Pendulum control & isolation valve

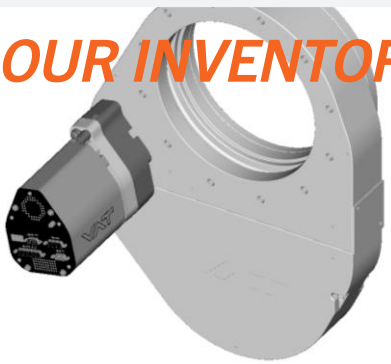
with extended control range
with RS232 interface

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

651 . . - . . GG -	(1 sensor input)
651 . . - . . GH -	(2 sensor inputs)
651 . . - . . AG -	(1 sensor input / ±15V SPS)
651 . . - . . AH -	(2 sensor inputs / ±15V SPS)
651 . . - . . HG -	(1 sensor input / PFO)
651 . . - . . HH -	(2 sensor inputs / PFO)
651 . . - . . CG -	(1 sensor input / ±15V SPS / PFO)
651 . . - . . CH -	(2 sensor inputs / ±15V SPS / PFO)
651 . . - . . GV -	(1 sensor input / analog outputs)
651 . . - . . GW -	(2 sensor inputs / analog outputs)
651 . . - . . AV -	(1 sensor input / analog outputs / ±15V SPS)
651 . . - . . AW -	(2 sensor inputs / analog outputs / ±15V SPS)
651 . . - . . HV -	(1 sensor input / analog outputs / PFO)
651 . . - . . HW -	(2 sensor inputs / analog outputs / PFO)
651 . . - . . CV -	(1 sensor input / analog outputs / ±15V SPS / PFO)
651 . . - . . CW -	(2 sensor inputs / analog outputs / ±15V SPS / PFO)

SPS = Sensor Power Supply PFO = Power Failure Option

configured with firmware **651P.1E.00**



sample picture

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

made in Switzerland
Fabrication No.:
651 . .–. . . .–. . . . / . . . .
A –. . . . . ← Fabrication number

Explanation of symbols:

Read declaration carefully before you start any other action!

Attention!

Loaded springs and/or air cushions are potential hazards!

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

Keep body parts and objects away from the valve opening!

Hot surfaces; do not touch!

Wear gloves!

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

Imprint

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Editor VAT Vakuumventile AG, CH-9469 Haag, Switzerland

Print VAT Vakuumventile AG, CH-9469 Haag, Switzerland

Series 651 DN 160-250 (I.D. 6“ - 10”), RS232

Contents:

1 Use of product

This product is a throttling pendulum valve with isolation functionality. It is intended to use for downstream pressure control applications.

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

1.1 Technical data

Control and actuating unit	
Power input [1] **(α)** [651 . . - . . **A** . - . . . . / 651 . . - . . **G** . - . . . .] [651 . . - . . **C** . - . . . . / 651 . . - . . **H** . - . . . .]	+24 VDC (±10%) @ 0.5 V pk-pk max. [connector: POWER] 50 W max. (operation of valve with max. load) without PFO [4] 50 W plus 10 W for PFO [4]
Sensor power supply [2] **(β)** [651 . . - . . **A** . - . . . . / 651 . . - . . **C** . - . . . .] Input Output	 +24 VDC / 1500 mA max. [connector: POWER] ±15 VDC (±5%) / 1000 mA max. [connector: SENSOR]
Sensor power supply [2] **(β)** [651 . . - . . **G** . - . . . . / 651 . . - . . **H** . - . . . .] Input Output	 + 24 VDC resp. ± 15 VDC [connector: POWER] same as input but: [connector: SENSOR] 2.0 A max. at ± 15 VDC 1.5 A max. at + 24 VDC

Calculation of complete power consumption:

P_{tot} = α + β

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

Control and actuating unit (continuation)			
Sensor input Signal input voltage ADC resolution Sampling time	0-10 VDC / Ri>100 kΩ 0.23 mV 10 ms	[connector: SENSOR]	
Digital inputs [3]	±24 VDC max.	[connector: INTERFACE]	
Digital outputs [3] Input voltage Input current Breaking capacity	70 VDC or 70 V peak max. 0.5 ADC or 0.5 A peak max. 10 W max.	[connector: INTERFACE]	
Analog outputs [3]	0-10 VDC / 1 mA max.	[connector: INTERFACE]	
PFO [4] battery pack [651 . . - . . **C** . - . . . . / 651 . . - . . **H** . - . . . .] Charging time Durability	2 minutes max. up to 10 years @ 25°C ambient; refer to «Durability of power fail battery» for details		
Compressed air supply	4 - 7 bar / 55 - 100 psi (above ATM)		
Ambient temperature	0 °C to +50 °C max. (<35 °C recommended)		
Pressure control accuracy	5 mV or 0.1% of setpoint, whichever is greater		
	DN 160 **6"** (651**44** - ....)	**DN 200** **8"** (651**46** - ....)	**DN 250** **10"** (651**48** - ....)
Position resolution / position control capability	11111 steps (full stroke)	12266 steps (full stroke)	12533 steps (full stroke)
Closing time throttling only	0.8 s typ. (full stroke)	0.9 s typ. (full stroke)	0.9 s typ. (full stroke)
Opening time throttling only	0.8 s typ. (full stroke)	0.9 s typ. (full stroke)	0.9 s typ. (full stroke)
Closing time throttling & isolation	4 s typ. (full stroke)	4 s typ. (full stroke)	4 s typ. (full stroke)
Opening time throttling & isolation	4 s typ. (full stroke)	4 s typ. (full stroke)	4 s typ. (full stroke)

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

Valve unit			
Pressure range at 20°C			
- Aluminum	(651 . . - . **A** . . - . . . .)	1 x 10E-8 mbar to 1.2 bar (abs)	
- Aluminum hard anodized	(651 . . - . **H** . . - . . . .)	1 x 10E-6 mbar to 1.2 bar (abs)	
- Aluminum nickel coated	(651 . . - . **I** . . - . . . .)	1 x 10E-8 mbar to 1.2 bar (abs)	
Leak rate to outside at 20°C			
- Aluminum	(651 . . - . **A** . . - . . . .)	1 x 10E-9 mbar l/s	
- Aluminum hard anodized	(651 . . - . **H** . . - . . . .)	1 x 10E-5 mbar l/s	
- Aluminum nickel coated	(651 . . - . **I** . . - . . . .)	1 x 10E-9 mbar l/s	
Leak rate valve seat at 20°C			
- Aluminum	(651 . . - . **A** . . - . . . .)	1 x 10E-9 mbar l/s	
- Aluminum hard anodized	(651 . . - . **H** . . - . . . .)	1 x 10E-4 mbar l/s	
- Aluminum nickel coated	(651 . . - . **I** . . - . . . .)	1 x 10E-9 mbar l/s	
Cycles until first service - Isolation cycles (open - closed - open) - Throttling cycles (open - max. throttle - open)		200’000 (unheated and under clean conditions) 1’000’000 (unheated and under clean conditions)	
Admissible operating temperature		10°C to +150°C	
Mounting position		any (valve seat on chamber side is recommended) (valve seat to face chamber is recommended)	
Wetted materials			
- Body	(651 . . - . **A** . . - . . . .)	Aluminum 3.2315 (AA6082)	
- Body	(651 . . - . **H** . . - . . . .)	Aluminum 3.2315 (AA6082) hard anodized	
- Body	(651 . . - . **I** . . - . . . .)	Aluminum 3.2315 (AA6082) nickel coated	
- Pendulum plate	(651 . . - . **A** . . - . . . .)	Aluminum 3.2315 (AA6082), 1.4310 (301), PTFE	
- Pendulum plate	(651 . . - . **H** . . - . . . .)	Aluminum 3.2315 (AA6082) hard anodized, 1.4310 (301), PTFE	
- Pendulum plate	(651 . . - . **I** . . - . . . .)	Aluminum 3.2315 (AA6082) nickel coated, 1.4310 (301), PTFE	
- Sealing ring	(651 . . - . **A** . . - . . . .)	Aluminum 3.2315 (AA6082), 1.4306 (304L)	
- Sealing ring	(651 . . - . **H** . . - . . . .)	Aluminum 3.2315 (AA6082) hard anodized, 1.4306 (304L)	
- Sealing ring	(651 . . - . **I** . . - . . . .)	Aluminum 3.2315 (AA6082) nickel coated, 1.4306 (304L)	
- Other parts		Stainless steel 316L (1.4404 or 1.4435), 1.4122, 1.4310 (301), 1.4303 (304), 1.4571, A2 (304)	
- Seals		FKM (e.g. Viton®). Other materials available. Seal materials are declared on dimensional drawing of specific valve ordering number.	
		DN 160 **6"** (651**44** - ....)	**DN 200** **8"** (651**46** - ....)	**DN 250** **10"** (651**48** - ....)
Max. differential pressure on plate during isolation		1200 mbar in either direction	1200 mbar in either direction	1200 mbar in either direction
Max. differential pressure on plate during opening and throttling		10 mbar	5 mbar	5 mbar
Min. controllable conductance (N_2 molecular flow)		1.6 l/s	2 l/s	2.5 l/s
Dimensions		Refer to dimensional drawing of specific valve ordering number (available on request)		

2 Installation

2.1 Unpacking

As this valve is a heavy component you should lift it with adequate equipment to prevent any injury to humans.
Valves DN200 (8”) and larger are equipped with attachment points (tapped holes). Add eyebolts to these attachment points for lifting. The attachment points are indicated on the dimensional drawing of the specific valve part number (available on request).

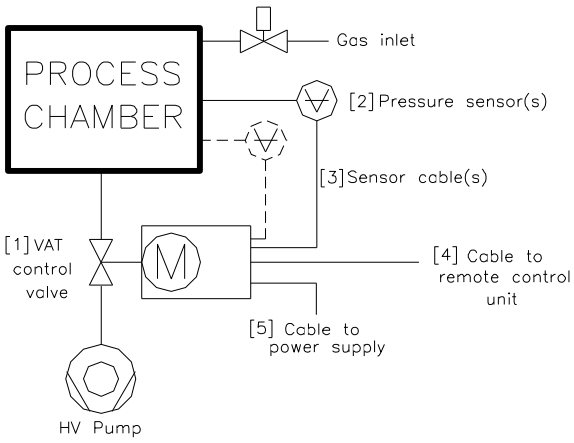
Never lay the valve down with control and actuating unit downwards as it may be damaged.

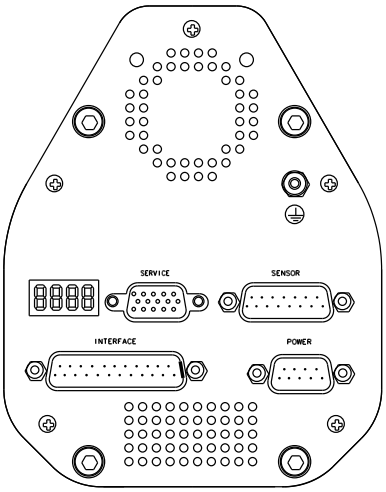
2.2 Installation into the system

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

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

Do not disconnect air supply when device is under power.
Compressed air pressure must be in the range of: 4 - 7 bar / 55 - 100 psi (above ATM).
Use only clean, dry or slightly oiled air.





1. Install valve [1] into the vacuum system. Valve seat side should face process chamber. The valve seat side is indicated by the symbol "∇" on the valve flange.
   Caution: Do not tighten the flange screws stronger than indicated under «Tightening torque».
   Caution: Do not admit higher forces to the valve than indicated under «Admissible forces».
   Note: Make sure that enough space is kept free to do preventive maintenance work. The required space is indicated on the dimensional drawing.

2. Connect compressed air supply to connection labeled ‘**IN**’ located at actuator, see Figure 1 below.
   Connect compressed air return line connection labeled ‘**OUT**’ located at actuator, see Figure 1 below.
   Caution: Compressed air pressure must be in the range of: **4 - 7 bar / 55 - 100 psi (above ATM)**.
   Note: Use only clean, dry or slightly oiled air. IN / OUT connections are 1/8“ ISO/NPT internal threads.

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

4. Connect sensor cable [3] to sensor(s) and then to valve (connector: SENSOR).
   Refer to chapter «Electrical connection» for correct wiring.
   Note: Input for second sensor is available on 651 . . - . . . **H** - . . . . and 651 . . - . . . **W** - . . . . versions only.

5. Connect valve to RS232 [4] (connector: INTERFACE). Refer to «RS232 schematics» for correct wiring.

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

7. This valve has a double sealed rotary feedthrough and optionally an intermediate pumping port for the actuator shaft. This port (1/8“ ISO/NPT) could be connected to the vacuum line, see Figure 2 below.

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

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

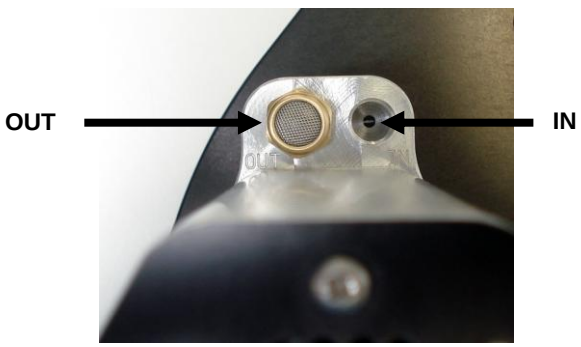


Fig. 1

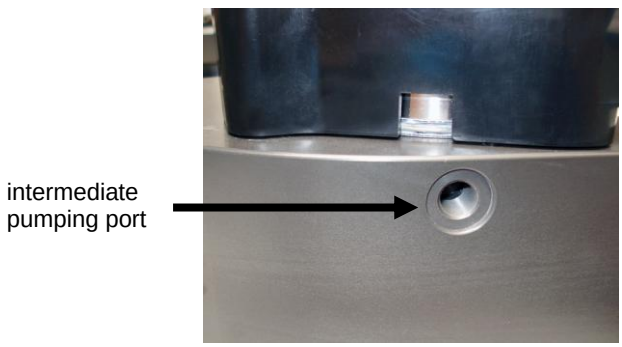


Fig. 2

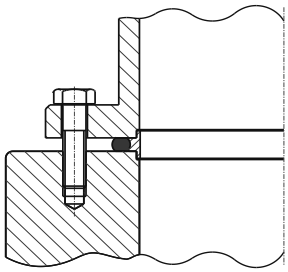
2.3 Tightening torque

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

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

2.3.1 Mounting with centering rings

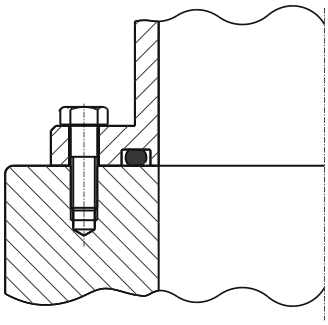
Valve size	ISO-F	ISO-F
	max. tightening torque (Nm)	**max. tightening torque (lbs . ft)**
DN160 / 6“ (651**44** - . . . . - . . . .)	13-15	9-11
DN200 / 8“ (651**46** - . . . . - . . . .)	13-15	9-11
DN250 / 10“ (651**48** - . . . . - . . . .)	17-20	13-15
	hole depth (mm)	**hole depth (inch)**
DN160 / 6“ (651**44** - . . . . - . . . .)	14	0.55
DN200 / 8“ (651**46** - . . . . - . . . .)	15	0.59
DN250 / 10“ (651**48** - . . . . - . . . .)	16	0.63



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

2.3.2 Mounting with O-ring in grooves

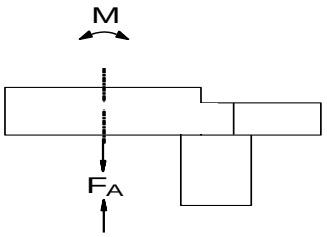
Valve size	ISO-F	JIS	ASA-LP	ISO-F	JIS	ASA-LP
	max. tightening torque (Nm)			max. tightening torque (lbs . ft)		
DN160 / 6“ (651**44** - . . . . - . . . .)	35-40	35-40	35-40	26-30	26-30	26-30
DN200 / 8“ (651**46** - . . . . - . . . .)	35-40	35-40	80-90	26-30	26-30	59-67
DN250 / 10“ (651**48** - . . . . - . . . .)	35-40	65-70	80-90	26-30	48-52	59-67
	hole depth (mm)			hole depth (inch)		
DN160 / 6“ (651**44** - . . . . - . . . .)	14	14	14	0.55	0.55	0.55
DN200 / 8“ (651**46** - . . . . - . . . .)	15	15	14	0.59	0.59	0.59
DN250 / 10“ (651**48** - . . . . - . . . .)	16	16	16	0.63	0.63	0.63



2.4 Admissible forces

Forces from evacuating the system, from the weight of other components, and from baking can lead to deformation and malfunctioning of the valve. Stress has to be relieved by suitable means, e.g. bellows sections.

