pressure Limit [SFS]	FLOAT	RW	TX/RX	NV	SFS	0.01	1.2	1.0	Learn procedure will be executed to the Pressure Limit
	05	Open Speed	FLOAT	RW		NV		0.00 1	1.0	1.0	1.0 equals to full speed
	06	Status	SINT8	RO	TX	V		0	4		0: Not Started 1: In Progress 2: Completed Successfully 3: Aborted 4: Failed
	07	Warning Info	UINT16	RO	TX	V					Bit 0: Learn is running Bit 1: Checksum error (learn data corrupt) Bit 2: Learn procedure terminated by user Bit 3: Pressure at position open > 50% of pressure limit Bit 4: Pressure at minimal conductance position < 10 % of pressure limit Bit 5: Pressure falls while move valve in direction of close

										Bit 6: Pressure at open position does not match pressure of previous open Bit 7: Learn procedure terminated by program Bit 8: Pressure <= 0 at open position (no gas flow set?)
	08	Delete All Learn Bank Data	BOOL	RW		V		0	1	Set to 1 delete all learn bank data.
	09	Pressure Limit	FLOAT	RW		NV	mbar*			See Pressure Limit [SFS] above, same functionality but user pressure scaling is used
2351		Adaptive Learn Position Table	ARRAY							
	01 - 3C	SubIndex 001 SubIndex 060	FLOAT	RW		NV	[pos]	0.0	1.0	0 : minimum position 1 : open position -1 : not used element
2360		Adaptive Learn Bank 1	REC							
	01	Status	SINT8	RO		NV		0	2	0 1 : Available 2 : Available with Warnings
	02	Warning Info	UINT16	RO		NV			0	
	03	Type	SINT8	RO		NV		0	0	0 0 : Standard
	04	Delete Learn Bank Data	BOOL	RW		V				Set to 1 delete learn bank data.
2361		Adaptive Learn Bank 1 Data	ARRAY							
	01 - 7C	SubIndex 001 SubIndex 124	UINT32	RW		NV				To copy learn data copy this content to another bank (or valve)
2362		Adaptive Learn Bank 1 Position Table	ARRAY							
	01 - 3C	SubIndex 001 SubIndex 060	FLOAT	RO		NV	[pos]*	0.0*	100.0*	
2363		Adaptive Learn Bank 1 Pressure Table	ARRAY							
	01 - 3C	SubIndex 001 SubIndex 060	FLOAT	RO		NV	mbar*			
2370		Adaptive Learn Bank 2	REC							
	01	Status	SINT8	RO		NV		0	2	0 1 : Available 2 : Available with Warnings
	02	Warning Info	UINT16	RO		NV			0	
	03	Type	SINT8	RO		NV		0	0	0 0 : Standard
	04	Delete Learn Bank Data	BOOL	RW		V				Set to 1 delete learn bank data.
2371		Adaptive Learn Bank 2 Data	ARRAY							

	01 - 7C	SubIndex 001 SubIndex 124	UINT32	RW		NV					To copy learn data copy this content to another bank (or valve)
2372		Adaptive Learn Bank 2 Position Table	ARRAY								
	01 - 3C	SubIndex 001 SubIndex 060	FLOAT	RO		NV	[pos]*	0.0*	100.0*		
2373		Adaptive Learn Bank 2 Pressure Table	ARRAY								
	01 - 3C	SubIndex 001 SubIndex 060	FLOAT	RO		NV	mbar*				
2380		Adaptive Learn Bank 3	REC								
	01	Status	SINT8	RO		NV		0	2	0	0: Not used 1: Available 2: Available with Warnings
	02	Warning Info	UINT16	RO		NV				0	
	03	Type	SINT8	RO		NV		0	0	0	0: Standard
	04	Delete Learn Bank Data	BOOL	RW		V					Set to 1 delete learn bank data.
2381		Adaptive Learn Bank 3 Data	ARRAY								
	01 - 7C	SubIndex 001 SubIndex 124	UINT32	RW		NV					To copy learn data copy this content to another bank (or valve)
2382		Adaptive Learn Bank 3 Position Table	ARRAY								
	01 - 3C	SubIndex 001 SubIndex 060	FLOAT	RO		NV	[pos]*	0.0*	100.0*		
2383		Adaptive Learn Bank 3 Pressure Table	ARRAY								
	01 - 3C	SubIndex 001 SubIndex 060	FLOAT	RO		NV	mbar*				
2390		Adaptive Learn Bank 4	REC								
	01	Status	SINT8	RO		NV		0	2	0	0: Not used 1: Available 2: Available with Warnings
	02	Warning Info	UINT16	RO		NV				0	
	03	Type	SINT8	RO		NV		0	0	0	0: Standard

	04	Delete Learn Bank Data	BOOL	RW		V					Set to 1 delete learn bank data.
2391		Adaptive Learn Bank 4 Data	ARRAY								
	01 - 7C	SubIndex 001	UINT32	RW		NV					To copy learn data copy this content to another bank (or valve)
2392		SubIndex 124 Adaptive Learn Bank 4 Position Table	ARRAY								
	01 - 3C	SubIndex 001	FLOAT	RO		NV	[pos]*	0.0*	100.0*		
2393		SubIndex 060 Adaptive Learn Bank 4 Pressure Table	ARRAY								
	01 - 3C	SubIndex 001	FLOAT	RO		NV	mbar*				
2400		SubIndex 060 Sensor Zero Adjust	REC								
	01	Sensor Selection	SINT8	RW	TX/RX	V		0	2		0: Sensor 1 + 2 1: Sensor 1 2: Sensor 2
	02	Target Pressure	FLOAT	RW	TX/RX	V	mbar*				This value is typically the value 0.0 when the chamber is fully pumped down. But it could also be the value of another pressure.
	03	Execute	SINT8	RW	TX/RX	V		1	2		Write to this object to execute a Zero Adjust or clear the Zero Adjust offset value. The calculated offset value can read in Sensor 1 Zero Adjust Offset Value [SFS] or Sensor 2 Zero Adjust Offset Value [SFS]. Be sure that Zero Adjust Enable (Zero Adjust Enable Sensor 1 and Sensor 2) is 1, in other case the executed Zero Adjust has no effect on the Actual Pressure value 1: Execute Zero Adjust 2: Clear Offset Value
2401		Sensor 1	REC								
	01	Available	BOOL	RW		NV		0	1	1	Is a sensor available? (Set Available = 1 if a digital sensor or the pressure simulation is used)
	02	Enable	BOOL	RW		NV		0	1	1	0: Not used for pressure control, object Pressure Sensor 1 can be used for monitoring 1: Used for pressure control (to build Actual Pressure value)
	03	Data Unit	SINT8	RW		NV		0	7	4	0: Pa 3: mbar 6: psia 1: kPa 4: Torr 7: psig 2: bar 5: mTorr
	04	Upper Limit Data Value	FLOAT	RW		NV	refers to 2401: 03			1.0	

	05	Lower Limit Data Value	FLOAT	RW		NV	refers to 2401:03			0.0	
	06	Upper Limit Voltage Value	FLOAT	RW		NV	volt			10.0	
	07	Lower Limit Voltage Value	FLOAT	RW		NV	volt			0.0	
	08	Scale	SINT8	RW		NV		0	1	0	0: Linear 1: Logarithmic (not supported yet)
	09	Voltage Per Decade	FLOAT	RW		NV	volt			0.0	
	0A	Zero Adjust Enable	BOOL	RW		NV		0	1	1	
	0B	Zero Adjust Offset Value [SFS]	FLOAT	RW		NV	SFS			0.0	Value 1.0 means sensor full scale. For example for a 0-10 Volt gauge the value 0.1 means 1 Volt
	0F	Filter Enable	BOOL	RW		NV		0	1	0	
	10	Filter Time	FLOAT	RW		NV	sec	0.0	1.0	0.0	
	12	Input Source	SINT8	RW		NV		0	2	0	0: Analog 1: Digital 2: Simulation
	14	Pressure Input Digital Sensor 1	FLOAT	RW	TX/RX	V	mbar*				Only used if Input Source = Digital. In this case the actual sensor pressure value is send by the customer via EtherCAT.
	18	Pressure Sensor 1	FLOAT	RO	TX	V	mbar*				Pressure value for sensor 1
2402		Sensor 2	REC								
	01	Available	BOOL	RW		NV		0	1	1	Is a sensor available? (Set Available = 1 if a digital sensor or the pressure simulation is used)
	02	Enable	BOOL	RW		NV		0	1	0	0: Not used for pressure control, object Pressure Sensor 2 can be used for monitoring 1: Used for pressure control (to build Actual Pressure value)
	03	Data Unit	SINT8	RW		NV		0	7	5	0: Pa 1: kPa 2: bar 3: mbar 4: Torr 5: mTorr 6: psia 7: psig
	04	Upper Limit Data Value	FLOAT	RW		NV	refers to 2402:03			100.0	
	05	Lower Limit Data Value	FLOAT	RW		NV	refers to 2402:03			0.0	
	06	Upper Limit Voltage Value	FLOAT	RW		NV	volt			10.0	
	07	Lower Limit Voltage Value	FLOAT	RW		NV	volt			0.0	
	08	Scale	SINT8	RW		NV		0	1	0	0: Linear 1: Logarithmic (not supported yet)

