Installation, Operating & Maintenance Instructions

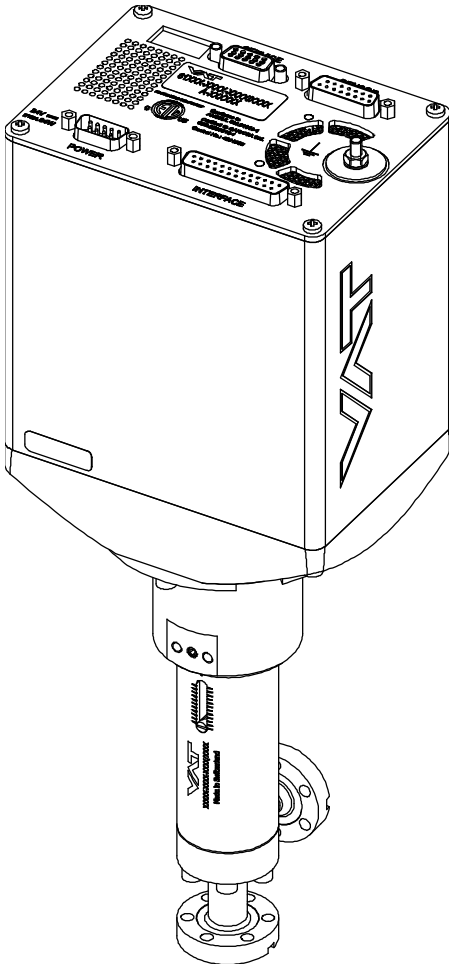
Variable leak valve DN 16 (5/8")
with integrated controller
with RS232 interface

Series 590
DN 16 mm (I.D. 5/8")

This manual is valid for the following product ordering number:

59024-.EGG-….

configured with firmware **600P.1G.21.00**



Sample picture

820655EA Edition 2015-12-02

Imprint

Manufacturer VAT Vakuumventile AG, CH-9469 Haag, Switzerland

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

Publisher VAT Vakuumventile AG, CH-9469 Haag, Switzerland

Editor VAT Vakuumventile AG, CH-9469 Haag, Switzerland

Print VAT Vakuumventile AG, CH-9469 Haag, Switzerland

Contents

1 Description of product

1.1 Identification of product

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

← Fabrication number

1.2 Use of product

Use product for clean and dry vacuum applications only. Other applications are only allowed with the written permission of VAT.

1.3 Used abbreviations

Abbreviation	Description
CPA	Control Performance Analyzer

1.4 Related documents

- Product data sheet
- Dimensional drawing

1.5 Important information

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

Example:

VAT disclaims any liability for damages resulting from inappropriate packaging.

1.6 Technical data

1.6.1 Control and actuating unit

Description		
Input voltage [1]	+24 VDC (±10%) @ 0.5 V pk-pk max.	[connector: POWER]
Power consumption	38 W	[connector: POWER]
Sensor power supply output [2]	+24 VDC / 1500 mA max.	[connector: SENSOR]
Sensor input Signal input voltage / Input resistance ADC resolution Sampling time	 0-10 VDC / Ri>100 kΩ 0.23 mV 10 ms	[connector: SENSOR]
Ambient temperature	0 °C to +50 °C max. (<35 °C recommended)	
Pressure control accuracy	5 mV or 0.1% of setpoint, whichever is greater	
Position resolution / position control capability	100’000 (full stroke)	
Typical closing / opening time	3.5 s	

[1] Internal overcurrent protection by a PTC device.
[2] Refer to chapter «Sensor supply concepts» for details.

1.6.2 Valve unit

Please refer to Product data sheet.

2 Safety

2.1 Compulsory reading material

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

NOTICE

Lack of knowledge

Failing to read this manual may result in property damage.

Firstly, read manual.

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

2.2 Danger levels

DANGER

High risk

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

WARNING

Medium risk

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

CAUTION

Low risk

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

NOTICE

Command

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

2.3 Personnel qualifications

⚠ WARNING

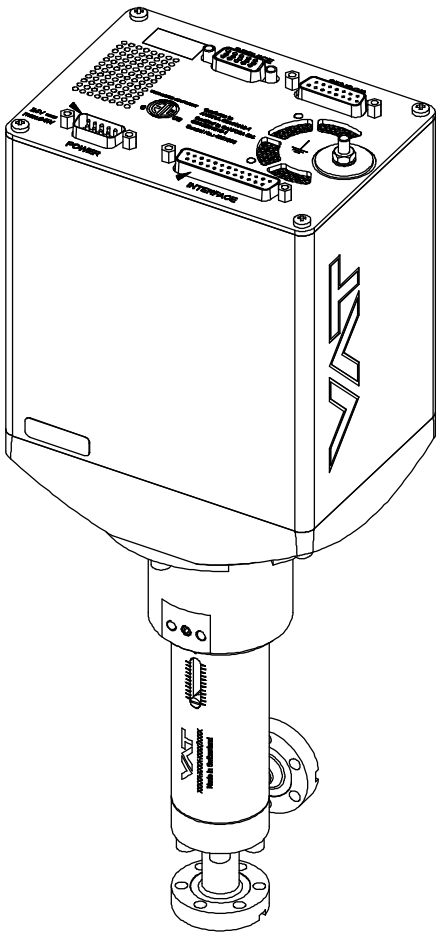
Unqualified personnel

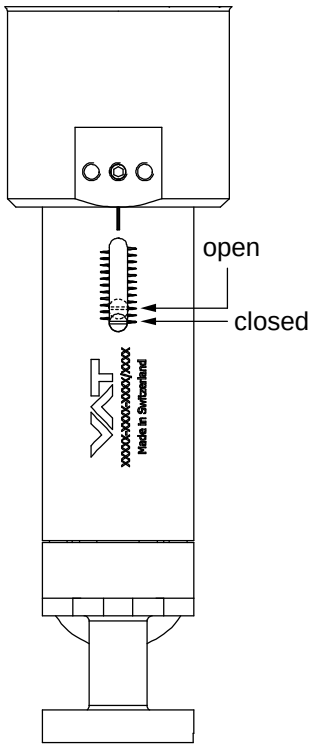
Inappropriate handling may cause serious injury or property damage.

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

3 Design and Function

3.1 Design





mechanical position indicator

3.2 Function

The valve plate acts as a throttling element and varies the conductance of the valve opening. Actuation is performed with a stepper motor and controller. The stepper motor/controller version ensures accurate pressure control due to exact gate positioning.

4 Installation

⚠ WARNING

Unqualified personnel

Inappropriate handling may cause serious injury or property damage.

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

4.1 Unpacking

NOTICE

Physical overstraining at controller

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

Do not place the valve on the controller panel.

NOTICE

Damage of valve and flanges

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

Pay attention that valve and flanges don't get damaged when the valve is lifting out of the box and handled afterwards.

NOTICE

Contamination

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

Always wear clean room gloves when handling the valve.

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

1. Open the transport case and remove inside packing material as far as necessary.
2. Lift the valve carefully and place it on a clean place.

Do not remove protective foils from valve opening

4.2 Installation into the system

NOTICE

Sealing surfaces

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

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

NOTICE

Wrong connection

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

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

NOTICE

Burned connector pins (spark)

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

Do not plug or unplug connectors under power.

NOTICE

Contamination

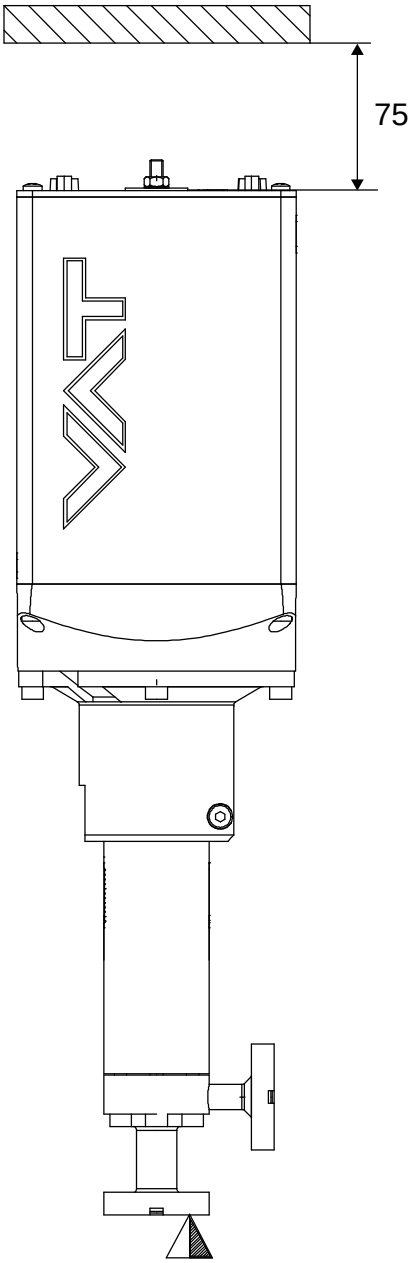
Plate and other parts of the valve must be protected from contamination.

Always wear clean room gloves when handling the valve.

Mount valve to a clean system only.

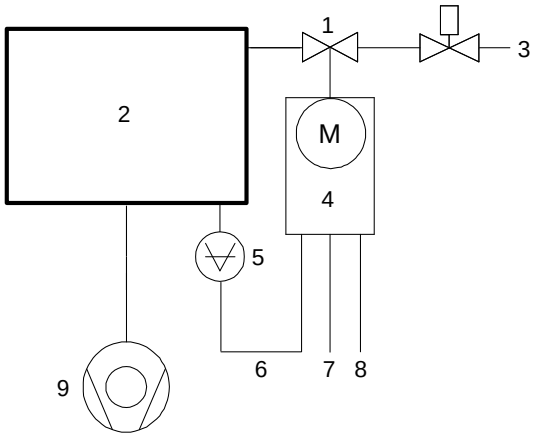
4.2.1 Installation space condition

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



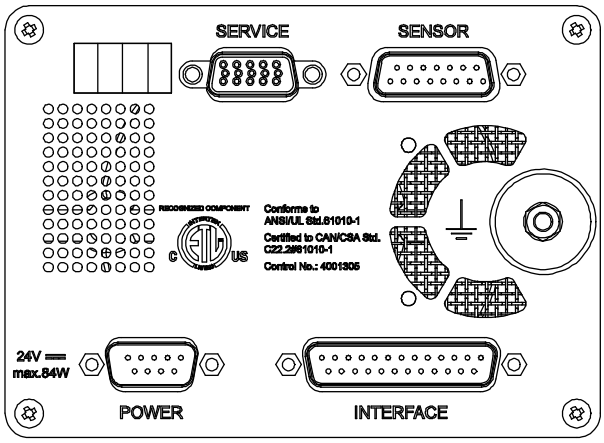
4.2.2 Connection overview

System:



1 Valve
2 Process chamber
3 Gas inlet
4 Controller
5 Pressure sensor
6 Sensor cable
7 Cable to remote control unit (RS232)
8 Cable to power supply
9 Pump

Controller:



4.2.3 Installation procedure

1. Remove protection flanges only prior assembly into the vacuum system.
2. Install valve [1] into the vacuum system.

- The valve seat side is indicated by the symbol «Δ» on dimensional drawing, see also «Installation space condition».
- Do not admit higher forces to the valve than indicated under «Admissible forces».
- Make sure that enough space is kept free to do preventive maintenance work. The required space is indicated on the dimensional drawing.

3. Install the sensor [5] according to the recommendations of the sensor manufacturer and directives given under «Requirements to sensor connection».
4. Connect pressure sensor cable [6] to sensor and then to valve (connector: SENSOR). Refer to chapter «Electrical connection» for correct wiring. 59024-.EGG-…. supports 1 sensor.
5. Connect valve to RS232 [7] (connector: INTERFACE). Refer to «RS232 schematics» for correct wiring.
6. Connect power supply [8] to valve (connector: POWER). Refer to chapter «Electrical connection» for correct wiring.

To provide power to the valve motor pins 4 and 8 must be bridged, otherwise motor interlock is active and thevalve enters the safety mode and is not operative. Refer also to «Safety mode».

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

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

4.2.4 Admissible forces

NOTICE

Force at valve body and flange

Forces from the weight of other components can lead to deformation of the valve body and flanges.

Do not apply any force at valve body or flanges.

4.2.4.1 Admissible forces at controller

NOTICE

Force at controller

Forces from the weight of other components can lead to deformation the controller.

Do not apply any force at controller.

