# Installation, Operating & Maintenance Instructions

## Control gate valve
**with CC-Link interface**

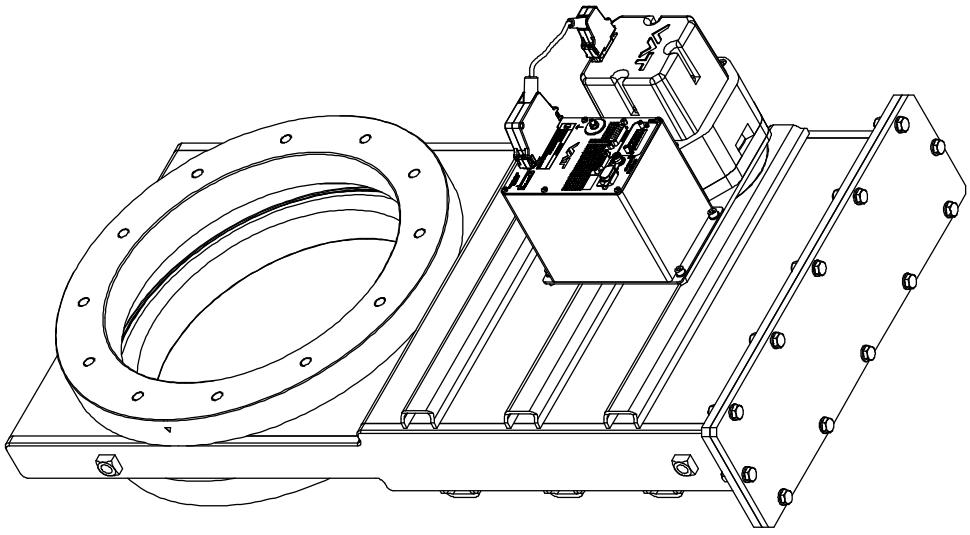
## Series 642
## DN 63 – 400 mm (I.D. 2.5” - 16")

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

| | |
|---|---|
| **642 . . - . .GL - . . . .** | (1 sensor input) |
| **642 . . - . .GN - . . . .** | (2 sensor inputs) |
| **642 . . - . .AL - . . . .** | (1 sensor input / ±15V SPS) |
| **642 . . - . .AN - . . . .** | (2 sensor inputs / ±15V SPS) |
| **642 . . - . .HL - . . . .** | (1 sensor input / PFO) |
| **642 . . - . .HN - . . . .** | (2 sensor inputs / PFO) |
| **642 . . - . .CL - . . . .** | (1 sensor input / ±15V SPS / PFO) |
| **642 . . - . .CN - . . . .** | (2 sensor inputs / ±15V SPS / PFO) |

SPS = Sensor Power Supply  PFO = Power Failure Option

configured with firmware **600P.1G.00.08**



Sample picture

## Imprint

Manufacturer VAT Vakuumventile AG, CH-9469 Haag, Switzerland

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

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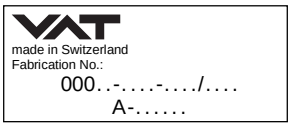
## Contents

# 1 Description of product

## 1.1 Identification of product

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




← Fabrication number
← Order number

## 1.2 Use of product

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

## 1.3 Used abbreviations

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

## 1.4 Related documents

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

## 1.5 Important information

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

**Example:**

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

## 1.6 Technical data

### 1.6.1 Control and actuating unit

| Description | | |
|---|---|---|
| Input voltage [1] | +24 VDC (±10%) @ 0.5 V pk-pk max. | [connector: POWER] |
| Power consumption | 55 W (standard)<br>with optional SPS + 36 W<br>with optional PFO + 10 W | [connector: POWER] |
| Interface | remote | [connector: CC-Link] |
| | local (RS232) | [connector: SERVICE] |
| LOGIC I/O[2] (configurable) | 1 digital input | [connector: Logic I/O] |
| | 1 digital output | |
| Sensor power supply output [3] | +24 VDC / 1500 mA max. | [connector: SENSOR] |
| Sensor input<br>Signal input voltage / Input resistance<br>ADC resolution<br>Sampling time | <br>0-10 VDC / Ri>100 kΩ (linear to pressure)<br>0.23 mV<br>10 ms | [connector: SENSOR] |
| PFO[4] battery pack<br>Charging time<br>Durability | <br>2 minutes max.<br>up to 10 years @ 25°C ambient<br>refer to «Durability of power fail battery» for details | |
| Ambient temperature | 0 °C to +50 °C max. (<35 °C recommended) | |
| Ambient humidity | 0 to 95% RH, non-condensing | |
| Pressure control accuracy | 5 mV or 0.1% of setpoint, whichever is greater | |

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

### 1.6.2 Valve unit

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

# 2 Safety

## 2.1 Compulsory reading material

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

**NOTICE**

**Lack of knowledge**

Failing to read this manual may result in property damage.

Firstly, read manual.

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

## 2.2 Danger levels

**⚠ DANGER**

**High risk**

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

**⚠ WARNING**

**Medium risk**

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

**⚠ CAUTION**

**Low risk**

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

**NOTICE**

**Command**

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

## 2.3 Personnel qualifications

**⚠ WARNING**

**Unqualified personnel**

Inappropriate handling may cause serious injury or property damage.

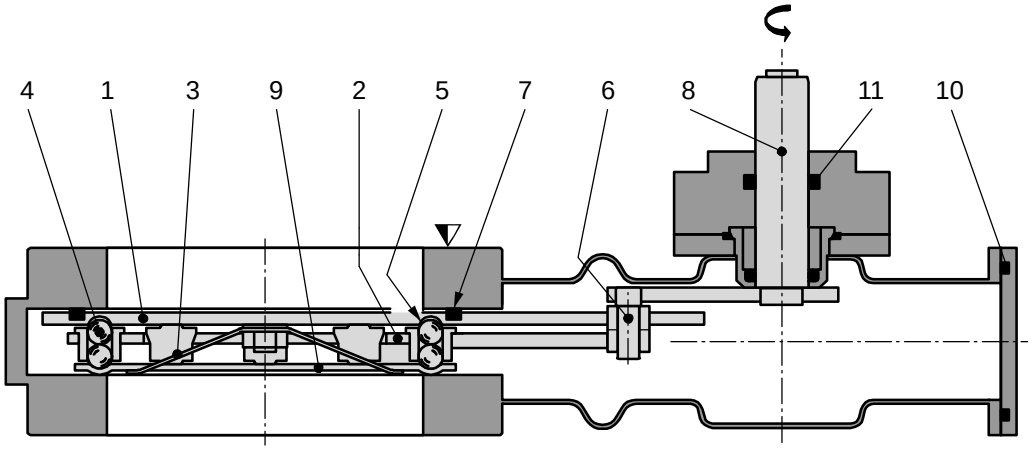
Only qualified personnel are allowed to carry out the described work.

## 2.4 Safety labels

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

# 3 Design and Function

## 3.1 Design



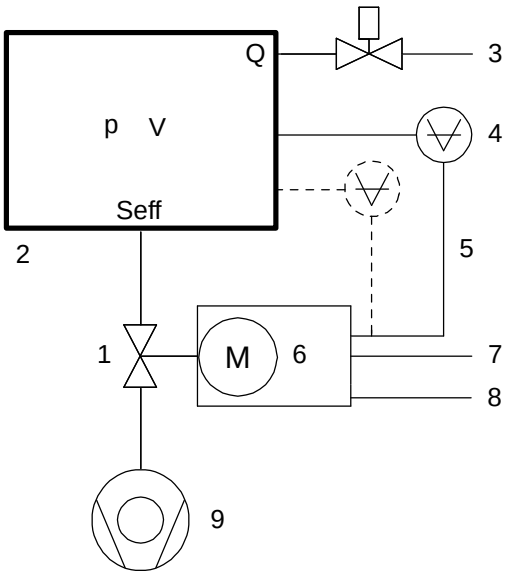

| | | | |
|---|---|---|---|
| 1 | Valve gate | 7 | Gate seal |
| 2 | Ball guidance | 8 | Actuator shaft |
| 3 | Leaf spring | 9 | Counter plate |
| 4 | Ball pairs | 10 | Bonnet seal |
| 5 | Detents | 11 | Rotary feed through seals |
| 6 | Crank bolt | | |

## 3.2 Function

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

### 3.2.1 Pressure control system overview and function

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




Example: Downstream control

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

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

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

### 3.2.1.1 Way of operation

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

### 3.2.1.2 Pressure control

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

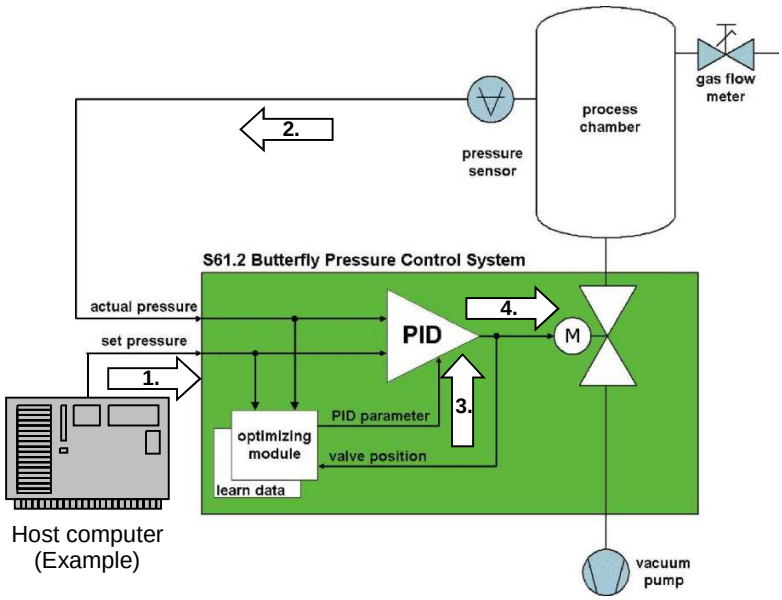
1. Downstream control (standard):
   The pressure is controlled by changing the conductance of a control valve between pump and process chamber. This changes the effective pumping speed at the process chamber. Pressure and gas flow can be independently controlled over a wide range.

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

### 3.2.1.3 Adaptive controller (standard)

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

## 3.2.2 Principle of a pressure control system




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

# 4 Installation

**⚠ WARNING**

**Unqualified personnel**

Inappropriate handling may cause serious injury or property damage.

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

## 4.1 Unpacking

***NOTICE***

**Physical overstraining at controller**

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

Do not place the valve on the controller.

**⚠ CAUTION**

**Valve is a heavy component**

Physical overstraining.

Use a crane to lift valves DN 200 (8”) and larger.

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

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

Do not remove protective foils from valve opening

## 4.2 Installation into the system

**⚠ WARNING**

**Valve opening**

Risk of serious injury.

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

***NOTICE***

**Sealing surfaces**

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

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

***NOTICE***

**Wrong connection**

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

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

***NOTICE***

**Burned connector pins (spark)**

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

Do not plug or unplug connectors under power.

***NOTICE***

**Contamination**

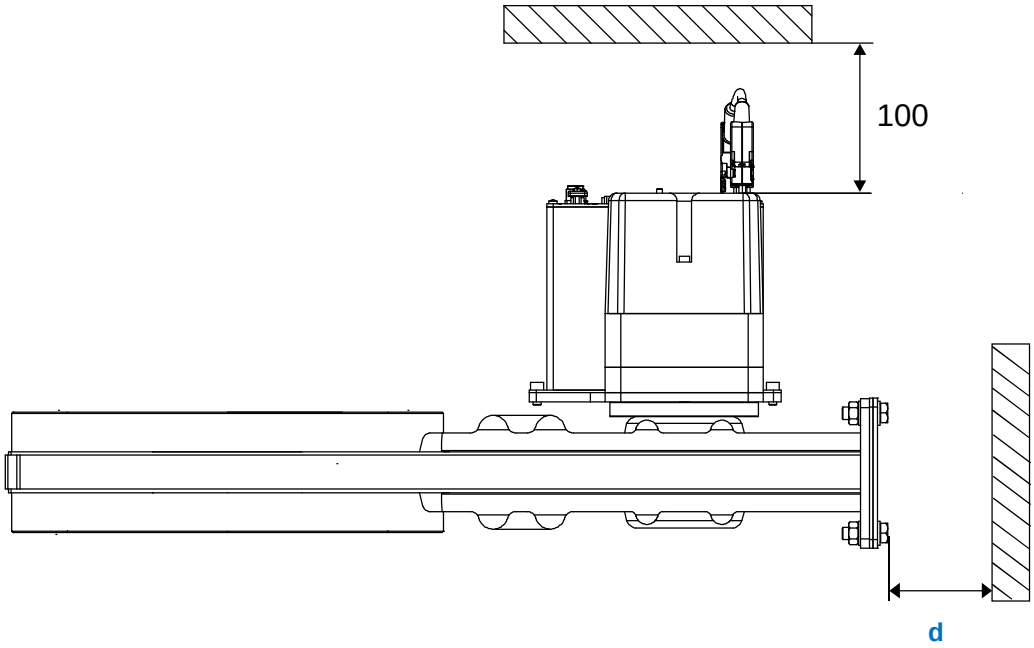
Gate and other parts of the valve must be protected from contamination.

Always wear clean room gloves when handling the valve.

Mount valve to a clean system only.

### 4.2.1 Installation space condition

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

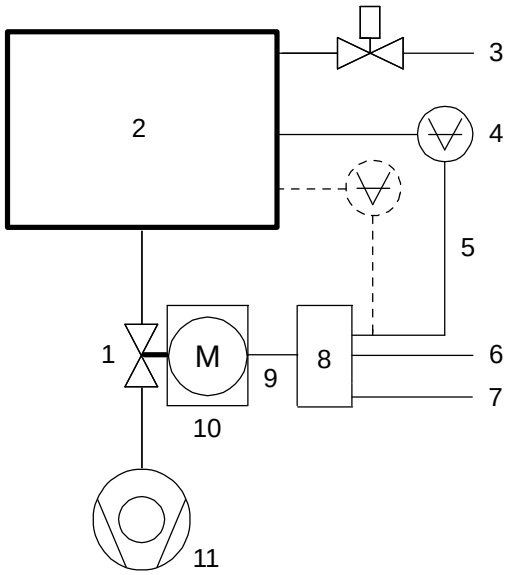



Overview table: DN to required distance (d) for maintenance.

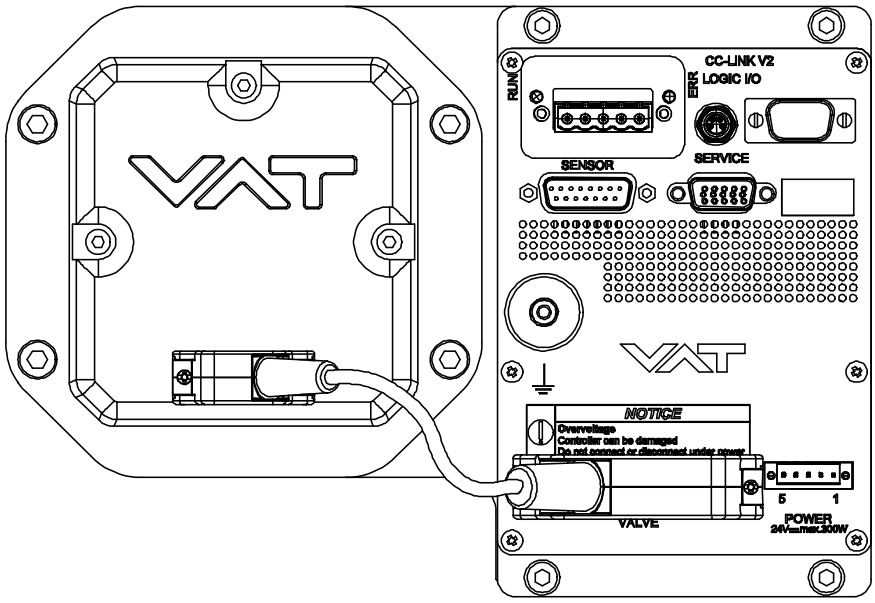
| DN | 63 | 80 / 100 | 160 | 200 | 250 | 320 / 350 | 400 |
|---|---|---|---|---|---|---|---|
| d | 180 | 220 | 300 | 350 | 450 | 550 | 600 |

### 4.2.2 Connection overview

System:




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




Actuator Controller

### 4.2.3 Installation procedure

1. Install valve [1] into the vacuum system, with valve seat side to process chamber. The valve seat side is indicated by the symbol "Δ" on the valve flange.

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

2. Install the ground connection cable at controller. Refer to «Electrical connection»
3. Install connection cable between actuator (connector) and controller (connector: VALVE)
4. Install sensor(s) [4] according to the recommendations of the sensor manufacturer and directives given under «Requirements to sensor connection».
5. Connect pressure sensor cable [5] to sensor(s) and then to valve (connector: SENSOR). Refer to chapter «Electrical connection» for correct wiring.
6. Connect valve to CC-Link [6] (CC-Link connector). Refer to «CC-Link interface connection» for correct wiring.
7. Connect power supply [7] to valve (connector: POWER). Refer to chapter «Electrical connection» for correct wiring.

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

8. This valve may optionally be equipped with a heating device. Connect VAT heating device according to manual of respective heating device.
9. Perform «Setup procedure» to prepare valve for operation.

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

## 4.3 Tightening torque

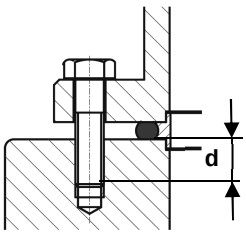
The torque values below are dependent on many factors, such as materials involved, surface quality, surface treatment, and lubrication.

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

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

### 4.3.1 Mounting with centering rings

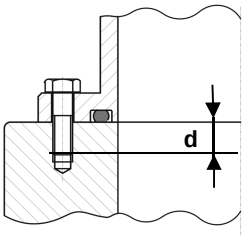
| DN | | max. torque (Nm) | | | max. torque (lbs . ft) | | | Max. hole depth [d] (mm) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| mm | inch | ISO-F | JIS | ASA-LP | ISO-F | JIS | ASA-LP | ISO-F | JIS | ASA-LP |
| 63 | 2 1/2 | 8 – 10 | 8 – 10 | 8 – 10 | 6 – 8 | 6 – 8 | 6 – 8 | 13 | 13 | 15 |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




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

### 4.3.2 Mounting with O-ring in grooves

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



## 4.4 Admissible forces

**NOTICE**

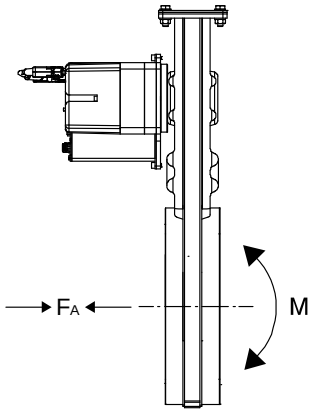
**Force at flange and valve body**

Forces from evacuating the system, from the weight of other components, and from baking can lead to deformation and malfunctioning of the valve.

