

Operating Instructions
for the
PLUGSYS® Module

VSM Ventilation Sequencer Module Type 698

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I. Introduction, manufacturer's information

These Operating Instructions describe the function and the use of the **VSM** module Type 698. It forms an essential constituent of the instrument and should be stored close to it.

All the information in these instructions have been assembled after careful examination but do not represent any warranty of product properties. Modifications in line with technical progress are reserved.

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Trademark

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III. Safety note



Warning:The instrument is not suitable for use in hazardous areas and/or in an inflammable atmosphere.

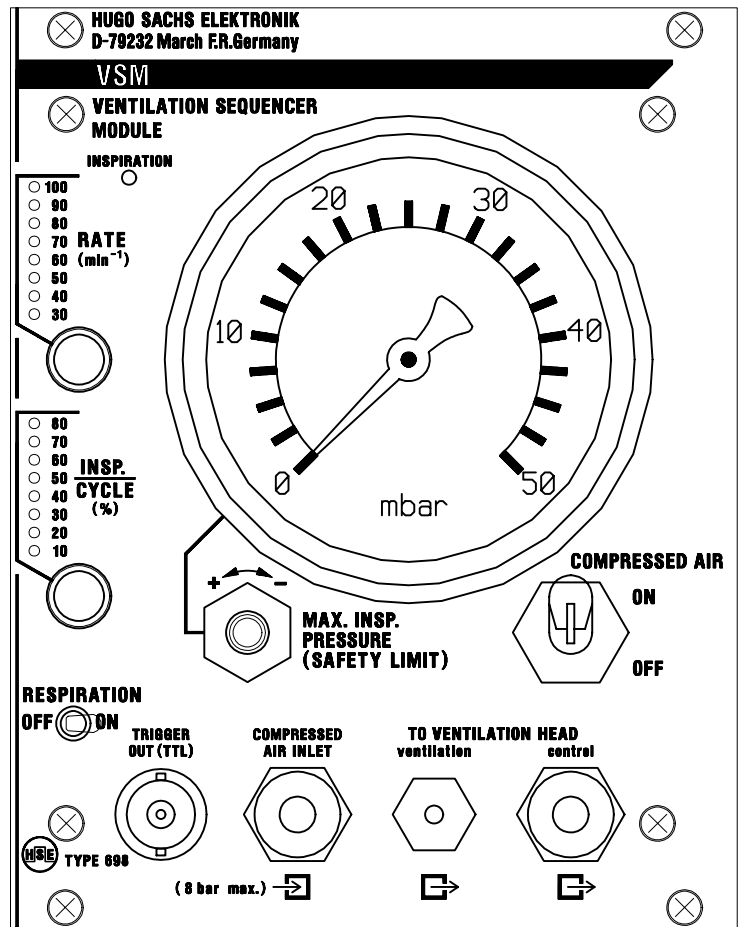
Not for human use !!!

V. General description, application

The **VSM Ventilation Sequencer Module** Type 698 is a plugin module for the HSE PLUGSYS measurement system. It has been essentially developed to ventilate up to eight anesthetized guinea pigs for bronchospasmolysis test after EINTHOVEN. It is feasible that the apparatus can also be used for the ventilation of small animals (mice, rats) in other applications (e.g. blood pressure measurement on eight anesthetized ventilated rats).

The module operates in combination with up to eight ventilation heads (see appendixes). The heads are connected to the module via a connecting block.

The VSM must be installed in a PLUGSYS housing Series 600. It operates from the standard supply voltages. The only modification required is to wire an existing voltage (+ 24 V) to the module slot (see Section 0). The VSM module requires a compressed air supply (8 bar max.)



VII. Operating principle

The VSM module in connection with the ventilation head operates on the principle of intermittent positive-pressure ventilation. An air stream (adjustable by a needle valve) is passed by a main valve either to the animal or to an overflow outlet. The main valve (part of the ventilation head) consists of a silicone membrane. The valve is controlled by applying air pressure on the control port. The control air pressure can be adjusted on the VSM module. If the effective ventilation pressure is higher than the control pressure the main valve opens automatically and protects the animal against excessive pressure rise in the lung.

The module consists of an electronic and a pneumatic section. The compressed air appears at the outlet "**TO VENTILATION HEAD, ventilation**". This port is connected to the ventilation heads via a needle valve. The constant inspiratory flow is adjusted using this valve. Each head has its own valve to adjust the inspiratory flow for each animal individually. The port "**TO VENTILATION HEAD**", control is connected via the connection block to the control port at all the ventilation heads. The air pressure at the control port is switched on and off electronically according to the selected respiration rate (RATE) and the selected inspiratory cycle (INSP. CYCLE %). The outputs therefore consist of a continuous air stream to generate the respiratory flow, and a rhythmically modulated air stream with a positive pressure set at the module as "**MAX. INSP. PRESSURE (SAFETY LIMIT)**" to control the main valves.

IX. Installing the module in a housing

(If the module has been supplied already installed, you can omit Sections 0 and continue with Section 0. If you have received the module as a separate unit you should continue here.)

Before you can use the **VSM** module it has to be installed in a suitable HSE PLUGSYS housing Series 600 (Available types at Jan. 95: 601 to 607). If the module is supplied as part of a completely installed PLUGSYS system the work described below has already been carried out and the selected signal path has been entered in the bus diagram.

The module requires a special 24 Volt supply. This supply is provided by the power supply in the housing but is not available at every slot. The supply has to be wired internally on the bus board to the desired slot position. Null (PGND) must be connected to "**P2**" (pins 30 a/b/c) and + 24 Volt to "**P0**" (pins 28 a/b/c) [see picture on page]. If you want to change the slot position of the module in the housing, you have to alter the 24 Volt supply wiring and move it to the new slot as described before. If this is not done the module will not operate when the equipment is switched on.

Before the module is installed in a housing the connection of the module to the bus lines has to be determined by plugging in the link as described in the next section (Section 0).