4.3 Electrical connection

NOTICE

Wrong connection

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

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

NOTICE

Burned connector pins (spark)

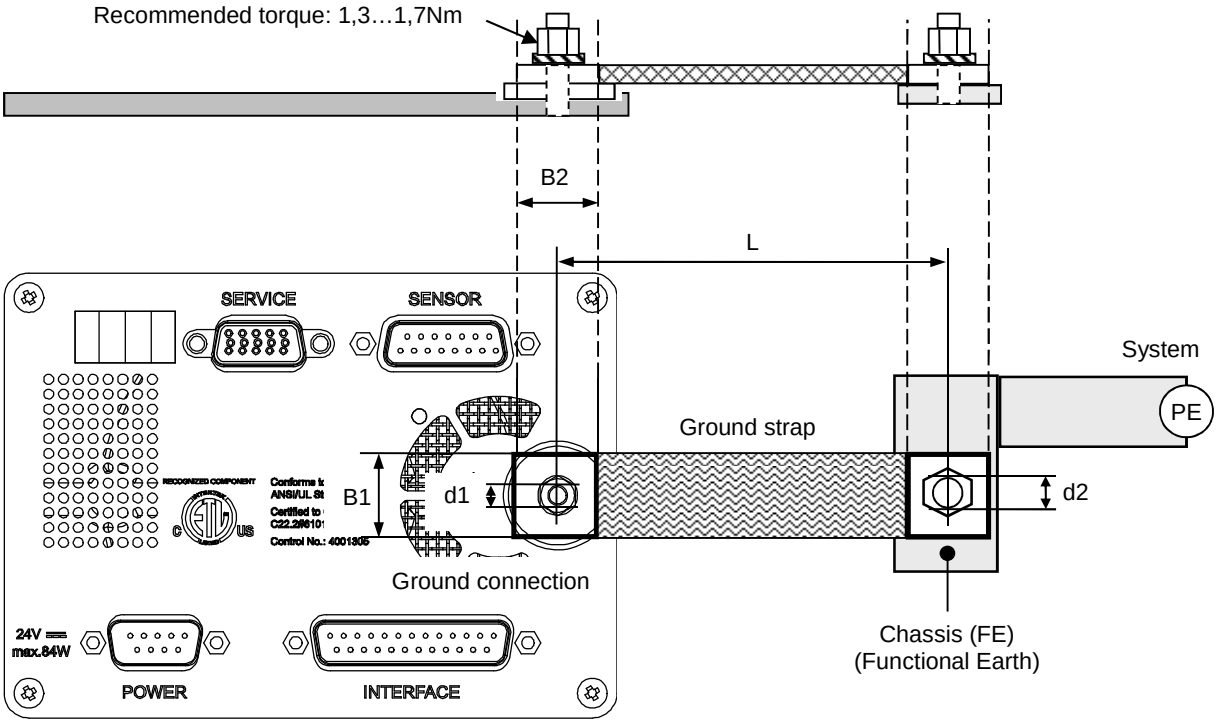
Connector pins or electronic parts could damage, if plugged and unplugged under power.

Do not plug or unplug connectors under power.

4.3.1 Ground connection

Recommendation for ground strap between controller and system (chassis)

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



Valve controller

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

4.3.2 Sensor supply concepts

This valve offers 2 alternative concepts to supply the sensor(s) with power. This depends on the sensor type and valve version that is used.

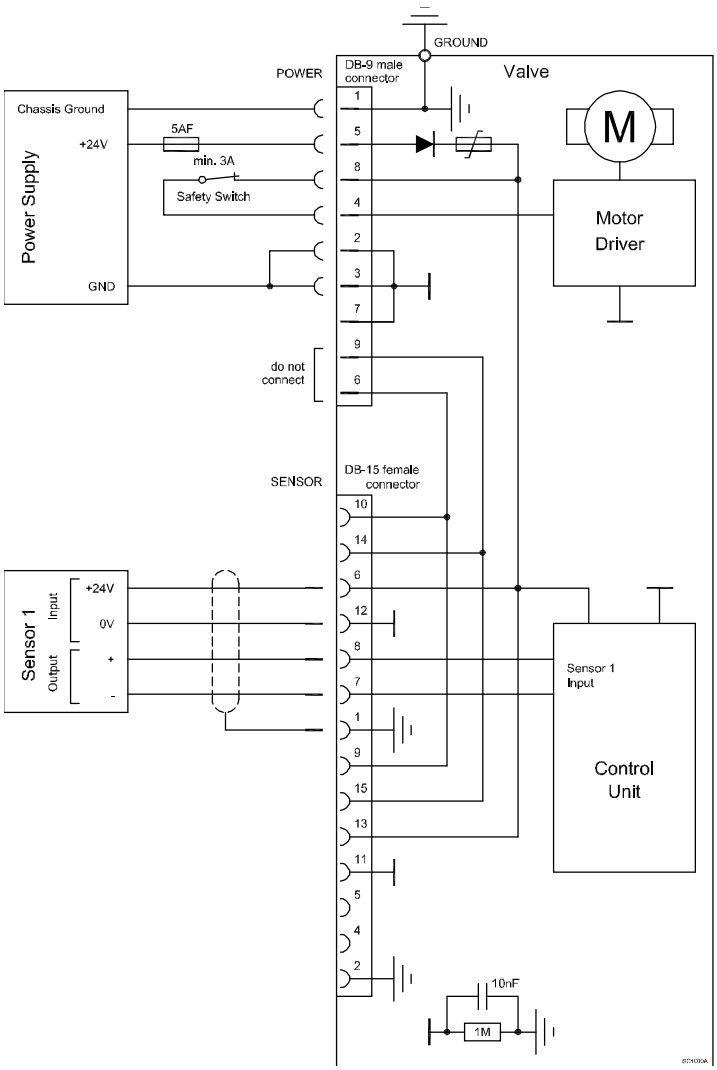
Concepts:

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

- External ±15 VDC supplied to POWER connector is feedthrough to SENSOR connector to supply ±15 VDC sensors. Refer to chapter «Power and sensor connection (±15 VDC sensors) without optional SPS module» for schematic and correct wiring.

4.3.3 Power and sensor connection (+24 VDC sensors)

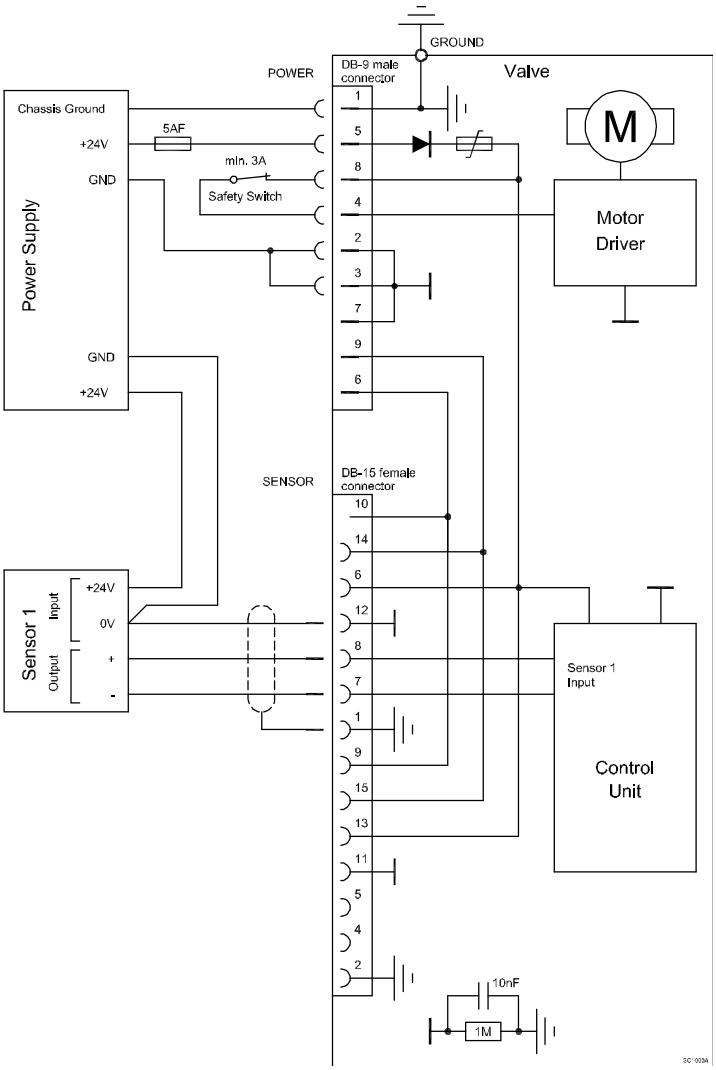
4.3.3.1 Sensor power wiring via controller



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

- Use shielded sensor cable(s). Keep cable as short as possible, but locate it away from noise sources.
- Connect Power supply (+24 / GND) at DB–9 male power connector and Sensors (+24V / 0V / + / -) at DB–15 female sensor connector exactly as shown in the drawing above!
- Connector: Use only screws with 4–40 UNC thread for fastening the connectors!

4.3.3.2 Sensor power wiring external



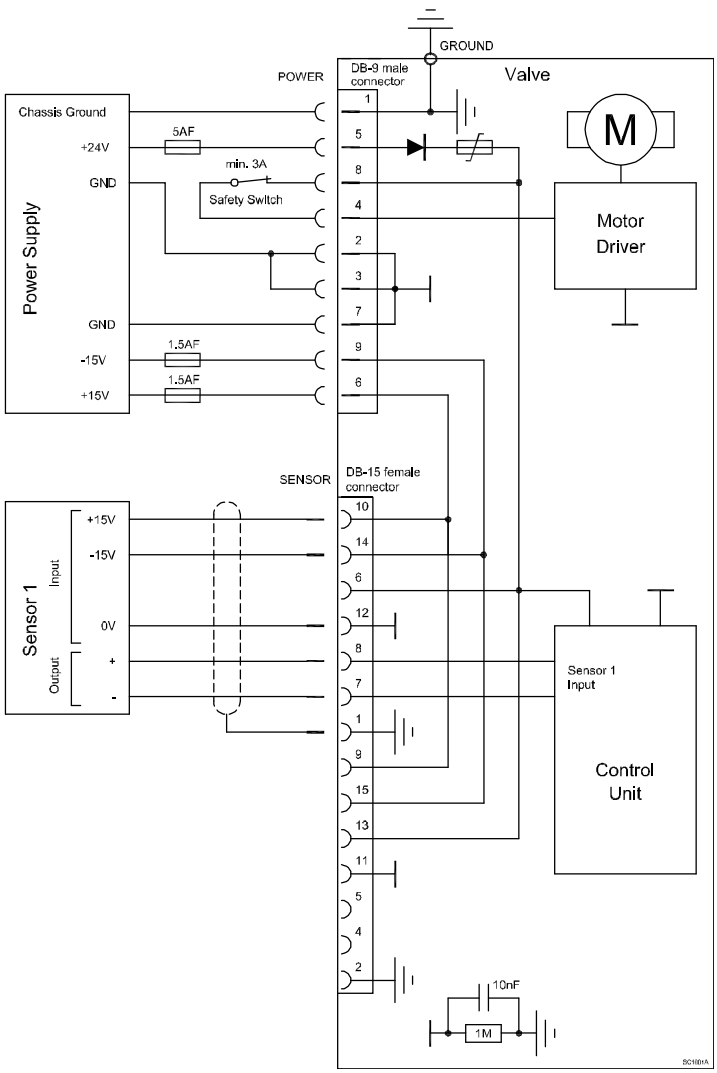
Pins 4 and 8 must be bridged for operation. An optional switch would allow for motor interlock to prevent valve from moving.

- Use shielded sensor cable(s). Keep cable as short as possible, but locate it away from noise sources.
- Connect Power supply (+24 / GND) at DB–9 male power connector and Sensors (0V / + / -) at DB–15 female sensor connector exactly as shown in the drawing above!
- Connector: Use only screws with 4–40 UNC thread for fastening the connectors!

