Installation, Operating & Maintenance Instructions

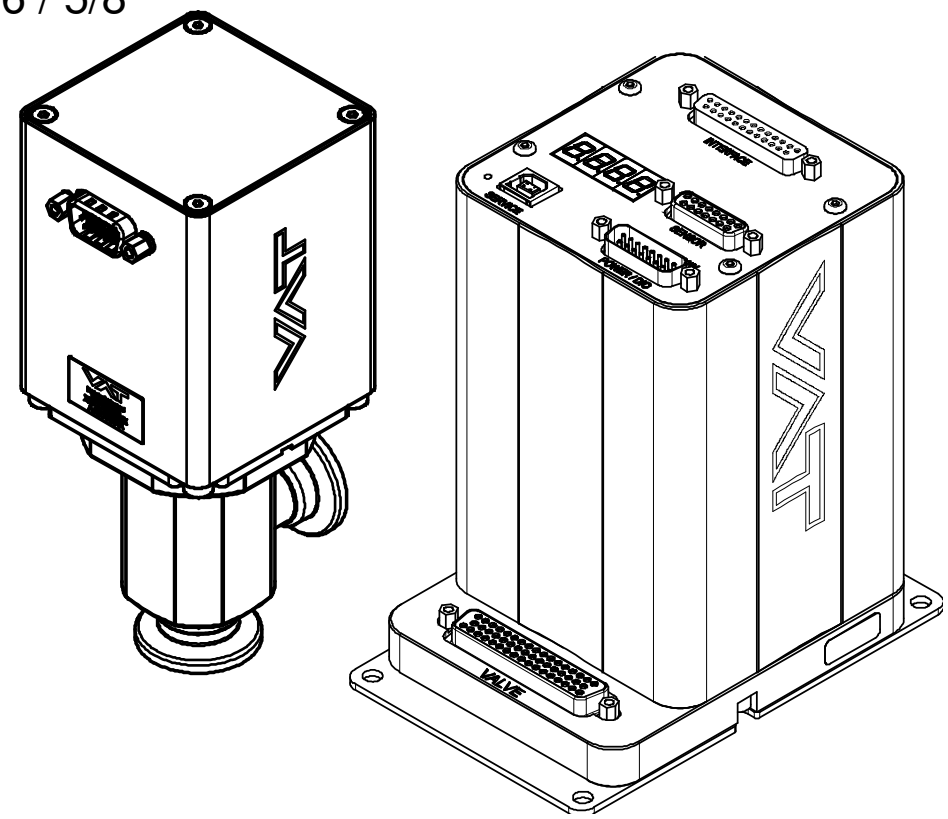
HV Gas Dosing Valve

External Controller (IC2-H3)

62824-KE52-….

62824-KE..-AEJ1 (1 m cable)
62824-KE..-AEK1 (2 m cable)
62824-KE..-AEL1 (3 m cable)
62824-KE..-AEM1 (5 m cable)

DN16 / 5/8"



Publication details

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List of contents

1 General information

1.1 Scope of delivery

The scope of delivery corresponds to your purchase order with VAT Vakuumventile AG. When you receive your purchase order, check it against your order list. If you find discrepancies between what was ordered and delivered, contact VAT Vakuumventile AG. Publication details [▶ 2]

1.2 Other applicable documents

The following documents belong to the product and must be observed:

- Product Data Sheet
- Dimension Drawing
- Programmers Reference

To obtain the Programmers Reference please contact your local VAT representative.

1.3 Typographical conventions

1.3.1 Important information

This icon indicates important and useful information.

1.3.2 Danger levels

To avoid injury and equipment damage, you must observe the warning and safety information in the instructions. The warnings describe the following danger levels:

	**⚠ DANGER** Situations which, if not avoided, will lead directly to death or serious injury.

	**⚠ WARNING** Situations which, if not avoided, could lead to death or serious injury.

	**⚠ CAUTION** Situations which, if not avoided, could lead to moderately serious or slight injury.

	NOTICE Situations which, if not avoided, could lead to equipment damage.

1.4 Forwarding

This document is part of the product and if the product is forwarded, the document must also be forwarded to the product recipient.

If the product becomes part of a machine by installation or combination with other parts or by any other method, this document must also be forwarded when the machine is sold. The only circumstance in which forwarding is not required is when all relevant parts of this document are included in the documentation that accompanies the new machine. In the latter two cases, the machine manufacturer, not the manufacturer of this product, is legally responsible for the safety and for the content and scope of the instructions that accompany the machine.

1.5 Document number and index

The cover sheet includes the document number and indexing as well as the product definition and document type. The document number consists of at least 6 and at most 7 numbers. The index consists of 2 letters.

Example:

1234567DA

The document number allows the documentation to be assigned to the product. The index indicates the language and version.

Version **Language**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**…**
German	DA	DB	DC	DD	DE	DF	DG	D…
English	EA	EB	EC	ED	EE	EF	EG	E…

1.6 Representation of parameters

The parameters are described in the corresponding sections. In general, parameters are represented in the following form.

First, there is a description where the parameters can be found in the parameter window of the CPA, followed by the table in which the parameters are named and their functions are described.

Localized `CPA/Parameters: Pressure Control.Controller1…4.Control Settings`

Parameter	**Description**
Gain Factor	Main parameter to influence the control performance
Sensor Delay	Control parameter for compensating delays during pressure detection
Learn Data Selection	Four different learning data sets can be selected for the pressure control of the adaptive controller: *Bank 1* *Bank 2* *Bank 3* *Bank 4*

The parameters and parameter values are marked in these operating instructions as follows:

Parameter *Parameter Value*

Example: Set ***Learn Data Selection*** to *Bank 1*.

1.7 Quick installation and operation guide

1.7.1 Installation

1. Follow the safety instructions and warnings. See section Safety [▶ 11]
2. Unpack the valve. See section Unpacking [▶ 22]
3. Install the valve mechanically in the system. Consider torques and space. See section Mechanical installation [▶ 22]
4. Connect the ground connection. See section Installation [▶ 22]
5. Connect the power and choose the sensor supply concept. See section Power and sensor supply
6. Connect the pressure sensor. If you are using 2 sensors, install both sensors (not part of the delivery).
7. If required, use the following safety functions additionally:
   - Drive power switch. See section Drive power switch [▶ 34]
   - Digital IOs for interlocks. See section Display messages [▶ 71]
8. Connect the valve via the interface to the host computer:
   - Set the interface basics like baudrate, device address or fieldbus host files.

1.7.2 Operation

1. For initial valve configuration, choose your Access Mode. See section Access Mode [▶ 65]:
   - Local = through VAT's graphical user interface called CPA
   - Remote = through commands sent to the valve's interface port
2. Configure the specific valve settings, especially the following:
   - Homing procedure during startup. See section Power on – homing [▶ 37]
   - Power failure option. See section Power down [▶ 38]
3. Select how the valve is controlled. See section Control Mode [▶ 66]:
   - ***Control Mode*** *Position*. See section Position control [▶ 75]
   - ***Control Mode*** *Pressure Control*. See section Pressure control [▶ 83]
4. For pressure control:
   - Configure the pressure sensor first. See section Pressure sensor [▶ 78]
   - Select your choice of the Control Algorithm. See section Pressure control [▶ 83]
   - Trigger the learn, if ***Control Algorithm*** *Adaptive* is used. See section Pressure control Adaptive [▶ 85]
5. Respect the periodic maintenance cycles. See section Maintenance [▶ 117]

2 Safety

2.1 Intended use

The valve is intended for use together with the controller for controlling the pressure in a clean, dry indoor vacuum system. It can be operated with a variable gas flow (Upstream control) or with a variable conductance value (Downstream control). Conveying powders or liquids is considered to be misuse or incorrect use. It is intended to be used with inert gases.

- The product is intended solely as a component for further use in a commercial context.
- The product may only be operated under the technical conditions described in the Product Data Sheet.
- The product may only be operated under the environmental conditions described in the Product Data Sheet.
- Examine the product prior to use and never operate if visibly damaged.
- Never technically modify the product.
- Never operate the product if it has not been completely mounted.
- Only connect and disconnect plug-in connections when not under voltage.
- Only connect and disconnect compressed air connections in an unpressurized state.
- If any change is made to the product that has not been agreed with VAT Vakuumventile AG, the guidelines applied and the corresponding declarations will become invalid.

2.2 Qualified personnel

Qualified personnel are the people authorized to operate devices, systems and electrical circuits in accordance with safety standards.

2.3 Predictable misuse and improper use

Any use of the product that does not comply with the intended use, be this intentional or negligent, is forbidden by the manufacturer.

2.4 Personal protective equipment

Personal protective equipment is not included in the scope of delivery.

To ensure the product is not contaminated or damaged, VAT recommends that the end user provides at least the following personal protective equipment for work with and on the product. If further protective clothing is required as a result of a special use of the product, the end user is responsible for making this known.

	Wear antistatic shoes
	Wear protective clothing
	Use gloves
	Use a hairnet

2.5 End user's obligations

The end user of the system is responsible for observing the safety regulations. Unqualified personnel working on the product or located in danger zones can cause risks that could lead to serious injury.

- ► Have all activities carried out by qualified personnel.
- ► Keep unqualified personnel away from danger zones.
- ► Make sure that everybody who works on or with the product has read and understood the document.
- ► Make sure that safety information is observed.
- ► File this document together with the documentation of the entire system and ensure that it can be accessed at all times.
- ► This document is part of the product. Pass it along with the product.
- ► Note the relevant accident protection regulations and the recognized local safety rules.
- ► Provide the necessary personal protective equipment.
- ► Provide possibilities for ESD measures.

2.6 Personnel obligations

To avoid equipment damage and injury when handling the product, personnel are obliged to:

- ► Read the operating instructions and in particular follow the safety information.
- ► Note the relevant accident protection regulations and the other generally recognized safety rules.
- ► Wear the necessary personal protective equipment.

2.7 Safety labels

The following safety labels can be found on the product. It is the responsibility of the end user to ensure that the safety labels are clean, legible and undamaged. Damaged safety labels must be replaced promptly.

	Electrical voltage
	Toxic substances
	Corrosive substances
	Danger of contusion
	Being pulled in

2.8 Damage to the product

2.8.1 Electrostatic discharge

Electrostatic discharge can cause injury and can damage electronic parts of the product.

- ► Provide counter measures to prevent Electrostatic Discharge (ESD) damage to control valve electronics.
- ► Carry out all work on the control and actuation unit under ESD-protected conditions.

2.8.2 Connections

Incorrectly connected cables can cause damage to the product and disrupt the voltage supply.

- ► Follow the instructions in the document when connecting the cables.
- ► Note the wiring diagrams.

2.8.3 Sparks

If plug connectors are connected and disconnected when the power is on, electrical arching (sparks) can damage connector pins and electronic parts.

- ► Do not plug in or remove plug connectors when the power is on.

2.8.4 Product contamination

To ensure correct operation of the product, the product must be protected from contamination.

Personal protective equipment is not included in the scope of delivery.

- ► When working on and with the product, wear clean-room gloves.

2.8.5 Hazardous materials

Improper handling of hazardous materials can cause injury and harm the environment.

- ► Remove, for example, any toxic, corrosive or microbiological hazardous materials before you send the product to VAT.
- ► Dispose of the product and parts in accordance with the local regulations.

2.9 Product handling

The default value can differ depending on the customer specification and firmware.

2.9.1 Moving parts

Moving parts of the product can cause serious injury.

- ► Make sure that moving parts cannot be touched.
- ► Make sure that the opening is free as soon as the product is connected to a supply line.
- ► Do not connect the product to the supply line until it has been completely installed.

2.9.2 Unsuitable packaging

Unsuitable packaging material can cause product contamination.

- ► Keep the original packaging material.
- ► Use the original packaging material during transport and storage.
- ► Handle the product with care.

3 Technical data

See supporting documentation, Product Data Sheet.

4 Design and function

4.1 Type label

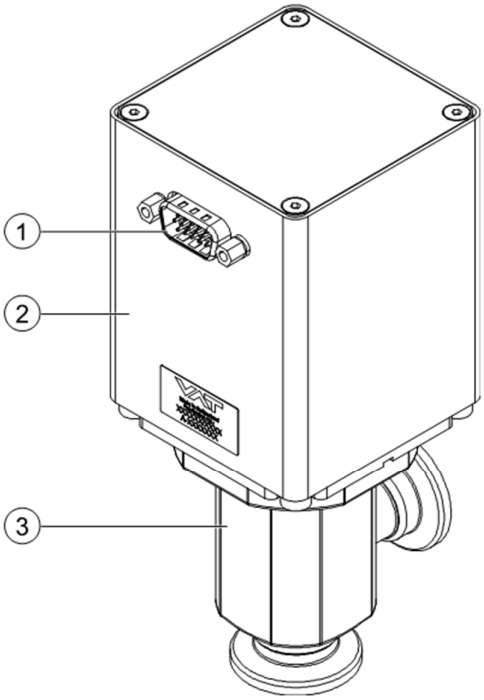
The article and serial number and the order number are indicated on the product or on a type label.

1 Article and serial number

2 Order number

The type label may vary in form and content.

4.2 Valve structure

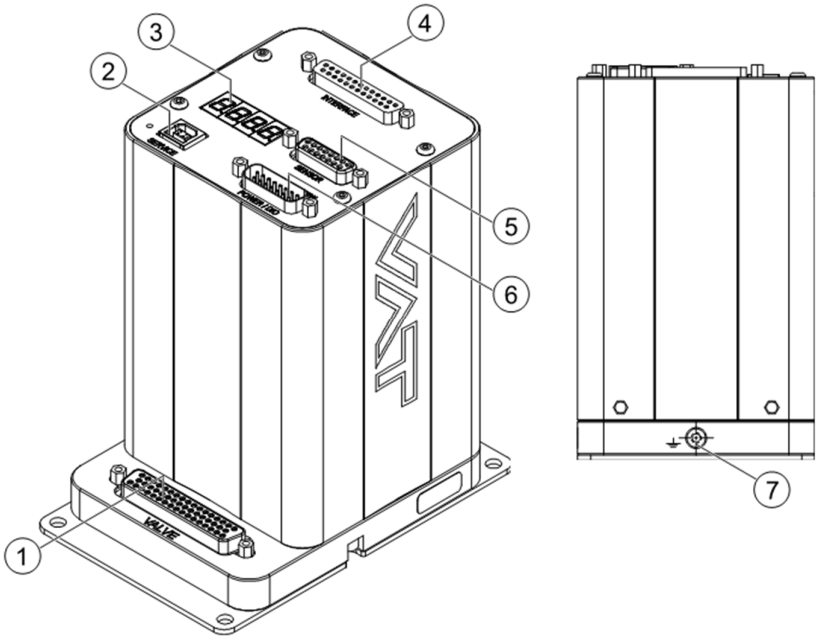


1 Socket

2 Body

3 Valve body

4.3 Controller structure

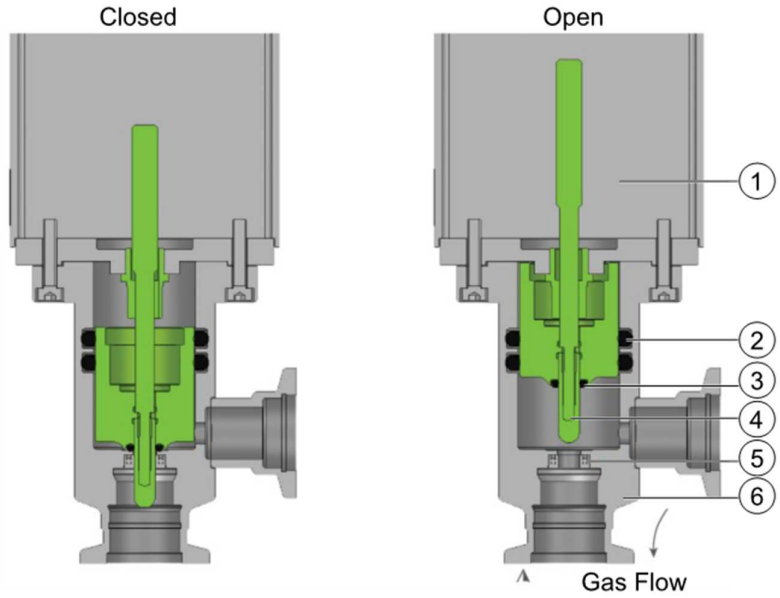


1 Valve connector
2 Service connector
3 4 Digit display
4 Interface connector
5 Sensor(s) connector
6 Power connector / DIO
7 Functional Ground M4

4.4 Valve function

The variable inlet valve acts as a throttling element and varies the gas flow. The integrated controller calculates the required valve position to achieve the setpoint pressure. Actuation is handled by a stepper motor with an encoder monitoring the position. This principle ensures very fast and accurate process pressure control even in demanding processes.

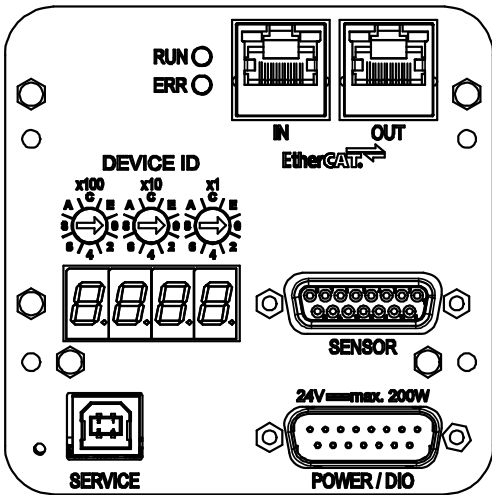
The gas flow is reduced if an additional filter is installed.



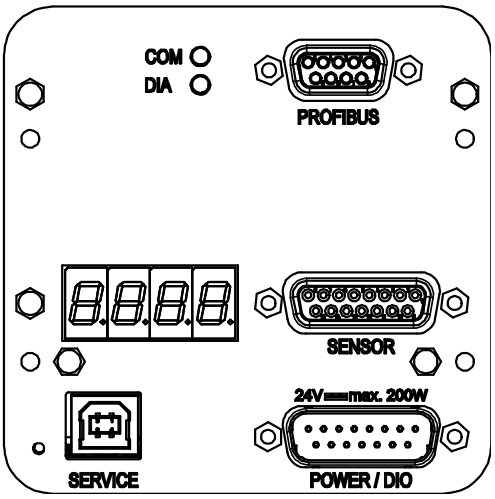
1 Motor
2 Feedthrough seal
3 Plate seal
4 Needle
5 Nozzle
6 Body

4.5 Front panel of controller

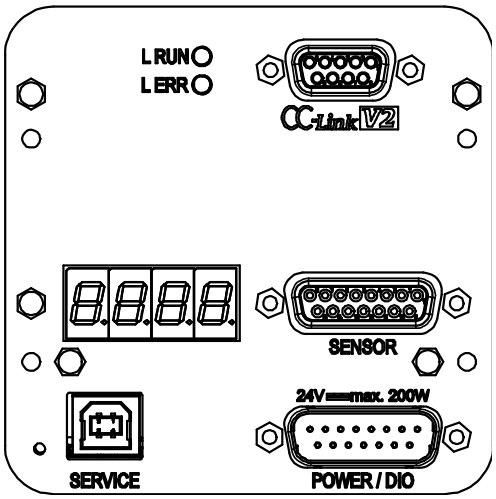
EtherCAT



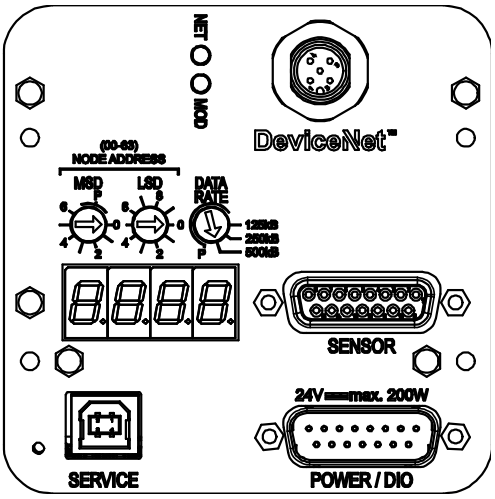
Profibus



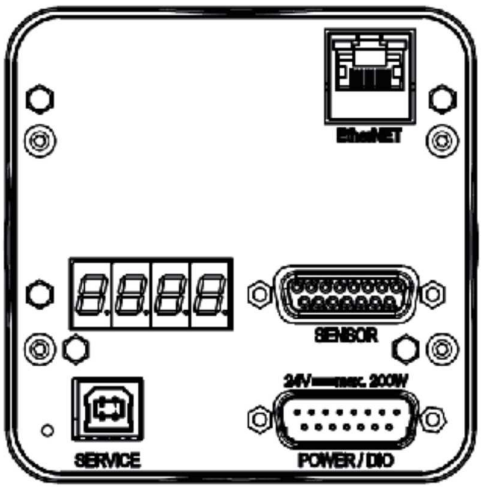
CC-Link



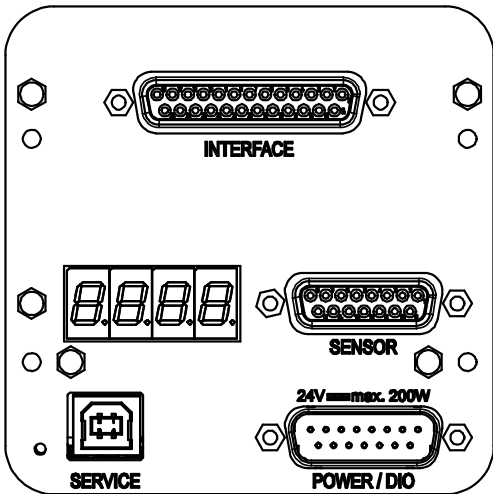
DeviceNet



Ethernet



RS232/485/Logic



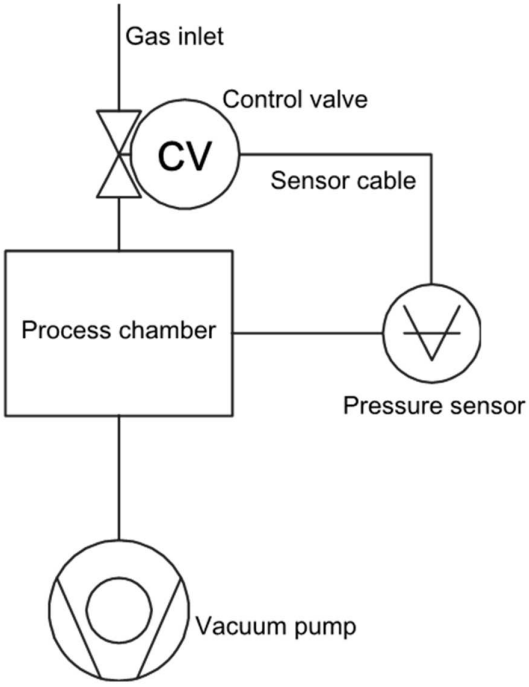
4.6 Way of operation

The controller compares the ***Actual Pressure*** in the process chamber given by the pressure sensor with the ***Target Pressure***. The controller uses the difference between ***Actual Pressure*** and ***Target 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 ***Target 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.

4.7 Functional structure of Upstream Pressure Control

Upstream Pressure Control defines a tool layout where the pressure control valve is located between and gas inlet and process chamber.



5 Installation

5.1 Mechanical installation

⚠ WARNING

Danger of burns from hot valve surface!

Serious burns on the skin.

► Let the system cool down before you perform work on it.

5.1.1 Unpacking

If the product or the packaging is damaged in any way, take a photograph of the damage and the type label and report the damage to the VAT service center.

Use a blunt object to open the plastic bag.

1. Check whether the packaging is damaged. If it is, report this to VAT.
2. Make sure that the protective sleeves are not damaged.
3. Remove the packaging material.
4. Check whether the product is damaged. If it is, report this to VAT.
5. Lift the product out of the packaging.

5.1.2 Mounting valve

⚠ WARNING

Moving parts

Body parts can be trapped or severely injured.

► Only connect electrical current and compressed air once the product is completely installed in the system.

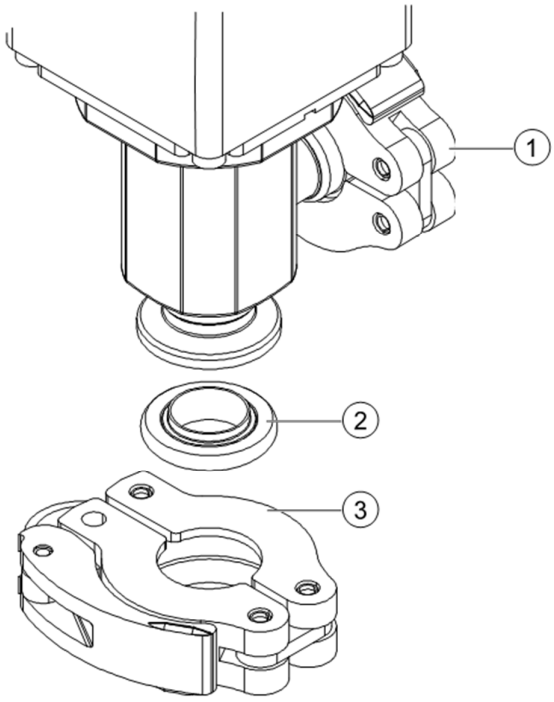
NOTICE

Leak due to incorrect handling of the sealing surfaces!

Leakage at the sealing surfaces.

► Get qualified staff to install the product in the vacuum system.

The mounting aid is not included in the scope of delivery.



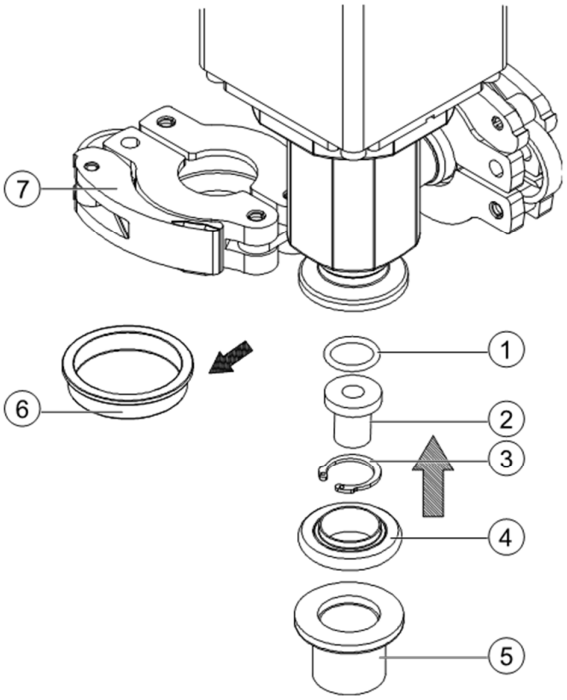
1 Tightening element
2 Sealing ring
3 Tightening element

1. Ensure that the filter on the gas inlet is fitted.
2. Position the sealing ring with the centering ring between the valve nozzle and the connection flange (2).
3. Clamp the connection flanges (1) and (3) to the valve nozzle.

⇨ The valve is mounted.

Mounting additional filter

Mounting optional filter can help to protect the device. In addition, it will reduce the gas flow.



