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Vamos

Variable Anesthetic Gas Monitor

Technical
Documentation

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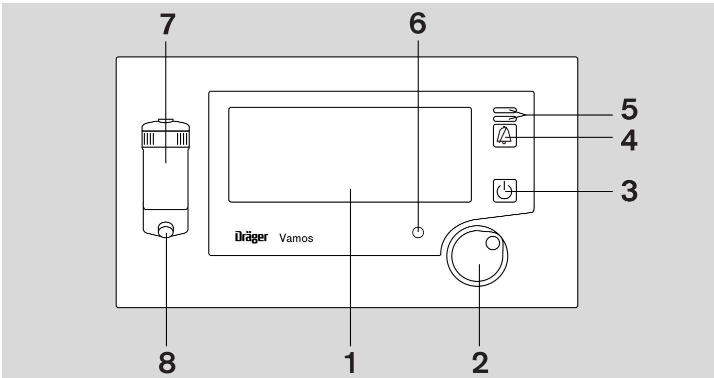
Function Description

1 Introduction

1.1 What's what?



Key to front view

1 Screen

2 Central control knob for selection and confirmation

3 Standby Key

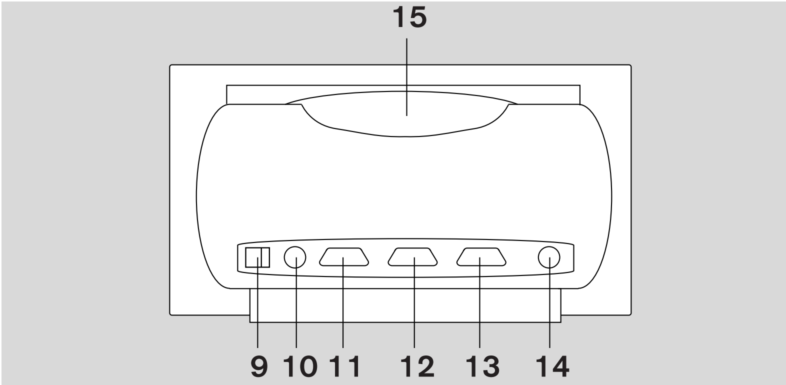
4 Key for silencing the alarm sound for 2 minutes

5 Indicator lamps for alarm

6 Power indicator lamp
Mains voltage = green
Battery operation = yellow

7 Water trap WaterLock

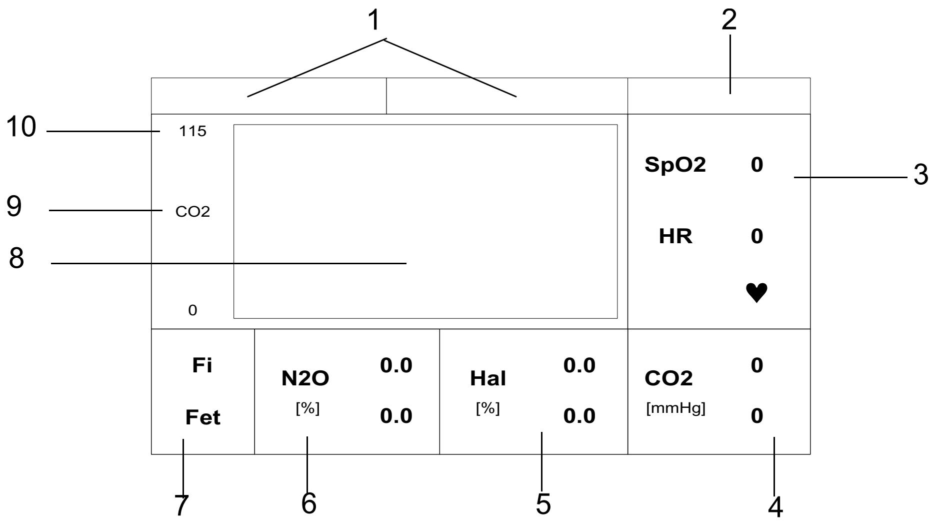
8 Connection for sampling line



Key to rear view

9	ON/OFF switch	13	"SpO2" connection for SpO2 sensor
10	"15 V DC" connection for desktop power pack	14	Outlet for sampling gas scavenging or return line
11	Connection for RS 232 interface (Medibus)	15	Handle
12	Connection for RS 232 interface		