Valve size	Axial tensile or compressive force «F_A»		Bending moment «M»	
	N	lb.	Nm	lbf.
DN160 / 6“ (651**44** - . . . . - . . . .)	2000	440	80	60
DN200 / 8“ (651**46** - . . . . - . . . .)	2000	440	80	60
DN250 / 10“ (651**48** - . . . . - . . . .)	2500	550	100	75
For a combination of both forces (F_A and M) the values are invalid. Verify that the depth of the mounting screws is min. 1 x thread diameter. Please contact VAT for more information.				



2.5 Requirements to sensor connection

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

Sensor response time: < 50ms

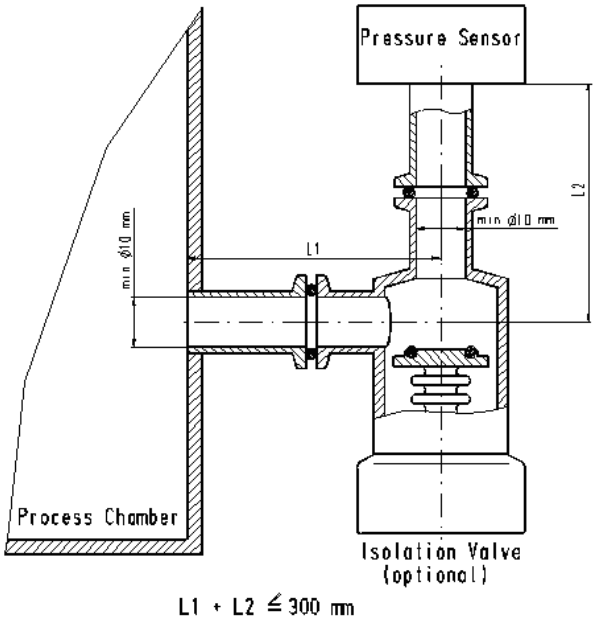
The sensor is normally connected to the chamber by a pipe. To maintain that the response time is not degraded by this connection it needs to meet the following requirements:

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

These conductance guidelines must include all valves and limiting orifices that may also be present.

Make also sure that there is no obstruction in front of sensor connection port inside the chamber.

The sensor should also be mounted free of mechanical shock and vibration.
Dynamic stray magnetic fields may introduce noise to sensor output and should be avoided or shielded.



2.6 Electrical connection

2.6.1 Sensor supply concepts

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

Concepts:

- External + 24 VDC supplied to POWER connector is feed through to SENSOR connector to supply 24 VDC sensors. Refer to chapter «2.6.2 Power and sensor connection (+24 VDC sensors)» for schematic and correct wiring.
- External ±15 VDC supplied to POWER connector is feed through to SENSOR connector to supply ±15 VDC sensors. Refer to chapter «2.6.3 Power and sensor connection (±15 VDC sensors) without optional SPS module» for schematic and correct wiring.
- External + 24 VDC supplied to POWER connector is converted into ±15 VDC by the valve internal SPS and supplied to SENSOR connector to supply ±15 VDC sensors. Refer to chapter «2.6.4 Power and sensor connection (±15 VDC sensors) with optional SPS module» for schematic and correct wiring.

Valve versions:

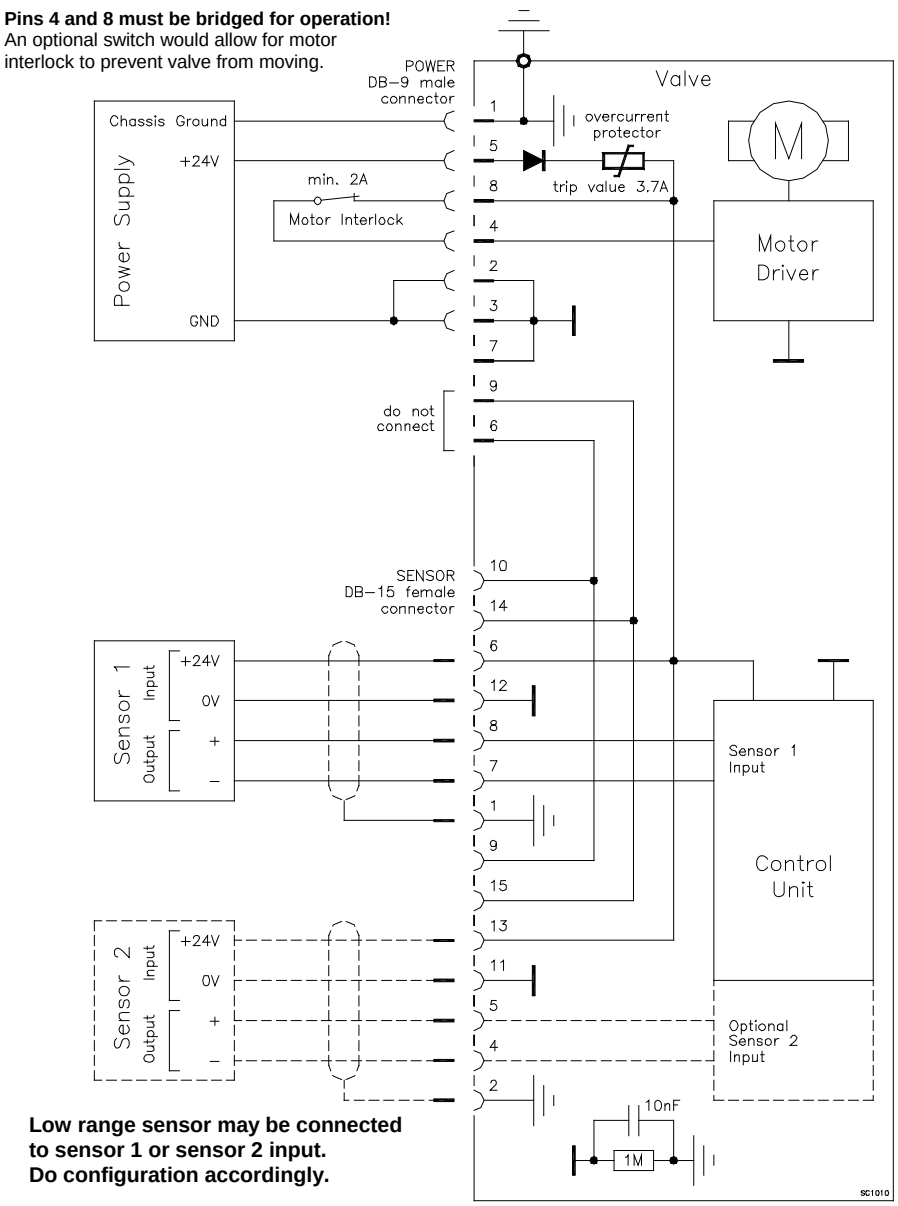
- 651 . . - . . **G** . - . . . . / 651 . . - . . **H** . - . . . . SPS module not included
- 651 . . - . . **A** . - . . . . / 651 . . - . . **C** . - . . . . SPS module included

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

2.6.2 Power and sensor connection (+24 VDC sensors)

[651 . . - . . **G** . - . . . . / 651 . . - . . **H** . - . . . . versions recommended]

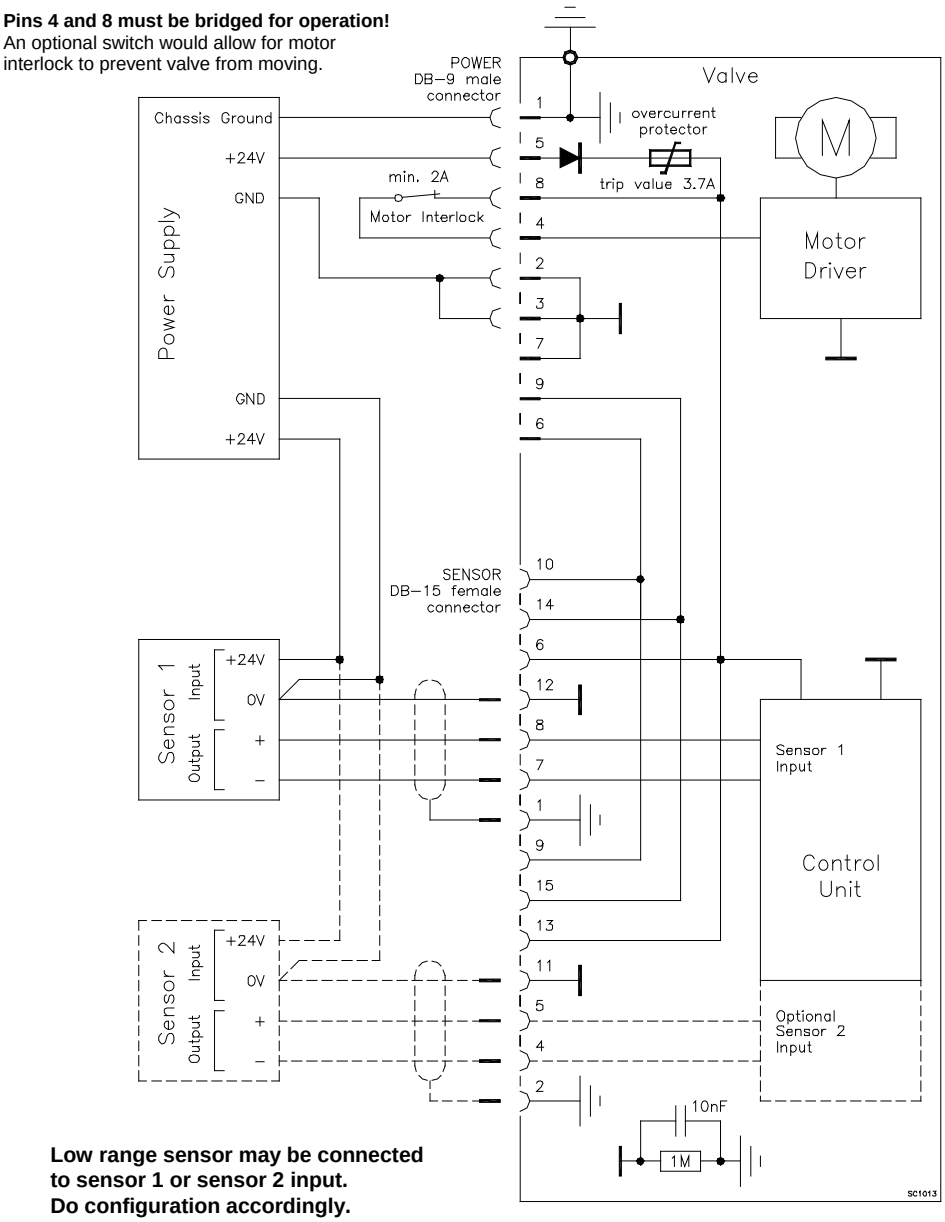
2.6.2.1 Sensor power wiring via controller



Note:

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

2.6.2.2 Sensor power wiring external



Note:

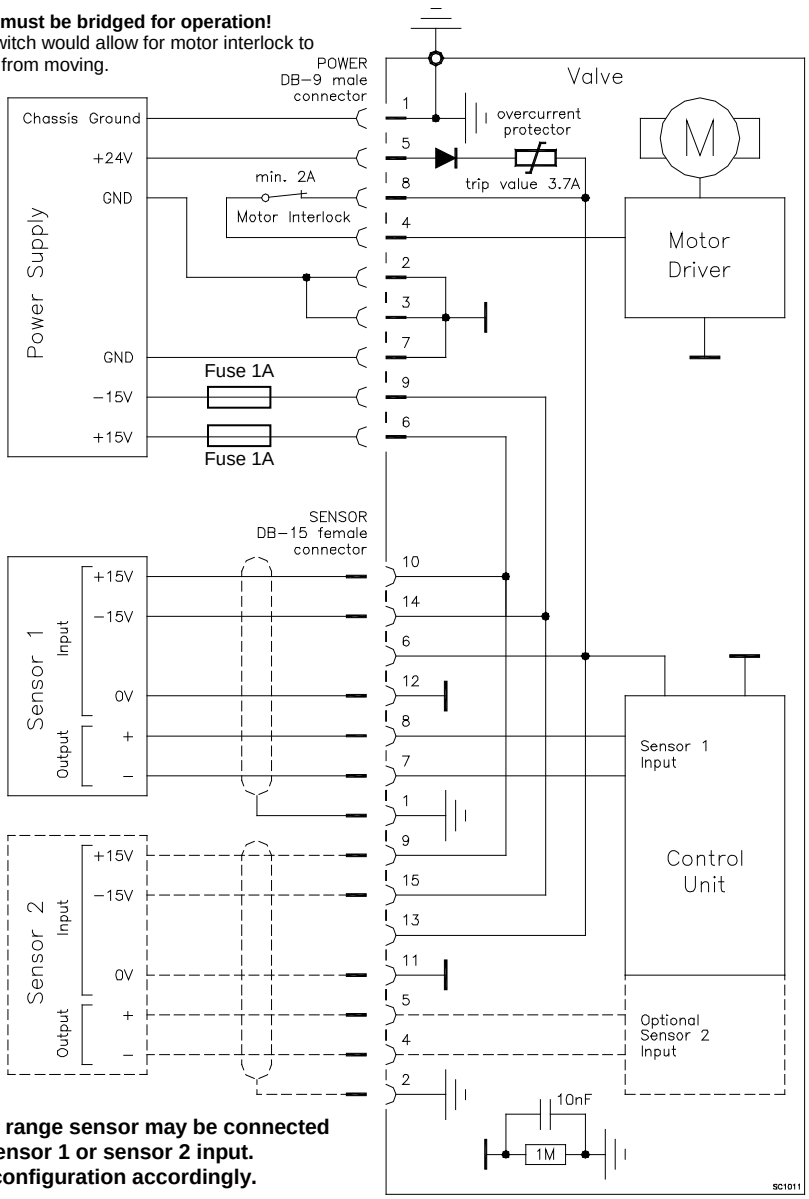
- Use shielded sensor cable(s). Keep cable as short as possible, but locate it away from noise sources.
- Connect the +24 VDC sensors at DB–15 female sensor connector exactly as shown in the drawing above. Do not connect other pins that may damage sensors, power supply or controller!
- Connector: Use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

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

[651 . . - . . **G** . - . . . . / 651 . . - . . **H** . - . . . . versions only]

2.6.3.1 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.