1 O-ring
2 Filters
3 Snap ring
4 Centering sealing ring
5 Connection flange
6 Protective cap
7 Tightening element

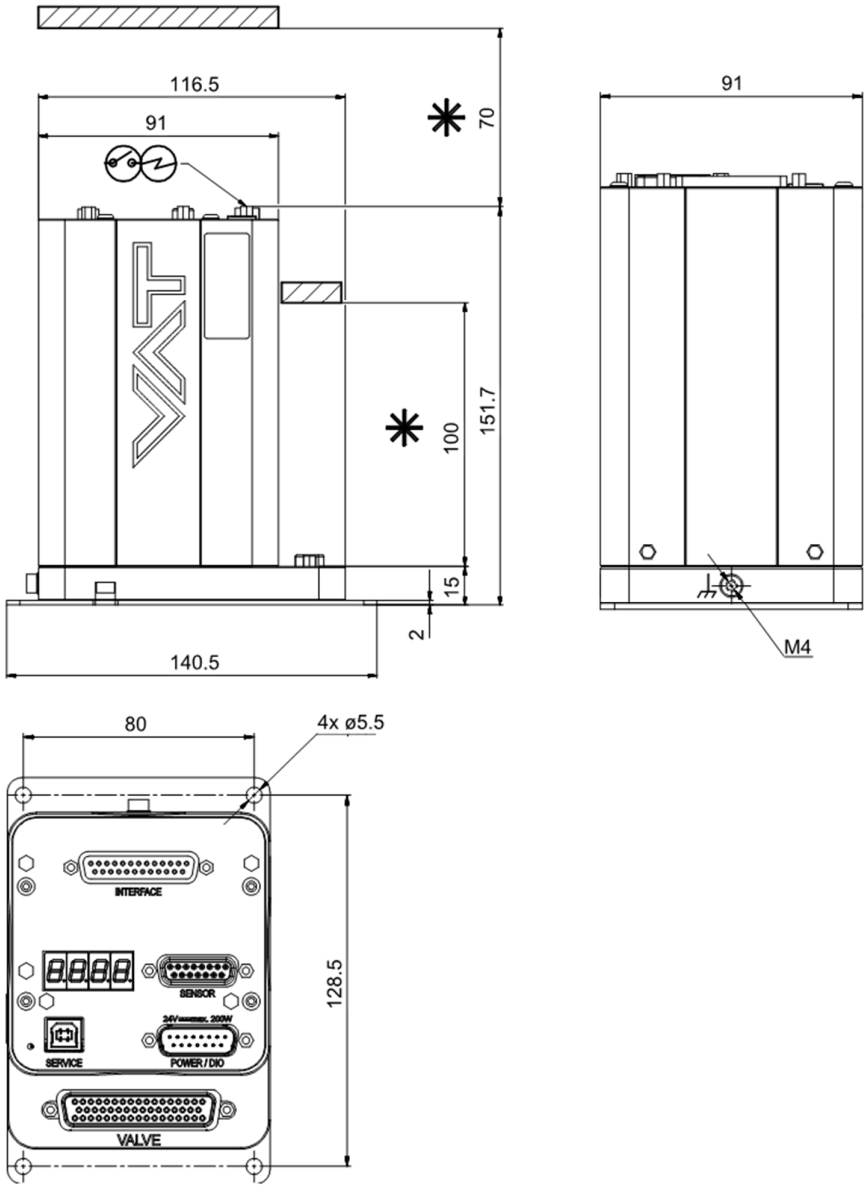
1. Remove the protective cap (6) and keep it in a safe place.
2. Mount the O-Ring (1) and the filter (2) and secure them with the snap ring (3).
3. Using the centering ring (4), place the sealing ring between the connection flange (5) and the valve nozzle.
4. Clamp the connection flange (5) and the valve nozzle with the tightening element (7).
5. Check the tightness of the flange.

⇨ The filter and the valve are mounted.

5.1.3 Installation in the system

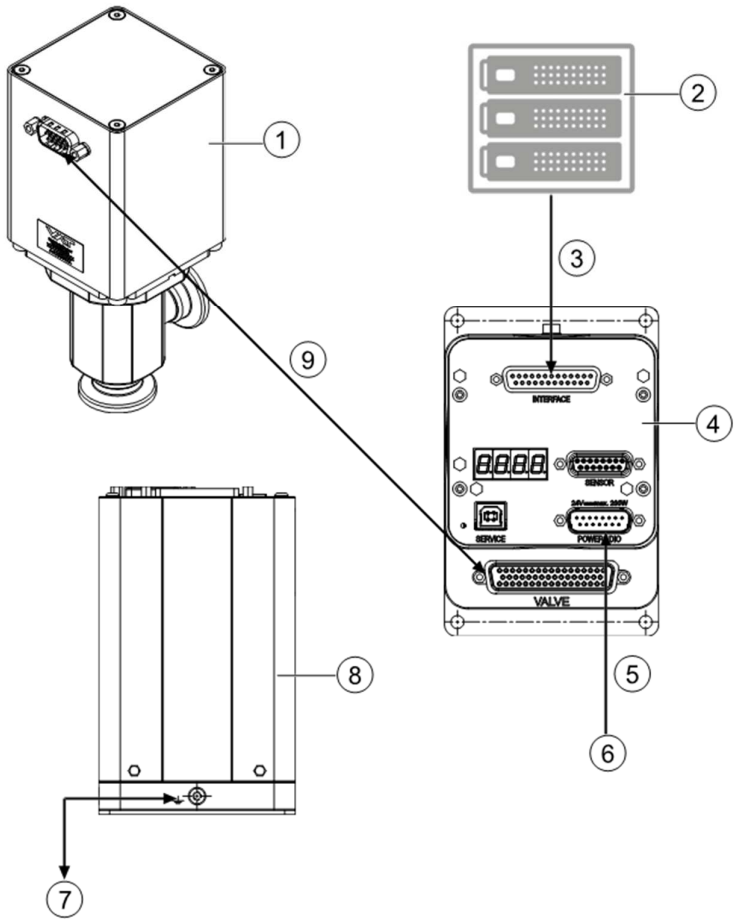
	NOTICE
	Misuse of the controller! If the controller is used as a footrest, it may become damaged and fail. ► Never use the controller as a footrest.

Dimension of controller



Required space for dismantling the connector cables.

Connection overview (Sample)



1 Valve
2 Host
3 Interface cable
4 Controller (top view)
5 Power supply / DIO cable
6 Power supply 24 V DC
7 Ground (FE) connection
8 Controller (back view)
9 Actuator cable

✓ Packaging material is removed.

1. Mount the valve in the vacuum system in such a way that the valve seat side faces the process chamber. The valve seat side is indicated with the symbol ∆ on the flange or in the drawing. For "downstream" seat valve to be facing vacuum pump.
2. Make sure that enough space is kept free to do preventive maintenance work. The required space is indicated on the dimensional drawing.
3. Install a ground connection cable to the ground connection of the controller backside.
4. Connect the host and the interface connector of the controller with the interface cable.
5. Connect the valve and the controller with an actuator cable.
6. Connect the pressure sensor. If you are using 2 sensors, install both sensors. See section Mechanical installation [▷ 78]
7. Connect the power supply and the power connector of the controller with a power supply / DIO cable.

To supply power to the valve motor, pins 4 and 11 must be bridged, otherwise the motor interlock is active and the valve switches safety mode. The valve is not ready for operation.
See section Drive power switch [▶ 34]

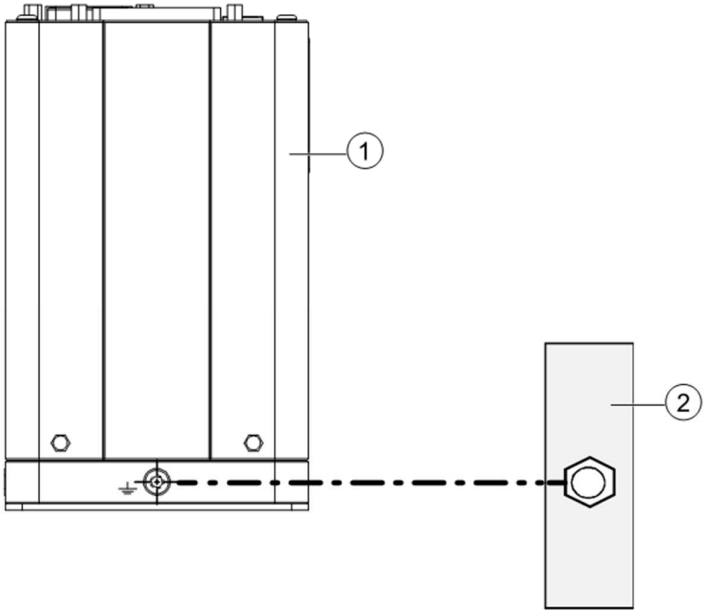
5.1.4 Installation clearances

During installation, ensure there is sufficient clearance. This ensures there is enough space for connections and air circulation.

See supporting documentation, Dimensional Drawing.

5.2 Grounding connection

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



1 Controller backside (sample) 2 Chassis (Functional Earth, FE)

- Recommended torque for mounting: 1.3 … 1.7 Nm
- Recommendation for ground connection cable: AWG 12 (4 mm²)
- The connection point at chassis (FE) must be blank metal (not coated).
- Connection plates of ground strap must be total plane for a good electrical contact.
- The connection point at chassis (FE) must be blank metal (not coated). It is also possible to connect the ground strap at system chamber if it is well connected to PE.
- Avoid low chassis cross section to the system PE connection (min. same cross section as ground strap).

5.3 Power and sensor supply

⚠ DANGER

Fire hazard as a result of incorrectly connected cables!

Burns caused by cable fire.

► See the connection diagram.

– The valve is operated with 24VDC.
– The sensors can be supplied via the power connector (D-Sub 15-pin male). Therefore, power supply and sensor supply are described together in the below diagrams.
– Note that pins 4 and 11 must be bridged to supply power to the motor.
– The external Drive Power Switch makes it possible to interrupt the motor voltage supply. See section Drive power switch [▶ 34]

5.3.1 Electrical installation

NOTICE

Damage to electronic components as a result of insufficient ESD measures!

The electronic components no longer work.

► Ensure potential equalization before working on the product.

NOTICE

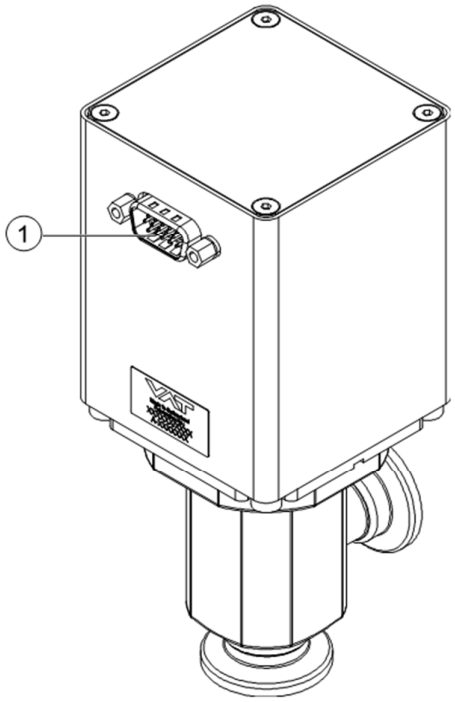
Damage as a result of incorrectly connected cables!

Damaged control unit and interrupted power supply.

► Follow the instructions in the assembly and operating instructions when connecting the cables.

► Note the wiring diagrams.

To operate the valve, use the accessories described in the Product Data Sheet.



1 Socket(s)

► Connect the cable(s) to the socket(s) (1).

5.3.2 Sensor supply concept

The valve supports 2 sensor inputs via one D-Sub 15-pin female.

Select the appropriate supply concept according to the voltage required by the sensor.

+24 VDC sensor supply voltage:

– The 24 V supplied to the valve is fed to the sensor.

±15 VDC sensor supply voltage:

– Supply via external power supply via the power connector
– Supply via internal optional sensor supply (SPS)
  The following valve versions are equipped with the SPS module:
  XXX . . - . . A . - . . . . and XXX . . - . . C . - . . . . SPS module included.
  The following valve versions are not equipped with the SPS module:
  XXX . . - . . G . - . . . . and XXX . . - . . H . - . . . . SPS module not included.

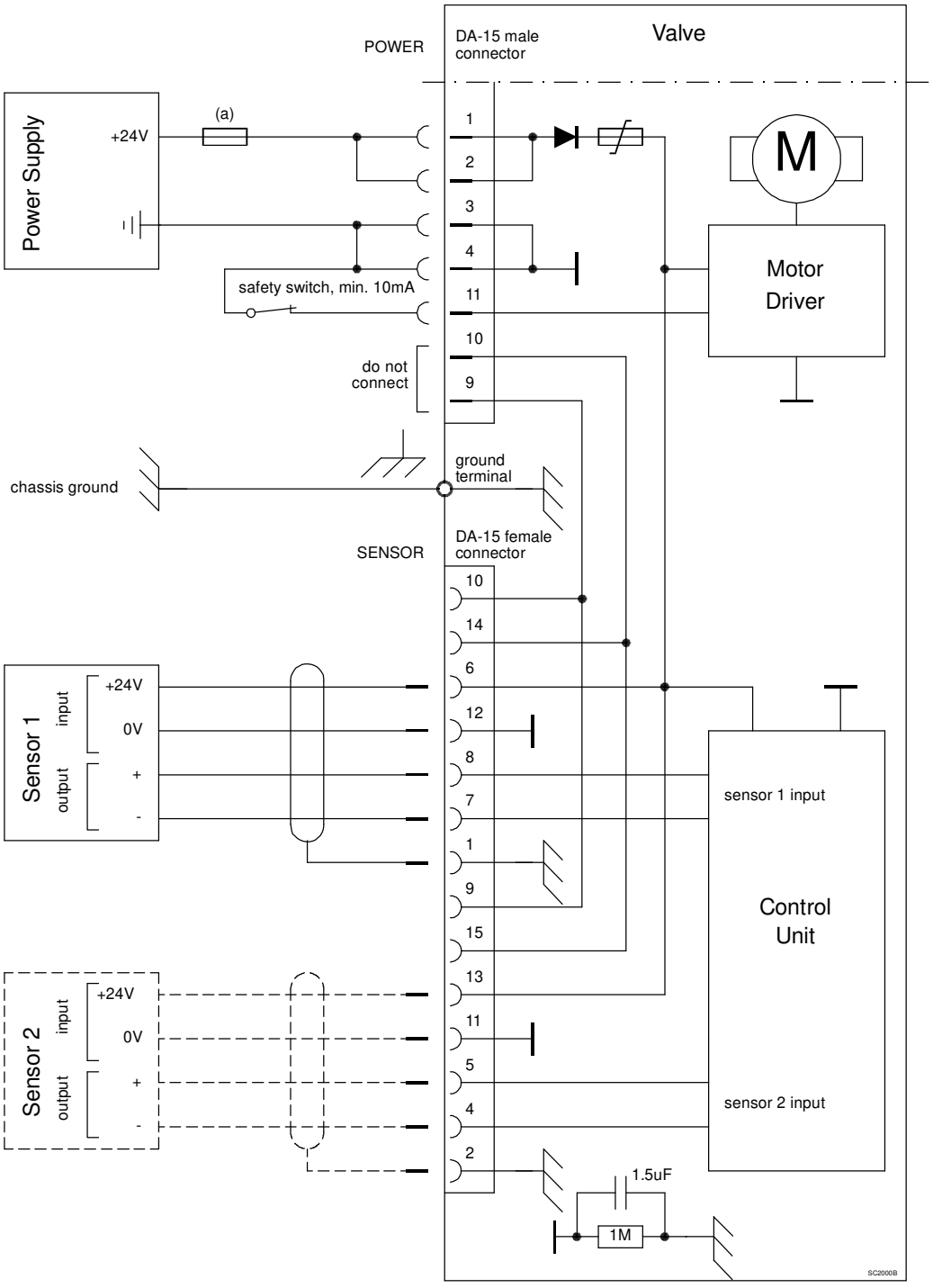
The SPS module can be retrofitted.

5.3.3 Power and sensor supply (+24 VDC via controller)

Valve Versions recommended: XXX . . - . . G . - . . . . and XXX . . - . . H . - . . . .

The power is supplied via the external supply of +24 VDC. The current is carried through the controller to the sensors. The sensors are not directly connected to the power supply.

Pins 4 and 11 must be bypassed on power connector.



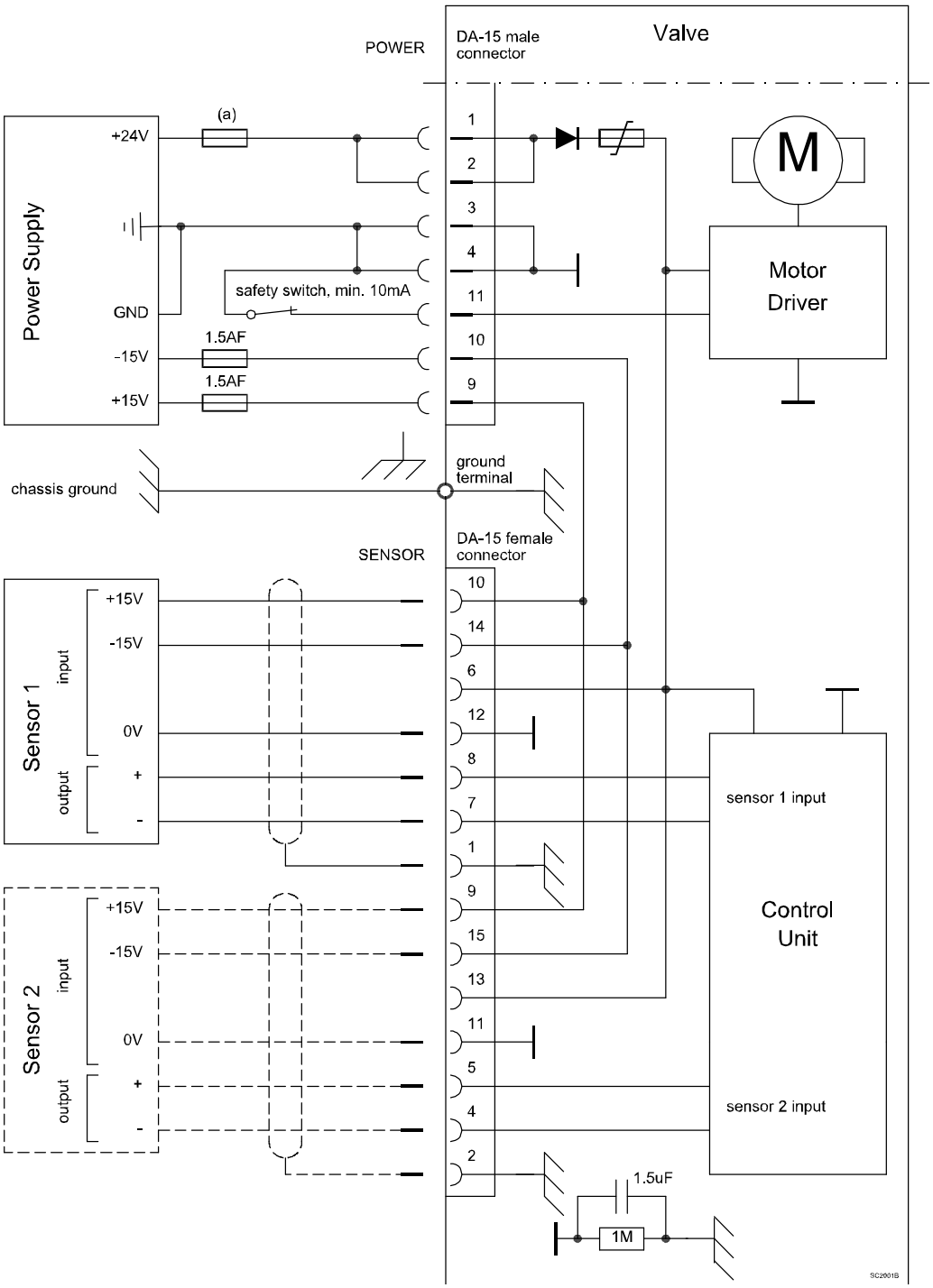
- (a) 7 AF fuse
- Only use shielded cables to connect the sensors.
- Use the shortest possible cables.
- Keep the cables away from sources of interference.
- Fasten the plug connectors with threaded screws 4-40 UNC.

5.3.4 Power and sensor supply (±15 VDC w/o SPS via controller)

Valve Versions recommended: XXX . . - . . G . - . . . . and XXX . . - . . H . - . . . .

The power is supplied via an external supply of +24 VDC. The sensors are connected via the controller to the power supply with ±15 V. There is no direct connection between the sensors and power supply.

Pins 4 and 11 must be bypassed on power connector.



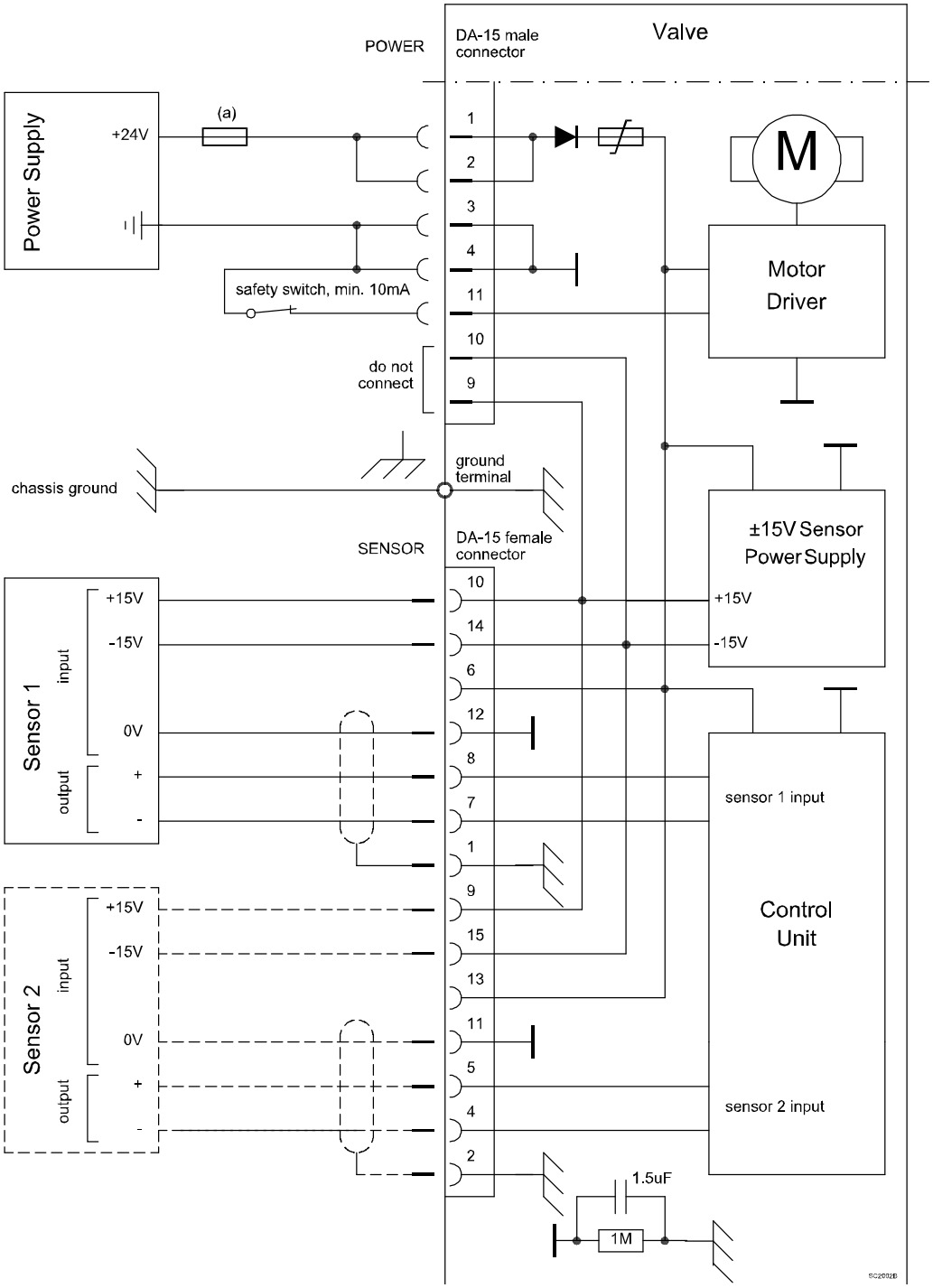
- (a) 5 AF fuse.
- Only use shielded cables to connect the sensors.
- Use the shortest possible cables.
- Keep the cables away from sources of interference.
- Fasten the plug connectors with threaded screws 4-40 UNC.
- Voltages of ±15 VDC and +24 VDC are applied to the sensor connector. The required voltage must be routed on to the sensor.

5.3.5 Power and sensor supply (±15 VDC with SPS)

Valve versions recommended: XXX . . - . . A . - . . . . and XXX . . - . . C . - . . . .

The power is supplied via an external supply of +24 VDC. The 15 V sensors are connected via an internal transformer to the 24 V power supply. There is no direct connection between the sensors and power supply.

Pins 4 and 11 must be bypassed on power connector.



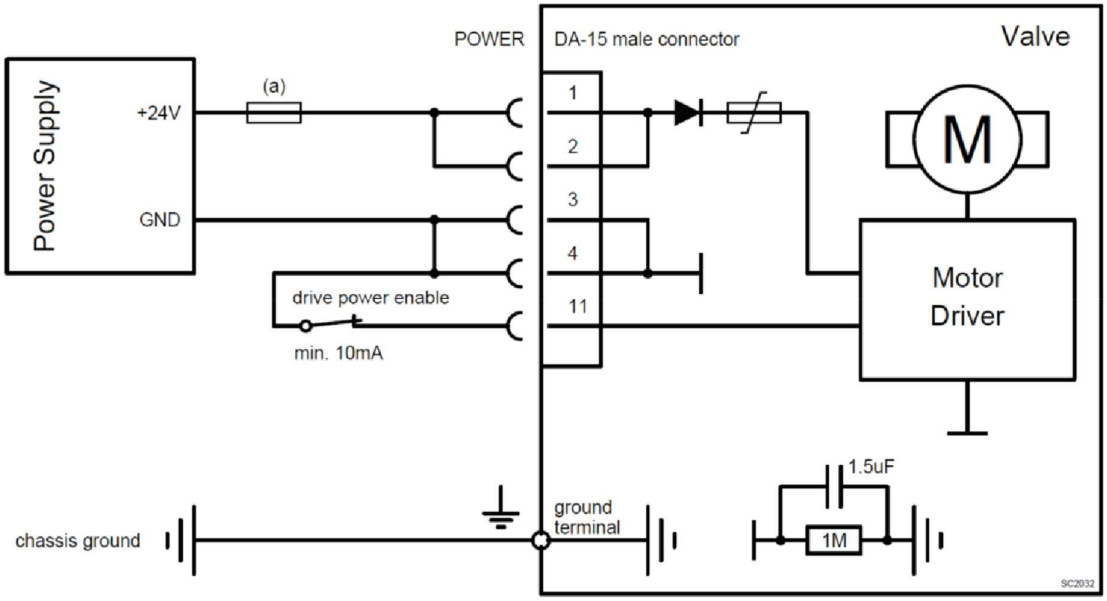
– (a) 7 AF fuse.
– Only use shielded cables to connect the sensors.
– Use the shortest possible cables.
– Keep the cables away from sources of interference.
– Fasten the plug connectors with threaded screws 4-40 UNC.
– Voltages of ±15 VDC and +24 VDC are applied to the sensor connector. The required voltage must be routed on to the sensor.

5.4 Drive power switch

The external Switch makes it possible to interrupt the motor voltage supply. In this case, the valve switches to ***Control Mode*** *Safety*. This actuator switch-off prevents all valve movement. Data can still be read out.

If ***Control Mode*** *Safety* is exited, the system goes into ***Control Mode*** *Init* and *Homing* must be carried out.

For a safety function without a risk to persons, it is advisable to use the Digital Input locking function, as no Homing is required after the locking is released.



5.5 System settings and states

5.5.1 Firmware information

The firmware version can be found in the CPA, see section Product identification. The firmware is shown on the display when the valve is switched on.