	09	Voltage Per Decade	FLOAT	RW		NV	volt			0	
	0A	Zero Adjust Enable	BOOL	RW		NV		0	1	1	
	0B	Zero Adjust Offset [SFS]	FLOAT	RW		NV	SFS			0.0	Value 1.0 means sensor full scale. For example for a 0-10 Volt gauge the value 0.1 means 1 Volt
	0F	Filter Enable	BOOL	RW		NV		0	1	0	
	10	Filter Time	FLOAT	RW		NV	sec	0.0	1.0	0.0	
	12	Input Source	SINT8	RW		NV		0	2	0	0:Analog 1:Digital 2:Simulation
	14	Pressure Input Digital Sensor 2	FLOAT	RW	TX/RX	V	mbar*				Only used if Input Source = Digital.
	18	Pressure Sensor 2	FLOAT	RO	TX	V	mbar*				Pressure value for sensor 2
2405		Sensor Crossover	REC								
	01	Crossover Mode	SINT8	RW		NV		0	1	0	Execution method of the transient area from sensor 1 to sensor 2 or sensor 2 to sensor 1 0:Soft Switch -> Actual Pressure is a summation of the pressure value of sensor 1 pressure and sensor 2 1:Hard Switch -> Actual Pressure is the value of sensor 1 or sensor 2 2:Target Pressure -> If Target Pressure falls into low range sensor, the low sensor is used for Actual Pressure . In other case the high range sensor is used.
	02	Threshold High [SFS low sensor]	FLOAT	RW		NV	SFS of low sensor	0.0	1.0	1	Defines the crossover area.
	03	Threshold Low [SFS low sensor]	FLOAT	RW		NV	SFS of low sensor	0.0	1.0	0.95	Example: Threshold High = 1.0 [SFS of low sensor] Threshold Low = 0.9 [SFS of low sensor] <u>Soft switch:</u> At pressure <= 0.9*SFS (low sensor): Actual Pressure = Sensor low pressure At pressure 0.95*SFS (low sensor): Actual Pressure = 50% * Sensor low pressure + 50% sensor high pressure At pressure >= 1.0*SFS (low sensor): Actual Pressure = Sensor high pressure <u>Hard switch:</u> At pressure increase over 1.0*SFS (low sensor): Actual Pressure = Sensor high pressure after Delay At pressure decrease under 0.9*SFS (low sensor): Actual Pressure = Sensor low pressure after Delay
	04	Delay	FLOAT	RW		NV		0.0	10.0	0	Only relevant in Crossover Mode = Hard Switch
2601		Interface EtherCAT	REC								



	01	EtherCAT State	UINT8	RO	TX	V		1	8		1:Init 2:Pre-OP 3:Bootstrap 4:Safe-Op 8:Op
	02	Address	UINT16	RO	TX	V		0	4095		Defined by the address switches on the valve controller
	03	Connection Loss Reaction Enable	BOOL	RW		NV		0	1	1	
	04	Connection Loss Reaction Functionality	SINT8	RW		NV		0	1	1	0:Open 1:Close
2610		Scaling	REC								
	01	Position Unit	SINT16	RW		NV		0	7	3	0:0 - 1 1:0 - 10 2:0 - 90 3:0 - 100 4:0 - 1000 5:0 - 10000 6:0 - 100000 7:User specific (Range is defined by Value Closest Position and Value Open Position)
	02	Value Closest Position	FLOAT	RW		NV				0.0	Only used if Position Unit is set to User Specific. Defines the value for the closest position.
	03	Value Open Position	FLOAT	RW		NV				1.0	Only used if Position Unit is set to User Specific. Defines the value for the open position.
	05	Pressure Unit	SINT16	RW		NV		0	7	3	0:Pa 1:kPA 2:bar 3:mbar 4:Torr 5:mTorr 6:psi 7:User specific (Range is defined by Value Pressure 0 and Value Pressure Sensor Full Scale)
	06	Value Pressure 0	FLOAT	RW		NV				0.0	Only used if Pressure Unit is set to User specific. Defines the value for pressure 0.
	07	Value Pressure Sensor Full Scale	FLOAT	RW		NV				1.0	Only used if Pressure Unit is set to User specific. Defines the value for actual sensor full scale.
	09	Digital Sensor 1 Input Pressure Unit	SINT16	RW		NV		0	7	5	0:Pa 1:kPa 2:bar 3:mbar 4:Torr 5:mTorr 6:psi 7:User specific (Range is defined by Value Sensor 1 Lower Limit Data Value and Value Sensor 1 Upper Limit Data Value)

	0A	Value Sensor 1 Lower Limit Data Value	FLOAT	RW		NV				0.0	Only used if Pressure Unit is set to User specific. Defines the value for the pressure value 2401:05 (Sensor1.Lower Limit Data Value)
	0B	Value Sensor 1 Upper Limit Data Value	FLOAT	RW		NV				1.0	Only used if Pressure Unit is set to User specific. Defines the value for the pressure value 2401:04 (Sensor1.Upper Limit Data Value)
	0D	Digital Sensor 2 Input Pressure Unit	SINT16	RW		NV		0	7	5	0:Pa 1:kPa 2:bar 3:mbar 4:Torr 5:mTorr 6:psi 7:User specific (Range is defined by Value Sensor 2 Lower Limit Data Value and Value Sensor 2 Upper Limit Data Value)
	0E	Value Sensor 2 Lower Limit Data Value	FLOAT	RW		NV				0.0	Only used if Pressure Unit is set to User specific. Defines the value for the pressure value 2402:05 (Sensor2.Lower Limit Data Value)
	0F	Value Sensor 2 Upper Limit Data Value	FLOAT	RW		NV				1.0	Only used if Pressure Unit is set to User specific. Defines the value for the pressure value 2402:04 (Sensor2.Upper Limit Data Value)
2C01		Power Connector IO Digital Input 1	REC								Logic IO available on the valve power connector
	01	Enable	BOOL	RW		NV		0	1	1	
	02	State	BOOL	RO	TX	V		0	1		0:Signal level low 1:Signal level high
	03	Functionality	SINT8	RW		NV		0	1	0	0:Interlock Open 1:Interlock Close
	04	Inverted	BOOL	RW		NV		0	1	0	
2C02		Power Connector IO Digital Input 2	REC								Logic IO available on the valve power connector
	01	Enable	BOOL	RW		NV		0	1	1	
	02	State	BOOL	RO	TX	V		0	1		0:Signal level low 1:Signal level high
	03	Functionality	SINT8	RW		NV		0	1	1	0:Interlock Open 1:Interlock Close
	04	Inverted	BOOL	RW		NV		0	1	0	
2C03		Power Connector IO Digital Output 1	REC								Logic IO available on the valve power connector
	01	Enable	BOOL	RW		NV		0	1	1	
	02	State	BOOL	RO	TX	V		0	1		0:Signal level low 1:Signal level high
	03	Functionality	SINT8	RW		NV		0	1	0	0:Open 1:Close
	04	Inverted	BOOL	RW		NV		0	1	0	



2C04		Power Connector IO Digital Output 2	REC								Logic IO available on the valve power connector
	01	Enable	BOOL	RW		NV		0	1	1	
	02	State	BOOL	RO	TX	V		0	1		0:Signal level low 1:Signal level high
	03	Functionality	SINT8	RW		NV		0	1	1	0:Open 1:Close
	04	Inverted	BOOL	RW		NV		0	1	0	
2E00		Power Fail Option	REC								Only valid if a Power Fail Option is available
	01	Enable	BOOL	RW		NV				1	
	02	State	SINT8	RO	TX	V		0	3		0:Battery is Charging 1:Ready to Use 2:Active 3:Failure
	03	Functionality	SINT8	RW		NV		0	1	1	0:Open 1:Close
	04	Delay	FLOAT	RW		NV	sec	0.0	2.0	0.5	
	05	Battery Voltage	FLOAT	RO		V	volt				
	06	Power Fail Cycles	UINT16	RW	TX	NV					
2F00		VAT Profile Objects	REC								
	01	Target Pressure	SINT32	RW	TX/RX	V	mbar*	0.0	SFS		
	02	Target Position	SINT32	RW	TX/RX	V	[pos]*	0.0*	100.0*		
	03	Pressure Input Digital Sensor 1	SINT32	RW	TX/RX	V	mbar*				
	04	Pressure Input Digital Sensor 2	SINT32	RW	TX/RX	V	mbar*				
	05	Control Mode Setpoint (possibly not available)	UINT8	RW	TX/RX	V		1	7		1: Homing 2: Position 3: Close 4: Open 5: Pressure 6: Hold 7: Learn
	06	General Control Setpoint	UINT16	RW	TX/RX	V		0	31		Bit 0: Zero Bit 1: Not used Bit 2: Ping Pong TX Bit Bit 3: Not Used Bit 4: Access Mode Locked Bit 5-15: Not Used
	07	Pressure Ramp Time	FLOAT	RW	TX/RX	NV**	sec	0.0	1000000.0	1.0	
	08	Actual Pressure	SINT32	RO	TX	V	mbar*				
	09	Pressure Sensor 1	SINT32	RO	TX	V	mbar*				
	0A	Pressure Sensor 2	SINT32	RO	TX	V	mbar*				
	0B	Actual Position	SINT32	RO	TX	V	[pos]*	0.0*	100.0*		

