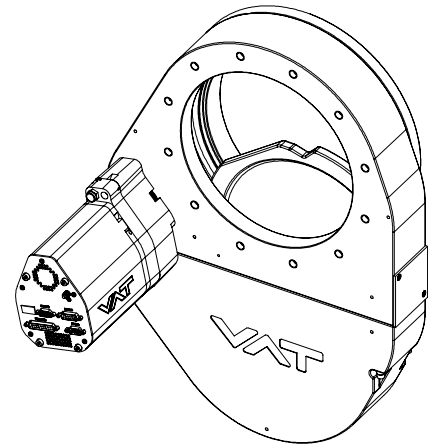


## Pendulum control & isolation valve with Logic interface

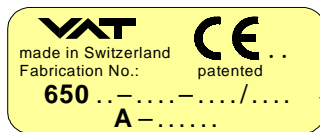
This manual is valid for the valve ordering number(s):

- 650 . . . . . GC - . . . . . (1 sensor input)
- 650 . . . . . GE - . . . . . (2 sensor inputs)
- 650 . . . . . AC - . . . . . (1 sensor input / ±15V SPS)
- 650 . . . . . AE - . . . . . (2 sensor inputs / ±15V SPS)
- 650 . . . . . HC - . . . . . (1 sensor input / PFO)
- 650 . . . . . HE - . . . . . (2 sensor inputs / PFO)
- 650 . . . . . CC - . . . . . (1 sensor input / ±15V SPS / PFO)
- 650 . . . . . CE - . . . . . (2 sensor inputs / ±15V SPS / PFO)

SPS = Sensor Power Supply PFO = Power Failure Option  
 configured with firmware **650P.1D.00**



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



← Fabrication number

### Explanation of symbols:



Read declaration carefully before you start any other action!



Keep body parts and objects away from the valve opening!



Attention!



Hot surfaces; do not touch!



Product is in conformity with EC guidelines!



Loaded springs and/or air cushions are potential hazards!



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



Wear gloves!



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



**Contents:**

1	Use of product.....	3
1.1	Technical data.....	3
2	Installation.....	6
2.1	Unpacking.....	6
2.2	Installation into the system.....	6
2.3	Tightening torque.....	8
2.3.1	Mounting with centering rings.....	8
2.3.2	Mounting with O-ring in grooves.....	9
2.4	Admissible forces.....	9
2.5	Requirements to sensor connection.....	10
2.6	Electrical connection.....	11
2.6.1	Sensor supply concepts.....	11
2.6.2	Power and sensor connection (+24 VDC sensors).....	12
2.6.3	Power and sensor connection (±15 VDC sensors) without optional SPS module.....	13
2.6.4	Power and sensor connection (±15 VDC sensors) with optional SPS module.....	14
2.6.5	Logic interface connection.....	15
2.6.6	Service port connection.....	15
3	Operation.....	16
3.1	Introduction.....	16
3.1.1	Local operation.....	16
3.1.2	Remote operation.....	17
3.1.3	Safety mode.....	17
3.2	Operation under increased temperature.....	18
3.3	Behavior during power up.....	18
3.4	Behavior in case of power failure.....	18
3.5	Display information.....	19
3.6	Setup procedure.....	21
3.6.1	Interface configuration.....	21
3.6.2	Valve and sensor configuration.....	22
3.6.3	ZERO.....	22
3.6.4	LEARN.....	23
3.7	Close valve.....	25
3.8	Open valve.....	25
3.9	Position control.....	25
3.10	Pressure control.....	26
3.10.1	Pressure control operation with 2 sensors.....	26
3.10.2	Tuning of control performance.....	26
3.11	Logic interface.....	32
3.11.1	Schematics.....	32
3.11.2	Digital inputs.....	34
3.11.3	Digital outputs.....	36
3.11.4	Analog inputs and outputs.....	37
4	Trouble shooting.....	38
5	Maintenance & repairs.....	40
5.1	Maintenance procedures.....	41
5.2	Option board.....	46
5.2.1	Durability of power fail battery.....	46
5.2.2	Retrofit / replacement procedure.....	47
6	Drawing.....	48
7	Spare parts and accessories.....	49
7.1	Accessories.....	49
7.2	Control unit.....	49
7.3	Valve unit.....	50
8	Warranty.....	51



## 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 <sup>1)</sup> <b>(α)</b> [650 . . . . . <b>A</b> . . . . . / 650 . . . . . <b>G</b> . . . . . ] [650 . . . . . <b>C</b> . . . . . / 650 . . . . . <b>H</b> . . . . . ]	+ 24 VDC (±10%)                      [connector: POWER] 50 W max. (operation of valve with max. load) without PFO <sup>4)</sup> 60 W max. (operation of valve with max. load) with PFO <sup>4)</sup>
Sensor power supply <sup>2)</sup> <b>(β)</b> [650 . . . . . <b>A</b> . . . . . / 650 . . . . . <b>C</b> . . . . . ] Input Output	+ 24 VDC (±10%) / 36 W max.                      [connector: POWER] ± 15 VDC (±5%) / 1.0 A max.                      [connector: SENSOR]
Sensor power supply <sup>2)</sup> <b>(β)</b> [650 . . . . . <b>G</b> . . . . . / 650 . . . . . <b>H</b> . . . . . ] 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:

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

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



Installation, Operating & Maintenance Instructions  
**Series 650, DN 100 – 250 (I.D. 4" - 10")**

Control and actuating unit (continuation)				
Sensor input Signal input voltage Input resistance ADC resolution Sampling time	0 – 10 VDC (linear to pressure) [connector: SENSOR] 100kΩ 0.23 mV 10 ms			
Digital inputs <sup>3)</sup>	± 24 VDC max. [connector: INTERFACE]			
Digital outputs <sup>3)</sup> 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 input <sup>3)</sup>	0 - 10 VDC / R <sub>i</sub> 100 kΩ [connector: INTERFACE]			
Analog outputs <sup>3)</sup>	0 - 10 VDC / 1mA max. [connector: INTERFACE]			
PFO <sup>4)</sup> battery pack [650 . . . . C . . . . / 650 . . . . H . . . . ] Charging time Durability	2 minutes max. up to 10 years @ 25°C ambient; refer to «5.2.1 Durability of power fail battery» for details			
Compressed air supply	4 - 7 bar / 55 - 100 psi (above ATM)			
Ambient temperature	50 °C max. (<35°C recommended)			
Pressure control accuracy	0.1% of sensor full scale			
	<b>DN 100</b> <b>4"</b> (65040 - ....)	<b>DN 160</b> <b>6"</b> (65044 - ....)	<b>DN 200</b> <b>8"</b> (65046 - ....)	<b>DN 250</b> <b>10"</b> (65048 - ....)
Position resolution / position control capability (full stroke)	9'155 steps	11'111 steps	12'266 steps	12'444 steps
Closing time throttling only (full stroke)	0.7 s	0.8 s	0.9 s	0.9 s
Opening time throttling only (full stroke)	0.7 s	0.8 s	0.9 s	0.9 s
Closing time throttling & isolation (full stroke)	3 s typ.	3 s typ.	3 s typ.	3 s typ.
Opening time throttling & isolation (full stroke)	4 s typ.	4 s typ.	4 s typ.	4 s typ.

- 1) Internal overcurrent protection by a PTC device.
- 2) Refer to chapter «2.6.1 Sensor supply concepts» for details.
- 3) Refer to chapter «3.11.1 Schematics» for details.
- 4) PFO = Power Failure Option. Refer to «3.4 Behavior in case of power failure» for details.



Valve unit				
Pressure range at 20°C				
- Aluminum (650 . . . . <b>A</b> . . . . .)	1 x 10 <sup>-8</sup> mbar to 1.2 bar (abs)			
- Aluminum hard anodized (650 . . . . <b>H</b> . . . . .)	1 x 10 <sup>-6</sup> mbar to 1.2 bar (abs)			
- Aluminum nickel coated (650 . . . . <b>I</b> . . . . .)	1 x 10 <sup>-8</sup> mbar to 1.2 bar (abs)			
Leak rate to outside at 20°C				
- Aluminum (650 . . . . <b>A</b> . . . . .)	1 x 10 <sup>-9</sup> mbar ls <sup>-1</sup>			
- Aluminum hard anodized (650 . . . . <b>H</b> . . . . .)	1 x 10 <sup>-5</sup> mbar ls <sup>-1</sup>			
- Aluminum nickel coated (650 . . . . <b>I</b> . . . . .)	1 x 10 <sup>-9</sup> mbar ls <sup>-1</sup>			
Leak rate valve seat at 20°C				
- Aluminum (650 . . . . <b>A</b> . . . . .)	1 x 10 <sup>-9</sup> mbar ls <sup>-1</sup>			
- Aluminum hard anodized (650 . . . . <b>H</b> . . . . .)	1 x 10 <sup>-4</sup> mbar ls <sup>-1</sup>			
- Aluminum nickel coated (650 . . . . <b>I</b> . . . . .)	1 x 10 <sup>-9</sup> mbar ls <sup>-1</sup>			
Cycles until first service				
- Isolation cycles (open - closed - open)	200'000 (unheated and under clean conditions)			
- Throttling cycles (open - max. throttle - open)	1 Mio. (unheated and under clean conditions)			
Admissible operating temperature	10 ... 150°C			
Mounting position	Any (valve seat to face chamber is recommended)			
Wetted materials				
- Body (650 . . . . <b>A</b> . . . . .)	Aluminum 3.2315 (AA6082)			
- Body (650 . . . . <b>H</b> . . . . .)	Aluminum 3.2315 (AA6082) hard anodized			
- Body (650 . . . . <b>I</b> . . . . .)	Aluminum 3.2315 (AA6082) nickel coated			
- Pendulum plate (650 . . . . <b>A</b> . . . . .)	Aluminum 3.2315 (AA6082)			
- Pendulum plate (650 . . . . <b>H</b> . . . . .)	Aluminum 3.2315 (AA6082) hard anodized			
- Pendulum plate (650 . . . . <b>I</b> . . . . .)	Aluminum 3.2315 (AA6082) nickel coated			
- Sealing ring (650 . . . . <b>A</b> . . . . .)	Aluminum 3.2315 (AA6082), 1.4306 (304L)			
- Sealing ring (650 . . . . <b>H</b> . . . . .)	Aluminum 3.2315 (AA6082) hard anodized, 1.4306 (304L)			
- Sealing ring (650 . . . . <b>I</b> . . . . .)	Aluminum 3.2315 (AA6082) nickel coated, 1.4306 (304L)			
- Other parts	Stainless steel 1.4435 (316L), 1.4404 (316L), 1.4122, 1.4310 (301), 1.4303 (304), 1.4571, A2 (304)			
- Seals	Viton® (standard). Other materials available. Seal materials are declared on dimensional drawing of specific valve ordering number.			
	<b>DN 100</b> <b>4"</b> (65040 - ....)	<b>DN 160</b> <b>6"</b> (65044 - ....)	<b>DN 200</b> <b>8"</b> (65046 - ....)	<b>DN 250</b> <b>10"</b> (65048 - ....)
Max. differential pressure on plate during isolation	1200 mbar	1200 mbar	1200 mbar	1200 mbar
Max. differential pressure on plate during opening and throttling	30 mbar	10 mbar	5 mbar	5 mbar
Min. controllable conductance (N <sub>2</sub> molecular flow)	3 ls <sup>-1</sup>	5 ls <sup>-1</sup>	10 ls <sup>-1</sup>	15 ls <sup>-1</sup>
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.