Do not higher force the valve body as specified.

The following forces are admissible.

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

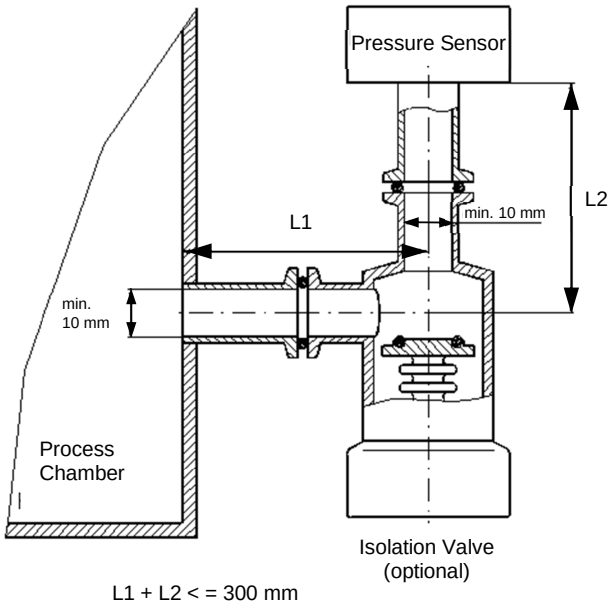


### 4.4.1 Requirements to sensor connection

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

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

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




## 4.5 Electrical connection

**NOTICE**

**Wrong connection**

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

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

**NOTICE**

**Burned connector pins (spark)**

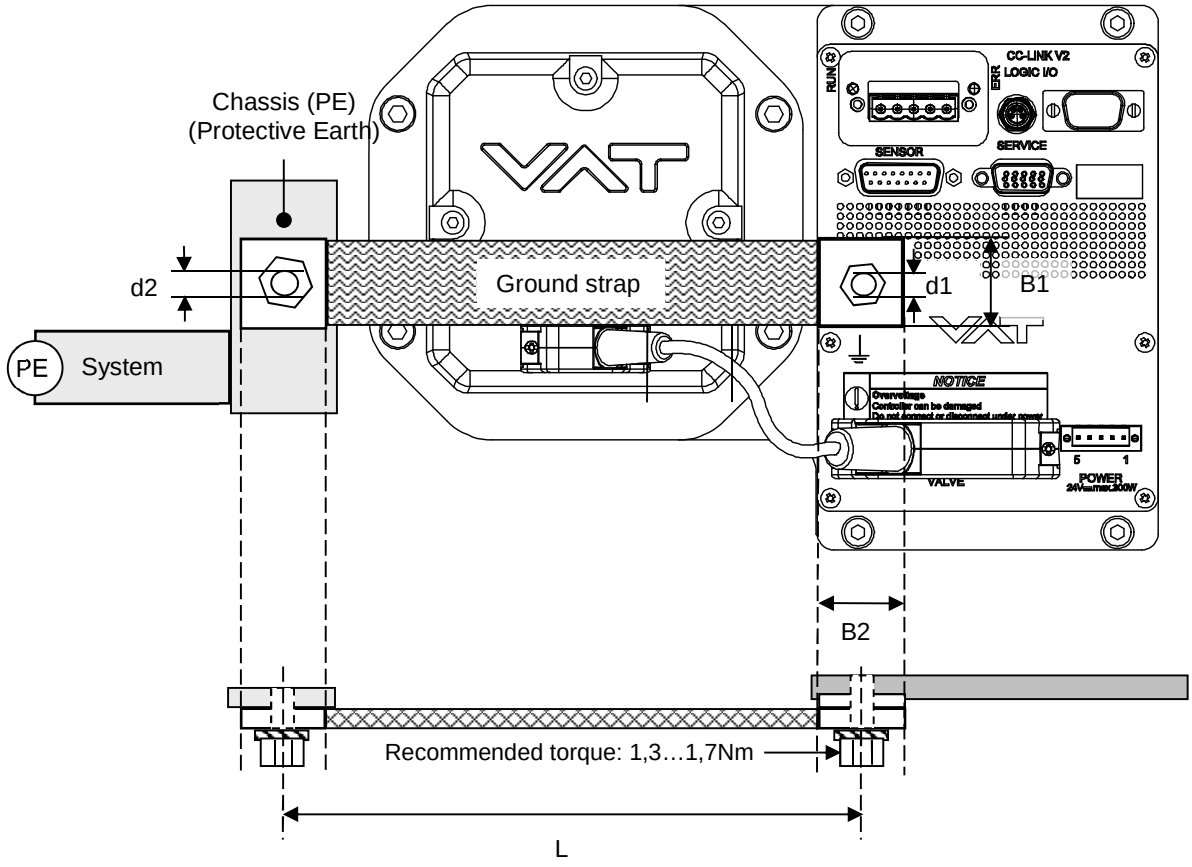
Connector pins or electronic parts could damage, if plugged and unplugged under power.

Do not plug or unplug connectors under power.

### 4.5.1 Ground connection

Recommendation for ground strap between controller ground and system chassis.

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




- Connection plates of ground strap must be total plane for a good electrical contact!
- The connection point at chassis (FE) must be blank metal (not coated). It is also possible to connect the ground strap at system chamber if it is well connected to PE.
- Avoid low chassis cross section to the system PE connection. (min. same cross section as ground strap)

### 4.5.2 Sensor supply concepts

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

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

- 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 SPS module» for schematic and correct wiring.

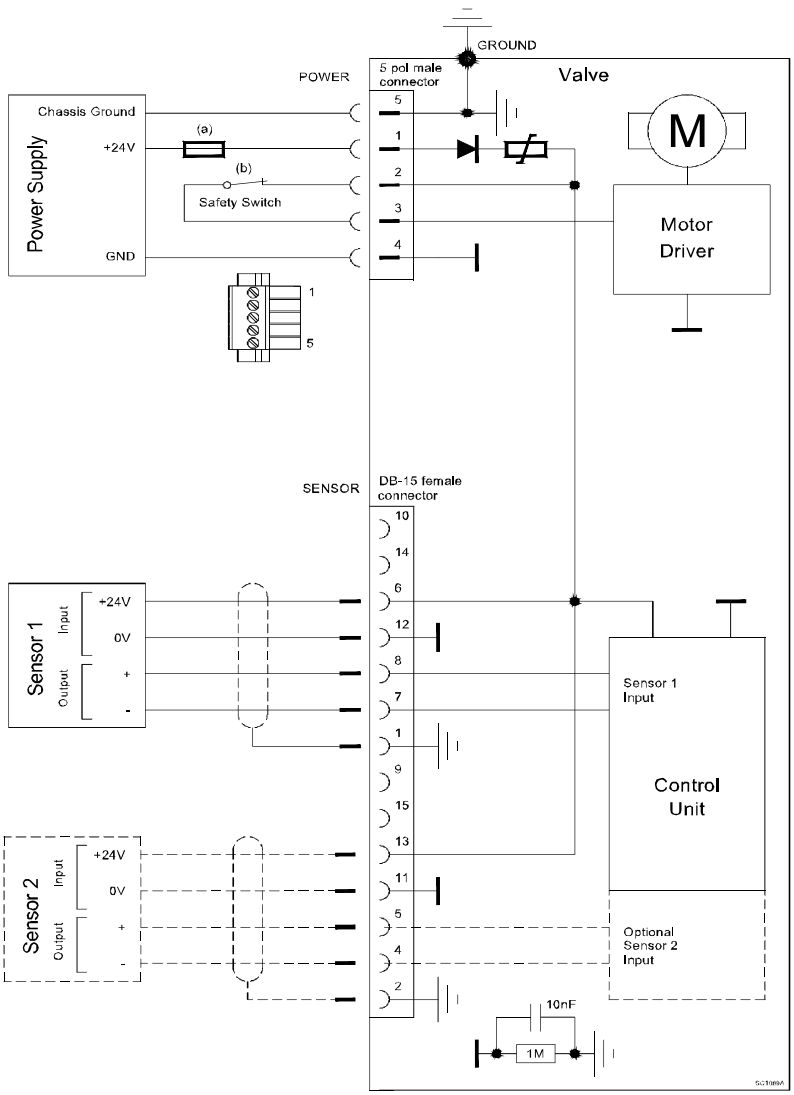
- External ±15 VDC power to supply ±15 VDC sensors without SPS option externally. Refer to chapter «Power and sensor connection (±15 VDC sensors) without SPS module» for schematic and correct wiring.

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

### 4.5.3 Power and sensor connection (+24 VDC sensors)

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

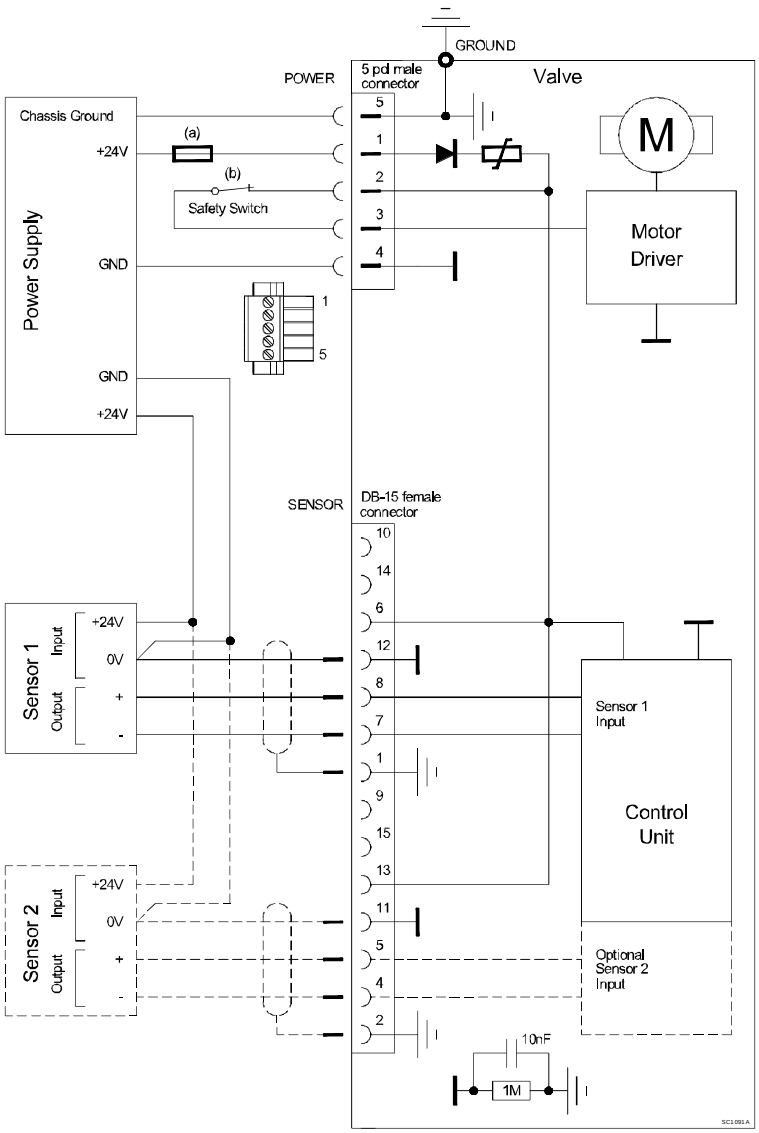
#### 4.5.3.1 +24 VDC power to supply +24 VDC sensors via controller




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

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

#### 4.5.3.2 +24 VDC power to supply +24 VDC sensors externally

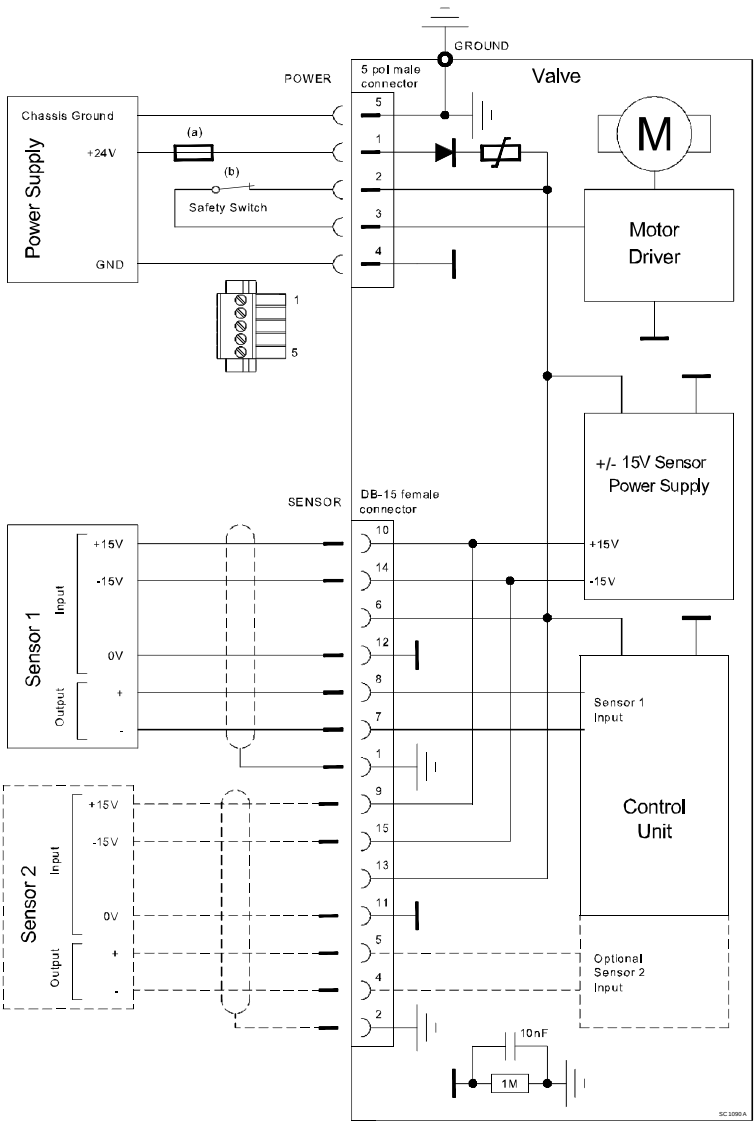



Pins 2 and 3 must be bridged for operation. An optional switch would allow for motor interlock to prevent valve from moving.

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

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

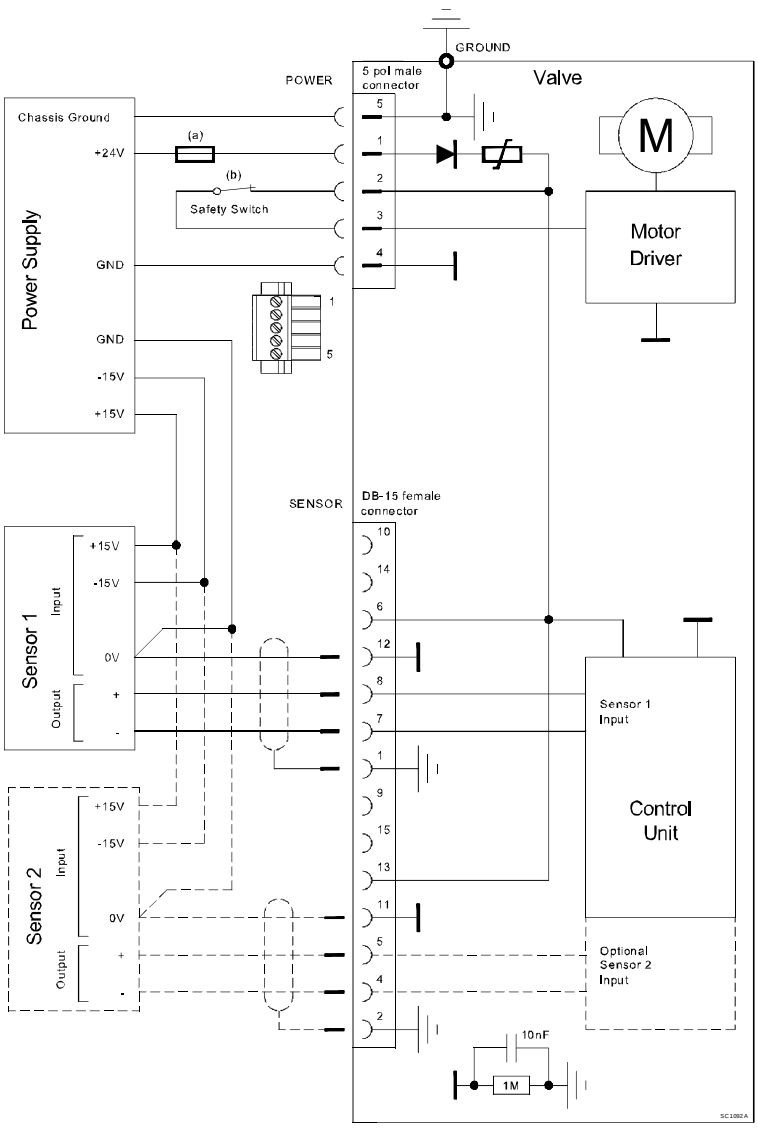
[642 . . - . . **A** . - . . . . / 642 . . - . . **C** . - . . . . versions only]




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

### 4.5.4.1 External sensor power wiring without SPS module

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

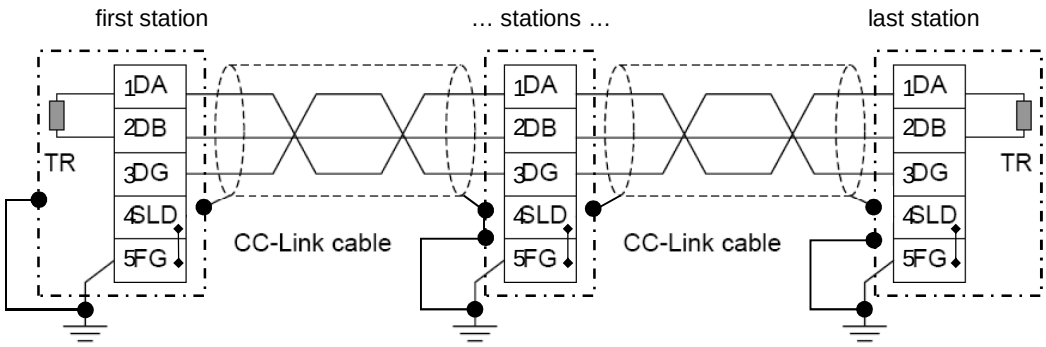



Pins 2 and 3 must be bridged for operation. An optional switch would allow for motor interlock to prevent valve from moving.