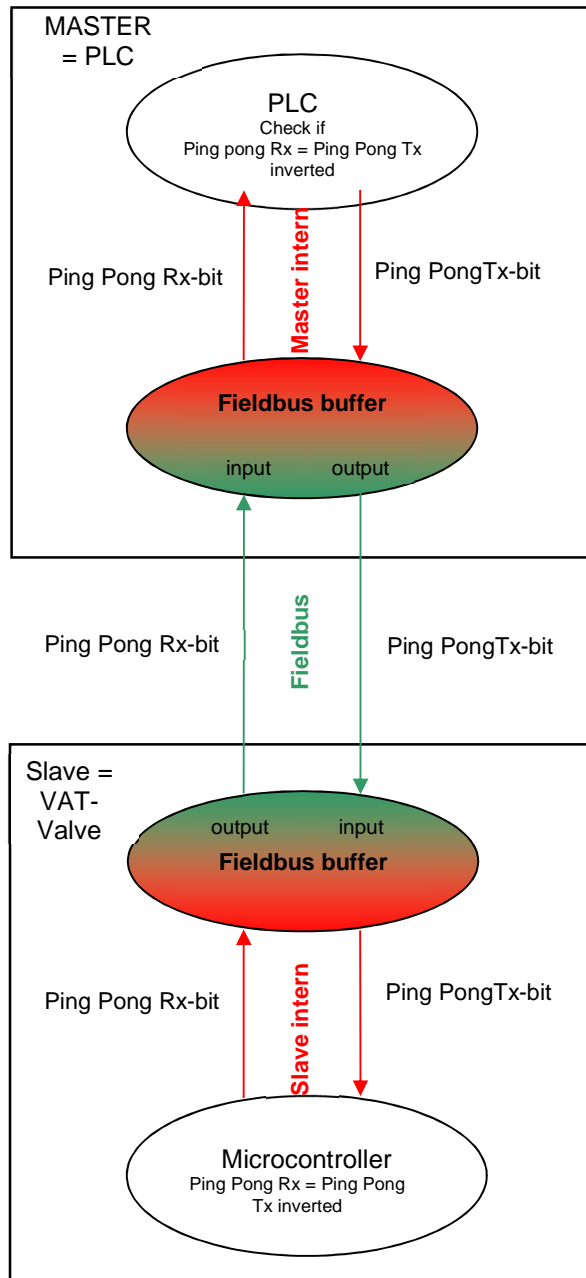
0C	Control Mode (possibly not available)	UINT8	RO	TX	V		0	14		0: Init 1: Homing 2: Position 3: Close 4: Open	5: Pressure Control 6: Hold 7: Learn 8: Interlock Open 9: Interlock Close	12: Power Failure 13: Safety 14: Error
0D	General Status	UINT16	RO	TX	V		0	4095		Bit 0: Fieldbus data valid Bit 1: Zero executed Bit 2: Ping pong RX-Bit Bit 3: Pressure simulation	Bit 4: Target pressure reached Bit 5-6: Not used Bit 7-8: Access Mode	Bit 9: Warnings active Bit 10: Sealing state Bit 11: Interlock active Bit 12-15: Not used
0E	General Warnings	UINT16	RO	TX	V		0	15		Bit 0: Not used Bit 1: Learn data set	Bit 2: Not used Bit 3: Power Failure Battery	Bit 4-15: Not used
0F	Extended Warnings	UINT16	RO	TX	V		0	4095		Bit 0: Remote Control not possible Bit 1: Actual Control Mode Setpoint not allowed Bit 2: Zero disabled Bit 3: PFO deactivated	Bit 4: Not used Bit 5: Out Of Range: Pressure Setpoint Bit 6: Out Of Range: Position Setpoint	Bit 7-9: Not used Bit 10: Out Of Range: Control Mode Setpoint Bit 11: Out Of Range: General Control Setpoint Bit 12-15: Not Used

Scaling:

- Position:** Use object **Scaling 2610h** (SI 01h, 02h and 03h) to adjust the value range of all position objects
Note: In case of a isolation functionality is available the minimum position does not mean the isolation state
- Pressure:** Use object **Scaling 2610h** (SI 05h, 06h and 07h) to adjust the value range of all pressure objects
- Digital Pressure Sensor 1:** Use object **Scaling 2610h** (SI 09h, 0Ah and 0Bh) to adjust the value range of object Pressure Input Digital Sensor 1
- Digital Pressure Sensor 2:** Use object **Scaling 2610h** (SI 0Dh, 0Eh and 0Fh) to adjust the value range of object Pressure Input Digital Sensor 2


4.14 Communication and timing between Master (PLC) and Slave (VAT-Valve)

See chapter: «OUTPUT Buffer» > «PING PONG TX-BIT» and «INPUT Buffer» > «PING PONG RX-BIT». For visual overview see the diagram below.



5 Operation


⚠ WARNING



Unqualified personnel

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

⚠ WARNING



Valve opening

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

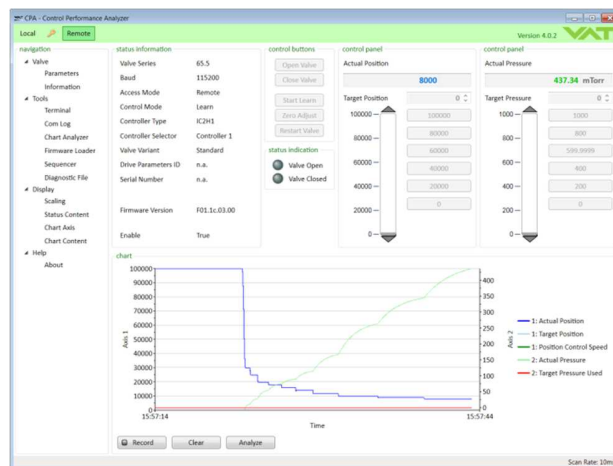
5.1 Normal operation

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

5.1.1 Remote operation

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

'Control Performance Analyzer' software



sample picture



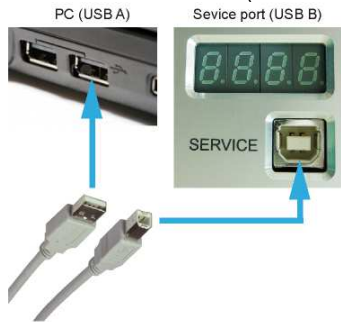
In case 'Control Performance Analyzer' is used, make sure 'Remote' button is pushed to enable for remote operation.

5.2 Local operation

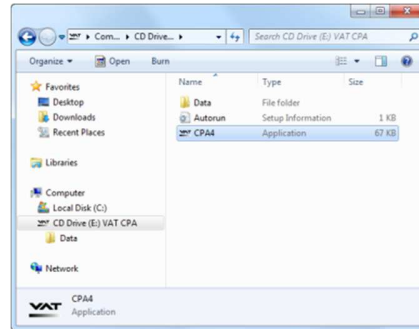
Local operation means that the valve is operated via the service port using a computer. You can use our software 'Control Performance Analyzer' for Local operation, which is integrated in the controller. The software is beneficial especially for setup, testing and maintenance.