Do not forget to enter the selected connection in the bus diagram (in the white Operating Manual folder under Section 1).

Brief procedure (for full details see the Operating Manual of the housing):

- Pull out the mains plug on the housing.
- Remove the blank panel(s) at the housing slot position intended for the **VSM** module.
- Check for the wiring of the extra supply of 24 Volt, install it if necessary.
- Prepare the module according to Section 4 (set lines and link).
- Insert the **VSM** module, note the guide rails.
- Push the module firmly into the bus connector.
- Screw on the front panel.
- Connect the ventilation head(s).
- Reconnect the mains plug to the housing.
- Connect the compressed air to the VSM module.
- Switch on the housing.

1. Internal instrument setting, link

Before you install the **VSM** module into the PLUGSYS housing it is necessary to set a link on the circuit board to have the trigger signal linked to the appropriate or required bus line. The module can only be used together with the complete system if the bus line has been connected correctly.

Do not forget to enter the selected signal assignment in the bus diagram for the PLUGSYS housing (the bus diagram is filed in the Operating Manual folder under Section 1).

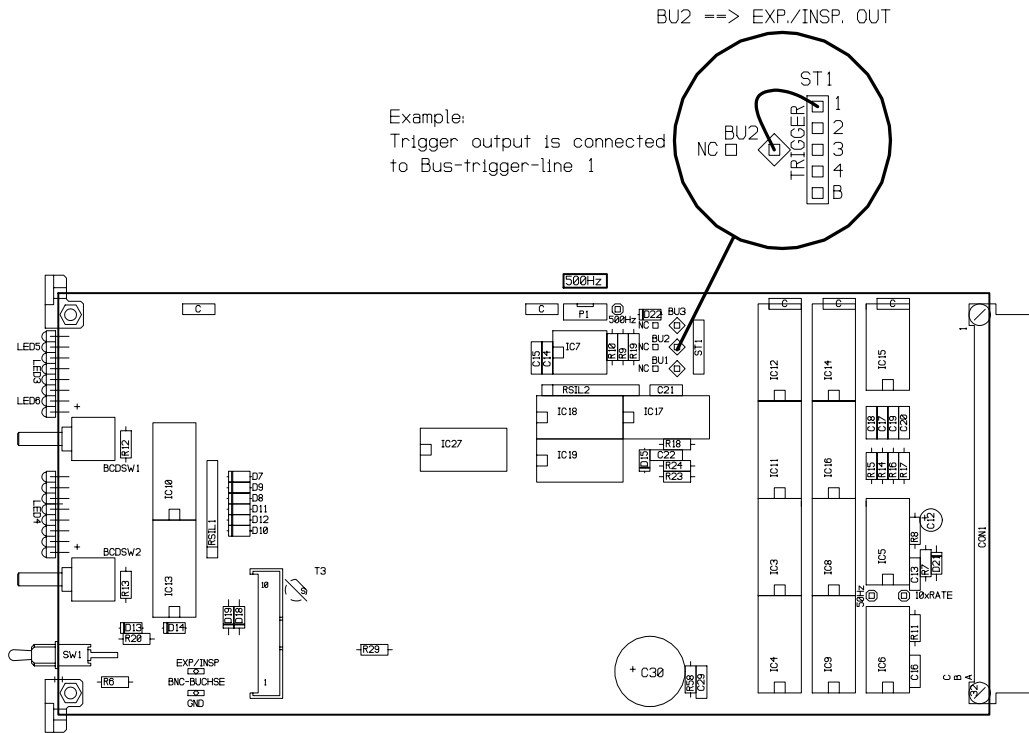
The trigger signal is intended for operating the module in conjunction with a computer. This signal can be used to synchronize data acquisition by the ventilator. If the module is being used without computer the trigger signal is unnecessary and does not have to be linked to the system bus. If the trigger signal is not connected, the link line must be placed in the parking pin provided (NC).



Note:When selecting the bus line (TRIG1...4 or BINT) be sure to use a line where no other trigger output is connected and check this in the bus diagram. If there is no appropriate information in the bus diagram you can define the bus line assignment only by removing all the modules and figuring out the signal paths selected on them using the corresponding operating instructions.

You find the position of the links from the diagram below. The following link has to be set:

Trigger output to PLUGSYS bus system



XI. Input, output connections

The VSM module is equipped with one inlet port for the compressed air and with two outlet ports for connecting the ventilation head(s).

On the compressed air inlet, the pressure should be at least 4 bar but not exceed 8 bar. Large fluctuations on the compressed air supply (> 0.5 bar) influence slightly the stability of the inspiratory flow. The line should be connected directly to the main compressed air supply line without any flow regulator or other pressure regulator between, if the line pressure doesn't exceed the 8 bar max pressure. It is important to ensure that the connecting tubing is also suitable for this pressure. The tubing must be secured on the connector using the appropriate fitting-nut delivered with the module.

If only one ventilation head is used, it is connected directly to the corresponding outlets (see appendixes for the description of the ventilation head). If more than one ventilation head are used, they are connected together on a connecting block. The connecting block is the main supply for all the ventilation heads and is connected to the two outlets at the VSM module. The outlets on the VSM module are of different diameters to prevent from wrong connections.

XIII. Starting up

After the VSM module has been installed into the housing the ventilation head(s) and the compressed air must be connected to the module. Before connecting the compressed air to the module be sure the line pressure will not exceed 8 bar.

Brief procedure:

- close all the needle valves for flow adjustment on the ventilation head(s) (fully counterclockwise).
- Switch on the PLUGSYS main switch.
- Set the switch "**COMPRESSED AIR**" in OFF position.
- Open compressed air supply at the main line (check for < 8 bar).
- Set the switch "**COMPRESSED AIR**" in position ON and switch "**RESPIRATION**" in position OFF.
- Set the safety limit "**MAX. INSP. PRESSURE**" to e.g. 30 cmH₂O.
- Set the switch "**RESPIRATION**" in position ON.
- Adjust "**RATE**" and "**INSP. CYCLE %**" to the required values (check for rhythmic flashing of the LED "**INSPIRATION**").
- Prepare the animal by installing the trachea cannula.
- Plug the trachea on the ventilation head.
- Adjust the needle valve for inspiratory flow during monitoring of the ventilation pressure (e.g. ventilation pressure of 10 cmH₂O at the end of inspiratory). If multiple ventilation heads are used, after a first adjustment of the inspiratory flow on all the heads, repeat this step to correct eventual interactions.