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

### 4.5.5 CC-Link interface connection

#### 4.5.5.1 CC-Link cable installation (example)




PE = Protective Earth PE PE

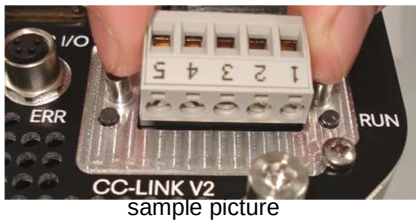
= Connector housing = Internal connection between «SLD and FG»

TR = Terminal resister (Must be compatible to used CC-Link cable version!)

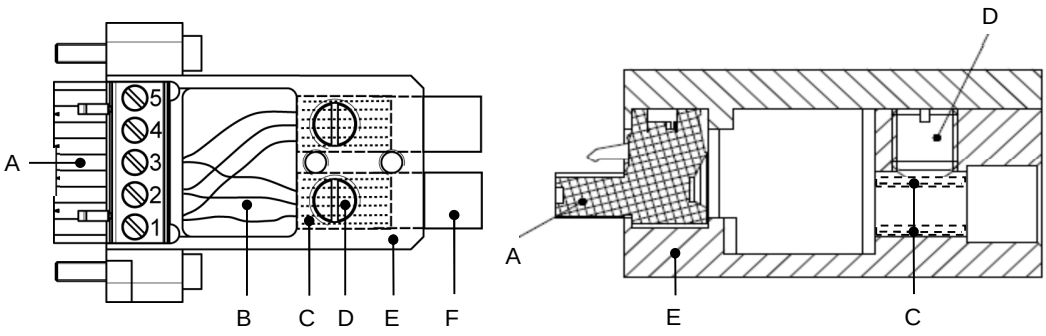
The valve can be defined as «first station», «…stations…» between first and last, or «last station».
**If the valve at first or last station, «TR» must be installed between 1 (DA) and 2 (DB).**

The station type for VAT valves are: Version 2 Remote Device Station.

### 4.5.5.2 Preparing CC-Link connector

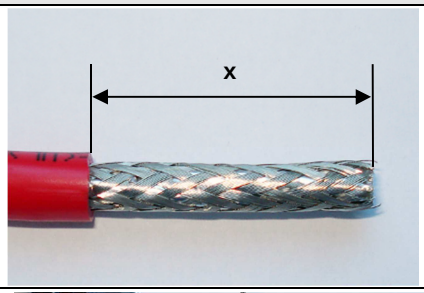
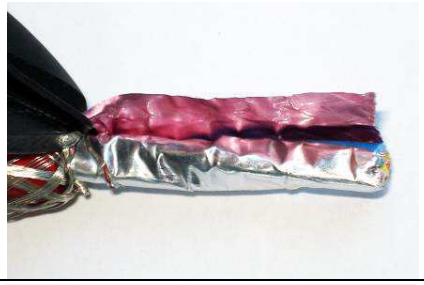
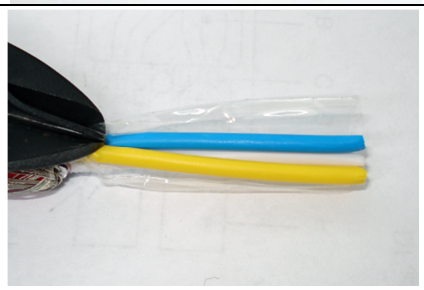
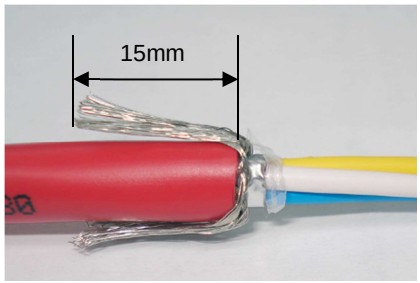
| Description | | Required tool |
|---|---|---|
| 1. Remove «COMBICOM» connector (A) at valve controller |  sample picture | |
| 2. Prepare all parts of connector for installation<br><br>All parts of connector are supplemented in a plastic bag (407612), except «COMBICOM» connector from valve controller |  | |

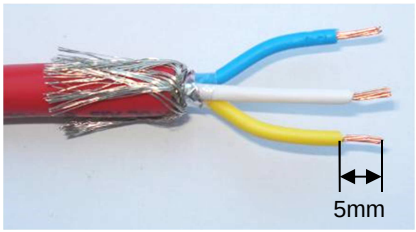
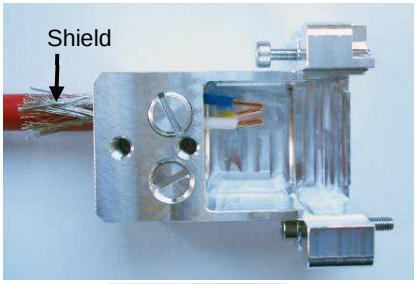
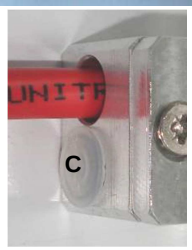
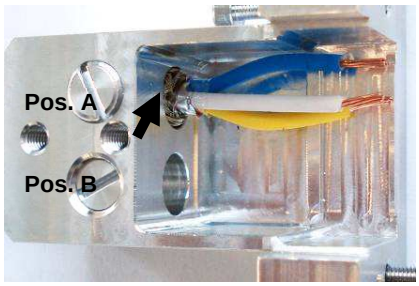
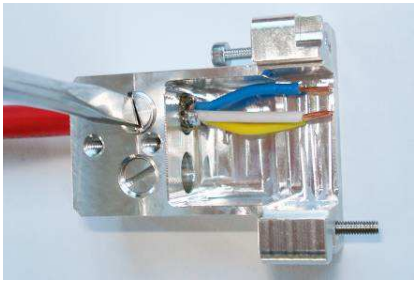
### 4.5.5.3 CC-Link connector overview

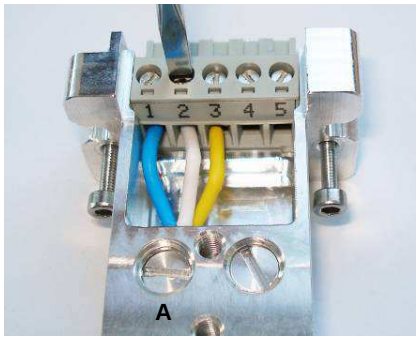
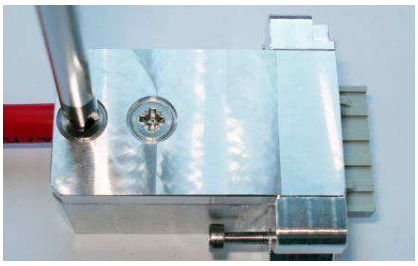
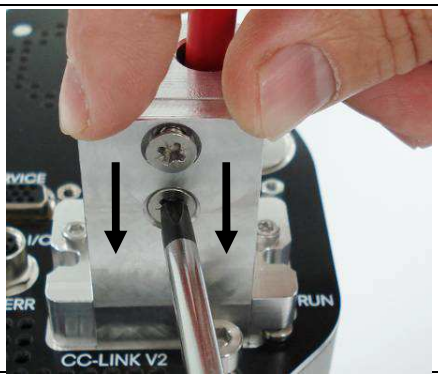



| | | | |
|---|---|---|---|
| A | COMBICON | D | Strain-relief screw for shield mesh and cable |
| B | CC-Link wires | E | Connector housing VAT |
| C | Shield mesh | F | CC-Link cable |

#### 4.5.5.4 Install CC-Link cable at valve controller

| Description | | Required tool |
|---|---|---|
| 3. Remove the cable coat carefully<br>■ Cable Pos. A, **x** about 30mm<br>■ Cable Pos. B, **x** about 40mm<br>Pos. see step 8 |  | Knife |
| 4. Cut off the shield wire |  | Side-cutting pliers |
| 5. Cut off the aluminum shield and remove it |  | Side-cutting pliers |
| 6. Cut off the plastic and remove it<br>Take care to the wires. Do not damage the isolation of wires! |  | Side-cutting pliers |
| 7. Cut off the shield wires about 15mm<br>8. Separate the shield wires in two equal quantum and place them 180° opposite |  | Side-cutting pliers |

| Description | | Required tool |
|---|---|---|
| 9. Remove the wire coat carefully about 5mm |  | Wire strippers |
| 10. Insert the cable(s) at connector hosing as shown in the pictures, see also chapter CC-Link connector<br><br>If valve in CC-Link network is at «first or last station» install the CC-Link cable at position A and close B with blind plug C.<br><br>If valve in CC-Link network at «…stations…» install the CC-Link cables at position A and B. |  <br>  <br>  | |
| 11. Fasten the strain-relief screw until the cable can not pulled out by manual force |  | Screw driver size 4 |

| Description | | Required tool |
|---|---|---|
| 12. Install the CC-Link wires, see also «Connector type» table below<br><br>If cable at pos. A (first or last station) install<br>«TR» between 1 and 2<br>1 x blue to 1<br>1 x white to 2<br>1 x yellow to 3<br><br>If cables at pos. A + B (…stations…) install<br>2 x blue to 1<br>2 x white to 2<br>2x yellow to 3 |  | Screw driver size 1 |
| 13. Close the cover of connector and fasten the screws a little |  | Pozidriv screw driver size 2 |
| 14. Connect the connector and fasten it with the screws at controller (sample picture) |  | Allen Wrench 2.5 mm |
| 15. Push the cover down to controller and fasten the cover screws (sample picture) |  | Pozidriv screw driver size 2 |

**Connector type:** COMBICON 2.5 / 5 - ST – 5, 08 with special VAT housing

| PIN interface connector | Signal | Color of isolator (CC-Link wires) | Comment |
|---|---|---|---|
| 1 | DA | Blue | Positive RS485 RxD/TxD |
| 2 | DB | White | Negative RS485 RxD/TxD |
| 3 | DG | Yellow | Signal Ground |
| 4 | SLD | - | Cable Shield |
| 5 | FG | - | Functional Ground |

The CC-Link interface is galvanic isolated from control unit.

#### 4.5.5.5 CC-Link network and cable

For detail information about ***«CC-Link cable, wiring and TR»*** refer to CC-Link homepage: http://www.cc-link.org > «CC-Link Cable Wiring Manual»

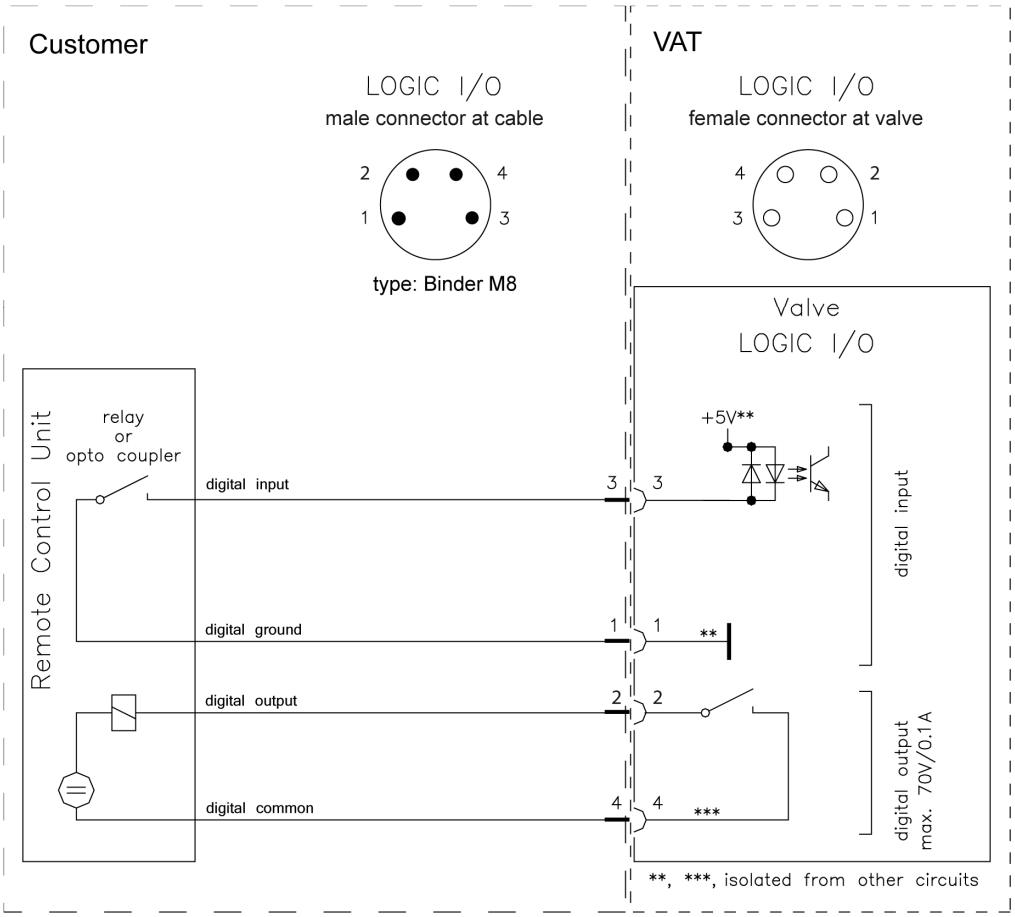
### 4.5.6 LOGIC I/O

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

Active **digital input** has:

- **higher priority than CC-Link** commands
- higher priority than Local commands

**Configuration with switch for digital input:**




Do not connect other pins than indicated in the schematics above! Connector type: Binder M8 (99-3363-00-04).

#### 4.5.6.1 Digital input

| Pin | Signal type | Description |
|---|---|---|
| 3 | Digital input | This function will close the valve.<br>Valve will be in interlock mode as long as function is activated.<br>After deactivation of function it will remain effective until<br>- converse CC-Link control command have been received<br>The function is activated when optocoupler is 'on' in **non inverted** configuration.<br>The function is activated when optocoupler is 'off' in **inverted** configuration.<br>Configuration can be adjusted in local operation via service port with CV, CPA or Hyper terminal. Refer to chapter: «LOGIC I/O configuration». |
| 1 | Digital ground | Ground for digital input. Connect switch to ground.<br>See also chapter: «LOGIC I/O». |

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

#### 4.5.6.2 Digital output

| Pin | Signal type | Description |
|---|---|---|
| 2 | Digital output | This function will indicate that the valve is closed. If the function "ON" is configured the output is continous on.<br>Configuration can be changed in local operation via service port with CV, CPA or Hyper terminal. Refer to chapter: «LOGIC I/O configuration». |
| 4 | Digital common | Common for all digital output. Connect + or – terminal of source with common.<br>See also chapter: «LOGIC I/O ». |

### 4.5.7 Service port connection

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

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

## 4.6 Initial operation

### 4.6.1 Setup procedure

To enable the valve for **pressure control** setup steps **1 to 6 must be performed**. In case position control is required only it's sufficient to perform steps 1 to 5.

| Setup step | | Description |
|---|---|---|
| 1 | **Power up** | Turn on external + 24VDC power supply (and external ±15 VDC for sensor power supply if required). Refer to chapter «Behavior during power up» for details. |
| 2 | **CC-Link configuration** | 1. Station Number<br>2. Transmission rate<br>3. Operational settings mode<br>Refer to chapter «CC-Link configuration» for details. |
| 3 | **Valve configuration** | Basic configurations of the valve must be adapted according to application needs.<br>Refer to chapter «Valve configuration» for details. |
| 4 | **Sensor configuration** | Basic configurations of the valve must be adapted according to application needs.<br>Refer to chapter «Sensor configuration» for details. |
| 5 | **ZERO** | Compensation of the sensor offset voltage.<br>Refer to chapter «ZERO» for details. |
| 6a | **LEARN** | Determination of the vacuum system characteristic to accommodate the PID controller. Refer to chapter «LEARN adaptive» for details. |
| 6b | **PRESSURE CONTROL COFIGURATION** | Accommodation of PID controller to the vacuum system characteristic.<br>Refer to chapter: «Pressure Control configuration» for details. |

- Without «LEARN adaptive» or «Pressure Control configuration» the valve is not able to run pressure control.
- For ease setup (in Local mode) of 'Interface', 'Valve', 'Sensor', 'Senor ZERO', 'LEARN' and 'PRESSURE CONTROL COFIGURATION' it is possible to use the CPA 3.0, The free download is available on the VAT homepage: http://www.vatvalve.com/customer-service/informations-and-downloads/control-performance-analyzer

### 4.6.2 CC-Link configuration

The station type for VAT valves are: Version 2 Remote Device Station.

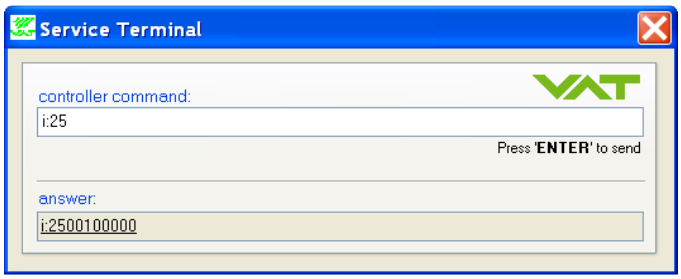
**1. Station Number**

The «station number» is used to distinguish between stations on the CC-Link network. Unique station numbers in consecutive order without duplication must be used, when assigning stations to the CC-Link network.

The «station number» can be configured by 'Control View', 'Control Performance Analyzer' or 'Universal Hyper Terminal'.

The **«set-command»** is: **«s:25xxx00000»**. The xxx value is the «station number». Valid range is 001 to 064.
The **«get-command»** is: **«i:25»**. The answer returns the node address → «i:25xxx00000». The xxx value is the current «station number».
Consider that the controller must be in local mode to accept the commands! After a «s:25» command is sent the module is reseted and starts up again.
«c:0100» → change into local mode
«c:0101» → change into remote mode

Example «get-command» with Terminal:



### 2. Transmission rate

Use the same «transmission rate» for all stations in the bus and also for master station. If any of the settings for at least one station is different, data link cannot be established normally.

The «transmission rate» can select from 156 kbps / 625 kbps / 2.5 Mbps / 5 Mbps / 10 Mbps

The «transmission rate» can be configured by 'Control View', 'Control Performance Analyzer', or 'Universal Hyper Terminal'.