How to start:

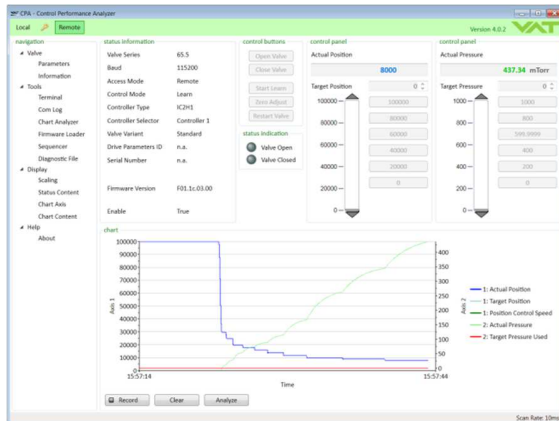
1. Connect service cable (USB A-B cable male-male) between PC and valve:



A drive opens:



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



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



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

5.3 Close valve

Local operation: (‘Control Performance Analyzer’)	Remote operation: (Refer to chapter «OUTPUT Buffer» > «CONTROL MODE SETPOINT» for details)
Push CLOSE button	<ol style="list-style-type: none"> 1. «OUTPUT Buffer» > «CONTROL MODE SETPOINT» 2. Select [Close] (value = 3)

5.4 Open valve

Local operation: (‘Control Performance Analyzer’)	Remote operation: (Refer to chapter «OUTPUT Buffer» > «CONTROL MODE SETPOINT» for details)
Push OPEN button	<ol style="list-style-type: none"> 1. «OUTUT Buffer» > «CONTROL MODE SETPOINT» 2. Select [Open] (value = 4)

5.5 Position control

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

Local operation: (‘Control Performance Analyzer’)	Remote operation: (Refer to chapter «OUTPUT Buffer» > «POSITION SETPOINT» for details)
Select or enter position setpoint	<ol style="list-style-type: none"> 1. In «OUTPUT Buffer» > « POSITION SETPOINT» 2. Select a valid value 3. In «OUTPUT Buffer» > «CONTROL MODE SETPOINT» 4. Select [Position] (value = 2)

5.6 Pressure control



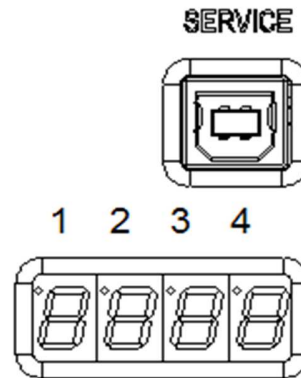
To prepare valve for PRESSURE CONTROL perform complete «Setup procedure». The valve has parameters that may be modified to tune pressure control performance. Refer to «Tuning of control performance».

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

Local operation: with ‘Control Performance Analyzer’, refer to chapter: «Local operation»	Remote operation:
<ol style="list-style-type: none"> 1. Open the CPA 2. Click [Local] 3. Click [Parameters] 4. Click [Pressure Control] and do the settings 5. Click [Save] 	Refer to “EtherCAT control commands” for details.

5.7 Display information

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



5.7.1 Power up

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

5.7.2 Operation

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

5.7.3 Error

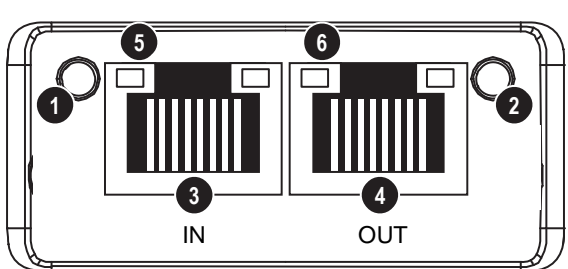
Description	Digit 1	Digit 2	Digit 3	Digit 4
Error number (xyz)	E	x	y	z
alternately (if error code exist)				
Error code	-	u	v	w



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

5.7.4 EtherCAT LEDs

#	Item
1	RUN LED ^{a)}
2	Error LED ^{a)}
3	EtherCAT (port 1) IN
4	EtherCAT (port 2) OUT
5	Link/Activity (port 1) IN
6	Link/Activity (port 2) OUT



a) The flash sequences for these LEDs are defined in DR303-3 (CiA)

5.7.4.1 Run LED (1)

This LED reflects the status of the CoE (CANopen over EtherCAT) communication.

LED State	Indication	Description
Off	INIT	CoE device in 'INIT'-state (or no power)
Green	OPERATIONAL	CoE device in 'OPERATIONAL'-state
Green, blinking	PRE- OPERATIONAL	CoE device in 'PRE-OPERATIONAL'-state
Green, single flash	SAFE- OPERATIONAL	CoE device in 'SAFE-OPERATIONAL'-state
Red ^{a)}	EXCEPTON state (Fatal Event)	-

a) If RUN and ERR turns red, this indicates a fatal event, forcing the bus interface to a physically passive state.

5.7.4.2 Error LED (2)

This LED indicates EtherCAT communication errors etc.

LED State	Indication	Description
Off	No error	No error (or no power)
Red, blinking	Invalid configuration	State change received from master is not possible due to invalid register or object settings.
Red, single flash	Unsolicited state change	Slave device application has changed the EtherCAT state autonomously; parameter 'Change' in the AL status register is set to 01h (change/error).
Red, double flash	Application watchdog timeout	Sync manager watchdog timeout
Red ^{a)}	Application controller is not responding any more	EXCEPTION state

a) If RUN and ERR turns red, this indicates a fatal event, forcing the bus interface to a physically passive state.

5.7.4.3 Link/Activity LED's (5 / 6)

These LED's indicate the EtherCAT link status and activity.

LED State	Indication	Description
Off	No link	Link not sensed (or no power)
Green	Link sensed, no activity	Link sensed, no traffic detected
Green flickering	Link sensed, no activity detected	Link sensed, traffic detected

5.7.5 Safety mode

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

When 'safety mode' is entered from operation (i.e. pressure control mode), the unit will automatically switch to position control mode and remain at current position. Once motor interlock is deactivated the unit remains in position control mode.

5.8 Operation during power up

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

Refer also to chapter: «Display information».

5.9 Behavior in case of power failure

Valve position before power failure:	Reaction of valve:	
	Without Power Failure Option (PFO)	With Power Failure Option (PFO)
653 G		653 H
653 A		653 C
653 T		653 U
653 V		653 W
Closed (isolated)	Valve remains closed.	Valve will close or open depending on valve configuration 1).
Valve open or in any intermediate position	Sealing ring moves down and blocks the pendulum plate at the current position.	Default is not defined. Display indicates F .

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



All parameters are stored in a power fail save memory.

5.10 Operation under increased temperature

	CAUTION
	<p>Hot valve</p> <p>Heated valve may result in minor or moderate injury.</p> <p>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.</p>



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

5.11 Behavior In case of compressed air pressure drop

Valve position before pressure drop:	Reaction of valve:
Valve closed	Valve remains closed.
Valve open or in any intermediate position	Sealing ring moves down and blocks the pendulum plate at the current position.



Refer to chapter: «Troubleshooting» for details.

6 Trouble shooting

6.1 Controller Display

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

6.2 Error numbers



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

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

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

6.3 Warning bitmap

Name	Bit	Decimal Value	Description
No Learn Data	0	1	Learn data is not available
Isolation Valve Warning	1	2	Isolation valve does not work.
No Sensor Active	2	4	Sensor is not active
PFO Not Active	3	8	PFO is not active
Cluster Slave Offline	4	16	Cluster Slave Offline
Compressed Air Not Falling	8	256	Compressed Air Not Falling when valve close
Compressed Air Too Low	9	512	Compressed Air Too Low
Compressed Air Too High	10	1024	Compressed Air Too High
Fan Stall Alarm	12	4096	Fan stall

6.4 Error bitmap

Name	Bit	Decimal Value	Description
Motor 1 Homing Position Error	0	1	Homing position error happened
Motor 1 Homing Not Running	1	2	Homing has not performed
Motor 1 Homing Error State	2	4	Homing does not work
Motor 1 Op Position Error	3	8	Position cannot be reached
Motor 1 Op Position Not Running	4	16	Not ready -> example: error during initialization
Motor 1 Op Error State	5	32	Error during operation -> example: input voltage too low
Other Component	18	262144	Other component does not work
General	30	1073741824	For example Do Not Operate Mode is active

6.5 Error code

Error Code			Description	Solution
u	v	w		
		1	No valve connected	Connect valve controller to the valve
		2	Non volatile memory failure	Replace valve controller
		3	Analog digital converter of sensor input failure	Replace valve controller
		4	Initialization of motion controller failed	<ul style="list-style-type: none"> Wrong motion controller firmware version → Update motion controller firmware
		5	Encoder index pulse not found	<ul style="list-style-type: none"> Encoder failure O-Ring sticking 1)
		6	Initialization of interface module failed	<ul style="list-style-type: none"> Fieldbus: Valve firmware does not support interface type → Update valve firmware Wrong interface firmware version → Update interface firmware
1	0		Closing position can't be reached	<ul style="list-style-type: none"> 1)
1	1		Homing position can't be reached	<ul style="list-style-type: none"> 1)
1	2		Motion controller: Internal voltage error	<ul style="list-style-type: none"> Check power supply
1	3		Motion controller: Internal error temperature	<ul style="list-style-type: none"> Check for a heat accumulation
1	4		Motion controller: Unexpected behavior	Contact vat support <ul style="list-style-type: none"> Achsen vertauscht Encoder nicht angeschlossen
1	5		Motion controller: Target position can't be reached	<ul style="list-style-type: none"> 1) Current settings
1	6		Motion controller: Position minimal conductance cannot be reached	<ul style="list-style-type: none"> 1) Check Plate and Seal ring