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

[590 . . - . . **G** . - . . . . / 590 . . - . . **H** . - . . . . versions only]

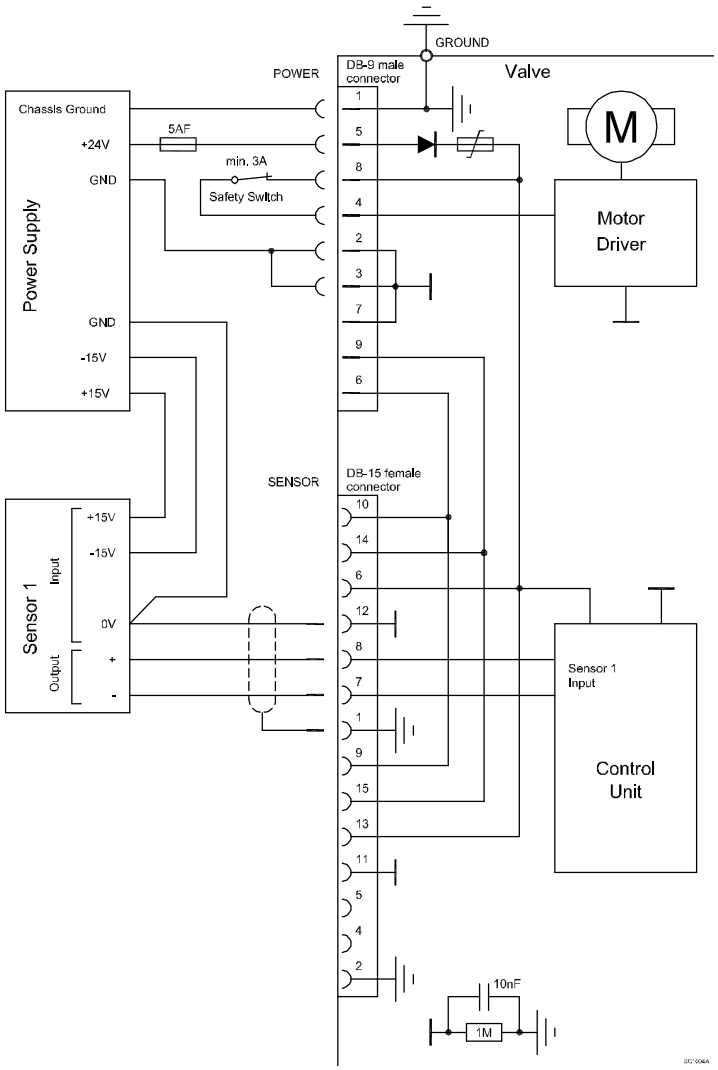
4.3.4.1 Sensor power wiring via controller



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

- Use shielded sensor cable(s). Keep cable as short as possible, but locate it away from noise sources.
- Connect Power supply (+24 / GND and GND / -15V / +15V) at DB–9 male power connector and Sensors (+15V / -15V / 0V / + / -) at DB–15 female sensor connector exactly as shown in the drawing above!
- Connector: Use only screws with 4–40 UNC thread for fastening the connectors!

4.3.4.1 Sensor power wiring external



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

- Use shielded sensor cable(s). Keep cable as short as possible, but locate it away from noise sources.
- Connect Power supply (+24 / GND and GND / -15V / +15V) at DB–9 male power connector and Sensors (0V / + / -) at DB–15 female sensor connector exactly as shown in the drawing above!
- Connector: Use only screws with 4–40 UNC thread for fastening the connectors!

4.3.5 Service port connection

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

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

4.4 RS232 interface

NOTICE

Wrong connection

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

Connect all cables exactly as shown in the following schematic.

4.4.1 Settings

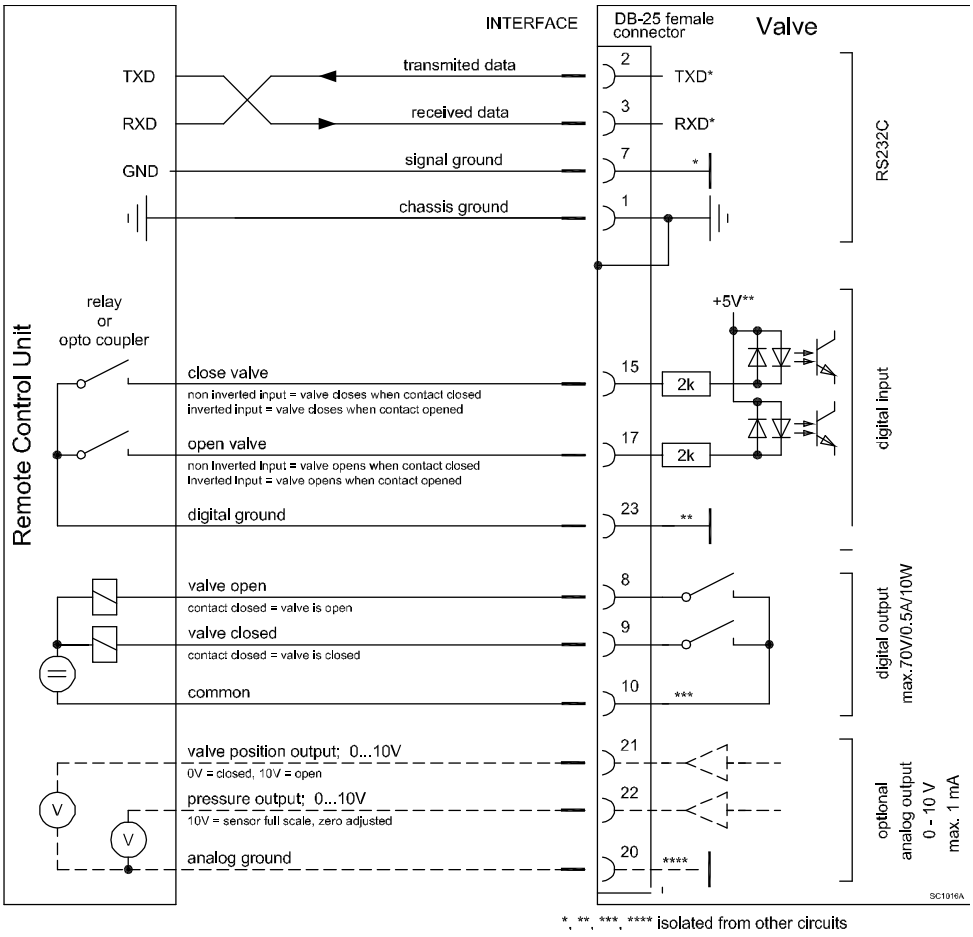
The factory default setting of the RS232 interface might be changed to fit the application by using the Control View software, the Control Performance Analyzer software or the Service Box 2. Refer to chapter: «RS232 Interface configuration».

4.4.2 RS232 Schematics

This interface allows for remote operation by means of a command set based on the RS232 protocol. In addition there are 2 digital inputs and 2 digital outputs. Digital inputs may be operated either by switches or by voltage sources.

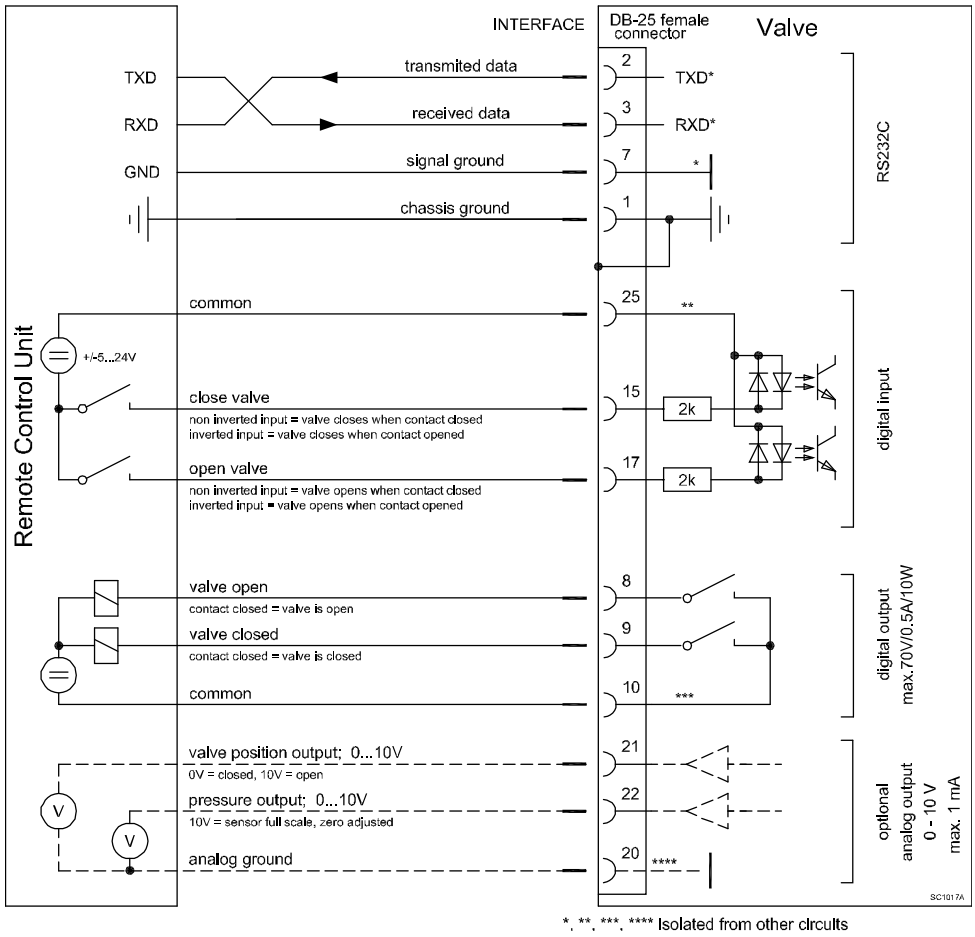
Active digital inputs have higher priority than RS232 commands.

4.4.2.1 Configuration with switches for digital inputs



- Connect the RS232 interface connector exactly as shown in the drawing above!
- Use only screws with 4–40 UNC thread for fastening the DB-25 connector!

4.4.2.2 Configuration with voltage source for digital inputs



- Connect the RS232 interface connector exactly as shown in the drawing above!
- Use only screws with 4–40 UNC thread for fastening the DB-25 connector!

4.4.2.3 Digital inputs

Pin	Function	Signal type	Description	Priority
15	**CLOSE VALVE**	Digital input [1)]	This function will close the valve. Valve will be in interlock mode as long as function is activated. After deactivation of function it will remain effective until - OPEN valve digital input is active - converse RS232 control command have been received The function is activated when optocoupler is 'on' in **non inverted** configuration. The function is activated when optocoupler is 'off' in **inverted** configuration. Configuration can be done in local operation via service port or in remote operation.	1 [2)]
17	**OPEN VALVE**	Digital input [1)]	This function will open the valve. Valve will be in interlock mode as long as function is activated. After deactivation of function it will remain effective until converse RS232 control command have been received. The function is activated when optocoupler is 'on' in **non inverted** configuration. The function is activated when optocoupler is 'off' in **inverted** configuration. Configuration can be done in local operation via service port or in remote operation.	2 [2)]
23	**DIGITAL GROUND**	Digital ground	Ground for all digital inputs. Ground is used when digital inputs are operated by switches. Connect switches to ground. See also to chapter: «Configuration with switches for digital inputs».	
25	**DIGITAL COMMON**	Digital common	Common for all digital inputs. Common is used when digital inputs are driven by voltage sources. Connect + or – terminal of source with common (optocoupler inputs are capable of bidirectional operation). See also chapter: «Configuration with voltage source for digital inputs».	

[1)] All digital inputs are digitally filtered. Filter delay is 50ms. This means that digital signals must be applied for at least 50ms to be effective. Refer to chapter: «Schematics» for details about input circuit.

[2)] Highest priority is 1. Functions with lower priorities will not be effective as long as higher priority functions are active. These digital inputs have higher priority than all RS232 commands. RS232 commands will not be accepted while digital inputs are active.

4.5 Initial operation

4.5.1 Setup procedure

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

Setup step		Description
1	**POWER UP**	Turn on external + 24VDC power supply (and external ±15 VDC for sensor power supply if required). Refer to chapter «Behavior during power up» for details.
2	**INTERFACE CONFIGURATION**	RS232 with analog output Baud rate, parity, data length and number of stop bits for valve must be selected. Refer to chapter «Interface configuration» for details.
3	**VALVE CONFIGURATION**	Basic configurations of the valve must be adapted according to application needs. Refer to chapter «Valve configuration» for details.
4	**SENSOR CONFIGURATION**	Basic configurations of the valve must be adapted according to application needs. Refer to chapter «Sensor configuration» for details.
5	**ZERO**	Compensation of the sensor offset voltage. Refer to chapter «ZERO» for details.
6	**Fixed PI upstream configuration**	Basic configurations of the valve must be adapted according to application needs. Refer to chapter «Fixed PI upstream configuration » for details.

4.5.2 RS232 Interface configuration

Interface configuration must be adapted according to application needs.

The factory default setting of the interface is shown in the table below.

Baud rate	Data bits	Stop bits	Parity	Digital input OPEN	Digital input CLOSE
9600	7	1	even	not inverted	not inverted

- Functionality of digital interlock inputs CLOSE VALVE and OPEN VALVE. These may be configured as ‘not inverted‘, ‘inverted‘ or ‘disabled‘. Default is ‘not inverted‘. Refer also to chapter «Digital inputs».
- Pressure and position range for RS232 communication must be selected. Default for pressure is 0 - 1‘000‘000. Default for position is 0 - 100‘000.

Local operation: (‘Control View’, ‘Control Performance Analyzer’ or ‘Service Box 2‘)	**Remote operation:** (Refer to chapter: «RS232 Setup commands» for details.)
Do configuration in menu ‘Setup / Interface’.	1. Send INTERFACE CONFIGURATION
	2. Send RANGE CONFIGURATION

4.5.3 LOGIC I/O configuration

Default configuration for LOGIC I/O are:

#	Function	Mode	Input
Digital input	close valve	non inverted	enabled
#	Function	Mode	Output
Digital output	close	non inverted	enabled

The «LOGIC I/O» Digital input and Digital output can be adjusted.