DN200 (8") and DN250 (10") valves 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



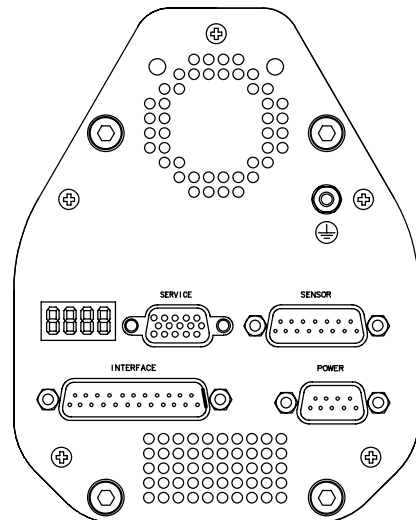
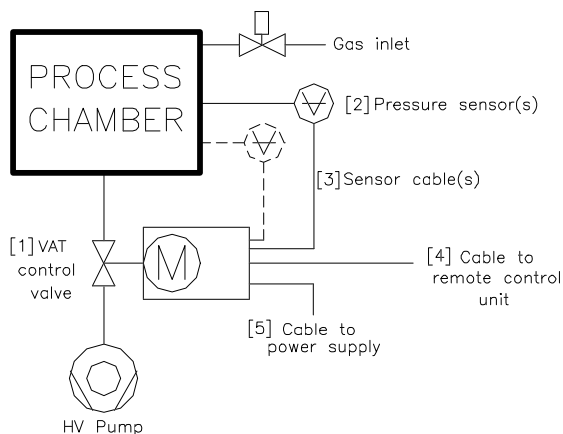
Fingers and objects must be kept out of the valve opening and away from moving parts. The valve plate may start to move just after power is supplied.



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



Do not disconnect air supply when device is under power.





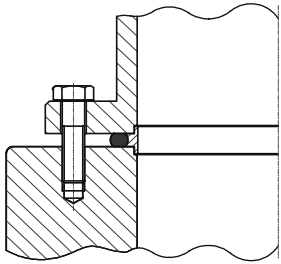
1. Install valve [1] into the vacuum system. Valve seat side should face process chamber. The valve seat side is indicated by the symbol "∇" on the valve flange.  
**Caution:** Do not tighten the flange screws stronger than indicated under «2.3 Tightening torque».  
**Caution:** Do not admit higher forces to the valve than indicated under «2.4 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.  
Connect compressed air return line connection labeled 'OUT' located at actuator.  
Compressed air pressure (above ATM) must be in the range of: **4 - 7 bar / 55 - 100 psi**. Use only clean, dry or slightly oiled air. IN / OUT connections are 1/8" ISO/NPT internal threads.
3. Install sensor(s) [2] according to the recommendations of the sensor manufacturer and directives given under «2.5 Requirements to sensor connection».
4. Connect sensor cable [3] to sensor(s) and then to valve (connector: SENSOR). Refer to chapter «2.6 Electrical connection» for correct wiring.  
**Note:** Input for second sensor is available on 650 . . . . . E - . . . . . version only.
5. Connect valve to remote control unit [4] (connector: INTERFACE). Refer to «3.11.1 Schematics» for correct wiring.
6. Connect power supply [5] to valve (connector: POWER). Refer to chapter «2.6 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 «3.1.3 Safety mode».
7. This valve has a double sealed rotary feedthrough with intermediate pumping port for the actuator shaft. This port (1/8" ISO/NPT) may optionally be connected to the vacuum line.
8. This valve may optionally be equipped with a heating device. Connect VAT heating device according to manual of respective heating device.
9. Perform «3.6 Setup procedure» to prepare valve for operation.  
**Note:** Without performing the setup procedure the valve will not be able to do pressure control.

## 2.3 Tightening torque

Tighten mounting screws of the flanges uniformly in crosswise order. Observe the maximum torque levels in the following table. Higher tightening torques deforms the valve body and may lead to malfunction of the valve.

### 2.3.1 Mounting with centering rings

Valve size	ISO-F	ISO-F
	max. tightening torque (Nm)	max. tightening torque (lbs . ft)
DN100 / 4" (65040 - .....)	8 – 10	6 - 8
DN160 / 6" (65044 - .....)	13 – 15	9 - 11
DN200 / 8" (65046 - .....)	13 – 15	9 - 11
DN250 / 10" (65048 - .....)	17 – 20	13 – 15
	hole depth (mm)	hole depth (inch)
DN100 / 4" (65040 - .....)	12	0.47
DN160 / 6" (65044 - .....)	14	0.55
DN200 / 8" (65046 - .....)	15	0.59
DN250 / 10" (65048 - .....)	16	0.63



**Caution:** Make sure that screws are not too long otherwise the valve body may be damaged.

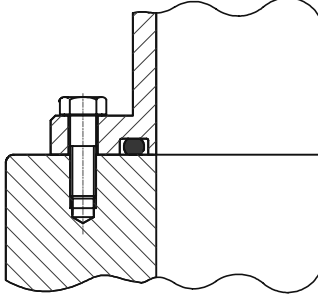
**Note:** Use slightly lubricated screws.

Refer to «7 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)		
DN100 / 4" (65040 - . . . . .)	20-23	35-40	35-40	15 - 17	26 - 30	26 - 30
DN160 / 6" (65044 - . . . . .)	35-40	35-40	35-40	26 - 30	26 - 30	26 - 30
DN200 / 8" (65046 - . . . . .)	35-40	35-40	80-90	26 - 30	26 - 30	59 - 67
DN250 / 10" (65048 - . . . . .)	35-40	65-70	80-90	26 - 30	48 - 52	59 - 67
	hole depth (mm)			hole depth (inch)		
DN100 / 4" (65040 - . . . . .)	12	12	12	0.47	0.47	0.47
DN160 / 6" (65044 - . . . . .)	14	14	14	0.55	0.55	0.55
DN200 / 8" (65046 - . . . . .)	15	15	15	0.59	0.59	0.59
DN250 / 10" (65048 - . . . . .)	16	16	16	0.63	0.63	0.63



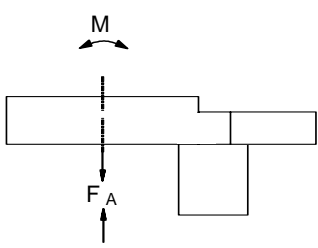
**Caution:** Make sure that screws are not too long otherwise the valve body may be damaged.

**Note:** These torques are valid if depth of the mounting screws is min. 1 x thread diameter. Make sure that screws in use are capable to withstand applied torques. Lubricate screws slightly.

**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 <sub>A</sub> »		Bending moment «M»	
	N	lb.	Nm	lbf.
DN100 / 4" (65040 - . . . 52 - . . . .)	1000	220	40	30
DN160 / 6" (65044 - . . . 52 - . . . .)	2000	440	80	60
DN200 / 8" (65046 - . . . 52 - . . . .)	2000	440	80	60
DN250 / 10" (65048 - . . . 52 - . . . .)	2500	550	100	75



For a combination of both forces (F<sub>A</sub> 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:

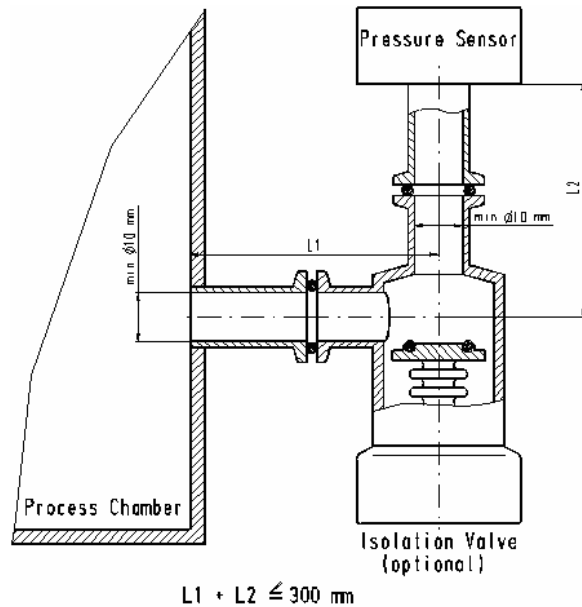
Inner diameter of connection pipe:  $\geq 10 \text{ mm}$   
 Length of connection pipe:  $\leq 300 \text{ mm}$

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

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

The sensor should also be mounted free of mechanical shock and vibration.

Dynamic stray magnetic fields may introduce noise to sensor output and should be avoided or shielded.





## 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  $\pm 15$  VDC from the 24 VDC.

Valve versions:

- 650 ... G ... and 650 ... H ... SPS module not included
- 650 ... A ... and 650 ... C ... SPS module included

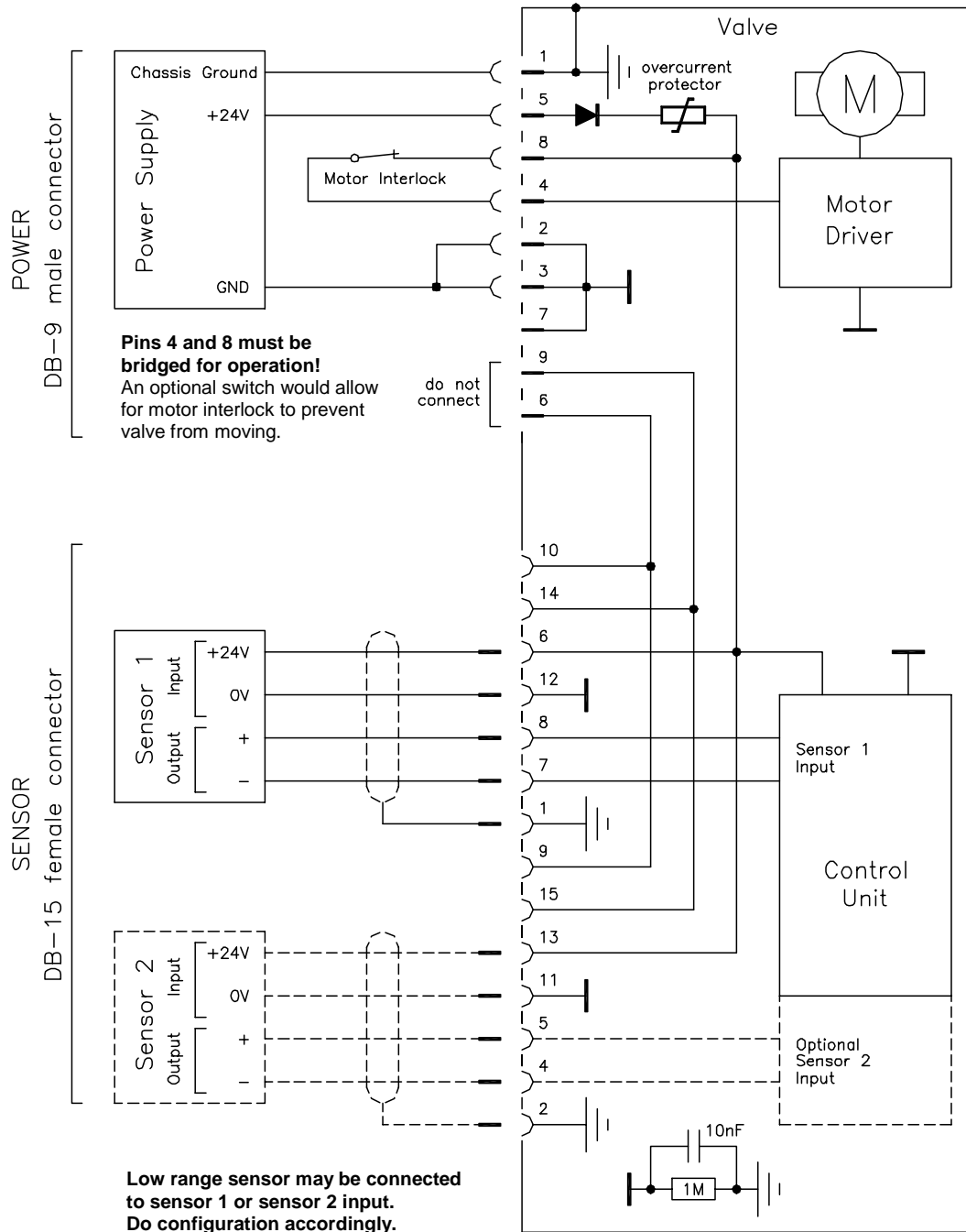
**Note:** The SPS module can be retrofitted. Refer to chapter «5.2.2 Retrofit / replacement procedure» for instruction.