				<ul style="list-style-type: none"> • Check Parameter "Isolation Position Enter [r]"
	1	7	Motion controller: Position to push back the Differential Plate cannot be reached	<ul style="list-style-type: none"> • 1) • Check Different Plate • Check Parameter "Differential Plate Push Back Position [r]"
	1	8	Motion controller: Minimal isolation position cannot be reached	<ul style="list-style-type: none"> • 1) • Check Plate and Seal ring • Check Parameter "Isolation Position [r]"
	2	0	Break slippery detected	Replace actuator
	3	0	SFV: Motion controller failure in master-slave communication	Contact vat support
	4	0	Compressed air error	Check compressed air
	4	2	Power supply, low voltage detected	Check if power supply is ok and is able to deliver needed power
	9	6	SFV: Position deviation axis1 to axis2 at homing procedure	<ul style="list-style-type: none"> • O-Ring sticking • 1)
	9	7	SFV: Position deviation axis1 to axis2 at operating	1)
	9	8	Position error during closing procedure	1)
	9	9	Position error at operating	1)
2	0	0	Valve configuration error, not possible to operate the valve with these configuration	Contact VAT support
7	7	7	Do not operating mode active	

1) Mechanical movement problem:

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



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

7 Maintenance

	<p style="text-align: center;">⚠ WARNING</p> <p>Unqualified personnel Inappropriate handling may cause serious injury or property damage. Only qualified personnel are allowed to carry out the described work.</p>
	<p style="text-align: center;">⚠ WARNING</p> <p>Valve opening Risk of serious injury. Human body parts must be kept out of the valve opening and away from moving parts. Disconnect power on controller before doing any work.</p>
	<p style="text-align: center;">⚠ CAUTION</p> <p>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.</p>
	<p style="text-align: center;">NOTICE</p> <p>Contamination Gate and other parts of the valve must be protected from contamination. Always wear clean room gloves when handling the valve.</p>

7.1 Maintenance intervals

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

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

7.2 Maintenance procedures

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

- **Replacement of isolation seals** (gate and body seal of sealing ring) **and valve cleaning**
- **Replacement of actuator shaft seals**



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


VAT can give the following recommendations for preventive maintenance:

Replacement of	unheated ¹⁾	heated ≤ 80 °C ¹⁾	heated > 80 °C ¹⁾
isolation seals (gate and body seal of sealing ring)	12 month but max. 200'000 cycles	6 months but max. 200'000 cycles	3 months but max. 200'000 cycles
actuator shaft seals	1'000'000 cycles	6 months	3 months



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

NOTICE



Vacuum grease

Vacuum grease may be distributed and contaminate the valve.

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


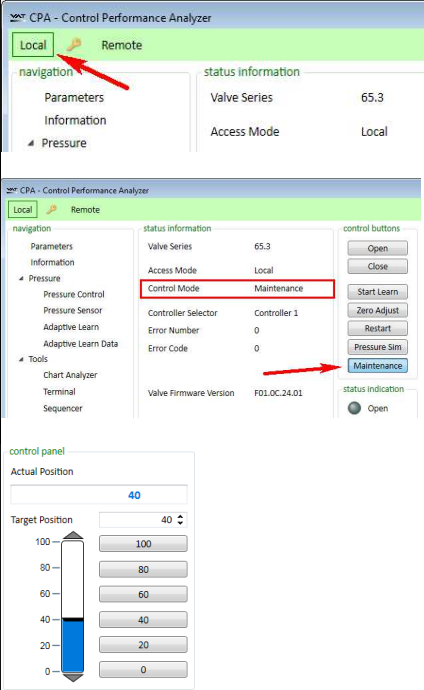

See figure below:


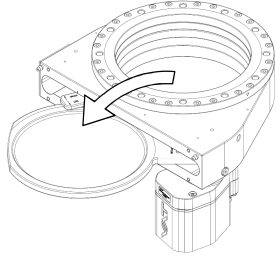
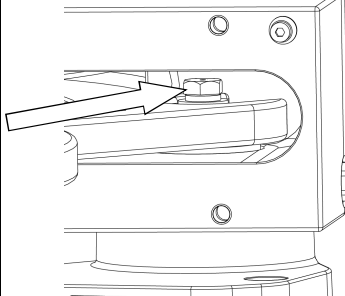
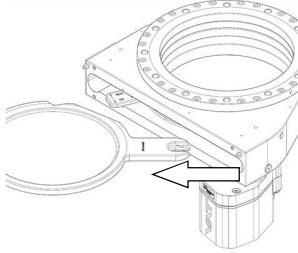

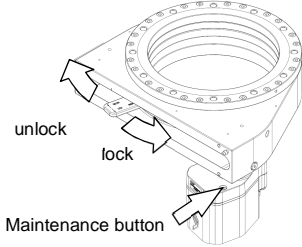


7.2.1 Replacement of isolation seals and valve cleaning

7.2.1.1 Required tools

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

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


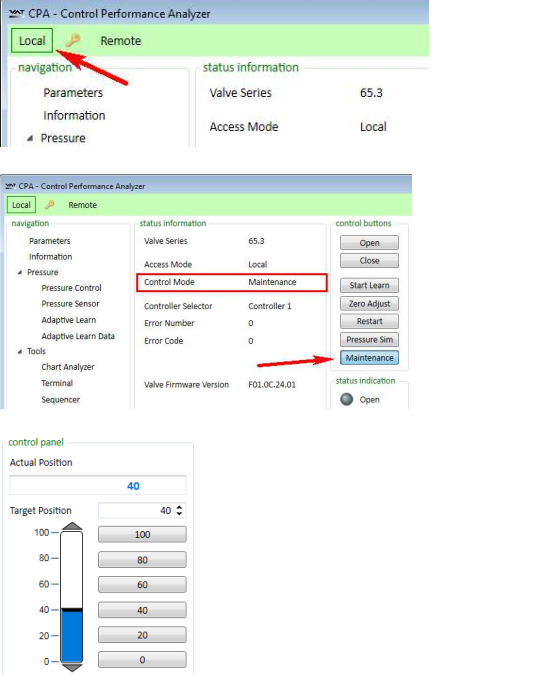

Description		Required tool
<p>5. Open valve</p>  Stand away from valve – pendulum plate moves out of the valve body.		
<p>6. Unfasten mounting screw for pendulum plate.</p>		<p>Open end wrench 13mm</p>
<p>7. Remove pendulum plate.</p>		
<p>8. With one hand press the MAINTENANCE BUTTON to lower the sealing ring, with your second hand unlock the sealing ring by pressing the handle.</p> <p>9. Release MAINTENANCE BUTTON.</p> <p>10. Remove sealing ring.</p> <p>11. To prevent the shaft and retaining pins from moving during work, switch the valve to safety mode. Refer to «Drive Power Enabled Switch, Safety Mode». for details.</p>  Retaining pins will move up.	 <p>unlock</p> <p>lock</p> <p>Maintenance button</p>	


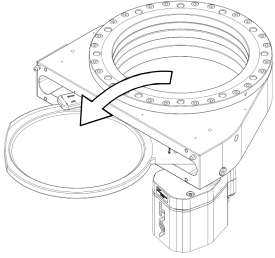
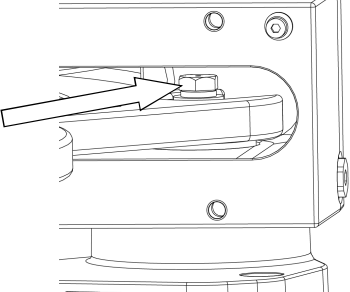
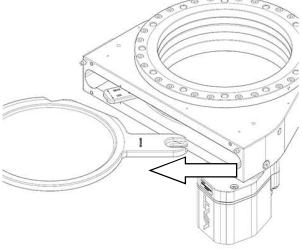