5.5.2 Product identification

Localized `CPA/Parameters: System.Identification`

Parameter	Description
Serial Number	VAT-specific article number

Configuration

Localized `CPA/Parameters: System.Identification.Configuration`

Parameter	Description
Valve Series	Consisting of a three-digit value e.g. 653 means series 65 design version 3
Valve Variant	Variants of valve series
Nominal Diameter	Valve opening diameter in millimeters e.g. DN250 means 250 mm
Drive Parameters ID	ID of the last actuator parameter file loaded on to the valve Defines the motor movement
Configuration Parameters ID	ID of the last configuration file loaded on to the valve Defines the settings of Interface, Pressure Control, Pressure Sensor,…

Firmware

Localized `CPA/Parameters: System.Identification.Firmware`

Parameter	Description
Valve Firmware ID	VAT-specific article numbers of the Firmware used
Valve Firmware Version	Faa.bb.cc.dd a = Platform, Controller Type b = Type **B**asis **C**ustomer **R**etrofit **T**est **P**roduction c = Version d = Revision
CPA Version	VAT PC software version
Motion Controller Firmware Version	The Motion Contoller Firmware is displayed for each axis. These should alway have the same Firmware Version.

Hardware

Localized `CPA/Parameters: System.Identification.Hardware`

Parameter	Description
Controller Type	Type designation of the controller used *IC2 H1…H7*
Interface Type	*RS232/RS485* *EtherCAT* *DeviceNet* *Logic* *Profibus* *CC-Link* *Ethernet*
Option Type	*None* *SPS* *PFO* *Cluster* *SPS & PFO* *SPS & Cluster* *PFO & Cluster* *SPS & PFO & Cluster* *PFO2* *SPS + PFO2* *PFO2 + Cluster* *SPS + PFO2 + Cluster* *PFO3* *SPS + PFO3* *PFO3 + Cluster* *SPS + PFO3 + Cluster* *Unknown*

5.5.3 Storing/restoring settings

Settings can be backed up.

Localized `CPA/Parameters: System.Services.Store/Restore Settings`

Parameter	Description
Store User Parameter	Stores all settings in a Backup Memory on the Controller.
Restore User Parameter	Restores the most recently stored settings.
Restore Factory Parameter	Restores the valve to the factory settings.

5.5.4 Locking the settings

Settings can be locked to prevent accidentally changing the Controllers settings.

Localized `CPA/Parameters: System.Services/Configuration Lock Mode`

Parameter	Description
Configuration Lock Mode	Locks all settings on the Controller by activating the function. *False* *True*

5.5.5 Statistics

Localized `CPA/Parameters: System.Statistics`

Parameter	Description
Start Up Counter	Indicates how often the valve has been restarted
Total Time Powered	Shows how long the valve is switched on in total
Time Since Power On	Shows how long the valve has been running since the last switch-on

5.6 Power on – homing

Whether the valve moves after being switched on depends on the Homing settings.

The valve's position must be initialized after switch-on. To this end, the valve searches for a mechanical stop or a limit switch during the reference run, normally in the closed direction. If the reference run is started in the tight state, then the valve becomes not tight.

The following settings determine the start time and the end position of the reference run.

Localized `CPA/Parameters: System.Control Mode.Homing`

Parameter	Description
Start Condition	The Homing start option defines when the valve carries out the Homing function
	Default If the valve is not in isolated state, then the Homing starts with Power On. If the valve is in isolated state, then the Homing starts with the first move command
	Open Command For an open command
	Move Command For every move command
	At Startup At restart.
	Homing Command ***Control Mode*** is set to *Homing*
	Move Command Without Close For every move command except the close command when the valve is isolated
End Control Mode	***Control Mode*** is set after successful Homing. This applies only if the ***Start Condition*** is either *Standard*, *Startup* or *Homing Command*
	Position Moves to the position defined in ***End Position***
	Close Closes the valve

Parameter	Description
	Open Opens the valve
	Pressure Control The valve controls to the pressure defined in ***Target Pressure***
End Position	Defines which ***Target Position*** is set after successful Homing if ***End Control Mode*** is set to *Position*

Sending a move command that does not match the start condition may result in an error response.

5.7 Power down

The valve remains in its position in the event of power failure.

Power Fail Option

The Power Fail Option is a board with capacitors that deliver enough energy to open or close the valve in the event of a power failure.

The following settings define how the valve responds if the power fails.

Localized `CPA/Parameters: Power fail option`

Parameter	Description
Enable	*True:* Activates the response in the event of a power failure *False:* No response in the event of a power failure
State	*Battery is Charging* *Ready to Use* *Active* *Failure*
Functionality	*Open* *Close*
Delay	In seconds. Triggering the selected Functionality is delayed. This is how a short power interruption can be bridged
Battery Voltage	Shows the charging status
Power Fail Cycles	Counts power failures

The PFO does not supply the sensor with voltage in the event of a power interruption!

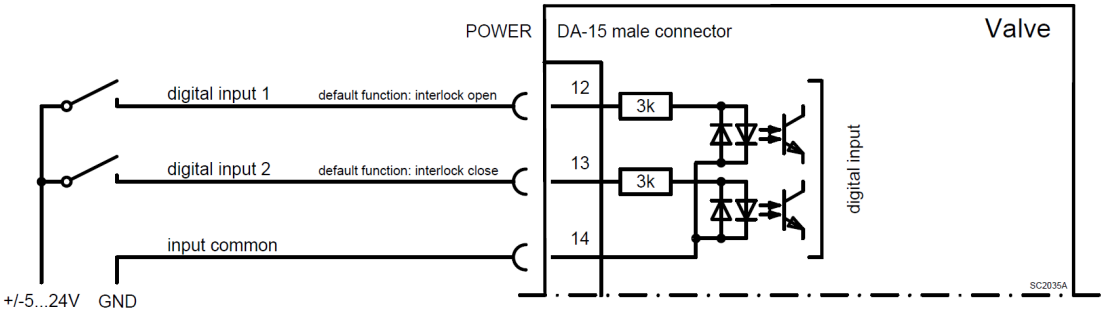
Technical data:

	PFO*	PFO2*	PFO3*
Charging time	Max. 2 minutes	Max. 4 minutes	Max. 8 minutes
Lifetime	Max. 10 years at 25° ambient temperature		

* See product information which PFO type is installed in your valve.

5.8 Digital I/O at power connection

Digital inputs



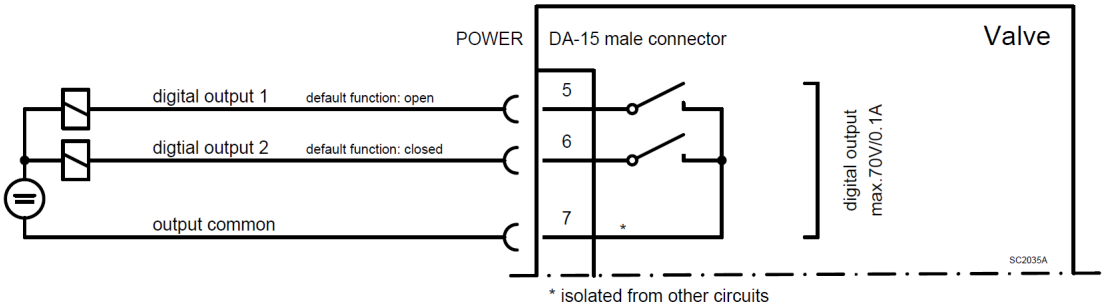
valve power supply can be used: pin 1,2 (24V) and 3,4 (GND)

Localized `CPA/Parameters: Power Connector IO`

Parameter	Description
Enable	*False*: Deactivates the Input *True*: Activates the Input
Functionality	*Interlock Open* *Interlock Close* *Hold*
Inverted	*False* *True*
State	*False*: Functionality not active *True*: Functionality active

- Interlock has higher priority than the Remote interface.
- *Interlock Close* has a higher priority than *Interlock Open*.
- *Hold* has no priority over the Remote interface, but can be adjusted.

Digital output



Localized `CPA/Parameters: Power Connector IO`

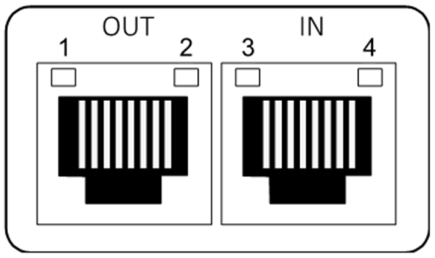
Parameter	Description
Enable	*False* *True*
Functionality	*Open* *Close:* Isolated when the valve is able to isolate *Hold:* ***Control Mode*** *Hold*
Inverted	*False* *True*
State	*False*: Output switch is open *True*: Output switch is closed

5.9 Interface EtherCAT®

5.9.1 Connection

The connection cable between master and slave must not exceed a length of 100 m.

There are two LAN interfaces on the valve. Both ports can be operated with a speed of 10/100 Mbit. The LED on the right-hand side of the RJ45 socket shows the status of the LAN connection, irrespective of whether the port is connected to a network. The LED flashes if there is data traffic on the port (link/activity).

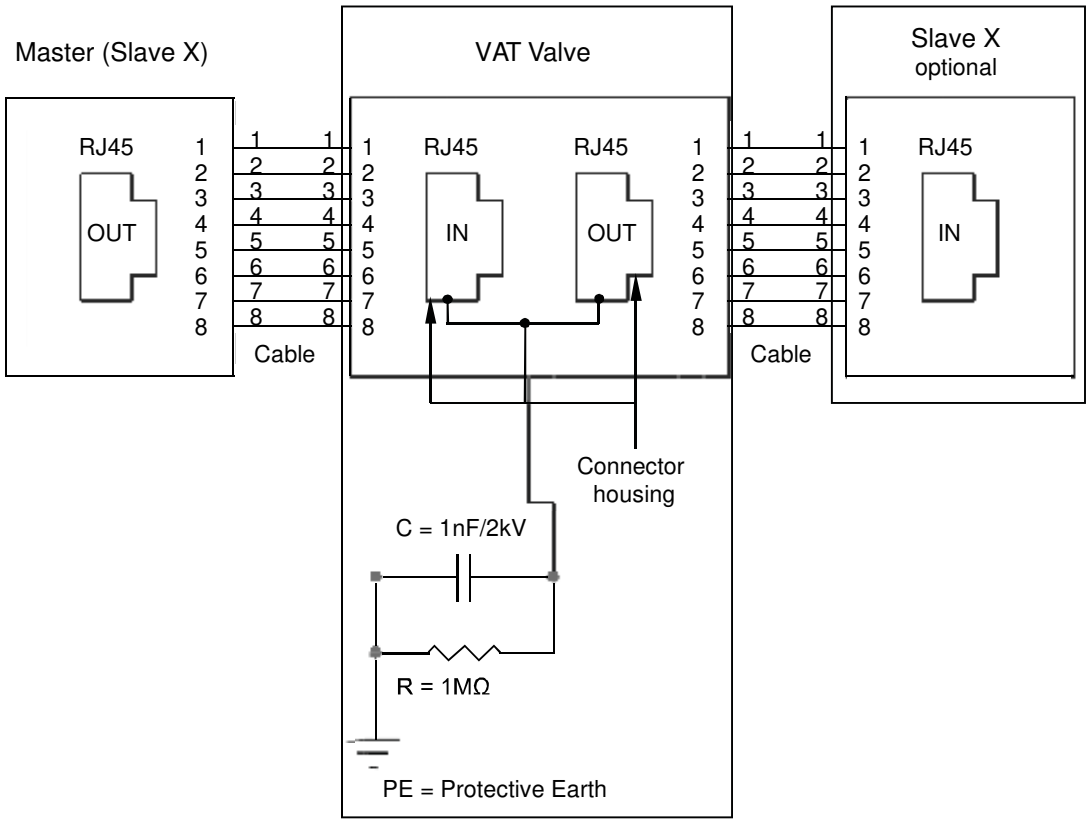


1 TD + Transmit Data+

2 TD – Transmit Data -

3 RD + Receive Data +

4 RD – Receive Data -



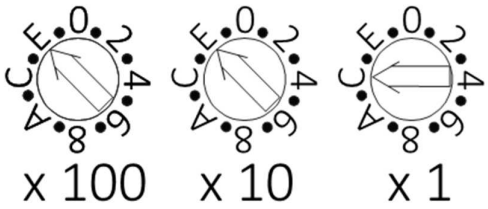
5.9.2 Device address

The device identification is set using the turn-switches on the device.

The device identification is read once after switch-on.

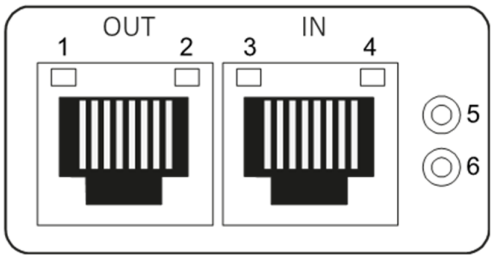
The identification number must be set as a hexadecimal value.

Example: EEC corresponds to decimal value 3820.



5.9.3 LED status display

The illumination and flashing frequencies are defined by CiA DR 303-3.



1 Link Port 1

2 Activity Port 1

3 Link Port 2

4 Activity Port 2

5 RUN

6 ERROR

LED 1 RUN

The LED shows the status of the CoE communication (CANopen over EtherCAT).

Status	Condition	Description
Off	INIT	After switching on, the EtherCAT-Slave is in Init status. Neither mailbox nor process data communication is possible there. The EtherCAT Master initializes the Sync-Manager channels 0 and 1 for mailbox communication.
Flashing green	PRE OPERATIONAL	At the transition between Init and Pre-Operational the EtherCAT Slave checks whether the mailbox is correctly initialized. In Pre-Operational status mailbox communication is possible but process data communication is not. The EtherCAT Master initializes the Sync Manager channels for process data (from Sync Manager channel 2), the FMMU channels and, if the slave supports configurable mapping, the PDO mapping or the Sync-Manager-PDO-Assignment. The settings for the process data transfer and, if relevant, terminal-specific parameters that may deviate from the default settings are also transferred in this status.

Status	Condition	Description
 Illuminated green	OPERATIONAL	Before the EtherCAT Master switches the Ether-CAT-Slave from Safe-Operational to Operational, it must transfer valid source data. In Operational status the slave copies the master's source data to its outputs: Process data and mailbox communication is possible
 Flashes once green	SAFE OPERATION-AL	At the transition from Pre-Operational to Safe-Operational the EtherCAT Slave checks the Sync Manager channels for process data communication and, if applicable, whether the settings for the Dis-tributed-Clocks are correct. Before the EtherCAT Slave exits the status change, it copies current input data to the corresponding DP-RAM areas of the EtherCAT Slave Controller (ECSC). Mailbox and process data communication is possi-ble in Safe-Operational status, although the slave keeps its outputs in safe status and does not output them. The input data are already cyclically updated.
 Illuminated red	EXCEPTION	State critical

LED 4 ERROR

The LED shows the status of the EtherCAT communication.

Status	Condition	Description
 Off	No error, or switched off	#
 Flashing red	Invalid configuration	Status change not possible
 Flashes once red	Unwanted status change	Slave has changed its EtherCAT status inde-pendently
 Flashes twice red	Watchdog timeout	Timeout synchronization manager
 Illuminated red	Controller not re-sponding	State critical

LED 2…3 link

The LED shows the status of the EtherCAT connection.

Status	Condition	Description
 Off	No connection, or switched off	#
 Illuminated green	Connection available, no activity	No data exchange
 Flickering green	Connection available, no activity identified	Data exchange

5.9.4 ESI-File

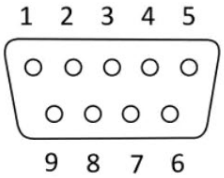
The EtherCAT Slave Information (ESI) file is XML based and contains the complete description of its network accessible properties, such as process data and their mapping options, the supported mailbox protocols including optional features, as well as the supported modes of synchronization. The Network Configuration Tool uses this information for online and offline configuration of the network.

► For the correct ESI file, please contact VAT: www.vatvalve.com/contact

5.10 Interface Profibus

5.10.1 Connection

The PROFIBUS- interface connector is DB9F (DB 9-pin socket), it is isolated from the rest of the controller. Incorrect pin assignment may result in the interface being damaged.



Pin assignment

Pin	Signal	Description
1	-	Not used
2	-	Not used
3	B Line	Positive RxD / TxD, RS485 level
4	RTS	Request to send
5	GND Bus	Bus grounding (insulating)
6	*5V bus output	+5V termination power (insulating)
7	-	Not used

Pin	Signal	Description
8	A Line	Negative RxD / TxD, RS485 level
9	-	Not used
Housing	Shield	Internally connected to the protective ground using the cable shield filter in accordance with the PROFIBUS standard.

Signal transmission

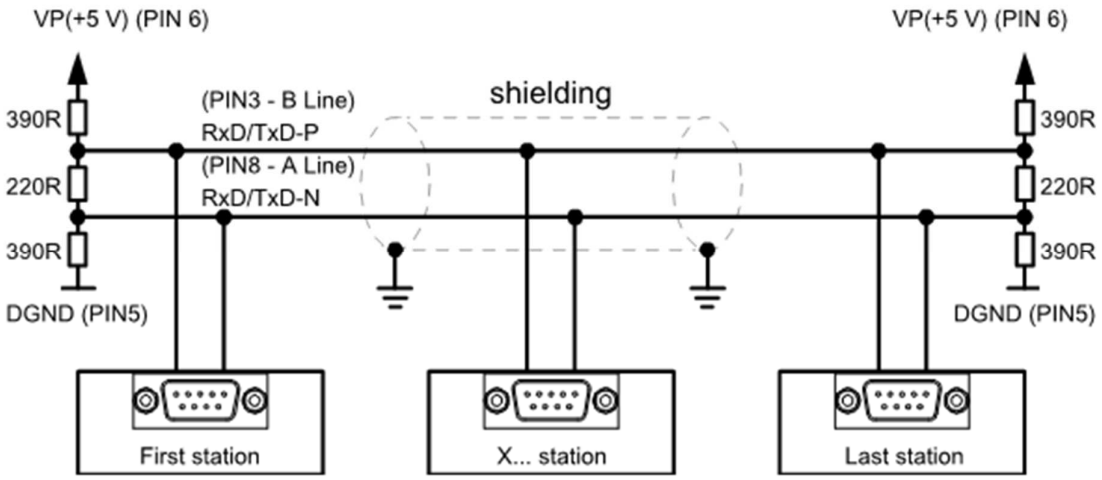
The following demands on the cable are required:

Impedance	135…165 [Ω]
Capacitance	< 30 [pF / m]
Resistance	< 110 [Ω / km]
Diameter	≥ 0.64 [mm]
Conductor cross-section	≥ 0.34 [mm^2]

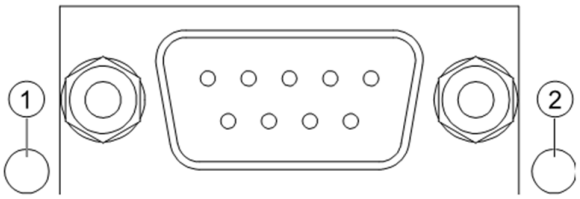
Depending on the baud rate, the connection cable is not permitted to be longer than the specified maximum length.

Baud rate [kbit / s]	9.6	19.2	45.45	93.75	187.5	500	1500	3000	6000	12000
Max. cable length [m]	1200				1000	400	200	100		

The ends of the Profibus cable must be closed at the connectors of the first and last participants using network resistors. Sometimes this network is integrated in the Profibus connector in an already switchable state. The switch must be set to On at the first and last station. At the stations in between it is set to Off.
The cable shielding must be connected to the protective ground.



5.10.2 LED status display



1 LED operation

2 LED status

COM LED (Communication)

LED operation	Description	Measures
Off	Not online / no voltage supply	Check Profibus connection Check voltage supply
Green	Online, data exchange	
Flashing green	Online clear	
Flashing red 1 x	Parameterization error Blink interval: 0.75s on, 0.25s off	Check configuration
Flashing red 2 x	Configuration error Blink interval: 0.25s on, 0.25s off	Reconfiguration/correct configuration
Red	Incorrect PROFIBUS DP configuration	

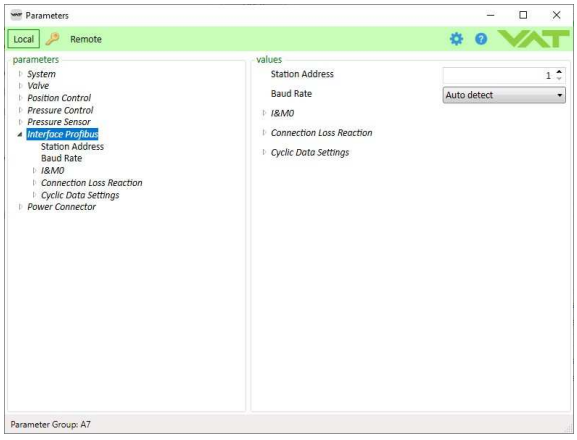
DIA LED (Diagnostic)

LED status	Description	Measures
 Off	No voltage supply / not initialized	Check voltage supply
 Green	Initialized	
 Flashing green	Initialized, diagnostic, event present	
 Red	Exception error	Controller Reset

5.10.3 Configuration

Localized `CPA/Parameters: Interface Profibus`

Parameter	Description
Station Adress	1-126 0: reserved for diagnosis equipment
Baud Rate	The DDBF sets the Profibus Baud Rate to Auto-Detection-Mode. The controller can also be adjusted manually to each of the offered baud rates. *9.6, 19.2, 31.25, 45.45, 93.75, 187.5, 500 [kBit/s]* *1.5, 3, 6, 12 [Mbit/s]*



Baud Rates	Unit	Maximum cable length [m]
9.6	kBit/s	1200
19.2		

Baud Rates	Unit	Maximum cable length [m]
31.25		
45.45		
93.75		
187.5		1000
500		400
1.5	Mbit/s	200
3		100
6		
12		

5.10.4 DDBF file

The device data base file (DDBF) provides an unequivocal and complete description of the characteristics of a device type in a precisely defined format. The defined data format means that it is easy for the configuration system to read in the device data of any Profibus device and automatically take it into account when configuring the bus system. The person implementing the configuration is spared the irritating search through device manuals. Even during the configuration phase the configuring system can automatically run checks for input errors and check the consistency of the entered data in relation to the overall system.

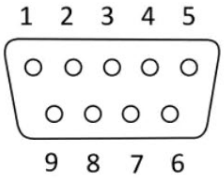
DDBF files can be downloaded at www.vatvalve.com/downloads.

Select the "Software & Updates" tab and enter "GSD" (DDBF) in the search field. All available DDBF files will be listed. If the relevant DDBF file is not available, please contact VAT. www.vatvalve.com/contact

5.11 Interface CC link

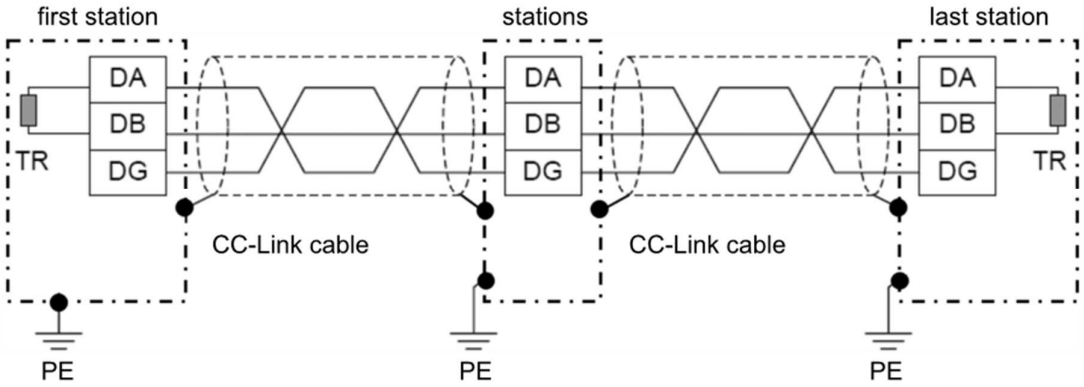
5.11.1 Connection

The CC-Link interface connector is DB9F (DB-9 pin socket), it is galvanically isolated from the rest of the controller.



Pin	Signal	Description
1	-	
2	-	
3	DA	Positive Ground RS485 RxD/TxD
4	DG	Signal Ground
5	-	

Pin	Signal	Description
6	-	
7	-	
8	DB	Negative RS485 RxD/TxD
9	-	
Housing	Cable Shield	Internally connected to the protective earth via cable shield filters.



PE Protective Earth

– · – Connector housing

TR Terminal resistor (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 DA and DB. The station type for VAT valves are: Version 2 Remote Device Station.

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

5.11.2 LED status display

LED L-RUN status display

Status	Meaning
Off	Power Off Connection with network not yet established No carrier can be recognized Timeout occurred Hardware reset happened
Green	Participating, normal operation After establishing the connection with the CC-Link network, the device is receiving the cyclic data
Red	Major fault (FATAL error)

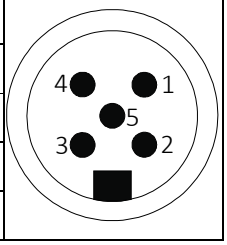
LED L ERROR status display

Status	Meaning
Off	Power Off Normal communication Hardware is resetting
Red	CRC error Address parameter error (Address 0, or greater than 64 is set, including number of occupied stations) Error in settings of baud rate switches while pulling the reset (5 or greater)
Red flashing	Switch position has been changed while pulling the reset (it blinks for 0.4 seconds)

5.12 Interface DeviceNet®

5.12.1 Connection

The DeviceNet connector is a 5-pin connector. The pins are assigned as follows:

Pin	Name	Color	Description	Male
1	Drain	Blank	Shield	
2	V+	Red	Voltage supply +	
3	V-	Black	Voltage supply -	
4	CAN_H	White	Signal	
5	CAN_L	Blue	Signal	

5.12.2 Configuration

Node address

There are 64 valid node addresses:

– 0…63

There are several invalid node addresses:

– Values > 63

If a valid node address is set, this number is used as the MAC-ID of the device on system start and is saved in the device memory. This node address can no longer be selected by the DeviceNet service. If an invalid node address is set, this node address is read by the device memory and can then be changed via DeviceNet Object Class 3, Instance 1, Attribute 1.

The node address is the device address and can be selected using two turn-switches. The turn-switches are located on the controller.

Proceed as follows to set the device address to 13, for example.

1. Turn the MSD (most significant digit) turn-switch to 1.
2. Turn the LSD (least significant digit) turn-switch to 3.

⇨ The device address is set to 13.

Baud rate

The baud rate is selected using the turn-switch. The turn-switch is located on the controller.

There are 3 valid baud rates:

– 125 kbaud

– 250 kbaud

– 500 kbaud

If one of the 3 baud rates is set using the turn-switch, this is set on system start and is saved in the device memory.
If the turn-switch is set to “P” the baud rate is read from the device memory and set on system start. The baud rate can then be changed via DeviceNet Object Class 3, Instance 1, Attribute 2.

5.12.3 Electronic Data Sheet (EDS)

DeviceNet offers more parameters than are needed to operate the valve. All parameters can be set via the electronic data sheet (EDS) or the Explicit Messaging Connections. The parameters needed for valve operation are described in this document.

► For the correct EDS file, please contact VAT: www.vatvalve.com/contact

5.12.4 LED status display

Module Status

Indicates the status of the communication module.

Status	Meaning	Description
 Off	Not Powered	There is no power applied to the device.
 Green	Module OK	Operating in normal condition.
 Green flashing	–	The configuration is missing, incomplete or incorrect. The device may be in standby mode.
 Red flashing	Recoverable Fault	–
 Red	Unrecoverable Fault	May need replacing.