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

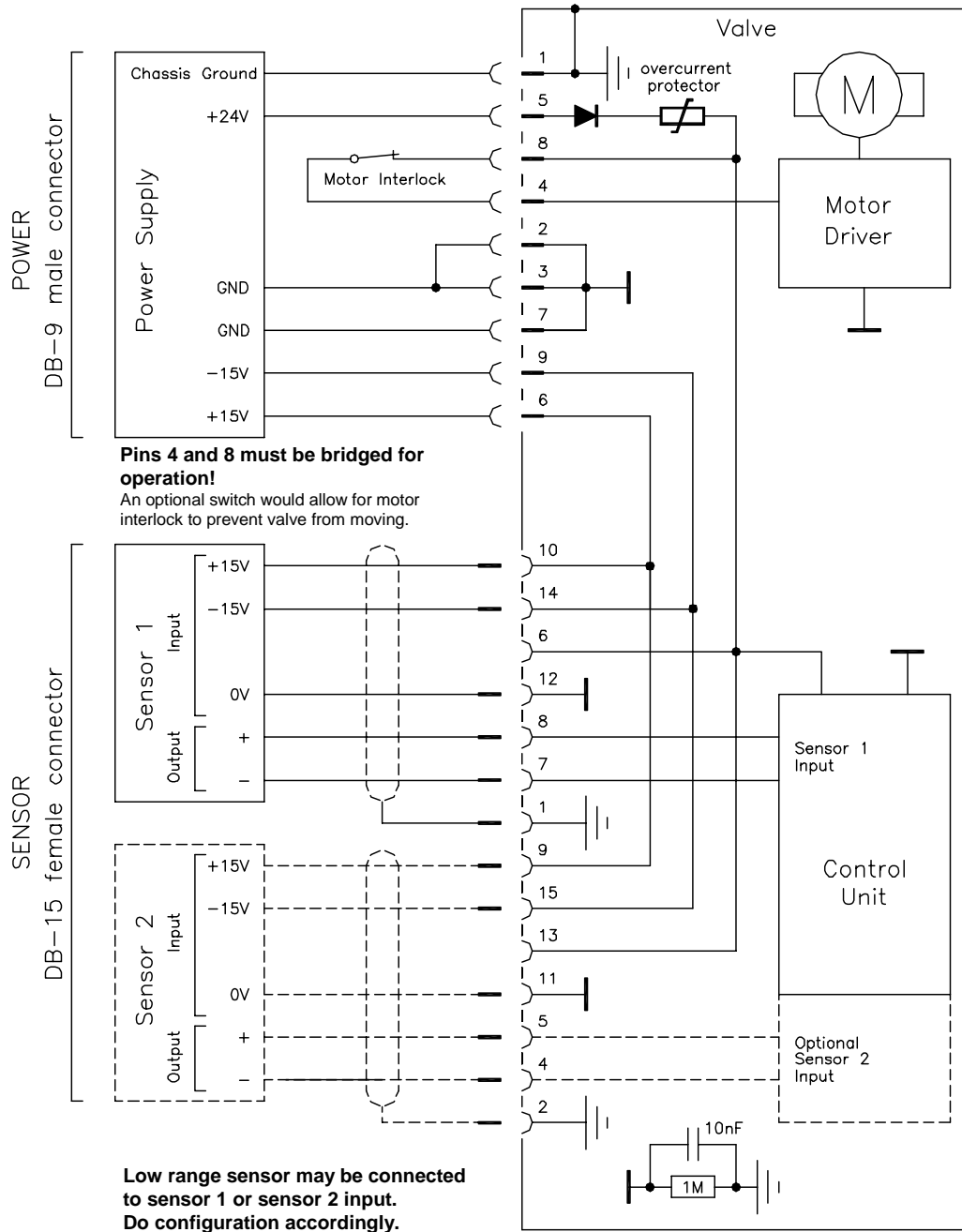
**2.6.2 Power and sensor connection (+24 VDC sensors)**

[650 . . . . . G . . . . . / 650 . . . . . H . . . . . versions recommended]



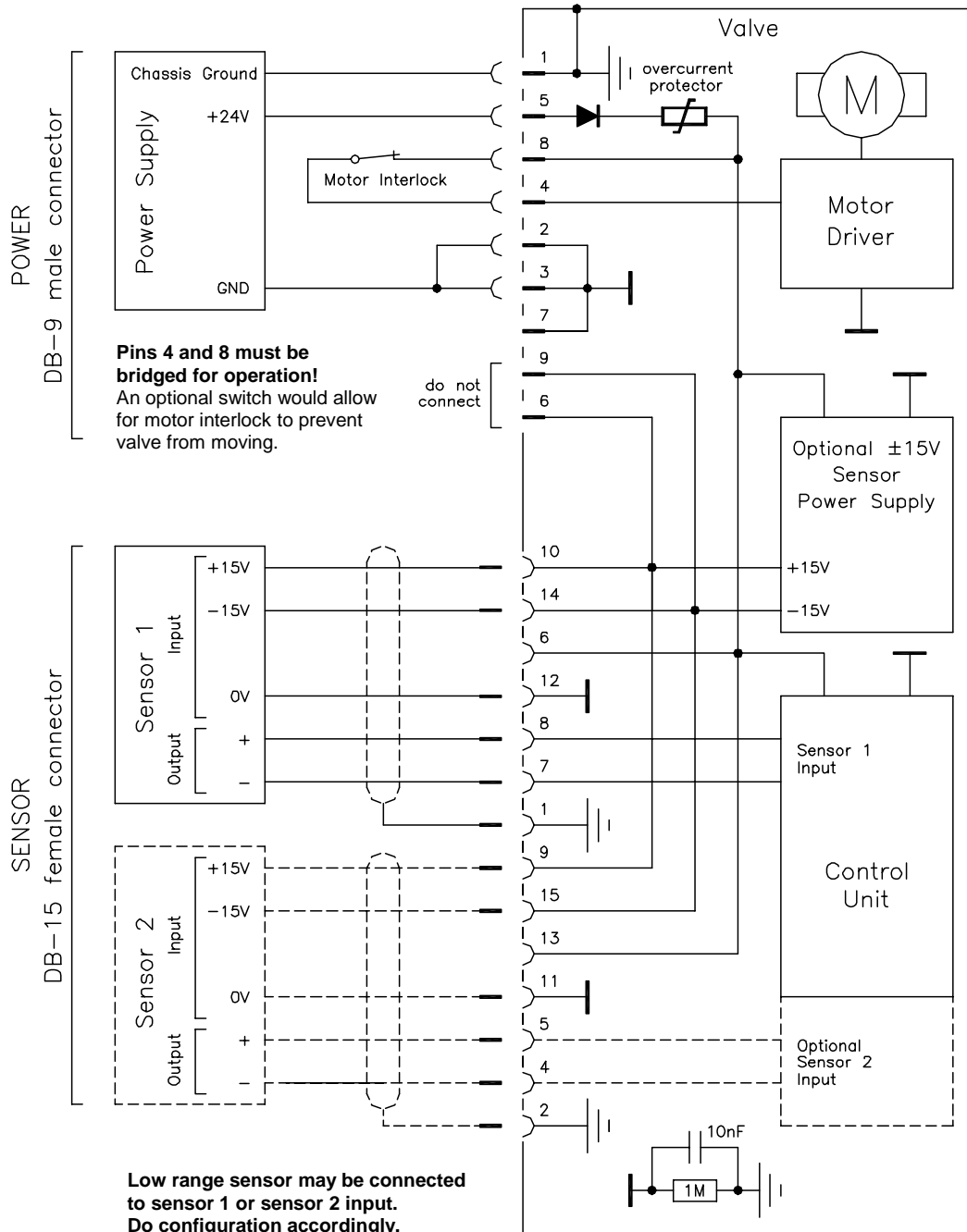
**Note:** Use shielded sensor cable(s). Keep cable as short as possible, but locate it away from noise sources.

**2.6.3 Power and sensor connection ( $\pm 15$  VDC sensors) without optional SPS module**  
 [650 . . . . . G . . . . . / 650 . . . . . H . . . . . versions only]



**Note:** Use shielded sensor cable(s). Keep cable as short as possible, but locate it away from noise sources.

**2.6.4 Power and sensor connection ( $\pm 15$  VDC sensors) with optional SPS module**  
 [650 . . . . . A . . . . . / 650 . . . . . C . . . . . versions only]



**Note:** Use shielded sensor cable(s). Keep cable as short as possible, but locate it away from noise sources.



#### **2.6.5 Logic interface connection**

Refer to «3.11.1 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 a software from VAT. You can either use our freeware 'Control View' or purchase our 'Control Performance Analyzer'.

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 «3.1.1 Local operation» for details and to «7 Spare parts and accessories» for ordering numbers of service cable and software.



## 3 Operation

### 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 by means of a computer. A service cable and a software from VAT is required. You can either download our freeware 'Control View' from [www.vatvalve.com](http://www.vatvalve.com) or purchase our 'Control Performance Analyzer'.

These softwares 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.

<p>'Control view' supports:</p> <ul style="list-style-type: none"><li>- parameter setup</li><li>- manual control</li><li>- numeric monitoring</li><li>- basic diagnostic</li></ul>	
<p>'Control Performance Analyzer' supports:</p> <ul style="list-style-type: none"><li>- parameter setup</li><li>- manual control</li><li>- sequence control</li><li>- numeric and graphical monitoring</li><li>- data recording</li><li>- data analysis</li><li>- advanced diagnostic</li></ul>	

**Note:** 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.

Refer to «7 Spare parts and accessories» for ordering numbers of service cable and software.





### 3.1.2 Remote operation

This product is equipped with a Logic interface to allow for remote operation by means of digital and analog signals. See section «3.11 Logic interface» for details. 'Control View' or 'Control Performance Analyzer' software may be used for monitoring during remote control.

**Note:** In case 'Control View' or 'Control Performance Analyzer' is connected to valve make sure 'REMOTE' button is pushed to enable for remote operation.

### 3.1.3 Safety mode

By means of an external switch (see connection diagrams «2.6.1 to 2.6.4») 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, the valve plate stops at current position. Once motor interlock is deactivated the unit starts a power up cycle according «3.3 Behavior during power up».



### 3.2 Operation under increased temperature

This valve may be operated in the temperature range mentioned in chapter «1.1 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 «3.5 Display information».

### 3.4 Behavior in case of power failure

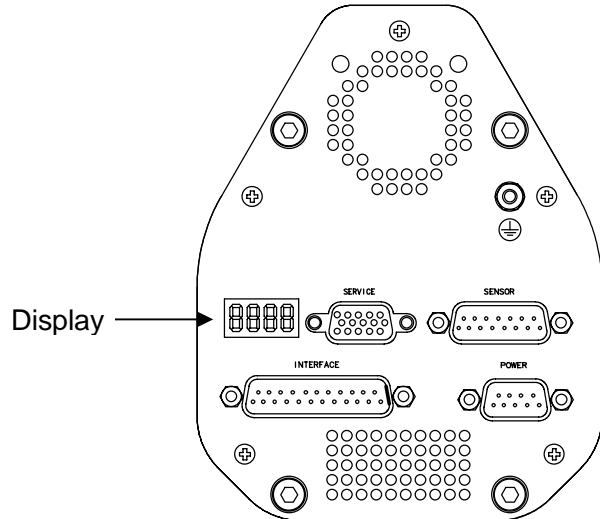
Valve position before power failure:	Reaction of valve:	
	Without Power Failure Option (PFO) 650 . . . . <b>G</b> . . . . . 650 . . . . <b>A</b> . . . . .	With Power Failure Option (PFO) 650 . . . . <b>H</b> . . . . . 650 . . . . <b>C</b> . . . . .
Closed (isolated)	Valve remains closed.	Valve remains closed. Display indicates <b>F</b>
Valve open or in any intermediate position	Sealing ring moves down and blocks the pendulum plate at the current position.	Valve will close or open depending on valve configuration *). Display indicates <b>F</b>

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

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 see table on next page.