The **«set-command»** is: **«s:21xxx00000»**. The xxx value is the «transmission rate» shown in the table below
The **«get-command»** is: **«i:21»**. The answer returns the «transmission rate» → «i:21xxx00000». The xxx value is the current «transmission rate».
Consider that the controller must be in local mode to accept the commands! After a s:21 command is sent the module is reseted and starts up again.
«c:0100» → change into local mode
«c:0101» → change into remote mode

| Value | Transmission rate |
|---|---|
| 000 | 156 kbps |
| 001 | 625 kbps |
| 002 | 2.5 Mbps |
| 003 | 5 Mbps |
| 004 | 10 Mbps |

### 3. Operational settings mode

The «operational settings mode» defines the following CC-Link parameters:

- **CC-Link version**
- **Number of occupied stations**: The number of stations (occupying one stations worth of memory area) used by a single slave station in a network.
- **Extended cyclic settings**: In the extended cyclic transmission (only Ver.2), the extended cyclic points can be set as 2 times, 4 times or 8 times of the normal cyclic transmission points.

The VAT slave supports two combinations of the CC-Link parameter settings.

| Value | Operational settings |
|---|---|
| 001 | CC-Link Ver.2 / Occupies 1 station / Octuple expanded cyclic |
| 004 | CC-Link Ver.2 / Occupies 4 stations / Double expanded cyclic |

The «operational settings mode» can be configured by 'Control View', 'Control Performance Analyzer', 'Universal Hyper Terminal' or 'Service Box 2'.

The **«set-command»** is: **«s:22xxx00000»**. The xxx value is the operational settings mode!
The **«get-command»** is: **«i:22»**. The answer returns the «operational settings mode» → «i:22xxx00000». The xxx value is the current operational settings mode.
Consider that the controller must be in local mode to accept the commands! After a s:22 command is sent the module is reseted and starts up again.
«c:0100» → change into local mode
«c:0101» → change into remote mode

### 4. Data type of pressure and position values (optional)

The «data type of pressure and position» can be configured by 'Control View', 'Control Performance Analyzer', or 'Universal Hyper Terminal'.

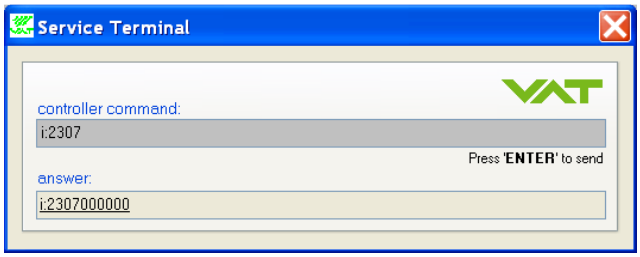
The **«set-command»** is: **«s:23xxy00000»**. The xxy value is the data type of a pressure and position signal.

y: 0 = signed integer(32 bit), 1 = floating point (32 bit, IEEE-754 standard), default = 0
xx: signal number in the buffer

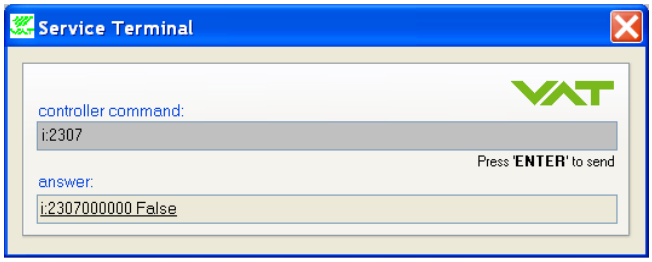
| xx | Value |
|---|---|
| 00 | Pressure |
| 01 | Pressure sensor 1 |
| 02 | Pressure sensor 2 (optional, only in case of 2 sensor version) |
| 03 | Position |
| 04 | *Not used – reserved* |
| 05 | *Not used – reserved* |
| 06 | Pressure setpoint |
| 07 | Position setpoint |
| 08 | *Not used – reserved* |
| 09 | *Not used – reserved* |
| 10 | *Not used – reserved* |
| 11 | *Not used – reserved* |

The **«get-command»** is: **«i:23xx»**. The answer returns the data type of a pressure and position signal → «i:23xxy00000». The y value is the current data type of buffer value xx.

Example «get-command» with Terminal: Get the data Type of Position setpoint:




If at start up the data type value in the memory is out of range the default value is taken. In this case the data type is set to default value (0 = singed integer) and the get command i:23 add a string "False":



### 5. Range of pressure and position values (optional)

The «range of pressure and position values» can be adjusted. That means:

- For position values, the value for valve position **"CLOSE"** and the valve position **"OPEN"** can be set to a other ones then the default 0...100'000 is.
- For pressure values, the value for physical **0 Volt** and **10 Volt** of the sensor output can be set to other values then the default 0...1'000'000 is.

The range of pressure and position values can be configured by 'Control View', 'Control Performance Analyzer' or 'Universal Hyper Terminal'.

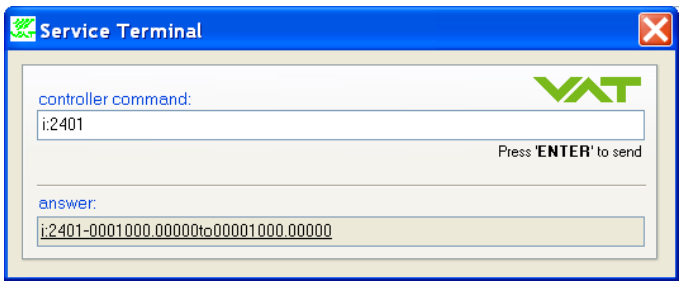
The **«set-command»** is: **«s:24xxy**to**z»**.
y: **lower scale value**, floating point, entry with a point '.' and '-' for negative values possible
z: **upper scale value**, floating point, entry with a point '.' and '-' for negative values possible
xx: signal number in the buffer

| xx | Value | Default range | | Min/Max range | |
|---|---|---|---|---|---|
| | | Default lower scale value | Default upper scale value | Min lower scale vlaue | Max upper scale value |
| 00 | Pressure | 0 | 1'000'000 | -1'000'000 | 1'000'000 |
| 01 | *Not used – reserved* | - | - | - | - |
| 02 | *Not used – reserved* | - | - | - | - |
| 03 | Position | 0 | 100'000 | -1'000'000 | 1'000'000 |
| 04 | *Not used – reserved* | - | - | - | - |
| 05 | *Not used – reserved* | - | - | - | - |
| 06 | Pressure setpoint | 0 | 1'000'000 | -1'000'000 | 1'000'000 |
| 07 | Position setpoint | 0 | 100'000 | -1'000'000 | 1'000'000 |
| 08 | *Not used – reserved* | - | - | - | - |
| 09 | *Not used – reserved* | - | - | - | - |
| 10 | *Not used – reserved* | - | - | - | - |
| 11 | *Not used – reserved* | - | - | - | - |

The **«get-command»** is: **«i:24xx»**. The answer returns the range → «i:24xxytoz». The xx is the value number, y value is the current lower scale value of buffer and value z the upper scale value.
The format of y and z has following syntax: _ _ _ _ _ _ _ _._ _ _ _ _

Examples: i:2400-0012345.12345to00123456.12345
i:2401-0001000.00000to00001000.00000
i:240200001000.00000to00001500.00000

Example «get-command» with Terminal: Get the range of Pressure Sensor 1:

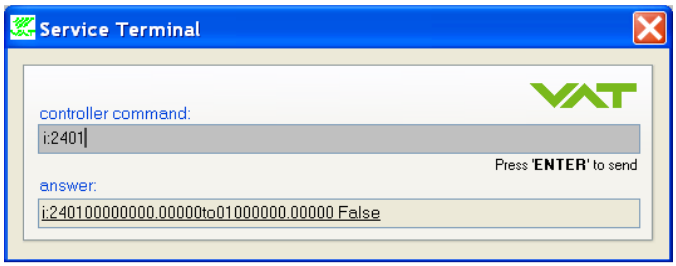


The «range of pressure and position values» is independent of the data type, equal for «signed integer» and «floating point».

The internal accuracy of valve is for all positions 100'000 steps and for all pressures 1'000'000 steps. If the range of pressure and position values is rising, the accuracy of pressure and position will not rise. There is only the gain factor between the VAT valve and the CC-Link Master which will be adapted.

(upper scale value - lower scale value) $\geq 1$

If at startup the scale values in the memory are out of range or the rule above is broken the default values are taken. In this case the get command i:24 add a string "False":




Example: s:24031234.56to7890 → set the range of position from 1234.56 (= closed position) to 7890 (= opened position)

Example: s:24000to100.75 → set the range of pressure from 0 (= 0 V) to 100.75 (= 10 V)

Example: s:2411-10.5to20.5 → set the range of cluster valve freeze position from -10.5 (=closed position) to 20.5 (=opened position)

### 4.6.3 LOGIC I/O configuration

The «logic digital input close valve» can adjusted. See also chapter «LOGIC I/O».

The «logic digital input close valve» can be configured by 'Control View', 'Control Performance Analyzer', 'Universal Hyper Terminal' or 'Service Box 2'.

The **«set-command»** is: **«s:20000000a0»**.
The **«get-command»** is: **«i:20»**. The answer returns the «operational settings mode» → «i:20000000a0».

Description:

| code | description | data range |
|---|---|---|
| s:20 | command header | |
| a | mode selection | **0** = non inverted<br>**1** = inverted<br>**2** = disabled |

### 4.6.4 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 [642 . . - . . **C** . - . . . . or 642 . . - . . **H** . - . . . . ].
- **Network failure**, for default settings refer to individual product data sheet.

| **Local operation**:<br>(‘Control View’, ‘Control Performance Analyzer’ or ‘Service Box 2‘) | **Remote operation**: |
|---|---|
| With CPA:<br>• Do valve configuration in menu ‘Valve / Setup’.<br><br>With SB2:<br>• Do power up configuration in menu ‘Setup / Valve’.<br>• Do power fail configuration in menu ‘Setup / Valve’. | It is not possible to do ‘Valve configurations’ via CC-Link. |

### 4.6.5 Sensor configuration

Basic sensor configuration must be adapted according to application needs.

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

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

### 4.6.6 ZERO

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

| **Local operation**:<br>('Control Performance Analyzer' or 'Service Box 2') | **Remote operation**:<br>(Refer to chapter «OUTPUT Buffer» > «GENERAL CONTROL SETPOINT» for details) |
|---|---|
| With CPA:<br>• Do the ZERO in menu 'Sensor / Zero'.<br><br>With SB2:<br>• Go to menu 'Zero / ZERO' and follow instructions. | 1. Wait until process chamber is evacuated and sensor signal is not shifting anymore. |
| | 2. In «OUTPUT Buffer» > «GENERAL CONTROL SETPOINT» set [ZERO] (value = 1) only short impulse ca. 1sec. |
| | 3. Wait until «ZERO EXECUTED» (value = 1) (see INPUT Buffer). |

- Do not perform ZERO as long as pressure gauge voltage is shifting otherwise incorrect pressure reading is the result. Refer to manual of sensor manufacturer for warm up time.
- Do not perform ZERO, if the base pressure of your vacuum system is higher than 1‰ of sensor full scale. We recommend disabling ZERO function in this case; refer to «Valve and sensor configuration» of the setup procedure. Otherwise incorrect pressure reading is the result.

### 4.6.7 **LEARN** (adaptive)

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

| **Local operation**:<br>('Control View', 'Control Performance Analyzer' or 'Service Box 2') | **Remote operation**: |
|---|---|
| Go to 'Learn / LEARN' menu and follow instructions.<br><br>**Remark:** Gasflow calculation according to recommendation below is done automatically based on inputs. | 1. Go to «OUTPUT Buffer» > «CONTROL MODE SETPOINT», set «Open Valve» (value = 4) |
| | 2. Set specific gas flow according to calculation below and wait until flow is stable.<br>Autolearn does not need to be performed with the process gas. Instead $N_2$ or Ar may be used. |
| | 3. Go to «OUTPUT Buffer» > «CONTROL MODE SETPOINT» |
| | 4. Set «Learn» (value = 7) |
| | 5. In «INPUT Buffer» > «CONTROL MODE» value 7 (Learn) is display, as long Learn is running. If Learn is finished, value 7 is no more displayed. |

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

**Gasflow calculation for LEARN:**

Do not apply a different gasflow for learn than determined below. Otherwise pressure control performance may be insufficient. Required pressure / flow regime must be known to calculate the most suitable learn gas flow for a specific application.

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

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

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

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

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

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

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

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

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

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

To make sure that the valve is capable to control the most extreme working point verify that CR ≥ Cmin of the valve (refer to «Technical data»).

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

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

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

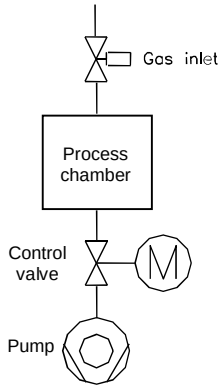
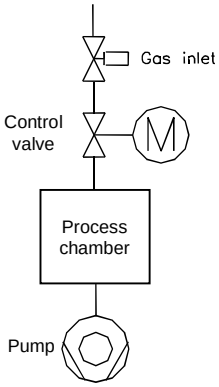
$$q_L = \frac{p_{SFS} \bullet C_{min}}{1.1}$$

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

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

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

### 4.6.8 Pressure control configuration

| System Configuration | Constant gas flow available | | Constant gas flow not available |
|---|---|---|---|
| | Tv*<= 500 sec | Tv* > 500 sec | |
| **Downstream**<br>  | **Adaptive pressure controller**<br>(Refer to chapter: Pressure controller) | **Fixed pressure controller**<br>(Refer to chapter: Pressure controller) | |
| **Upstream**<br>  | **Fixed pressure controller**<br>(Refer to chapter: Pressure controller) | | |
| **Soft Pump** | **Soft Pump** (Refer to chapter: Pressure controller) | | |

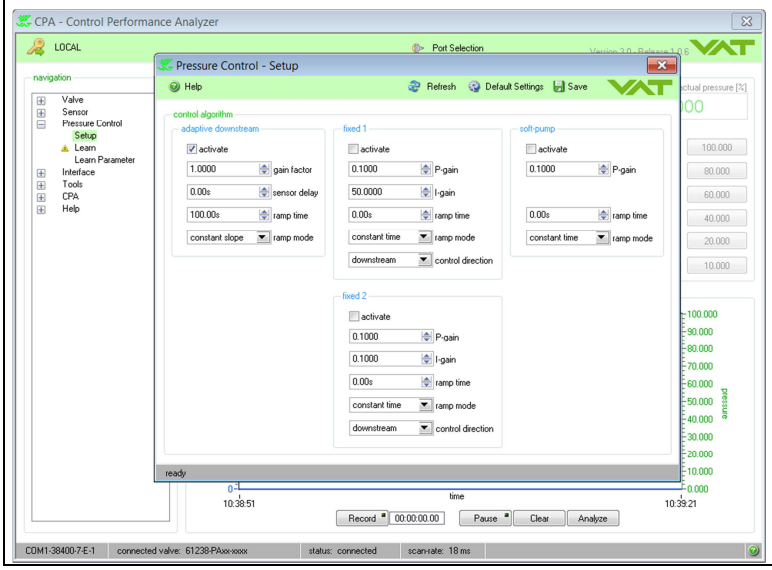
Use the formula below to define the applicable pressure control algorithm.

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

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

#### 4.6.8.1 Pressure controller

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

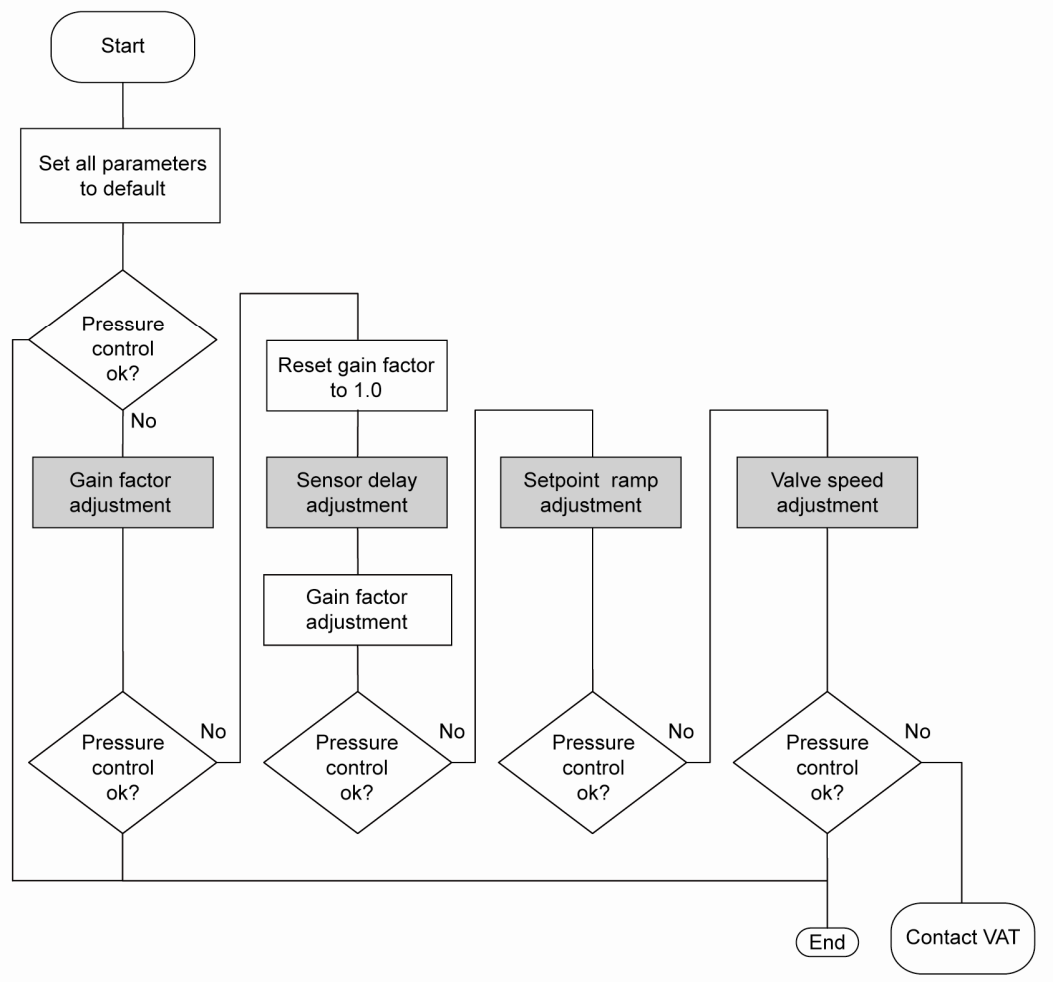
| **Local operation**:<br>(‘Control View’ or ‘Control Performance Analyzer’) | **Remote operation**: |
|---|---|
| 1. Open the CPA<br>2. In menu ‘Pressure Control’ / ‘Setup’, select the ‘Pressure controller’ and do the setup for pressure control algorithm (parameter).<br>  | Refer to chapter: «CC-Link interface commands» |