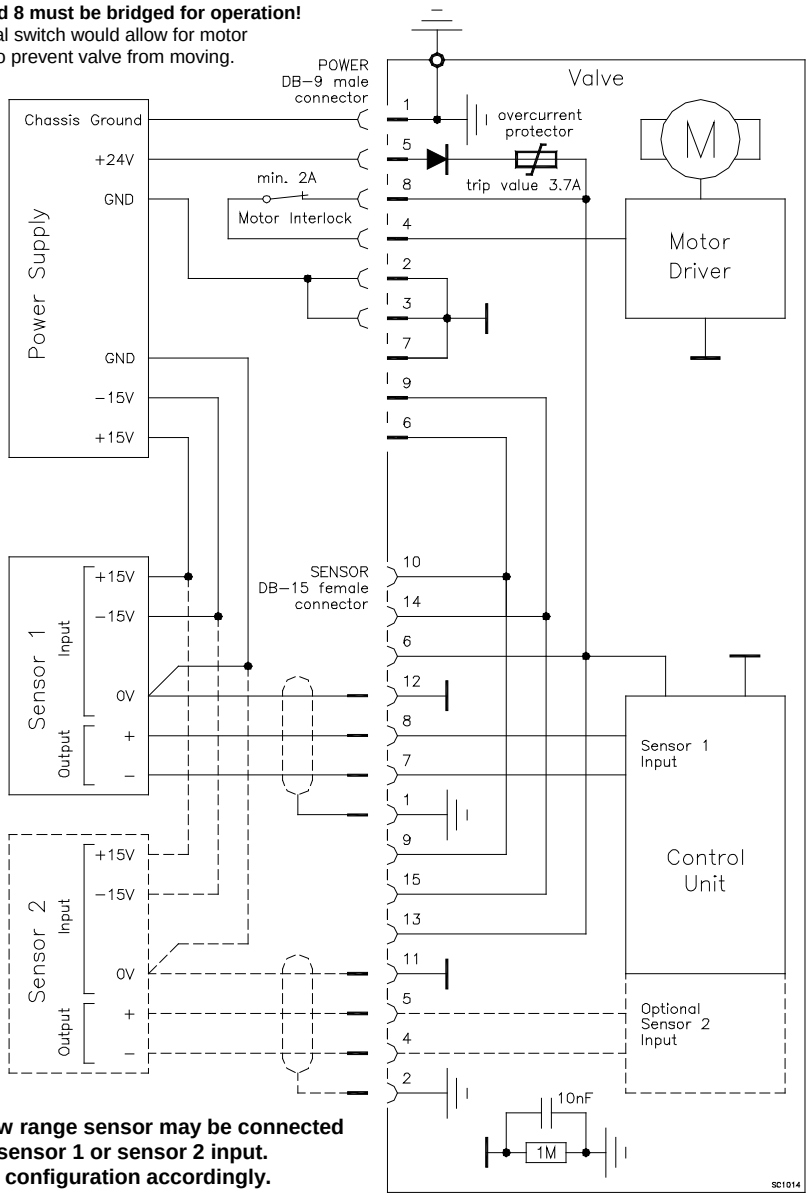
Low range sensor may be connected to sensor 1 or sensor 2 input.
Do configuration accordingly.

Note:

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

2.6.3.2 Sensor power wiring external

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



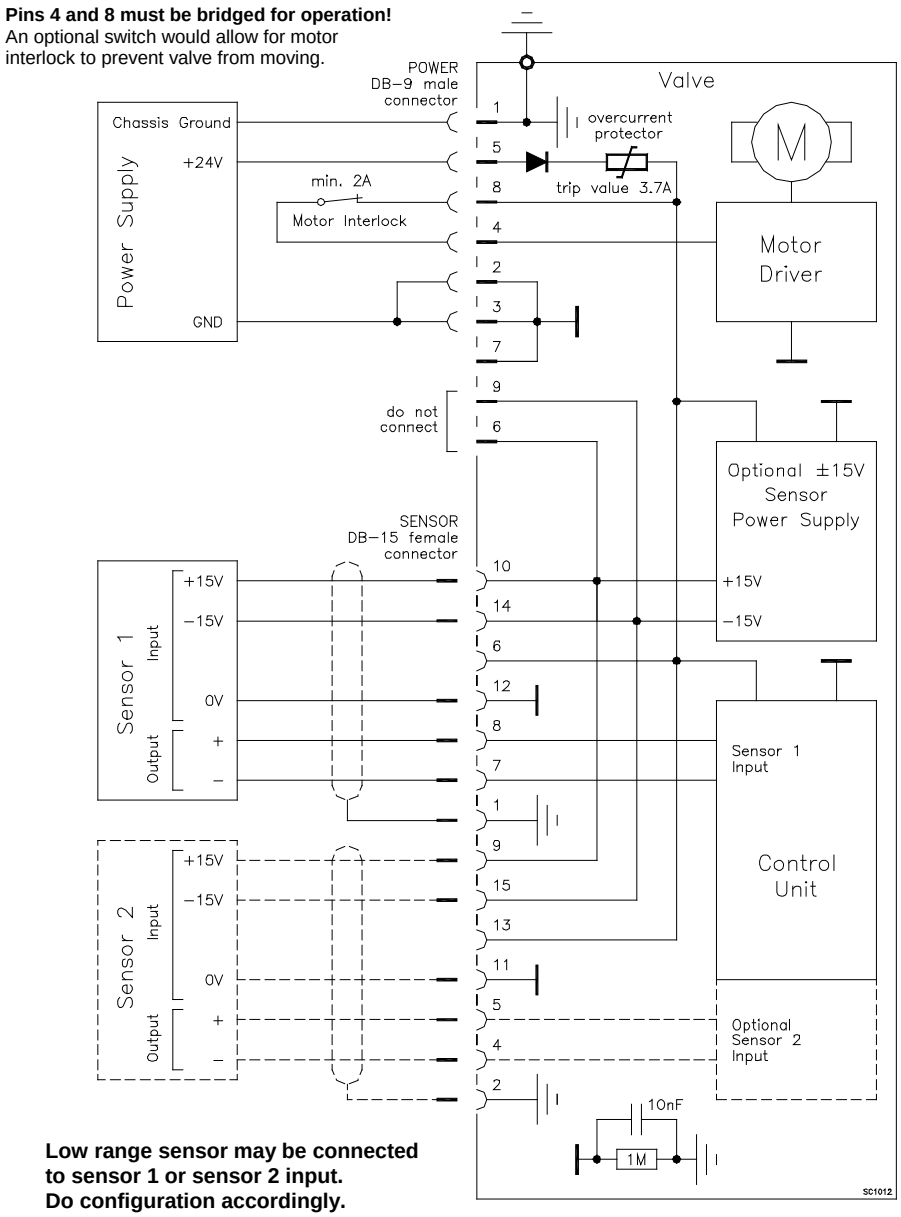
Low range sensor may be connected to sensor 1 or sensor 2 input. Do configuration accordingly.

Note:

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

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

[651 . . - . . **A** . - . . . . / 651 . . - . . **C** . - . . . . versions only]



Note:

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

2.6.5 RS232 interface connection

Refer to «Schematics» for wiring information.

2.6.6 Service port connection

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

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

3 Operation

⚠ CAUTION

Valve opening

Fingers and objects must be kept out of the valve opening and away from moving parts. Risk of injury.

Do not connect the controller to power before the valve isn’t installed complete into the system.

3.1 Introduction

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

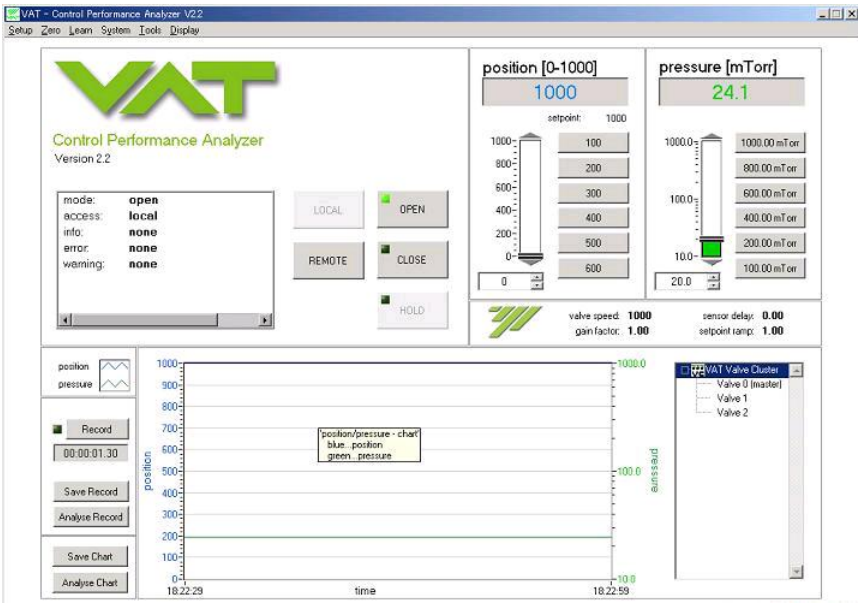
3.1.1 Local operation

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

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

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

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



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

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

3.1.2 Remote operation

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

3.1.3 Safety mode

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

3.2 Operation under increased temperature

⚠ CAUTION

Hot valve

Heated valve may result in minor or moderate injury.

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

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

3.3 Behavior during power up

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

Refer also to chapter «Display information».

3.4 Behavior in case of power failure

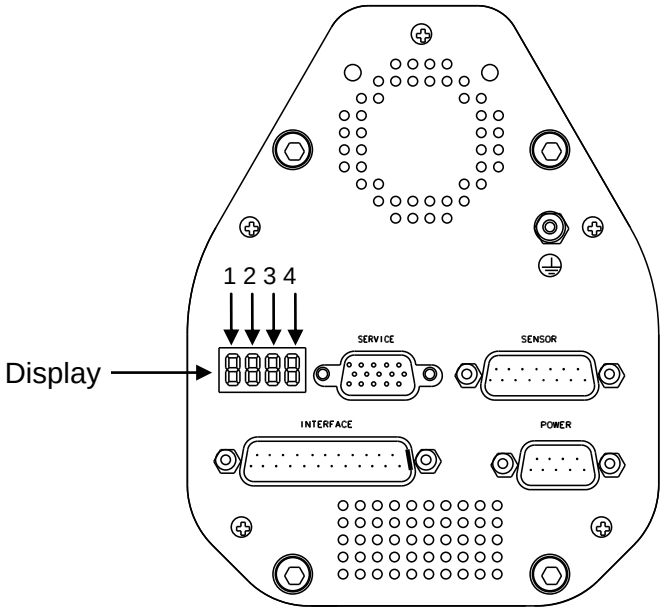
Valve position before power failure:	**Reaction of valve:**	
	Without Power Failure Option (PFO) 651 . . - . . **G** . - . . . . 651 . . - . . **A** . - . . . . 651 . . - . . **T** . - . . . . 651 . . - . . **V** . -	With Power Failure Option (PFO) 651 . . - . . **H** . - . . . . 651 . . - . . **C** . - . . . . 651 . . - . . **U** . - . . . . 651 . . - . . **W**. - . . . .
Closed (isolated)	Valve remains closed.	Valve will close or open depending on valve configuration *).
Valve open or in any intermediate position	Sealing ring moves down and blocks the pendulum plate at the current position.	Default is not defined. Display indicates **F**.

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

All parameters are stored in a power fail save memory.

3.5 Display information

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



Power up:

Description	Digit 1	Digit 2	Digit 3	Digit 4
At first all dots are illuminated then configuration is displayed:	**1**	**E**	**0**	**0**
• Firmware version [e.g. 1E00] (1st information for about 2s) • Controller configuration (2nd information for about 2s) In case **D C** or **D999** is displayed, motor interlock is active. Refer to «Safety mode» for details. If valve is closed (isolated) display shows alternately **C C** and **INIT**. Synchronization will be done when first movement command is received.		**2** = RS232 Interface **3** = RS232 Interface with analog outputs	**0** = basic **1** = with SPS[1)] **2** = with PFO[2)] **3** = with SPS[1)] and PFO[2)]	**1** = 1 sensor version **2** = 2 sensor version
SYNC indicates that synchronization is running.	**S**	**Y**	**N**	**C**

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

Operation:

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

Note: 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.

Errors:

Description	Digit 1	Digit 2	Digit 3	Digit 4
Compressed air failure (< 4 bar / 55 psi)	**A**	**I**	**R**	**f**
Compressed air on exhaust	**A**	**I**	**R**	**x**
Fatal error occurred	**E**	Error code. Refer to «Trouble shooting» for details		

3.6 Setup procedure

To enable the valve for **pressure control** setup **steps 1 to 5 must be performed**.
In case position control is required only it’s sufficient to perform steps 1 to 3.

Setup step		Description
1	**Power up**	Turn on external + 24VDC power supply of valve (and external ±15 VDC for sensor power supply if required). Refer to chapter «Behavior during power up» for details.
2	**Interface configuration**	RS232 parameters and digital inputs for valve may be changed from the default values. Refer to chapter «RS232 interface» for details.
3	**Valve and sensor configuration**	Basic configurations of valve must be adapted according to application needs. Refer to chapter «Valve and sensor configuration» for details.
4	**ZERO**	Compensation of the sensor offset voltage. Refer to chapter «ZERO» for details.
5	**LEARN**	Determination of the vacuum system characteristic to accommodate the PID controller. Refer to chapter «LEARN» for details. **Note:** Without LEARN the valve is not able to run pressure control

3.6.1 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 «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 «Setup commands» for details)
Do configuration in menu ‘Setup / Interface’.	1. Send INTERFACE CONFIGURATION
	2. Send RANGE CONFIGURATION

3.6.2 Valve and sensor configuration

Basic valve configuration must be adapted according to application needs.