<table>
<tr><td>Local operation:
(‘Control View’, ‘Control Performance Analyzer’ or Hyper terminal)</td><td>Remote operation:</td></tr>
<tr><td>Go to ‘Tools / Terminal’ menu and use the following commands.

For Digital input:
to change the configuration: [s:2601][abcdef][CR][LF]
to read the configuration: [i:2601][CR][LF]

Each element is separated with square brackets for clarity. Square brackets are not part of command syntax. All elements are ASCII characters. There are no spaces between the elements necessary. Command is <u>case sensitive</u>.

data length 6 characters
a 0 = close valve
1 = open valve
b 0 = non inverted
1 = inverted
c 0 = enabled
1 = disabled
def 000 (reserved)

For Digital output:
to change the configuration: [s:2611][abcdef][CR][LF]
to read the configuration: [i:2611][CR][LF]

data length 6 characters
a 0 = close
1 = open
2 = On
b 0 = non inverted
1 = inverted
c 0 = enabled
1 = disabled
def 000 (reserved)

For LOGIC I/O connector schematics see also chapter «LOGIC I/O».</td><td>It’s not possible to configuration in remote operation.</td></tr>
</table>

4.5.4 Valve configuration

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

- **After power up**, default is ‘close‘.
- **Network failure**, for default settings refer to individual product data sheet.

Local operation: (‘Control Performance Analyzer’ or ‘Service Box 2‘)	**Remote operation**: (Refer to chapter «Setup commands» for details)
With CPA: • Do valve configuration in menu ‘Valve / Setup’. With SB2: • Do power up configuration in menu ‘Setup / Valve’. • Do power fail configuration in menu ‘Setup / Valve’.	1. Send VALVE CONFIGURATION

4.5.5 Sensor configuration

Basic sensor configuration must be adapted according to application needs.

- ZERO function: This may be ‘disabled’ or ‘enabled’. Default is ‘enabled‘. Refer also to chapter «ZERO».
- Sensor configuration with 1 sensor version [590 . . - . . . **G** - . . . .].

Local operation: (‘Control Performance Analyzer’ or ‘Service Box 2‘)	**Remote operation**: (Refer to chapter «RS232setup commands» for details)
With CPA: 1. Do sensor configuration in menu ‘Sensor / Setup’. With SB2: 2. Enable or disable ZERO function in menu ‘Setup / Sensor’. 3. Do 1 sensor configuration in menu ‘Setup / Sensor’.	Send SENSOR CONFIGURATION[1)]

4.5.6 ZERO

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

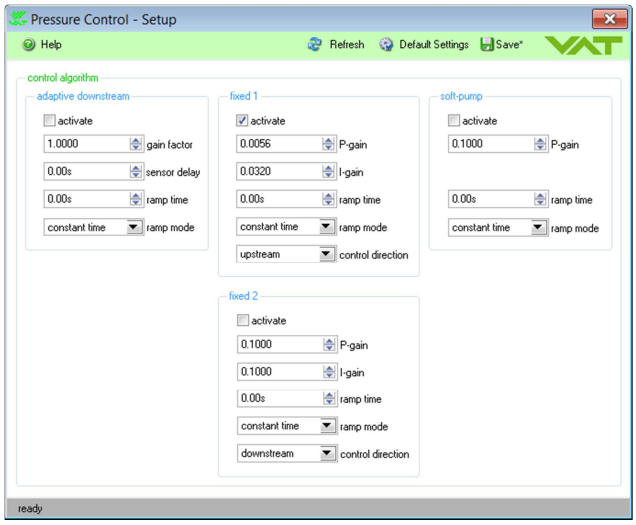
Local operation: ('Control Performance Analyzer' or 'Service Box 2')	**Remote operation**: (Refer to chapter «Control commands» resp. «Setup commands» for details)
With CPA: 4. Do the ZERO in menu 'Sensor / Zero'. With SB2: 5. Go to menu 'Zero / ZERO' and follow instructions.	1. Send OPEN VALVE
	2. Wait until process chamber is evacuated and sensor signal is not shifting anymore.
	3. Send ZERO

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

4.5.7 Fixed PI upstream configuration

For easy setup (Local operation) of ‘Pressure controller’ and ‘Pressure control parameter’ please use the VAT “Control Performance Analyzer” CPA 3.0.

There is a free download on the VAT home page, refer to: http://www.vatvalve.com/customer-service/informations-and-downloads/control-performance-analyzer

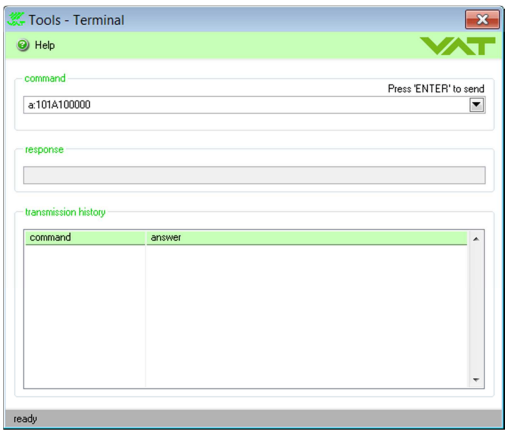
Local operation: (‘Control Performance Analyzer’ 3.0)	**Remote operation**:
1. Open the CPA 2. Click [Enter CPA] 3. Click [LOCAL] 4. Click [Setup] in menu ‘Pressure Control’ 1. Activate “fixed 1” (fixed PI upstream) and do the setup parameter adjustment according to application needs. (Default: P-Gain: 0.0056 / I-Gain: 0.0320) 	Refer to «Setup commands» > PRESSURE CONTROLLER CONFIGURATION.

4.5.7.1 Position Limit open adjustment

Setup function	Command		Acknowledgement
	Description		
POSITION LIMIT OPEN	Set	**a:101A**aaaaaa	**a: 101A**
	Get	**a: 101A**	**a: 101A**aaaaaa
	data length 6 characters a Position Limit open 1…100'000 (Default is 100'000) This function does the «Position Limit open».		

Adjust the «Position Limit open» with Local operation. Refer the chapter: «Local operation» and follow the instructions.

- Open the CPA 3.0
- Click [LOCAL]
- Go to Tools / Terminal
- Enter (example) a:101A100000



4.6 Tuning of control performance

- Tuning of pressure control performance with PI control, refer to chapter: 4.7.2 Tuning of control performance with fixed PI pressure controller

4.6.1 Tuning of control performance with fixed PI pressure controller

4.6.1.1 Optimizing P gain and I gain

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

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

Local operation: ('Control Performance Analyzer')	**Remote operation**: (Refer to chapter «Pressure control algorithm» > «Fixed 1 control algorithm » for details)
With CPA: Do the 'fixed 1' adjustment in menu 'Pressure Control' / 'Setup' / 'fixed 1'. (Default: P-Gain: 0.0056 / I-Gain: 0.0320)	Send 'Fixed 1 control algorithm parameter'.

Introduction

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

1. Optimizing P gain and I gain.

1.1 Pressure and gas flow for optimization

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

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

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

Pressure set points and gas flow for optimization:

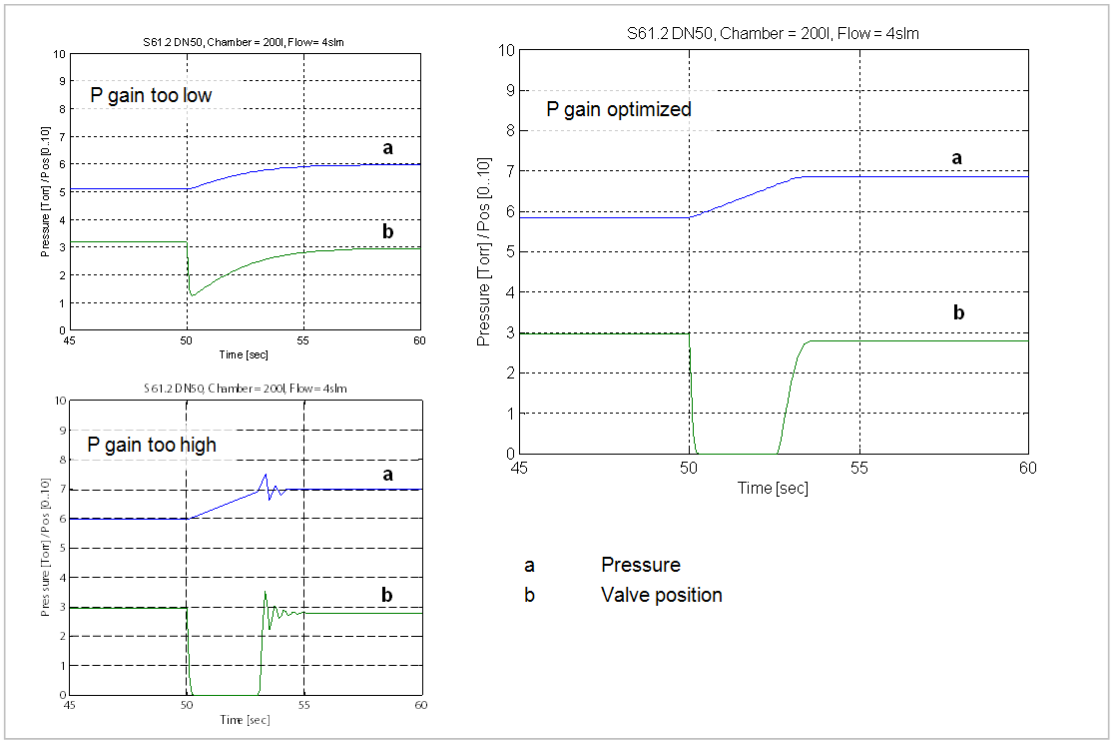
SP1	=	7 Torr
SP2	=	6 Torr
Gas flow	=	4slm

1.2 Optimizing P gain

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

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

Example:

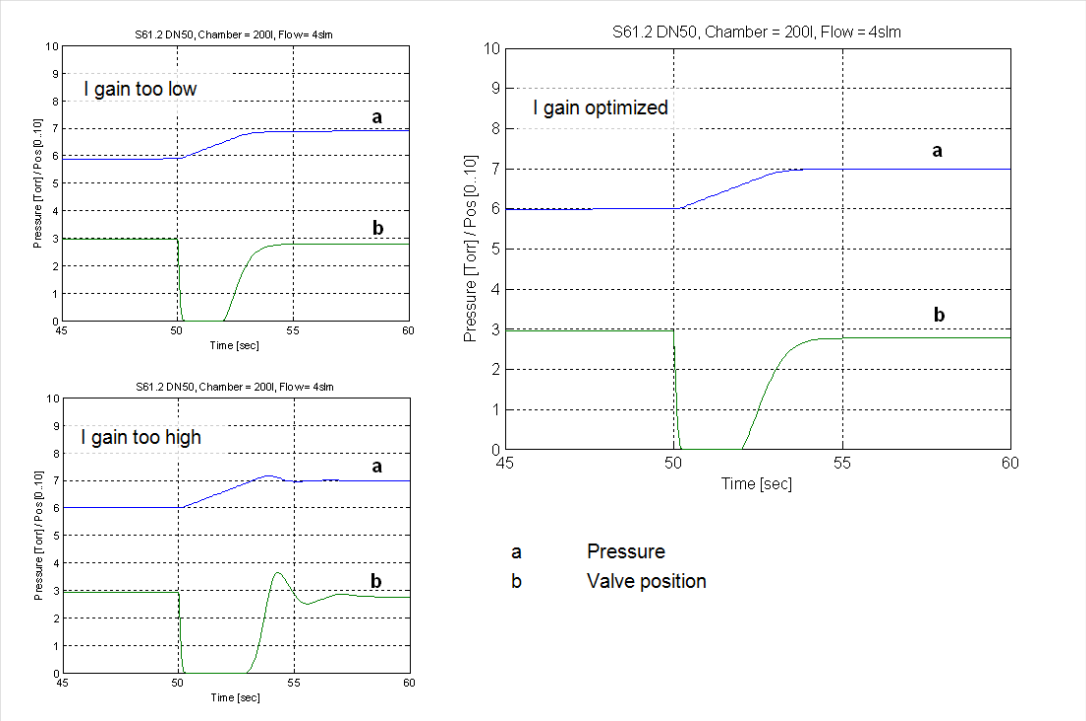


1.3 Optimizing I gain

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

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

Example:



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

Required information for support:

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

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

4.7 RS232 interface commands

4.7.1 RS232 command syntax

- Commands and values are case sensitive.
- Acknowledgement within 10ms after reception of command.
- Wait for acknowledgement before sending a new command.
- Command termination of each command is CR and LF.
  CR = Carriage Return (0D hexadecimal), LF = Linefeed (0A hexadecimal)

4.7.2 Control commands

Control function	Command		Acknowledgement
	Description		
CLOSE VALVE	Set	**C:**	**C:**
	Valve will close.		
OPEN VALVE	Set	**O:**	**O:**
	Valve will open.		
HOLD	Set	**H:**	**H:**
	This function stops the valve at the current position. It is effective in PRESSURE CONTROL and POSITION CONTROL. The function can be revoked by a POSITION CONTROL, PRESSURE CONTROL, OPEN VALVE or CLOSE VALVE command.		
POSITION CONTROL	Set	**R:**aaaaaa	**R:**
	Get	**i:38**	**i:38**aaaaaaaa
	data length for Set 6 characters, for Get 8 characters aaaaaa position SETPOINT, value depends on configuration, refer to «RS232 setup commands, COMMUNICATION RANGE» for details Change to POSITION CONTROL mode and transfer of position SETPOINT value resp. reading of position SETPOINT. **Remark:** Reading returns position setpoint only in case pressure control is not selected.		
PRESSURE CONTROL	Set	**S:**aaaaaaaa	**S:**
	Get	**i:38**	**i:38**aaaaaaaa
	data length 8 characters aaaaaaaa pressure SETPOINT, value depends on configuration, refer to «RS232 setup commands, COMMUNICATION RANGE» for details Change to PRESSURE CONTROL mode and transfer of pressure SETPOINT resp. reading of pressure SETPOINT. **Remark:** Reading returns pressure setpoint only in case pressure control is selected, otherwise position setpoint is returned.		