## 4.7 Tuning of control performance

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

### 4.7.1 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.



#### 4.7.1.1 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».

| **Local operation**:<br>('Control Performance Analyzer' or 'Service Box 2') | **Remote operation**: |
|---|---|
| With CPA:<br>• Do the 'Gain Factor' adjustment in menu 'Pressure Control' / 'Setup' / 'adaptive downstream'.<br><br>With SB2:<br>• Do the 'Gain Factor' adjustment in menu 'Setup / Control Parameter' |  It's not possible via «Remote operation» |

#### 4.7.1.2 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».

| **Local operation**:<br>('Control Performance Analyzer' or 'Service Box 2') | **Remote operation**: |
|---|---|
| With CPA:<br>• Do the 'Sensor Delay' adjustment in menu 'Pressure Control' / 'Setup' / 'adaptive downstream'.<br><br>With SB2:<br>• Do the 'Sensor Delay' adjustment in menu 'Setup / Control Parameter' | It's not possible via «Remote operation» |

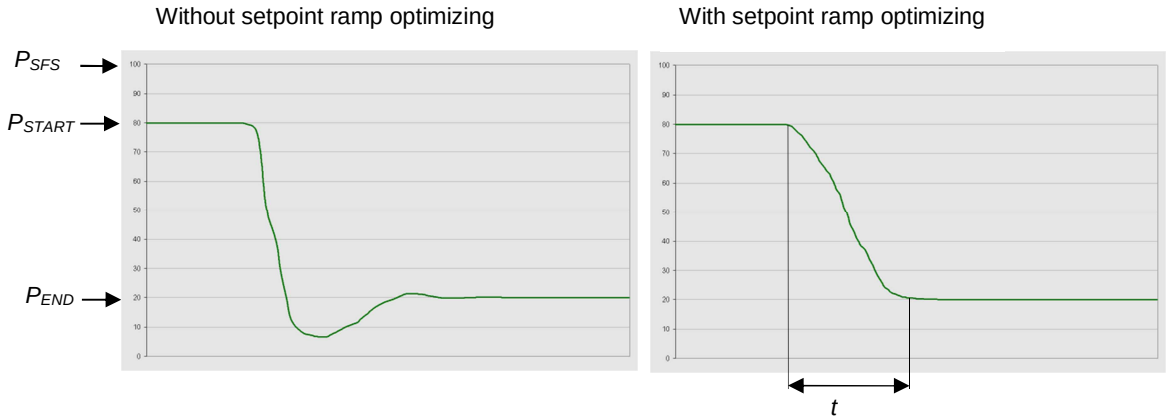
#### 4.7.1.3 Setpoint ramp adjustment

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 = 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.

| **Local operation**:<br>('Control Performance Analyzer' or 'Service Box 2') | **Remote operation**: |
|---|---|
| With CPA:<br>• Do the 'Ramp Time' and 'Ramp Mode' adjustment in menu 'Pressure Control' / 'Setup' / 'adaptive downstream'.<br><br>With SB2:<br>• Do the 'Setpoint Ramp' adjustment in menu 'Setup / Control Parameter' (Ramp Mode is not possible with SB2) | It's not possible via «Remote operation» |

#### 4.7.1.4 Valve speed adjustment

Valve speed effects: **Response time**

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

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

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

Adjustment procedure:

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

| **Local operation**:<br>('Control Performance Analyzer' or 'Service Box 2') | **Remote operation**: |
|---|---|
| With CPA:<br>• Do the 'Valve Speed in menu 'Valve' / 'Setup' / 'valve speed'.<br><br>With SB2:<br>• Do the 'Valve Speed' adjustment in menu 'Setup / Control Parameter' |  It's not possible via «Remote operation» |

Required information for support:

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

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

## 4.7.2 Tuning of control performance with fixed PI pressure controller

### 4.7.2.1 Optimizing P gain and I gain

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

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

| **Local operation**:<br>('Control Performance Analyzer') | **Remote operation**: |
|---|---|
| With CPA:<br>• Do the 'Fixed 1' or 'Fixed 2' adjustment in menu 'Pressure Control' / 'Setup' / 'fixed 1' / 'fixed 2'. | It's not possible via «Remote operation» |

**Introduction**

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

**1. Optimizing P gain and I gain**

1.1 Pressure and gas flow for optimization

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

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

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

Pressure set points and gas flow for optimization:

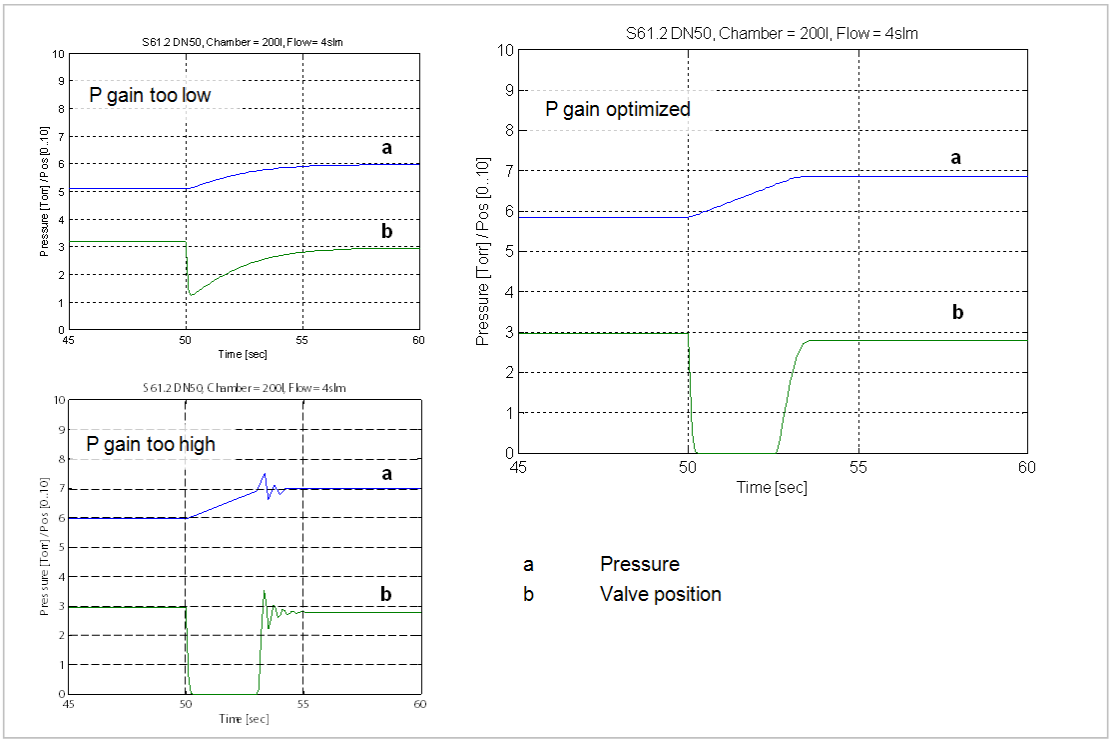
| | | |
|---|---|---|
| SP1 | = | 7 Torr |
| SP2 | = | 6 Torr |
| Gas flow | = | 4slm |

1.2 Optimizing P gain

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

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

Example:

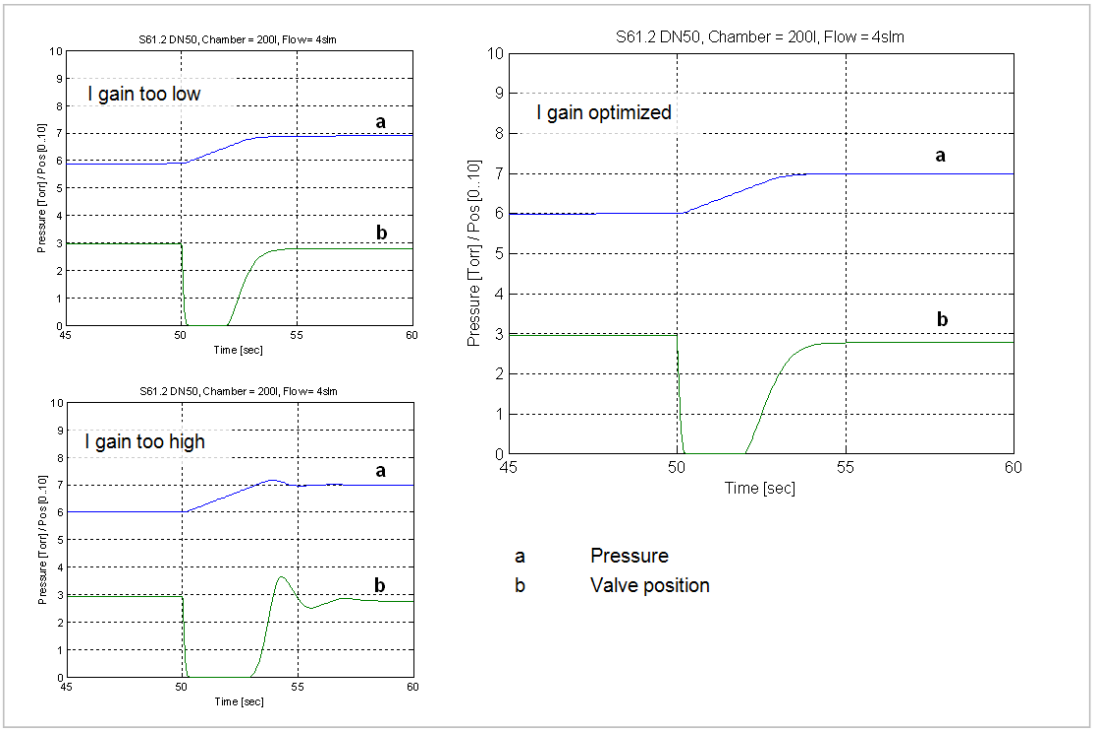


### 1.3 Optimizing I gain

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

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

Example:




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

Required information for support:

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

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

### 4.7.3 Tuning of control performance with soft pump pressure controller

#### 4.7.3.1 Optimizing P gain

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

| **Local operation**:<br>('Control Performance Analyzer') | **Remote operation**: |
|---|---|
| With CPA:<br>• Do the 'Soft pump' adjustment in menu 'Pressure Control' / 'Setup' / 'soft pump'. | It's not possible via «Remote operation» |

**Introduction**

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

**1. Optimizing P gain**

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

1.1 Basic settings

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

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

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

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

## 1.2 Optimizing P gain

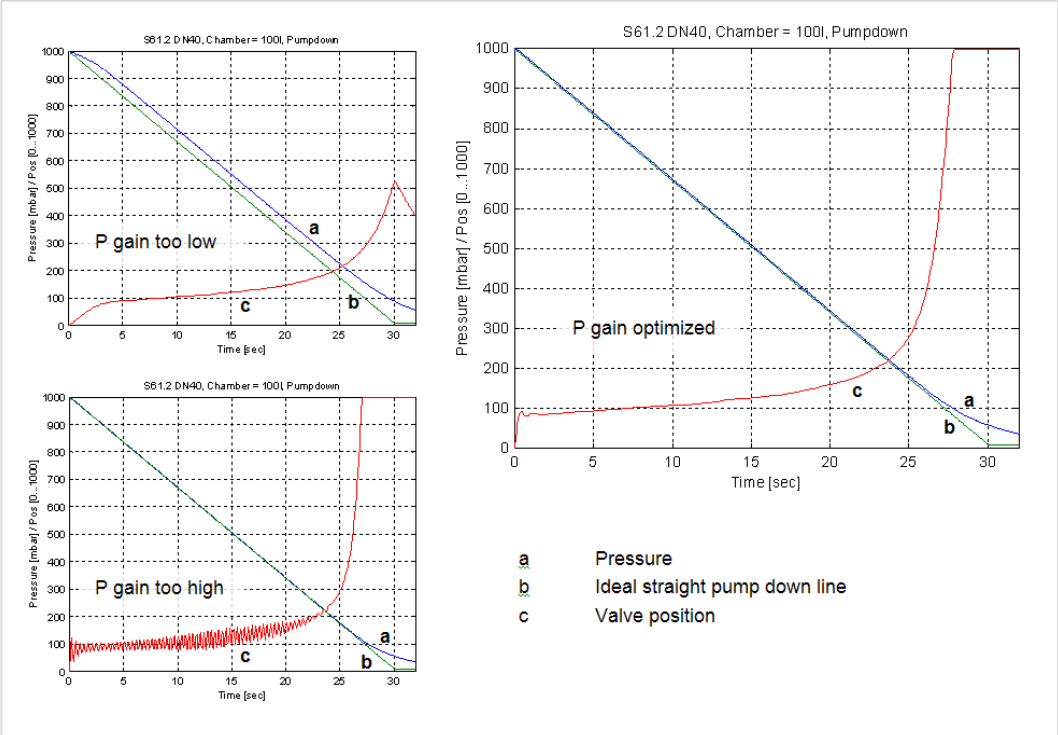
WE start by setting the P gain to 1.0 as a trial value and adjust according to the response.
The pump down routine has to be controlled as follows:

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

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

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

Example:



Required information for support:

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

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

## 4.8 CC-Link interface commands

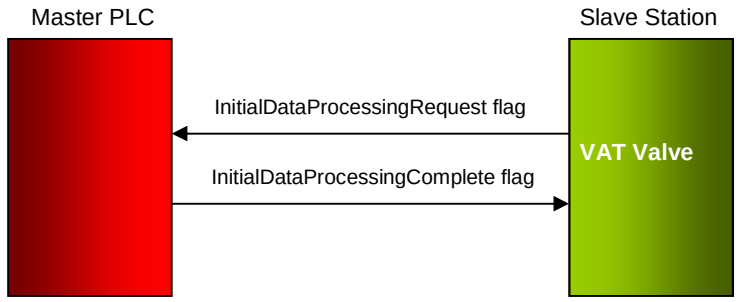
### 4.8.1 CC-Link Handshaking

Before the CC-Link slave station (VAT valve) can be operated by the CC-Link Master (PLC), handshaking is necessary. If the handshake is not done, no data from the master will be transmitted to station.

An indication of a successful handshaking is the bit «FIELDBUS DATA VALID» (= 1) in the input buffer > GENERAL STATUS.

The CC-Link “Network failure” is independent of the CC-Link handshaking. That means the “Network failure” is inactive if the handshaking is not done yet.

Procedure:

<table>
<tr>
<td>1. If the network parameter are correct the slave station will set the bit ’Initial data processing request flag’.<br>2. The master have to answer the request with the bit ’Initial data processing complete flag’.</td>
<td> 
</td>
</tr>
<tr>
<td>3. Now the station sets the bit ’Remote READY’. That means the normal operation mode.</td>
<td> 
</td>
</tr>
</table>

The Flag ‘Remote READY’ from slave station must be set for normal operation.

### 4.8.2 Location of the handshaking bits

| Slave → Master | | Master → Slave | |
|---|---|---|---|
| *Device* | *Signal name* | *Device No.* | *Signal name* |
| RX m0 | Not used | RY m0 | Not used |
| RX m1 | | RY m1 | |
| RX m2 | | RY m2 | |
| RX m3 | | RY m3 | |
| RX m4 | | RY m4 | |
| RX m5 | | RY m5 | |
| RX m6 | | RY m6 | |
| RX m7 | | RY m7 | |
| RX m8 | | RY m8 | |
| RX m9 | | RY m9 | |
| RX mA | | RY mA | |
| RX mB | | RY mB | |
| RX mC | | RY mC | |
| RX mD | | RY mD | |
| RX mE | | RY mE | |
| RX mF | | RY mF | |
| to | | to | |
| RX(m+n)0 | Reserved | RY(m+n)0 | Reserved |
| RX(m+n)1 | | RY(m+n)1 | |
| RX(m+n)2 | | RY(m+n)2 | |
| RX(m+n)3 | | RY(m+n)3 | |
| RX(m+n)4 | | RY(m+n)4 | |
| RX(m+n)5 | | RY(m+n)5 | |
| RX(m+n)6 | | RY(m+n)6 | |
| RX(m+n)7 | | RY(m+n)7 | |
| RX(m+n)8 | Initial data processing request flag | RY(m+n)8 | Initial data processing complete flag |
| RX(m+n)9 | Initial data setting complete flag | RY(m+n)9 | Initial data setting request flag |
| RX(m+n)A | Error status flag | RY(m+n)A | Error reset request flag |
| RX(m+n)B | Remote READY | RY(m+n)B | Reserved |
| RX(m+n)C | Reserved | RY(m+n)C | |
| RX(m+n)D | | RY(m+n)D | |
| RX(m+n)E | | RY(m+n)E | |
| RX(m+n)F | | RY(m+n)F | |

Table 1: Bit Memory Map Profile of VAT CC-Link slave

m: Address assigned to the master module by the station number setting. This means that the address range for this slave begins at address m of the master.

n: Dependent on the VAT Operational settings mode (number of occupied stations and number of extension cycles)

- Operational settings mode = 1 → n = 0x7 (hex)
- Operational settings mode = 4 → n = 0xD (hex)

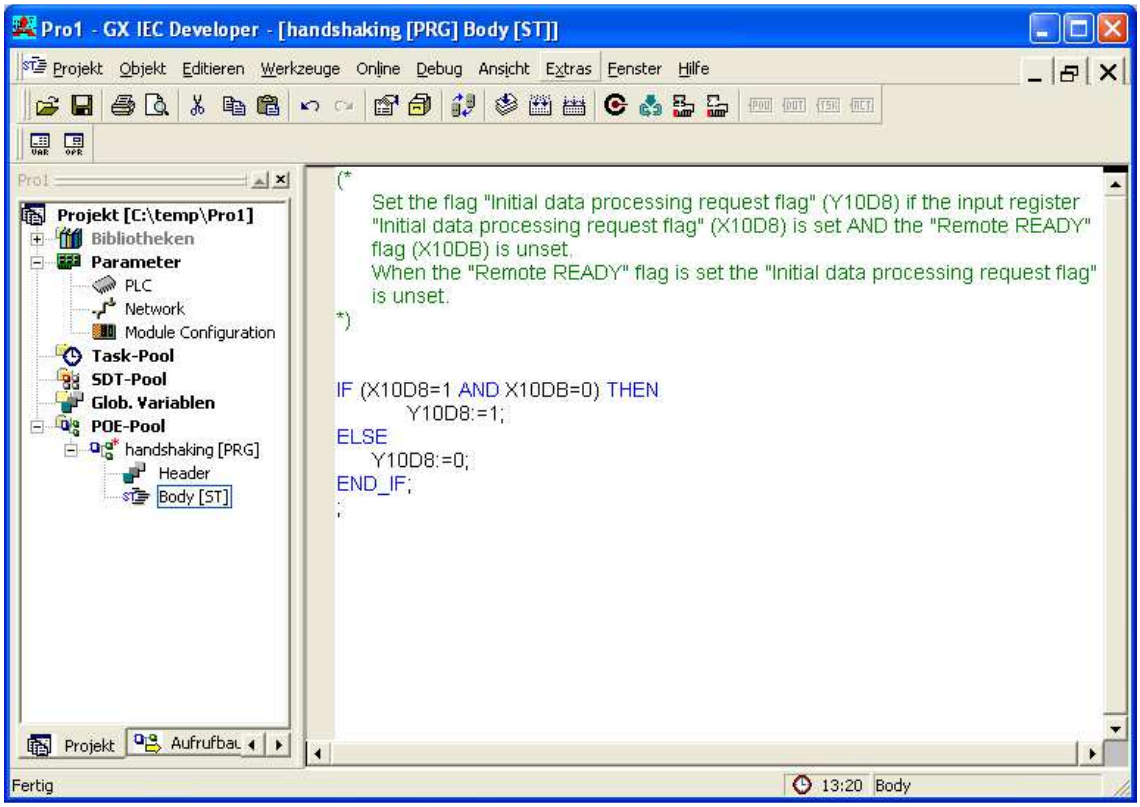
Example see chapter: 4.8.3 Example of the handshaking by a **PLC-program**.