1.2 Screen content



Key to possible screen content

1	Alarm window	8	Window for real-time curve
2	Status window	9	Displayed parameter
3, 4, 5, 6, 7	Parameter window	10	Scaling of real-time curve

1.3 Operating modes

The operating modes of Vamos are defined as follows:

Measuring mode:	The measured values of the sensors are displayed on-screen.
Standby:	Vamos is switched on. No measured value is shown on the screen, but the following message: "Standby" "Software XX.XX" (XX.XX = MFM software version) The light in the standby key should come on. In "Standby" mode the pump of the ILCA module is off.
AC mains supply operation:	Vamos is in standby mode or in measuring mode and is powered from the desktop power pack. The power-on indicator light should turn green.
Battery operation:	Vamos is in standby mode or in measuring mode and is powered from the internal rechargeable battery (optional). The power-on indicator light should turn yellow.
Charging mode:	The optional internal rechargeable battery is charged from the desktop power pack.
No operation:	None of the above operating modes is active.

2 Operating concept

The central control element is the control knob on the front plate. The control knob has two functions:

- Rotate = select/set
- Press = confirm

The two buttons on the front plate have the following functions:

- Button to silence the alarm for 2 minutes.
- Standby key.

2.1 Power-up behavior

1. All LEDs are actuated.
2. Bleeps and screen test
3. LEDs are actuated one after the other. LED sequence: Standby, silence, advisory, alarm, standby.......
4. Standby screen

2.2 Alarms

Vamos classifies alarm signals into three priorities, identified by up to three different exclamation marks. Alarm messages with a higher priority supersede those with a lower priority.

Alarm priority	**Alarm tone**	**LED**
Alarm = !!! (highest priority)	intermittent	The red (top) LED flashes accompanied by a tone sequence at 2.5-second intervals.
Caution = !! (medium priority)	intermittent	The yellow (bottom) LED flashes accompanied by a tone sequence at 30-second intervals.
Advisory = ! (lowest priority)	once	The yellow (bottom) LED comes on accompanied by a single tone.