Useful informations:

- Large fluctuations on the compressed air supply (> 0.5 bar) influence slightly the stability of the inspiratory flow.
- Many ventilation heads increase the dead volume of the system. This influences the delay of the valve closing. Not used ventilation heads should be disconnected from the connecting block therefore. The unit is delivered with standard tubings, after installation on site the tubings should be reduced to the minimum required length.

- Due to construction, the effective safety limit pressure is approximately 5 cmH₂O higher than the adjusted value.
- The rhythmic changes shown by the pressure gauge are related to the dead volume of the system and normal since they are lower than 10 cmH₂O. The amplitude depends on the number of ventilation heads connected. The effective value is the maximum value shown by the gauge.
- A spontaneously breathing animal can be connected to the ventilation head if the switch "**COMPRESSED AIR**" is in position ON and the switch "**RESPIRATION**" in position OFF.

XV. Description of the controls

(1) Switch "**RESPIRATION ON-OFF**" switches on or off the electronic control module. In the off position the sequencer stops in the expiratory state. The air stream across the main valve to the overflow outlet is maintained. This allows to stop the forced ventilation but to continue to flush the ventilation head in case of spontaneous respiration

(2) Switch "**COMPRESSED AIR ON-OFF**" switches on or off the compressed air supply for the module. Switching off the sequencer or the power supply will not automatically switch off the compressed air stream to the ventilation head.

(3) Knob "**RATE**" is used to set the respiratory rate in fixed steps of 30, 40, 50, 60, 70, 80, 90, 100 min⁻¹.

(4) Knob "**INSP. CYCLE %**" is used to set the inspiratory duration. This time is expressed as a proportion (10, 20, 30, 40, 50, 60, 70, 80 %) of the total ventilation cycle duration in %

(5) This is the adjustment for the pressure of the control air line. This is the maximum ventilation pressure that can be reached during operation before the main valve opens to prevent against excessive pressure rise in the lung.

(6) Pressure gauge for adjusting and monitoring the control pressure (0 - 40 mbar = 0 - 40 cmH₂O).

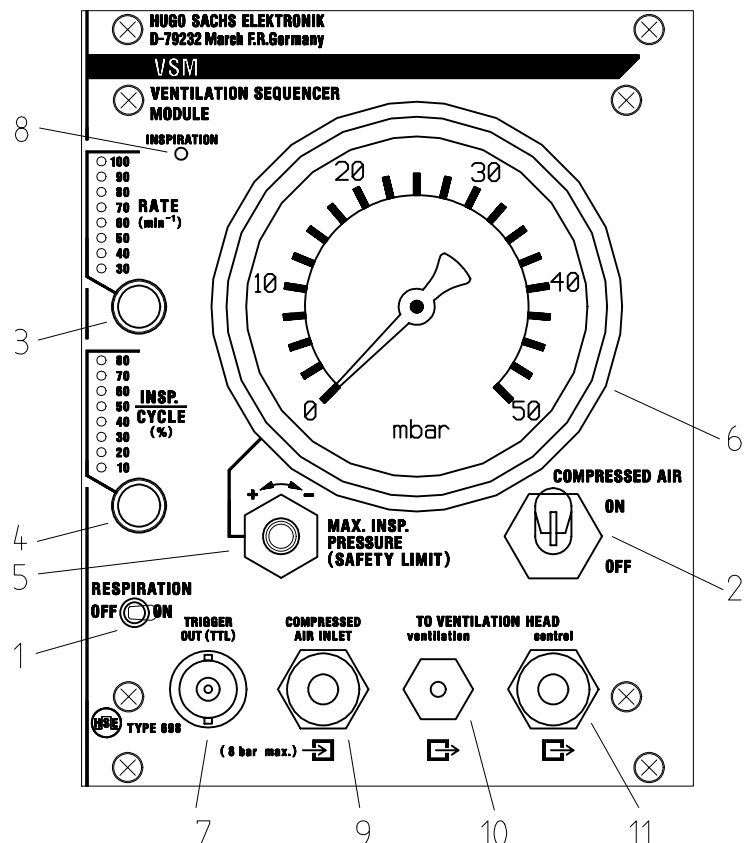
(7) BNC socket "**TRIGGER OUT (TTL)**". This socket carries the trigger signal in the TTL voltage range (5 V). This socket can be used to synchronize an oscilloscope.

(8) LED "**INSPIRATION**". This LED lights up during the inspiration phase of the ventilation cycle.

(9) Inlet port "**COMPRESSED AIR**". Must be connected to the main supply line of compressed air (pressure < 8 bar)

(10) Outlet port "**TO VENTILATION HEAD ventilation**". Connected to the ventilation head, provides the air pressure for inspiratory flow

(11) Outlet port "**TO VENTILATION HEAD control**". Connected to the ventilation head, provides the air pressure to control the main valve (inspiratory-expiratory cycle).



XVII. Faults, their causes and remedies

Fault:LED "INSPIRATORY" is not flashing

Causes:Instrument is not switched on or "RESPIRATION" switch is in off position

Remedy:Check the power cord connection, the main power switch and the "RESPIRATION" switch

Fault:Control pressure cannot be set with the knob "MAX. INSP. PRESSURE" (pressure gauge shows 0 cmH₂O).

Causes:No compressed air available

Remedy:Check the compressed air supply connection. Check if the "COMPRESSED AIR" switch is in on position

Fault:Control pressure set with the knob "MAX. INSP. PRESSURE" drops down more than 10 cmH₂O during inspiration (see the pressure gauge).