#### Power up:

Description	Digit 1	Digit 2	Digit 3	Digit 4
At first all dots are illuminated then configuration is displayed:	<b>1</b>	<b>D</b>	<b>0</b>	<b>0</b>
<ul style="list-style-type: none"> <li>Firmware version [e.g. 1D00] (1<sup>st</sup> information for about 2s)</li> <li>Controller configuration (2<sup>nd</sup> information for about 2s)</li> </ul> <p><b>SYNC</b> indicates that power up synchronization is running.</p> <p>In case <b>D C</b> or <b>D999</b> is displayed, motor interlock is active. Refer to «3.1.3 Safety mode» for details.</p> <p>If valve is closed (isolated) display shows alternately <b>C C</b> and <b>INIT</b>. Synchronization will be done when first movement command is received.</p>	<b>1</b> = Logic interface	<b>0</b> = basic  <b>1</b> = with SPS <sup>1)</sup>  <b>2</b> = with PFO <sup>2)</sup>  <b>3</b> = with SPS <sup>1)</sup> and PFO <sup>2)</sup>	<b>1</b> = 1 sensor version  <b>2</b> = 2 sensor version	

1) SPS = optional ±15 VDC Sensor Power Supply module

2) PFO = Power Failure Option



**Operation:**

Description / Mode	Digit 1	Digit 2	Digit 3	Digit 4
PRESSURE CONTROL mode	P	<p style="text-align: center;"><b>0 . . . 100</b> = valve position (% , 0 = closed / 100 = open)</p>		
POSITION CONTROL mode	V			
Valve closed	C			
Valve open	O			
HOLD (position frozen) activated	H			
ZERO running	Z			
LEARN running	L			
Safety mode established. Refer to «3.1.3 Safety mode» for details.	D			
Power failure	F			

**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 «4 Trouble shooting» for details		

### 3.6 Setup procedure



To enable this 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	<b>Power up</b>	Turn on external + 24VDC power supply (and external $\pm 15$ VDC for sensor power supply if required). Refer to chapter «3.3 Behavior during power up» for details.
2	<b>Interface configuration</b>	Functionality of multi purpose digital inputs and outputs must be configured. Refer to chapter «3.6.1 Interface configuration» for details.
3	<b>Valve and sensor configuration</b>	Basic configurations of the valve must be adapted according to application needs. Refer to chapter «3.6.2 Valve and sensor configuration» for details.
4	<b>ZERO</b>	Compensation of the sensor offset voltage. Refer to chapter «3.6.3 ZERO» for details.
5	<b>LEARN</b>	Determination of the vacuum system characteristic to accommodate the PID controller. Refer to chapter «3.6.4 LEARN» for details. <b>Note:</b> 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.

- Functionality of digital inputs CLOSE VALVE and OPEN VALVE must be selected. These may be configured as 'not inverted' or 'inverted'. Default is 'not inverted'.
- LEARN range configuration for remote operation must be selected. This may either be 'full range' or pressure limit according of analog SETPOINT input. Default is 'full range'.

Local operation: (‘Control View’ resp. ‘Control Performance Analyzer’)	Remote operation:
Do configuration in menu ‘Setup / Interface’.	<b>Note:</b> It's not possible to do interface configuration via remote operation.



### 3.6.2 Valve and sensor configuration

Basic valve configuration must be adapted according to application needs.

- Definition of valve plate position (CLOSED or OPEN) after power up sequence. Default is closed.
- Definition of valve plate position (CLOSED or OPEN) in case of a power failure. Default is closed. Only for versions that have Power Fail Option equipped [650 . . . . **C** . . . . . or 650 . . . . **H** . . . . .].
- ZERO function. This may be 'disabled' or 'enabled'. Default is 'enabled'. Refer also to «3.6.3 ZERO».
- Sensor configuration for 2 sensor versions [650 . . . . **E** . . . . only]. Refer also to «3.10.1 Pressure control operation with 2 sensors».

Local operation: (‘Control View’ resp. ‘Control Performance Analyzer’)	Remote operation:
1. Do power up configuration in menu ‘Setup / Valve’.	<b>Note:</b> It’s not possible to do interface configuration via remote operation.
2. Do power fail configuration in menu ‘Setup / Valve’.	
3. Enable or disable ZERO function in menu ‘Setup / Sensor’.	
4. Do 2 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 +/-1.4V can be compensated. The offset value can be read via local and remote operation.

Local operation: (‘Control View’ resp. ‘Control Performance Analyzer’)	Remote operation: (Refer to chapter «3.11.2 Digital inputs» for details)
Go to menu ‘Zero / ZERO’ and follow instructions.	1. Set OPEN VALVE
	2. Wait until process chamber is evacuated and sensor signal is not shifting anymore.
	3. Set 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 «3.6.2 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.

Local operation: (‘Control View’ resp. ‘Control Performance Analyzer’)	Remote operation: (Refer to chapter «3.11.2 Digital inputs» for details)
Go to ‘Learn / LEARN’ menu and follow instructions.  <b>Note:</b> Gasflow calculation according to recommendation below is done automatically based on inputs.	1. Set OPEN VALVE
	2. Set specific gas flow according to calculation below and wait until flow is stable. Autolearn does not need to be performed with the process gas. Instead N <sub>2</sub> or Ar may be used.
	3. Set SETPOINT (= pressure limit for learn) to p <sub>max</sub> (max. pressure to control during process)
	4. Set LEARN
	5. Reset OPEN VALVE

**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.

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

$$q_L = \frac{p_{SFS} \cdot C_{min}}{2000}$$

$q_L$  gasflow for learn [**Pa m<sup>3</sup>/s**]  
 $p_{SFS}$  sensor full scale pressure [**Pa**]  
 $C_{min}$  min. controllable conductance of valve [l/s]  
(refer to «1.1 Technical data»)

$$q_L = \frac{p_{SFS} \cdot C_{min}}{2}$$

$q_L$  gasflow for learn [**mbar l/s**]  
 $p_{SFS}$  sensor full scale pressure [**mbar**]  
 $C_{min}$  min. controllable conductance of valve [l/s]  
(refer to «1.1 Technical data»)

$$q_L = 39.4 \cdot p_{SFS} \cdot C_{min}$$

$q_L$  gasflow for learn [**sccm**]  
 $p_{SFS}$  sensor full scale pressure [**Torr**]  
 $C_{min}$  min. controllable conductance of valve [l/s]  
(refer to «1.1 Technical data»)





### 3.7 Close valve

<b>Local operation:</b> (‘Control View’ resp. ‘Control Performance Analyzer’)	<b>Remote operation:</b> (Refer to chapter «3.11.2 Digital inputs» for details)
Push CLOSE button	Set CLOSE VALVE

### 3.8 Open valve

<b>Local operation:</b> (‘Control View’ resp. ‘Control Performance Analyzer’)	<b>Remote operation:</b> (Refer to chapter «3.11.2 Digital inputs» for details)
Push OPEN button	Set OPEN VALVE

### 3.9 Position control

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

<b>Local operation:</b> (‘Control View’ resp. ‘Control Performance Analyzer’)	<b>Remote operation:</b> (Refer to chapter «3.11.2 Digital inputs» and «3.11.4 Analog inputs and outputs» for details)
Select or enter position setpoint	<ol style="list-style-type: none"><li>1. Set CONTROL MODE to POSITION CONTROL</li><li>2. Set position SETPOINT</li></ol>

**Note:** In case CLOSE VALVE, OPEN VALVE or HOLD is also set these have higher priority.

### 3.10 Pressure control



To **prepare valve for PRESSURE CONTROL** perform complete «**3.6 Setup procedure**».  
 The valve has parameters that may be modified to tune **pressure control performance**.  
 Refer to «**3.10.2 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’ resp. ‘Control Performance Analyzer’)	Remote operation: (Refer to chapter «3.11.2 Digital inputs» and «3.11.4 Analog inputs and outputs» for details)
Select or enter pressure setpoint	<ol style="list-style-type: none"> <li>1. Set CONTROL MODE to PRESSURE CONTROL</li> <li>2. Set pressure SETPOINT</li> </ol>

**Note:** In case CLOSE VALVE, OPEN VALVE or HOLD is also set these have higher priority.

#### 3.10.1 Pressure control operation with 2 sensors

[applicable with 650 . . . . . E - . . . . version only]

If 2 sensor operation is enabled, changeover between the sensors is done automatically during pressure control. For configuration refer to chapter «3.6 Setup procedure». We recommend a ratio of 10:1 between the pressure gauges. Max. ratio is 100:1. High range respectively low range pressure gauge may be either connected to sensor 1 or sensor 2 input. It's required to do correct sensor configuration.

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

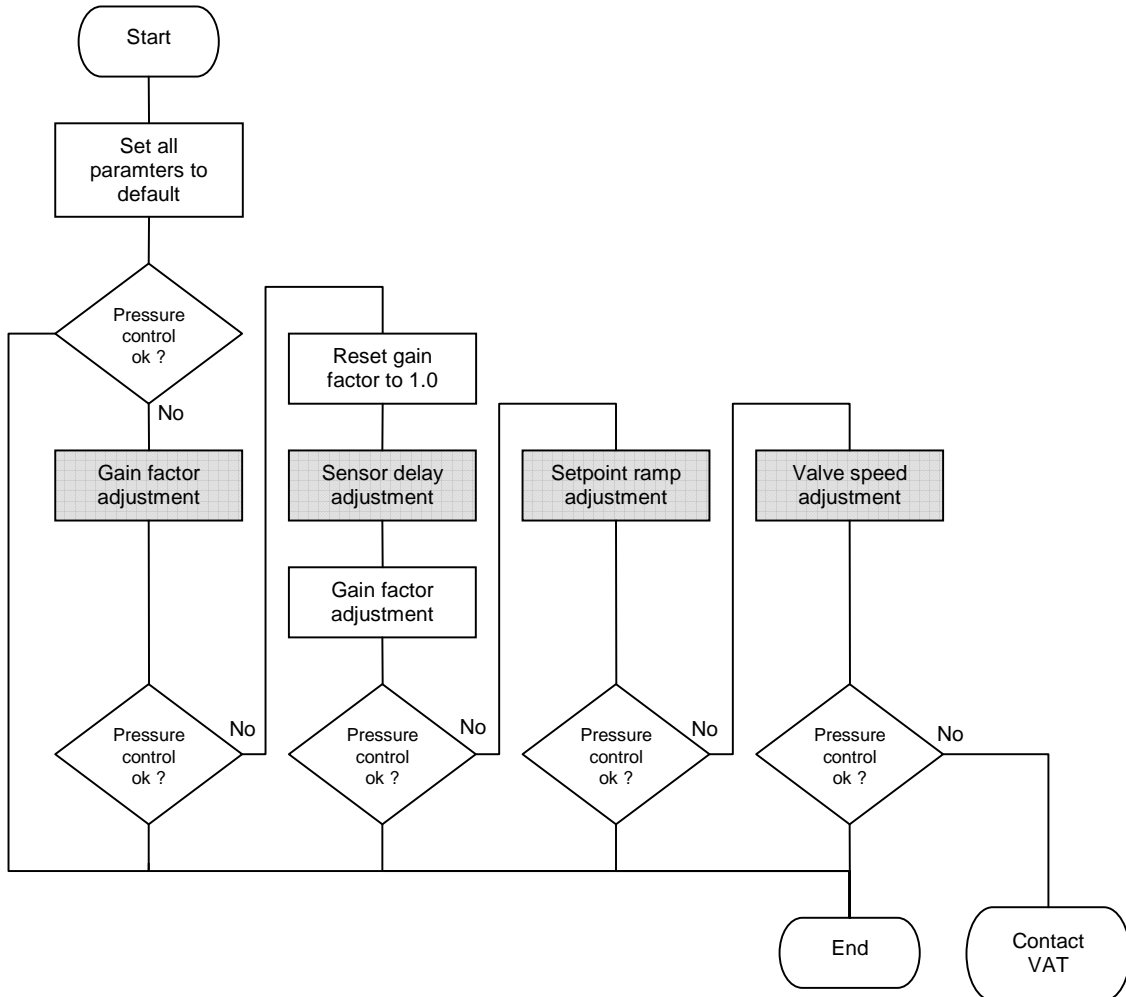
**Note:** Make sure that both sensors are calibrated.