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2.3 Menu structure

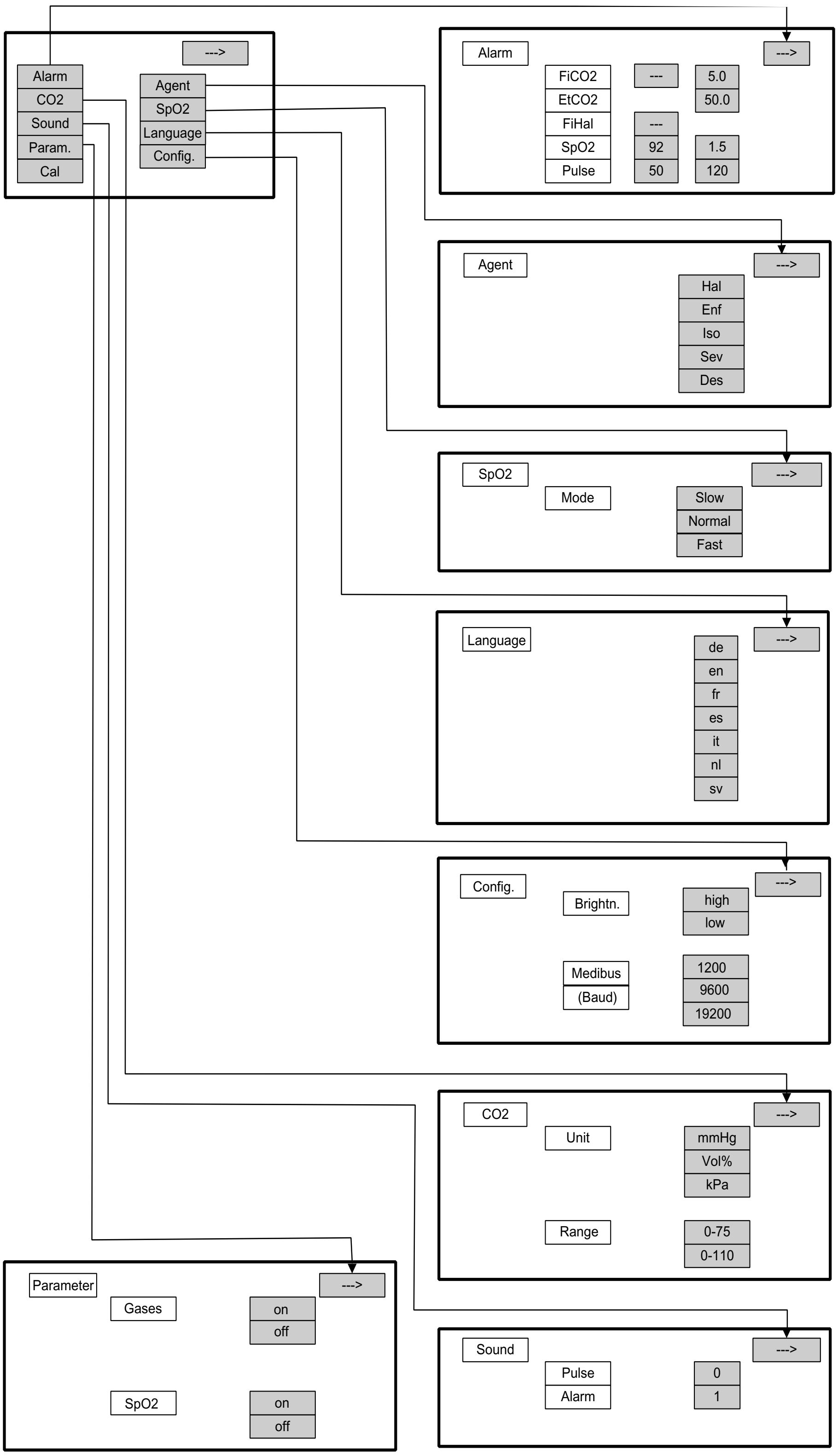

Fig. 1: Vamos menu structure

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2.4 Simplified Vamos block diagram