- Definition of valve plate position (CLOSE or OPEN) after power up sequence. Default is ‘close‘.
- Definition of valve plate position (CLOSE or OPEN) in case of a power failure. Default is ‘not defined‘.
- Only for versions that have Power Fail Option equipped [651 . . - . . **H** . - . . . .; 651 . . - . . **C** . - . . . .].
- ZERO function: This may be ‘disabled’ or ‘enabled’. Default is ‘enabled‘.
  Refer also to «ZERO».
- Sensor configuration for 2 sensor version [651 . . - . . . **H** - . . . .].
  Refer also to «Pressure control operation with 2 sensors».

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

3.6.3 ZERO

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

Local operation: (‘Control View’, ‘Control Performance Analyzer’ or ‘Service Box 2‘)	**Remote operation**: (Refer to chapter «RS232 control commands» resp. «RS232 setup commands» for details)
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

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

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

3.6.4 LEARN

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

Local operation: (‘Control View’, ‘Control Performance Analyzer’ resp. ‘Service Box 2‘)	**Remote operation**: (Refer to chapter «RS232 control commands» resp. «RS232 setup commands» for details)
Go to ‘Learn / LEARN’ menu and follow instructions. **Note:** Gasflow calculation according to recommendation below is done automatically based on inputs.	1. Send OPEN VALVE
	2. Set specific gas flow according to calculation below and wait until flow is stable. LEARN does not need to be performed with the process gas. Instead N_2 or Ar may be used.
	3. Send LEARN with pressure limit set to p_{max} (max. pressure to control during process)

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

Note: Learn may take several minutes. Do not interrupt the routine as **a single full run is required to ensure fast and accurate pressure control**. The PID controller covers 5% to 5000% of the gas flow which was used for learn.

Gasflow calculation for LEARN:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

3.7 Close valve

Local operation: (‘Control View’, ‘Control Performance Analyzer’ or ‘Service Box 2‘)	Remote operation: (Refer to chapter «RS232 control commands» for details)
Push CLOSE button	Send CLOSE VALVE

3.8 Open valve

Local operation: (‘Control View’, ‘Control Performance Analyzer’ or ‘Service Box 2‘)	Remote operation: (Refer to chapter «RS232 control commands» for details)
Push OPEN button	Send OPEN VALVE

3.9 Position control

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

Local operation: (‘Control View’, ‘Control Performance Analyzer’ or ‘Service Box 2‘)	Remote operation: (Refer to chapter «RS232 control commands» for details)
Select or enter position setpoint	Send POSITION CONTROL

3.10 Pressure control

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

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

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

Local operation: (‘Control View’, ‘Control Performance Analyzer’ or ‘Service Box 2‘)	Remote operation: (Refer to chapter «RS232 control commands» for details)
Select or enter pressure setpoint	Send PRESSURE CONTROL

3.10.1 Operation with 2 sensors

[applicable with 651 . . - . . . **H** - . . . ., 651 . . - . . . **W** - . . . . and 651 . . - . . . **Z** - . . . . version only]

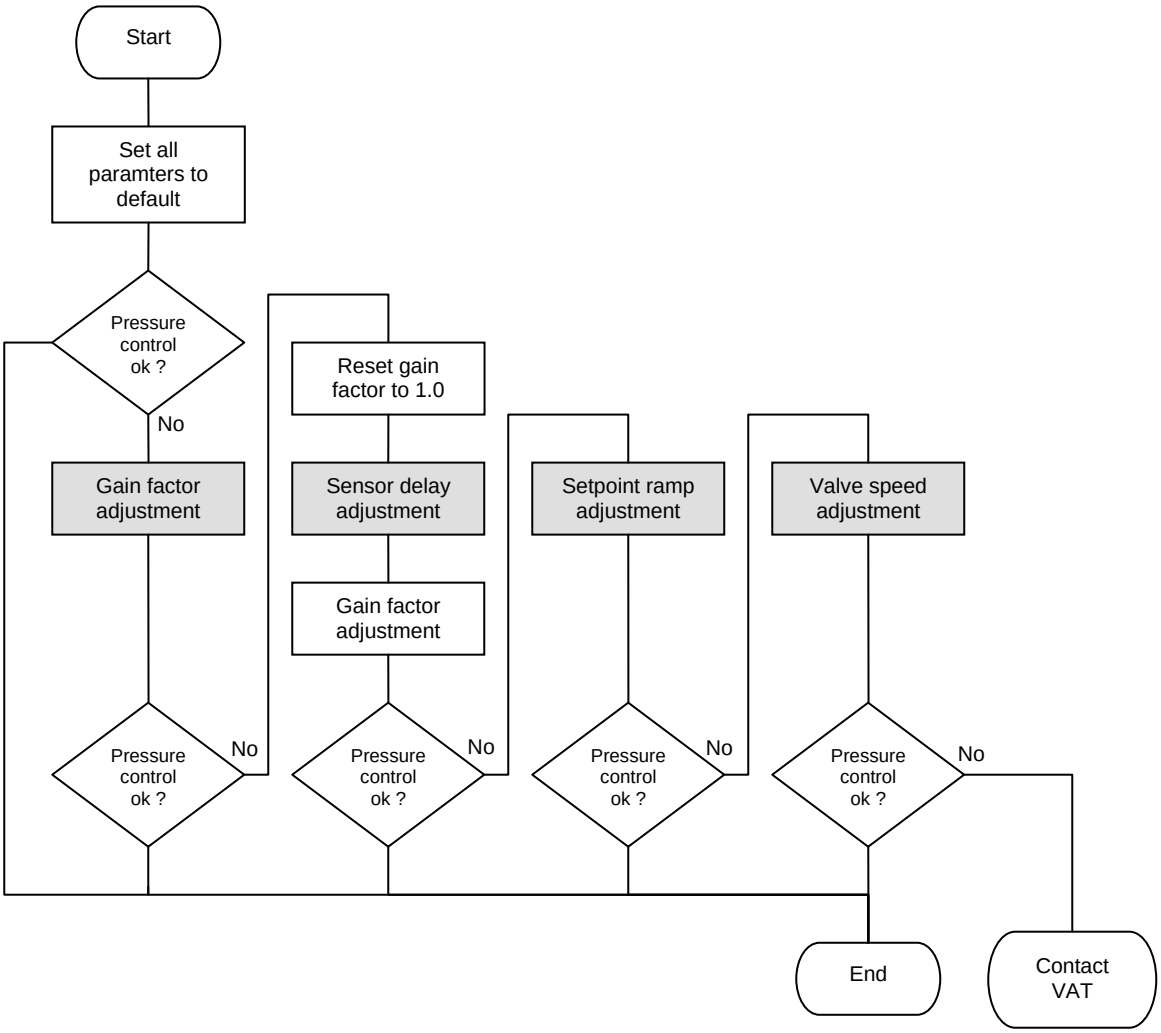
If 2 sensor operation is enabled, changeover between the sensors is done automatically during pressure control. For configuration refer to chapter «Setup procedure». We recommend a ratio of 10:1 between the pressure gauges. Max. ratio is 100:1. It is required that the high range pressure gauge is connected to sensor 1 input and the low range pressure gauge to the sensor 2 input.
Between 90 and 100% of the low range sensor full scale, the low range sensor is phased out while high range sensor is phased in. This maintains a functional response behavior in case of small calibration errors between the two sensors. The pressure output in this range is a blend between both sensors.
For monitoring purpose each sensor signal may be read out individually.

Note: Make sure that both sensors are calibrated.

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

3.10.2 Tuning of control performance

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



Required information for support:

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

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

3.10.2.1 Gain factor adjustment

The gain factor effects:

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

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

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

Adjustment procedure:

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

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

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

3.10.2.2 Sensor delay adjustment

Sensor delay adjustment effects:

- **Stability**

Default value is 0. Adjustment range is from 0 to 1.0s.

Pipes and orifices for sensor attachment delay response time and so badly impact pressure control stability.
By adapting this parameter to the approximate delay time stability problems can be reduced. But control response time will be slowed down by this measure.

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

Adjustment procedure:

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

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

3.10.2.3 Setpoint ramp adjustment

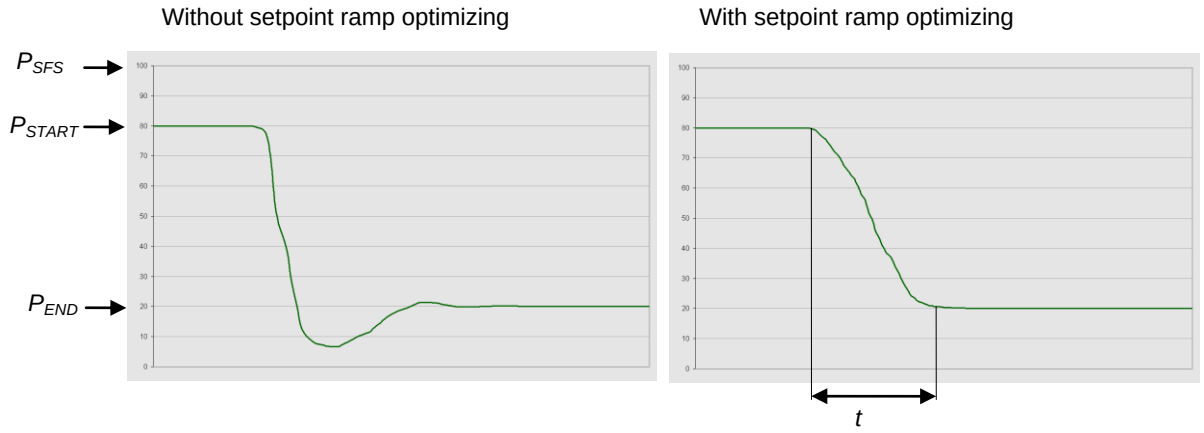
Setpoint ramp effects:

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

Default value for *Setpoint Ramp* is 1. Adjustment range for *Setpoint Ramp* is from 0 to 10 s.

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

Pressure chart



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

t = Setpoint Ramp

Adjustment procedure:

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

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

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

3.10.2.4 Valve speed adjustment

Valve speed effects:

- **Response time**

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

This parameter effects valve plate actuating speed.
Speed adjustment is effective for PRESSURE CONTROL and POSITION CONTROL.
Note: Normally best pressure control response is achieved with max. valve speed. In particular applications it may be of advantage to have a slower valve response.
Note: OPEN and CLOSE are always done with max. speed.

Adjustment procedure:

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

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

3.11 RS232 interface

3.11.1 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.

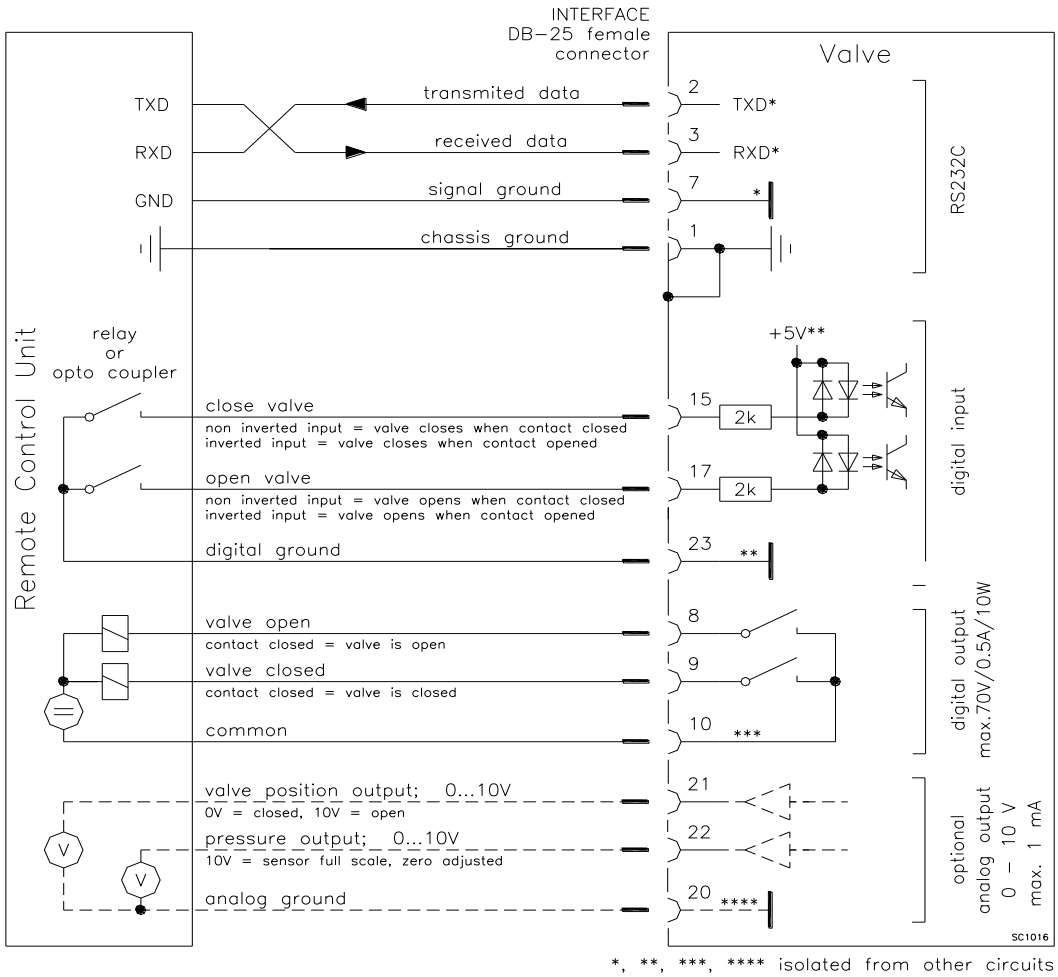
3.11.2 Schematics

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.

Note: Optional analog outputs are available on 651 . . - . . . **V** - . . . . and 651 . . - . . . **W** - . . . . versions only.