**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](mailto:tuning-support@vat.ch)



### 3.10.2.1 Gain factor adjustment

The gain factor effects:

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

Default value is 1.00. 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 «2.5 Requirements to sensor connection».

<b>Local operation:</b> (‘Control View’ resp. ‘Control Performance Analyzer’)	<b>Remote operation:</b>
Go to ‘Setup / Controller’ menu. Select gain factor.	<b>Note:</b> It’s not possible to do gain factor adjustment via remote operation.



### 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 «2.5 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 «3.10.2.1 Gain factor adjustment».

Local operation: (‘Control View’ resp. ‘Control Performance Analyzer’)	Remote operation:
Go to ‘Setup / Controller’ menu. Select sensor delay.	<b>Note:</b> It’s not possible to do sensor delay adjustment via remote operation.

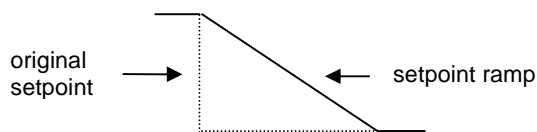
### 3.10.2.3 Setpoint ramp adjustment

Setpoint ramp effects:

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

Default value is 1.0 s. Adjustment range 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.



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.

<b>Local operation:</b> ('Control View' resp. 'Control Performance Analyzer')	<b>Remote operation:</b>
Go to 'Setup / Controller' menu. Select setpoint ramp.	<b>Note:</b> It's not possible to do setpoint ramp adjustment via remote operation.



### 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.

**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.

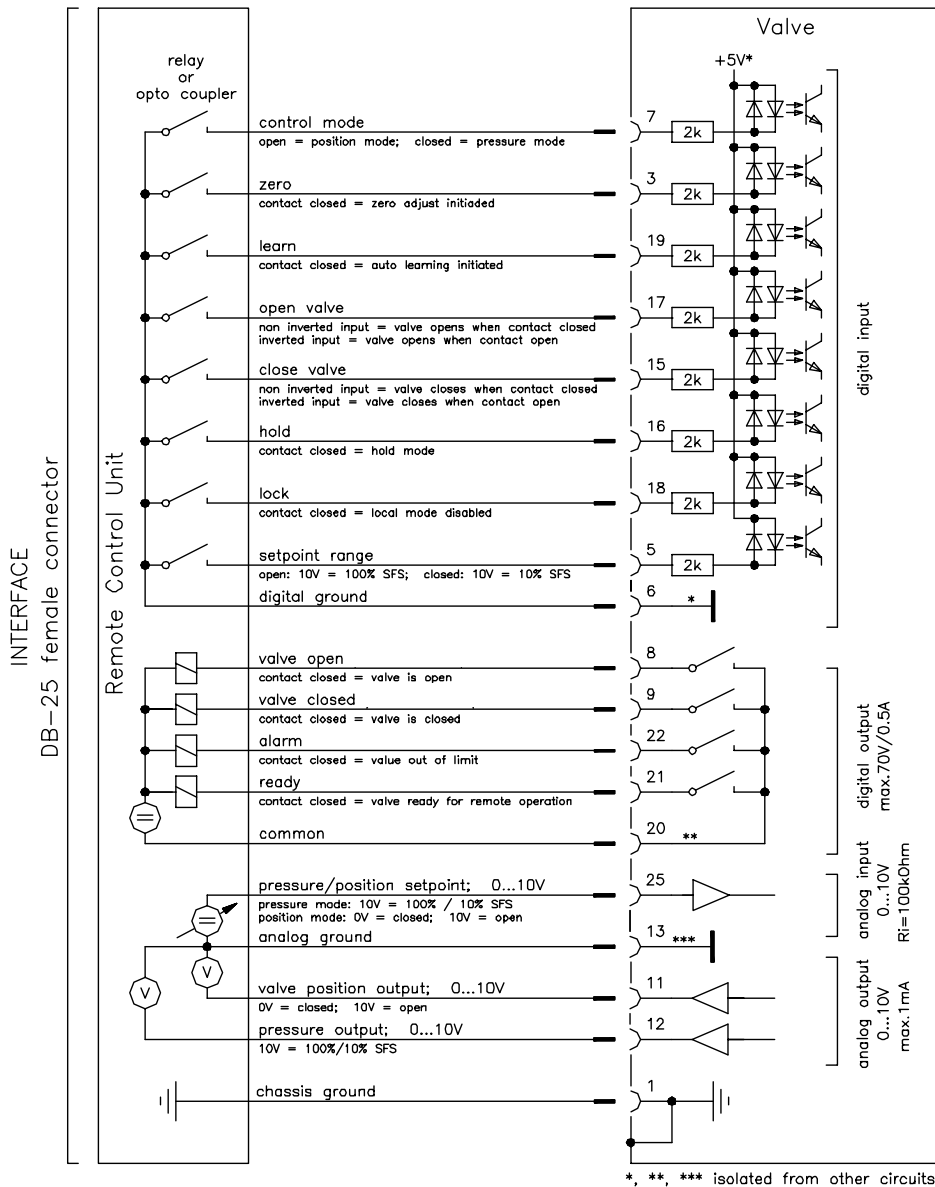
Local operation: (‘Control View’ resp. ‘Control Performance Analyzer’)	Remote operation:
Go to ‘Setup / Controller’ menu. Select valve speed.	<b>Note:</b> It’s not possible to do valve speed adjustment via remote operation.

### 3.11 Logic interface

#### 3.11.1 Schematics

Logic interface allows for remote operation by means of digital and analog signals. Digital inputs may be operated either by switches or by voltage sources.

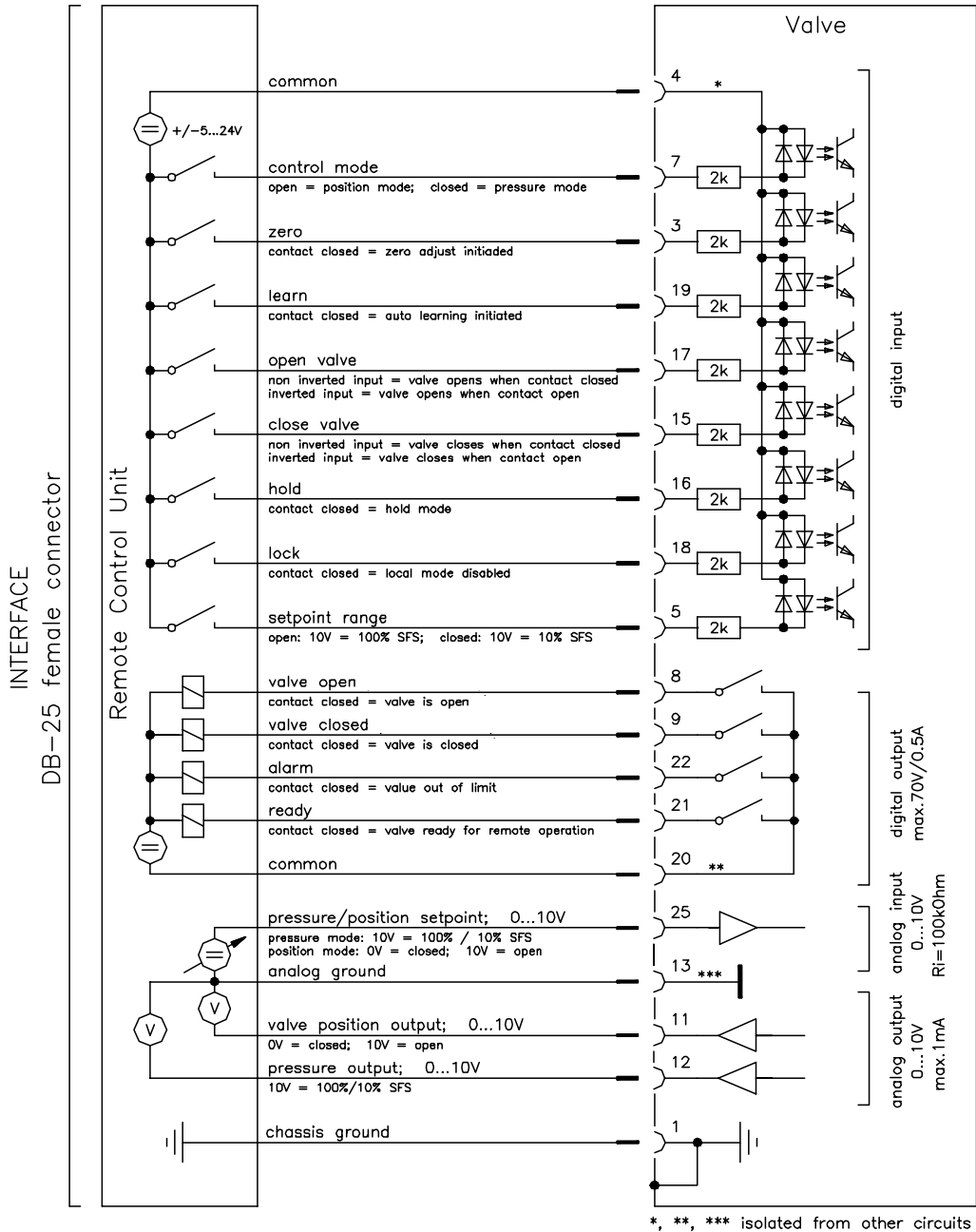
##### a) Configuration with switches for digital inputs:



**Note:** Use a shielded cable for analog inputs. Do not connect other pins than indicated above!



**b) Configuration with voltage source for digital inputs:**



**Note:** Use a shielded cable for analog inputs. Do not connect other pins than indicated above!



## 3.11.2 Digital inputs

Pin	Function	Signal type	Description	Priority
7	<b>CONTROL MODE</b>	Digital input <sup>1)</sup>	This pin selects the control mode. This valve may either be operated as pressure controller or as position controller. <u>PRESSURE CONTROL</u> is activated as long as optocoupler is 'on'. The PID controller controls the chamber pressure according to the pressure SETPOINT by means of the valve position. <u>POSITION CONTROL</u> is activated when optocoupler is 'off'. The valve position is directly controlled according to the position SETPOINT.	6 <sup>2)</sup>
5	<b>SETPOINT RANGE</b>	Digital input <sup>1)</sup>	This pin selects the SETPOINT RANGE. Low range extension is activated as long as optocoupler is 'on'. It's effective in pressure control mode only. This function extends the lower 10% range of sensor full scale (SFS) to the full 0-10V for SETPOINT input. Herewith you can achieve better resolution, especially in case of a 2 sensor system. Example with SFS = 100mTorr: Not active (10V=100%) >> 10V setpoint = 100mTorr Active (10V=10%): >> 10V setpoint = 10mTorr	N/A
16	<b>HOLD</b>	Digital input <sup>1)</sup>	This function stops the valve at the current position. After release of the signal the valve will return to the selected CONTROL MODE. This function is activated as long as optocoupler is 'on'.	5 <sup>2)</sup>
17	<b>OPEN VALVE</b>	Digital input <sup>1)</sup>	This function will open the valve completely. This function is activated as long as optocoupler is 'on' in <b>non inverted</b> configuration. This function is activated as long as optocoupler is 'off' in <b>inverted</b> configuration. Configuration can be done in local operation via service port.	3 <sup>2)</sup>
15	<b>CLOSE VALVE</b>	Digital input <sup>1)</sup>	This function will close (isolate) the valve. This function is activated as long as optocoupler is 'on' in <b>non inverted</b> configuration. This function is activated as long as optocoupler is 'off' in <b>inverted</b> configuration. Configuration can be done in local operation via service port.	2 <sup>2)</sup>

- 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 «3.11.1 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.