### 4.8.3 Example of the handshaking by a PLC-program

The following program sends an answer to the VAT CC-Link station which return a “Remote READY” flag. It is important to correct register address is used. In this example the address for this slave station (valve) starts at 1000 (hex). So m = 100 (see capture

Location of the handshaking **bits**). The Operational setting mode of the slave is 4 – therefore n = D.

Table 1 said RX(m+n)8 for the location of the ’Initial data processing request flag’. So the address X10D8 is used. For the ’Remote Ready’ flag the address RX(m+n)B = X10DB is used.



## 4.9 CC-Link interface (Process data – cyclic communication)

- The buffer naming is in view from customer (master) PLC.
- Data format: All signals are transmitted and received in intel format (low byte first).
- All one-byte signals use the least significant byte (LSB).

Neither valve display information nor CONTROL MODE values or any other fieldbus cyclic/acyclic data are related to any fieldbus states/notation

### 4.9.1 OUTPUT Buffer (Master PLC)

#### 4.9.1.1 Overview

| Data model | Index | Buffer | |
|---|---|---|---|
| | | Contents (MSB) | Contents (LSB) |
| 16 bit (Word) | 0 | Pressure setpoint | |
| | 1 | | |
| | 2 | Position setpoint | |
| | 3 | | |
| | 4 | *Not used – reserved* | |
| | 5 | | |
| | 6 | | |
| | 7 | | |
| | 8 | | |
| | 9 | | |
| | 10 | *Not used – reserved* | Control mode setpoint |
| | 11 | General control setpoint | |
| | 12 | *Not used – reserved* | |
| | 13 | | |
| | 14 | | |
| | 15 | | |
| | 16 | *Not used – reserved* | |
| | 17 | | |
| | 18 | *Not used – reserved* | *Not used – reserved* |
| | 19 | *Not used – reserved* | |
| | 20 | *Not used – reserved* | *Not used – reserved* |

For data consistency make sure your master PLC is supporting “block guarantee of cyclic data per station”.

#### 4.9.1.2 Details

| Signal Type | Name | Start Word | Byte Length | Data Type | Valid Range | Description |
|---|---|---|---|---|---|---|
| Signal | **PRESSURE SETPOINT** | 0 | 4 | signed integer (default) or floating point | 0..1'000'000 (default), adjustable[1)] | In case of the valve is is pressure mode (**CONTROL MODE** = Pressure (5)), the signal is used as setpoint value. |
| Signal | **POSITION SETPOINT** | 2 | 4 | signed integer (default) or floating point | 0..100'000 (default), adjustable[1)] | In case of the valve is is position mode (**CONTROL MODE** = Position (2)), the signal is used as setpoint value.<br>min signal value (default 0) = "valve is closed"<br>max signal value (default 100'000) = "valve is opened" |
| Signal | **CONTROL MODE SETPOINT** | 10 | 1 | unsigned integer | 2…7 | **2** = Position: Position control mode<br>**3** = Close: The valve is closed<br>**4** = Open: The valve is opened<br>**5** = Pressure: Pressure control mode<br>**6** = Hold: Valve is kept in current position; only valid in **CONTROL MODE** position and pressure<br>**7** = Learn: Valve starts the internal learn procedure |
| Bitmap | **GENERAL CONTROL SETPOINT** | 11 | 2 | boolean array | - | See bitmap table below |
| - | **NOT USED (reserved)** | 16 | 4 | - | - | - |
| - | **NOT USED (reserved)** | 18 | 1 | - | - | - |
| - | **NOT USED (reserved)** | 19 | 1 | - | - | - |
| - | **NOT USED (reserved)** | 20 | 1 | - | - | - |

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

**GENERAL CONTROL SETPOINT bitmap table:**

<table>
<tr><th colspan="2">Bit</th><th>Description</th></tr>
<tr><td>0</td><td>ZERO</td><td>0 = No Operation<br>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!</td></tr>
<tr><td>1</td><td>NOT USED (reserved)</td><td>-</td></tr>
<tr><td>2</td><td>PING PONG TX BIT</td><td>PING PONG TX BIT transmitted from the master (PLC), is used to check the loop "master PLC - VAT station". See chapter: 3.11.9 Communication and timing control between Master (PLC) and Station (Valve)</td></tr>
<tr><td>3</td><td>NOT USED (reserved)</td><td>-</td></tr>
<tr><td>4</td><td>ACCESS MODE LOCKED</td><td>
<table>
<tr><th>Start mode</th><th>Access mode locked bit</th><th>End mode</th></tr>
<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>
</table>
Example:<br>1. from local to locked<br>• 1st step : set bit (0→1)<br><br>2. from local to remote<br>• 1st step : set bit (0→1)<br>• 2nd step: reset bit (1→0)<br><br>3. from remote to locked<br>• 1st step : set bit (0→1)<br><br>4. from locked to remote<br>• 1st step : reset bit (1→0)
</td></tr>
<tr><td>5-15</td><td>NOT USED (reserved)</td><td>-</td></tr>
</table>

### 4.9.2 INPUT Buffer (Master PLC)

#### 4.9.2.1 Overview

| Data model | Index | Buffer | |
|---|---|---|---|
| | | Contents (MSB) | Contents (LSB) |
| 16-Bit (Word) | 0 | Pressure | |
| | 1 | | |
| | 2 | Pressure Sensor 1 | |
| | 3 | | |
| | 4 | Pressure Sensor 2 (optional, only in case of 2 sensor version) | |
| | 5 | | |
| | 6 | Position | |
| | 7 | | |
| | 8 | *Not used – reserved* | |
| | 9 | | |
| | 10 | *Not used – reserved* | Control mode |
| | 11 | Fatal error | |
| | 12 | *Not used – reserved* | |
| | 13 | | |
| | 14 | | |
| | 15 | | |
| | 16 | General status | |
| | 17 | General warnings | |
| | 18 | Extended warnings | |
| | 19 | *Not used – reserved* | *Not used – reserved* |
| | 20 | *Not used – reserved* | |
| | 21 | | |
| | 22 | *Not used – reserved* | *Not used – reserved* |
| | 23 | *Not used – reserved* | |
| | 24 | *Not used – reserved* | |

#### 4.9.2.2 Details

| Signal Type | Name | Start Word | Byte Length | Data Type | Valid Range | Description |
|---|---|---|---|---|---|---|
| Signal | **PRESSURE** | 0 | 4 | signed integer (default) or floating point | -270000.. 1'230'000 (default) (-2.7V..12.3V sensor signal), adjustable[1)] | *In case of default valid range:* Physical full scale value of the sensor (10 Volt) equals to 1'000'000. (In case of 2 sensor operation the full scale of high range sensor equals to 1'000'000.) |
| Signal | **PRESSURE SENSOR 1** | 2 | 4 | signed integer (default) or floating point | -270000.. 1'230'000 (default) (-2.7V..12.3V sensor signal), adjustable[1)] | *In case of default valid range:* Physical full scale value of the sensor (10 Volt) equals to 1'000'000. |
| Signal | **PRESSURE SENSOR 2** | 4 | 4 | signed integer (default) or floating point | -270000.. 1'230'000 (default) (-2.7V..12.3V sensor signal), adjustable[1)] | *Optional, only in case of 2 sensor version.* *In case of default valid range:* Physical full scale value of the sensor (10 Volt) equals to 1'000'000. |
| Signal | **POSITION** | 6 | 4 | signed integer (default) or floating point | 0..100'000 (default), adjustable[1)] | min signal value = "valve is closed" max signal value = "valve is opened" The position 9'999'999 (or 9'999'999.0 for floating point) show an unknown valve position – e.g. during synchronization at startup |
| Signal | **CONTROL MODE** | 10 | 1 | unsigned integer | 0…14 | **0** = init<br>**1** = synch<br>**2** = position<br>**3** = close<br>**4** = open<br>**5** = pressure<br>**6** = hold<br>**7** = learn<br>**8** = interlock open<br>**9** = interlock close<br>**10** = maintenance open<br>**11** = maintenance close<br>**12** = power failure<br>**13** = safety<br>**14** = fatal error |
| Signal | **FATAL ERROR** | 11 | 2 | unsigned integer | 20,21,22,25,40 | **20 =** no stop detected during synch mode<br>**21 =** valve blocked during synch mode<br>**22 =** valve blocked<br>**25 =** step loss during synch mode<br>**40 =** motor driver fault |
| Bitmap | **GENERAL STATUS** | 16 | 2 | boolean array | | See bitmap table below |
| Bitmap | **GENERAL WARNING** | 17 | 2 | boolean array | | See bitmap table below |

| Signal Type | Name | Start Word | Byte Length | Data Type | Valid Range | Description |
|---|---|---|---|---|---|---|
| Bitmap | **EXTENDED WARNING** | 18 | 2 | boolean array | | See bitmap table below |
| - | **NOT USED (reserved)** | 19-22 | 1 | - | - | - |
| - | **NOT USED (reserved)** | 23-24 | 1 | - | - | - |

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

**GENERAL STATUS bitmap table:**

| Bit | | Description |
|---|---|---|
| 0 | **FIELDBUS DATA VALID** | **0** = Valve is not ready for communication (has not received the rising edge of "Initial Data Processing Complete")<br>**1** = Valve is ready for communication (has received the rising edge of "Initial Data Processing Complete") |
| 1 | **ZERO EXECUTED** | ZERO 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), See chapter: 4.9.3 **Communication and timing between Master (PLC) and Slave (VAT-Valve)** |
| 3 | **PRESSURE SIMULATION** | **0** = off<br>**1** = on |
| 4 | **PRESSURE SETPOINT REACHED** | **0** = The actual pressure is not within 2% of the pressure setpoint<br>**1** = The actual pressure is within 2% of the pressure setpoint |
| 5-6 | **NOT USED (reserved)** | - |
| 7-8 | **ACCESS MODE** | **bit 8** **bit 7**<br>0 0 = LOCAL<br>0 1 = REMOTE<br>1 0 = LOCKED |
| 9 | **WARNINGS ACTIVE** | **0** = No WARNINGS<br>**1** = At least one WARNING of the warning bitmaps is active (GENERAL WARNING bitmap and EXTENDED WARNING bitmap) |
| 10-15 | **NOT USED (reserved)** | - |

**GENERAL WARNING bitmap table:**

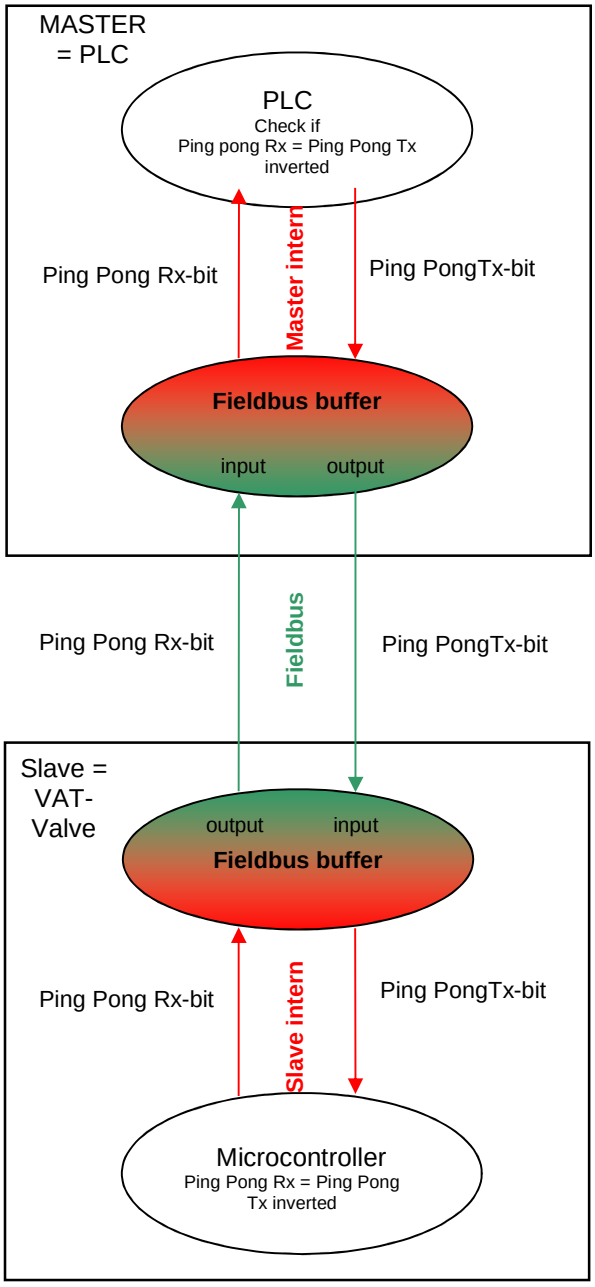
| Bit | | Description |
|---|---|---|
| 0 | **SERVICE REQUEST** | Valve movement tight |
| 1 | **LEARN DATA SET** | Learn data not present. Learn required for adaptive pressure control. |
| 2 | **NOT USED (reserved)** | - |
| 3 | **POWER FAILURE BATTERY** | Not ready, voltage too low |
| 4 | **SENSOR OVERLAPPING** | Sensor deviation between sensor 1 and sensor 2 >= ±10% |
| 5 | **NOT USED (reserved)** | - |
| 6 | **NOT USED (reserved)** | - |
| 7-9 | **NOT USED (reserved)** | - |
| 10 | **SENSOR MEASUREMENT UNIT FAULTY** | AD-converter of Sensor input 1 and/or 2 (optional, only in case of 2 sensor version) on the master board is faulty. |
| 11-15 | **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 acces 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 (for example control mode is interlock or fatal error) |
| 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 | **PROCESS DATA SETTING(S) NOT VALID** | Value of PROCESS DATA SETTING(S) not valid (DATA TYPE or RANGE of pressure and position signals) |
| 13-15 | **NOT USED (reserved)** | - |

### 4.9.3 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**<br>**Unqualified personnel**<br>Inappropriate handling may cause serious injury or property damage.<br>Only qualified personnel are allowed to carry out the described work. |

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

## 5.1 Normal operation

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

### 5.1.1 Local operation

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

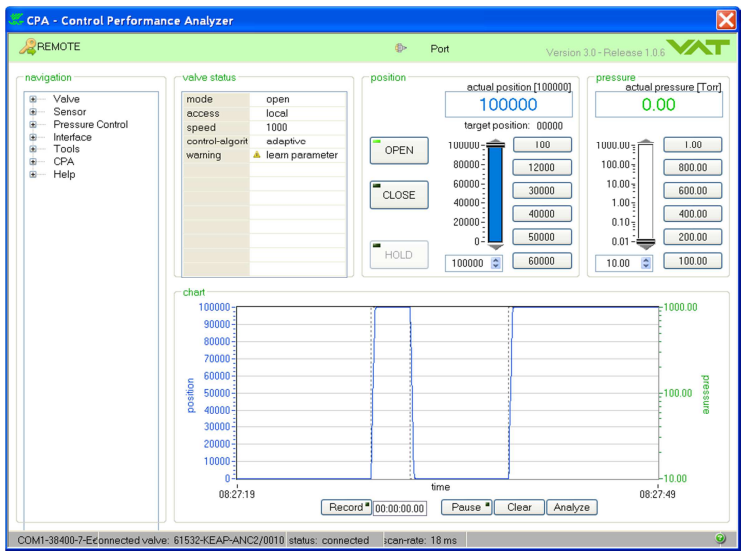
These softwares are beneficial especially for setup, testing and maintenance.

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

‘

'Control Performance Analyzer' supports:

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



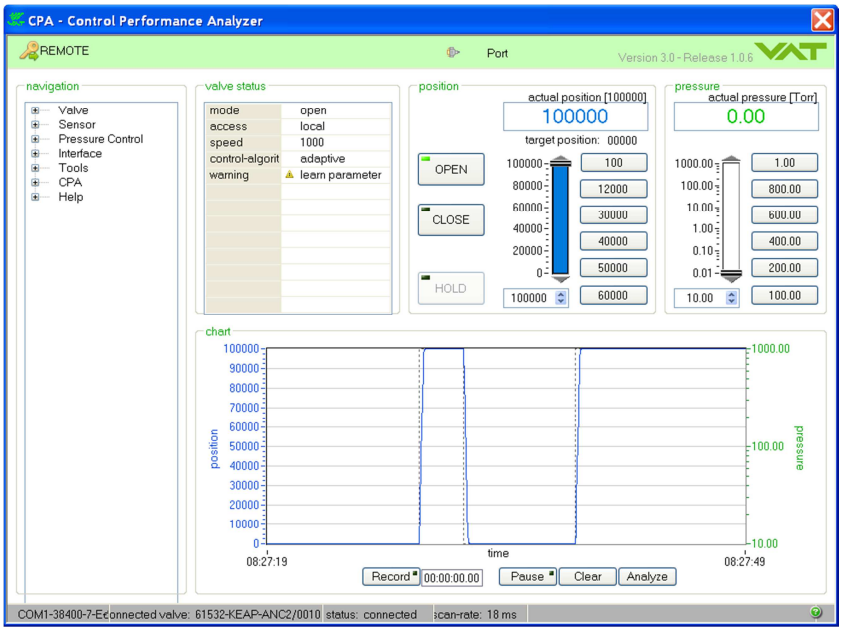

When communication to service port is interrupted the valve will change to remote operation. So when service cable will be disconnected or software will be shut down, the valve returns automatically to remote operation. This may result in an immediate movement of the valve depending on remote control.