4.7.3 Inquiry commands

Inquiry function	Command	Acknowledgement
	Description	
POSITION	Get **A:**	**A:**aaaaaa
	data length 6 characters aaaaaa position, return value depends on configuration, refer to «RS232 setup commands, COMMUNICATION RANGE» for details This function returns the current valve position. **Remark:** 999'999 is returned when the position is unknown, for example after power up during synchronization	
PRESSURE	Get **P:**	**P:**saaaaaaa
	data length 8 characters s sign, 0 for positive readings, - for negative readings aaaaaaa pressure, return value depends on configuration, refer to «RS232 setup commands, COMMUNICATION RANGE» for details This function returns the actual pressure.	
SENSOR 1 OFFSET	Get **i:60**	**i:60**aaaaaaaa
	data length 8 characters aaaaaaaa sensor 1 offset (-140000 ... 0140000 = -1.4V ... +1.4V) This function returns the sensor 1 offset voltage (adjusted by ZERO).	
SENSOR 2 OFFSET (not used)	Get **i:61**	**i:61**aaaaaaaa
	data length: 8 characters aaaaaaaa sensor 2 offset (-140000 ... 0140000 = -1.4V ... +1.4V) This function returns the sensor 2 offset voltage (adjusted by ZERO).	
SENSOR 1 READING	Get **i:64**	**i:64**saaaaaaa
	data length 8 characters s sign, 0 for positive readings, - for negative readings aaaaaaa sensor 1 reading, return value depends on configuration, refer to «RS232 setup commands, COMMUNICATION RANGE» for details This function returns direct reading from sensor 1 input.	
SENSOR 2 READING (not used)	Get **i:65**	**i:65**saaaaaaa
	data length 8 characters s sign, 0 for positive readings, - for negative readings aaaaaaa sensor 2 reading, return value depends on configuration, refer to «RS232 setup commands, COMMUNICATION RANGE» for details This function returns direct reading from sensor 2 input.	

Inquiry function	Command	Acknowledgement
	Description	
DEVICE STATUS	Get **i:30**	**i:30**abcdefgh
	data length 8 characters a Access Mode **0** = local operation **1** = remote operation **2** = locked remote operation b Control Mode **1** = synchronization **2** = POSITION CONTROL **3** = CLOSED **4** = OPEN **5** = PRESSURE CONTROL **6** = HOLD **7** = (reserved) **8** = INTERLOCK OPEN (by digital input) **9** = INTERLOCK CLOSED (by digital input) **C** = power failure **D** = safety mode **E** = fatal error (read «FATAL ERROR STATUS» for details) c Power Failure Option **0** = disabled **1** = enabled d Warning **0** = no warnings **1** = warnings (read «WARNINGS» and «ERROR STATUS» for details) efg Reserved h Simulation **0** = normal operation **1** = system simulation running This function returns status information about the valve. **Remark:** In simulation mode the valve can demonstrate pressure control capability independent of other equipment such as vacuum chamber, flow controller and gauge. Normal operation is not possible when simulation is running.	
FATAL ERROR STATUS	Get **i:50**	**i:50**abc
	data length 3 characters abc error code See in chapter «Trouble shooting» for details. This function returns an error code in case of any malfunction of the device.	

Inquiry function	Command	Acknowledgement
	Description	
WARNINGS	Get **i:51**	**i:51**abcdefgh
	data length 8 characters a **0** = no service required **1** = service request, it is indicated when the control unit detects that motor steps are apparently not effective. This may happen when the valve is heavily contaminated or the gate seal is heavily sticking. These ‚lost' steps are recognized and will be repeated to attempt target position in the short term. But in the medium term the valve requires cleaning or inspection. b **0** = LEARN (not used) data set present, **1** = LEARN (not used) data set not present c **0** = power failure battery ready **1** = power failure battery not ready d **0** = compressed air supply ok **1** = compressed air supply not ok efgh reserved, do not use This function returns warning information about the valve. If a warning is present countermeasure should be taken. Use RESET command to delete service request bit. **Remark:** Without LEARN (not used)the valve is not able to run pressure control	
THROTTLE CYCLE COUNTER	Get **i:70**	**i:70**aaaaaaaaaa
	data length 10 characters aaa…aaa number of throttle cycles This function returns the number of throttle cycles. A movement from max. throttle position to open back to max. throttle position counts as one cycle. Partial movements will be added up until equivalent movement is achieved.	
ISOLATION CYCLE COUNTER	Get **i:71**	**i:71**aaaaaaaaaa
	data length 10 characters aaa…aaa number of isolation cycles This function returns the number of isolation cycles. Each closing of the sealing ring counts as one cycle.	
POWER UP COUNTER	Get **i:72**	**i:72**aaaaaaaaaa
	data length 10 characters aaa…aaa number of power ups This function returns the number of control unit power ups.	

Inquiry function	Command	Acknowledgement
	Description	
ASSEMBLY	Get **i:76**	**i:76**xxxxxxsyyyyyyyabc
	data length 17 characters xxxxxx position, return value depends on configuration, refer to «RS232 setup commands, COMMUNICATION RANGE» for details s sign, 0 for positive pressure readings, - for negative pressure readings yyyyyyy pressure, return value depends on configuration, refer to «RS232 setup commands, COMMUNICATION RANGE» for details a **0** = local operation **1** = remote operation **2** = locked remote operation b **0** = Initialization (refer to chapter: «Behavior during power up») **1** = synchronization **2** = POSITION CONTROL **3** = CLOSE **4** = OPEN **5** = PRESSURE CONTROL **6** = HOLD **7** = LEARN (not used) **8** = INTERLOCK OPEN (by digital input) **9** = INTERLOCK CLOSE (by digital input) **C** = power failure **D** = safety mode **E** = fatal error (read «FATAL ERROR STATUS» for details) c **0** = no warning **1** = warning present (read «WARNINGS» and «ERROR STATUS» for details) This function returns an assembly consisting of POSITION, PRESSURE and main status information for the valve.	
HARDWARE CONFIGURATION	Get **i:80**	**i:80**abcdefgh
	data length 8 characters a **0** = Power Failure Option (PFO) not equipped **1** = Power Failure Option (PFO) equipped b **0** = ±15V sensor power supply (SPS) not equipped **1** = ±15V sensor power supply (SPS) equipped c **2** = RS232 Interface without analog outputs **3** = RS232 Interface with analog outputs d **1** = 1 sensor version, **2** = 2 sensor version efgh reserved, do not use This function returns the hardware configuration of the device.	
FIRMWARE CONFIGURATION	Get **i:82**	**i:82**aaaaaaaa
	data length 8 characters aaaaaaaa firmware version, e.g. 600P1G0002 This function returns firmware version of the device.	
IDENTIFICATION	Get **i:83**	**i:83**aaaaaaaaaaaaaaaaaaaa
	data length 20 characters aaa...aaa with identification code, e.g. 59024-GEAG-0001/0001/, unused digits are filled up spaces (20 hexadecimal) This function returns an identification code. This code is unique for each valve and allows tracing.	

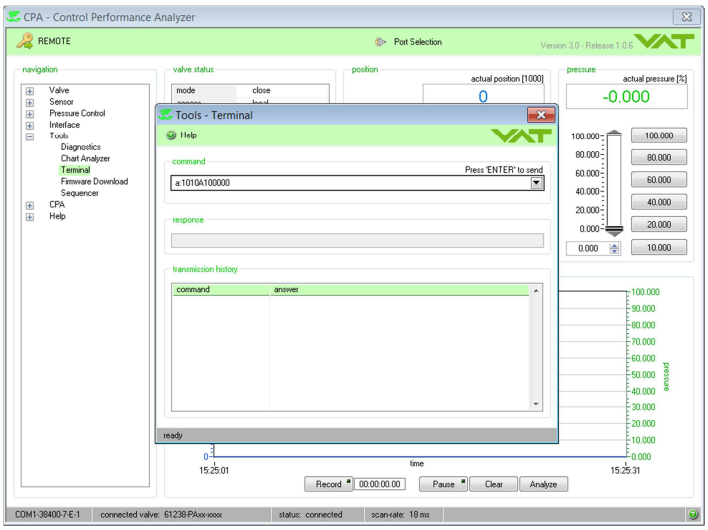
Inquiry function	Command	Acknowledgement
	Description	
FIRMWARE NUMBER	Get **i:84**	**i:84**aaaaaa
	data length 20 characters aaaaaa Firmware number e.g. 769650 This function returns the VAT Firmware number.	

4.7.4 Position Limit open (setup command)

Setup function	Command	Acknowledgement
	Description	
POSITION LIMIT OPEN	Set **a:101A**aaaaaa	**a: 101A**
	Get **a: 101A**	**a: 101A**aaaaaa
	data length 6 characters a Position Limit open 1…100'000 (Default is 100'000) This function does the «Position Limit open».	

It is also possible to do «Position Limit open» with Local operation. Refer the chapter: «Local operation» and follow the instructions.

- Open the CPA 4.0
- LOCAL
- Tools / Terminal



Example

4.7.5 Setup commands

Setup function	Command		Acknowledgement
	Description		
ACCESS MODE	Set	**c:01**aa	**c:01**
	data length: 2 characters aa **00** = local operation (service port) **01** = remote operation, change to local enabled **02** = locked remote operation, change to local not possible via service port This function selects the access authorization to the valve. To read access mode use inquiry command DEVICE STATUS. **Remark:** If ACCESS MODE is local operation and communication to service port is interrupted the valve will automatically change to remote operation.		
VALVE CONFIGURATION	Set	**s:04**abcdefgh	**s:04**
	Get	**i:04**	**i:04**abcdefgh
	data length 8 characters a Valve position after power up **0** = close, **1** = open b Valve position after power failure **0** = close, **1** = open c External isolation valve function **0** = no, **1** = yes d Control stroke limitation **0** = no, **1** = yes e Network failure end position **0** = valve will close, **1** = valve will open, **2** = valve stay on actual position f Slave offline position **0** = valve will close, **1** = valve will open, **2** = valve stay on actual position g Synchronization start **0** = standard, **1** = special command, **2** = open command, **3** = all move commands, **4** = always h Synchronization mode **0** = short, **1** = full This function does the valve configuration.		