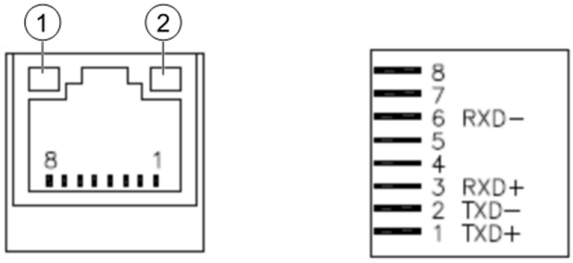
Network Status

Indicates the status of the communication link.

Status	Meaning	Description
 Off	Not Powered No network detected	Several attempts were made to publish a message (usually a duplicate MACID check message), but no acknowledgement for this message was received. This is the normal operating mode when the network connection is not in use.
 Green flashing	Network OK Device online Not connected	The device has passed the duplicate MACID test, is online, but has no established connections. Device is in standby mode and is ready for the master node to establish a connection.
 Green	Network OK Device online Connected	Successful connection establishment by the master.
 Red flashing	Connection Time-Out	One or more I/O connections are in the Timed-Out state. The expected request from the master has failed to arrive. The master must now either reset the connection or reopen it.
 Red	Critical Link Failure	Duplicate MACID, bus off, incompatible baud rate setting, short in the communication line.

5.13 Interface Ethernet

5.13.1 Connection, LEDs



1 Network link (Yellow LED) 2 Network activity (Green LED)

Network link	When it is lit, it indicates that there is an active connection on the Ethernet port.
Network activity	When it flashes, it indicates that data is being transmitted or received between the server and a network device.

5.13.2 TCP/IP

Localized `CPA/Parameters: Interface Ethernet TCP/IP`

Parameter	Default Value	Description
IP-Address	192.168.1.10	Address of the valve in the network. Used if DHCP is off.
IP-Address active		Visible if different to IP-Address. IP-Address will become active after next restart.
Network Mask	255.255.255.0	In IPv4 networks, it specifies how many bits make up the network prefix for an IP-Address. Together with the IP-Address, it defines the address of a device in the network. The network prefix part shows which devices are in a network.
Network Mask active		Visible if different to Network Mask. Network Mask will become active after next restart.
Gateway Address	0.0.0.0	Address of the gateway. A gateway serves as a link between two systems or networks that use different protocols and communication services.
DHCP	OFF	When ON, the IP-Addresses are automatically being assigned by a DHCP server
MAC-Address		Unique identification 6 byte address of the device in format: XX:XX:XX:XX:XX:XX

5.13.3 Control port

Standard port to control the valve and request values.

Localized `CPA/Parameters: Interface Ethernet TCP/IP.Control Port`

Parameter	Default Value	Description
Number	503	Changeable Port enumeration that takes effect after a restart. The range is from 501 until 2501.

5.13.4 Stream port

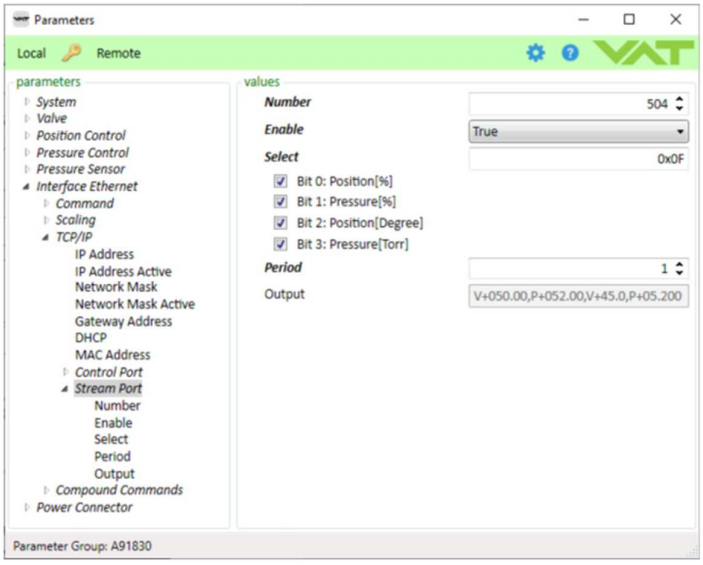
It is possible to stream ***Actual Pressure*** and/or ***Actual Position*** with a specific period (settable frequency).

Localized `CPA/Parameters: Interface Ethernet TCP/IP.Stream Port`

Parameter	Default Value	Description
Number	504	Changeable Port enumeration that takes effect after a restart. The range is from 501 until 2501.
Enable		Streaming activation
Select		*Bit 0*: *Position %* *Bit 1*: *Pressure %* *Bit 2*: *Position Degree* *Bit 3*: *Pressure Torr*
Period		In milliseconds
Output		Depending on Select resulting output string

Since this function was introduced for the Tylan instruction set, the format of the values corresponds to the format of the Tylan instruction set.

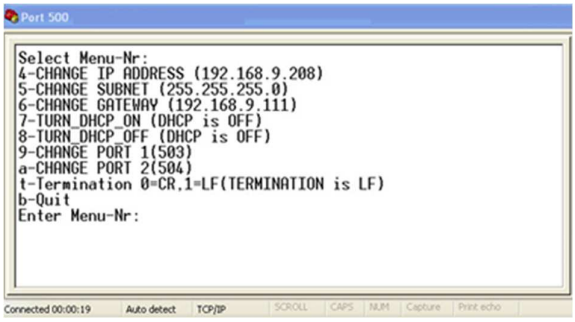
Example:



5.13.5 Configuration port 500

Enables configuration via Ethernet.

The following menu is displayed when a connection is established:



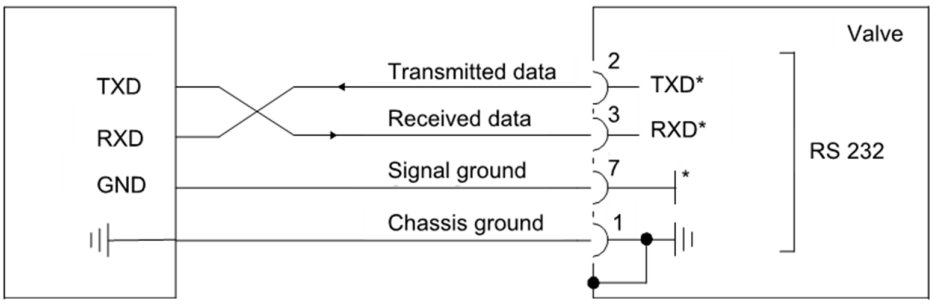
5.14 Interface RS232 and RS485

5.14.1 Operation mode

Both interfaces RS232 / RS485 are used with the same hardware. RS232 relates to point-to-point communication. RS485 enables individual devices in a network to be addressed.

Parameter	Description
RS232	Two-wire point-to-point communication via RS232 Use pin RXD and TXD
RS485	Four-wire multiple-device communication via RS485 Use pin A, B, X, Y
Service Interface over RS232	Communication via CPA via RS232

5.14.2 RS232



Settings

The valve port settings must be identical to the system settings of the host control.

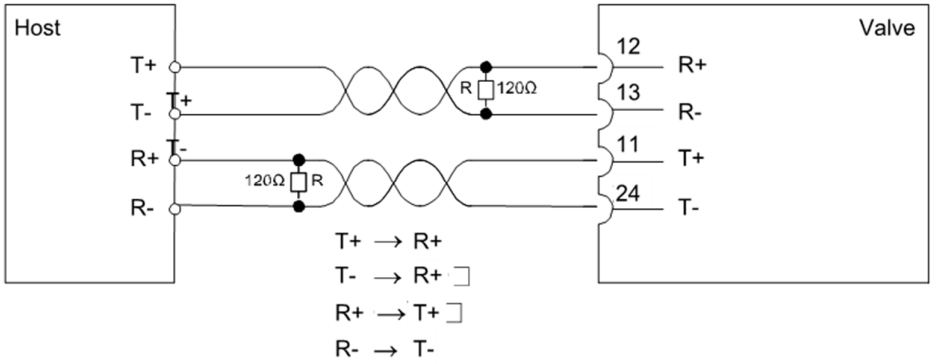
Localized `CPA/Parameters: Interface RS232-RS485.Settings`

Parameter	Description
Baud Rate	*300, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200*
Data Bit Length	*7, 8*

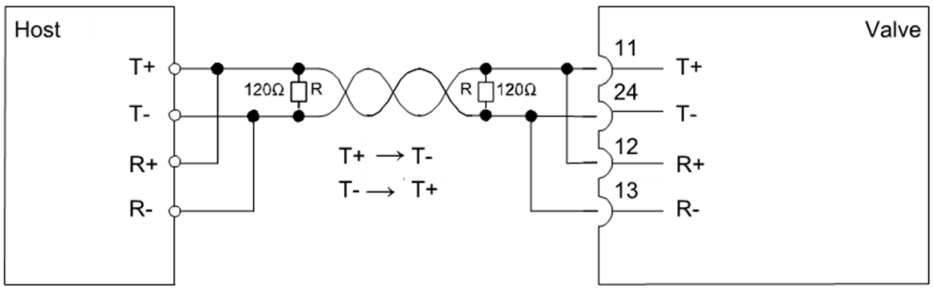
Parameter	Description
Stop bit	*1, 2*
Parity Bit	*None, Even, Odd*
Command Termination	*Carriage Return + Line Feed, Line Feed, Carriage Return*

5.14.3 RS485

Full duplex



Half duplex



Settings

The valve port settings must be identical to the host control system settings.

Localized `CPA/Parameters: Interface RS232-RS485.Settings`

Parameter	Description
Baud Rate	*300, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200*
Data Bit Length	*7, 8*
Stop bit	*1, 2*
Parity Bit	*None, Even, Odd*
Command Termination	*Carriage Return + Line Feed, Line Feed, Carriage Return*

Parameter	Description
Topology	*Full Duplex, Half Duplex*
Network	*Multiple Devices*: Commands with address *Point to Point*: Commands with address
Address	*0...255*

Addressing

For *Multiple Devices* the ***Address*** #aaa precedes each command, also the response has the address prefix. The length of the address is always 3 characters. The format is decimal.

Syntax

#[aaa][command]

Example: Set ***Control Mode*** to *Open* on device with ***Address*** 47:

send	response
#047p:010F0200000004	#047p:00010F0200000004

5.15 Interface Logic

5.15.1 General settings

Localized `CPA/Parameters.Interface Logic.Settings`

Parameter	Description
Learn Limit	If TRUE the analog input voltage is used as ***Pressure Limit [SFS]*** at the start of learning.
Pressure Range [SFS]	The factor with which the pressure values on Analog Input and Analog Output are assigned. Activated by Digital Input *Pressure Low Range* Increasing the resolution of lower values. Example: ***Pressure Range [SFS]*** = 0.1, SFS = 1000 Torr *Pressure Low Range*: Off → 10V = 1000Torr *Pressure Low Range*: On → 10V = 100Torr
IC1 Compatible Mode	If TRUE behavior of the Digital Output *Ready* and *Busy* is identical to that of the IC1 controller

5.15.2 Digital inputs

There are 8 digital inputs, each of them can be configured individually.

The inputs are debounced with 50 msec.

Localized `CPA/Parameters.Interface Logic.Digital Input`

Parameter	Description	Prio	Description
Enable	*False, True*		
State	*False, True*		
Functionality	*Open*	2	
	Close	1	
	Pressure Control	7	0: ***Control Mode*** *Position* 1: ***Control Mode*** *Pressure Control*
	Pressure Low Range		***Pressure Range [SFS]*** factor is assigned to pressure values
	Zero		0 → 1 Initiates a zero adjust
	Learn	3	0 → 1 Initiates ***Control Mode*** *Learn* 1 → 0 Stops learn if active
	Remote Locked		0 → 1 Change ***Access Mode*** to *Remote Locked* 1 → 0 Change ***Access Mode*** to *Remote*
	Hold	4	Stops valve movement in ***Control Mode*** *Pressure Control* and ***Control Mode*** *Position*
	Controller Selector		0: *Controller 1*, 1: *Controller 2*
	Homing	6	0 → 1 Initiates the homing routine
Inverted	*False, True*		

0 → 1 ,1 → 0 = edge triggered

No.	Pin	Default functionality
1	7	*Pressure Control*
2	5	*Pressure Low Range*
3	3	*Zero*
4	15	*Close*
5	17	*Open*
6	19	*Learn*
7	18	*Remote Locked*
8	16	*Hold*
	6	Digital ground for configuration with switches: see schematics
	4	Common pin for configuration with voltage source ±5 ... 24V: see schematics

5.15.3 Digital outputs

There are 4 digital outputs, each of them can be configured individually.

Localized `CPA/Parameters.Interface Logic.Digital Output`

Parameter	Description	
Enable	*False, True*	
State	*False, True*	
Functionality	*Open*	Valve is fully opened
	Close	Valve is fully closed (isolated if the valve can do this)
	Busy	***Control Mode***: *Init, Homing, Learn, Power Failure, Error* ***Control Mode*** = *Position* AND ***Actual Position*** out of range (±0.1% of ***Target Position***) ***Control Mode*** = *Pressure Control* AND ***Actual Pressure*** out of range (±2% of ***Target Pressure***) → same Ranges if ***Control Mode*** = *Hold*
	Ready	Valve is ready for remote operation *Ready* = 0 when ***Access Mode*** = *Local* ***Control Mode*** = *Init, Homing, Interlock Open, Interlock Close, Power Failure, Safety*
Inverted	*False, True*	

IC1 compatibility behavior

Localized `CPA/Parameters.Interface Logic.Digital Output`

Parameter	Description	
IC1 Compatible Mode		If TRUE behavior of the digital output *Ready* and *Busy* is identical to that of the IC1 controller
Functionality	*Busy*	True when ***Control Mode*** = *Homing, Learn, Power Failure, Error* ***Control Mode*** = Pressure Control AND ***Actual Pressure*** out of range (±2% of ***Target Pressure***) ***Control Mode*** = *Position, Open, Interlock Open* AND ***Actual Position*** out of range (±0.1% of ***Target Position***) → same Ranges if ***Control Mode*** = *Hold* If valve has an isolation functionality: ***Control Mode*** = *Init, Close, Interlock Close* AND valve is still not isolated
Functionality	*Ready*	Valve is ready for remote operation *Ready* = 0 when ***Access Mode*** = *Local* ***Control Mode*** = *Interlock Open, Interlock Close, Power Failure, Safety, Error* If valve has an isolation functionality: ***Control Mode*** = *Init, Homing* AND valve is not isolated

No.	Pin	Default functionality
1	8	*Open*
2	9	*Close*
3	21	*Ready*
4	22	*Busy*
	20	Common pin

5.15.4 Analog input

There is 1 analog input that works as a setpoint value.

Technical data	
Range	0.0 – 10.0V
Ri	100kOhm

Localized `CPA/Parameters.Interface Logic.Analog Input`

Parameter		Description
Enable		
Value		Indicates the measured voltage
User Factor		Scaling of the input value
User Offset		Scaling Formula: Used Value = (Value + User Offset) * User Factor Example: Desired input range = 1 … 9 V User Offset = -1.0 V User Factor = 10 / (9-1) = 1.25
Filter	Enable Time	*Low-pass Filter* Default Time = 0.1 sec
Deadband	Enable Number Of ADC Digits	Reducing of value fluctuations
Functionality		Indicates the current functionality which is depending on the Digital Inputs: *Position* *Pressure* *Learn*

Pin	Description
25	***Target Pressure*** or ***Target Position*** depending on digital input *Pressure Control*
13	Analog Ground

5.15.5 Analog output

There are 2 analog outputs, each of them can be configured individually.

Technical data	
Range	0.0 – 10.0V
Max Current	1 mA

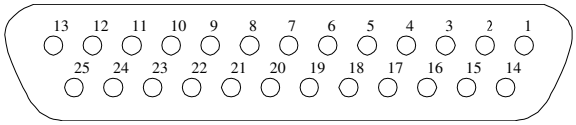
Localized `CPA/Parameters.Interface Logic.Analog Output`

Parameter	Description
Enable	
Value	Indicates the applied output voltage
User Factor	Scaling of the output value
User Offset	Scaling Formula: Output = Prs/Pos[V] * User Factor + User Offset Example: Desired Output = 1-9V User Offset = 1.0V User Factor = (9-1) / 10 = 0.8
Functionality	*Position* *Pressure*

No.	Pin	Default function
1	11	*Position*
2	12	*Pressure*
	13	Analog Ground

5.15.6 Connection table and scheme

The inputs are debounced with 50 msec.

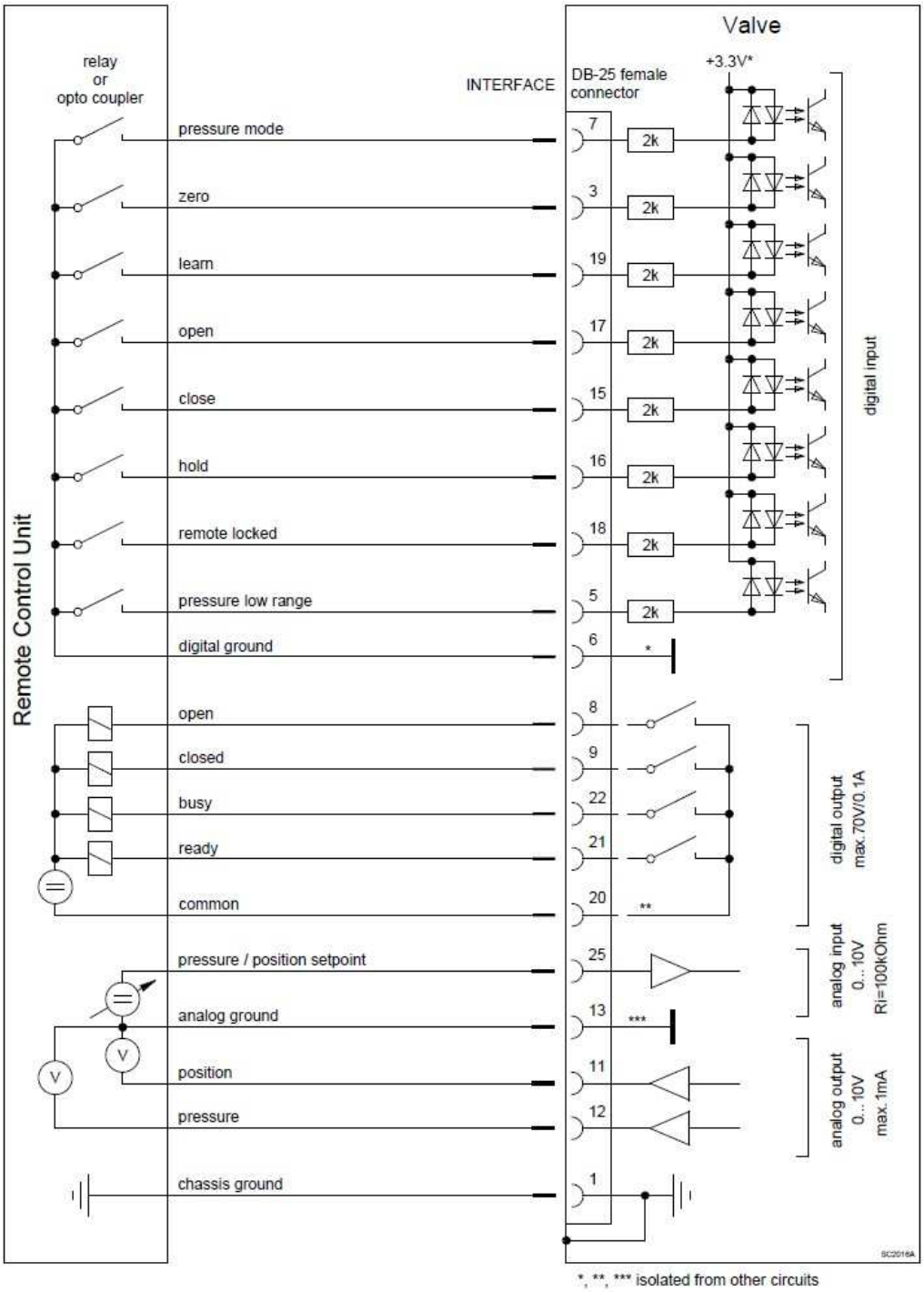


The Logic connector is a 25-pin socket connector. The standard pin assignment is as follows:

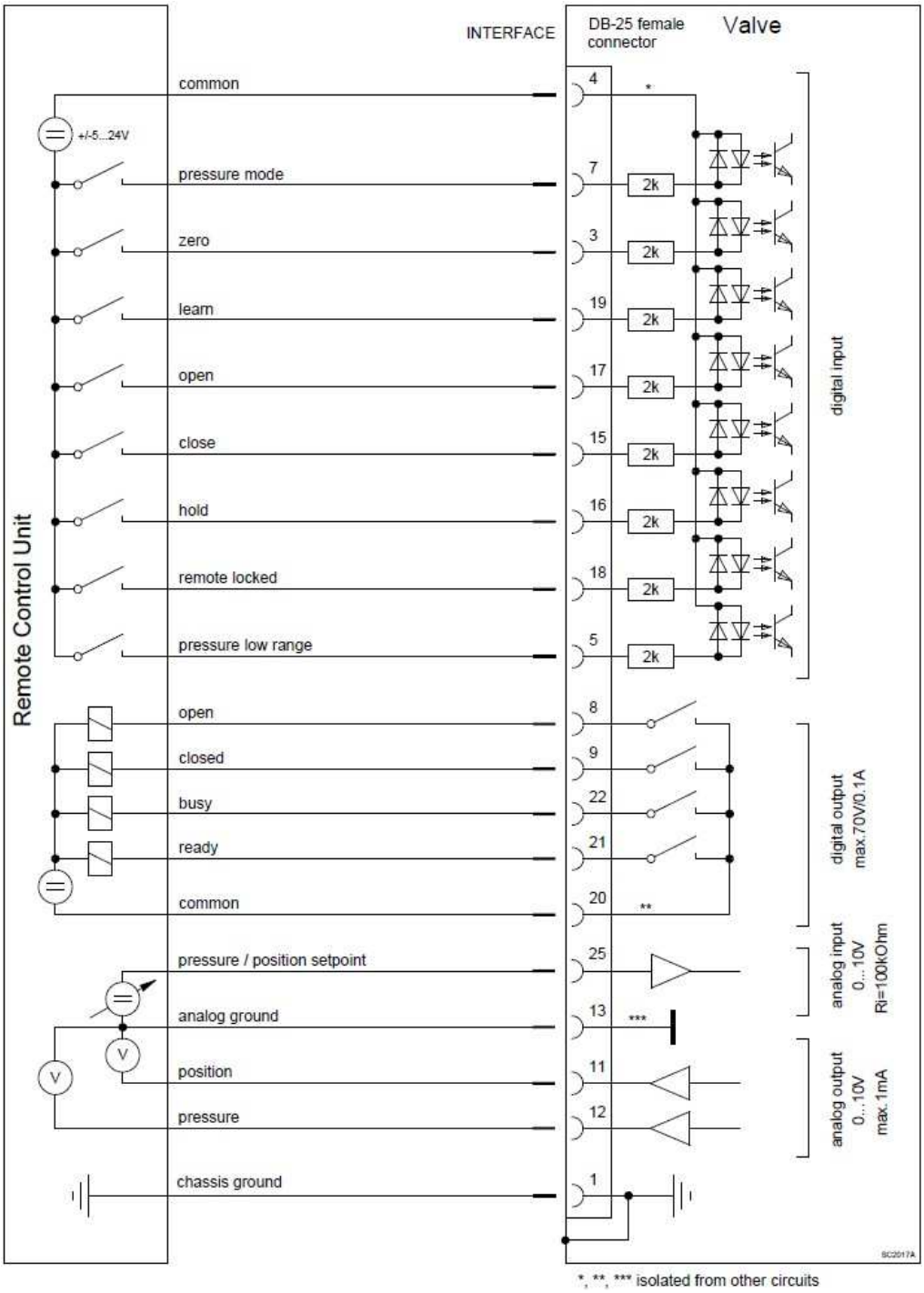
Pin	Function	Description
1	Chassis GND	Connection to body
2	Reserved	***Digital Input***
3	*Zero*	***Digital Input 3***

Pin	Function	Description
5	*Pressure Range SFS*	***Digital Input 2***
6	GND	GND Input
7	*Pressure Control*	***Digital Output 1***
8	*Open*	***Digital Output 1***
9	*Close*	***Digital Output 2***
10	Reserved	***Digital Input 10***
11		***Analog Output 1***
12	*Pressure*	***Analog Output 2***
13	GND	Analog
14	Reserved	***Digital Input 12***
15	*Close*	***Digital Input 4***
16	*Hold*	***Digital Input 8***
17	*Open*	***Digital Input 5***
18	*Remote Locked*	***Digital Input 7***
19	*Learn*	***Digital Input 6***
20	Output Common	Output Common
21	*Ready*	***Digital Output 3***
22	*Busy*	***Digital Output 4***
23	Reserved	***Digital Input 9***
25	*Pressure*	***Analog Input 1***

Switch-controlled



Voltage-controlled



6 Operation

6.1 Access Mode

Defines whether the interface or the CPA via the service port has the rights to control the valve.

Localized `CPA/Parameters.System`

Parameter	Description
Access Mode	*Local*: Control permission via CPA
	Remote: Control permission via host computer CPA can switch to Local
	Locked: Control permission via host computer CPA can't switch to Local

Power On state is 'Remote'.

6.1.1 Remote and locked operation

This product is equipped with an interface to allow for remote operation, see Programmers Reference.

CPA software may be used for monitoring during remote control.

In case CPA is used, make sure the 'remote' button is pushed to enable for remote operation.

6.1.2 Local operation

⚠ CAUTION

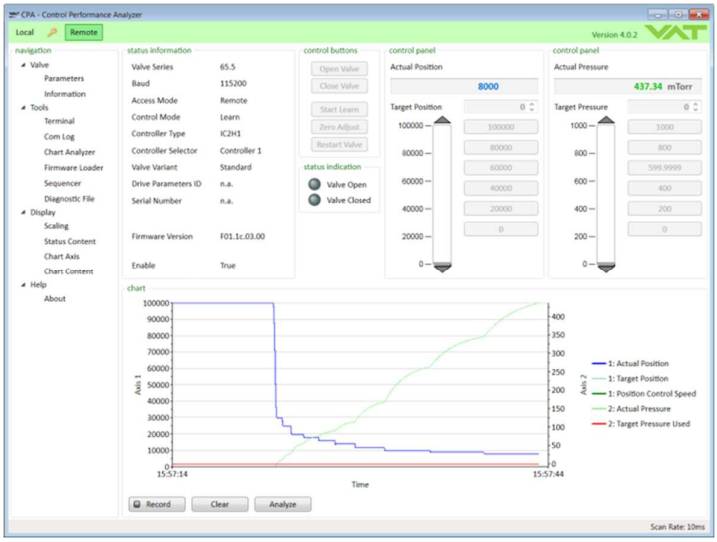
Danger of crushing due of unintended movement!

If communication with the service port is interrupted, the valve automatically switches to remote operation. Depending on the remote control, this can trigger immediate movement of the valve, which can cause crushing hand and fingers.

► Do not reach into the valve opening.

Local operation means that the valve is operated via the service port using a computer.

You can use our software 'Control Performance Analyzer' (CPA) for local operation, which is integrated in the controller. The software is beneficial especially for setup, testing and maintenance.