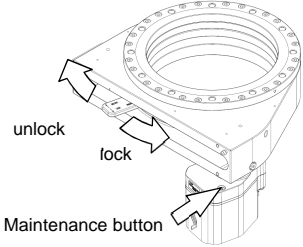
Description		Required tool										
<p>12. Remove gate and body o-ring from sealing ring carefully with a soft tool.</p> <p>13. Remove grease residues at sealing ring with alcohol. Clean sealing ring and pendulum plate with alcohol or in an ultrasonic bath.</p> <p>14. Clean out valve body with alcohol. Use an appropriate non metal tool with a cloth to enter valve body. Do not enter valve body with hands! Then blow out valve body with clean air. Do not directly expose seals (actuator and retaining pin feedthroughs) to air stream!</p> <p>15. Clean or replace gate seal if necessary. Install gate o-ring to sealing ring without grease.</p>												
<p>16. Clean or replace body seal if necessary. Lubricate body with the quantity of vacuum grease listed in the table to the right.</p>	<table border="1"> <thead> <tr> <th>Valve size</th> <th>Quantity of grease [ml]</th> </tr> </thead> <tbody> <tr> <td>DN 100</td> <td>0.1</td> </tr> <tr> <td>DN 160</td> <td>0.15</td> </tr> <tr> <td>DN 200</td> <td>0.2</td> </tr> <tr> <td>DN 250</td> <td>0.2</td> </tr> </tbody> </table>	Valve size	Quantity of grease [ml]	DN 100	0.1	DN 160	0.15	DN 200	0.2	DN 250	0.2	<p>Soft tool (o-ring remover)</p> <p>Vacuum grease</p>
	Valve size	Quantity of grease [ml]										
	DN 100	0.1										
	DN 160	0.15										
DN 200	0.2											
DN 250	0.2											
<p>17. Install body seal into sealing ring.</p>												
<p>18. Deposit vacuum grease on the bottom side of the body seal according to drawing below. Pay attention that the quantity of vacuum grease listed in the table to the right is distributed constantly over the whole circumference.</p>	<table border="1"> <thead> <tr> <th>Valve size</th> <th>Quantity of grease [ml]</th> </tr> </thead> <tbody> <tr> <td>DN 100</td> <td>0.2</td> </tr> <tr> <td>DN 160</td> <td>0.25</td> </tr> <tr> <td>DN 200</td> <td>0.3</td> </tr> <tr> <td>DN 250</td> <td>0.4</td> </tr> </tbody> </table>	Valve size	Quantity of grease [ml]	DN 100	0.2	DN 160	0.25	DN 200	0.3	DN 250	0.4	Vacuum grease
	Valve size	Quantity of grease [ml]										
	DN 100	0.2										
	DN 160	0.25										
DN 200	0.3											
DN 250	0.4											
		Vacuum grease										
<p>19. Reassembly the valve in reverse order, step 9...3. 20. Close the valve bonnet, see steps 31...33.</p>												
<p>21. Mount valve bonnet.</p> <ul style="list-style-type: none"> Tightening torques for bonnet screws, see in table to the right. 	<p>Max. torque 6 Nm</p>	<p>Allen wrench 5mm</p>										
<p>22. To leave the maintenance mode press "Restart" button or power cycle the controller.</p> <p>23. Set the valve to remote mode</p>		<p>CPA & Service cable (PC to valve Service connector)</p>										

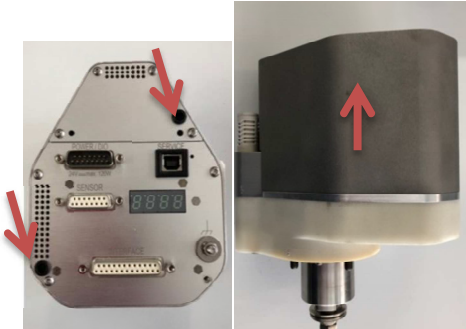
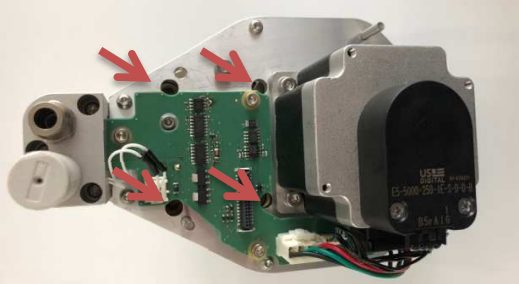

7.2.2 Replacement of actuator shaft seals

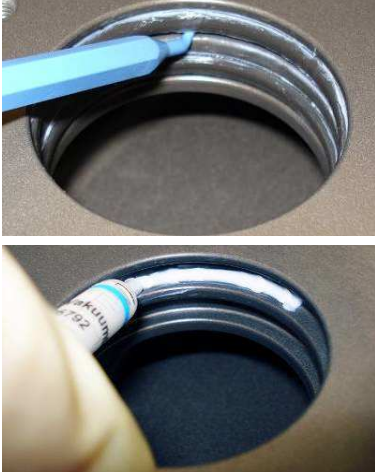


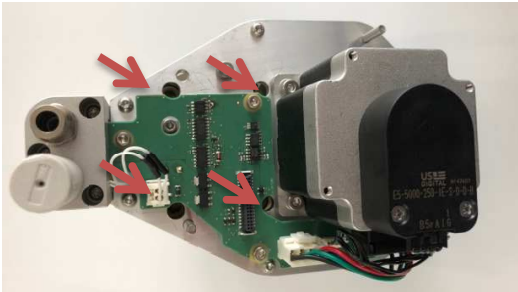
7.2.2.1 Required tools

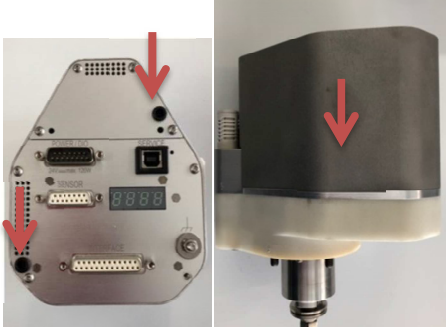



- Allen Wrench 2mm
- Allen Wrench 4mm
- Allen Wrench 5mm
- O-ring removal tool (see chapter Accessories)
- Vacuum grease (see chapter spare parts)
- Open end wrench 13mm
- Clean room wiper
- Isopropyl alcohol
- Service cable USB Type A to B (PC to valve Service connector)

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


Description	Required tool	
<p>24. Open valve</p>  Stand away from valve – pendulum plate moves out of the valve body.		
<p>25. Unfasten mounting screw for pendulum plate.</p>		<p>Open end wrench 13mm</p>
<p>26. Remove pendulum plate.</p>		
<p>27. With one hand press the MAINTENANCE BUTTON to lower the sealing ring, with your second hand unlock the sealing ring by pressing the handle.</p> <p>28. Release MAINTENANCE BUTTON.</p> <p>29. Remove sealing ring.</p> <p>30. To prevent the shaft and retaining pins from moving during work, switch the valve to safety mode. Refer to «Drive Power Enabled Switch, Safety Mode». for details.</p>  Retaining pins will move up.	 <p>unlock</p> <p>lock</p> <p>Maintenance button</p>	


Description	Required tool
<p>31. Release the valve from safety mode. Refer to «Safety mode» for details</p> <p>32. Move the valve to position 50% (half opened) This is necessary, in order to dismount the actuator. See step 15.</p> <p>33. Disable PFO option feature via 'Power Fail Status' in menu 'System' of CV or CPA software, and turn off the power</p>	<ul style="list-style-type: none"> • CPA software
<p>34. Disconnect 24VDC power. Wait for 60s, then disconnect cables and compressed air from valve actuator.</p> <p>35. Unfasten all 2 controller screws and lift controller carefully from actuator.</p>	 <p>Allen Wrench 4 mm</p>
<p>36. Unfasten all 4 actuator screws and remove actuator.</p>	 <p>Allen Wrench 5 mm</p>
<p>37. Replace pressed air gasket</p>	 <p>927458</p>

Description	Required tool
<p>38. Remove actuator shaft seals carefully with a soft tool.</p> <p>39. Clean actuator feedthrough with alcohol.</p> <p>40. Lubricate each o-ring groove with 0.1 ml vacuum grease. Pay attention that grease is distributed constantly over the whole circumference.</p>	 <p>Soft tool (o-ring remover)</p> <p>Vacuum grease</p>
<p>41. Clean or replace seals if necessary. Lubricate each o-ring with 0.05 ml vacuum grease.</p> <p>42. Install o-rings.</p> <p>43. Deposit 0.1 ml vacuum grease on each o-ring. Pay attention that grease is distributed constantly over the whole circumference.</p>	 <p>Vacuum grease</p>
<p>44. Remove fixation kit and mounting screw for pendulum plate.</p> <p>45. Clean screw and slightly lubricate thread. Then reinstall fixation kit.</p> <p>46. Clean actuator shaft and lubricate it with 0.1 ml vacuum grease.</p>	 <p>Vacuum grease</p>
<p>47. Install actuator</p> <ul style="list-style-type: none"> • Tighten actuator screws with 10 Nm. • Remove vacuum grease from actuator shaft face after installation. 	 <p>Allen Wrench 5mm</p>