<table>
<tr><th rowspan="2">Setup function</th><th colspan="2">Command</th><th>Acknowledgement</th></tr>
<tr><th colspan="3">Description</th></tr>
<tr><td rowspan="3">SENSOR
CONFIGURATION</td><td>Set</td><td>s:01abcdefgh</td><td>s:01</td></tr>
<tr><td>Get</td><td>i:01</td><td>i:01abcdefgh</td></tr>
<tr><td colspan="3">data length 8 characters
a 0 = no sensor
1 = 1 sensor operation (sensor 1 input)
2 = 2 sensor operation with automatic changeover (not used)
(low range = sensor 2 input, high range = sensor 1 input)
3 = 1 sensor operation (sensor 2 input)
4 = 2 sensor operation with automatic changeover (not used)
(low range = sensor 1 input, high range = sensor 2 input)
Remark: Sensor operation modes 2, 3 and 4 are possible with 2 sensors (590 . . - . . . H - . . . . and 590 . . - . . . W - . . . .) only.
Remark: For applications where the high range sensor is used for for monitoring purpose only, select sensor operation modes 1 or 3 for pressure control with low range sensor and read high range sensor from «SENSOR 2 READING» resp. «SENSOR 1 READING».
b 1 = ZERO enabled, 0 = ZERO disabled
cdefgh High range / Low range sensor full scale ratio * 1’000 (1000 … 100000).
In case of a 1 sensor valve use any value within the valid range.
This function does the sensor configuration.</td></tr>
</table>

<table>
<tr><th rowspan="2">Setup function</th><th colspan="2">Command</th><th>Acknowledgement</th></tr>
<tr><th colspan="3">Description</th></tr>
<tr><td rowspan="3">SENSOR SCALE</td><td>Set</td><td>s:05aaaaabcd</td><td>s:05</td></tr>
<tr><td>Get</td><td>i:05</td><td>i:05aaaaabcd</td></tr>
<tr><td colspan="3">data length 8 characters

a Value 00001…99999 (10000 = 1.0000)
b Sign Exponent 0 = “-“, 1 = “+”
c Exponent 0…4
d Pressure Unit 0 = Pa
1 = bar
2 = mbar
3 = ubar
4 = Torr
5 = mTorr
6 = atm
7 = psi
8 = psf

Example: 10000114 = 10Torr (input from high range sensor)</td></tr>
<tr><td rowspan="3">SENSOR 1 LINEARIZATION</td><td>Set</td><td>s:17aaaabbbb</td><td>s:17</td></tr>
<tr><td>Get</td><td>i:17</td><td>i:17aaaabbbb</td></tr>
<tr><td colspan="3">data length 8 characters

a logarithmic resolution[millivolt /decade]
0000 = linearizing off
0001 = min. value
9999 = max. value
(default value: 0000 = linearizing off)

b full scale [millivolt]
0001 = min. value
9999 = max. value
(default value in logarithmic mode: 5324 = 5.324V)
(becomes linear full scale = 1000000)

Pressure control algorithm adaptive downstream needs a linear sensor signal, therefore a logarithmic signal must be linearized.

Example: s:1700000000 = Linear sensor
Example: s:1810007800 = Logarithmic sensor (1.0V/decade, Linear full scale at 7.8V)</td></tr>
</table>

<table>
<tr><th rowspan="2">Setup function</th><th colspan="2">Command</th><th>Acknowledgement</th></tr>
<tr><th colspan="3">Description</th></tr>
<tr><td rowspan="4">SENSOR 2
LINEARIZATION
(not used)</td><td>Set</td><td>s:18aaaabbbb</td><td>s:18</td></tr>
<tr><td>Get</td><td>i:18</td><td>i:18aaaabbbb</td></tr>
<tr><td colspan="3">data length 8 characters

a logarithmic resolution[millivolt /decade]
0000 = linearizing off
0001 = min. value
9999 = max. value
(default value: 0000 = linearizing off)

b full scale [millivolt]
0001 = min. value
9999 = max. value
(default value in logarithmic mode: 5324 = 5.324V)
(becomes linear full scale = 1000000)

Pressure control algorithm adaptive downstream needs a linear sensor signal, therefore a logarithmic signal must be linearized.

Example: s:1700000000 = Linear sensor
Example: s:1810007800 = Logarithmic sensor (1.0V/decade, Linear full scale at 7.8V)</td></tr>
<tr><td rowspan="4">SENSOR AVERAGE</td><td>Set</td><td>s:19abbbbbbb</td><td>s:19</td></tr>
<tr><td>Get</td><td>i:19</td><td>i:19abbbbbbb</td></tr>
<tr><td colspan="3">data length 8 characters

a Average time 0 = 0.0 sec
1 = 0.1 sec
2 = 0.2 sec
3 = 0.3 sec
4 = 0.4 sec
5 = 0.5 sec
6 = 0.6 sec
7 = 0.7 sec
8 = 0.8 sec
9 = 0.9 sec
A = 1.0 sec
b Reserved set to 0000000

Remark: For pressure control averaging of sensor signal is not recommended.
This function does the sensor average configuration.</td></tr>
</table>

<table>
<tr><th rowspan="2">Setup function</th><th colspan="2">Command</th><th>Acknowledgement</th></tr>
<tr><th colspan="3">Description</th></tr>
<tr><td rowspan="3">COMMUNICATION RANGE CONFIGURATION</td><td>Set</td><td>s:21abcdefgh</td><td>s:21</td></tr>
<tr><td>Get</td><td>i:21</td><td>i:21abcdefgh</td></tr>
<tr><td colspan="3">data length 8 characters
a range for POSITION: 0 = 0 – 1’000, 1 = 0 – 10’000, 2 = 0 – 100’000
bcdefgh upper value for PRESSURE and SENSOR READING: 1000 ... 1000000
e.g. 0010000 -> pressure range 0 – 10’000
This function defines the communication range between the valve and the host computer for POSITION, PRESSURE and SENSOR READING.
Remark: In case ZERO has been performed, gauge offset for PRESSURE and SENSOR READING is compensated.
Remark: In case 2 sensor operation for pressure control is selected, PRESSURE covers high range gauge because switchover between sensors is done automatically.
SENSOR 1 READING and SENSOR 2 READING always return full scale values according to selected range.</td></tr>
</table>

<table>
<tr><th rowspan="2">Setup function</th><th colspan="2">Command</th><th>Acknowledgement)</th></tr>
<tr><th colspan="3">Description</th></tr>
<tr><td rowspan="3">INTERFACE CONFIGURATION</td><td>Set</td><td>s:20abcdefgh</td><td>s:20</td></tr>
<tr><td>Get</td><td>i:20</td><td>i:20abcdefgh</td></tr>
<tr><td colspan="3">data length 8 characters
a baud rate:
0 = 600
1 = 1200k
2 = 2400
3 = 4800
4 = 9600
5 = 19.2k
6 = 38.4k
7 = 57.6k
8 = 115.2k
b parity bit:
0 = even
1 = odd
2 = mark
3 = space
4 = no
c data length:
0 = 7 bit
1 = 8 bit
d number of stop bits:
0 = 1
1 = 2
e 0 (reserved, do not change)
f digital input OPEN VALVE:
0 = not inverted
1 = inverted
2 = disabled
g digital input CLOSE VALVE:
0 = not inverted
1 = inverted
2 = disabled
h 0 (reserved, do not change)
This function does the RS232 and digital input configuration.
Remark: Digital outputs are always enabled.</td></tr>
<tr><td rowspan="2">ZERO</td><td>Set</td><td>Z:</td><td>Z:</td></tr>
<tr><td colspan="3">This command initiates ZERO to compensate for offset of gauge(s).
Remark: Refer to «ZERO» for correct zero procedure.</td></tr>
<tr><td rowspan="2">PRESSURE ALIGNMENT</td><td>Set</td><td>c:6002aaaaaaaa</td><td>c:60</td></tr>
<tr><td colspan="3">data length: 8 characters
aaaaaaaa System base pressure, value depends on configuration, refer to «RS232 setup commands, COMMUNICATION RANGE» for details. Alignment range is equivalent to max. +/-1.4V sensor signal.
This command aligns PRESSURE to a certain value. Also SENSOR READING will be aligned accordingly. It might be used instead of ZERO in case base pressure is not low enough.</td></tr>
</table>

<table>
<tr><th rowspan="2">Setup function</th><th colspan="2">Command</th><th>Acknowledgement</th></tr>
<tr><th colspan="3">Description</th></tr>
<tr><td rowspan="4">VALVE SPEED</td><td>Set</td><td>V:00aaaa</td><td>V:</td></tr>
<tr><td>Get</td><td>i:68</td><td>i:680000aaaa</td></tr>
<tr><td colspan="3">data length 6 characters starting with double zero for writing
8 characters starting with quadruple zero for reading
aaaa valve speed, 1 ... 1000 (1 = min. speed, 1000 = max. speed)
This command allows changing the actuating speed of the valve plate. Speed selection is effective for pressure control and position control. Open valve and close valve are always done with max. speed.
Remark: Refer to «Valve speed adjustment» for details.</td></tr>
<tr><td rowspan="2">RESET</td><td>Set</td><td>c:82aa</td><td>c:82</td></tr>
<tr><td colspan="3">data length 2 characters
aa 00 = reset service request bit from WARNINGS
01 = reset FATAL ERROR (restart control unit)
This function resets warnings and errors.</td></tr>
<tr><td rowspan="3">PRESSURE CONTROLLER</td><td>Set</td><td>s:02Z00a
select pressure controller as active pressure controller</td><td>s:02</td></tr>
<tr><td>Get</td><td>i:02Z00
get active pressure controller</td><td>i:02Z00a</td></tr>
<tr><td colspan="3">This command selects the pressure controller mode.
a Pressure controller:
0 = Adaptive downstream
1 = Fixed 1 (PI) upstream (default)
2 = Fixed 2 (PI) (downstream or upstream)
3 = Soft pump
Examples:
• To set the soft pump pressure controller as active pressure controller, send s:02Z003
• If the answer of the command i:02Z00 is i:02Z002, the fixed 2 pressure controller is active.</td></tr>
</table>

<table>
<tr><th rowspan="2">Setup function</th><th colspan="2">Command</th><th>Acknowledgement</th></tr>
<tr><th colspan="3">Description</th></tr>
<tr><td rowspan="4">PRESSURE CONTROLLER CONFIGURATION</td><td>Set</td><td>s:02abbc
configure parameter: set parameter bb of pressure controller a to value c</td><td>s:02</td></tr>
<tr><td>Get</td><td>i:02abb
get value c of parameter bb of pressure controller a</td><td>i:02abbc</td></tr>
<tr><td colspan="3"><table>
<tr><td>a</td><td>Pressure controller:
A = Adaptive downstream pressure controller
B = Fixed 1 pressure controller (downstream or upstream)
C = Fixed 2 pressure controller (downstream or upstream)
D = Soft pump pressure controller</td></tr>
<tr><td>bb</td><td>Parameter number
(see table below)</td></tr>
<tr><td>c</td><td>Parameter value, depends on parameter number a floating-point type or a integral type value, max length = 20 characters

floating-point type
format: x.y or x
Maximum length of expression: 12
Examples: 3455.1505, 21154.0 or 318

integer type
format: x
Maximum length of expression: 12
Examples: 9785, 4565, 1</td></tr>
</table>
For details (commands etc.), see the next tables.</td></tr>
</table>

4.7.5.1 Overview pressure controller

Parameter	Parameter number (bb)	Pressure controller (a)			
		A Adaptive	**B Fixed 1**	**C Fixed 2**	**D Soft pump**
SENSOR DELAY	00	✓	–	–	–
RAMP TIME	01	✓	✓	✓	✓
RAMP MODE	02	✓	✓	✓	✓
CONTROL DIRECTION	03	–	✓	✓	–
P-GAIN (for A = GAIN FACTOR)	04	✓	✓	✓	✓
I-GAIN	05	–	✓	✓	–

✓ Existent for this pressure controller / – Not used for this pressure controller

Command examples:

Set GAIN FACTOR of the adaptive pressure controller to the value 1.075	s:02A041.075
GET GAIN FACTOR of adaptive pressure controller	i:02A04 → Answer is i:02A041.075 → Value = 1.075
Set RAMP TIME of soft pump pressure controller to the value 281 seconds	s:02D01281
Get RAMP TIME of soft pump pressure controller	i:02D01 → Answer is i:02D01281→ Value = 281

4.7.6 Pressure control algorithem

4.7.6.1 Adaptive control algorithm (downstream)

Parameter	Command		Request	Data Type	Values
SENSOR DELAY	Set	s:02A00**c**	s:02	FLOAT	**c** = 0.00…1.00 Default is: 0.00 s
	Get	i:02A00	i:02A00**c**		
RAMP TIME	Set	s:02A01**c**	s:02	FLOAT	**c** = 0.00…1'000'000.0 Default is: 0.00 s
	Get	i:02A01	i:02A01**c**		
RAMP MODE	Set	s:02A02**c**	s:02	UINT	**c** = 0 or 1 **0** = constant time **1** = constant slope Default is: 0
	Get	i:02A02	i:02A02c		
GAIN FACTOR	Set	s:02A04**c**	s:02	FLOAT	**c** = 0.0001…7.5 Default is: 1.0
	Get	i:02A04	i:02A04**c**		

Explanation:

SENSOR DELAY
Sensor response time [s]
The SENSOR DELAY is a control parameter to compensate delays during the pressure detection. Pipes and orifices for sensor attachment can cause delays in response time and could impact badly the pressure control stability. By adapting this parameter to the approximate delay time stability problems can be reduced. But control response time will be slowed down by this measure.

RAMP TIME
Pressure setpoint ramp time [s]

RAMP MODE

Mode = 0 Cocnstant Time	The RAMP TIME is dependent on the adjusted parameter ramp time and is always the same independent of the control deviation. That means the ramp time from the actual value to the setpoint value is the adjusted parameter ramp time value.
Mode = 1 Constant Slope	The RAMP TIME is dependent on the adjusted parameter ramp time and is different depending on the control deviation. The RAMP TIME is calculated corresponding to the sensor full scale value (10V). Ramp time = 10 sec.; ramp time slope is SFS (10V) in 10 Seconds.

In the adaptive pressure controller mode, the RAMP TIME parameter also can be a value to minimize over- / undershooting. The ramp could be used to harmonize the adaptive control algorithm.