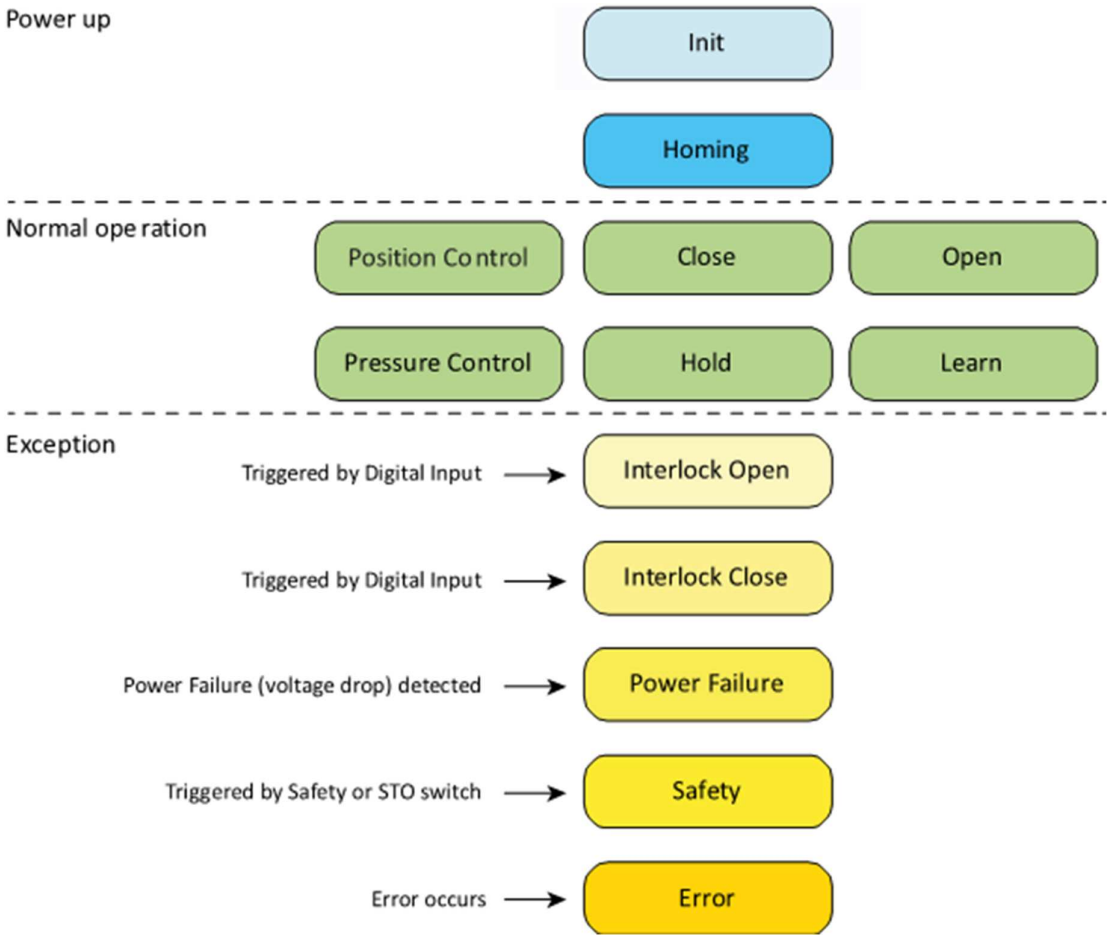


6.2 Control Mode

The ***Control Mode*** represents the valve's State Machine. Setting the ***Control Mode*** demands a change in the state, while reading the ***Control Mode*** returns the current state of the State Machine.

The valve is controlled with the ***Control Modes*** in 'Normal operation', the most important of which are:

- *Close*: The valve is fully closed (isolated if the valve can do this)
- *Position Control*: Valve moves to the desired ***Target Position***
- *Pressure Control*: The valve tries to reach the desired ***Target Pressure*** via the valve position

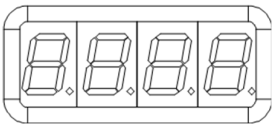


No.	Control Mode	Description
0	*Init*	Status after switch-on. Remains in the status if the Homing is not started or no Exception occurs.
1	*Homing*	The valve performs homing to initialize the position. The start behavior depends on the ***Homing.Start Condition***. The valve state after homing depends on the ***Homing.End Control Mode***.
2	*Position Control*	The valve moves to the defined ***Target Position***.
3	*Close*	The valve closes.
4	*Open*	The valve opens.
5	*Pressure Control*	The valve controls to the defined ***Target Pressure***.
6	*Hold*	The valve stops in the current position. Use during pressure control: – Avoids the valve response during a plasma ignition. – Halt the valve movement to assess the stability of the sensor, flow meter, ... It is not possible to change from ***Control Mode*** *Close* to *Hold*.

No.	Control Mode	Description
7	*Learn*	The valve runs through a movement sequence to learn the vacuum system. Necessary for ***Control Algorithm*** *Adaptive*.
8	*Interlock Open*	The valve opens and interlocks by sending a control signal to a Digital Input. Release response: ***Control Mode*** changes to *Open* or to *Init*, if Homing has not yet been carried out.
9	*Interlock Close*	The valve closes and interlocks by sending a control signal to a Digital Input. Release response: ***Control Mode*** changes to *Close* or to *Init*, if Homing has not yet been carried out.
12	*Power Failure*	A power failure has occurred. The valve opens or closes, only for optional Power Fail Option. Closing or opening depends on ***Power Failure.Functionality***.
13	*Safety*	The valve motor is currentless because of a digital input on the power connector. Release response: ***Control Mode*** changes to *Init*
14	*Error*	The valve has error status, no movement possible. Corrective action of error status via ***Services.Error Recovery*** or ***Services.Restart Controller***.

Localized `CPA/Parameters: System/Control Mode`

The first digit on the controller display provides information on the ***Control Mode***.



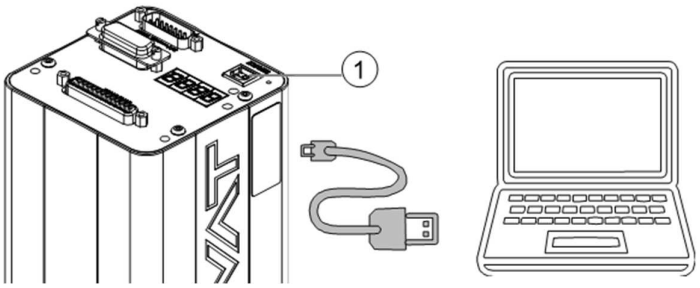
I	*Init*
H	*Homing*
C	*Close*
O	*Open*
P	*Pressure Control*
A	*Position Control*
I	*Interlock Open / Close*
H	*Hold*
L	*Learn*
S	*Safety*
F	*Power Failure*
E	*Error*

6.3 Service port/CPA software

6.3.1 Commissioning

The Control Performance Analyzer (CPA) is used to analyze, configure and monitor the valve.

1. Connect the valve to the overriding control using a USB-B – USB-A cable.



1 Service connection

⇨ The drive VAT-CPA appears.

2. Open the drive and double-click on the .exe file.

⇨ The CPA software is displayed.

3. Click on Local.

⇨ The control is connected.

6.3.2 Operation using CPA

⚠ CAUTION

Danger of contusion caused by moving valve gate!

Crushing of the hand and fingers.

► Do not reach into the valve opening.

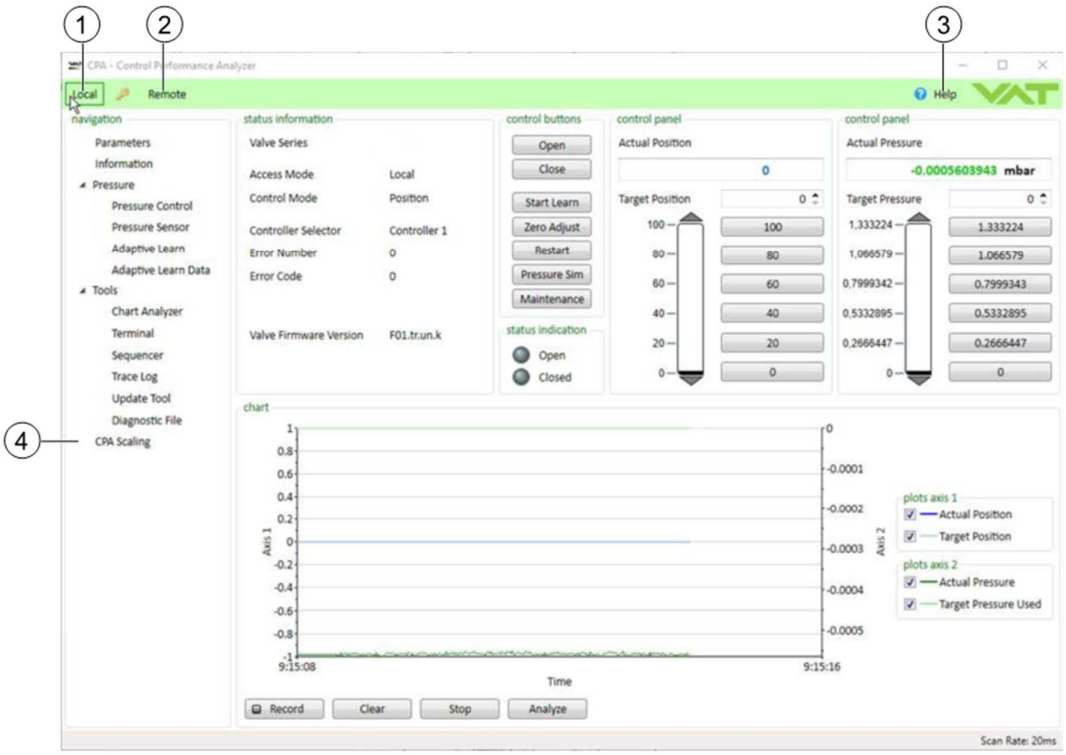
To operate the valve with CPA, you must set the ***Access Mode*** to *Local*.

– *Local:* The valve is operated using the CPA software.

– *Remote:* The valve is operated via the interface; the CPA software can be used as a monitoring tool.

– *Remote Locked:* Access to the valve via CPA is blocked by the host computer. CPA is simply used for monitoring. To restore access to the valve via CPA, it is necessary to switch from the host computer back to Remote or Local.

Detailed instructions for using CPA can be found in the CPA help area. Click the HELP button [3] to access them.



1 Local, control via CPA

2 Remote, control via host

3 Help, access to the help area

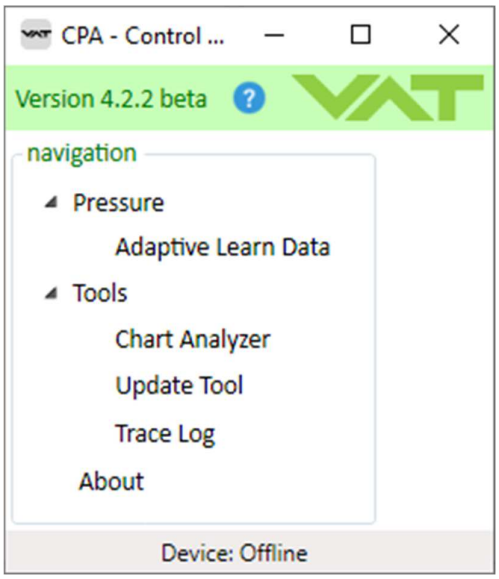
4 CPA scaling, defines pressure and position values

If communication with the service connection is interrupted, the valve switches to remote operation. Therefore, if the service cable is disconnected or the software is switched off, the valve automatically returns to remote operation.

Depending on the remote control, this can lead to an **immediate movement** of the valve.

6.3.3 Offline operation

It is possible to copy the CPA to a drive and run it from there without a valve. The CPA then has a reduced range of functions.



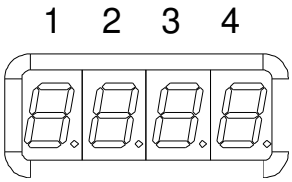
Adaptive Learn Data	View the learn data loaded from a diagnostic or learn data file
Chart Analyzer	View the measurement data recorded and stored with the CPA
Update Tool	Is needed to update a valve to which no communication is possible due to damaged firmware
Trace Log	View the logged data recorded and stored with the CPA
	Open the help for the CPA and the valve functionality
About	Shows the CPA version, CPA Manual Version

6.3.4 Update of CPA

The latest CPA version can be found on the VAT homepage, http://www.vatvalve.com.

6.4 Display messages

The controller has a 4-character display for configuration, status and position information. The displayed codes are described in the table below.



6.4.1 Switch-on sequence

Description	Digit 1	Digit 2	Digit 3	Digit 4
1. All digits illuminated	#	#	#	#
2. Valve type (e.g. 65.3) (3 seconds)		6	5	3

Description	Digit 1	Digit 2	Digit 3	Digit 4
3. Firmware generation & firmware type (e.g. 01.0C) (3 seconds)	0	1	0	C
4. Firmware generation & firmware revision (e.g. 07.00) (3 seconds)	0	7	0	0
5. Configuration of the controller (3 seconds)	Controller 1 H1 2 H2 3 H3 4 H4 5 H5 6 H6 7 H7	Interface 1 RS232/RS485 2 EtherCAT 3 DeviceNet 5 Logic 7 Profibus 8 CC-Link 9 Ethernet A Step-Dir	Option 00 none 01 SPS 02 PFO 03 Cluster 04 SPS & PFO 05 SPS & Cluster 06 PFO & Cluster 07 SPS & PFO & Cluster 08 PFO2 09 SPS + PFO3 0A PFO2 + Cluster 0B SPS + PFO2 + Cluster 0C PFO3 0D SPS + PFO3 0E PFO3 + Cluster 0F SPS + PFO 3 + Cluster FF Unknown	

6.4.2 Operation

Description	Digit 1*	Digit 2	Digit 3	Digit 4
Init (commissioning)	I	n.	–	–
Init (commissioning). closed	I	n.	–	C
Homing (Reference run)	H	O		
Close	C.	–	–	C
Open	O.	***Actual Position*** 0…100 0 = minimum conductivity 100 = max. open		
Pressure Mode	P.			
Position	A.			
Interlock (Valve closed/open through digital input)	I.			
Hold (Position frozen)	H.			
Learn	L.			

Description		Digit 1*	Digit 2	Digit 3	Digit 4
Safety		S.			
Power Failure		F.			
Error (Alternating Number and Code)	Error numbers [▶ 110]	E.	x	y	z
	Error codes [▶ 110]	-	0 ... 999		

* ***Control Mode***

6.5 Valve settings and states

6.5.1 Position feedback messages

Localized `CPA/Parameters: Valve`

Parameter	Description for sealing systems
Actual Position	0…100 % opened 0 % = minimal conductance Value range is adjustable, see CPA Scaling
Position State	*Closed* *Intermediate* *Open*
Isolation State	*Not Isolated* *Isolated*

6.5.2 Cycle counter

Control Cycles

A control cycle is a full movement of the valve. From closed 0% → 100% → 0% = 200%. Each movement is added on until 200% of the movement is reached, then the loop counter is increased by 1.

Localized `CPA/Parameters: Valve.Cycle Counter`

Parameter	Description
Control Cycles	Can be reset. E.g. after a service
Control Cycles Total	Number of control cycles during the lifetime of the valve. Cannot be reset

Isolation Cycles

Only for valves with isolation function. Counts every time the O-ring is compressed during the closing operation, each junction of the ***Isolation Status*** of *Not Isolated* to *Isolated*.

Localized `CPA/Parameters: Valve.Cycle Counter`

Parameter	Description
Isolation Cycles	Can be reset. E.g. after a service
Isolation Cycles Total	Number of isolation cycles during the lifetime of the valve. Cannot be reset

6.5.3 Position restriction

Defines the maximum possible range in which the valve can move.

Localized `CPA/Parameters: Valve.Position Restriction`

Parameter	Description
Enable	*False* *True*
Maximum Position	0…100% opened 0% = minimum [controllable conductance] Value range is adjustable, see CPA Scaling
Restriction Active	***Target Position***, either from the pressure controller or from the interface, in limited range

6.5.4 Position adaptation

With the position adaptation, it is possible to assign an offset to the ***Target Position*** and/or the ***Actual Position***.

Possible applications:

Chamber to Chamber Matching

Adaptation of the conductance curve of different valves in order to reach the same position at the same processes points in different systems.

Cluster Balance

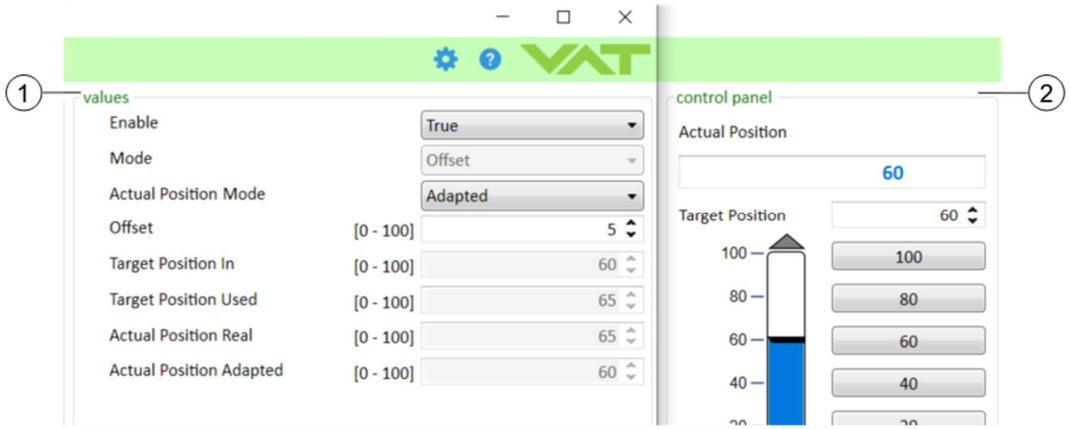
Setting the position of individual valves in a Cluster can be used to balance or move the pumping capacity in the system.

Localized `CPA/Parameters: Valve.Position Adaption`

Parameter	Description
Enable	*False* *True*
Mode	Currently only *Offset* is available. ***Target Position*** and / or ***Actual Position*** are adapted by the ***Offset***
Actual Position Mode	Determines which position the valve ***Actual Position*** shows *Real* *Adapted*

Parameter	Description
Offset	That value which is added to the ***Target Position*** and deducted from the ***Actual Position Real***
Target Position In	Value that is sent via the interface or the CPA Is identical to ***Target Position***
Target Position Used	***Target Position In*** + ***Offset***
Actual Position Real	With the setting ***Actual Position Mode*** = *Real* the valve indicates this position
Actual Position Adapted	***Actual Position Real*** – ***Offset*** With the setting ***Actual Position Mode*** = *Adapted* the valve indicates this position

Example:



1 Parameter window with Position Adaption settings

2 Main window with ***Actual Position*** and ***Target Position***

Parameter	Value
Offset	5%
Target Position in	60%
Target Position Used	65% The valve moves to 65%
Actual Position Mode	*Adapted* The ***Actual Position*** shows the real position

6.6 Position control

6.6.1 Parameter

In the ***Control Mode*** *Position*, the valve setting is controlled directly in accordance with the ***Target Position***.

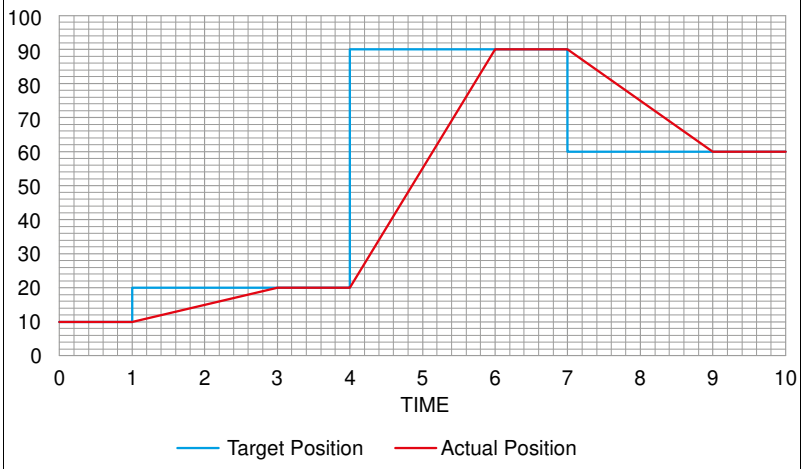
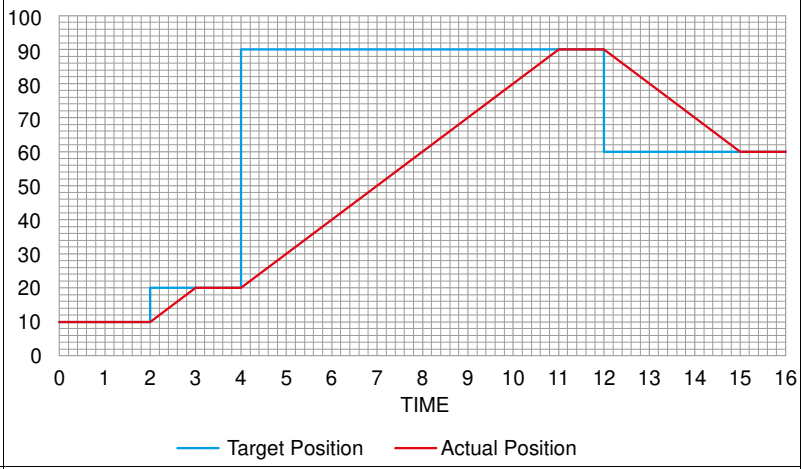
Localized `CPA/Parameters: Position Control`

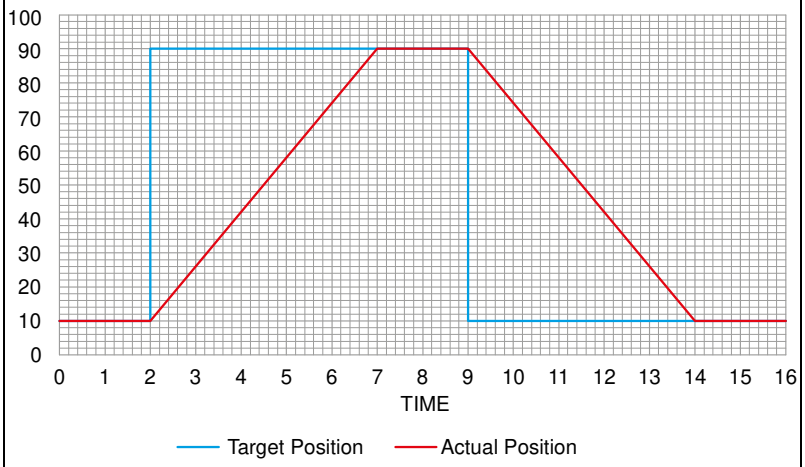
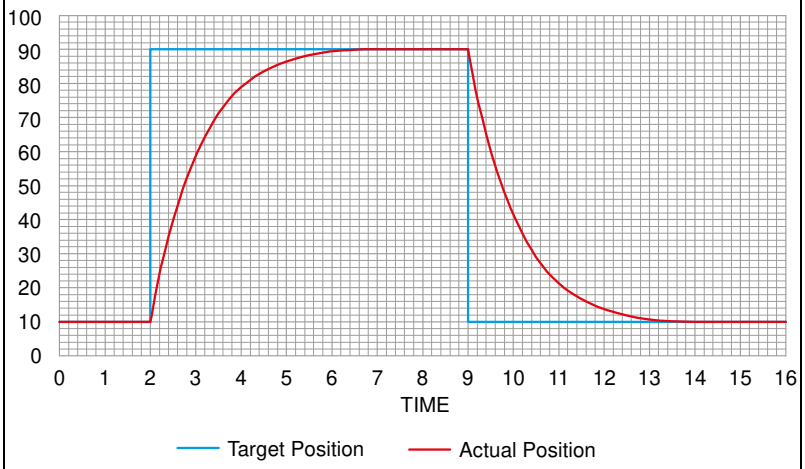
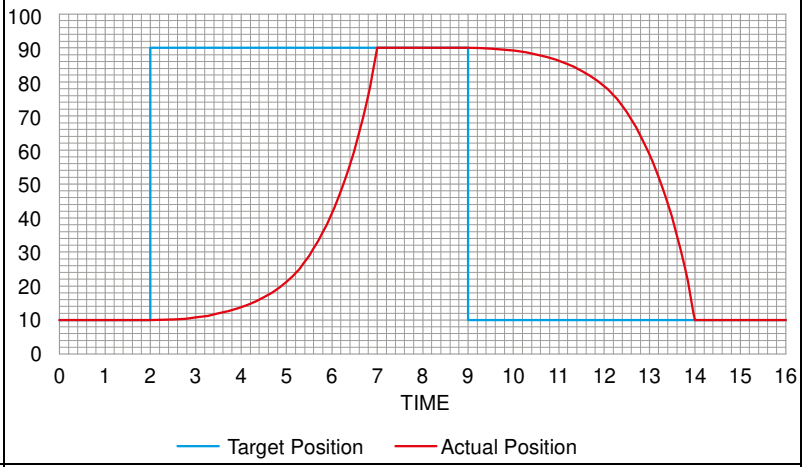
Parameter	Description
Actual Position	Outputs the current position.
Target Position	The entry defines the position to move to.
Position Control Speed	Defines the speed in the ***Control Mode*** *Position*. 0.001…1.0 (full speed)

6.6.2 Position ramp

The position ramp functions are only valid in ***Control Mode*** *Position*.

Localized `CPA/Parameters: Position Control.Ramp`

Parameter	Description
Enable	Activates / deactivates the Position Target Ramp.
Mode	*Use Ramp Time* The set ***Target Position*** is reached after a defined period. The setting is defined in [s]. The time is constant and the slope variable.  *Use Ramp Slope* The set ***Target Position*** is reached in a defined slope. The setting is defined in [position / s]. The slope is constant and the time variable. 
Time	Time in seconds until target reached Use when ***Mode*** = *Use Ramp Time*.

Parameter	Description
Slope	Value until target is reached in position / second. Use when ***Mode*** = *Use Ramp Slope*.
Type	*Linear*  *Logarithmic*  *Exponential* 
Ramp Start Value	*Previous Ramp Value* *Actual Value*

6.7 Pressure sensor

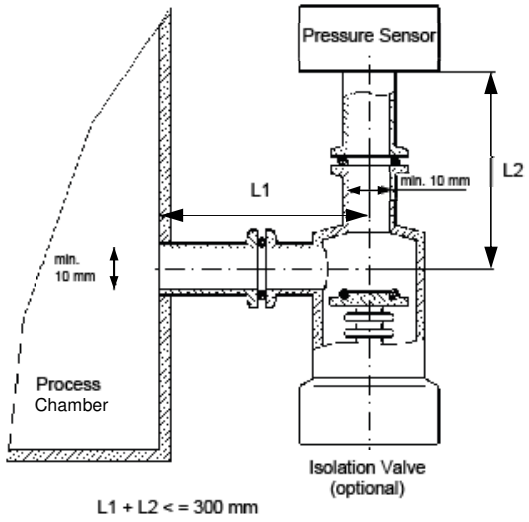
6.7.1 Mechanical installation

The valve supports 2 sensor inputs via one D-Sub 15-pin female.

The connection cable is not included in the scope of delivery.

Observe the manufacturer specifications.

Recommended operating point: >3 %, <98 % of Sensor Full Scale (SFS).



For a safe and reliable process, the pressure sensors must respond quickly.