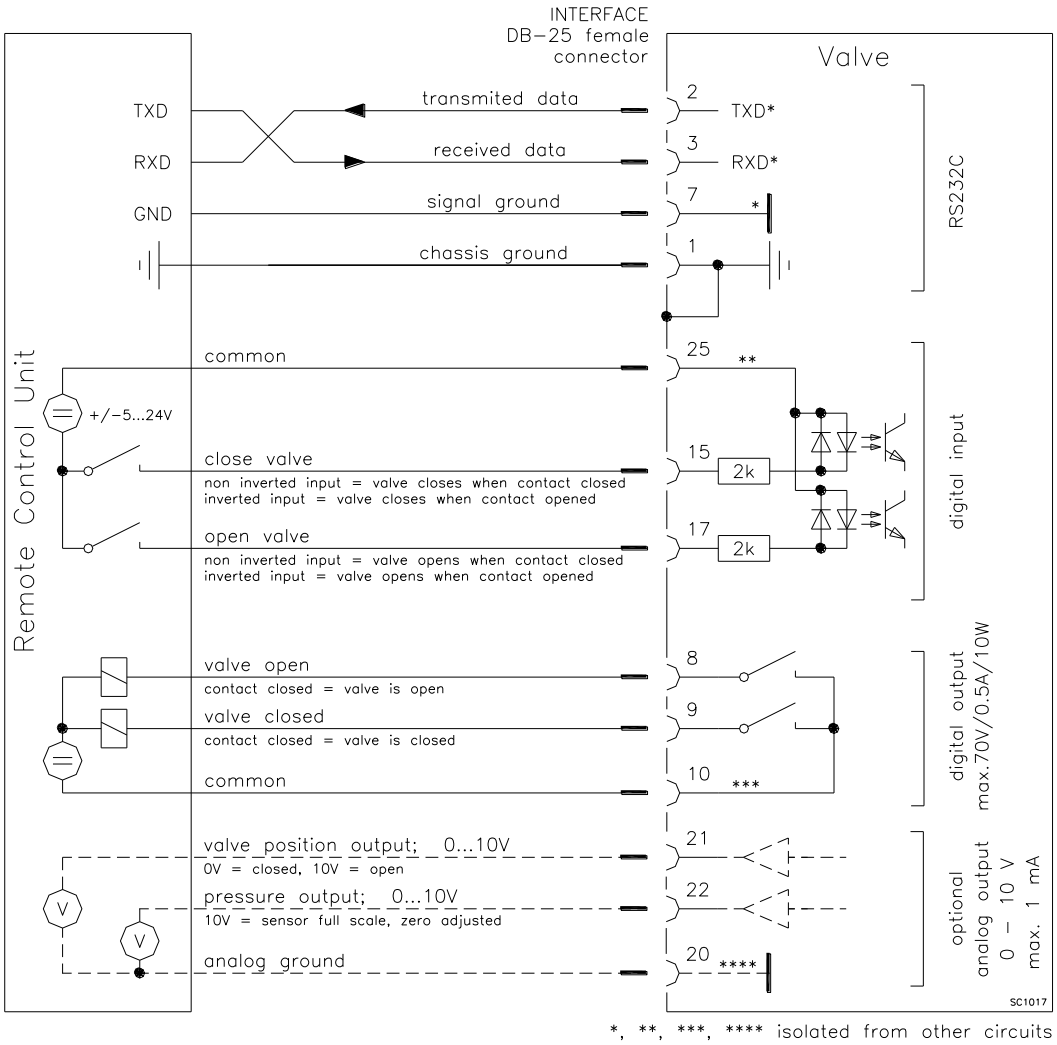
Active **digital inputs** have **higher priority than RS232** commands.

a) Configuration with switches for digital inputs:



Note: Do not connect other pins than indicated in the schematics above!
Connector: Use only screws with 4-40UNC thread for fastening the DB-25 connector!

b) Configuration with voltage source for digital inputs:



Note: Do not connect other pins than indicated in the schematics above!
Connector: Use only screws with 4-40UNC thread for fastening the DB-25 connector!

3.11.3 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 «3.11.2 Schematics» configuration a).	
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 «3.11.2 Schematics» configuration b).	

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 «3.11.2 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.

3.11.4 RS232 Command syntax

[function][value][CR][LF]

Each element is separated with square brackets for clarity. Square brackets are not part of command syntax. Unless otherwise specified all elements are ASCII characters. There are no spaces between the elements necessary. Commands and values are case sensitive.
Data length of value depends on command. Number of characters is specified in the description. Some commands do not require the value element.
[CR] is Carriage Return (0D hexadecimal).
[LF] is Linefeed

3.11.5 Control commands

Control function	Command		Acknowledgement (within 10ms after reception of command)
	Description		
POSITION CONTROL	Set	[R:][xxxxxx][CR][LF]	[R:][CR][LF]
	Get	[i:38][CR][LF]	[i:38][00xxxxxx][CR][LF]
	data length 6 characters for writing 8 characters starting with double zero for reading xxxxxx position SETPOINT, value depends on configuration, refer to «RS232 setup commands, RANGE CONFIGURATION» for details Change to POSITION CONTROL mode and transfer of position SETPOINT value resp. reading of position SETPOINT. **Note:** Reading returns position setpoint only in case pressure control is not selected.		
HOLD	Set	[H:][CR][LF]	[H:][CR][LF]
	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.		
CLOSE VALVE	Set	[C:][CR][LF]	[C:][CR][LF]
	Valve will close.		
OPEN VALVE	Set	[O:][CR][LF]	[O:][CR][LF]
	Valve will open.		
PRESSURE CONTROL	Set	[S:][0xxxxxxx][CR][LF]	[S:][CR][LF]
	Get	[i:38][CR][LF]	[i:38][0xxxxxxx][CR][LF]
	data length 8 characters starting with a zero xxxxxxx pressure SETPOINT, value depends on configuration, refer to «RS232 setup commands, RANGE CONFIGURATION» for details Change to PRESSURE CONTROL mode and transfer of pressure SETPOINT resp. reading of pressure SETPOINT. **Note:** Reading returns pressure setpoint only in case pressure control is selected, otherwise position setpoint is returned.		

3.11.6 Inquiry commands

Inquiry function	Command		Acknowledgement (within 10ms after reception of command)
	Description		
ASSEMBLY	Get	[i:76][CR][LF]	[i:76][xxxxxxsyyyyyyyyabc][CR][LF]
	data length 17 characters xxxxxx position, return value depends on configuration, refer to «RS232 setup commands, RANGE CONFIGURATION» 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, RANGE CONFIGURATION» 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** = CLOSED **4** = OPEN, **5** = PRESSURE CONTROL, **6** = HOLD , **7** = LEARN **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 **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.		
POSITION	Get	[A:][CR][LF]	[A:][xxxxxx][CR][LF]
	data length 6 characters xxxxxx position, return value depends on configuration, refer to «RS232 setup commands, RANGE CONFIGURATION» for details This function returns the current valve position. **Note:** When motor interlock is active during power up the valve enters the ‘safety mode’ and is not able to recognize position. In this case position 999’999 is returned.		
PRESSURE	Get	[P:][CR][LF]	[P:][sxxxxxxx][CR][LF]
	data length 8 characters s sign, 0 for positive readings, - for negative readings xxxxxxx pressure, return value depends on configuration, refer to «RS232 setup commands, RANGE CONFIGURATION» for details This function returns the actual pressure.		

Inquiry function	Command		Acknowledgement (within 10ms after reception of command)
	Description		
SENSOR 1 READING	Get	[i:64][CR][LF]	[i:64][sxxxxxxx][CR][LF]
	data length 8 characters s sign, 0 for positive readings, - for negative readings xxxxxxx sensor 1 reading, return value depends on configuration, refer to «RS232 setup commands, RANGE CONFIGURATION» for details This function returns direct reading from sensor 1 input.		
SENSOR 2 READING	Get	[i:65][CR][LF]	[i:65][sxxxxxxx][CR][LF]
	data length 8 characters s sign, 0 for positive readings, - for negative readings xxxxxxx sensor 2 reading, return value depends on configuration, refer to «RS232 setup commands, RANGE CONFIGURATION» for details This function returns direct reading from sensor 2 input.		
PRESSURE CONTROL STATUS	Get	[i:36][CR][LF]	[i:36][abcdefgh][CR][LF]
	data length 8 characters a **0** = no pressure control (e.g. if position control is selected) **1** = wide range control (PD control) **2** = close up control (PID control) cdefgh reserved, do not use The controller distinguishes 2 control ranges and acts accordingly.		
DEVICE STATUS	Get	[i:30][CR][LF]	[i:30][abcdefgh][CR][LF]
	data length 8 characters 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** = CLOSED **4** = OPEN, **5** = PRESSURE CONTROL, **6** = HOLD , **7** = LEARN **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 **0** = Power Failure Option (PFO) disabled **1** = Power Failure Option (PFO) enabled d **0** = no warning, **1** = warning present (read «WARNINGS» and «ERROR STATUS» for details) efg reserved, do not use h **0** = normal operation, **1** = simulation running This function returns status information about the valve. **Note:** 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.		

Inquiry function	Command		Acknowledgement (within 10ms after reception of command)
	Description		
WARNINGS	Get	[i:51][CR][LF]	[i:51][abcdefgh][CR][LF]
	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 data set present, **1** = LEARN 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. **Note:** Without LEARN the valve is not able to run pressure control		
SENSOR OFFSET	Get	[i:62][CR][LF]	[i:62][aaaabbbb][CR][LF]
	data length 8 characters aaaa offset sensor 1 (-140 ... 0140 = -1.40V ... +1.40V) bbbb offset sensor 2 (-140 ... 0140 = -1.40V ... +1.40V) This function returns the sensor offset voltages for both sensors (adjusted by ZERO).		
SENSOR 1 OFFSET	Get	[i:60][CR][LF]	[i:60][xxxxxxxx][CR][LF]
	data length 8 characters xxxxxxxx offset sensor 1 (-140000 ... 0140000 = -1.400000V ... +1.400000V) This function returns the sensor 1 offset voltage (adjusted by ZERO).		
SENSOR 2 OFFSET	Get	[i:61][CR][LF]	[i:61][xxxxxxxx][CR][LF]
	data length: 8 characters xxxxxxxx offset sensor 2 (-140000 ... 0140000 = -1.400000V ... +1.400000V) This function returns the sensor 2 offset voltage (adjusted by ZERO).		

Inquiry function	Command	Acknowledgement (within 10ms after reception of command)
	Description	
LEARN STATUS	Get [i:32][CR][LF]	[i:32][abcdefgh][CR][LF]
	data length 8 characters a **0** = LEARN not running, **1** = LEARN running b **0** = LEARN data set present, **1** = LEARN data set not present c **0** = ok **1** = last LEARN interrupted by user (control command) **2** = last LEARN interrupted by control unit (valve open pressure > sensor full scale) d **0** = ok **1** = valve open pressure > 50% sensor full scale (gasflow too high) **2** = valve open pressure < 0 (sensor offset present) e **0** = ok **1** = valve max. throttle pressure < 10% sensor full scale (gasflow too low) f **0** = ok **1** = pressure not raising during LEARN (gasflow missing) g **0** = ok **1** = sensor unstability during LEARN h reserved, do not use This function checks the status of LEARN and indicates if the conditions during LEARN were ok.	
LEARN PRESSURE LIMIT	Get [i:34][CR][LF]	[i:34][0xxxxxxx][CR][LF]
	data length 8 characters starting with a zero xxxxxxx pressure limit for LEARN, return value depends on configuration, refer to «RS232 setup commands, RANGE CONFIGURATION» for details This function returns the pressure limit applied for LEARN.	
ERROR STATUS	Get [i:52][CR][LF]	[i:52][abcdefgh][CR][LF]
	data length 8 characters a reserved, do not use b **1** = sensor 1 signal converter failure c reserved, do not use d **1** = firmware memory failure efgh reserved, do not use This function returns an error code in case of any malfunction of the device otherwise 0 is returned.	
FATAL ERROR STATUS	Get [i:50][CR][LF]	[i:50][abc][CR][LF]
	data length 3 characters abc error code = 000 (no error) or 020 (E·20) or 022 (E·22) or 040 (E·40) See in chapter «Trouble shooting» for details. This function returns an error code in case of any malfunction of the device.	

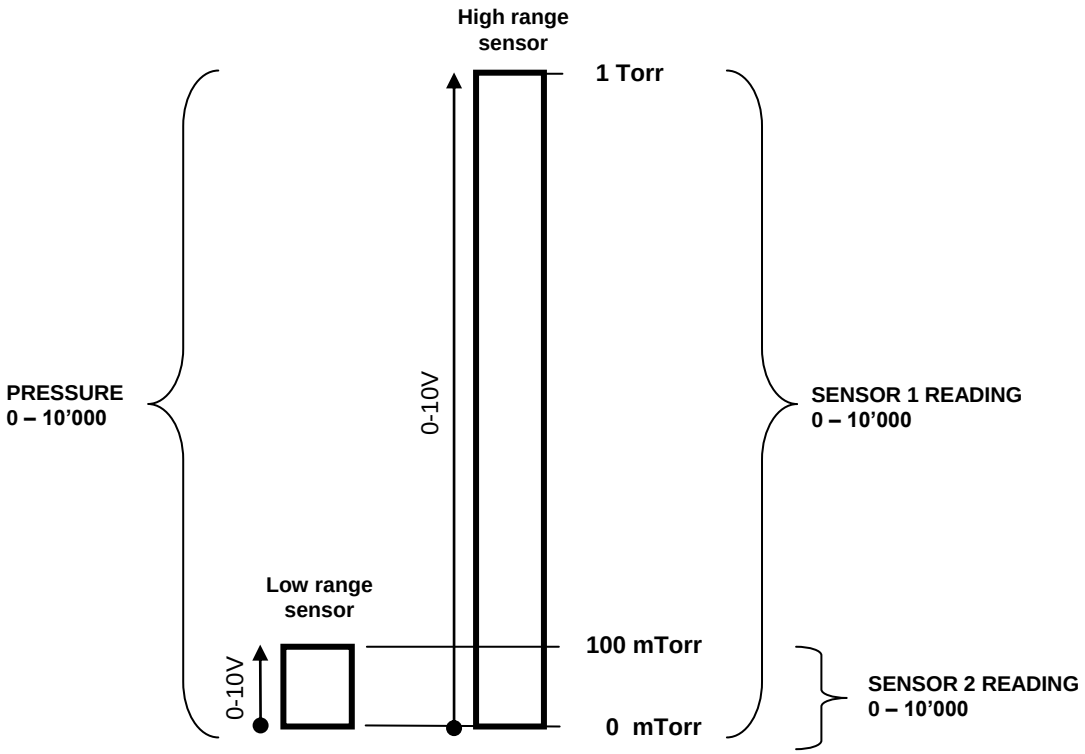
Inquiry function	Command	Acknowledgement (within 10ms after reception of command)
	Description	
THROTTLE CYCLE COUNTER	Get [i:70][CR][LF]	[i:70][xxxxxxxxxx][CR][LF]
	data length 10 characters xxxxxxxxxx number of throttle cycles This function returns the number of throttle cycles. A movement from max. 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][CR][LF]	[i:71][xxxxxxxxxx][CR][LF]
	data length 10 characters xxxxxxxxxx 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][CR][LF]	[i:72][xxxxxxxxxx][CR][LF]
	data length 10 characters xxxxxxxxxx number of power ups This function returns the number of control unit power ups.	
HARDWARE CONFIGURATION	Get [i:80][CR][LF]	[i:80][abcdefgh][CR][LF]
	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][CR][LF]	[i:82][xxxxxxxx][CR][LF]
	data length 8 characters xxxxxxxx firmware version, e.g. 650P1D00 This function returns firmware version of the device.	
IDENTIFICATION	Get [i:83][CR][LF]	[i:83][xxxxxxxxxxxxxxxxxxxx][CR][LF]
	data length 20 characters xxx...xxx identification code, e.g. 651..-..G-.... 651..-..H-..../0001/, unused digits are filled up with spaces (20 hexadecimal) This function returns an identification code. This code is unique for each valve and allows tracing.	