Description	Required tool	
48. Install controller <ul style="list-style-type: none"> • Tighten the controller screws with 3 Nm. • Connect cables at controller • Connect compressed air at actuator 		Allen Wrench 4mm
49. Turn on power of controller.  Valve moves to close position. 50. Open valve and install sealing ring and pendulum plate in reverse order as they had been disassembled (steps 11 to 2).		open end wrench 13mm
51. Clean the valve sealing surface		Lint-and dust-free towel a little soaked with isopropyl alcohol
52. Clean the valve bonnet o-ring		Lint-and dust-free towel
53. Mount valve bonnet. <ul style="list-style-type: none"> • Tightening torques for bonnet screws, see in table to the right. 	Max. torque 6 Nm	Allen wrench 5mm
54. To leave the maintenance mode press "Restart" button or power cycle the controller. 55. Set the valve to remote mode		CPA & Service cable (PC to valve Service connector)

7.2.3 Replacement of Option board

	NOTICE
	<p>Electrostatic discharge</p> <p>Electronic components could be damaged.</p> <p>All work on the control and actuating unit has to be done under ESD protected environment to prevent electronic components from damage.</p>

	NOTICE
	<p>Burned connector pins (spark)</p> <p>Connector pins or electronic parts could be damaged, if plugged and unplugged under power.</p> <p>Do not plug or unplug connectors under power.</p>

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

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

It is available in 3 versions. These are:

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

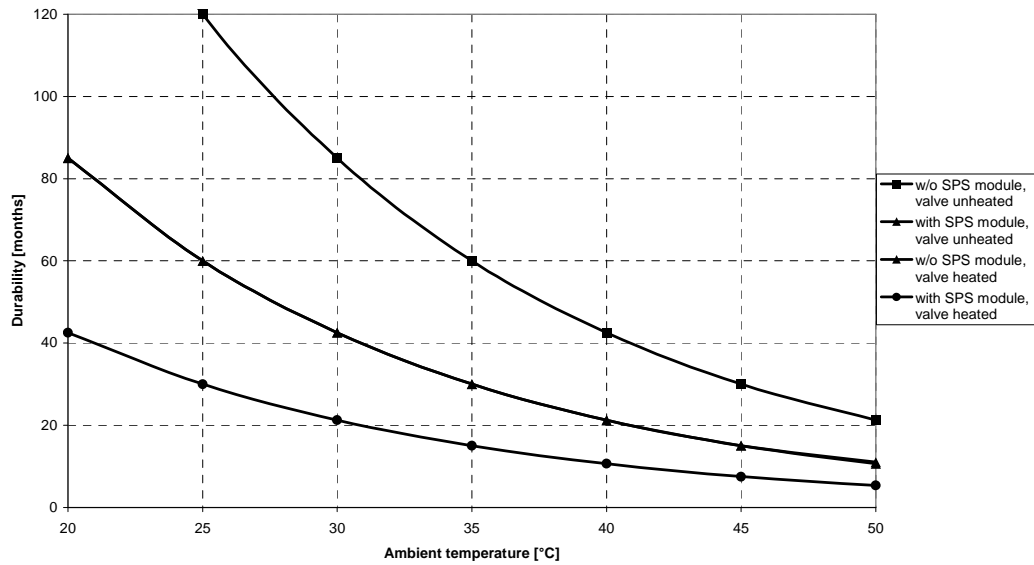
The modules may be retrofitted or replaced easily. The battery lifetime of the PFO module depends on the ambient temperature (see below). To assure PFO function the option board must be replaced after battery life has expired. For ordering number of the modules refer to chapter «Spare parts».

7.2.3.1 Durability of power fail battery

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

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

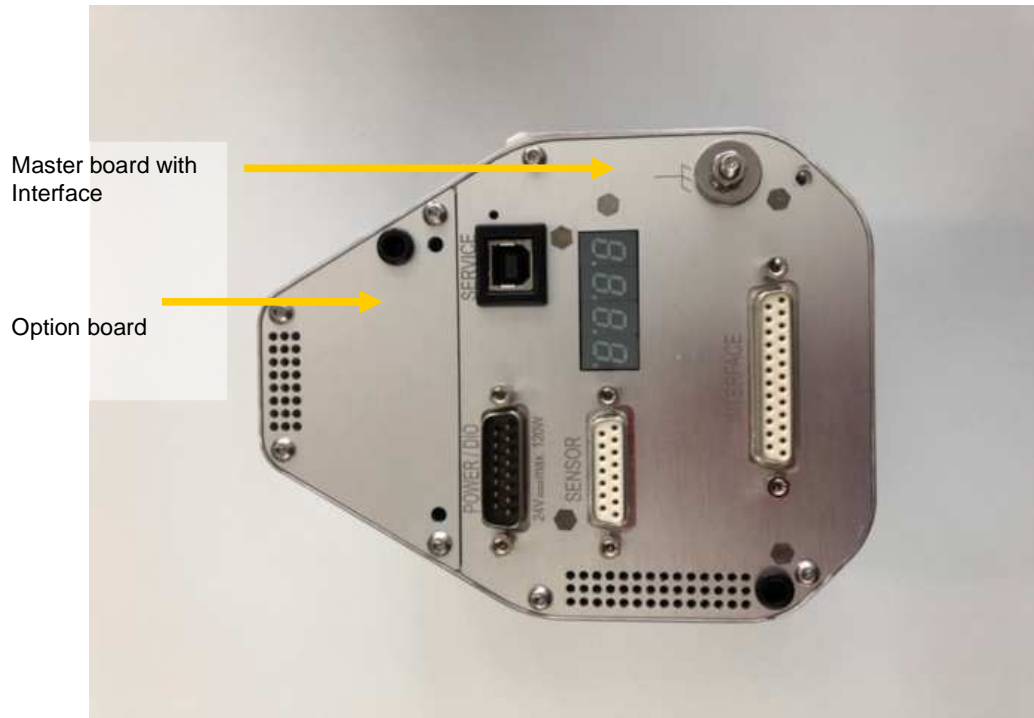
Therefore please determine the equivalent maintenance period for replacing the Ultra Cap battery (Option board).



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

7.2.4 Retrofit / replacement procedure



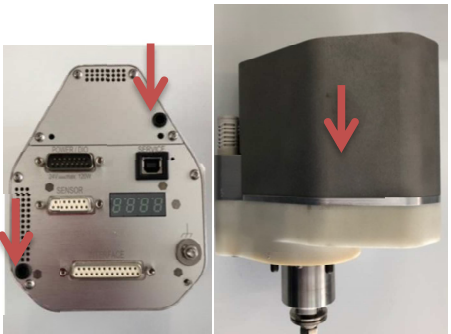
Top view on control and actuating unit with panel removed:



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

7.2.4.1 Required tools

- Pozidriv screw driver size 1
- Open end wrench 4.5mm

Description	Required tool
<ol style="list-style-type: none"> 1. Disconnect 24VDC power. Wait for 60s, then disconnect cables and compressed air from valve actuator. 2. Unfasten all 2 controller screws and lift controller carefully from actuator. 	
<ol style="list-style-type: none"> 3. Place Option board from behind in the controller. 4. Tighten option board with the 2 screws with 1.1Nm. 	
<ol style="list-style-type: none"> 5. 6. Fasten all 2 controller screws and lift controller carefully from actuator. 7. Connect cables and compressed air to valve actuator. 	




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

8 Repairs


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

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

9 Dismounting and Storage

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


9.1 Dismounting


	NOTICE
	Contamination Gate and other parts of the valve must be protected from contamination. Always wear clean room gloves when handling the valve.

	NOTICE
	Valve in open position Valve body may become damaged if valve gate is in open position. Move valve gate to the closed position before dismounting the valve.

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




9.2 Storage

NOTICE	
	<p>Wrong storage</p> <p>Inappropriate temperatures and humidity may cause damage to the product.</p> <p>Valve must be stored at:</p> <ul style="list-style-type: none">– relative humidity between 10% and 70%– temperature between +10 °C and +50 °C– non-condensing environment

NOTICE	
	<p>Inappropriate packaging</p> <p>Product may get damaged if inappropriate packaging material is used.</p> <p>Always use the original packaging material and handle product with care.</p>

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


10 Packaging and Transport

	<p style="text-align: center;">⚠ WARNING</p> <p>Unqualified personnel Inappropriate handling may cause serious injury or property damage. Only qualified personnel are allowed to carry out the described work.</p>
	<p style="text-align: center;">⚠ WARNING</p> <p>Harmful substances Risk of injury in case of contact with harmful substances. Remove harmful substances (e. g. toxic, caustic or microbiological ones) from valve before you return the valve to VAT.</p>
	<p style="text-align: center;">NOTICE</p> <p>Inappropriate packaging Product may get damaged if inappropriate packaging material is used. Always use the original packaging material and handle product with care.</p>



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

10.1 Packaging


NOTICE	
	<p>Valve in open position Valve mechanism may get damaged if valve is in open position. Make sure that the valve is closed.</p>

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



VAT disclaims any liability for damages resulting from inappropriate packaging.