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

### 5.1.2 Remote operation

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

'Control Performance Analyzer' software




'Service Box 2'


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

## 5.2 Close valve

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

## 5.3 Open valve

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

## 5.4 Position control

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

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

## 5.5 Pressure control

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

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

| **Local operation**:<br>('Control View' resp. 'Control Performance Analyzer') | **Remote operation**:<br>(Refer to chapter «OUTPUT Buffer» > «PRESSURE SETPOINT» for details) |
|---|---|
| Select or enter pressure setpoint | 1. In «OUTPUT Buffer» > «PRESSURE SETPOINT»<br>2. Select valid value<br>3. In «OUTPUT Buffer» > « CONTROL MODE SETPOINT»<br>4. Select [Pressure] (value = 5) |

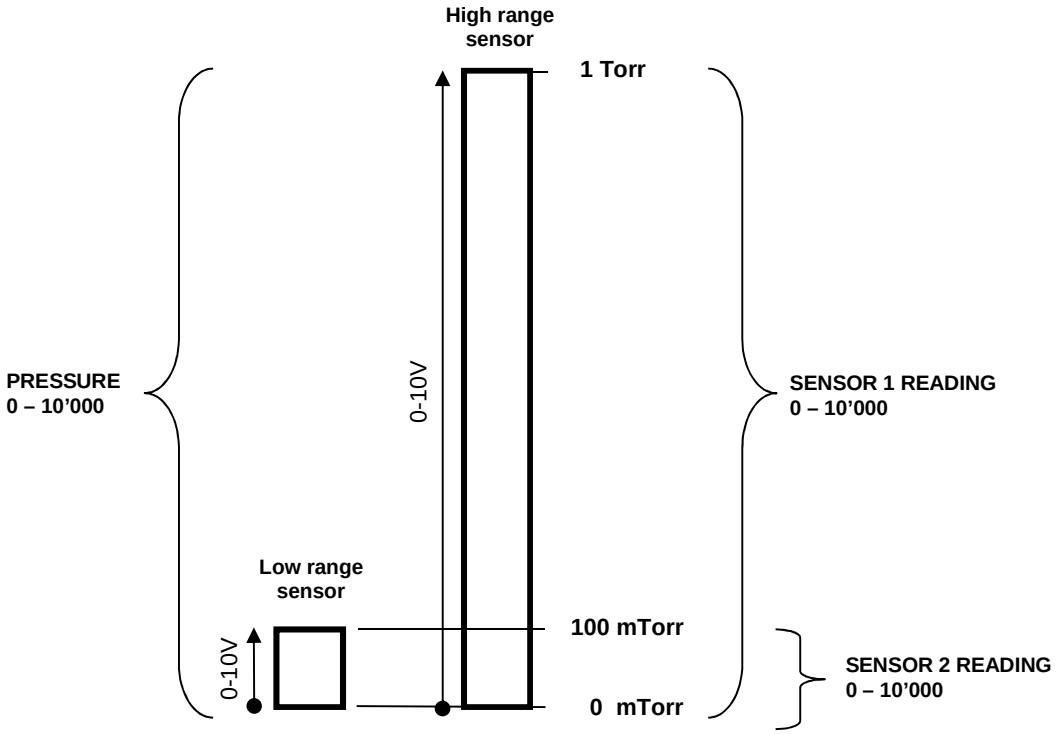
### 5.5.1 Pressure control operation with 2 sensors

[applicable with 642 . . - . . . F - . . . . version only]

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

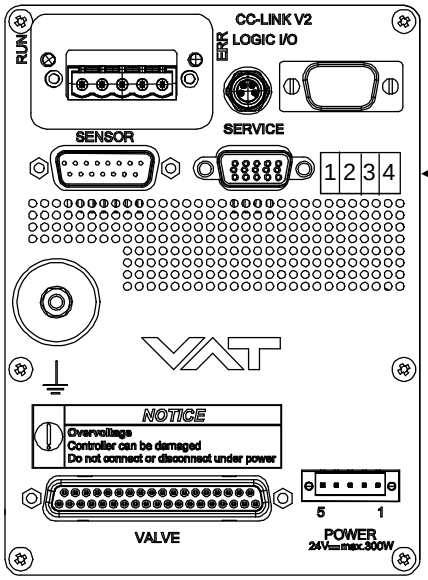
For monitoring purpose each sensor signal may be read out individually. Refer to «inquiry commands SENSOR 1 READING and SENSOR 2 READING»

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



## 5.6 Display information

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




### 5.6.1 Power up

| Description | Digit 1 | Digit 2 | Digit 3 | Digit 4 |
|---|---|---|---|---|
| ● Power On:<br>All dots are illuminated | # | # | # | # |
| ● 1st information for about 3s:<br>Firmware generation<br>[e.g. **1G..**] | **1** | **G** | | |
| ● 2st information for about 3s:<br>Firmware version and firmware revision [e.g. **00 08**] | **0** | **0** | **0** | **8** |
| ● 3nd information for about 3s:<br>Valve type [e.g. **642**] | | **6** | **4** | **2** |
| ● 4nd information for about 3s:<br>Controller configuration<br>In case **D999** is displayed, motor interlock is active. Refer to «Safety mode» for details. | | **A**<br>= No or unknown busmodule detected<br>**I**<br>= CC-Link interface | **0**<br>= basic<br>**1**<br>= with SPS[1)]<br>**2**<br>= with PFO[2)]<br>**3**<br>= with SPS[1)] and PFO[2)] | **1**<br>= 1 sensor version<br>**2**<br>= 2 sensor version |
| **SYNC** indicates that powerup synchronization is running. | **S** | **Y** | **N** | **C** |

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

### 5.6.2 Operation

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

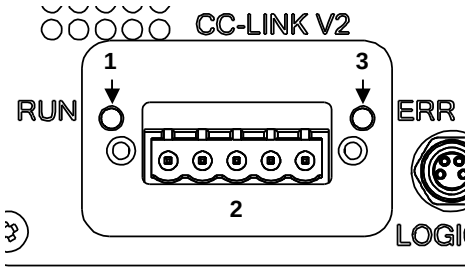
[1] If SR is blinking alternatively with the actual mode display (e.g. P.11 ⇔ ..SR) the valve requires cleaning.

### 5.6.3 Fatal error

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

### 5.6.4 CC-Link LEDs

| # | Item |
|---|---|
| 1 | Run LED |
| 2 | CC-Link Interface connector |
| 3 | Error LED |



**RUN LED (1)**

| State | Meaning |
|---|---|
| Off | No network participation, timeout status (no power) |
| Green | Participating, normal operation |
| Red | Major fault (FATAL error) |

**ERR LED (3)**

| State | Meaning |
|---|---|
| Off | No error detected (no power) |
| Red | Major fault (Exception or FATAL event) |
| Red, flickering | CRC error (temporary flickering) |
| Red, flashing | Station Number or Baud rate has changed since startup (flashing) |

### 5.6.5 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 synchronize. Display shows ‘D C’ or ‘D999’. In this case synchronization cycle will be done when motor interlock is deactivated. Then Display shows ‘INIT’ for a moment followed by ‘SYNC’.
When ‘safety mode’ is entered from operation (i.e. pressure control mode), the unit will automatically switch to position control mode and remain at current position. Once motor interlock is deactivated the unit remains in position control mode.

### 5.6.6 Service indication

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

## 5.7 Operation during power up

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

Refer also to chapter: «Display information».

## 5.8 Behavior in case of power failure

| Valve position before power failure: | Reaction of valve: | |
|---|---|---|
| | Without Power Failure Option (PFO)<br>642 . . - . . **G** . - . . . .<br>642 . . - . . **A** . - . . . .<br>642 . . - . . **T** . - . . . .<br>642 . . - . . **V** . - . . . . | With Power Failure Option (PFO)<br>642 . . - . . **H** . - . . . .<br>642 . . - . . **C** . - . . . .<br>642 . . - . . **U** . - . . . .<br>642 . . - . . **W** . - . . . . |
| Any | Valve remains at current position. | Valve will close or open depending on valve configuration 1).<br>Default is not defined.<br>Display indicates **F**. |

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

All parameters are stored in a power fail save memory.

## 5.9 Operation under increased temperature

**⚠ CAUTION**

**Hot valve**

Heated valve may result in minor or moderate injury.

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

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

# 6 Trouble shooting

| Failure | Check | Action |
|---|---|---|
| No dots lighted on display | 24 V power supply ok? | Connect valve to power supply according to «Electrical connection» and make sure that power supply is working. |
| Remote operation does not work | - Local operation via service port active<br>- Safety mode active, check for **D** on display? | - Switch to remote operation.<br>- Provide power to motor to allow for operation.<br>- Refer to «Electrical connection» for details. |
| Display shows «**E 20**» (**fatal error** - limit stop of valve unit not detected) | | - Replace actuator according to «Maintenance procedures». |
| Display shows «**E 21**» (**fatal error** - rotation angle of valve plate limited – power up) | - Valve plate mechanically obstructed? | - Resolve obstruction. |
| Display shows «**E 22**» (**fatal error** - rotation angle of valve plate limited - operation) | - Valve plate mechanically obstructed? | - Resolve obstruction. |
| Display shows «**E 40**» (**fatal error** - motor driver failure detected) | | - Replace control unit according to «Maintenance procedures». |
| Display shows «**D C**» or «**D999**» Motor Interlock is open | - Motor power supplied? | - Provide power to motor to allow for operation.<br>- Refer to «Electrical connection» for details. |
| Display shows «**SR**» (Service Request) | - Valve unit heavy contaminated or gate seal heavily sticking? | - Clean valve and/or replace gate seal according to «Maintenance procedures». |
| CLOSE VALVE does not work | - Safety mode active, check for **D** on display?<br>- Maintenance mode active | - Provide power to motor to allow for operation.<br>- Refer to «Electrical connection» for details.<br>- Refer to “Display shows «**M C**»” in this table |
| OPEN VALVE does not work | - Safety mode active, check for **D** on display?<br>- Maintenance mode active | - Provide power to motor to allow for operation.<br>- Refer to «Electrical connection» for details.<br>- Refer to “Display shows «**M100**»” in this table |
| Display shows «**M C**» Maintenance mode active | | - Pin 14 of service connector is connected to ground. Plate will close. Further movement of plate is blocked. [1)] |
| Display shows «**M100**» Maintenance mode active | | - Pin 13 of service connector is connected to ground. Plate will open. Further movement of plate is blocked. [1)] |
| POSITION CONTROL does not work | - Safety mode active, check for **D** on display? | - Provide power to motor to allow for operation.<br>- Refer to «Electrical connection» for details. |
| | - POSITION CONTROL selected, check for **V** on display? | - Select POSITION CONTROL mode. Refer to «Position control» for details. |
| Pressure reading is wrong or pressure reading is negative | - Sensor(s) connected? | - Refer to «Electrical connection». |
| | - 2 sensor version present at valve controller? | - Check valve version on page 1. Verify configuration. Refer to «Setup procedure».<br>- Refer to «Pressure control operation with 2 sensors». |
| | - ZERO done? | - Perform ZERO when base pressure is reached. Refer to «ZERO» for details. |

| | | |
|---|---|---|
| | - Does sensor power supply provide enough power for sensor(s)? | - Verify sensor supply voltage. |
| ZERO does not work | - Valve in open position, check for O on display? | - OPEN VALVE and bring chamber to base pressure before performing ZERO. |
| | - ZERO disabled? | - Enable ZERO.<br>Refer to «Valve and sensor configuration» for details. |
| Pressure is not '0' after ZERO | - Sensor voltage shifting? | - Wait until sensor does not shift any more before performing ZERO. |
| | - System pumped to base pressure? | - OPEN VALVE and bring chamber to base pressure before performing ZERO. |
| | - Sensor offset voltage exceeds ±1.4V | - Replace pressure gauge. |
| PRESSURE CONTROL does not work | - Safety mode active, check for D on display? | - Provide power to motor to allow for operation.<br>- Refer to «Electrical connection» for details. |
| | - PRESSURE CONTROL selected, check for P on display? | - Select PRESSURE CONTROL mode.<br>Refer to «Pressure control» for details. |
| | - LEARN done? | - Perform LEARN.<br>Refer to «Setup procedure» for details. |
| PRESSURE CONTROL not optimal | - Setup done completely? | - Perform «Setup procedure» completely. |
| | - LEARN done? | - Perform LEARN.<br>Refer to «LEARN» for details. |
| | - ZERO performed before LEARN? | - Perform ZERO then repeat LEARN.<br>Refer to «Setup procedure» for details. |
| | - LEARN interrupted? | - Repeat LEARN.<br>Refer to «LEARN» for details. |
| | - Was gas flow stable during LEARN? | - Repeat LEARN with stable gas flow.<br>Refer to «LEARN» for details. |
| | - Tuning done? | - Tune valve for application.<br>- Refer to «Tuning of control performance» for details. |
| | - Is sensor range suited for application? | - Use a sensor with suitable range (controlled pressure should be >3% and < 98% of sensor full scale). |
| | - Noise on sensor signal? | - Make sure a shielded sensor cable is used. |

## 6.1 Additional CC-Link warning

| Failure detection with CPA or CV software | Check | Action |
|---|---|---|
| Network failure: No CC-Link communication is active (warning 8)<br>  | - CC-Link cable ok?<br>- Connection to master ok? | - Check CC-Link cable.<br>- Check the CC-Link connection to master. |

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

# 7 Maintenance

**⚠ WARNING**

**Unqualified personnel**

Inappropriate handling may cause serious injury or property damage.

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

**⚠ WARNING**

**Valve opening**

Risk of serious injury.

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

**⚠ CAUTION**

**Hot valve**

Heated valve may result in minor or moderate injury.

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

***NOTICE***

**Contamination**

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

Always wear clean room gloves when handling the valve.

## 7.1 Maintenance intervals

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

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

## 7.2 Maintenance procedures

One maintenance procedures are defined for this valve:

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

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

VAT can give the following recommendations for preventive maintenance:

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

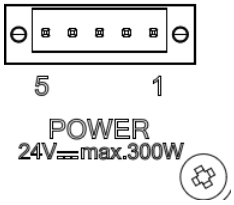
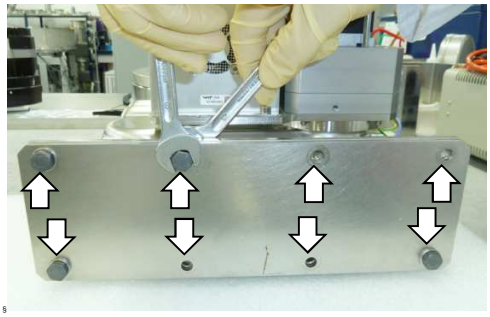
For spare parts of gate and bonnet seal refer to chapter: «Spare parts»

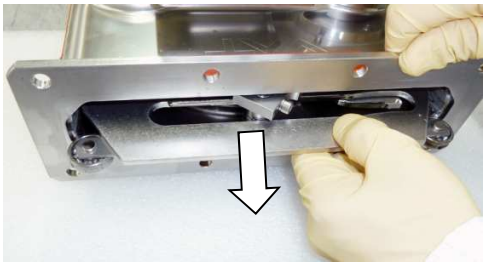
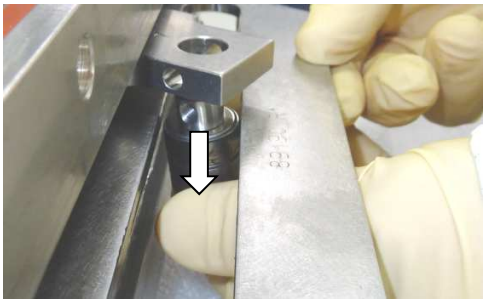
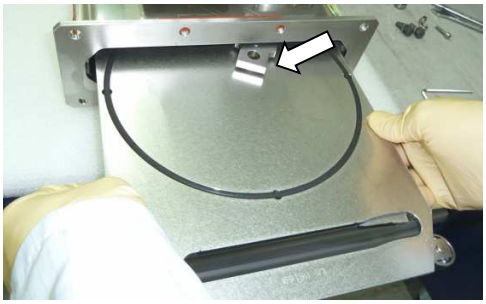
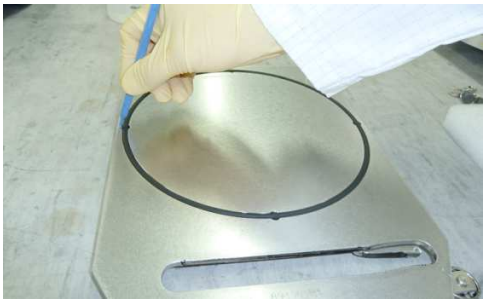
All pictures in maintenance procedure are sample pictures (DN63…400)

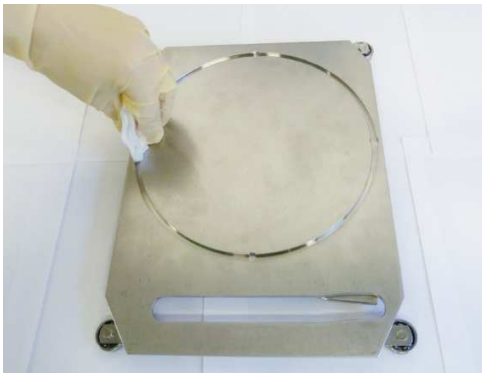
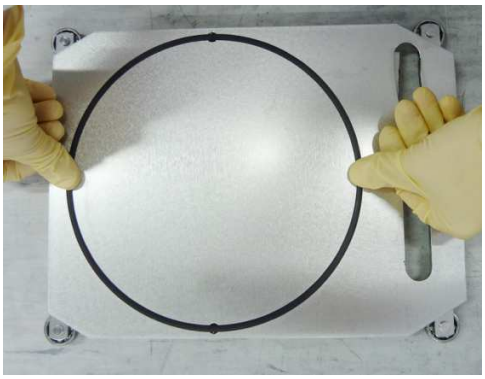
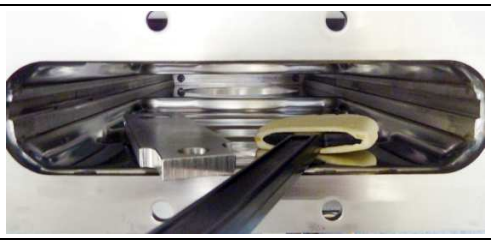
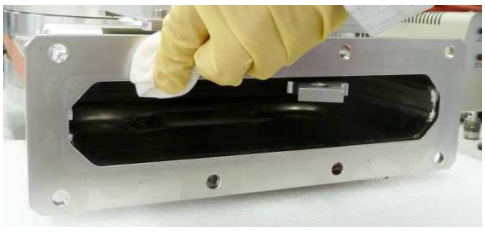
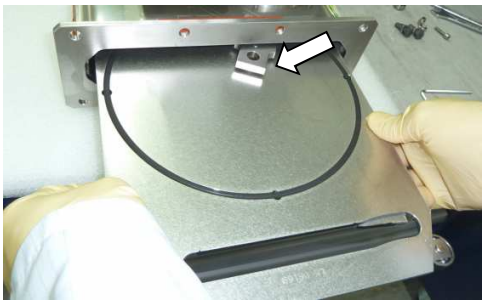
## 7.2.1 Replacement of gate seals and valve cleaning