3.11.7 Setup commands

Setup function	Command		Acknowledgement (within 10ms after reception of command)
	Description		
ACCESS MODE	Set	[c:01][xx][CR][LF]	[c:01][CR][LF]
	data length: 2 characters xx **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. **Note:** Local operation is only possible when either ‘Control View’ or ‘Control Performance Analyzer’ software is running. When communication to service port is interrupted the valve will automatically change to remote operation.		
INTERFACE CONFIGURATION	Set	[s:20][abcdefgh][CR][LF]	[s:20][CR][LF]
	Get	[i:20][CR][LF]	[i:20][abcdefgh][CR][LF]
	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. **Note:** Digital outputs are always enabled.		
VALVE CONFIGURATION	Set	[s:04][abcdefgh][CR][LF]	[s:04][CR][LF]
	Get	[i:04][CR][LF]	[i:04][abcdefgh][CR][LF]
	data length 3 characters a valve position after power up: **0** = closed, **1** = open b valve position after power failure: **0** = closed, **1** = open c **0** (reserved, do not change) d **0** (reserved, do not change) e **0** (reserved, do not change) f **0** (reserved, do not change) g **0** (reserved, do not change) h **0** (reserved, do not change) This function does the valve configuration.		

Setup function	Command		Acknowledgement (within 10ms after reception of command)
	Description		
SENSOR CONFIGURATION	Set	[s:01][abcdefgh][CR][LF]	[s:01][CR][LF]
	Get	[i:01][CR][LF]	[i:01][abcdefgh][CR][LF]
	data length	8 characters	
	a	**0** = no sensor **1** = 1 sensor operation (sensor 1 input) **2** = 2 sensor operation with automatic changeover (low range = sensor 2 input, high range = sensor 1 input) **3** = 1 sensor operation (sensor 2 input) **4** = 2 sensor operation with automatic changeover (low range = sensor 1 input, high range = sensor 2 input) **Note:** Sensor operation modes 2, 3 and 4 are possible with 2 sensor hardware (651 . . - . . . **H** - . . . . and 651 . . - . . . **W** - . . . .) only. **Note:** For applications where the high range sensor is used for for monitoring purpose only, select sensor operation modes 1 or 3 for pressure control with low range sensor and read high range sensor from «SENSOR 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 for pressure control.		

Setup function	Command		Acknowledgement (within 10ms after reception of command)
	Description		
RANGE CONFIGURATION	Set	[s:21][abcdefgh][CR][LF]	[s:21][CR][LF]
	Get	[i:21][CR][LF]	[i:21][abcdefgh][CR][LF]
	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. **Note:** In case ZERO has been performed, gauge offset for PRESSURE and SENSOR READING is compensated. **Note:** 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.		



Above picture shows a 2 sensor system. In this configuration sensor 2 covers low range (100 mTorr) and sensor 1 covers high range (1 Torr). RANGE CONFIGURATION for PRESSURE resp. SENSOR READING is set to 10’000. Switchover between sensors is done automatically.

Setup function	Command		Acknowledgement (within 10ms after reception of command)
	Description		
ZERO	Set	[Z:][CR][LF]	[Z:][CR][LF]
	This command initiates ZERO to compensate for offset of gauge(s). **Note:** Refer to «ZERO» for correct zero procedure.		
PRESSURE ALIGNMENT	Set	[c:6002][xxxxxxxx][CR][LF]	[c:60][CR][LF]
	data length: 8 characters xxxxxxxx System base pressure, value depends on configuration, refer to «RS232 setup commands, RANGE CONFIGURATION» 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.		
LEARN	Set	[L:][0xxxxxxx][CR][LF]	[L:][CR][LF]
	data length 8 characters starting with a zero xxxxxxx Pressure limit for LEARN, value depends on configuration, refer to «RS232 setup commands, RANGE CONFIGURATION» for details This command starts LEARN. By OPEN VALVE, CLOSE VALVE or POSITION CONTROL commands the routine may be interrupted. **Note:** Without LEARN the PID controller is not able to perform pressure control. Refer to «LEARN» for correct learn gas flow and procedure.		
DOWNLOAD LEARN DATA	Set	[d:][pppdddddddd][CR][LF]	[d:][ppp][CR][LF]
	data length 3 + 8 characters ppp pointer, **000** ... **103** dddddddd single data set This command downloads the LEARN data sets from the host computer to the valve. There are a total number of 104 data sets. Each data set consists of 8 data bytes and needs to be uploaded separately. **Note:** Make sure that all 104 data sets will be downloaded.		
UPLOAD LEARN DATA	Get	[u:][ppp][CR][LF]	[u:][pppdddddddd][CR][LF]
	data length 3 + 8 characters ppp pointer, **000** ... **103** dddddddd single data set This command uploads the LEARN data sets from the valve up to the host. There are a total number of 104 data sets. Each data set consists of 8 data bytes and needs to be uploaded separately. **Note:** Make sure that all 104 data sets will be uploaded.		

Setup function	Command		Acknowledgement (within 10ms after reception of command)
	Description		
PID CONTROLLER CONFIGURATION	Set	[s:02][abcdefgh][CR][LF]	[s:02][CR][LF]
	Get	[i:02][CR][LF]	[i:02][abcdefgh][CR][LF]
	data length 8 characters a **0** (reserved, do not change) b gain factor: **0** = 0.10, **1** = 0.13, **2** = 0.18, **3** = 0.23, **4** = 0.32, **5** = 0.42, **6** = 0.56 **7** = 0.75, **8** = 1.00, **9** = 1.33, **A** = 1.78, **B** = 2.37, **C** = 3.16, **D** = 4.22 **E** = 5.62, **F** = 7.50, **G** = 0.0001, **H** = 0.0003, **I** = 0.001, **J** = 0.003, **K** = 0.01, **L** = 0.02, **M** = 0.05 c sensor delay: **0** = 0.00, **1** = 0.02, **2** = 0.04, **3** = 0.06, **4** = 0.08, **5** = 0.10, **6** = 0.15, **7** = 0.20, **8** = 0.25, **9** = 0.30, **A** = 0.35, **B** = 0.4, **C** = 0.50, **D** = 0.60, **E** = 0.80, **F** = 1.00 d setpoint ramp: **0** = 0.0, **1** = 0.5, **2** = 1.0, **3** = 1.5, **4** = 2.0, **5** = 2.5, **6** = 3.0, **7** = 3.5, **8** = 4.0 , **9** = 4.5, **A** = 5.0, **B** = 5.5, **C** = 6.0, **D** = 6.5, **E** = 7.0, **F** = 7.5, **G** = 8.0, **H** = 8.5, **I** = 9.0, **J** = 9.5, **K** = 10.0 efgh **0000** (reserved, do not change) This command selects gain factor, sensor response time and setpoint ramp for the PID controller. **Note:** Refer to «Tuning of control performance» for details.		
VALVE SPEED	Set	[V:][00xxxx][CR][LF]	[V:][CR][LF]
	Get	[i:68][CR][LF]	[i:68][0000xxxx][CR][LF]
	data length 6 characters starting with double zero for writing 8 characters starting with quadruple zero for reading xxxx 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. **Note:** Refer to «Valve speed adjustment» for details.		
RESET	Set	[c:82][xx][CR][LF]	[c:82][CR][LF]
	data length 2 characters xx **00** = reset service request bit from WARNINGS **01** = reset FATAL ERROR (restart control unit) This function resets warnings and errors.		

3.11.8 Error messages

Description	Error message
Protocol	
Parity error	[E:][000001][CR][LF]
Framing error (data length, number of stop bits)	[E:][000003][CR][LF]
Input buffer overflow (to many characters)	[E:][000002][CR][LF]
Commands	
<CR> or <LF> missing	[E:][000010][CR][LF]
: missing	[E:][000011][CR][LF]
Unknown command	[E:][000020][CR][LF] [E:][000021][CR][LF]
Invalid value	[E:][000022][CR][LF] [E:][000023][CR][LF]
Value out of range	[E:][000030][CR][LF]
Invalid number of characters (between **:** and [CR][LF])	[E:][000012][CR][LF]
Setup	
ZERO disabled	[E:][000060][CR][LF]
Device Status	
Command not accepted due to local operation	[E:][000080][CR][LF]
Command not accepted due to synchronization, CLOSED or OPEN by digital input, safety mode or fatal error	[E:][000082][CR][LF]
Hardware	
Command not applicable for hardware configuration	[E:][000041][CR][LF]

4 Trouble shooting

Failure	Check	Action
No dots lighted on display	- 24 V power supply ok?	- Connect valve to power supply according to «Electrical connection» and make sure that power supply is working.
Remote operation does not work	- Local operation via service port active - Safety mode active, check for D on display?	- Switch to remote operation. - Provide power to motor to allow for operation. - Refer to «Electrical connection» for details.
Display shows «**E 20**» (**fatal error** - limit stop of valve unit not detected)		- Reset control unit. Cycle power (OFF→ON) or - Send reset command: - local via service port with CV/CPA/Service Box2 - If reset unsuccessful, replace actuator according to «Maintenance procedures».
Display shows «**E 22**» (**fatal error** - rotation angle of valve plate limited during operation)	- Valve plate mechanically obstructed?	- 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**» (**fatal error** - motor driver failure detected)		- Replace control unit according to «Maintenance procedures».
Display shows «**D C**» or «**D999**» Motor Interlock is open	- Motor power supplied?	- Provide power to motor to allow for operation. - Refer to «Electrical connection» for details.
Display shows «**SR**» (Service Request)	- Valve unit heavy contaminated or gate seal heavyly sticking?	- Clean valve and/or replace gate seal according to «Maintenance procedures».
CLOSE VALVE does not work	- Safety mode active, check for D on display? - Maintenance mode active	- Provide power to motor to allow for operation. - Refer to «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 «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)]
POSITION CONTROL does not work	- Safety mode active, check for D on display?	- Provide power to motor to allow for operation. - Refer to «Electrical connection» for details.
	- POSITION CONTROL selected, check for V on display?	- Select POSITION CONTROL mode. Refer to «Position control» for details.
COMPRESSED AIR FAILURE «**AIRf**»	- No or too less air pressure on air input of valve	- Connect air or increase air pressure. Make sure that the air pressure is more than 4 bar (55 psi).
COMPRESSED AIR FAILURE at Exhaust «**AIRx**»	- Wrong connection of compressed air input and output - No compressed air at output exhaust	- Connect compressed air in accordance chapter installation. - Contact your local VAT service centre for support.

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.

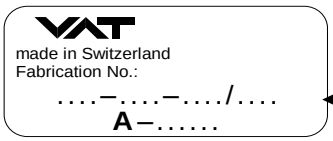
Failure	Check	Action
Pressure reading is wrong or pressure reading is negative	- Sensor(s) connected?	- Refer to «Electrical connection».
	- 2 sensor version present at valve controller?	- Check valve version on page 1. Verify configuration. Refer to «Setup procedure».
	- ZERO done?	- Perform ZERO when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

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

5 Maintenance & repairs

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

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



has always to be specified.

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

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

Keep fingers and objects away from the valve opening!

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

5.1 Maintenance procedures

Keep fingers out of the valve during maintenance work.

Use cleanroom gloves during maintenance work.

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

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

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

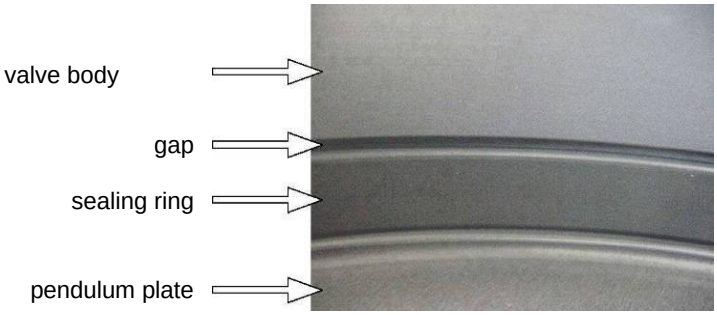
A critical factor influencing the maintenance period is the lifetime of the vacuum grease, being limited under increased temperature. In this case grease will separate to PTFE and oil. The oil may flow and contaminate the valve parts.

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

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

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

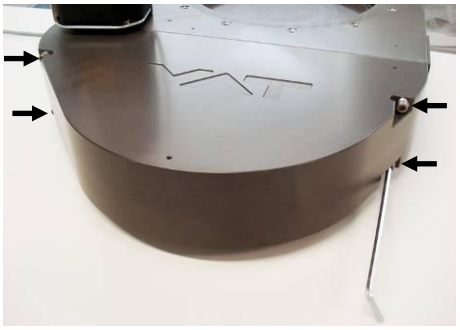
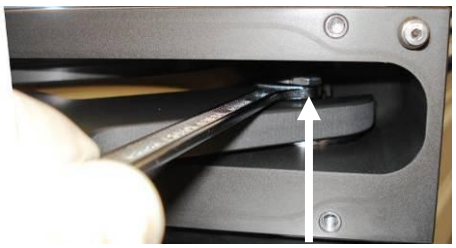
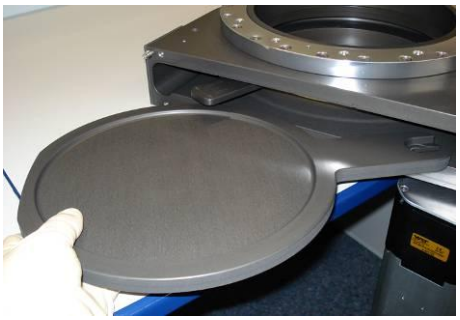
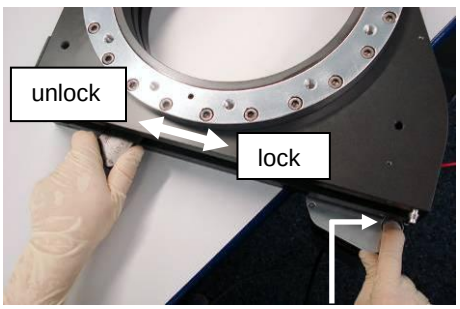
Prevent gap between body and sealing ring from air gun cleaning. Otherwise vacuum grease may be distributed and contaminate the valve.