Pin	Function	Signal type	Description	Priority
3	<b>ZERO</b>	Digital Input <sup>1)</sup>	<p>This function compensates the pressure gauge offset voltage and sets the pressure value to zero. In case of a 2 sensor system both sensor inputs will be adjusted.</p> <p>This function is initiated by the 'off' to 'on' transition of the optocoupler.            If 'on' remains established this will not re-initiate the function and does also not block functions with lower priorities.</p> <p><b>Note:</b> Do not perform ZERO as long as pressure gauge voltage is shifting.</p> <p><b>Note:</b> 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. You can disable the function in local operation via service port.</p>	1 <sup>2)</sup>
19	<b>LEARN</b>	Digital Input <sup>1)</sup>	<p>The LEARN routine determines the control characteristic of the vacuum system.</p> <p>This function is initiated by the 'off' to 'on' transition of the optocoupler. A transition from 'on' to 'off' while the routine is running would stop it.            While running, the routine may not be interrupted by another function with higher priority. If 'on' remains established after completion this will not re-initiate the function and does also not block functions with lower priorities.</p> <p><b>Note:</b> Without a LEARN data set the PID controller is not able to perform pressure control.</p>	4 <sup>2)</sup>
18	<b>LOCK</b>	Digital input <sup>1)</sup>	<p>This function locks the valve in remote operation. In case the valve is in local operation it will turn to remote operation. Local operation via service port is not possible when LOCK is activated.</p> <p>When the signal is released the valve remains in remote operation but local operation may be activated via service port.</p>	N/A
6	<b>DIGITAL GROUND</b>	Digital ground	<p>Ground for all digital inputs. Ground is used when digital inputs are operated by switches. Connect switches to ground.            Refer also to «3.11.1 Schematics» configuration a).</p>	
4	<b>DIGITAL COMMON</b>	Digital common	<p>Common for all digital inputs. Common is used when digital inputs are driven by voltage sources. Connect + or – terminal of source with common (input optocouplers are capable of bidirectional operation).            Refer also to «3.11.1 Schematics» configuration b).</p>	

- 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 «3.11.1 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.



### 3.11.3 Digital outputs

Pin	Function	Signal type	Description
8	VALVE OPEN	Digital output <sup>1)</sup>	This output is active in all operation modes and indicates that the valve is fully open.
9	VALVE CLOSED	Digital output <sup>1)</sup>	This output is active in all operation modes and indicates that the valve is closed (isolated).
22	ALARM	Digital output <sup>1)</sup>	The meaning of the alarm output depends on the operation mode. <u>LEARN:</u> LEARN is not completed yet. <u>PRESSURE CONTROL:</u> Actual pressure is out of $\pm 2\%$ range of SETPOINT <u>POSITION CONTROL:</u> Actual position is out of $\pm 0.1\%$ range of SETPOINT
21	READY	Digital output <sup>1)</sup>	This signal indicates that the valve is ready for remote operation. If this signal is not active the valve is in one of the following modes: <ul style="list-style-type: none"><li>• Synchronization during power up</li><li>• Local operation via service port</li><li>• Safety mode. Refer to «3.1.3 Safety mode» for details.</li></ul>
20	COMMON	Digital common	Common for all digital outputs.

1) Refer to «3.11.1 Schematics» for details about output circuit.



## 3.11.4 Analog inputs and outputs

Pin	Function	Signal type	Description
25	SETPOINT	Analog input <sup>1)</sup>	<p>The meaning of the setpoint input depends on the operation mode.</p> <p><u>LEARN:</u> A voltage of 0-10V shall be applied to this input as pressure limit for learn. The limit pressure is in linear relation to the applied voltage. 10V relates to sensor full scale. In case of 2 sensor operation 10V relates to high range sensor full scale. <b>Note:</b> To activate pressure limit function for remote operation it must be configured accordingly. Refer to «3.6.1 Interface configuration»</p> <p><u>PRESSURE CONTROL:</u> A voltage of 0-10V shall be applied to this input as pressure setpoint. The pressure setpoint is in linear relation to the applied voltage. Depending on selected SETPOINT RANGE 10V means either sensor full scale or 10% of sensor full scale. In case of 2 sensor operation 10V relates to high range sensor full scale.</p> <p><u>POSITION CONTROL:</u> A voltage of 0-10V shall be applied to this input as position setpoint. The voltage directly controls the position of the pendulum plate. The position is in linear relation to the applied voltage.</p> <ul style="list-style-type: none"><li>• 0V is related to the most closed (but not isolated) pendulum plate position</li><li>• 10V is related to the fully open pendulum plate position</li></ul>
12	PRESSURE	Analog output <sup>1)</sup>	<p>This output indicates the current pressure as 0-10V. The output voltage is in linear relation to the pressure. Depending on the selected SETPOINT RANGE 10V means either sensor full scale or 10% of sensor full scale. In case of 2 sensor operation 10V relates to high range sensor full scale.</p>
11	POSITION	Analog output <sup>1)</sup>	<p>This output indicates the current pendulum plate position as 0-10V voltage range. The voltage is in linear relation to the position. 0V is related to most closed pendulum plate position (valve not necessarily isolated) and 10V to fully open pendulum plate position.</p>
13	ANALOG GROUND	Analog ground	Ground for analog input and analog outputs.
1	CHASSIS GROUND	Chassis ground	Chassis ground connected to case. Shall be used to connect cable shield.

1) Refer to «3.11.1 Schematics» for details about input / output circuit.



## 4 Trouble shooting

Failure	Check	Action
Remote operation does not work	<ul style="list-style-type: none"><li>- Local operation via service port active</li><li>- Safety mode active, check for D on display?</li></ul>	<ul style="list-style-type: none"><li>- Switch to remote operation.</li><li>- Provide power to motor to allow for operation.</li><li>- Refer to «2.6 Electrical connection» for details.</li></ul>
Display shows «E 20» (fatal error - limit stop of valve unit not detected)		<ul style="list-style-type: none"><li>- Replace actuator according to «5.1 Maintenance procedures».</li></ul>
Display shows «E 22» (fatal error - rotation angle of valve plate limited during operation)	<ul style="list-style-type: none"><li>- Valve plate mechanically obstructed?</li></ul>	<ul style="list-style-type: none"><li>- Resolve obstruction.</li></ul>
Display shows «E 40» (fatal error - motor driver failure detected)		<ul style="list-style-type: none"><li>- Replace control unit according to «5.1 Maintenance procedures».</li></ul>
Display shows «D C» or «D999»	<ul style="list-style-type: none"><li>- Motor power supplied?</li></ul>	<ul style="list-style-type: none"><li>- Provide power to motor to allow for operation.</li><li>- Refer to «2.6 Electrical connection» for details.</li></ul>
Display shows «SR» (Service Request)	<ul style="list-style-type: none"><li>- Valve unit heavy contaminated or gate seal heavily sticking?</li></ul>	<ul style="list-style-type: none"><li>- Clean valve and/or replace gate seal according to «5.1 Maintenance procedures».</li></ul>
CLOSE VALVE does not work	<ul style="list-style-type: none"><li>- Safety mode active, check for D on display?</li></ul>	<ul style="list-style-type: none"><li>- Provide power to motor to allow for operation.</li><li>- Refer to «2.6 Electrical connection» for details.</li></ul>
OPEN VALVE does not work	<ul style="list-style-type: none"><li>- Safety mode active, check for D on display?</li></ul>	<ul style="list-style-type: none"><li>- Provide power to motor to allow for operation.</li><li>- Refer to «2.6 Electrical connection» for details.</li></ul>
POSITION CONTROL does not work	<ul style="list-style-type: none"><li>- Safety mode active, check for D on display?</li></ul>	<ul style="list-style-type: none"><li>- Provide power to motor to allow for operation.</li><li>- Refer to «2.6 Electrical connection» for details.</li></ul>
	<ul style="list-style-type: none"><li>- POSITION CONTROL selected, check for V on display?</li></ul>	<ul style="list-style-type: none"><li>- Select POSITION CONTROL mode.</li><li>- Refer to «3.9 Position control» for details.</li></ul>



**Installation, Operating & Maintenance Instructions**  
**Series 650, DN 100 – 250 (I.D. 4" - 10")**

Failure	Check	Action
Pressure reading is wrong or pressure reading is negative	<ul style="list-style-type: none"> <li>- Sensor(s) connected?</li> <li>- 2 sensor version ? 650 . . . . . E - . . . .</li> <li>- ZERO done?</li> <li>- Does sensor power supply provide enough power for sensor(s)?</li> </ul>	<ul style="list-style-type: none"> <li>- Refer to «2.6 Electrical connection».</li> <li>- Verify configuration.</li> <li>- Refer to «3.10.1 Pressure control operation with 2 sensors».</li> <li>- Perform ZERO when base pressure is reached. Refer to «3.6.3 ZERO» for details.</li> <li>- Verify sensor supply voltage.</li> </ul>
ZERO does not work	<ul style="list-style-type: none"> <li>- Valve in open position, check for O on display?</li> <li>- ZERO disabled?</li> </ul>	<ul style="list-style-type: none"> <li>- OPEN VALVE and bring chamber to base pressure before performing ZERO.</li> <li>- Enable ZERO. Refer to «3.6.2 Valve and sensor configuration» for details.</li> </ul>
Pressure is not '0' after ZERO  PRESSURE CONTROL does not work	<ul style="list-style-type: none"> <li>- Sensor voltage shifting?</li> <li>- System pumped to base pressure?</li> <li>- Sensor offset voltage exceeds <math>\pm 1.4V</math></li> <li>- Safety mode active, check for D on display?</li> <li>- PRESSURE CONTROL selected, check for P on display?</li> <li>- LEARN done?</li> </ul>	<ul style="list-style-type: none"> <li>- Wait until sensor does not shift any more before performing ZERO.</li> <li>- OPEN VALVE and bring chamber to base pressure before performing ZERO.</li> <li>- Replace pressure gauge.</li> <li>- Provide power to motor to allow for operation. Refer to «2.6 Electrical connection» for details.</li> <li>- Select PRESSURE CONTROL mode. Refer to «3.10 Pressure control» for details.</li> <li>- Perform LEARN. Refer to «3.6 Setup procedure» for details.</li> </ul>
PRESSURE CONTROL not optimal	<ul style="list-style-type: none"> <li>- Setup done completely?</li> <li>- LEARN done?</li> <li>- ZERO performed before LEARN?</li> <li>- LEARN interrupted?</li> <li>- Was gas flow stable during LEARN?</li> <li>- Tuning done?</li> <li>- Is sensor range suited for application?</li> <li>- Noise on sensor signal?</li> </ul>	<ul style="list-style-type: none"> <li>- Perform «3.6 Setup procedure» completely.</li> <li>- Perform LEARN. Refer to «3.6.4 LEARN» for details.</li> <li>- Perform ZERO then repeat LEARN. Refer to «3.6 Setup procedure» for details.</li> <li>- Repeat LEARN. Refer to «3.6.4 LEARN» for details.</li> <li>- Repeat LEARN with stable gas flow. Refer to «3.6.4 LEARN» for details.</li> <li>- Tune valve for application. Refer to «3.10.2 Tuning of control performance» for details.</li> <li>- Use a sensor with suitable range (controlled pressure should be &gt;3% and &lt; 98% of sensor full scale).</li> <li>- Make sure a shielded sensor cable is used.</li> </ul>

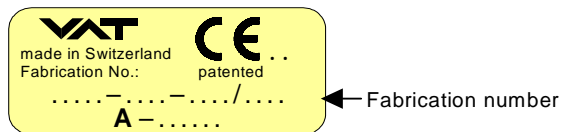
If you need any further information, please contact one of our service centers. You can find the addresses on our website: <http://www.vat.ch>



## 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 and for maintenance work.



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. toxic, caustic or microbiological 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.