GAIN FACTOR
The GAIN FACOTR is a control parameter to adapt the performance of the pressure control algorithm. A higher gain results in faster response, higher over- / undershoot of pressure. A lower gain results in slower response, lower over- / undershoot of pressure.

Example:
Set SENSOR DELAY of the adaptive pressure controller to the value 0.75

Command	Pressure controller	Parameter selection variable	Parameter value (seconds)
s:02	**A** (a)	**00** (bb)	**0.75** (c)

→ s:02A000.75

To optimize adaptive control algorithm, refer to chapter «Tuning of control performance».

4.7.6.2 Fixed 1 control algorithm (default fixed PI upstream)

Parameter	Command		Request	Data Type	Values
RAMP TIME	Set	s:02B01**c**	s:02	FLOAT	**c** = 0.00…1'000'000.0 Default is: 0.00
	Get	i:02B01	i:02B01**c**		
RAMP MODE	Set	s:02B02**c**	s:02	UINT	**c** = 0 or 1 **0** = constant time **1** = constant slope Default is: 0
	Get	i:02B02	i:02B02**c**		
CONTROL DIRECTION	Set	s:02B03**c**	s:02	UINT	**c** = 0 or 1 **0** = downstream **1** = upstream Default is: 0
	Get	i:02B03	i:02B03**c**		
P-GAIN	Set	s:02B04**c**	s:02	FLOAT	**c** = 0.001…100 Default is: 0.0056
	Get	i:02B04	i:02B04**c**		
I-GAIN	Set	s:02B05**c**	s:02	FLOAT	**c** = 0…100.0 Default is: 0.0320
	Get	i:02B05	i:02B05**c**		

Explanation:

RAMP TIME
Pressure setpoint ramp time [s]

RAMP MODE

Mode = 0 Constant Time	The RAMP TIME is dependent on the adjusted parameter ramp time and is always the same independent of the control deviation. That means the ramp time from the actual value to the setpoint value is the adjusted parameter ramp time value.
Mode = 1 Constant Slope	The RAMP TIME is dependent on the adjusted parameter ramp time and is different depending on the control deviation. The RAMP TIME is calculated corresponding to the sensor full scale value (10V). Ramp time = 10 sec.; ramp time slope is SFS (10V) in 10 Seconds.

CONTROL DIRECTION
The CONTROL DIRECTION defines the type of application, if the valve is mounted in downstream or upstream. Downstream means the valve is after the chamber and before the pump. Upstream, valve is mounted before chamber and pump.

P-GAIN / I-GAIN
The P-GAIN is the proportional factor of the fixed control algorithm. The I-GAIN is the integral factor.

Example:
Set RAMP MODE of the Fixed 1 pressure controller to the value 0 (fixed time)

Command	Pressure controller	Parameter selection variable	Parameter value
s:02	**B** (a)	**02** (bb)	**0** (c)

→ s:02B020

To optimize Fixed 1 control algorithm, refer to chapter «Tuning of control performance».

4.7.6.3 Fixed 2 control algorithm

Parameter	Command		Request	Data Type	Values
RAMP TIME Pressure setpoint ramp time [s]	Set	s:02C01**c**	s:02	FLOAT	**c** = 0.00…1'000'000.0 Default is: 0.00
	Get	i:02C01	i:02C01**c**		
RAMP MODE	Set	s:02C02**c**	s:02	UINT	**c** = 0 or 1 **0** = constant time **1** = constant slope Default is: 0
	Get	i:02C02	i:02C02**c**		
CONTROL DIRECTION	Set	s:02C03**c**	s:02	UINT	**c** = 0 or 1 **0** = downstream **1** = upstream Default is: 0
	Get	i:02C03	i:02C03**c**		
P-GAIN	Set	s:02C04**c**	s:02	FLOAT	**c** = 0.001…100 Default is: 0.1
	Get	i:02C04	i:02C04**c**		
I-GAIN	Set	s:02C05**c**	s:02	FLOAT	**c** = 0…100.0 Default is: 0.1
	Get	i:02C05	i:02C05**c**		

Explanation: Refer to: «Fixed 1 control algorithm»

4.7.6.4 Soft pump control algorithm

Parameter	Command		Request	Data Type	Values
RAMP TIME	Set	s:02D01**c**	s:02	FLOAT	**c** = 0.00…1'000'000.0 Default is: 0.00
	Get	i:02D01	i:02D01**c**		
RAMP MODE	Set	s:02D02**c**	s:02	UINT	**c** = 0…1 **0** = constant time **1** = constant slope Default is: 0
	Get	i:02D02	i:02D02**c**		
P-GAIN	Set	s:02D04**c**	s:02	FLOAT	**c** = 0.001…100 Default is: 0.1
	Get	i:02D04	i:02D04**c**		

Explanation:

RAMP TIME
Pressure setpoint ramp time [s]

RAMP MODE

Mode = 0 Constant Time	The RAMP TIME is dependent on the adjusted parameter ramp time and is always the same independent of the control deviation. That means the ramp time from the actual value to the setpoint value is the adjusted parameter ramp time value.
Mode = 1 Constant Slope	The RAMP TIME is dependent on the adjusted parameter ramp time and is different depending on the control deviation. The RAMP TIME is calculated corresponding to the sensor full scale value (10V). Ramp time = 10 sec ; ramp time slope is SFS (10V) in 10 Seconds.

P-GAIN
The P-GAIN is the proportional factor of the fixed control algorithm.

To optimize soft pump control algorithm, refer to chapter «Tuning of control performance».

4.7.7 Error messages

Description	Error message
Protocol	
Parity error	**E:**000001
Input buffer overflow (to many characters)	**E:**000002
Framing error (data length, number of stop bits)	**E:**000003
Overrun (Service interface: Input buffer register overflow)	**E:**000004
Commands	
<CR> or <LF> missing	**E:**000010
: missing	**E:**000011
Invalid number of characters (between **:** and)	**E:**000012
Invalid value	**E:**000023
Value out of range	**E:**000030
Hardware	
Command not applicable for hardware configuration	**E:**000041
Setup	
ZERO disabled	**E:**000060
Device Status	
Command not accepted due to local operation	**E:**000080
Command not accepted, Service Interface locked	**E:**000081
Command not accepted due to synchronization, CLOSED or OPEN by digital input, safety mode or fatal error	**E:**000082
Not accepted calibration and test mode	**E:**000089

5 Operation

⚠ WARNING

Unqualified personnel

Inappropriate handling may cause serious injury or property damage.

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

⚠ CAUTION

Valve opening

Human body parts may get jammed or easily injured.

Do not operate before valve is installed completely in the vacuum system.

5.1 Normal operation

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

5.1.1 Local operation

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

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

‘Control view’ supports:

- parameter setup
- manual control
- numeric monitoring
- basic diagnostic

'Control Performance Analyzer' supports:

- parameter setup
- manual control
- sequence control
- numeric and graphical monitoring
- data recording
- data analysis
- advanced diagnostic

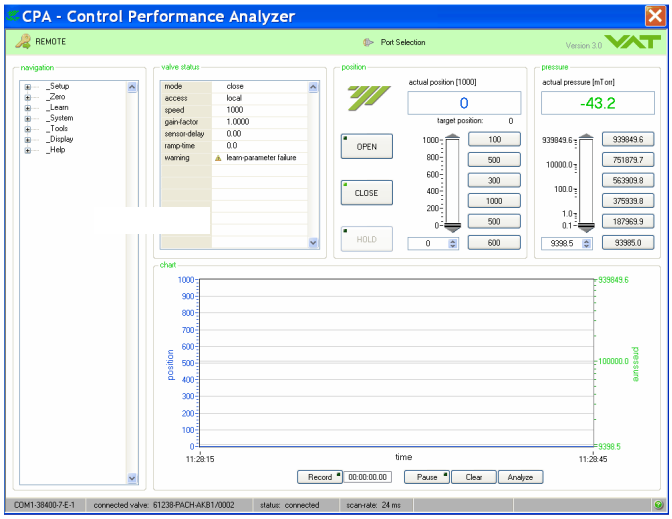


Figure 5-1

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

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

5.1.2 Remote operation

This product is equipped with an RS232 interface to allow for remote operation. See section «RS232 Interface» for details. ‘Control View’ software, 'Control Performance Analyzer' software or 'Service Box 2' may be used for monitoring during remote control.

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

5.2 Close valve

The valve is completely closed when the stop is reached. A stopper is implemented in the leak valve to prevent over tightening of the seat in the closed position.

Local operation: (‘Control View’, ‘Control Performance Analyzer’ or ‘Service Box 2‘)	**Remote operation:** (Refer to chapter: «control commands» for details.)
Push CLOSE button	Send CLOSE VALVE

5.3 Open valve

The valve is completely open when the mechanical stop is reached.

Local operation: (‘Control View’, ‘Control Performance Analyzer’ or ‘Service Box 2‘)	**Remote operation:** (Refer to chapter: «control commands» for details.)
Push OPEN button	Send OPEN VALVE

5.4 Position control

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

Local operation: ('Control View', 'Control Performance Analyzer' or 'Service Box 2')	**Remote operation:** (Refer to chapter: «control commands» for details.)
Select or enter position setpoint	Send POSITION CONTROL

Operating in position control mode can be done very easily. When setting a defined position by opening the valve, a pressure in the chamber will be achieved dependent on application specific parameters. This pressure will be slightly higher than the same defined position set by closing the valve.
It is therefore recommended that this difference is evaluated prior to operating in position control.

5.5 Pressure control

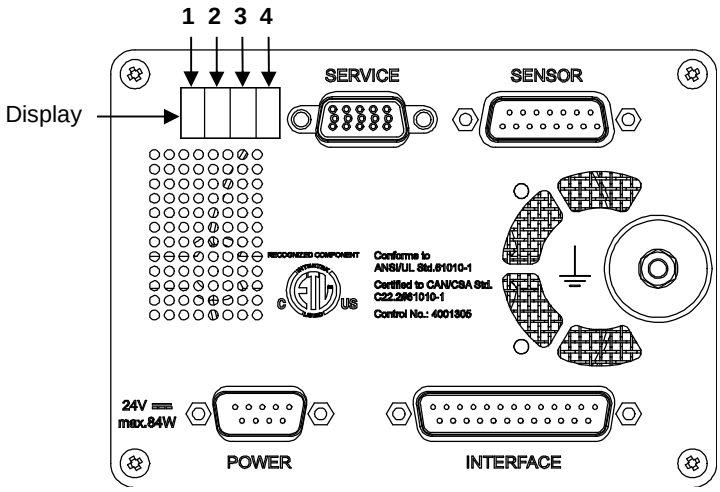
- To prepare valve for PRESSURE CONTROL perform complete chapter «Setup procedure».
- The valve has parameters that may be modified to tune pressure control performance. Refer to chapter: «Tuning of control performance».

Operating in position control mode can be done very easily.
When setting a defined position by opening the valve, a pressure in the chamber will be achieved dependent on application specific parameters. This pressure will be slightly higher than the same defined position set by closing the valve.
It is therefore recommended that this difference is evaluated prior to operating in position control.

Local operation: ('Control View', 'Control Performance Analyzer' or 'Service Box 2')	**Remote operation:** (Refer to chapter: «control commands» for details.)
Select or enter pressure setpoint	Send PRESSURE CONTROL

5.6 Display information

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



5.6.1 Power up

Description	Digit 1	Digit 2	Digit 3	Digit 4
● Power On: All dots are illuminated	#	#	#	#
● 1st information for about 3s: Firmware generation [e.g. **1G..**]	**1**	**G**		
● 2st information for about 3s: Firmware version and firmware revision [e.g. **21 00**]	**2**	**1**	**0**	**0**
● 3nd information for about 3s: Valve type [e.g. **590**]		**5**	**9**	**0**
● 4nd information for about 3s: Controller configuration In case **D999** is displayed, motor interlock is active. Refer to «Safety mode» for details.		**2** = RS232 interface	**0** = basic	**1** = 1 sensor version
SYNC indicates that powerup synchronization is running.	**S**	**Y**	**N**	**C**

5.6.2 Operation

Description / Mode	Digit 1	Digit 2	Digit 3	Digit 4
PRESSURE CONTROL mode	**P**	**0 . . . 100** = valve position (%, 0 = closed / 100 = open)		
POSITION CONTROL mode	**V**			
Valve closed	**C**			
Valve open	**O**			
Closed / open interlock (Valve closed / open by digital input)	**I**			
HOLD (position frozen) activated	**H**			
Safety mode established. Refer to chapter «Safety mode» for details.	**D**			
Power failure	**F**			

RxD / TxD activity of RS232 communication is displayed by 2 blinking dots in digit 2. The lower dot indicates RxD activity where the upper dot indicates TxD activity. The indication is not real time.

5.6.3 Errors

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

5.6.4 Safety mode

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

5.7 Operation under increased temperature

⚠ CAUTION

Hot valve

Heated valve may result in minor or moderate injury.