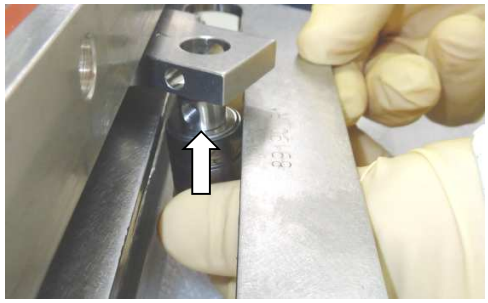
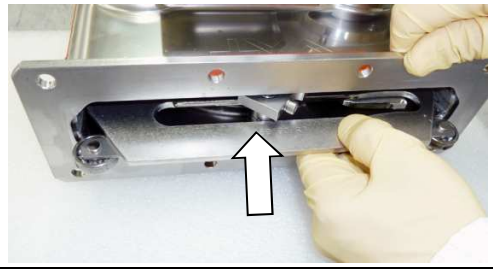
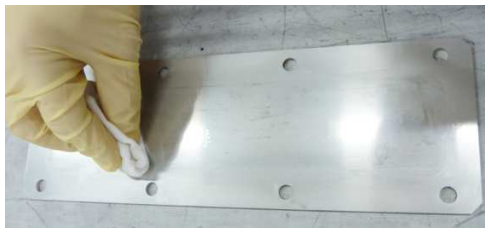
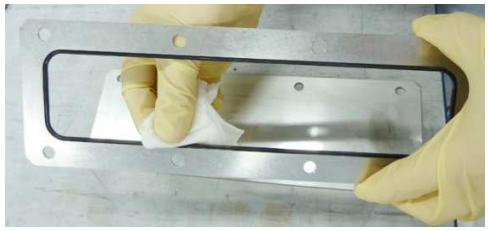
### 7.2.1.1 Required tools

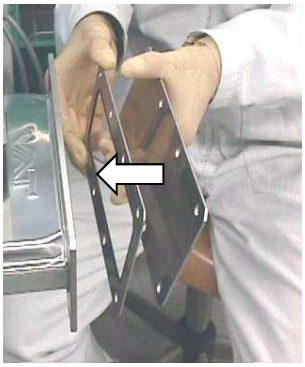
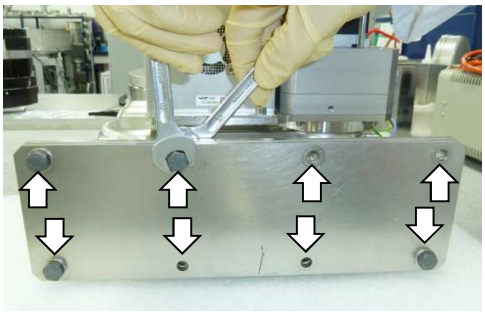
- Allen Wrench 4 mm (Allen torque wrench 4 mm)
- 2 × Open end wrench 13 mm
- Open end torque wrench 13 mm
- 2 × Open end wrench 10 mm
- Open end torque wrench 10 mm
- Isopropyl alcohol
- Vacuum grease (see chapter spare parts)
- O-ring removal tool (see chapter Accessories)
- Clean room wiper

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

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

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

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

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

### 7.2.2 Replacement of Option board

**NOTICE**

**Electrostatic discharge**

Electronic components could be damage.

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

**NOTICE**

**Burned connector pins (spark)**

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

Do not plug or unplug connectors under power.

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

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

It is available in 3 versions. These are:

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

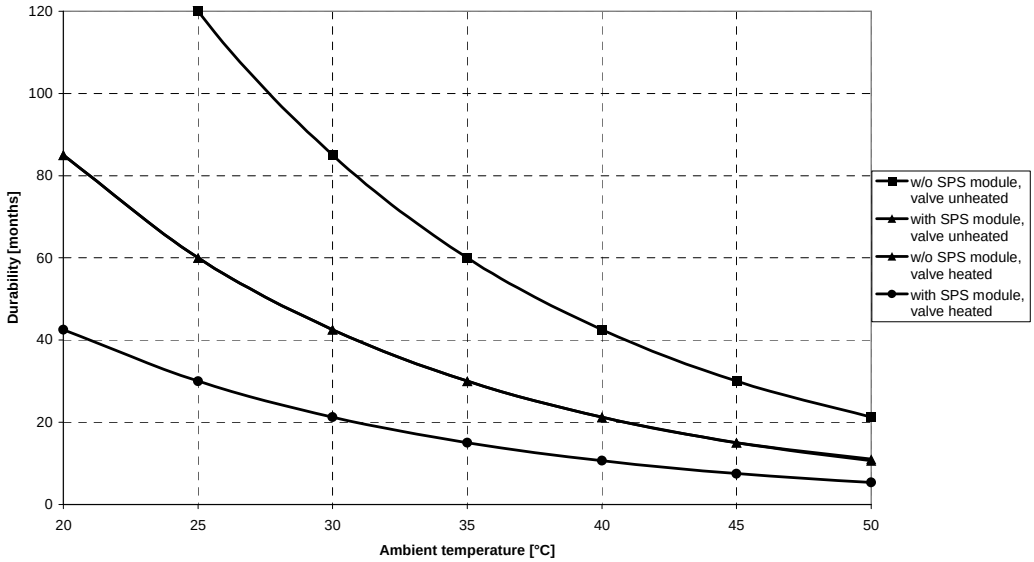
The modules may be retrofitted or replaced easily. The battery lifetime of the PFO module depends on the ambient temperature (see below). To assure PFO function the option board must be replaced after battery life has expired. For ordering number of the modules refer to chapter «Spare parts».

### 7.2.2.1 Durability of power fail battery

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

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

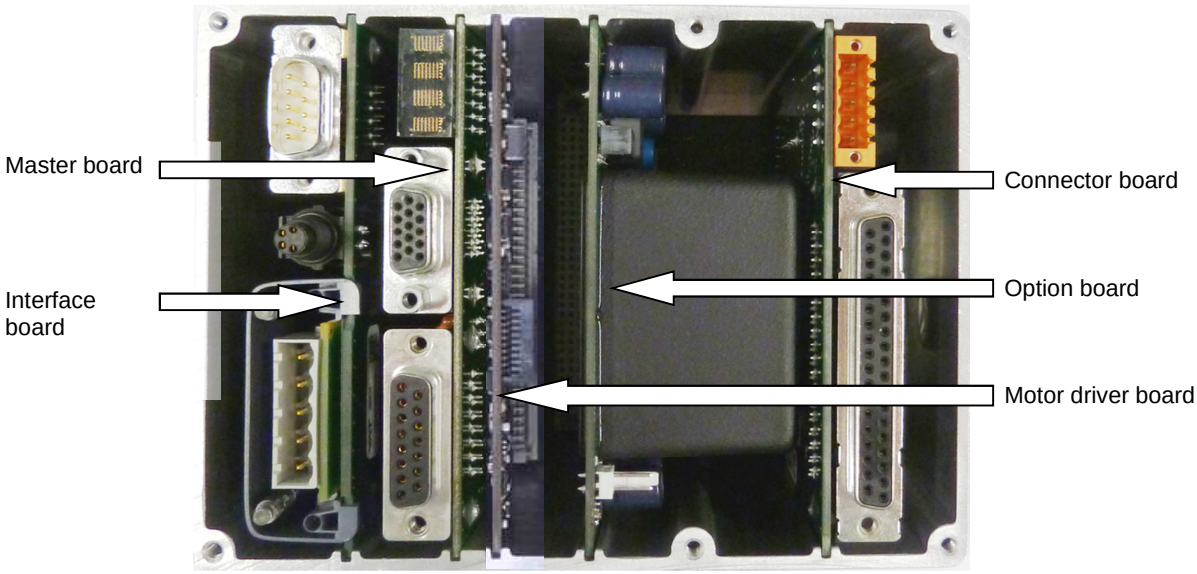
Therefore please determine the equivalent maintenance period for replacing the Ultra Cap battery (Option board).




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

### 7.2.3 Retrofit / replacement procedure

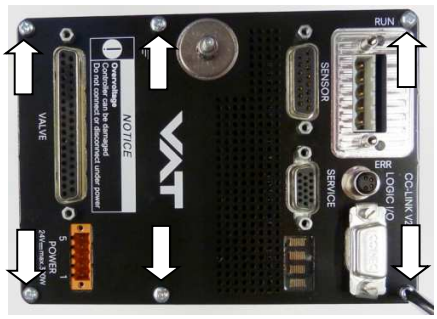
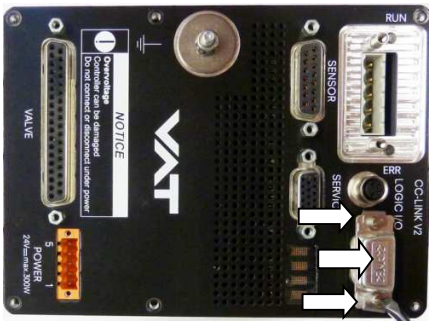
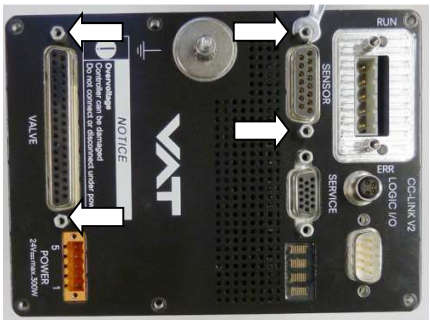
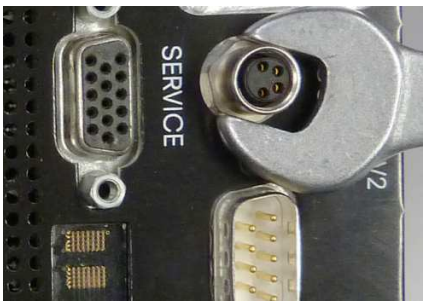
Top view on control and actuating unit with panel removed:

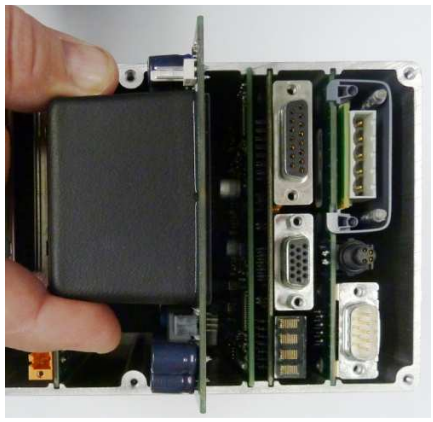



All boards have a fixed position into control and actuating unit. It is not possible to fit a board in other position as shown in picture above!

#### 7.2.3.1 Required tools

- Open end wrench 4.5 mm
- Open end wrench 10 mm
- Pozidriv screw driver size 1
- Screw driver size 2

| Description | | Required tools |
|---|---|---|
| 1. Disconnect all electrical connections at controller. | **Attention to ESD protection!**  | Pozidriv screw driver size1<br>Open end wrench 7 mm |
| 2. Remove the panel screws. |  | Pozidriv screw driver size1 |
| 3. Remove this screws and the cover. |  | Screw driver size 2 |
| 4. Remove the female screw locks from connectors. |  | Open end wrench 4.5 mm |
| 5. Loosen and remove the LOCIC connector screw |   | Open end wrench 10mm |

| Description | | Required tools |
|---|---|---|
| 6. Lift controller panel carefully. |  | |
| 7. Remove or replace option board. |  | |
| 8. Reassemble all parts in reverse order (see steps 6…3).<br>9. Tighten panel screws with 1.1 Nm (see step 2). | | |
| 10. Reconnect all electrical connections at controller. | | |

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

# 8 Repairs

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

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

# 9 Dismounting and Storage

**⚠ WARNING**

**Unqualified personnel**

Inappropriate handling may cause serious injury or property damage.

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

## 9.1 Dismounting

***NOTICE***

**Contamination**

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

Always wear clean room gloves when handling the valve.

***NOTICE***

**Valve in open position**

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

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

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

## 9.2 Storage

**NOTICE**

**Wrong storage**

Inappropriate temperatures and humidity may cause damage to the product.

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

**NOTICE**

**Inappropriate packaging**

Product may get damaged if inappropriate packaging material is used.

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

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

# 10 Packaging and Transport

**⚠ WARNING**

**Unqualified personnel**

Inappropriate handling may cause serious injury or property damage.

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

**⚠ WARNING**

**Harmful substances**

Risk of injury in case of contact with harmful substances.

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

***NOTICE***

**Inappropriate packaging**

Product may get damaged if inappropriate packaging material is used.

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

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

## 10.1 Packaging

***NOTICE***

**Valve in open position**

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

Make sure that the valve is closed.

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

VAT disclaims any liability for damages resulting from inappropriate packaging.

## 10.2 Transport

**NOTICE**

**Inappropriate packaging**

Product may get damaged if inappropriate packaging material is used.

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

VAT disclaims any liability for damages resulting from inappropriate packaging.

# 11 Disposal

**⚠ WARNING**

**Unqualified personnel**

Inappropriate handling may cause serious injury or property damage.

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

# 12 Spare parts

**NOTICE**

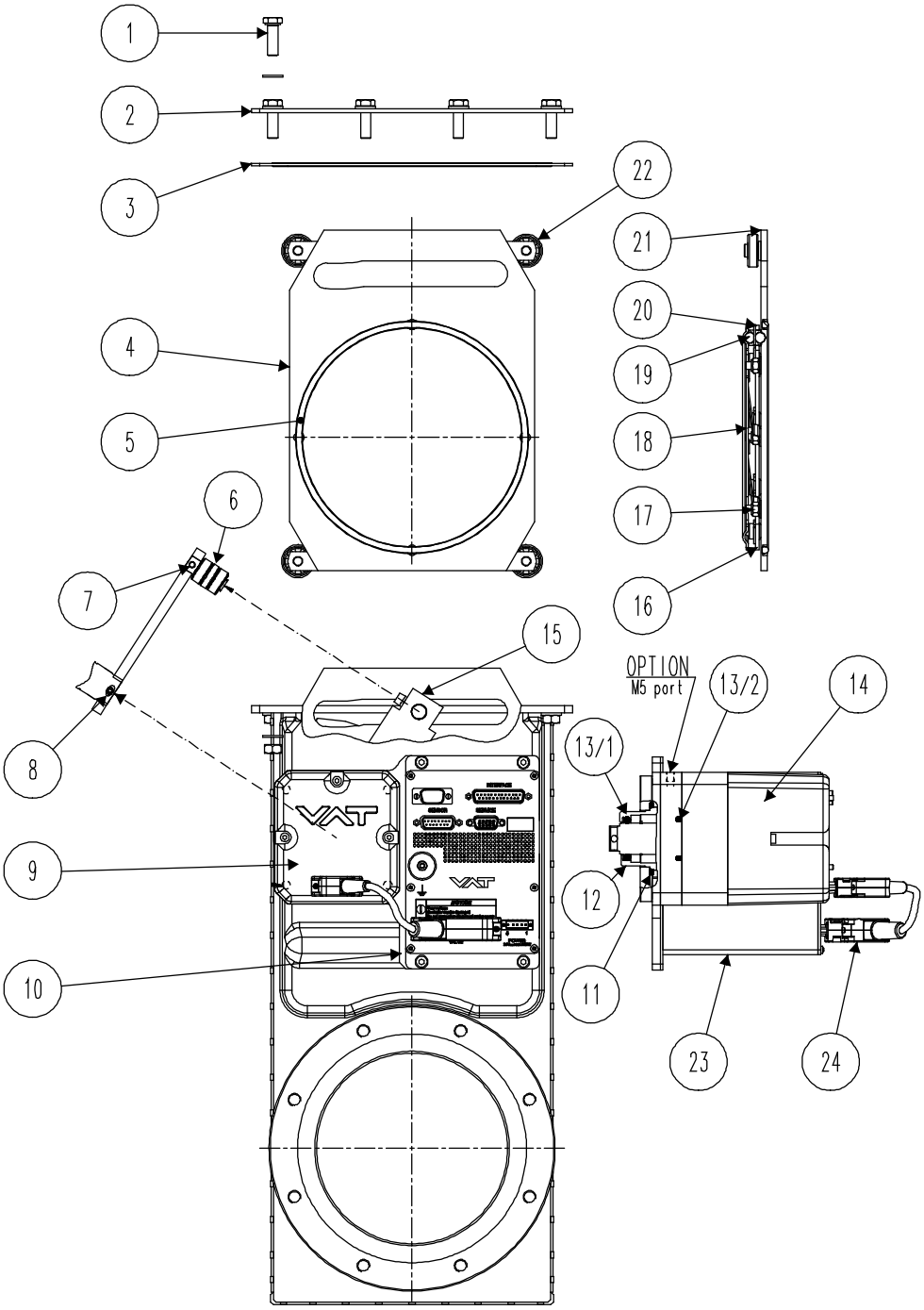
**Non-original spare parts**

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

Use original spare parts from VAT only.

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

## 12.1 Drawing




Sample picture

All “Item“ refer to chapter «Drawing»

### 12.1.1 Valve unit with seals and grease

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

### 12.1.2 Controller

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

### 12.1.3 Accessories

| Description | Part number |
|---|---|
| 24 VDC power supply unit<br>(input: 100 – 240 VAC) | 572699 |
| 'Control Performance Analyzer' package for Windows® | free download from:<br>http://www.vatvalve.com/customer-service/informations-and-downloads/control-performance-analyzer |
| Service cable<br>(PC to valve Service connector) | 230327<br>free wiring information available for download from www.vatvalve.com |
| Connector of:<br>• DB-15 male SENSOR plug | 81177-R1 |
| Service Box 2 | 601BS-29NN-000 |
| Control panel (rack-mount version of Service Box 2) | 602BS-29LE-000 |
| O-ring removal tool | 234859 |
| VAT valve cleaning tool | 305709 |

#### 12.1.3.1 Centering ring with Viton o-ring

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

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

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

# 13 Appendix

No information entered on time.

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