Causes:No ventilation head connected, leak on control port line

Remedy:Check the connection of the ventilation head. Check for a leak in the connection lines for the control port between VSM and ventilation head(s)

Fault:Inspiratory flow cannot be adjusted.

Causes:No compressed air available, leak

Remedy:Check if the control pressure can be adjusted. If not check the compressed air supply connection. Check if the "COMPRESSED AIR" switch is in on position otherwise check for a leak in the ventilation connecting line from the VSM module to the ventilation head(s). At a none used ventilation head the needle valve is fully open.

XIX. Maintenance and cleaning

The PLUGSYS module essentially does not require cleaning. The **VSM** module is supplied fully calibrated. Any operation on or alteration of the electronic circuitry invalidates the manufacturer's warranty and product liability.

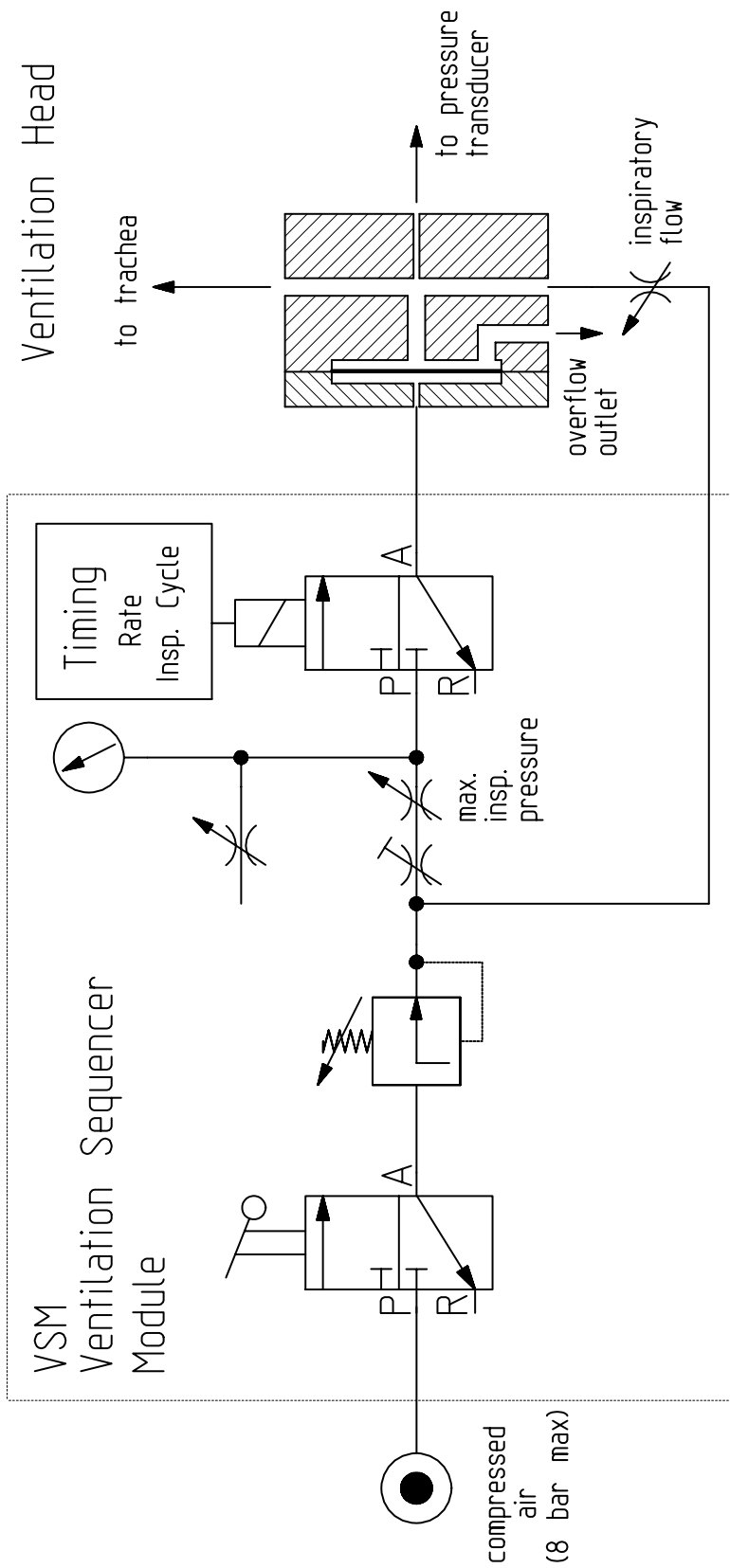
The front panel can be cleaned if necessary with a lightly moistened (not a wet) cloth. Before cleaning always pull out the main supply plug!

No moisture must find its way into the unit and especially not into the switches and keys, since this leads to corrosion at the switch contacts resulting in faulty operation. In general the PLUGSYS housing should be protected against water splashes and salt solutions as this may damage individual components and may cause a short-circuit!

XXI. Transport and storage

In order to avoid transport damage if the unit has to be returned to the factory, the PLUGSYS housing should be packed in a suitably large carton (the carton should allow a spacing of about 10 cm all round so that sufficient packing material such as polystyrene, hard foam panel or similar can be included to protect against impact damage). When shipping individual modules, these should also be well packed and enclosed in antistatic foil or envelope.

XXIII. Block diagram of the VSM module with ventilation head



XXV. CE Declaration of Conformity

This product and accessories conform to the requirements of the Low-voltage Directive 73/23 EEC as well as the EMC Directive 89/336 EEC and are accordingly marked with the CE mark. For conformity to the standards during operation it is essential that the details in the instructions provided are observed.

XXVII. Technical data

Compressed air input: 4 bar min, 8 bar max

Rate: 30, 40, 50, 60, 70, 80, 90, 100 min⁻¹

Inspiratory cycle duration: 10, 20, 30, 40, 50, 60, 70, 80 % of total respiratory cycle duration

Indication: LED lights up during inspiration

Trigger output: BNC socket on front panel (TTL) (Low = Inspiration, High = Expiration)
The trigger signal is also available on the PLUGSYS bus system.