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 feedthrough 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.

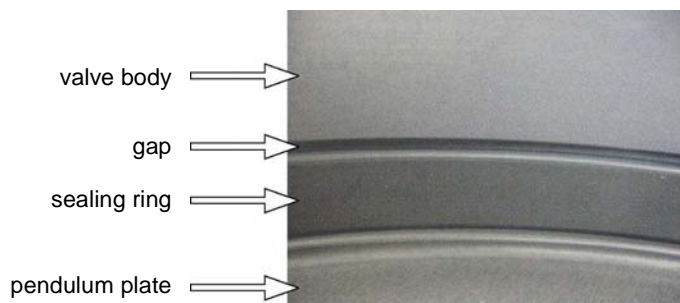
VAT can give the following **recommendations for preventive maintenance**:

	unheated *)	heated $\leq 80^{\circ}\text{C}$ *)	heated $> 80^{\circ}\text{C}$ *)
<b>isolation seals</b> (gate and body seal of sealing ring)	200'000 cycles	6 months but max. 200'000 cycles	3 months but max. 200'000 cycles
<b>actuator feedthrough seals</b>	1 Mio. 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.


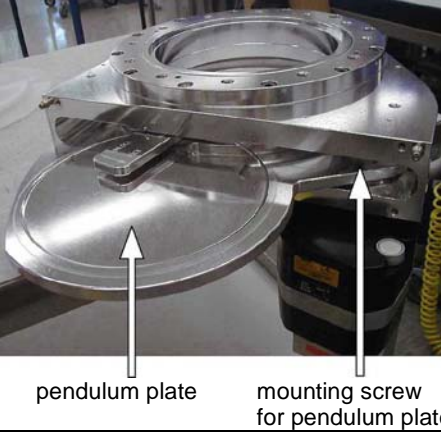




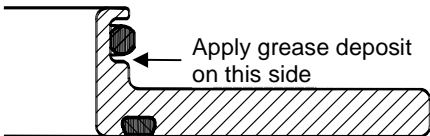



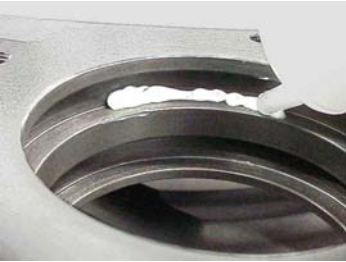
Installation, Operating & Maintenance Instructions  
**Series 650, DN 100 – 250 (I.D. 4" - 10")**


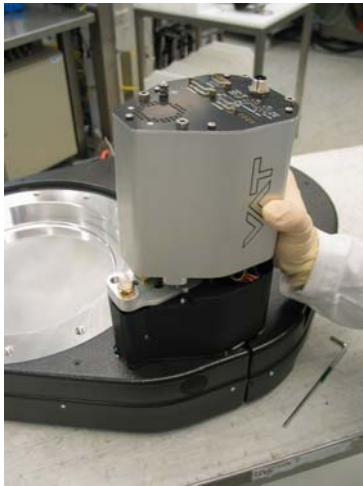
**Replacement of isolation seals (gate and body seal of sealing ring) and valve cleaning**

**Replacement of actuator feedthrough seals**

Description		Required tool		
<ol style="list-style-type: none"> <li>Vent both valve chambers.</li> <li>Open bonnet screws and remove valve bonnet.</li> </ol>		Allen wrench 5mm		
<ol style="list-style-type: none"> <li>Open valve <b>Caution:</b> Stand away from valve – pendulum plate moves out of the valve body.</li> <li>To prevent the pendulum plate from moving during work, switch the valve to safety mode. Refer to «3.1.3 Safety mode» for details.</li> <li>Unfasten mounting screw for pendulum plate.</li> <li>Remove pendulum plate.</li> </ol>		open end wrench 13mm		
<ol style="list-style-type: none"> <li>With one hand press the MAINTENANCE BUTTON to lower the sealing ring, with your second hand unlock the sealing ring by pressing the handle.</li> <li>Release MAINTENANCE BUTTON.</li> <li>Remove sealing ring.</li> </ol>				

Description	Required tool												
<p>10. Remove gate and body o-ring from sealing ring carefully with a soft tool.</p> <p>11. Remove grease residues at sealing ring with alcohol. Clean sealing ring and pendulum plate with alcohol or in an ultrasonic bath.</p> <p>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!</p> <p>13. Clean or replace gate seal if necessary. Install gate o-ring to sealing ring without grease.</p>	 <p style="text-align: center;">gate seal</p> <p style="text-align: center;">body seal</p>												
<p>14. Clean or replace body seal if necessary. Lubricate body o-ring with the quantity of vacuum grease listed in the table to the right.</p>		<table border="1"> <thead> <tr> <th>Valve size</th> <th>Quantity of grease [ml]</th> </tr> </thead> <tbody> <tr> <td>DN100 / 4" (65040 - . . . . - . . . .)</td> <td>0.1</td> </tr> <tr> <td>DN160 / 6" (65044 - . . . . - . . . .)</td> <td>0.15</td> </tr> <tr> <td>DN200 / 8" (65046 - . . . . - . . . .)</td> <td>0.2</td> </tr> <tr> <td>DN250 / 10" (65048 - . . . . - . . . .)</td> <td>0.2</td> </tr> </tbody> </table>	Valve size	Quantity of grease [ml]	DN100 / 4" (65040 - . . . . - . . . .)	0.1	DN160 / 6" (65044 - . . . . - . . . .)	0.15	DN200 / 8" (65046 - . . . . - . . . .)	0.2	DN250 / 10" (65048 - . . . . - . . . .)	0.2	
Valve size	Quantity of grease [ml]												
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DN160 / 6" (65044 - . . . . - . . . .)	0.15												
DN200 / 8" (65046 - . . . . - . . . .)	0.2												
DN250 / 10" (65048 - . . . . - . . . .)	0.2												
<p>15. Install body o-ring into sealing ring.</p>													
<p>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.</p>	<table border="1"> <thead> <tr> <th>Valve size</th> <th>Quantity of grease [ml]</th> </tr> </thead> <tbody> <tr> <td>DN100 / 4" (65040 - . . . . - . . . .)</td> <td>0.2</td> </tr> <tr> <td>DN160 / 6" (65044 - . . . . - . . . .)</td> <td>0.25</td> </tr> <tr> <td>DN200 / 8" (65046 - . . . . - . . . .)</td> <td>0.3</td> </tr> <tr> <td>DN250 / 10" (65048 - . . . . - . . . .)</td> <td>0.4</td> </tr> </tbody> </table>	Valve size	Quantity of grease [ml]	DN100 / 4" (65040 - . . . . - . . . .)	0.2	DN160 / 6" (65044 - . . . . - . . . .)	0.25	DN200 / 8" (65046 - . . . . - . . . .)	0.3	DN250 / 10" (65048 - . . . . - . . . .)	0.4		
Valve size	Quantity of grease [ml]												
DN100 / 4" (65040 - . . . . - . . . .)	0.2												
DN160 / 6" (65044 - . . . . - . . . .)	0.25												
DN200 / 8" (65046 - . . . . - . . . .)	0.3												
DN250 / 10" (65048 - . . . . - . . . .)	0.4												
 <p>Apply grease deposit on this side</p>													

Description	Required tool		
<p>17. Disconnect 24VDC power. Wait for 60s, then disconnect cable and compressed air from valve actuator.</p> <p>18. Unfasten all 4 controller screws and lift controller carefully from actuator. Unfasten the 4 screws of the shift adaptor plat and remove it carefully.</p>		<p>Allen Wrench 5 mm</p>	
<p>19. Unfasten all 3 actuator screws and remove actuator.</p>		<p>Allen Wrench 5 mm</p>	
<p>20. Remove seals from actuator feedthrough carefully with a soft tool.</p> <p>21. Clean actuator feedthrough with alcohol.</p> <p>22. Lubricate each o-ring groove with 0.1 ml vacuum grease. Pay attention that grease is distributed constantly over the whole circumference.</p>			
<p>23. Clean or replace seals if necessary. Lubricate each o-ring with 0.05 ml vacuum grease.</p> <p>24. Install o-rings.</p> <p>25. Deposit 0.1 ml vacuum grease on each o-ring. Pay attention that grease is distributed constantly over the whole circumference.</p>			

Description		Required tool										
<p>26. Remove fixation kit and mounting screw for pendulum plate.</p> <p>27. Clean screw and slightly lubricate thread. Then reinstall fixation kit.</p> <p>28. Clean actuator shaft and lubricate it with 0.1 ml vacuum grease.</p>												
<p>29. Install actuator and controller in reverse order as they had been disassembled (steps 19 to 17).</p> <ul style="list-style-type: none"> <li>• Tighten actuator screws with 6 Nm.</li> <li>• Remove vacuum grease from actuator shaft face after installation.</li> <li>• Tighten controller driver screws with 1 Nm.</li> </ul>		Allen Wrench 5mm										
<p>30. Install sealing ring and pendulum plate in reverse order as they had been disassembled (steps 9 to 2).</p> <p>31. Mount valve bonnet.</p> <ul style="list-style-type: none"> <li>• Tightening torques for bonnet screws are listed in the table to the right.</li> </ul>	<table border="1"> <thead> <tr> <th>Valve size</th> <th>Max. torque [Nm]</th> </tr> </thead> <tbody> <tr> <td>DN100 / 4" (65040 - . . . . - . . . .)</td> <td>6</td> </tr> <tr> <td>DN160 / 6" (65044 - . . . . - . . . .)</td> <td>6</td> </tr> <tr> <td>DN200 / 8" (65046 - . . . . - . . . .)</td> <td>6</td> </tr> <tr> <td>DN250 / 10" (65048 - . . . . - . . . .)</td> <td>6</td> </tr> </tbody> </table>	Valve size	Max. torque [Nm]	DN100 / 4" (65040 - . . . . - . . . .)	6	DN160 / 6" (65044 - . . . . - . . . .)	6	DN200 / 8" (65046 - . . . . - . . . .)	6	DN250 / 10" (65048 - . . . . - . . . .)	6	Allen wrench 5mm and open end wrench 13mm
Valve size	Max. torque [Nm]											
DN100 / 4" (65040 - . . . . - . . . .)	6											
DN160 / 6" (65044 - . . . . - . . . .)	6											
DN200 / 8" (65046 - . . . . - . . . .)	6											
DN250 / 10" (65048 - . . . . - . . . .)	6											