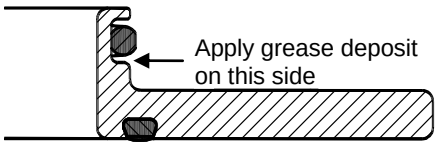


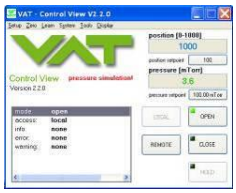
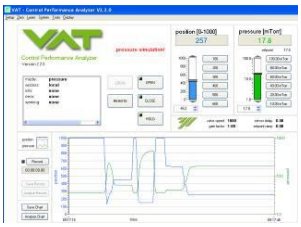
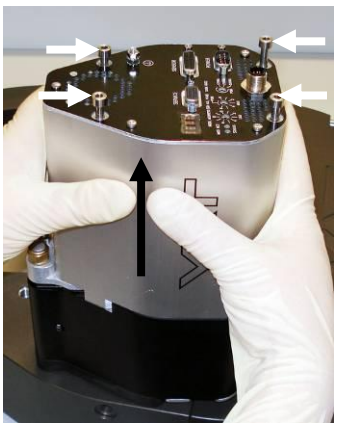
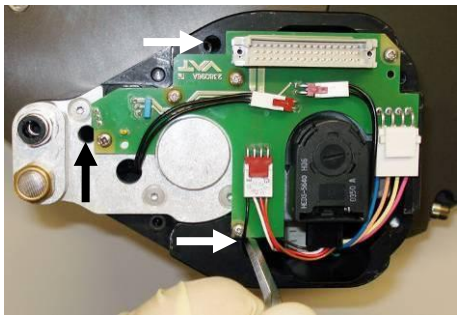
Replacement of isolation seals (gate and body seal of sealing ring) **and valve cleaning**

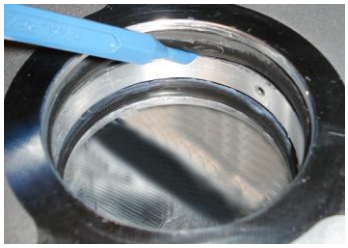
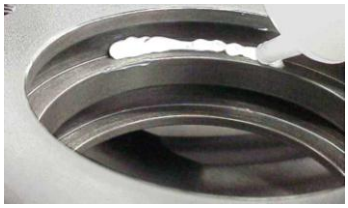
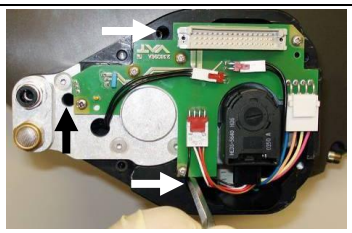
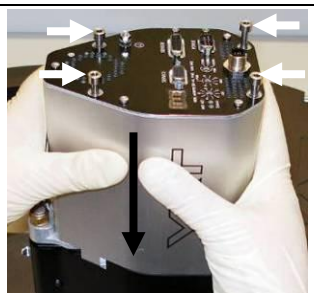
Replacement of actuator or actuator shaft seals

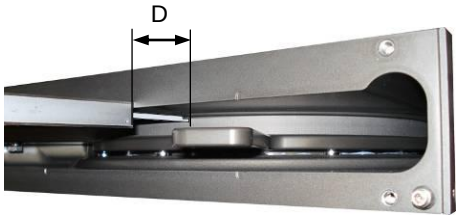
Note: Electrical power and compressed air is required to perform steps 2 to 9 during disassembly respectively 9 to 2 during assembly.

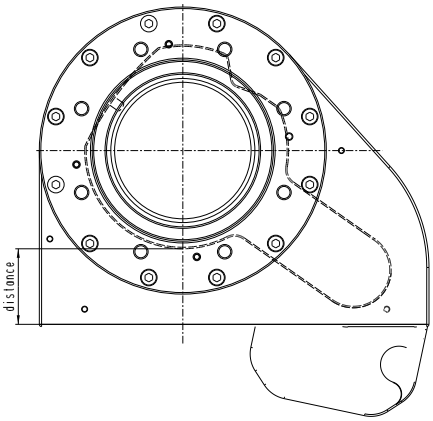
Description		Required tool		
1. Vent both valve chambers. 2. Open the 4 bonnet screws and remove valve bonnet.		Allen wrench 5mm		
3. Open valve **Caution:** Stand away from valve – pendulum plate moves out of the valve body. 4. Unfasten mounting screw for pendulum plate. (For reinstall the pendulum plate, tighten the mounting screw to block.) 5. Remove pendulum plate.	 mounting screw for pendulum plate 	open end wrench 13mm		
6. With one hand press the MAINTENANCE BUTTON to lower the sealing ring, with your second hand unlock the sealing ring by pressing the handle. 7. Release MAINTENANCE BUTTON. 8. Remove sealing ring. 9. To prevent the shaft and retaining pins from moving during work, switch the valve to safety mode. Refer to «Safety mode» for details. **Note:** Retaining pins will move up.	 maintenance button			

<table>
<tr>
<td>10. Remove gate and body seal from sealing ring carefully with a soft tool.
11. Remove grease residues at sealing ring with alcohol.
Clean sealing ring and pendulum plate with lint-and dust-free towel a little soaked with isopropyl alcohol or in an ultrasonic bath.
12. Clean out valve body with alcohol.
Use an appropriate non metal tool with a cloth to enter valve body.
Do not enter valve body with hands!
Then blow out valve body with clean air.
Do not directly expose seals (actuator and retaining pin feedthroughs) to air stream!
13. Clean or replace gate seal if necessary.
Install gate seal to sealing ring without grease.</td>
<td> 
gate seal
 
body seal</td>
<td>Soft tool
(o-ring remover)</td>
</tr>
<tr>
<td>14. Clean or replace body seal if necessary.
Lubricate body seal with the quantity of vacuum grease listed in the table to the right.</td>
<td><table>
<tr><th>Valve size</th><th>Quantity of grease [ml]</th></tr>
<tr><td>DN160 / 6”
(65144 - . . . . - . . . .)</td><td>0.15</td></tr>
<tr><td>DN200 / 8”
(65146 - . . . . - . . . .)</td><td>0.2</td></tr>
<tr><td>DN250 / 10”
(65148 - . . . . - . . . .)</td><td>0.2</td></tr>
</table></td>
<td>• Soft tool
(o-ring remover)
• Vacuum grease</td>
</tr>
<tr>
<td>15. Install body o-ring into sealing ring.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Deposit vacuum grease on the bottom side of the body seal according to drawing below. Pay attention that the quantity of vacuum grease listed in the table to the right is distributed constantly over the whole circumference.</td>
<td><table>
<tr><th>Valve size</th><th>Quantity of grease [ml]</th></tr>
<tr><td>DN160 / 6”
(65144 - . . . . - . . . .)</td><td>0.25</td></tr>
<tr><td>DN200 / 8”
(65146 - . . . . - . . . .)</td><td>0.3</td></tr>
<tr><td>DN250 / 10”
(65148 - . . . . - . . . .)</td><td>0.4</td></tr>
</table></td>
<td>Vacuum grease</td>
</tr>
<tr>
<td> 
</td>
<td>  </td>
<td>Vacuum grease</td>
</tr>
<tr>
<td>Note: For Replacement of actuator or actuator shaft seals, proceed with step 19 otherwise go to step 17.
17. Reassembly the valve in reverse order, step 9…3.
18. Close the valve bonnet, see steps 40…42.</td>
<td></td>
<td></td>
</tr>
</table>

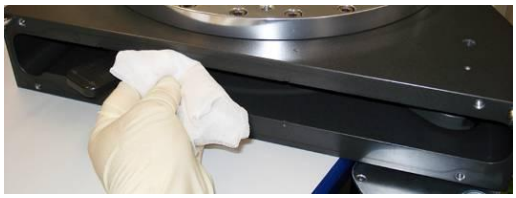
19. Release the valve from safety mode. Refer to «Safety mode» for details 20. Move the valve to position 50% (half opened) This is necessary, in order to dismount the actuator. See step 24. 21. Disable PFO option feature via 'Power Fail Status' in menu 'System' of CV or CPA software, and turn off the power	  	• CV software • CPA software or • Service Box 2		
22. Disconnect 24VDC power. Wait for 60s, then disconnect cables and compressed air from valve actuator. 23. Unfasten all 4 controller screws and lift controller carefully from actuator.		Allen Wrench 4 mm		
24. Unfasten all 3 actuator screws and remove actuator.		Allen Wrench 5 mm		

Description		Required tool		
25. Remove actuator shaft seals carefully with a soft tool. 26. Clean actuator feedthrough with alcohol. 27. Lubricate each o-ring groove with 0.1 ml vacuum grease. Pay attention that grease is distributed constantly over the whole circumference.	 	• Soft tool (o-ring remover) • Vacuum grease		
28. Clean or replace seals if necessary. Lubricate each o-ring with 0.05 ml vacuum grease. 29. Install o-rings. 30. Deposit 0.1 ml vacuum grease on each o-ring. Pay attention that grease is distributed constantly over the whole circumference.				
31. Remove fixation kit and mounting screw for pendulum plate. 32. Clean screw and slightly lubricate thread with 0.1 ml vacuum grease, then reinstall fixation kit. 33. Clean actuator shaft and lubricate it with 0.1 ml vacuum grease.				
34. Install actuator • Tighten actuator screws with 6 Nm. • Remove vacuum grease from actuator shaft face after installation.		Allen Wrench 5mm		
35. Install controller • Tighten the controller screws with 3 Nm. • Connect cables at controller • Connect compressed air at actuator		Allen Wrench 4mm		

<table>
<tr><th colspan="3">D e s c r i p t i o n</th><th>Required tool</th><th></th><th></th></tr>
<tr><td colspan="2">36. Turn on power of controller.
Note: valve moves to close position.
37. Open valve and install sealing ring and pendulum plate in reverse order as they had been disassembled (steps 8 to 3).</td><td></td><td>open end wrench 13mm</td><td></td><td></td></tr>
<tr><td rowspan="4">If actuator was replaced, proceed with step 38, otherwise go to step 40.
38. Close valve and check if pendulum plate is in center of flange. Check can be done either visual or by measurement.
When the valve is mounted to a tool, the bonnet has to be removed and the center position can be measured by a depth gauge (see picture).
If the centering (or distance D) is not correct, proceed with step 39.</td><td rowspan="4"> 


</td><td>DN</td><td>Distance D [mm] between bonnet flange surface and pendulum plate.</td><td rowspan="4"></td><td rowspan="4"></td></tr>
<tr><td>160</td><td>45.0 ±0.5</td></tr>
<tr><td>200</td><td>40.0 ±0.5</td></tr>
<tr><td>250</td><td>50.0 ±0.5</td></tr>
<tr><td colspan="2">39. If necessary adjust pendulum plate:
a. Move pendulum plate a little towards open (e.g. position 1% of full stroke)
b. Use adjustment screw at flange side of actuator (1 turn clockwise adjusts pendulum plate by about 3mm towards open).
c. Restart valve in menu ‘System/Recovery’
d. Check pendulum plate position according step 38 and redo adjustment procedure if necessary.</td><td>Adjusting screw mounted either in actuator position «B1 standard» or «B2 option»
 

 </td><td>Allen wrench 3mm</td><td></td><td></td></tr>
</table>

Description		Required tool		
40. Clean the valve bonnet sealing surface		Lint-and dust-free towel a little soaked with isopropyl alcohol		
41. Clean the valve bonnet o-ring		Lint-and dust-free towel		
42. Mount valve bonnet. • Tightening torques for bonnet screws, see in table to the right.	**Max. torque 6 Nm**	Allen wrench 5mm		

5.2 Option board

The option board may or may not be equipped in your valve depending on the order. Refer to page 1 of this manual to check valve version. This board includes the optional modules for the valve which are:
- ±15VDC sensor power supply (SPS)
- Power failure option (PFO)

It is available in 3 versions. These are:
- SPS module only
- PFO module only
- SPS and PFO module

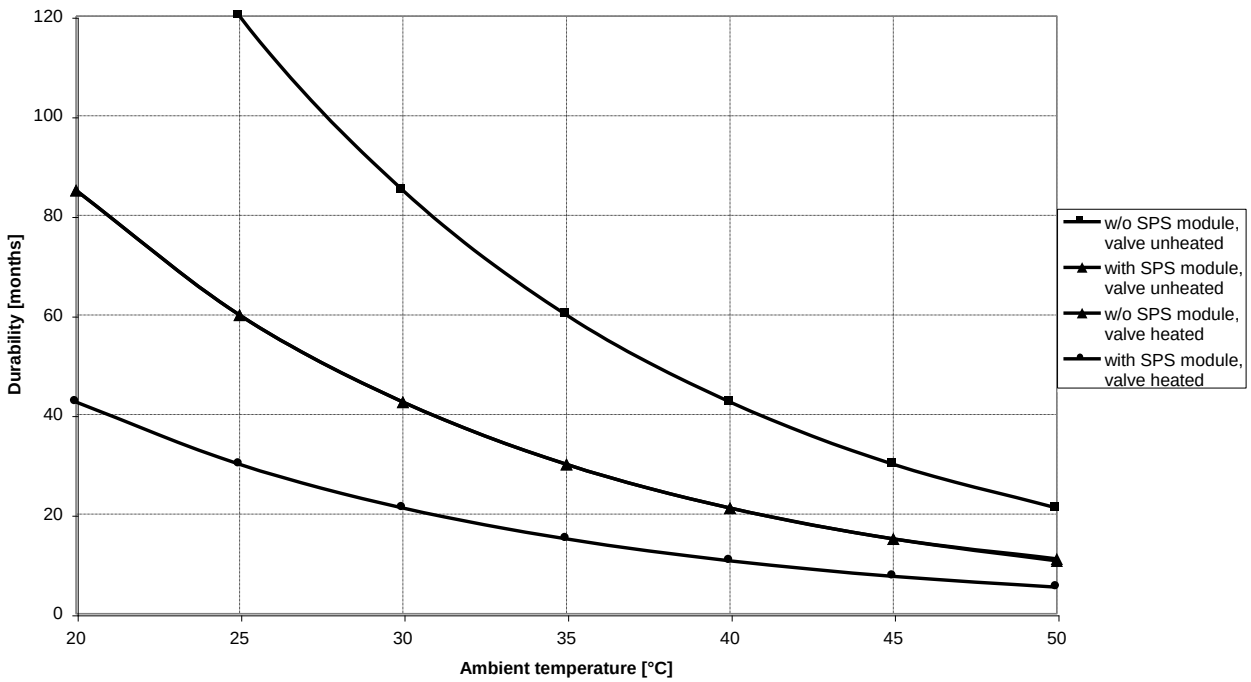
The modules may be retrofitted or replaced easily. The battery lifetime of the PFO module depends on the ambient temperature (see below). To assure PFO function the option board must be replaced after battery life has expired. For ordering number of the modules refer to «Spare parts and accessories».