Outputs to ventilation head: -ventilation: approximately 120 mmHg
-control: pressure set at control "MAX. INSP. PRESSURE" rhythmic pulsed

Control pressure: adjustable from 0 to 50 cmH₂O

Ambient conditions: working temperature: 10 to 40°C
rel. humidity: 20 to 80%, no condensation
storage temperature: -20 to 60°C

Supply: 5 V 600 mA and 24 V 180 mA via PLUGSYS system bus

Mechanical data:

Dimensions: module for PLUGSYS housing
width: 20 E (101.6 mm)
height: 3 U (128.7 mm)
depth: Eurocard (220 mm)

Weight: 1200 g

Connector: DIN 41612, 96-pin VG

Accessories: Operating Instructions

XXIX. Appendix 1: Standard Ventilation Head

1. Description

The standard ventilation head is commonly used for ventilating rodents or specifically for the bronchospasmolysis test after Einthoven. The ventilation head is equipped with a special holder with ball joint. It can easily be mounted on a stand and placed near to the trachea of the animal.

The trachea cannula is plugged on the ventilation head via a luer connector and can be removed for the surgical preparation. The ventilation head is delivered with a tracheal cannula of 3 mm diameter. On request cannulas with a diameter of 2.5, 3.3 mm are available.

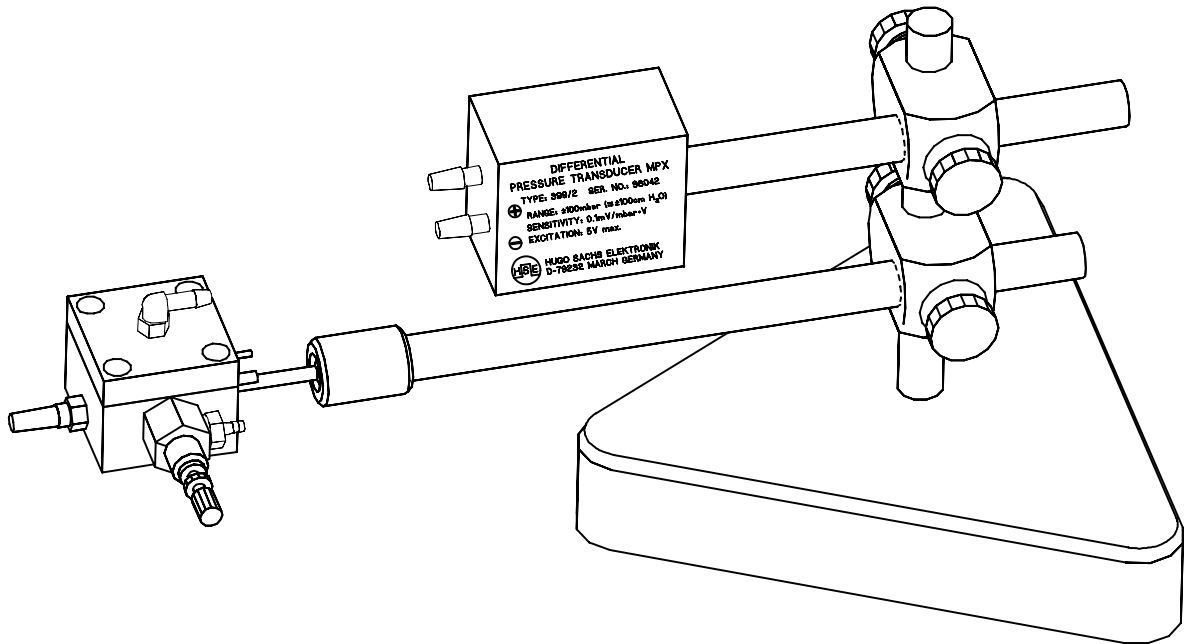
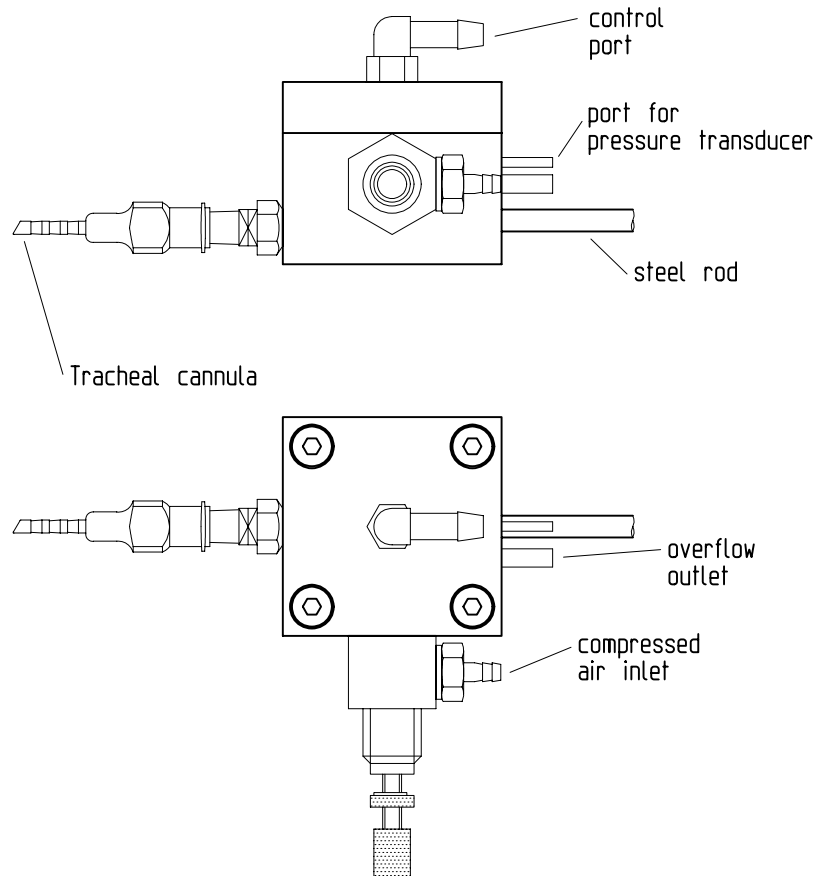
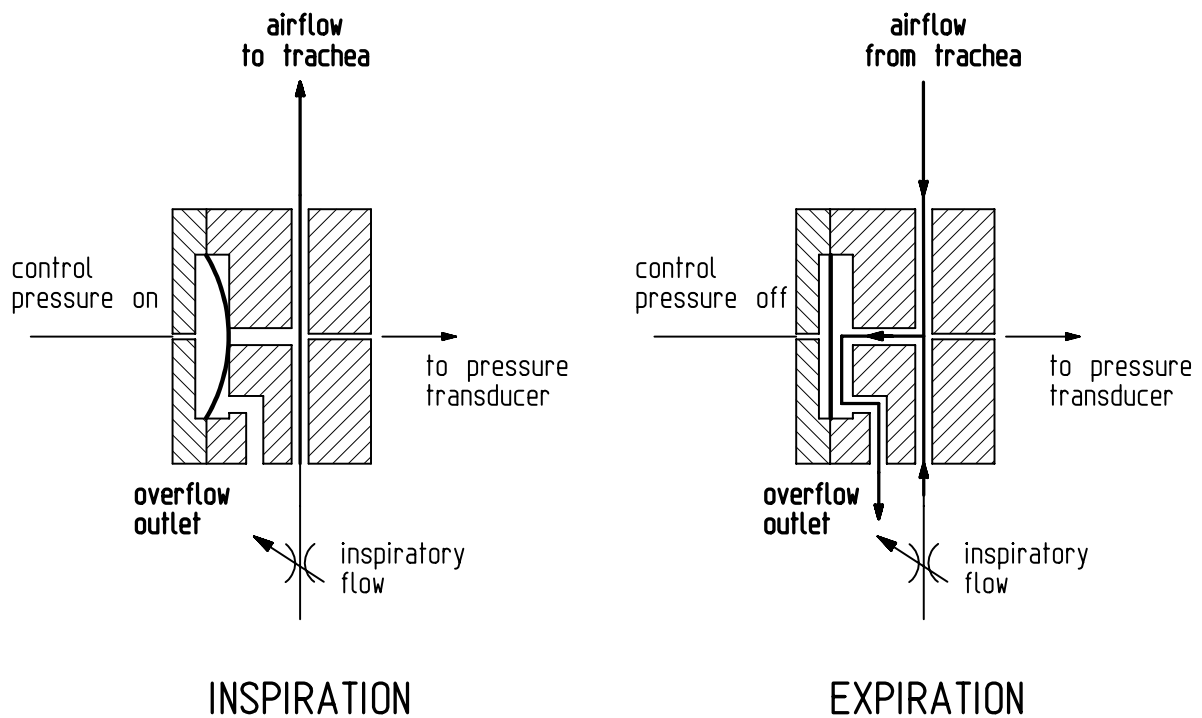