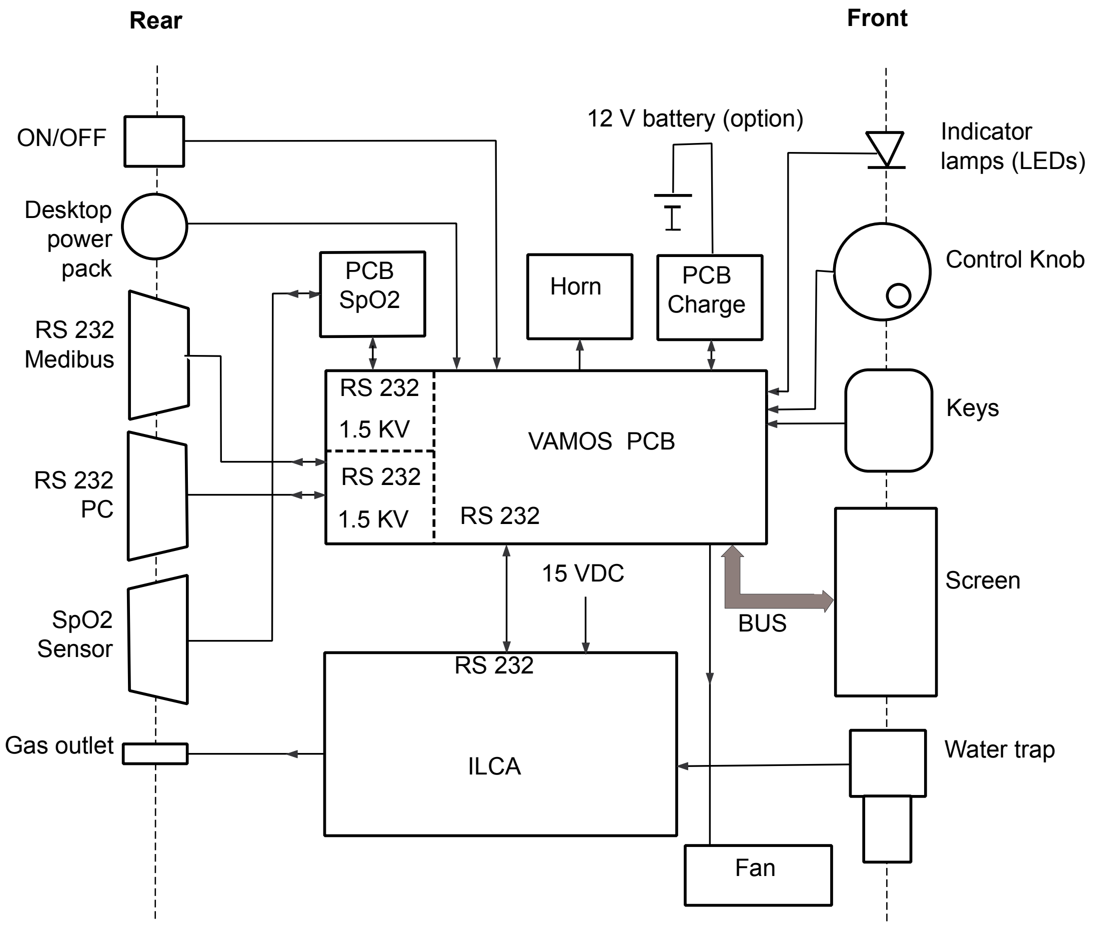

Fig. 2: Vamos block diagram

The ILCA patient gas module has no automatic anesthetic detector. The anesthetic being used must be specified by the user. Only one anesthetic may be used at any one time. The ILCA patient gas module conforms to the accuracy specified in the ISO standard.

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3 ILCA patient gas module

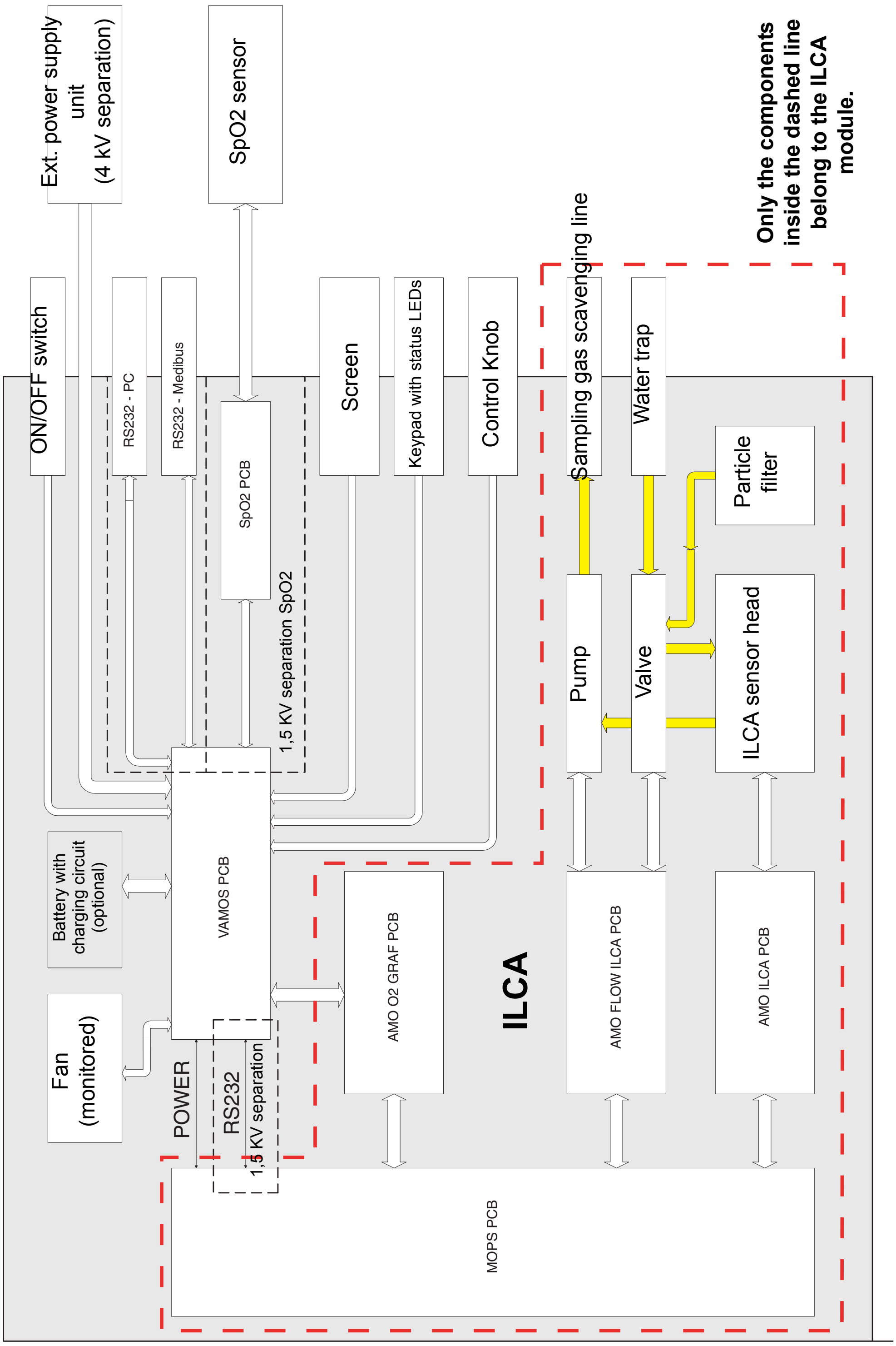

Fig. 3: ILCA patient gas module components in Vamos

3.1 Patient gas module structure

The ILCA patient gas module comprises the following components:

– Sensor head (electronics and optical system)
– Pump
– Valve
– AMO ILCA PCB (AMO = adapter for MOPS PCB)
– AMO FLOW ILCA PCB (flow controller)
– MOPS PCB (with PGM software, PGM = **P**atient **G**as **M**odule)
– AMO O2 GRAF PCB (with MFM software, MFM = **M**ulti **F**unction **M**odule)
– PCB mounting frame

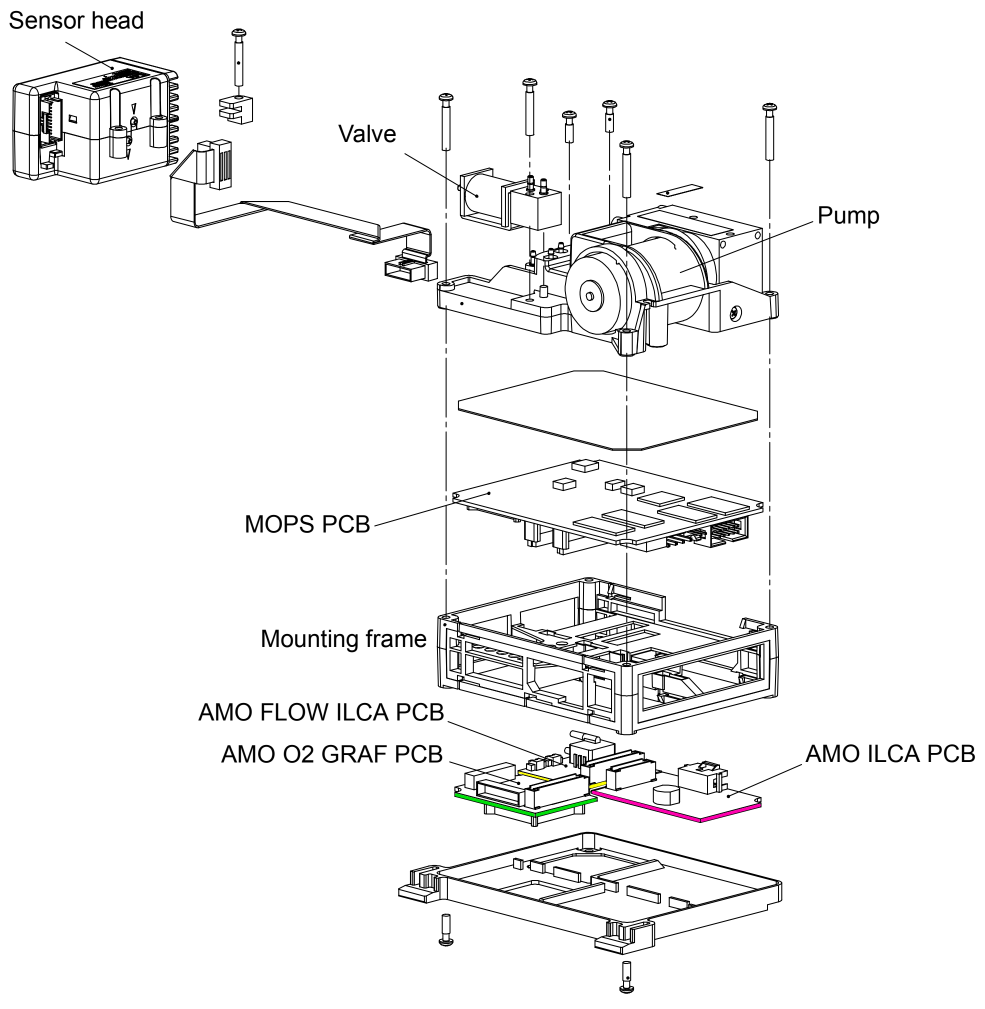

Fig. 4: Components of the ILCA module

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3.2 Sensor head function

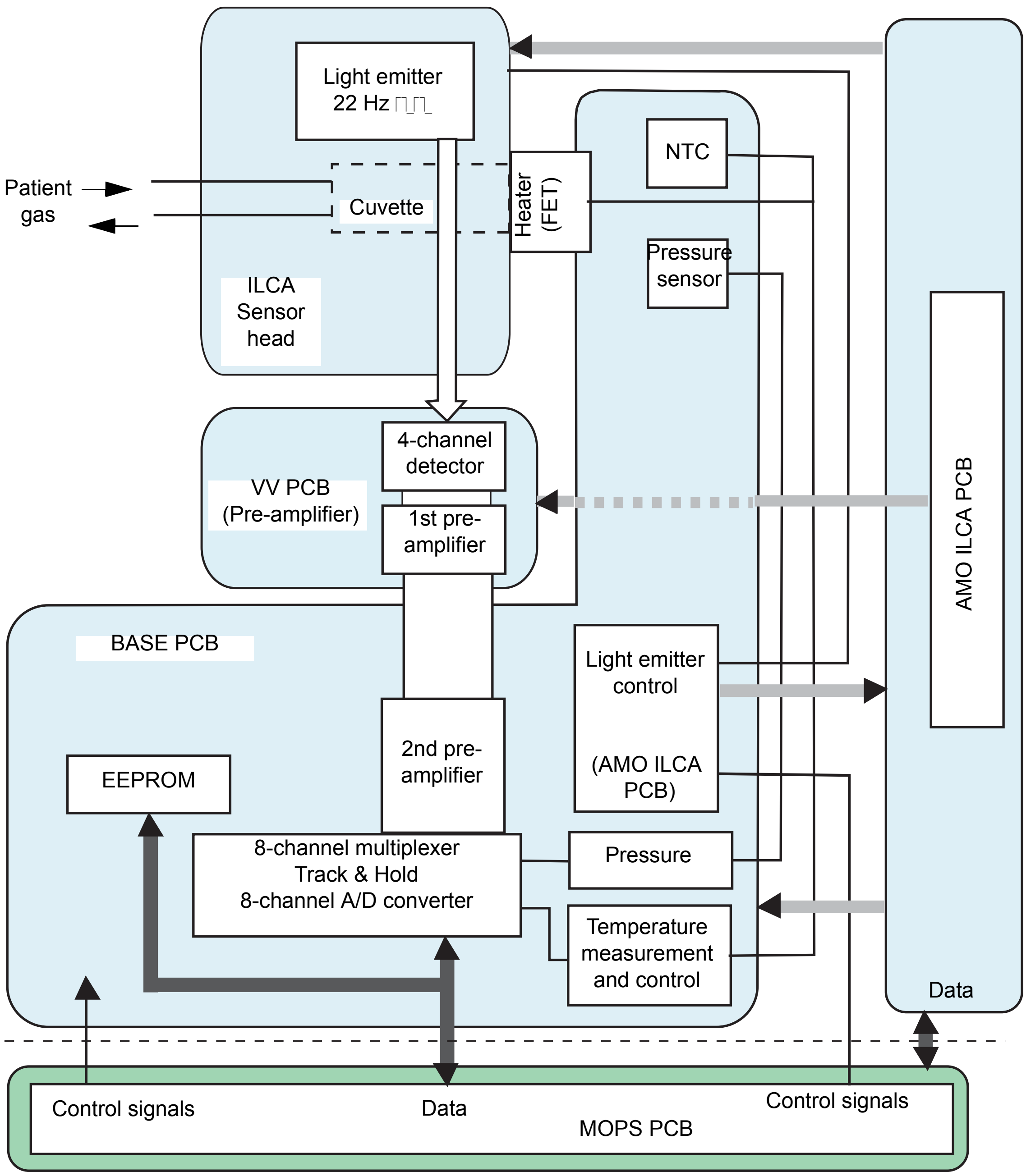

Fig. 5: Sensor head block diagram

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The hardware of the ILCA sensor head comprises the following three PCBs:

VV PCB:
- 1st amplifier for all channels of the four-channel detector including high/low pass combinations and EMC configurations.

BASE PCB:
- 2nd amplifier for all channels of the four-channel detectorLight emitter actuation, temperature control, absolute pressure measurement, AD converter, multiplexer, serial EEPROM.