- Attack time: ≤ 50 ms (please note the manufacturer's data sheet)

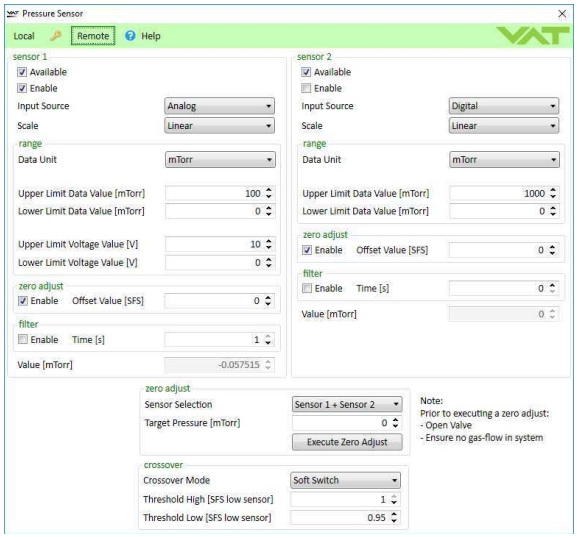
The pressure sensors are each connected to the process chamber by a pipe. The following values apply to ensure an appropriate pressure sensor response time:

- Inner diameter connection ≥ 10 mm
- Length connection: ≤ 300 mm

1. Observe the sensor manufacturer's manual.
2. Make sure that the pressure measurement in the process chamber is possible without any restrictions in the region of the connection tubes.
3. Make sure that the pressure sensors are free of mechanical vibrations.
4. Make sure that the pressure sensors are free of magnetic radiation.

6.7.2 Parameter

The valve supports 2 sensor inputs via one D-Sub 15-pin female.



Localized `CPA/Parameters: Pressure Sensor.Sensor1`

`CPA/Parameters: Pressure Sensor.Sensor2`

Parameter	Description	
Available	Activate or deactivate sensor	
Enable	Activate if the sensor signal is used for ***Control Mode*** *Pressure Control*	
Input Source	*Analog*	The sensor has an analog output and is directly connected to the valve
	Digital	The pressure value is transferred from the host via the interface
	Simulation	The pressure is simulated internally via the valve position and a stored system characteristic curve. Suitable for testing the valve without a real vacuum system
Range.Scale	Type of sensor signal: *Linear* *Logarithmic*	
Range.Data Unit	Sensor unit of measure	

Parameter	Description
Range.Upper Limit Data Value Range.Lower Limit Data Value	Upper and lower limit for the sensor pressure. The unit of measure depends on the setting in ***Data Units*** Example of a linear sensor 250 mTorr: Upper Limit: 250.0 Lower Limit: 0.0
Range.Upper Limit Voltage Value Range.Lower Limit Voltage Value	Parameter if there is an analog voltage interface. The values are the same as the previous ones. Example: Upper Limit 10.0 V = 250 mTorr ***Upper Limit Data Value*** Lower Limit 0.0 V = 0.0 mTorr ***Lower Limit Data Value***
Voltage Per Decade [V]	Defines the scale if logarithmic sensor is used. Example: Logarithmic Sensor with SFS = 1000Torr at 9V, 1V per Decade: ***Range.Scale*** = *Logarithmic* ***Range.Data Unit*** = *Torr* ***Range.Upper Limit Data Value*** = 1000 ***Range.Upper Limit Voltage Value*** = 9 ***Voltage Per Decade [V]*** = 1V
Zero Adjust.Enable	If this value is True, the Offset Value [SFS] is deducted from the ***Actual Pressure***
Zero Adjust.Offset Value [SFS]	0.1 = 10 % = 1 V (for a 10 V sensor)
Filter Enable	*True* enables the filter
Filter	*Low-pass* *Low-pass Simple* *Median* *Moving Average* *Line Frequency Suppression* *FIR custom*
Filter Time	Used for *Low-pass Simple* filter in the range of 0.0 to 1.0 second. Note: Filter delays the sensor signals which is detrimental for pressure control
Analog Sensor Input.Value	Measured value in volts
Digital Sensor Input.Value	Value transferred from the interface
Value	Sensor value currently used

6.7.3 Zero Adjust

Logarithmic sensors do not require zero adjustment, for this case deactivate this function.

Zero Adjust enables the sensor offset voltage to be compensated. The current value at the sensor input is set to zero as soon as the Zero Adjust is carried out. A maximum offset voltage of ±1.4 V can be compensated.

Conditions

- Process chamber fully evacuated Chamber pressure less than 1/1000 of ***SFS***
- Gas flow switched off
- Sensor warmed up / no further sensor drift present. Note the sensor manufacturer's specifications in respect of the zero point adjustment

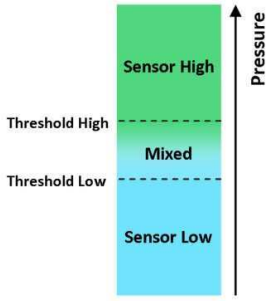
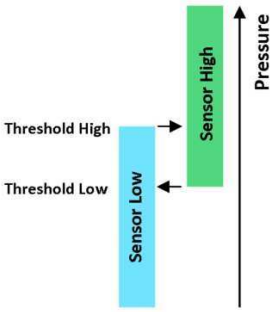
Localized `CPA/Parameters: Pressure.Pressure Sensor`

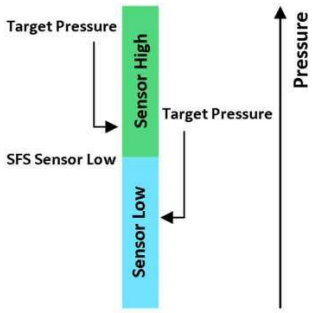
Parameter	Description
Sensor.Zero Adjust.Enable	*True*: – Zero Adjust can be carried out. – Current Offset is taken into consideration. *False*: – Zero Adjust cannot be carried out. – Current Offset is ignored.
Sensor.Zero Adjust.Offset Value [SFS]	The value subtracted from the measured sensor value. The value relates to the Sensor Full Scale [SFS]. 0.1 = 10% of the Sensor Full Scale [SFS].
Zero Adjust.Sensor Selection	*Sensor 1 and Sensor 2* *Sensor 1* *Sensor 2* *None*
Zero Adjust.Target Pressure	Desired ***Actual Pressure*** after Zero Adjust. Normally this value is 0 when the process chamber is completely evacuated (pressure ≤1‰ of the SFS). However, it can also be used to calibrate the sensors to a known pressure (reference sensor).
Zero Adjust.Execute	*None* *Executed Zero Adjust* *Clear Offset Value*

6.7.4 Crossover

To be used with linear sensors only.

Localized `CPA/Parameters: Pressure Sensor.Sensor1`

Parameter	Description
Sensor crossover mode	The crossover mode controls the transfer from one sensor to the other: *Soft Switch* *Hard Switch* *Target Pressure*
	Soft Switch  Within the Mixed range, the average value of the two sensor signals is calculated as the pressure value. The transition of the measurement ranges is superimposed steplessly. The measured values of the two pressure sensors must be almost identical in the mixed range, otherwise the pressure curve is not linear. The SFS ratio of the two sensors should not be greater than 100.
	Hard Switch  The switching behavior of the sensors depends on the set hysteresis and the optional delay time. Preferred setting if the sensor signals differ from one another in the transition region.

Parameter	Description
	Target Pressure  If the ***Target Pressure*** is in the range of the low pressure sensor, the low pressure sensor is used. If the ***Target Pressure*** is in the high pressure range, the measurement is transferred to the high pressure sensor. The sensor is selected in accordance with the ***Target Pressure*** and used for pressure control. No undesirable switching effects occur between the sensors. During ***Control Mode*** *Position*, the ***Crossover Mode*** *Soft Switch* is used.
Threshold High [SFS low sensor] Threshold Low [SFS low sensor]	2 threshold values define the transition area in ***Crossover Mode*** *Soft Switch* and *Hard Switch*. Example: 0.9 = 90 % of the low pressure sensor
Delay [s]	Switching delay in ***Crossover Mode*** *Hard Switch*.

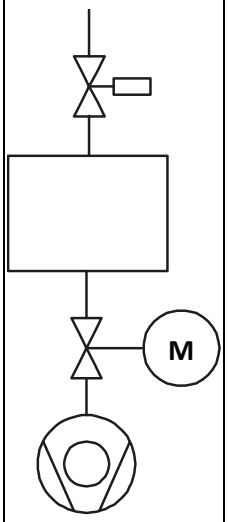
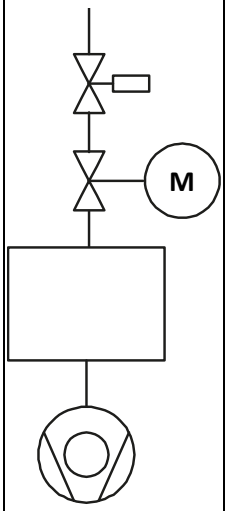
6.8 Pressure control

6.8.1 Control Algorithms

Adaptive	Most dynamic control algorithm Before use, the Adaptive Learn learning routine must be carried out; see section Learn [▶ 86]. During the learning routine, the valve carries out an internal parameter estimate for the vacuum system.
PI	Stable algorithm The performance is lower than that of the adaptive control algorithm. Depending on the process conditions, the PI algorithm can achieve good results.
Soft Pump/Vent	Modified PI control algorithm for pumping down and venting The pump down and venting curve is defined by the ramp function. See sections Pressure ramp [▶ 98] and Profile ramp [▶ 101]

Select correct Control Algorithm

Select the ***Control Algorithm*** that meets your requirements.

System configuration	Constant gas flow possible to		Constant gas flow not possible	Pump / Vent
	Tv*<= 500 s	Tv*> 500 s		
 Downstream	*Adaptive*	*PI*		*Soft Pump/Vent*
 Upstream	*PI*			*Soft Pump/Vent*

* Use the following formula to define the applicable ***Control Algorithm*** for the *Downstream* pressure control.

$$T_V = \frac{P_{SFS} * CV}{q_L}$$

Tv	Vacuum time constant [s]
PSFS	SFS [mbar]
CV	Volume of process chamber [l]
qL	Gas flow for Learn [mbar l/s]

6.8.2 Parameter

Localized `CPA/Parameters: Pressure control`

Parameter	Description
Actual Pressure	Outputs the current pressure.
Target Pressure	Entry defines desired pressure.
Target Pressure Used	Setpoint used by controller. This is different to ***Target Pressure*** if the Target Pressure Ramp is used.
Pressure Control Speed	Defines the speed in the ***Control Mode*** *Pressure Control*. 0.001…1.0 1.0 corresponds to the full speed.
Controller Selector	Determines the controller used.
Controller 1…4	4 Control units to define different control settings. See section Controller Selector [▶ 85]
General Settings	Additional functions can be found here: Store control parameter volatile [▶ 104] Control position restriction [▶ 104] Automated Controller Selector [▶ 103] Profile ramp [▶ 101]
Adaptive Learn	The adaptive control requires Learn [▶ 86].

6.8.3 Controller Selector

The valve has 4 identical controllers for pressure control. Use the ***Controller Selector*** to define which controller is used.

Localized `CPA/Parameters: Pressure Control/Controller Selector`

Most applications need one controller. If the result of pressure control does not meet your expectations, the controllers may be an option for tuning. The 4 controllers enable you to use a controller for a particular pressure operating point, or over a wide pressure and gasflow range. The controller can be optimally configured for these specific operation ranges.

6.8.4 Pressure control Adaptive

This ***Control Algorithm*** is used for the *Downstream* pressure control.

Before this ***Control Algorithm*** can be used, function Learn [▶ 86] must be carried out.

It requires a linear sensor signal.

Control parameters

Localized `CPA/Parameters: Pressure Control.Controller x`

Parameter	Description
Gain Factor	Main parameter to influence the control performance. A higher Gain Factor leads to a faster response, with pressure exceeding or falling below threshold to a greater extent. A lower Gain Factor leads to a slower response characteristic, with pressure exceeding or falling below threshold to a lesser extent.
Sensor Delay	Control parameter for compensating delays during pressure detection. Tubes and openings for fastening sensors can lead to delays in the response time and adversely affect the stability of the pressure control. By adjusting the ***Sensor Delay*** to the approximate delay time, you can reduce stability problems. The control response time is longer.
Learn Data Selection	The learning data is stored in learning banks. Select the learning bank to be used for pressure control. There are 4 learning banks available

Learn

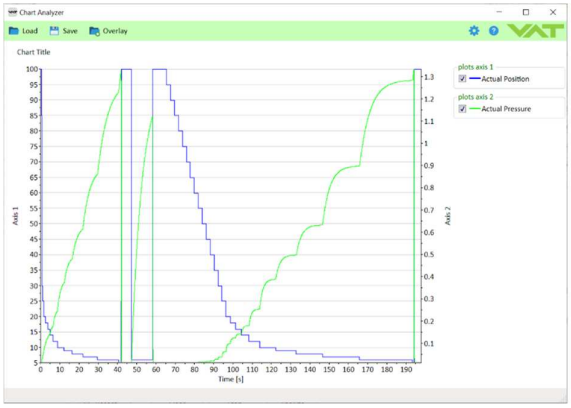
Learn adapts the PID controller of the valve to the vacuum system and its operating conditions. Learn must be executed only once during system setup. The Learn routine determines the characteristic of the vacuum system. Based on this, the PID controller is able to run fast and accurate pressure control cycles.

This characteristic depends on various parameters such as chamber volume, conductance and flow regime. Therefore, it must be performed with a specific gas flow according to instruction below.

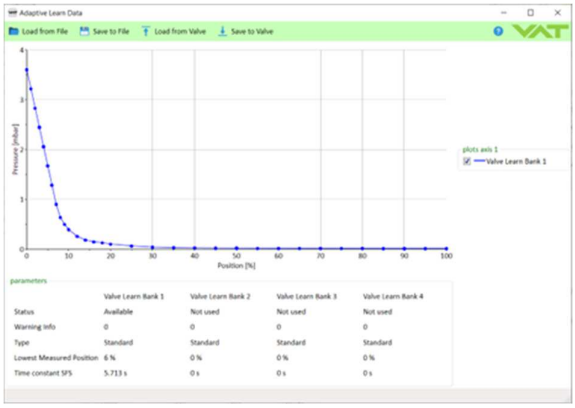
The result of Learn is a pressure versus valve position data table. This table is used to adapt the PID parameters. The data table is stored in the device memory which is power fail save. The data table can be up-/downloaded via 'Control Performance Analyzer' software or remote interface. Due to encoding,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

Learn will be interrupted by an *OPEN*, *CLOSE*, *POSITION CONTROL* or *PRESSURE CONTROL* command.

Recorded Standard Learn



Resulting Learn Data



The goal is to learn all the positions needed during the process.

Parameters executing

Localized `CPA/Navigation/Parameters: Pressure Control.Adaptive Learn`

Parameter	Description	
Start Learn	Starts the learn.	
Type	*Standard*	A positioning sequence is executed and various measured values are recorded in the process.
	Short	Opens the valve and measures the pumping speed. Information about flow and volume is required.
	Calculated	Calculates the learn data with the pumping speed information.
	Short or *Calculated* can be used when there is no way to set a constant gas flow.	
Bank Selection	Select 1 of 4 learn banks to place the result of the learn procedure. Note: Make sure that the ***Learn Data Selection*** in the pressure controller used is set to the appropriate learn bank.	

Parameter	Description
Pressure Limit [SFS]	Limits the maximum pressure, where the learn sequence stops, in order to shorten the learn time. The value is related to the sensor full scale of high sensor. 1.0 means the whole pressure range of the high sensor.
Pressure Limit	Same value as above but in ***Pressure Unit***
Open Speed	Define the speed for opening the valve during the learn procedure. Slower open speed during learn prevents the pump getting to much gas flow. 1.0 means full speed
Status	State of the current learn *Not Started* *In Progress* *Completed Successfully* *Aborted* *Failed*
Warning Info	Warning of current learn procedure: *Bit 0: Learn is running* *Bit 1: Checksum error (learn data corrupt)* *Bit 2: Learn procedure terminated by user* *Bit 3: Pressure at position open >50 % of pressure limit* *Bit 4: Pressure at minimal conductance position <10 % of pressure limit* *Bit 5: Pressure falls while move valve in direction of close* *Bit 6: Pressure at open position does not match pressure of previous open* *Bit 7: Learn procedure terminated by program* *Bit 8: Pressure <= 0 at open position (no gas flow set?)*
Delete All Learn Bank Data	Deletes the data of all learn banks

Sort Learn Parameter

Can be used as a substitute for a real learn process for example, if a constant gas flow is not possible or other influences prevent the execution of a standard learn.

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

Calculated Learn Parameter

If the pumping speed is known, this can replace a Short Learn.

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

Parameters learn bank

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

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

- Learn data can be moved between Learn Banks via the CPA
- Learn data can be saved and loaded via CPA (diagnostic files also store the learn data)

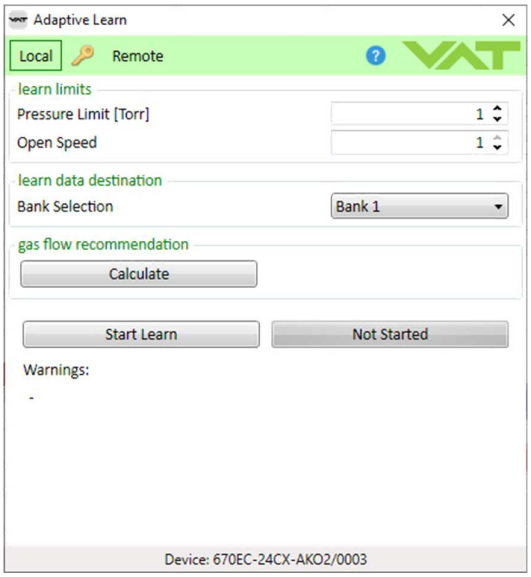
Execute a learn procedure

No out gassing, no drifting gauge and constant gas flow are key for a successful learn procedure.

1. Set specific gas flow according to calculation below or the calculation in the CPA ‘Adaptive Learn’ window.
   Learn does not need to be performed with the process gas. Instead, N2 or Ar may be used.
2. Set parameter ***Bank Selection***, if only one learn is used take *Bank 1*. Make sure that the ***Learn Data Selection*** in the pressure controller used is set to the appropriate learn bank.
3. Reduce ***Open Speed*** if it is critical for the chamber if the pressure drops rapidly when the valve is opened.
4. Set a ***Pressure Limit [SFS]*** limit if sensor full scale cannot or should not be reached.
5. Set ***Controller Mode*** to *Learn*.
6. Wait until the ***Controller Mode*** leaves the *Learn*. Learn is finished.
7. Check if the learn was successful by checking if ***Status*** shows *Completed Successfully*. In best case, ***Warning Info*** shows no warning.

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

CPA window '***Adaptive Learn***'



Gas flow determination empirical

1. Set the valve to the smallest position needed during the process (for non-tight closing valves this is most 0).
2. Set a gas flow so that the pressure is just below the sensor full scale or below the set learning limit.

Gas flow calculation

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

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

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 of the following formulas according to the units you are familiar.

1. Calculate the individual conductance of the working points of your application.

p[Pa] / q[m3/s]	p[mbar] / q[mbar l/s]	p[Torr] / q[sccm]
$C_{WP} = \frac{1000 \cdot q_{WP}}{p_{WP}} * k$	$C_{WP} = \frac{q_{WP}}{p_{WP}} * k$	$C_{WP} = \frac{q_{WP}}{78.7 \cdot p_{WP}} * k$

CWP Required conductance of working point [l/s]

qWP Gas flow of working point

pWP Pressure of working point

k k=1 for molecular flow with p(wp) < 1 Torr, k = 2.5 for viscous flow with p(pw) > 1 Torr

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

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

C_R Required lower conductance [l/s]

C_{WPx} Required conductance of working points [l/s]

To make sure that the valve is capable to control the most extreme working point verify that $C_R \geq C_{min}$ minimum conductance of the valve (refer to “product data sheet").

3. Calculate gas flow for learn.

p[Pa] / q[m3/s]	p[mbar] / q[mbar l/s]	p[Torr] / q[sccm]
$q_L = \frac{P_{SFS} * C_R}{1100}$	$q_L = \frac{P_{SFS} * C_R}{1.1}$	$q_L = 71 * P_{SFS} * C_R$

q_L Gas flow for learn

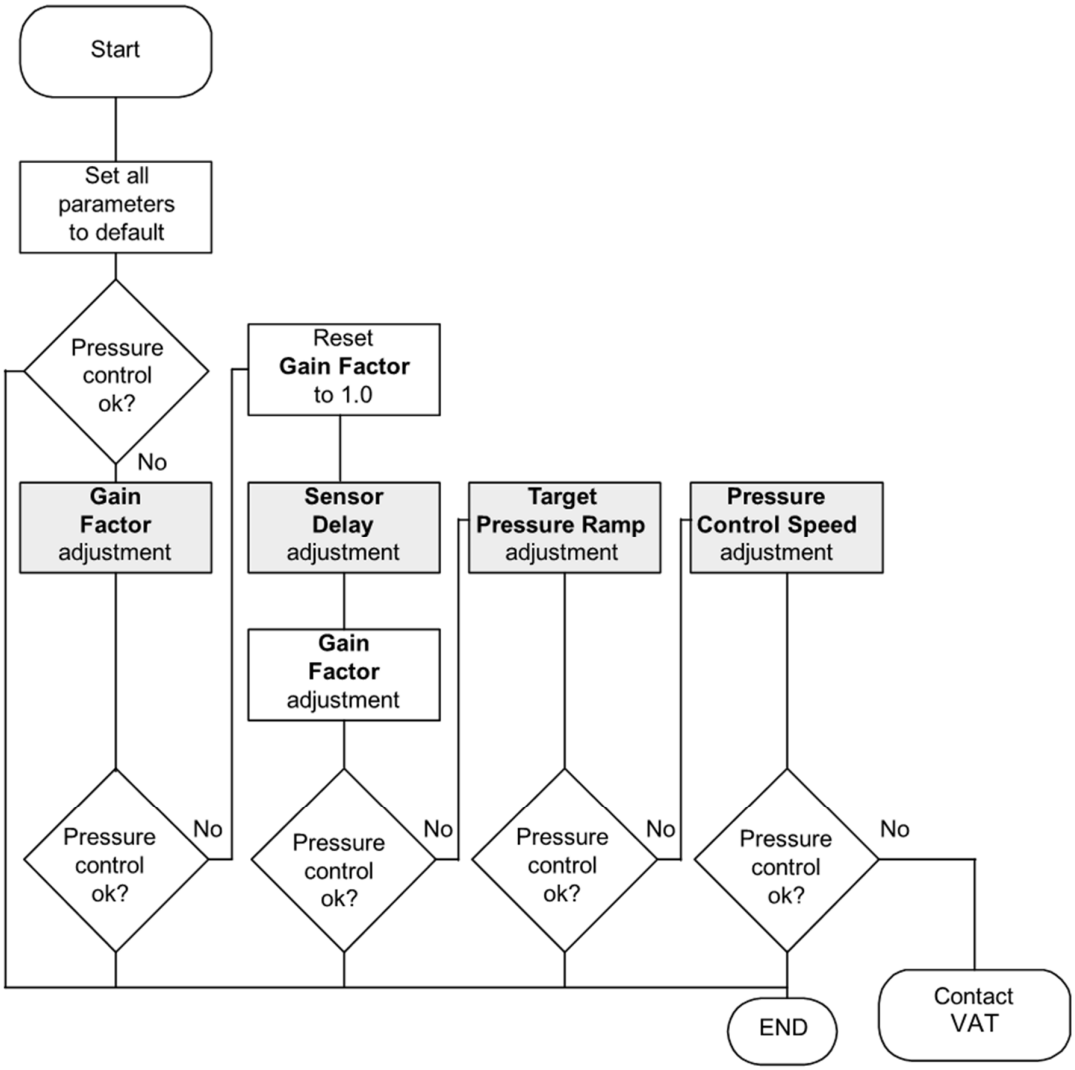
p_{SFS} Sensor full scale pressure

C_R Required lower conductance [l/s]

Tuning

In most cases, the default values provide good properties for pressure control. For some applications, it may be necessary to adjust the properties of the applications. The parameters and the description for making the settings are provided below.

Adhere to the process as described when setting the properties of the applications.



Gain Factor

The ***Gain Factor*** is a control parameter for adjusting the performance of the pressure control algorithm. The ***Gain Factor*** setting influences the stability and response time. The setting range is from 0.0001…7.5. If you increase the ***Gain Factor***, the response time is reduced and the pressure over- and undershoot increases. If you reduce the ***Gain Factor***, the response time is increased and the pressure over- and undershoot is lower.

1. Set ***Gain Factor*** to 1.0.
2. Open the valve.
3. Carry out a typical pressure sequence for your application.
4. Repeat the process with a higher and a lower ***Gain Factor*** until the pressure behavior is suitable for your application and you have sufficient stability.

⇨ The ***Gain Factor*** has been set.

If the pressure cannot be set reliably, an improvement in the sensor connection can lead to more reliable results. See section Mechanical installation [▸ 78].

Sensor Delay

Sensor Delay is a control parameter for compensating delays during pressure measurement. Tubes and openings for connecting sensors can lead a delayed response and negatively affect the

stability of the pressure control, especially in the molecular flow regime. These may result in a valve hunting the pressure and can be identified by an harmonic sinus curve for pressure and position. You can counter stability problems by adjusting ***Sensor Delay*** to the approximate delay time.

Whenever possible, the pressure sensor should be mounted as close as possible to the process chamber. This is the most effective method of preventing stability problems through delay times. See section Mechanical installation [▶ 78].

1. Set ***Gain Factor*** to 1.0.
2. Set ***Sensor Delay*** to 0 s.
3. Carry out a typical pressure sequence for your application.
4. Repeat the procedure with a higher ***Sensor Delay*** until the best possible stability is achieved.
   ⇨ ***Sensor Delay*** is set.
5. Now adjust the ***Gain Factor***.

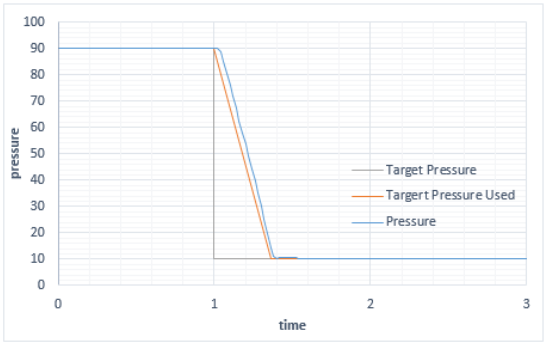
Target Pressure Ramp

The Target Pressure Ramp setting influences the pressure undershoot and response time. The Target Pressure Ramp influences the delay time between 2 setting points. In particular in situations with a pressure drop at low flow rates, an adjustment can significantly improve the pressure behavior.

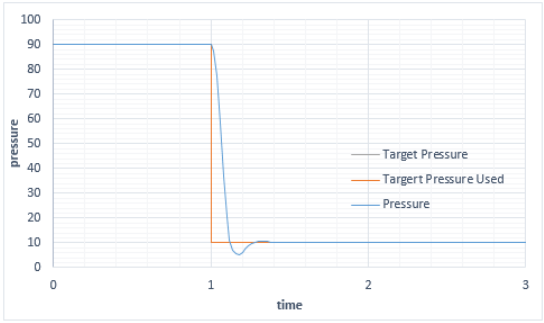
✓ ***Gain Factor*** is set.

✓ ***Sensor Delay*** is set.

1. Control a typical pressure/flow situation.
2. Control a pressure drop.
3. Repeat the pressure drop with longer Target Pressure Ramp settings until the optimum result has been achieved.



With Target Pressure Ramp



Without Target Pressure Ramp

Pressure Control Speed

Influences the rate of motion of the gate.

In most cases, the fastest rate of motion of the gate is the optimum solution. In only a few cases is it an advantage if the gate moves more slowly.

Control Mode *Open* and *Close* are always approached with maximum speed.

✓ ***Gain Factor*** is set.

✓ ***Sensor Delay*** is set.

✓ ***Target Pressure*** is set.

1. Carry out a typical pressure sequence for your application.
2. Repeat the procedure with slower Pressure Control Speed, until you have achieved the optimum result.