Fig. 8: is an example how the ventilation head and a pressure transducer type MPX for the measurement of the tracheal pressure can be mounted on a universal stand.

The ventilation head must be connected to the corresponding outlets at the VSM module. If more than one head is used they are connected to a connecting block that is connected to the corresponding outlets at the VSM. The connecting block allows the connection of up to 8 heads. The fittings on the connecting block are self-closing, therefore it is possible to equip the unit with 1 to 8 heads without special precautions. If a ventilation head is connected but not used the needle valve for adjusting the inspiratory flow must be closed (fully clockwise). It is always recommended to disconnect from the connecting block the not used ventilation heads.



3. Principle of operation

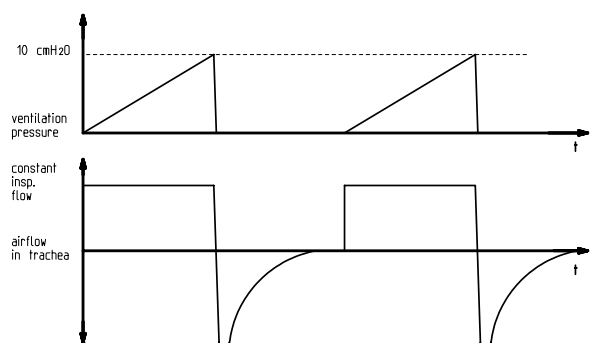


The essential part of the ventilation head is the main valve. The main valve consists of a silicone membrane. During inspiratory the VSM supplies pressure to the control port. The membrane closes the overflow outlet. The airflow adjusted with the needle valve goes to the trachea. During the expiratory phase the VSM removes pressure from the control line and the membrane opens the overflow outlet. The airflow coming from the needle valve goes now directly to the overflow outlet (lower resistance), the expired air from the animal goes the same way. The ventilation pressure can continuously be monitored by connecting a pressure transducer to the corresponding port.

If during the inspiration the ventilation pressure gets higher than the control pressure applied to the membrane valve, the valve escapes and opens the overflow outlet. The ventilation pressure can never be greater than the applied control pressure plus 5 cmH₂O. The membrane in combination with the control pressure works as an overpressure valve to prevent from excessive pressure in the lung.

5. Experiment, inspiratory flow adjustment

After the tracheotomy and the installation of the tracheal cannula, the ventilation head is installed near to the tracheal cannula. The control pressure and the timing are set on the VSM module. By opening slowly the needle valve (turn counterclockwise) a low inspiratory flow is set. The tracheal cannula is now connected on the ventilation head (luer connection). The connector is a cone that seals easily, there is no need to press to firmly or to rotate the cannula. The ventilation head must be positioned properly over the animal. The tracheal cannula must be parallel to the thorax to present a minimum of resistance and to prevent from damaging the trachea. The head must also be slowly inclined in direction of the trachea to prevent mucus coming up into the ventilation head



on the membrane valve. The inspiratory flow used during the experiment must now be set on the ventilation head. For the adjustment of the inspiratory flow the monitored ventilation pressure via the pressure transducer is used. The needle valve is set to have a pressure at the end of the inspiration of about 10 to 12 cmH₂O.