Do not touch valve during operation. Wait until the valve is cooled down complete before doing any work.

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

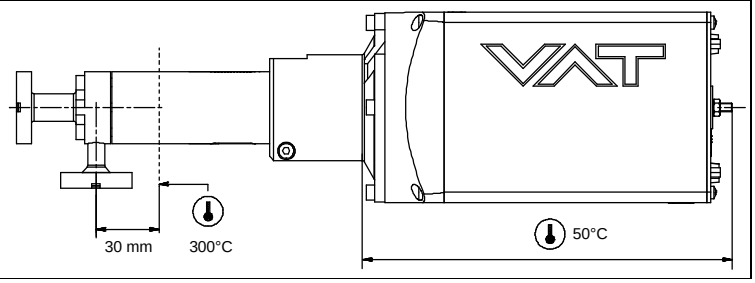
NOTICE

Temperature differences

Temperature differences they may affect the performance of the valve.

Temperature differences exceeding 30°C throughout the valve are not allowed. Ideally the valve do not get actuated until the temperature is levelled throughout the valve.

5.7.1 Bake-out

Bake out temperature	Beak-out area
• Open / Close:≤ 300°C • Actuator: ≤ 50°C	

5.8 Behavior during power up

Valve position before power up:	**Reaction of valve:**
	Valve power up configuration = closed (default)
Closed (isolated)	Valve remains closed. Display shows ‘C C’.
All other than closed (not isolated)	Valve position after power up is closed

Refer also to chapter «Display information».

5.9 Behavior during power failure

Valve position before power failure:	**Reaction of valve:**
Any	Valve remains at current position.

All parameters are stored in a power fail save memory.

5.10 Trouble shooting

Failure	Check	Action
- No dots lighted on display	- 24 V power supply ok?	- Connect valve to power supply according to chapter «Electrical connection» and make sure that power supply is working.
- Remote operation does not work	- Local operation via service port active	- Switch to remote operation.
	- Safety mode active, check for D on display?	- Provide power to motor to allow for operation. - Refer to chapter «Electrical connection» for details.
- Display shows «**E 20**» and position is 009999 - (fatal error - limit stop of valve unit not detected)	- Clamp coupling screw not fastened?	- Tighten screw. Refer to chapter «Tightening torque» for details. RESET or restart of valve is necessary.
- Display shows «**E 22**» and position is 009999 - (fatal error - rotation angle of valve plate limited during operation)	- Valve unit heavy contaminated? - Valve plate mechanically obstructed?	- Clean valve unit according to chapter «Maintenance procedure». - Resolve obstruction. - Reset control unit. Cycle power (OFF→ON). or - Send reset command: - local via service port with CV/CPA/Service Box2.
- Display shows «**E 40**» and position is 009999 - (fatal error - motor driver failure detected)		- Replace control and actuating unit according to chapter «Maintenance procedures».
- Display shows «**D 0**» - Motor Interlock is open	- Motor power supplied?	- Provide power to motor to allow for operation. - Refer to chapter «Electrical connection» for details.
- CLOSE VALVE does not work	- Safety mode active, check for D on display? - Maintenance mode active	- Provide power to motor to allow for operation. - Refer to chapter «Electrical connection» for details. - Refer to “Display shows «**M C**»” in this table
- OPEN VALVE does not work	- Safety mode active, check for D on display? - Maintenance mode active	- Provide power to motor to allow for operation. - Refer to chapter «Electrical connection» for details. - Refer to “Display shows «**M100**»” in this table
- Display shows «**M C**» - Maintenance mode active		- Pin 14 of service connector is connected to ground. Plate will close. Further movement of plate is blocked. [1)]
- Display shows «**M100**» - Maintenance mode active		- Pin 13 of service connector is connected to ground. Plate will open. Further movement of plate is blocked. [1)]

[1)] Priority of pin 14 is higher than pin 13. If pin 14 is connected to ground after pin 13 the valve will close. Ground of service connector is at pin 4 and 8.

Failure	Check	Action
- Pressure reading is wrong or - pressure reading is negative	- Sensor(s) connected?	- Refer to chapter «Electrical connection».
		- Check valve version on page 1. Verify configuration. Refer to chapter «Setup procedure».
	- Does sensor power supply provide enough power for sensor(s)?	- Verify sensor supply voltage.
- PRESSURE CONTROL does not work	- Safety mode active, check for D on display?	- Provide power to motor to allow for operation. - Refer to chapter «Electrical connection» for details.
	- PRESSURE CONTROL selected, check for P on display?	- Select PRESSURE CONTROL mode.
		- Refer to chapter «Pressure control» for details.
	- Fixed PI done?	- Perform Fixed PI.
		- Refer to chapter «Setup procedure» for details.
- PRESSURE CONTROL not optimal	- Setup done completely?	- Perform «Setup procedure» completely.
	- Fixed PI done?	- Perform Fixed PI.
	- Fixed PI interrupted?	- Repeat Fixed PI.
		- Repeat Fixed PI with stable gas flow.
	- Optimizing fixed PI done?	- Optimizing fixed PI for application. - Refer to «Optimize P-Gain, I-Gain » for details.
	- Is sensor range suited for application?	- Use a sensor with suitable range (controlled pressure should be >3% and < 98% of sensor full scale).
	- Noise on sensor signal?	- Make sure a shielded sensor cable is used.

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

6 Maintenance

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

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

7 Repairs

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

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

⚠ WARNING

Unqualified personnel

Inappropriate handling may cause serious injury or property damage.

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

⚠ WARNING

Danger of injury in case of insufficient skills

Inappropriate handling may cause serious injury or property damage.

Make sure that the valve does not topple or fall down while removing the protective covers from the flanges.

NOTICE

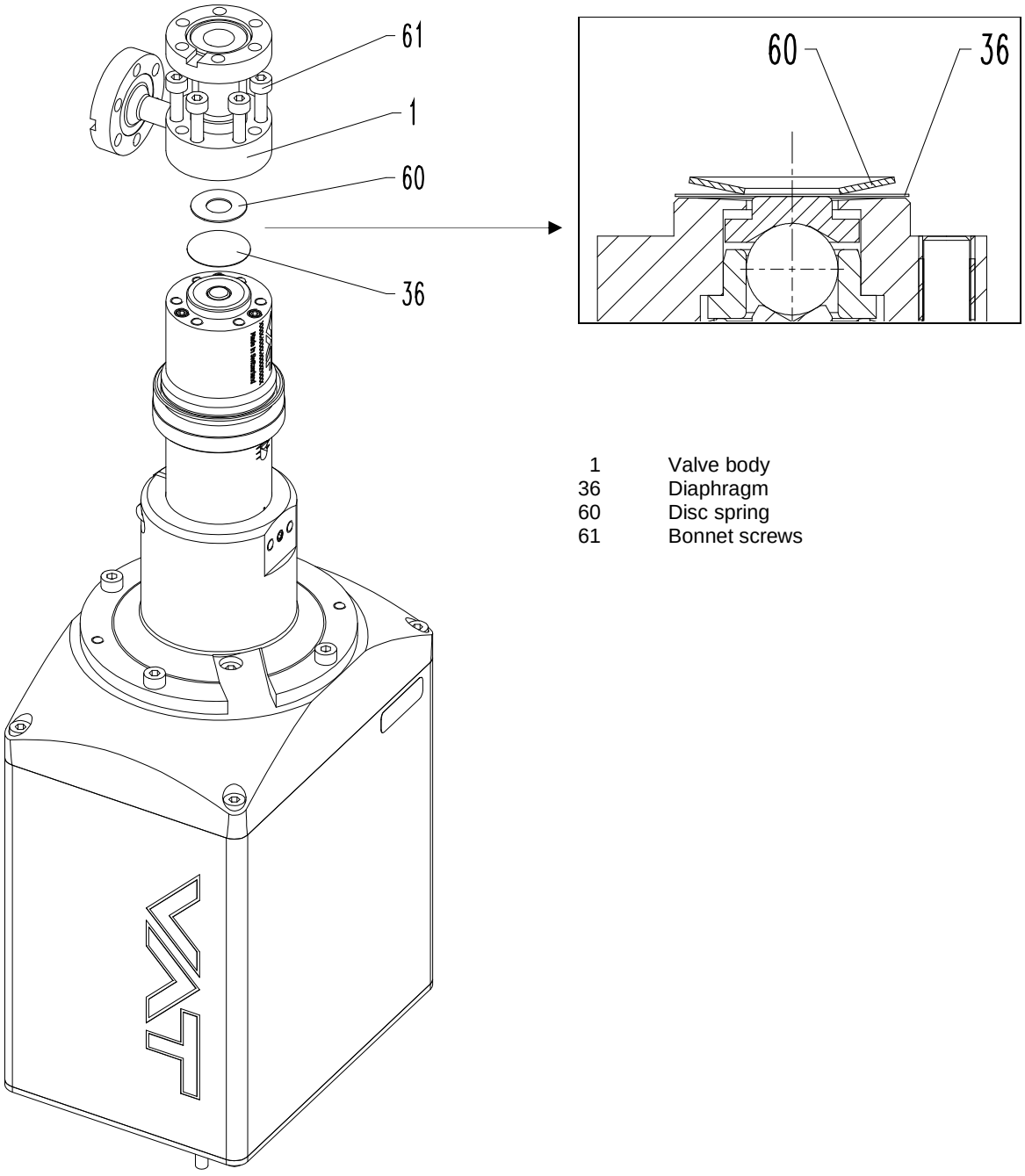
Contamination

Product may get contaminated.

Always wear cleanroom gloves when handling the product.

7.1 Replacement of diaphragm

In case of a seat seal leak caused by environmental influences and no visible damage of the sealing surface at the seat, the diaphragm seal can be replaced.
VAT offers a range of components; see «Table 11-1 » on page 75. The seal exchange can be carried out by the user.



1	Valve body
36	Diaphragm
60	Disc spring
61	Bonnet screws

Figure 7-1

Required material: Diaphragm

Ordering information: See chapter «11 Spare parts» on page 75.

NOTICE

Inappropriate mounting position of valve

Maintenance may be troublesome and parts may drop down.

Ideally dismount valve from the system and put it on a clean workbench with the actuator upwards.

Procedure:

The item numbers in brackets refer to «Figure 7-1» on page 68.

1. Open valve completely.
2. Loosen bonnet screws (61).
3. Remove valve body (1).
4. Remove disc spring (60).
5. Exchange diaphragm (36).

Check surfaces on its cleanliness and on damages.

Make sure that the sealing surface is free of scratches.

6. Insert disc spring (60) centered to the diaphragm (36).

Make sure that the disc spring (60) is assembled in the correct direction.

7. Clean valve body (1) with pure alcohol (Isopropanol), use a cleanroom wiper. Use oil free compressed air to blow off surfaces.
8. Assemble valve body (1) with caution. Tighten all bonnet screws (61) slowly in crosswise order with the following torque:

   DN 16: 2.5 Nm

9. Open and close valve 5 times.

Valve is ready for use.

8 Dismounting and Storage

⚠ WARNING

Unqualified personnel

Inappropriate handling may cause serious injury or property damage.

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

8.1 Dismounting

⚠ WARNING

Harmful substances

Risk of serious injury in case of contact with harmful substances.

Remove harmful substances (e. g. toxic, caustic or microbiological) from the valve before dismounting.

NOTICE

Contamination

Product may get contaminated.

Always wear cleanroom gloves when handling the product.

2. Close the valve

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

8.2 Storage

NOTICE

Wrong storage

Inappropriate temperatures and humidity may cause damage to the product.

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

NOTICE

Inappropriate packaging

Product may get damaged if inappropriate packaging material is used.

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

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

9 Packaging and Transport

WARNING

Unqualified personnel

Inappropriate handling may cause serious injury or property damage.

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

WARNING

Harmful substances

Risk of serious injury in case of contact with harmful substances.

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

NOTICE

Inappropriate packaging

Product may get damaged if inappropriate packaging material is used.

Always use original packaging material and handle product with care.

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

9.1 Packaging

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

VAT disclaims any liability for damages resulting from inappropriate packaging.

9.2 Transport

NOTICE

Inappropriate packaging

Product may get damaged if inappropriate packaging material is used.

Always use original packaging material and handle product with care.

VAT disclaims any liability for damages resulting from inappropriate packaging.

10 Disposal

⚠ WARNING

Harmful substances

Environmental pollution.

Discard products and parts according to the local regulations.

11 Spare parts

NOTICE

Non-original spare parts

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

Use original spare parts from VAT only.

- Please contact one of our service centers and specify the fabrication number of the product; see chapter «1.1 Identification of product». You will find the addresses on our website www.vatvalve.com.
- Parts may only be replaced by the VAT service staff.

Description	Item	Part No.	Quantity per valve	Repair procedure see chapter
Diaphragm	36	334578	1	«7.1 Replacement of diaphragm»

Table 11-1

12 Appendix

This Page Intentionally Left Blank