10.2 Transport


NOTICE	
	<p>Inappropriate packaging Product may get damaged if inappropriate packaging material is used. Always use the original packaging material and handle product with care.</p>





VAT disclaims any liability for damages resulting from inappropriate packaging.


11 Disposal

Observe the local regulations for disposal

	⚠ WARNING
	<p>Harmful substances Environmental pollution. Discard products and parts according to the local regulations.</p>

	⚠ WARNING
	<p>Unqualified personnel Inappropriate handling may cause serious injury or property damage. Only qualified personnel are allowed to carry out the disposal.</p>

	⚠ CAUTION
	<p>Risk of damage Indicates a hazardous situation which, if not avoided, may result in minor or moderate injury. A large number of diverse materials are used in the product. Some of them could cause human and machine damage in the case of improper handling.</p> <ul style="list-style-type: none"> • Observe local regulations in regard to waste disposal without fail. • Commission an authorized waste disposal company for the professional disposal of your waste.

	NOTICE
	<p>Improper disposal Some built-in materials can cause damage, if improperly handled. - When disposing, take into account all the different materials used</p>



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

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

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

12 Spare parts



NOTICE

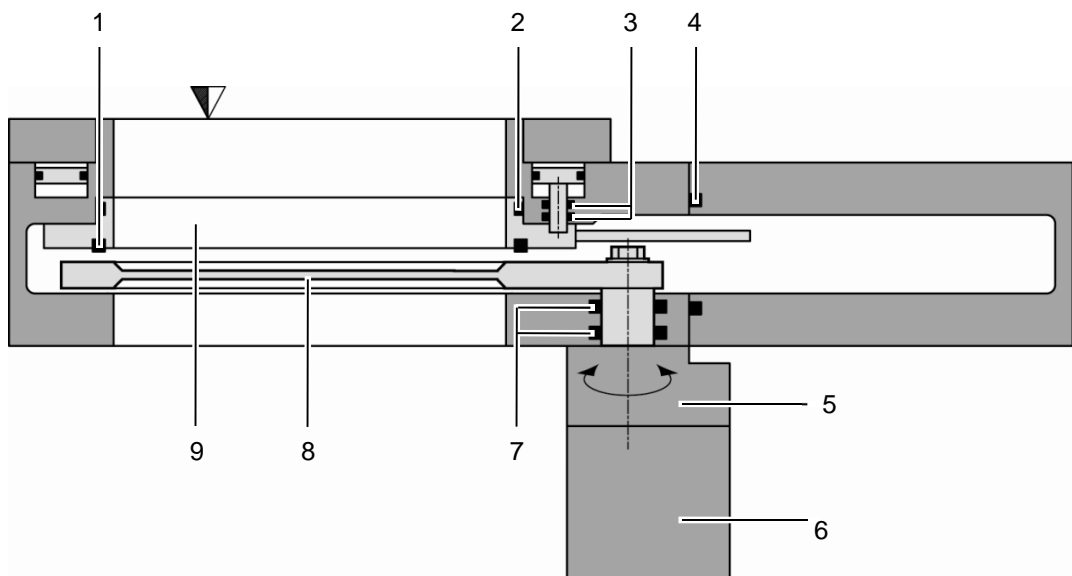
Non-original spare parts

Non-original spare parts may cause damage to the product.
Use original spare parts from VAT only.



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

12.1 Drawing



- | | | | |
|---|-------------------------|---|--------------------------|
| 1 | Plate seal | 6 | Integrated controller |
| 2 | Body seal | 7 | Rotary feedthrough seals |
| 3 | Shaft feedthrough seals | 8 | Pendulum plate |
| 4 | Bonnet seal | 9 | Sealing ring |
| 5 | Actuator | | |



All "Item" refer to chapter «Drawing»

12.1.1 Valve unit with seals and grease

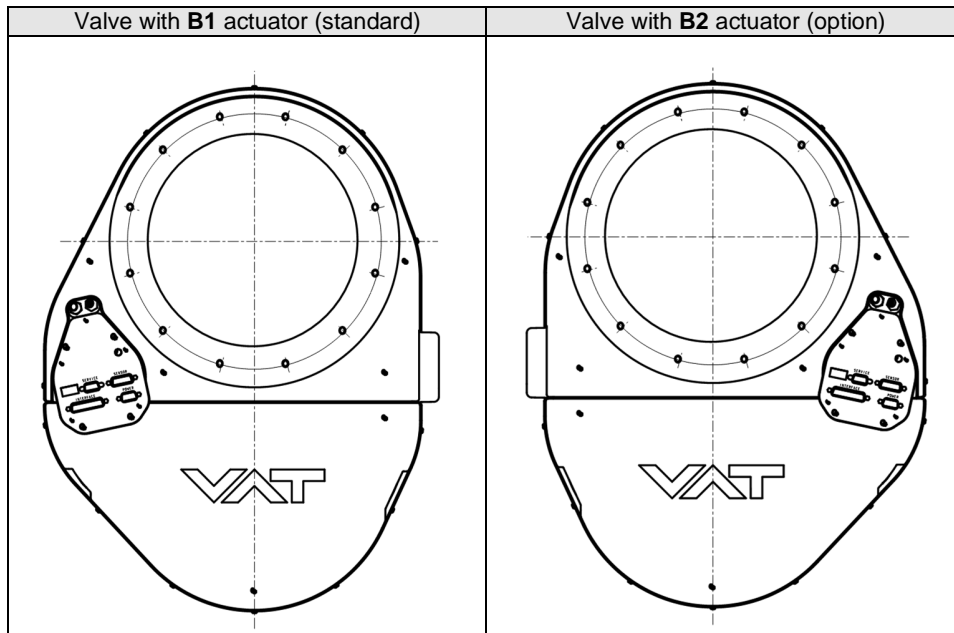
Item	Description	DN100	DN160	DN200	DN250
	Valve size Valve part number	DN100 65340 - -	DN160 65344 - -	DN200 65346 - -	DN250 65348 - -
1	Bonnet Viton seal other materials	N-5100-259 on request	N-5100-267 on request	N-5100-272 on request	N-5100-277 on request
2	Body seal (Viton) This includes a 2ml syringe of vacuum grease	204884	206527	200468	202592
3	Gate Viton seal other materials	N-5100-155 on request	N-5100-258 on request	N-5100-266 on request	N-5100-275 on request
	Seal kit vacuum (Viton). This consists of item 2 and 3.	204883	206526	204204	203883
	Syringe of 2ml vacuum grease 5ml	206792 206793			
4	Actuator shaft seals (Viton) Actuator compressed air gasket	N-5100-326 (2 pcs required per valve) 927458			
5	Sealing ring shaft seals (Viton)	N-5111-112 (12 pcs required per valve)	N-5111-112 (12 pcs required per valve)	N-5111-112 (16 pcs required per valve)	N-5111-112 (16 pcs required per valve)
6	Pendulum plate: - Blank B1 *) - Blank B2 *) - Hardanodized B1 *) - Hardanodized B2 *) - Nickel coated B1 *) - Nickel coated B2 *)	on request on request on request on request on request on request	on request on request on request on request on request on request	on request on request on request on request on request on request	on request on request on request on request on request on request
7	Sealing ring - Blank - Hardanodized - Nickel coated	on request on request on request	on request on request on request	on request on request on request	on request on request on request
8	Actuator B1 *) B2 *)	on request on request	342943 on request		

*) Refer to figures on next page to check for actuator position options.



Use only spare parts manufactured by VAT to assure safe and reliable operation All “

Actuator position options:



All "Item" refer to chapter «Drawing»

12.1.2 Control and actuating unit

Description	Part number
Control and actuating unit	Too many to list. Please contact VAT.
Option board with SPS module (±15 VDC Sensor Power Supply)	936205
Option board with PFO module (Power Failure Option)	936200
Option board with SPS and PFO module	936202

12.1.3 Accessories

Description	Part number
24 VDC power supply unit (input: 100 – 240 VAC)	891528
O-ring removal tool	234859
VAT valve cleaning tool	305709
Adapter cable for power supply with D-Sub9 connector	(735567) (D-Sub15 to D-Sub9)
Service cable (PC to valve Service connector)	809474 (USB A–B male-male)

12.1.3.1 Centering ring with Viton o-ring

Description					
Valve size		DN 100 / 4"	DN 160 / 6"	DN 200 / 8"	DN 250 / 10"
Product ordering number		65340 -	65344 -	65346 -	65348 -
Centering ring with Viton o-ring (for ISO-F installation only)	Aluminum	32040-QAZV	32044-QAZV	32046-QAZV	32048-QAZV
	Stainless steel	32040-QEZV	32044-QEZV	32046-QEZV	32048-QEZV

13 Appendix

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