7. Cleaning, maintenance

The ventilation head is of Plexiglas and can easily be cleaned with a lightly moistened (not a wet) cloth. If mucus finds its way into the unit, the head must be removed from the connection and opened. The head consists of 2 parts. The main body and a cover. By opening the 4 screws with the delivered tool, the 2 parts can be separated and the membrane removed. The body as well as the cover and the membrane can be washed under running water and dried up.

The silicone valve must periodically be inspected. If it presents holes or crimps it has to be exchanged. The elasticity of silicone changes over time. We would recommend changing the membranes once a year.

Part list:

Ventilation head body T18316

Ventilation head cover T18317

Silicone membrane T33015

Luer connector for tracheal cannula S16079

Fitting for control port S16004

Needle valve S15007

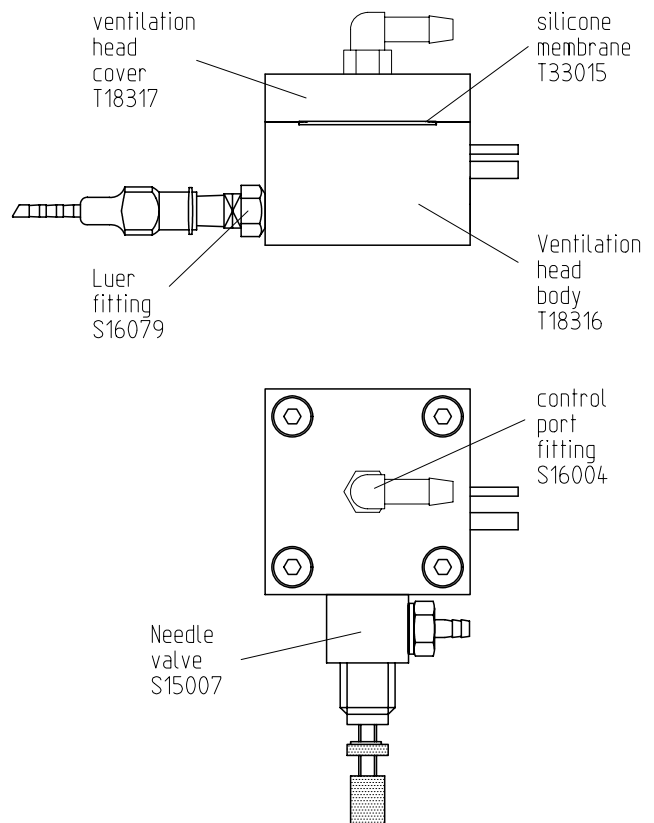
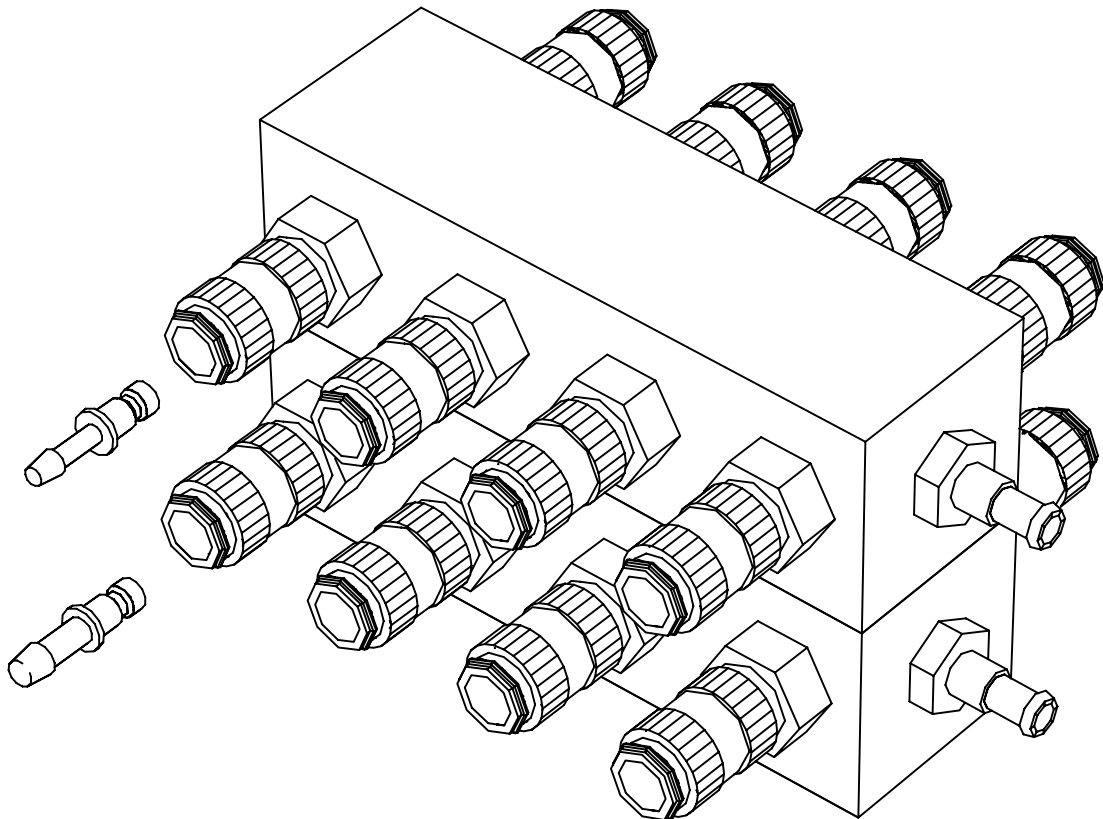


Fig. 12

XXXI. Appendix 2: Connecting block**1. Description**

The connecting block permits to connect up to 8 ventilation heads to one VSM module. The VSM module has only one output for the ventilation pressure and the control pressure. The function of the connecting block is the distribution of these two pressures to the ventilation heads. The connecting block is directly coupled to the VSM module using tubing, the ventilation heads are connected to the block using two selfsealing quick-couplings.