⇨ Pressure Control Speed is set.

6.8.5 Pressure control PI

PI algorithm is used for *Upstream* and *Downstream* pressure control. If PI agorithm is used, parameters ***P-Gain*** and ***I-Gain*** must be set. As described in the section Tuning [▷ 94] the best parameter set is calculated empirically.

Localized `CPA/Parameters: Pressure Control.Controller x`

Parameter	Description
P-Gain	Proportional factor A higher P-Gain leads to a faster response characteristic, with pressure exceeding or falling below threshold to a greater extent.
I-Gain	Integral factor Causes the setpoint value to be reached. With I gain = 0 a control deviation remains.
Control Direction	The Control Direction defines the type of application: *Downstream* *Upstream*

Tuning

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

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

Pressure and gas flow

A PI controller provides the best results for a particular operating point. If there is only one operating point, the pressure and gas flow there must be used to optimize ***P-Gain*** and ***I-Gain***.

If there are several operating points that need to be covered, the starting point for pressure optimization is the average value between the highest and lowest pressure to be controlled. The highest measured gas flow of all operating points is used as the starting point for gas flow optimization.

Two ***Target Pressure*** are needed for optimization. ***Target Pressure 1*** is the ***Target Pressure*** calculated above and ***Target Pressure 2*** is 10 – 20 % lower than ***Target Pressure 1***.

Example:

Pressure range	4…10 Torr
Gas flow	2…4 slm
Target Pressure and gas flow setpoint for optimization:	
Target Pressure 1	7 Torr
Target Pressure 2	6 Torr
Gas flow	4 slm

P-Gain

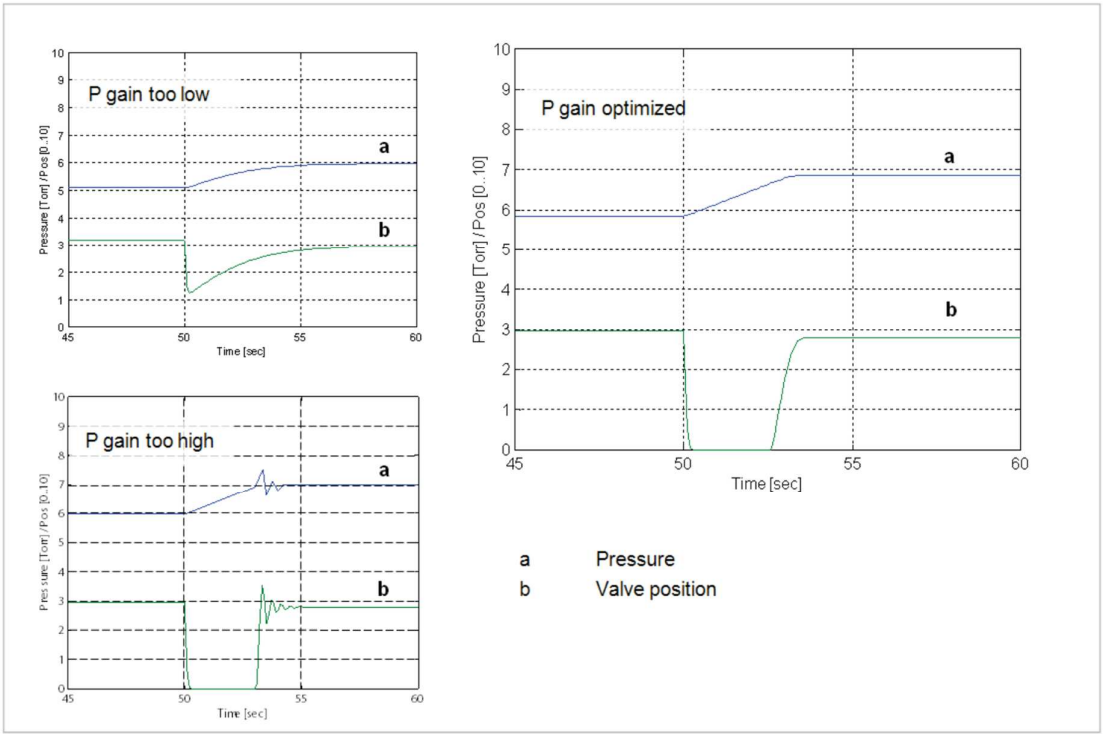
✓ During tuning of ***P-Gain***, the gas flow calculated above must be constant the entire time.

1. Set ***P-Gain*** to 1.0.
2. Set ***I-Gain*** to 0.0.
3. Set the chamber pressure to the value of ***Target Pressure 2***. Wait until the pressure is stable.
4. Set the chamber pressure ***Target Pressure 1***.
5. Assess the response on the basis of the graphics and adjust the ***P-Gain*** accordingly.

If the transition from ***Target Pressure 2*** to ***Target Pressure 1*** leads to ***Target Pressure 2*** not being exceeded by a significant amount, or is not stable, ***P-Gain*** is too high.

If the transition from ***Target Pressure 2*** to ***Target Pressure 1*** leads to ***Target Pressure 2*** not being exceeded at all, or is asymptotic, ***P-Gain*** is too low.

The optimum ***P-Gain*** is found when the transition from ***Target Pressure 2*** to ***Target Pressure*** 1 results in ***Target Pressure 1*** being slightly exceeded. It is irrelevant whether there is a deviation between ***Target Pressure 1*** and ***Actual Pressure***.



I-Gain

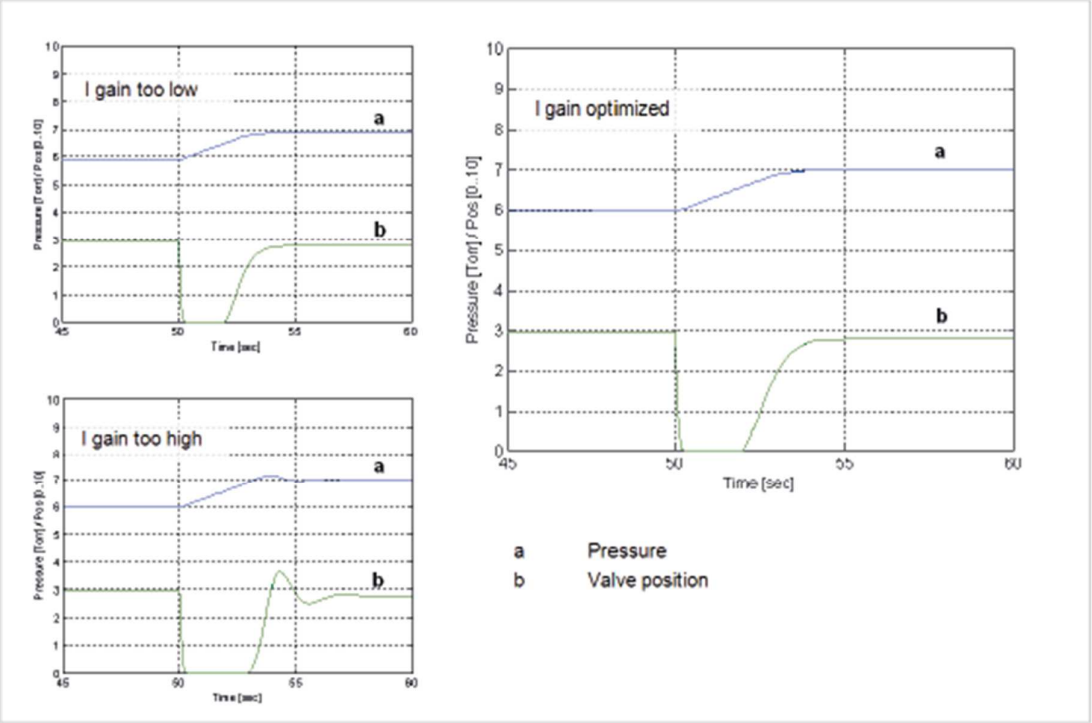
✓ During tuning of ***I-Gain***, the gas flow calculated above must be constant the entire time.

1. Set ***P-Gain*** to half the value calculated in the ***P-Gain*** section.
2. Set ***I-Gain*** to 1.0.
3. Set the chamber pressure to the value of ***Target Pressure 2***. Wait until the pressure is stable.
4. Set the chamber pressure to ***Target Pressure 1***.
5. Assess the response on the basis of the graphics and adjust the ***I-Gain*** accordingly.

If the transition from ***Target Pressure 2*** to ***Target Pressure 1*** leads to ***Target Pressure 2*** not being exceeded by a significant amount, or is not stable, ***I-Gain*** is too high.

If the transition from ***Target Pressure 2*** to ***Target Pressure 1*** leads to ***Target Pressure 2*** not being exceeded at all, or is asymptotic, ***I-Gain*** is too low.

The optimum ***I-Gain*** is found when the transition from ***Target Pressure 2*** to ***Target Pressure 1*** results in ***Target Pressure 1*** being slightly exceeded, the Actual Position is stable and the displayed pressure of ***Target Pressure 1*** corresponds.



6.8.6 Pressure control Softpump/Vent

The *Softpump/Vent* algorithm is an adapted *PI* algorithm. The critical point when pumping down or venting is the opening point of the valve (transition from tight to leaky). In this area, the ***P-Gain*** and ***I-Gain*** are reduced.

The pump down and venting curve is defined by the ramp function. See sections Pressure ramp [▶ 98] and Profile ramp [▶ 101]

Localized `CPA/Parameters: Pressure Control.Controller x`

Parameter	Description
P-Gain	Proportional factor A higher ***P-Gain*** leads to a faster response characteristic, with pressure exceeding or falling below threshold to a greater extent.
I-Gain	Integral Factor ***I-Gain*** is not necessarily needed for softpum/vent. This ensures that the target pressure is reached at the end of the process. If this is not so important, it can be left at 0.

P-Gain

The following section describes how ***P-Gain*** can be optimized within pump pressure control.

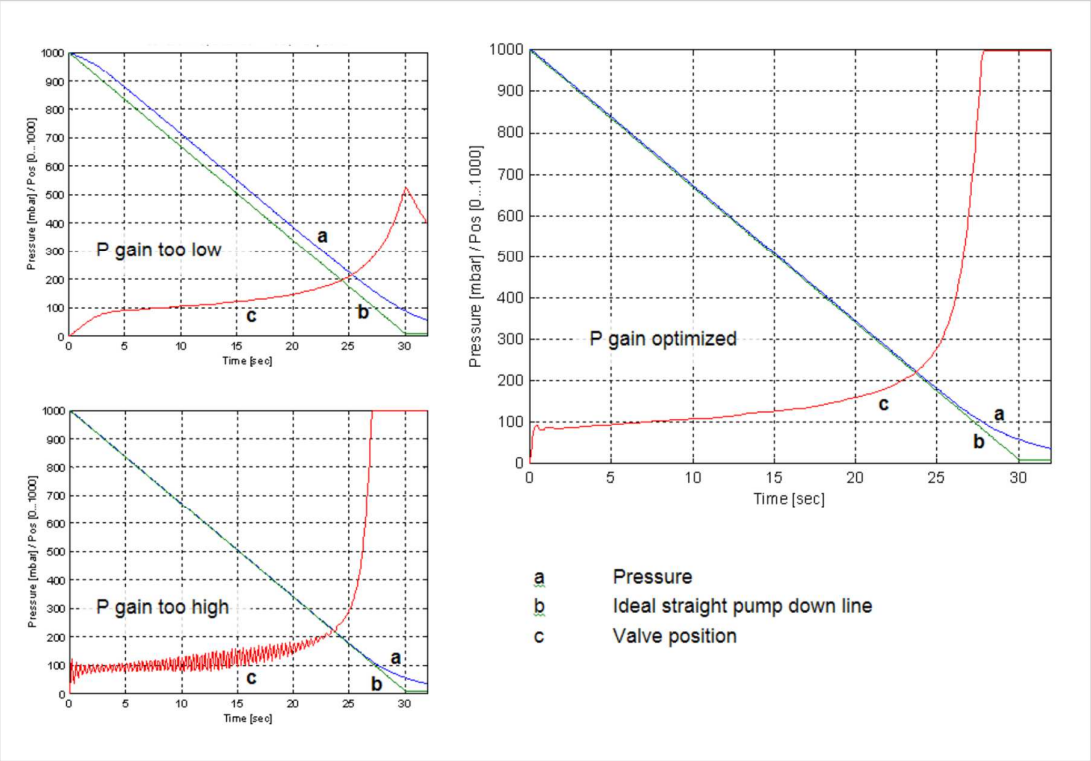
Optimize P-Gain

✓ ***P-Gain*** is set to 1.0.

1. Close the control valve.

2. Open the pump shut-off valve.
   ⇨ The pump starts.
3. Transmit the ***Target Pressure*** to the valve control.
   ⇨ The pump/vent process starts.
   ⇨ The pump/vent curve looks satisfactory -> p-gain is good.
   ⇨ The pump/vent curve is too slow -> increase the p-gain.
   ⇨ The pump vent curve oscillates -> reduce the p-gain.
4. Repeat the process until the pump/vent curve is satisfactory.

⇨ ***P-Gain*** is optimized.



I-Gain

I-Gain enables you to reach the ***Target Pressure*** exactly. If the ***Target Pressure*** is not important, set ***I-Gain*** to 0.

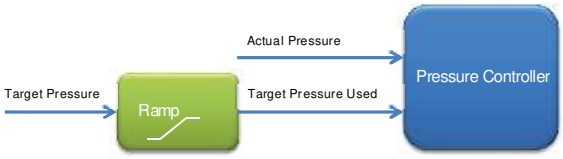
✓ During optimization of ***I-Gain***, the calculated gas flow must be constant the entire time.

1. Set ***P-Gain*** to half the value determined in the above section P-Gain.
2. Set ***I-Gain*** to 0.1.
3. Start pump down or venting.
4. Check how the ***Target Pressure*** is reached.
   ⇨ If the ***Target Pressure*** is reached too slowly, increase ***I-Gain***.
   ⇨ If the ***Target Pressure*** is not reached, increase ***I-Gain***.

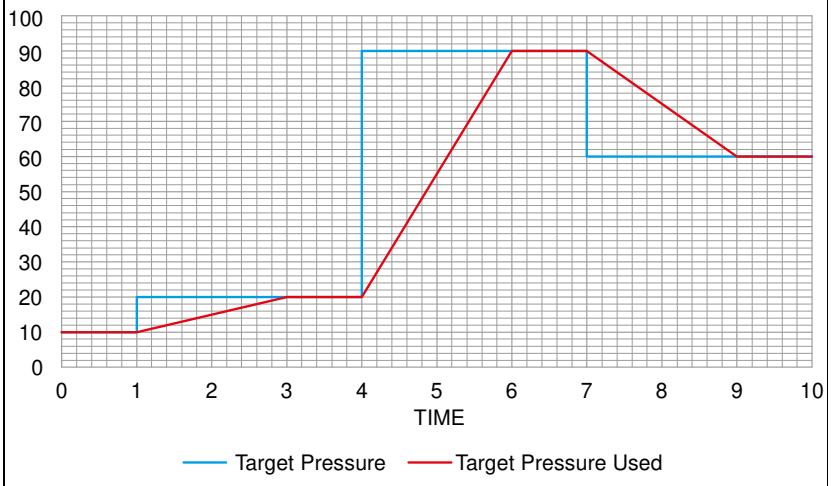
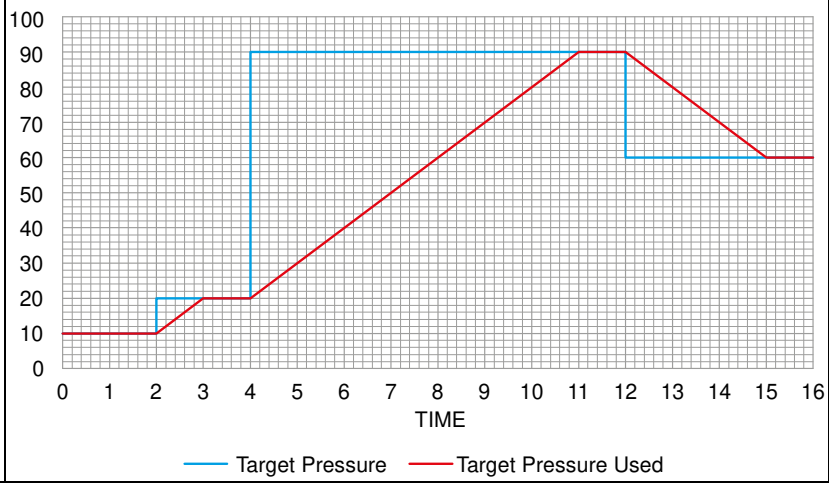
6.9 Pressure control features

6.9.1 Pressure ramp

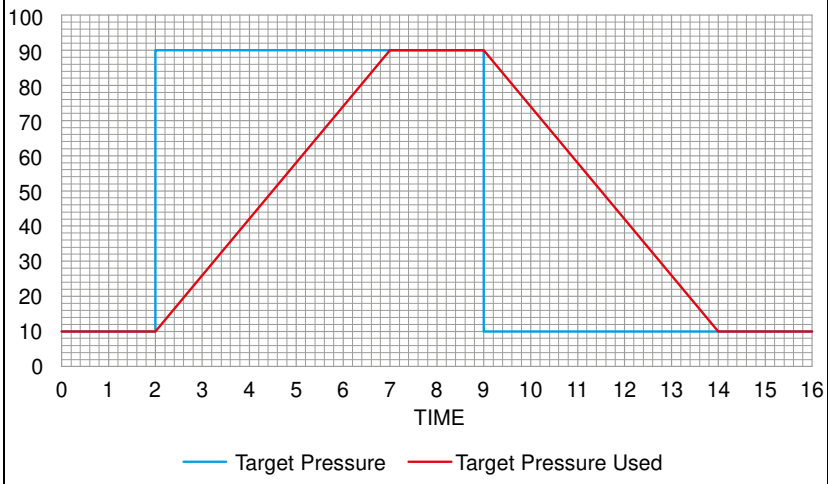
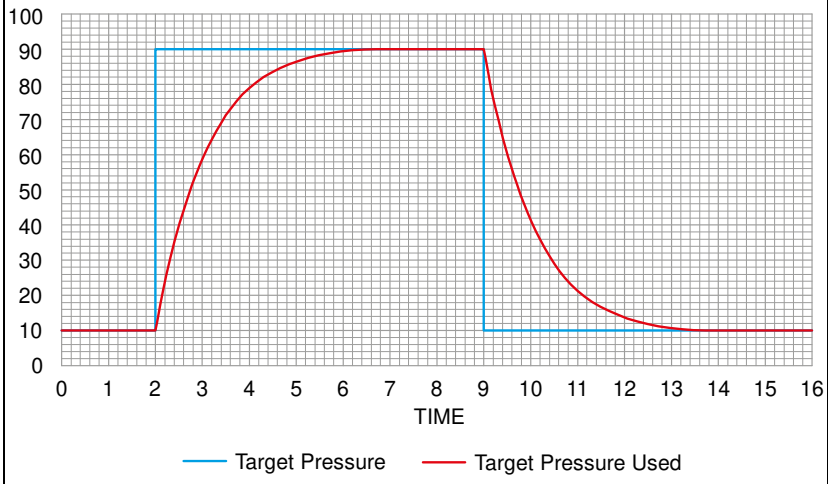
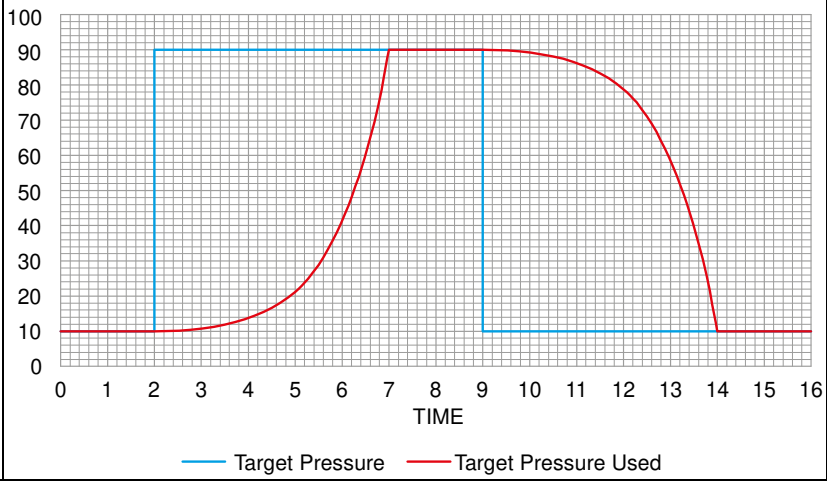
A pressure ramp can reduce the nominal pressure being overshot or not reached by a considerable amount. The pressure ramp must be configured for the ***Control Algorithm*** *Softpump/Vent*.



Localized `CPA/Parameters: Pressure Control.Controller x.Ramp`

Parameter	Description
Enable	Activates/deactivates the pressure ramp function.
Mode	*Use Ramp Time* The set ***Target Pressure*** is reached after a defined period. The setting is defined in [s]. The time is constant and the slope variable.  *Use Ramp Slope* The set ***Target Pressure*** is reached in a defined slope. The setting is defined in [pressure unit / s]. The slope is constant and the time variable. 

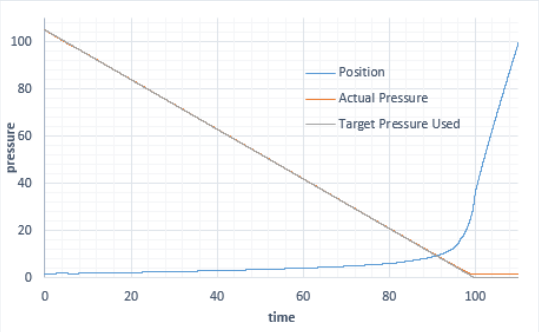
Parameter	Description
Ramp Time	Time in seconds until target reached Use when **Ramp Mode** = *Use Ramp Time*

Parameter	Description
Ramp Slope	Value until target is reached in pressure unit / second. Use when **Ramp Mode** = *Use Ramp Slope*
Type	*Linear*  *Logarithmic*  *Exponential* 

Parameter	Description
Ramp Start Value	*Previous Ramp Value* *Actual Value*

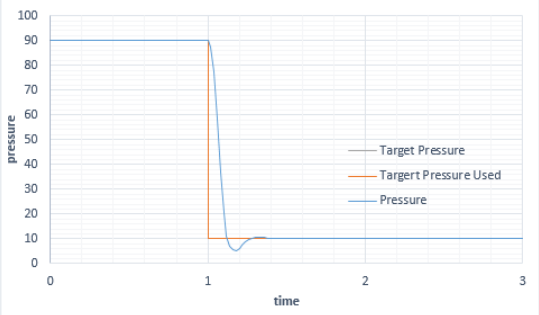
Examples

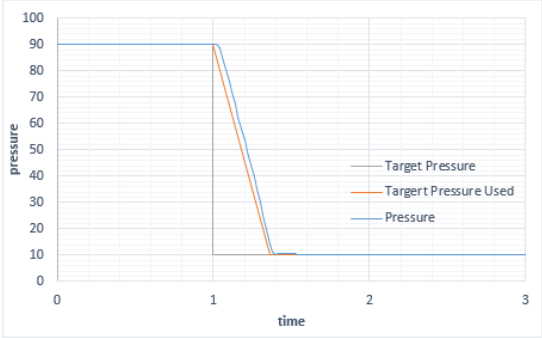
Softpump



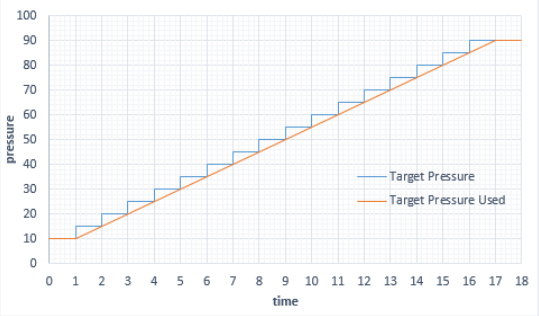
Ramp Mode: Time
Ramp Time: 100 s
Ramp Type: *Linear*
Target Pressure: 0

Prevent undershoot





Smoothing an interval ramp



The [***Target Pressure***] is sent every second, the curve is smoothed with a [Ramp Time] of 1 sec.

6.9.2 Profile ramp

Profile ramp is a Target Pressure ramp that depends on pressure ranges (segments). It is mainly used to create *Softpump* or *Softvent* profiles. The pressure ranges (segments) must be defined to create a profile. A segment is defined by the ***Segment Threshold*** and the ***Segment Slope***.

Up to 10 segments can be defined.

Example, profile ramp with 3 segments:

Segment No.	Threshold mBar*	Resulting Segment mBar*	Slope mBar*/sec
1	1000	1000 to 500	50
2	500	500 to 200	100
3	200	200 to 0	200

The result is a Target Pressure ramp (***Target Pressure Used***) with different slopes depending on the pressure range.

Localized `CPA/Parameters: Pressure Control.General Settings. Profile Ramp`

Parameter	Description
Enable	Switches on the function
Threshold Mode	Specifies to which pressure the Threshold refers *Actual Pressure* Change occurs if the ***Actual Pressure*** reaches the Threshold *Target Pressure Used* Change occurs if the ***Target Pressure Used*** reaches the Threshold
Ramp Type	Specifies the form of ramp. *Linear* *Logarithmic* *Exponential*
Actual Slope	Shows the slope currently used during pressure control in mBar*/sec.
Controller Selector Bitmap	Determines which controller the profile ramp is using. If a controller is selected, the ramp in the controller itself is no longer used. The ramp is therefore grayed out in the CPA.
Segment Selector Bitmap	Defines which segments are used for the profile ramp.
Segment x Threshold	This is the upper limit of the segment. The lower limit value is defined by the next lower threshold Threshold, or the lower threshold value is 0, if there is no lower Threshold. The Slope remains at the value of the upper segment, if the upper Threshold is exceeded.
Segment x Slope	Defines the slope (mBar*/Sec.) in the segment

* Units cannot be adjusted.

6.9.3 Automated Controller Selector

It is possible to define various pressure controller settings with the 4 Controller.

The Automated Controller Selector can select one of the 4 Controller, depending on the following:

- Pressure ranges defined with thresholds
- Up- or downwards control

Localized `CPA/Parameters: Pressure Control.General Settings.Automated Controller Selector`

Parameter	Description
Enable	Switches on a function
Mode	*Threshold* *Pressure Direction*
Controller Selector Bitmap	Used with ***Mode***: *Threshold* Determines which controllers participate in automatic selection
Threshold Condition	Used with ***Mode***: *Threshold* *Lower or Equal* *Equal* Threshold refers to the ***Target Pressure***
Controller 1 Threshold Controller 2 Threshold Controller 3 Threshold Controller 4 Threshold	Used with ***Mode***: *Threshold* Threshold refers to the ***Target Pressure*** Example: ***Controller 1 Threshold*** = 10mTorr → *Controller 1* is used if pressure is 0 … 10mTorr ***Controller 2 Threshold*** = 20mTorr → *Controller 2* is used if pressure is >10 ... 20mTorr ***Controller 3 Threshold*** = 50mTorr → *Controller 3* is used if pressure is >20 ... 50mTorr ***Controller 4 Threshold*** = 100mTorr → *Controller 4* is used if pressure is >50
Controller Pressure Rising Controller Pressure Falling	Used with ***Mode***: *Pressure Direction* Select one Controller for the upwards regulation and one for the downwards regulation

6.9.4 Control position restriction

Limits the valve movement during pressure control.