5.2.1 Durability of power fail battery

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

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

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



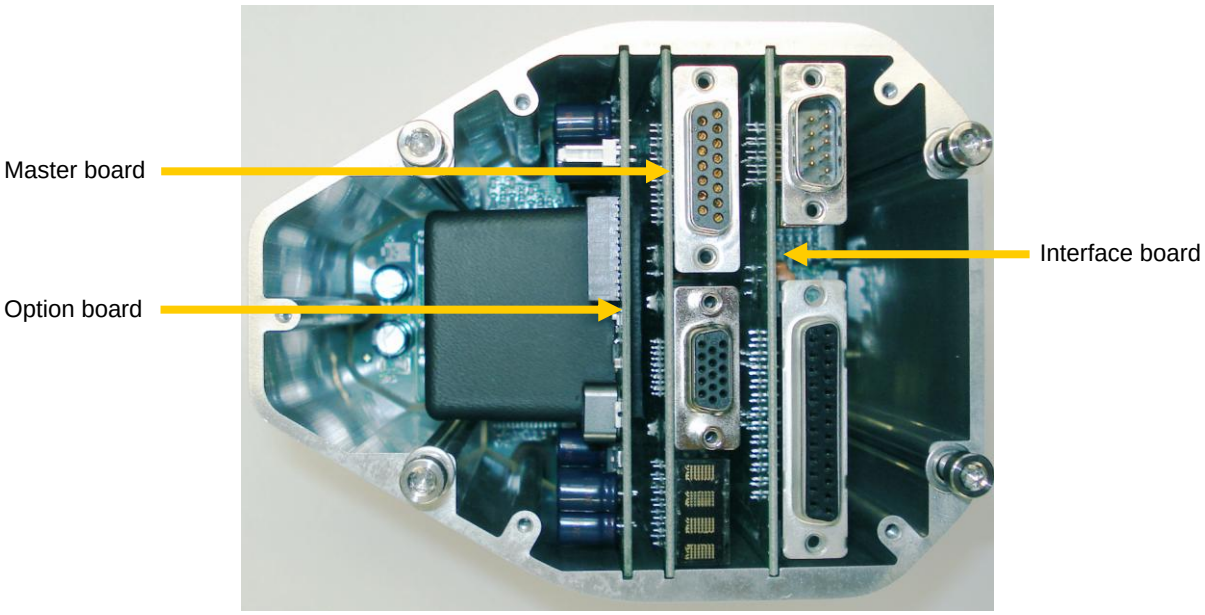
Note: This graph shows estimated life of UltraCap PFO for reference and not as guaranteed value.

5.2.2 Retrofit / replacement procedure

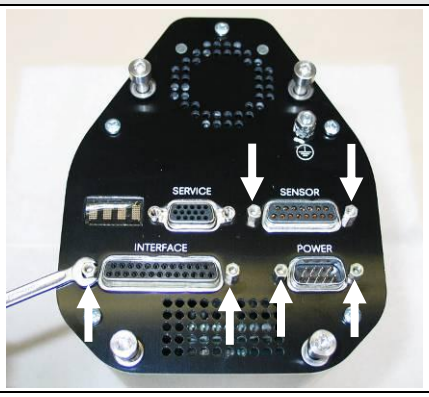
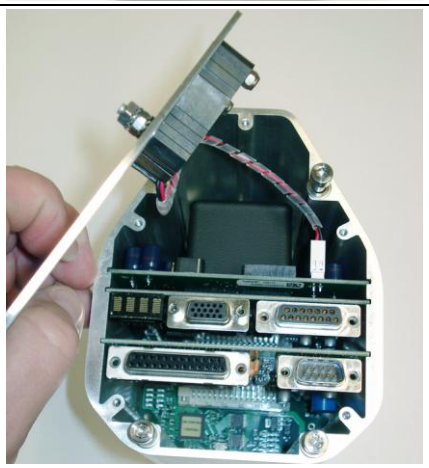
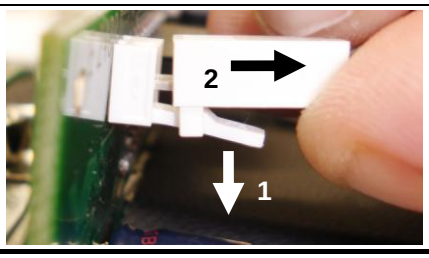
ESD Precaution!

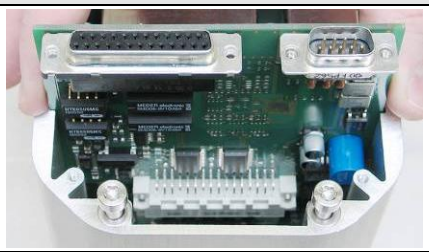
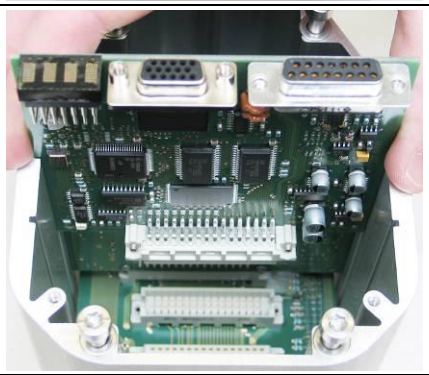
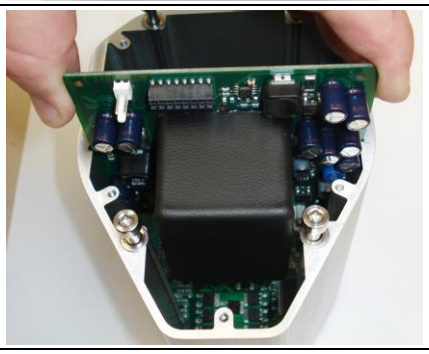
All work on the control and actuating unit has to be done under ESD protected environment to prevent electronic components from damage!

Top view on control and actuating unit with panel removed:

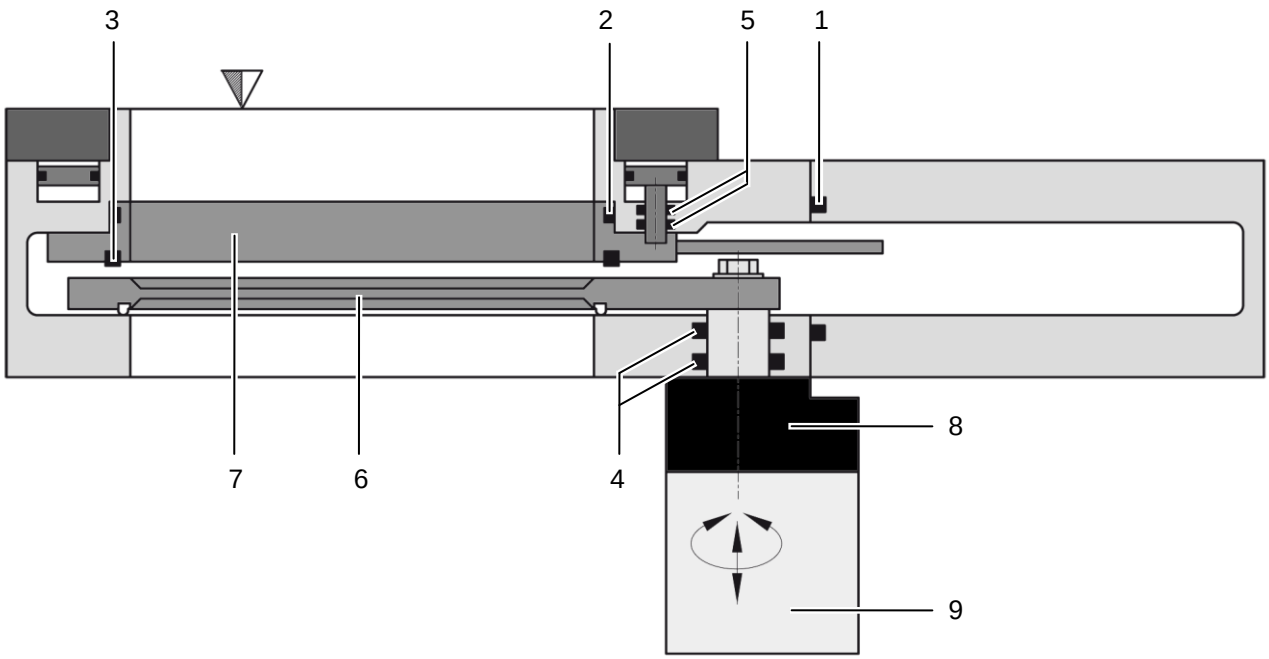


Note: All boards have a fixed position into control and actuating unit. It is not possible to fit a board in other position as shown in picture above. Do not try out other positions, that may be destroy the socket of boards!

Description		Required tool
1. Remove female screw locks from POWER, SENSOR and INTERFACE connectors.		Open end wrench 4.5 mm
2. Remove the panel screws.		Pozidriv screw driver size 1
3. Lift the panel carefully.		
4. Pull out the option board a little. 5. Push the connector release (1) a little down and disconnect fan cable (2) from option board.		

Description		Required tool
6. Remove or replace interface board.		
7. Remove or replace master board.		
8. Remove or replace option board.		
9. Insert master board and interface board in reverse order as disassembled at correct positions (see steps 7 to 6).		
10. Reconnect fan cable to option board (see steps 5 to 4).		
11. Place the panel and tighten panel screws with 1.1 Nm (see steps 3 to 2).		Pozidriv screw driver size 1
12. Tighten female screw locks from POWER, SENSOR and INTERFACE connectors with 1.1 Nm (see step 1).		Open end wrench 4.5 mm

6 Drawing



1 Bonnet seal
2 Body seal
3 Plate seal
4 Rotary feedthrough seals
5 Shaft feedthrough seals
6 Pendulum plate
7 Sealing ring
8 Actuator
9 Control unit

7 Spare parts

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

7.1 Valve unit

Item	Description			
	Valve size **Valve part number**	**DN160** **65144 - . . . . - . . . .**	**DN200** **65146- . . . . - . . . .**	**DN250** **65148 - . . . . - . . . .**
1	Bonnet seal Viton	N-5100-267	N-5100-272	N-5100-277
	Bonnet seal other materials	on request	on request	on request
2	Body seal (Viton) This includes a 2ml syringe of vacuum grease	206527	200468	202592
3	Gate seal Viton	N-5100-258	N-5100-266	N-5100-275
	Gate seal other materials	on request	on request	on request
	Seal kit vacuum (Viton). This consists of item 2 and 3.	206526	204204	203883
	Syringe of vacuum grease 2ml	206792		
	Syringe of vacuum grease 5ml	206793		
4	Actuator shaft seals (Viton)	N-5111-329 (2 pcs required per valve)		
5	Sealing ring shaft seals (Viton)	N-5111-112 (8 pcs required per valve)	N-5111-112 (12 pcs required per valve)	N-5111-112 (16 pcs required per valve)
6	Pendulum plate:			
	- Blank B1 *)	252056	262866	241979
	- Blank B2 *)	on request	on request	on request
	- Hardanodized B1 *)	252051	262864	230680
	- Hardanodized B2 *)	on request	on request	on request
	- Nickel coated B1 *)	on request	on request	on request
	- Nickel coated B2 *)	on request	on request	on request
7	Sealing ring			
	- Blank	207518	204453	205874
	- Hardanodized	204340	202046	203217
	- Nickel coated	on request	211610	on request
8	Actuator B1 *)	346960	346960	322336
	Actuator B2 *)	346971	346971	346963

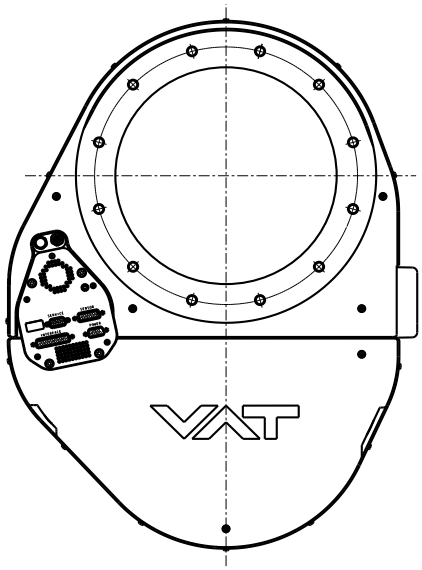
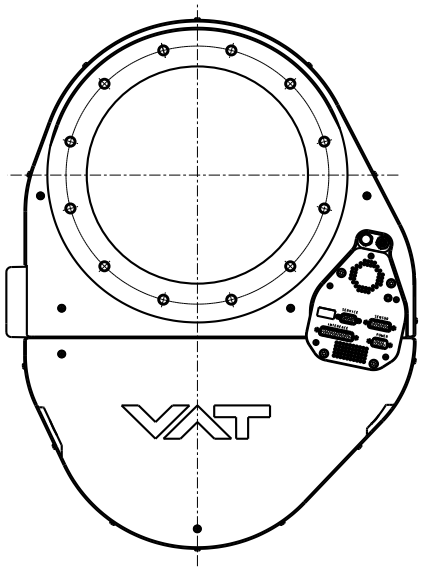
Note: Use <u>only</u> spare parts manufactured by VAT to assure safe and reliable operation!

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

7.2 Control unit

Item	Description	
	Valve size **Product ordering number**	**All sizes** **651 . . - . . . .**
9	Control unit	Too many to list. Depends on configuration, please contact VAT.
	Option board with SPS module (±15VDC sensor power supply)	371399
	Option board with PFO module (power failure option)	371397
	Option board with SPS and PFO module	326113
	Controller separation kit including 4.5m cable	264881

Actuator position options:

Valve with **B1** actuator (standard)	Valve with **B2** actuator (option)
	

7.3 Accessories

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

7.3.1 Centering ring with Viton o-ring

Description					
Valve size **Product ordering number**		**DN 100 / 4”** **65140 - . . . .**	**DN 160 / 6”** **65144 - . . . .**	**DN 200 / 8”** **65146 - . . . .**	**DN 250 / 10”** **65148 - . . . .**
Centering ring with Viton o-ring (for ISO-F installation only)	Aluminum	32040-QAZV	32044-QAZV	32046-QAZV	32048-QAZV
	Stainless steel	32040-QEZV	32044-QEZV	32046-QEZV	32048-QEZV

Description						
Valve size **Product ordering number**			**DN 320 / 12”** **65150 - . . . .**	**DN 350 / 14”** **65151 - . . . .**	**DN 400 / 16”** **65152 - . . . .**	
Centering ring with Viton o-ring (for ISO-F installation only)	Aluminum		32050-QAZV	-	32052-QAZV	

8 Warranty

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

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

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