3. Principle of operation

The connecting block consists of two identical distribution lines. The block of each line has a different color. The blue line is for the distribution of the ventilation pressure, the black line for the control pressure. Each line has a central supply connection that must be connected to the corresponding output at the VSM module, and 8 selfsealing quick-couplings to connect the ventilation head. Each ventilation head has two tubings for the connection to the connecting block, one for the connection to the black line, the other for the connection to the blue line. The connector to the blue line is marked. All the not used ventilation heads should be unplugged. See 14 for the connection.

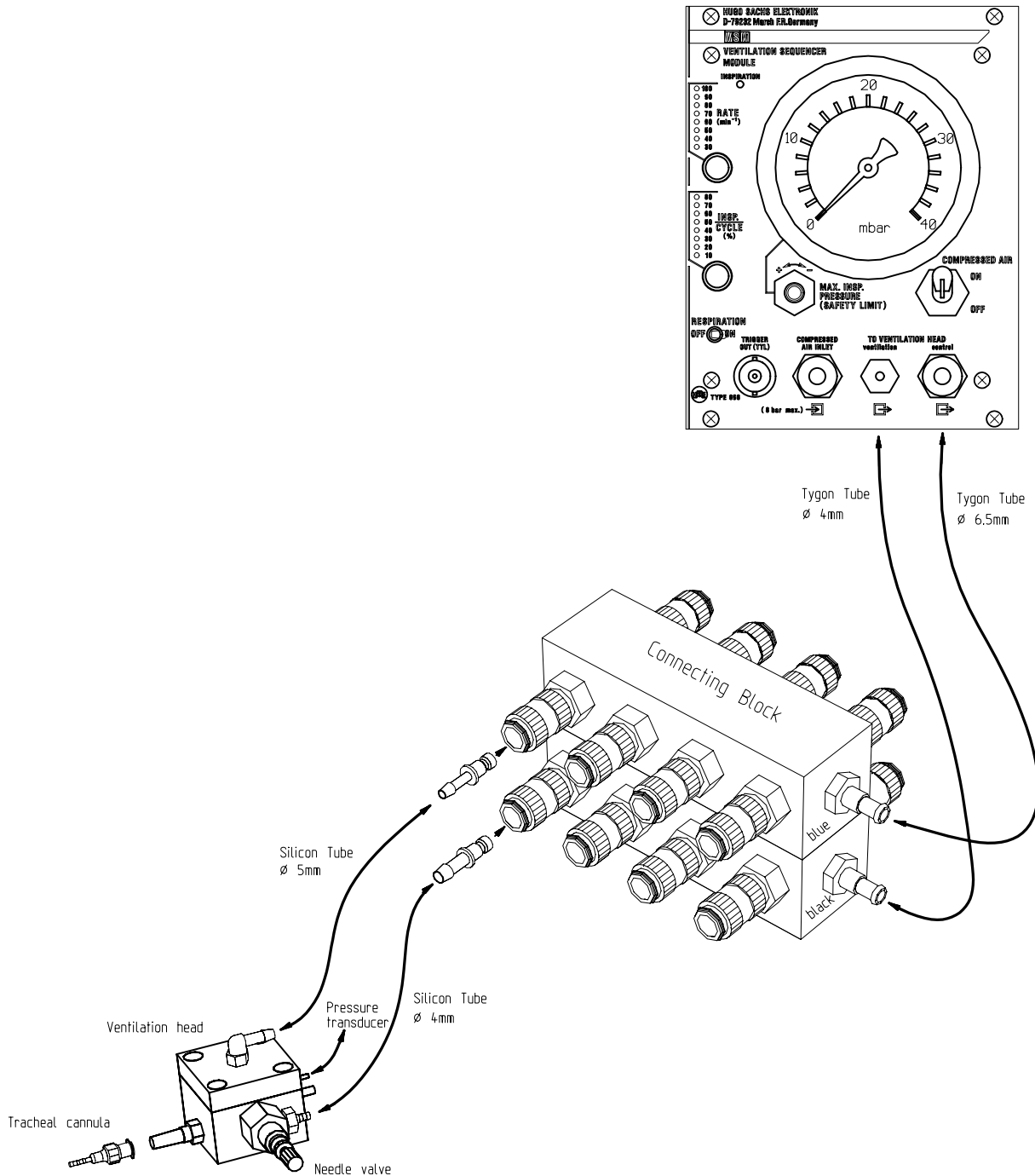


Fig. 14: Example: connection of the ventilation heads to the VSM using the connecting block

5. Operation of the quick-couplings

To connect or push the socket into the coupling master until it is clicked into place. To disconnect move the cap nut into the direction of the connecting block, the socket snaps out automatically. See 15 for operation. The coupling master is selfsealing. The not used ventilation head can be disconnected without special care.

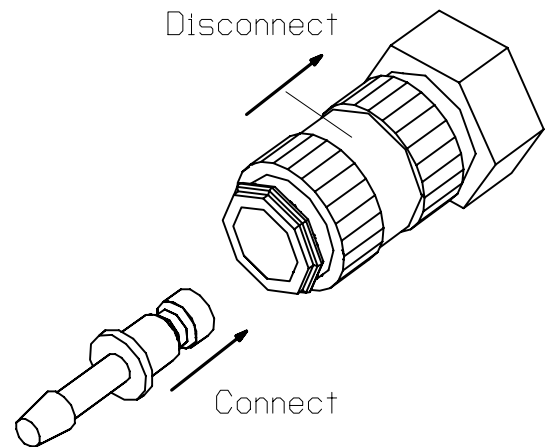


Fig. 15