Localized `CPA/Parameters: Pressure Control.General Settings.Control Position Restriction`

Parameter	Description
Enable	Switches on the function *False* *True*
Minimum Control Position	Lowest position of pressure control.
Maximum Control Position	Highest position of pressure control.
Restriction Active	Indicates True if the current position is limited (Output position of the pressure control in limited range)

6.9.5 Store control parameter volatile

Is used if the regulation parameter is frequently changed during the process and it is not sensible to store the value each time in the non-volatile memory.
The lifetime of the non-volatile memory is 1 million storage cycles.

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

Localized `CPA/Parameters: Pressure Control.General Settings`

Parameter	Description
Store Control Parameter Volatile	*False* *True*

6.10 Sequencer

Allows the creation of internal sequences for test purposes or for accurate timing.

Sequencer consists of up to 20 commands. Command sequences can be repeated.

Normally this function is not visible, contact VAT.

Localized `CPA/Parameters: Sequencer`

Parameter	Description
Enable	Provides the Sequencer function. *False* *True*
Run	Starts the sequence. *False* *True*

Parameter	Description
State	Represents the status of the current command sequence. *Idle* *Running* *Stopping…* *Stopped* *Finished* *Timeout* *Error*
Starting Command	Defines at which command to start. 1…20
Current Command	Represents the current or last command executed. 1…20
Pre-Cycle Commands	List of all commands from the Pre-Cycle Commands, if available. None 1…20
Cycle Commands	List of all commands within a repeat, if available. 1…20
Target Cycles	Number of repeats before the ***State*** reaches the value *Finished*.
Target Time	Duration in seconds before the ***State*** reaches the value *Finished*.
Cycle Counter	Number of cycles already executed, parameter ***Saving Mode*** specifies whether this memory is to be saved.
Cycle Time	Run time in seconds of the current run cycle
Running Time	Run time in total, parameter ***Saving Mode*** specifies whether this memory is to be saved.

Settings

Localized `CPA/Parameters: Sequencer.Settings`

Parameter	Description
Run From State Stopped	Defines how a paused sequence starts again: Continue with the next command or start the entire sequence from the beginning, with or without Pre-Cycle. *New Start Including Pre-Cycle* *New Start Without Pre-Cycle* *Continue*
Automatic Run After Restart	Further sequence runs, if restart takes place. *No* *With Pre-Cycle* *Without Pre-Cycle*

Parameter	Description
Stop At Command Error	Further execution of the sequence in the event of a sequence command error. *False* *True*
Command Timeout	Should it take too long to execute a command, it is defined here how long the Sequencer is to wait. As soon as this waiting time is reached, the Sequencer acts in accordance with the parameter ***Command Timeout Action***
Command Timeout Action	Action in the event of the command exceeding the time. The *Stop* option brings the Sequencer into the timeout condition. The *Next Command* option executes the next command, if available. *Next Command* *Stop*
Saving Mode	Periodic saving of the time elapsed or the number of cycles already ended. The counting is continued after an interruption. *OFF* *Cycles* *Running Time*
Saving Time Period	Cyclical storage duration in seconds, if the ***Saving Mode*** is *Running Time*

Commands

Localized `CPA/Parameters: Sequencer.Commands.1…20`

Parameter	Description
Function	Defines the function for each command in the sequence. There are eight options: *Parameter ID* *Open* *Close* *Position* *Pressure* *Learn* *Homing* *Time Delay* Depending on the ***Function*** selected, the remaining parameters may be irrelevant. E.g. the functions *Open* and *Close* do not depend on the parameter ***Value***.
Value	Value according to a ***Function***
Delay / Tolerance	Several functions depending on its value. If it is positive, it specifies a delay during which time the Sequencer waits until it starts with the execution of the next command in a sequence. If it is equal to -1, this means that the next command, if present, is only executed, if the current command has reached its target, *Open* and *Position* have reached the end position, Homing is completed, ***Target Pressure*** is reached, etc. If it is negative but greater than -1, it defines the percentage tolerance of the given ***Target Position*** or the ***Target Pressure***. E.g. -0.1 stands for 10%, -0.25 for 25% of the scale end value, etc. If the ***Function*** of a command is ***Position*** with the ***Value*** 73 (out of 100) and the tolerance is-0.2 (20%), the target is reached as soon as the position reaches the set range.
Next Command	Following command. It may be an old command, the same one or a new command. 1…20

7 Troubleshooting

7.1 Error detection

Error	Error source	Remedy	Section
Leakage	Contamination of the sealing surfaces	Clean the seal	Cleaning seals [▶ 117]
Leakage at the plate seat	Seal damaged	Replace seal	Fixed Price Refurbishment [▶ 122]
Valve does not move	Voltage supply interrupted	Check voltage supply	Electrical installation [▶ 28]
Flow too low	Sealing ring contaminated	Replace sealing ring	Cleaning filter [▶ 118]
Flow too low	Needle contaminated	Clean needle	Repair and service [▶ 122]
Flow too low or too large	Mechanism damaged	Replace mechanism	Repair and service [▶ 122]

7.2 Warnings

Localized `CPA/Parameters: System.Warning/Error`

Parameter	Description
Warning Bitmap	A Warning does not result in valve operation being interrupted. Note the following table to identify the different Warnings.

Warning Bitmap

Bit		Description
0	No Learn Data	Learn has not been executed. Displayed if ***Control Mode*** *Pressure Control* and ***Control Algorithm*** is *Adaptive*.
1	ISO Warning	Position indicator signal of the external isolation valve is false.
2	No Sensor Active	No Sensor active. Displayed if ***Control Mode*** *Pressure Control* or *Learn* applies.
3	PFO Not Ready	Required PFO charge not achieved.
4	Slave offline	Only applies for Cluster. Slave cannot be reached or not installed.
5	Service Request	Valve is sluggish, possibly dirty
6	Fieldbus Data Not Valid	Cyclic data in the output buffer out of range
12	Fan stall alarm	Speed too low

7.3 Errors

Valve is in ***Control Mode*** *Error*. No further movement is possible.

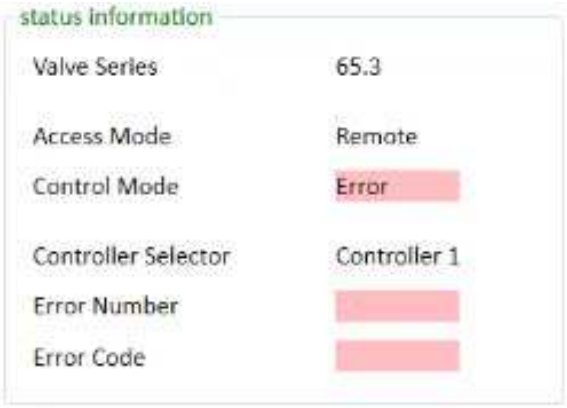
Corrective action of error status via `Services.Error Recovery` or `Services.Restart Controller`.

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

Localized `CPA/Parameters: System.Warning/Error`

Parameter	Description
Error Bitmap	Information about the error types:
Error Number	Information about the error components.
Error Code	Information about the different faults.

Error Number and ***Error Code*** are displayed in the Display messages [▶ 71] and on the CPA.



7.3.1 Error Bitmap

Bit		Description
0	Homing Position Error	Error occurred during reference run.
1	Homing Not Running	Homing has not been carried out.
2	Homing Error State	Homing not working.
3	Operation Position Error	Position cannot be reached
4	Operation Not Running	Not ready, e.g.: Fault during initialization.
5	Operation Error State	Error in operation, e.g. Input voltage too low.
12	Other Component	Other components do not function.
30	General	General errors.
31	Internal	Internal error.

7.3.2 Error numbers

X Component	Y Mode	Z Error type
1= All motors	0= Zero reference value	0= Position error*
2= Motor 1	2= Operating mode	1= No communication with valve
3= Motor 2	8= Other	2= Valve moves in error mode
4= Motor 3		8= Other
8= Other		

* Only in combination with components 1, 2, 3, 4

7.3.3 Error codes

Error code	Error description	Cause	Corrective action
1	No valve connected		Controller connected to valve
2	Non-volatile memory reports errors		Replace Controller
3	Analog-digital converter of sensor input reports errors		Replace Controller
4	Initialization of Motion Controller failed	– Incorrect firmware version of Motion Controller – Board damaged	– Update firmware – Replace board
5	Encoder index pulse not found	– Encoder failure – O-ring sticks	Mechanical problems: – Check differential pressure – Remove foreign objects in area of motion – Avoid tight movements – Carry out repairs
6	Initialization of Interface failed	Field bus: Firmware does not support the Interface	Update firmware
		Incorrect firmware version for the Interface	Update firmware.
7	Initialization of eeprom failed		Check cable

Error code	Error description	Cause	Corrective action
10	Close position is not reached	Mechanical damage	Mechanical problems: – Check differential pressure – Remove foreign objects in area of motion – Avoid tight movements – Carry out repairs
11	Homing position is not reached	Mechanical damage	Mechanical problems: – Check differential pressure – Remove foreign objects in area of motion – Avoid tight movements – Carry out repairs – Gate not mounted
12	Motion Controller: Internal voltage error	– Damaged voltage supply – Damaged board	– Check voltage supply – Replace board
13	Motion Controller: Internal temperature error		Check for heat accumulation
14	Motion Controller: Unexpected behavior	– Axes swapped – Encoder not connected – Brake applied – Coupling slips – Limit stop not defined	Contact VAT service
15	Motion Controller: ***Target Position*** cannot be reached	Current settings defective	Mechanical problems: – Check differential pressure – Remove foreign objects in area of motion – Avoid tight movements – Carry out repairs

Error code	Error description	Cause	Corrective action
16	Motion Controller: Minimum conductance value position cannot be reached		Mechanical problems: – Check differential pressure – Remove foreign objects in area of motion – Avoid tight movements – Carry out repairs – Check gate and sealing ring
18	Motion isolation position is not reached		Mechanical problems: – Check differential pressure – Remove foreign objects in area of motion – Avoid tight movements – Carry out repairs – Check gate and sealing ring.
20	Brake slips		Replace actuator
30	SFV: Failure of Motion Controller for the Master-Slave-communication		Contact VAT service
40	Compressed air supply defective		Check compressed air supply
42	Voltage supply: Minimal voltage detected		Check voltage supply
96	SFV: Position deviation axis 1 to axis 2 at homing procedure	O-ring sticks	Mechanical problems: – Check differential pressure – Remove foreign objects in area of motion – Avoid tight movements – Carry out repairs

Error code	Error description	Cause	Corrective action
97	SFV: Position deviation axis 1 to axis 2 at operating		Mechanical problems: – Check differential pressure – Remove foreign objects in area of motion – Avoid tight movements – Carry out repairs
98	Position error in close process		Mechanical problems: – Check differential pressure – Remove foreign objects in area of motion – Avoid tight movements – Carry out repairs
99	Position error during operation		Mechanical problems: – Check differential pressure – Remove foreign objects in area of motion – Avoid tight movements – Carry out repairs
200	Valve configuration error: The valve cannot be operated with this configuration		Contact VAT service.
701	False identification code axis 1		Check wiring
702	False identification code axis 2		Check wiring
703	False identification code axis 1 and 2		Check wiring
704	False identification code axis 3		Check wiring
705	False identification code axis 3 and 1		Check wiring
706	False identification code axis 3 and 2		Check wiring

Error code	Error description	Cause	Corrective action
707	False identification code axis 1, 2 and 3		Check wiring
777	Operating mode not active		
AR	Compressed air loss		Check compressed air supply

7.4 Malfunction and status table

Error	Error source	Remedy
Nothing displayed	Voltage supply not work	Check valve voltage supply
Control signal cannot be sent to valve	**Access Mode** is *local*	Switch **Access Mode** to *remote*
	Control Mode *Safety* is active	Deactivate external safety circuit, see section Drive power switch [▶ 34]
	Control Mode *Interlock* is active	Digital input is active. Switch over the switch position, see section Digital I/O at power connection [▶ 39]
	Valve is in error condition	Resolve error condition
Pressure reading is wrong or negative	No sensor connection	Connect the sensor, see section Mechanical installation [▶ 22]
	2-sensor operation selected and only one sensor is installed	See section Parameter [▶ 79]
	ZERO not done	Perform ZERO, when base pressure is reached, see section Zero Adjust [▶ 80]
	Not enough power supply for the sensor(s)	Verify sensor supply voltage
ZERO does not work	ZERO disabled	Enable ZERO, see section Zero Adjust [▶ 80]
	Pressure in chamber too high. Base pressure not reached	Valve open, switch off flow
	Sensor voltage not stable	Wait for sensor voltage to warm up before ZERO is set
	Sensor voltage exceeds ±1.4 V	Perform comparison on sensor, note manufacturer's documentation
PRESSURE CONTROL does not work	**Control Mode** *Safety* is active. An D is displayed.	Check motor voltage supply
	Control Mode *Pressure Control* not selected. An P is displayed	Set **Control Mode** to *Pressure Control*

Error	Error source	Remedy
	LEARN not done	Perform LEARN, see section Learn [▷ 86]
PRESSURE CONTROL not optimal	Commissioning not completed	Complete commissioning
	LEARN not successfully done (only for downstream / adaptive control algorithm)	Perform LEARN Check 'Status' and 'Warning Info' in 'Pressure Control', see section Learn [▷ 86]
	ZERO not performed before LEARN (only for downstream / adaptive control algorithm)	Perform ZERO, then repeat LEARN, see section Zero Adjust [▷ 80]
	Gas flow not stable during LEARN (only for downstream / adaptive control algorithm)	Repeat LEARN with stable gas flow, see section Learn [▷ 86]
	Optimization not completed	Optimize control algorithm
	Sensor range not suited for application	Use a sensor with suitable range (controlled pressure should be >3 % and < 98 % of sensor full scale
	Fluctuations in sensor signal	Use shielded sensor cable
Display shows I C Interlock Close	-	Configure interface
Display shows I100	-	Configure interface
Display shows S	Motor voltage supply interrupted	Check motor voltage supply
Display shows AirF	No compressed air connected	Connect compressed air supply
Close Valve does not work	**Control Mode** *Safety* is active. An D is displayed	Check motor voltage supply
Open Valve does not work	**Control Mode** *Safety* is active. An D is displayed	Check motor voltage supply
Valve gate stands and sealing ring is closed	Compressed air supply interrupted	Re-establish compressed air supply

7.5 Restart and error recovery

Localized `CPA/Parameters: System.Services`

Parameter	Description
Restart Controller	Emulates the switching on and off of the Controllers *False* *True*
Error Recovery	An attempt is made to bring the ***Control Mode*** out of the *Error* status without restarting the valve. Thus, communications are not interrupted. E.g. for Error motor, Air pressure for series 65.3 *False* *True*

7.6 Information for support

In case of problems, prepare the following information for VAT support:

- Create a diagnosis file in CPA via `Tools/Create Diagnostic File`
- Error Description

In case of problems with the pressure control:

- Graph with pressure/position curve
- Pressure, flow and gas type of the setpoints to be controlled
- Chamber volume
- Pumping speed and pump type
- System description

In case of problems with interface communication:

- Create a Trace Log in CPA via Tools/Trace Log (if the connection is established but a problem occurs)

Transmit the files and the information to mailto:tuning-support@vat.ch.

8 Maintenance

The maintenance intervals should be observed to ensure that the product works reliably throughout its lifetime. The type of application may make it necessary to shorten the maintenance intervals. In this case, the maintenance schedule must be adjusted accordingly.

In addition to the maintenance interval, the VAT Service Center also offers other services.

If you require further information about the maintenance intervals or services, contact VAT.

8.1 Maintenance schedule

For any deviating maintenance work or additional maintenance work that may be necessary, contact VAT. The VAT customer service will need the product serial number for this. See section Type label [▷ 16]

NOTICE

Non-original spare parts and consumable parts!

If you use non-original spare parts and consumable parts, you may damage the product.

► Only use original spare parts and consumable parts from VAT.

The frequency of the maintenance intervals depends on the process conditions.

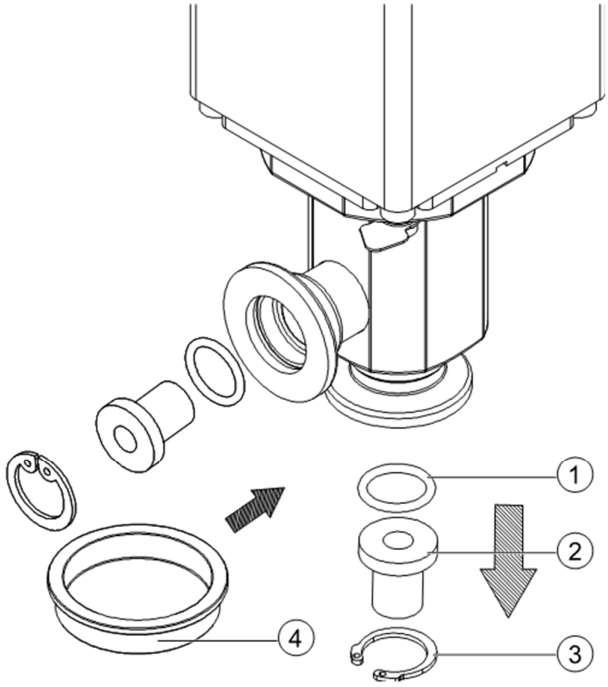
Maintenance interval	Maintenance section	Responsibility	Maintenance work
As required	Filter	Customer	Clean the filter.
If contamination is present	Nozzle and needle, no diagram	VAT	Fixed Price Refurbishment [▷ 122]

8.2 Cleaning seals

1. Clean the sealing surfaces using a lint-free and dust-free cloth and a little isopropanol.
2. Clean the O-ring using a lint-free and dust-free cloth.

8.3 Cleaning filter

The work steps for cleaning the filter are identical for both flanges.



1 O-ring
2 Filters
3 Snap ring
4 Protective cap

✓ Flange separated.
✓ O-ring with centering ring removed.

1. Remove the snap ring (3).
2. Remove the filter (2).
3. Remove the O-ring (1).
4. Cover the opening with the protective cap (4).
   ⇨ The filter (2) is dismounted and can be cleaned.
5. Clean the filter (2) with oil-free compressed air. If necessary, soak the filter (2) in alcohol.
6. Dry the filter (2) with oil-free compressed air.

⇨ The filter (2) is cleaned and can be mounted again.

8.4 Changing option board

NOTICE

Damage to electronic components as a result of insufficient ESD measures!

The electronic components no longer work.

► Ensure potential equalization before working on the product.

NOTICE

Burned connector pins (sparks)!

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

► Do not plug or unplug connectors under power.

NOTICE

Damage due to incorrect positioning of the boards!

All boards have a fixed position in the control unit. An incorrect position can damage the boards.

► Place the boards at the intended positions.

NOTICE

Damage to the sealing surfaces due to incorrect handling!

Leakage at the sealing surfaces.

► Do not move the gate by hands when the control and actuating unit is installed.

The option board is needed for the following modules:

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

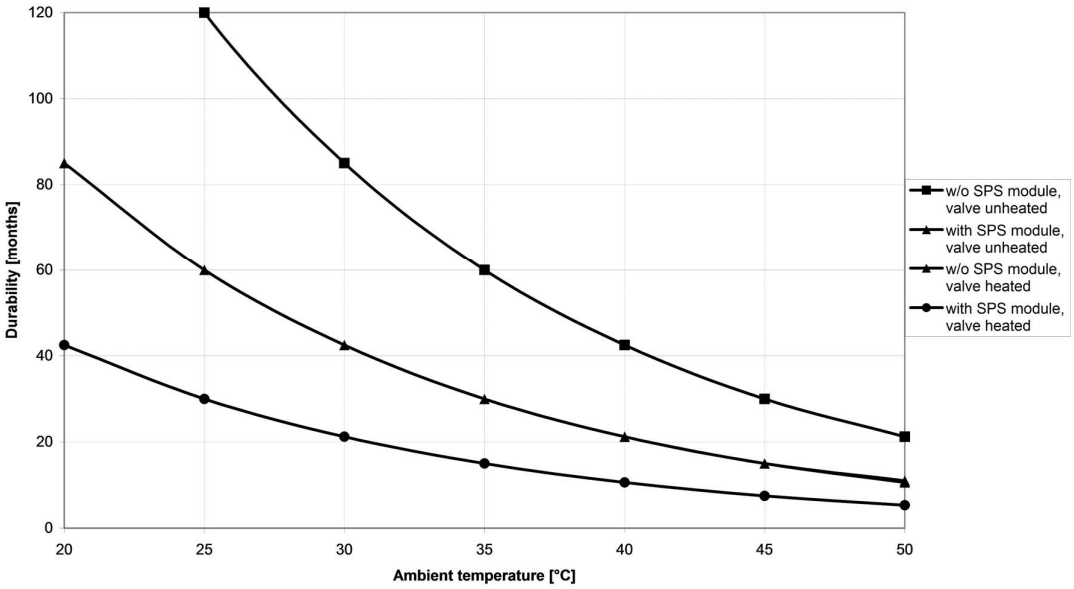
To assure PFO function the option board must be replaced after battery life has expired. The battery lifetime of the PFO module depends on the ambient temperature.

8.4.1 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).

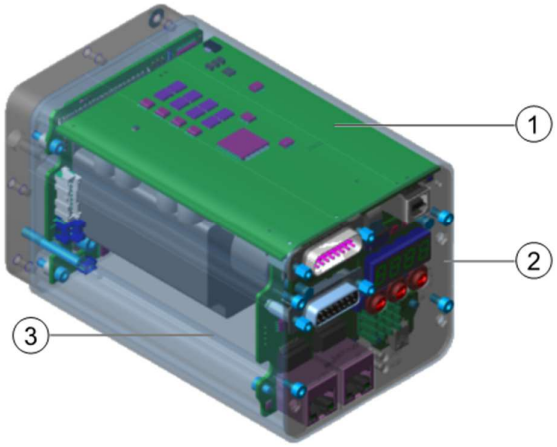
If the SPS is not fully loaded (< 1 A) or heating temperature of valve body is lower than 150 °C, the corresponding life time curve will be in between the upper and the lower curve.

Therefore, 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.

8.4.2 Changing option board



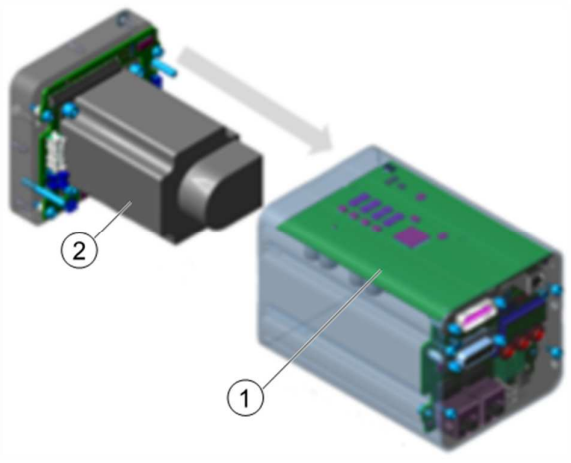
1 Master board
2 Interface board
3 Option board

Required tools:

- Allen wrench 2 mm / 2.5 mm
- Allen wrench 3 mm

1. Make sure the valve is in closed position.
2. Vent the vacuum system.

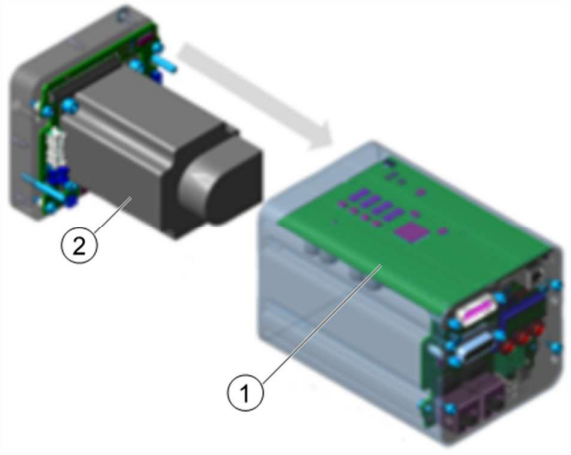
3. Disconnect the electrical connections and remove the valve from the vacuum system. If you only replace the control and actuating unit, the valve can remain in the system.
4. Unfasten the clamp coupling through the whole in the intermediate flange.
5. Unfasten the 4 connection bolts and separate the intermediate flange and the actuator.
6. Unfasten the two bolts from the bottom side and dismount the controller (1) from the actuator unit (2).



7. Dismount the SPS/PFO option board from the bottom side of the controller.

The controller and the interface board are fix connected and shall not be dismounted.

8. Pull the option board backwards out of the controller.
   ⇨ The option board is disassembled and can be replaced.
9. Push the controller (1) onto the actuator unit (2) and fasten the two bolts from bottom side.



10. Assemble the controller and actuator unit. Tighten the mounting screws adequately.
11. Assemble the intermediate flange and the actuator. Tighten the mounting screws adequately.
12. Reinstall the valve into the vacuum system.

9 Repair and service

1. Have repairs carried out by VAT service personnel.
2. Only carry out repairs yourself if you have first consulted VAT.
3. Contact a VAT service center, see www.vatvalve.com.

9.1 Fixed Price Refurbishment

During the Fixed Price Refurbishment (FPR), the VAT customer service can refurbish the product or individual components for you. Consumable parts are replaced, and the guarantee on the replaced parts is extended.

1. Select the desired service from our comprehensive FPR service program for the refurbishment.
2. Contact your assigned sales person or the nearest VAT service center to learn about the options for the product in question. VAT Service Center.

10 Dismantling and storage

10.1 Removing valve

⚠ WARNING

Risk of injury due to overpressure in the valve!

Injuries caused by ejected parts.

► Only dismount the valve once the internal pressure of the valve corresponds to the ambient pressure.

1. Disconnect the mains supply voltage.
2. Remove the cable.
3. Open the clamps on the flanges.

⇨ The valve is dismounted.

10.2 Storing valve

1. Clean and decontaminate the valve.
2. Cover all valve openings with a protective cap.
3. Pack the valve in the original packaging material.
4. Store the valve at the permitted environmental conditions, see Product Data Sheet.

10.3 Removing controller

1. Disconnect the power supply to the controller.
2. Disconnect the interface from the controller.
3. Disconnect the ground cable from the controller.
4. Dismantle the controller.

⇨ The controller is dismounted.

10.4 Storing controller

1. Clean and decontaminate the controller.
2. Pack the controller in the original packaging material.
3. Store the controller at the permitted environmental conditions, see Product Data Sheet.

10.5 Removing sensor

► Remove the pressure sensor in accordance with the manufacturer's instructions.

10.6 Storing sensor

► Store the pressure sensor in accordance with the manufacturer's instructions.

11 Transport packaging and shipping

11.1 Packing and transporting valve

1. Close the valve.
2. Cover all valve openings with a protective cap.
3. Pack the valve in the original packaging material.
4. Transport the valve in the original packaging only.

11.2 Sending returns

The end user is responsible for decontaminating the products and may only send decontaminated products back to VAT. When products are sent back to VAT, the declaration regarding chemical contamination must be completed and sent to VAT beforehand.

If contaminated products are sent to VAT, VAT will perform a decontamination process at the cost of the customer. The party sending the products is responsible for ensuring that the valve is sent in appropriate packaging.

1. Download the declaration form regarding chemical contamination of vacuum valves and valve components from the following website: http://www.vatvalve.com.
2. Fill out the form and send it in advance to VAT or the relevant sales company.
3. If the product is radioactively contaminated, ask VAT for the following form: Notification of contamination and radiation.

If you have any questions regarding the issue of decontamination and shipping, consult your VAT service center or the relevant sales company.

12 Disposal

12.1 Disposing

The product and its components are made of various materials, which must be disposed of correctly.

1. Dispose of the product and its components in accordance with local regulations.
2. Hire an authorized contractor to dispose of your waste in the proper manner and in accordance with environmental requirements.

Find out more and connect to your local VAT contact on

WWW.VATVALVE.COM

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