## 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:

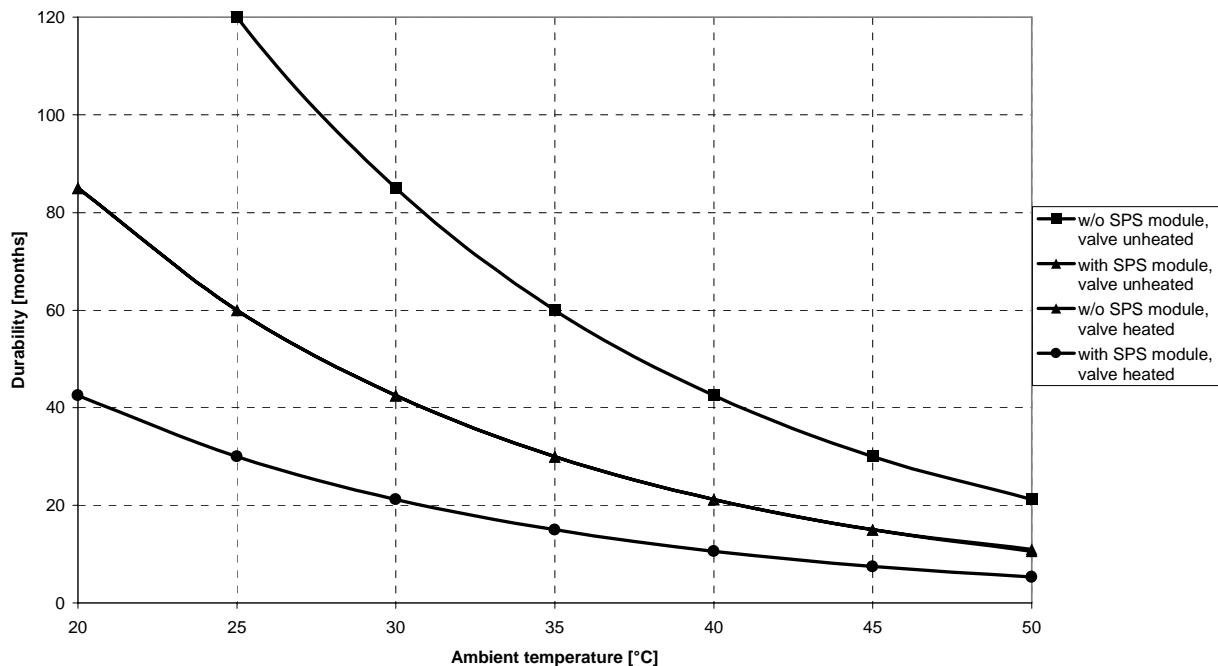
- $\pm 15\text{VDC}$  sensor power supply (SPS)
- Power failure option (PFO)

It is available in 3 versions. These are:

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

The modules may be retrofitted or replaced easily. The battery lifetime of the PFO module depends on the ambient temperature (see below). To assure PFO function the option board must be replaced after battery life has expired. For ordering number of the modules refer to «7 Spare parts and accessories».

### 5.2.1 Durability of power fail battery



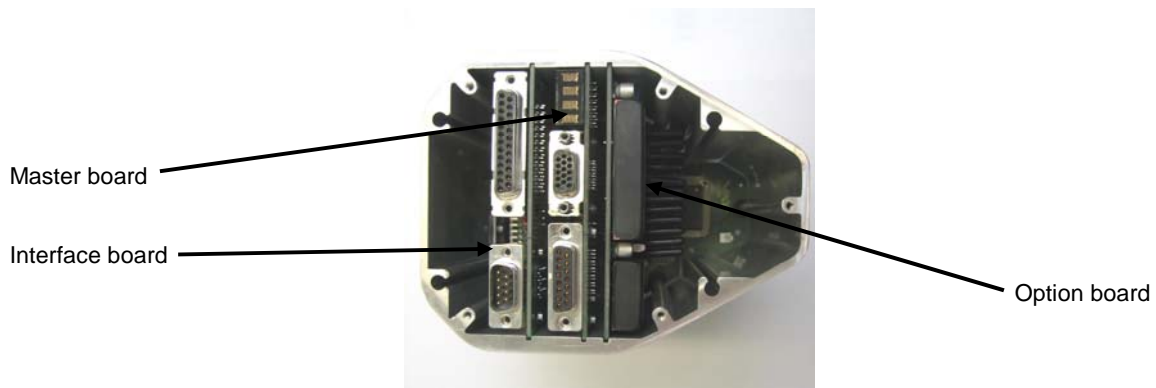
### 5.2.2 Retrofit / replacement procedure



**ESD Precaution!**

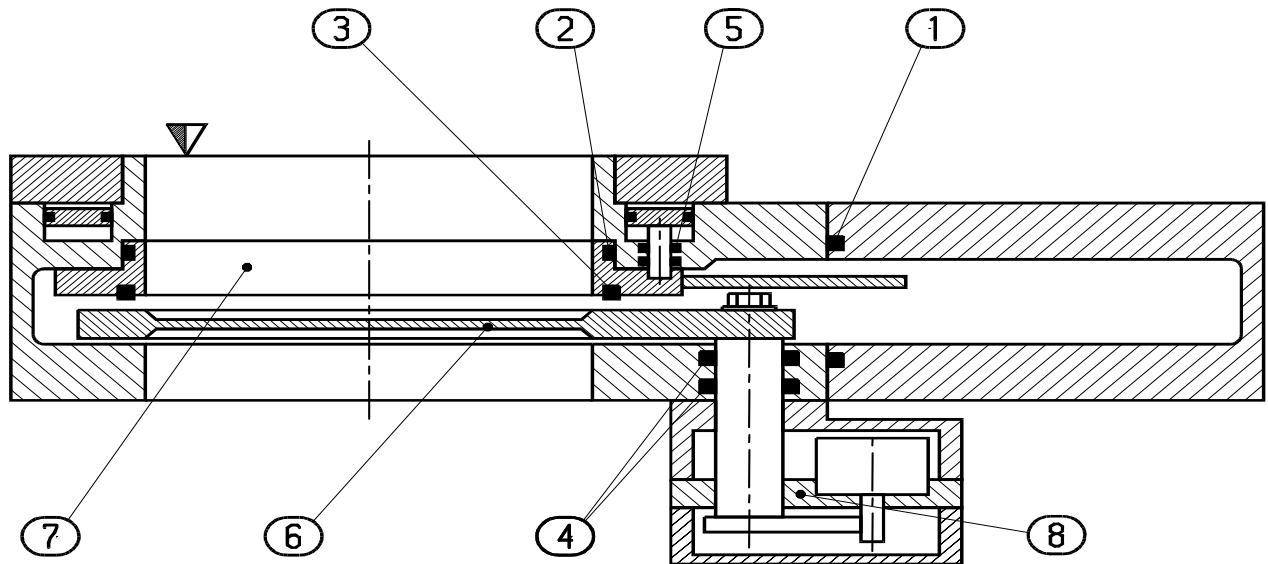
All work on the control and actuating unit has to be done under ESD protected environment to prevent electronic components from damage!

Top view on control and actuating unit with panel removed:



Description	Required tool
1. Remove screws from POWER, SENSOR and INTERFACE connectors.	open end wrench 4.5 mm
2. Remove panel screws.	Phillips screwdriver size 2
3. Lift panel carefully.	
4. Disconnect fan cable from board.	
5. Replace option board or insert it at free position.	
6. Reconnect fan cable to master board (step 4).	
7. Tighten panel screws with 1.1 Nm.	Phillips screwdriver size 2
8. Tighten screws from POWER, SENSOR and INTERFACE connectors with 1.1 Nm.	open end wrench 4.5 mm

## 6 Drawing







## 7 Spare parts and accessories

The item numbers refer to the drawing on page 48



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 Accessories

Item	Description	
	<b>Valve size</b>	<b>All sizes</b>
	<b>Product ordering number</b>	<b>650 . . . . .</b>
	24 VDC power supply unit (input: 100 – 240 VAC)	249775
	'Control Performance Analyzer' package for Windows® consisting of software and cable	600SP-99NN-AAA
	'Control View' software for Windows®	248126 free download from <a href="http://www.vatvalve.com">www.vatvalve.com</a> or available on order against charge
	Service cable (PC to valve connection)	230327 free wiring information available for download from <a href="http://www.vatvalve.com">www.vatvalve.com</a>
	Connector kit consisting of: •DB-9 female POWER plug •DB-15 male SENSOR plug •DB-25 male INTERFACE plug	242411

Item	Description		DN 100 / 4"	DN 160 / 6"	DN 200 / 8"	DN 250 / 10"
	<b>Valve size</b>		<b>DN 100 / 4"</b>	<b>DN 160 / 6"</b>	<b>DN 200 / 8"</b>	<b>DN 250 / 10"</b>
	<b>Product ordering number</b>		<b>65040 - . . . .</b>	<b>65044 - . . . .</b>	<b>65046 - . . . .</b>	<b>65048 - . . . .</b>
	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

### 7.2 Control unit

Item	Description	
	<b>Valve size</b>	<b>All sizes</b>
	<b>Product ordering number</b>	<b>650 . . . . .</b>
	Control unit	Too many to list. Depends on configuration, please contact VAT.
	Option board with SPS module (±15VDC sensor power supply)	238091
	Option board with PFO module (power failure option)	242413
	Option board with SPS and PFO module	239390



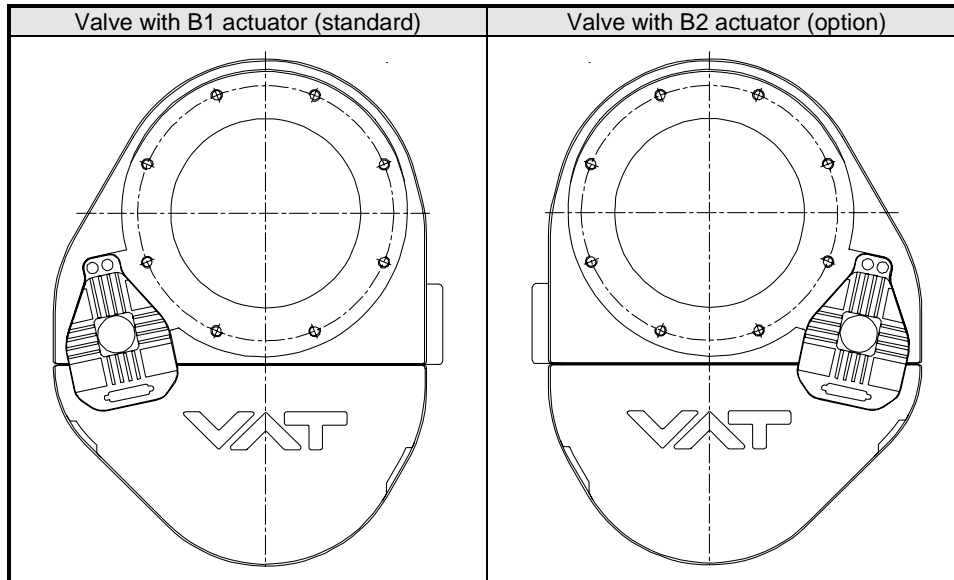
### 7.3 Valve unit

Item	Description	Valve size			
		DN100	DN160	DN200	DN250
	Valve part number	65040 - . . . . .	65044 - . . . . .	65046 - . . . . .	65048 - . . . . .
1	Bonnet Viton seal other materials	N-5100-259 on request	N-5100-267 on request	N-5100-272 on request	N-5100-277 on request
2	Body seal (Viton) This includes a 2ml syringe of vacuum grease	204884	206527	200468	202592
3	Gate Viton seal other materials	N-5100-155 on request	N-5100-258 on request	N-5100-266 on request	N-5100-275 on request
	Seal kit vacuum (Viton). This consists of item 2 and 3.	204883	206526	204204	203883
	Syringe of vacuum grease 2ml 5ml	206792 206793			
4	Actuator feedthrough seals (Viton)	N-5111-329 (2 pcs required per valve)			
5	Seals for sealing ring shaft feedthroughs (Viton)	N-5111-112 (12 pcs required per valve)	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 *)	91048-01	101570-01	201272	94632-01
	- Blank B2 *)	on request	231343	226661	on request
	- Hardanodized B1 *)	100741-01	98371-01	200500	92228-01
	- Hardanodized B2 *)	on request	98673-01	201437	92229-01
	- Nickel coated B1 *)	on request	on request	211613	on request
- Nickel coated B2 *)	on request	on request	on request	on request	
7	Sealing ring				
	- Blank	216490	207518	204453	205874
	- Hardanodized	217050	204340	202046	203217
	- Nickel coated	on request	on request	211610	on request
8	Actuator B1 *)	258676	241244		
	B2 *)	on request	242216		

**Note:** Use only spare parts manufactured by VAT to assure safe and reliable operation!

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

Actuator position options:



## 8 Warranty

Each product sold by VAT Vakuumentile 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.