AMO ILCA PCB
- Generation of the supply voltages
- Digitally adjustable voltage for the light emitter via the MOPS PCB.
- Heating voltage
- Supply to ILCA
- and setpoint setting for the sensor head heating (digital potentiometer).
- Data transport: ILCA sensor ↔ MOPS PCB for data evaluation

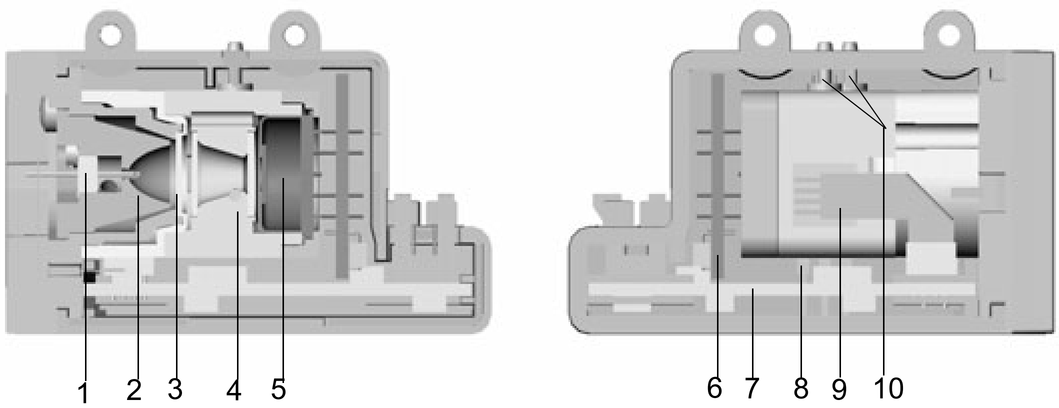

Fig. 6: Sensor head, sectional view

Key to sensor head sectional view

1	Light emitter (infrared range)	6, 7	PCBs
2	Reflector	8	Cuvette heating (FET)
3	CaF_2 disc of light emitter	9	Pressure sensor
4	Cuvette	10	Cuvette inlet and outlet
5	Multispectrum detector		

3.2.1 Light emitter with reflector

The reflector is ellipsoid in shape. The light emitter is positioned at the vertex of the ellipsoid. As a result, a beam is directed at an angle of incidence of < 12° onto the opposite detector.

The emitting element of the light emitter is a filament made of resistor wire. The alloy comprises Cr, Ni, Al. The filament wire is 40 µm thick.

In the assembled sensor, the reflector with built-in light emitter is encapsulated away from the interior of the sensor head by a CaF_2 disc. This design prevents sampling gas from reaching the hot light emitter, and igniting oxygen and the anesthetic, in the event of a leak in the cuvette. Furthermore, any gaseous substances emitted by the hot light emitter are kept away from the cuvette. This avoid an undesired coating on the optical components as a result of prolonged use.

3.2.2 Light emitter specification

Cold resistance Rc = 13.0 ohms ± 11%

Hot resistance Rh = 13.0 ohms * 1.06 = 13.78 ohms ±11%

Peak output = 290 mA * 290 mA * 13.78 ohms = 1.16 W

3.2.3 Light emitter control circuit

The light emitter is operated with a square-wave modulated constant current of 290 mA at 22.0 Hz.

This light emitter current is measured with an AD converter (shunt resistor 0.5 ohms ± 2%) and monitored by the software of the MOPS PCB.

The supply voltage of the light emitter control circuit is also monitored by AD converter and voltage divider. The setpoint is set via a digital serial potentiometer controlled by the MOPS PCB.

The supply voltage is measured when the light emitter is off (low phase of light emitter modulation).

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3.2.4 Light emitter protection circuits

When the connection between the MOPS PCB and the BASE PCB is interrupted, a protection circuit immediately shuts down the light emitter.

A protection circuit also prevents the average light emitter current from exceeding 81 mA (tolerance = 3%) in the event of a fault (e.g. software crash). The response time (t_A) of the protection circuit is 65 ms ± 15 ms. This condition applies when the light emitter was previously off and is then switched to continuous current.

3.2.5 Cuvette

Notice:

Do not generate an excess pressure in the cuvette.

The sampling gas is routed through a cuvette in the sensor head. In the optical beam path it is sealed on each side by a bonded-in CaF_2 glass window pane. The gas inlet and outlet form the two connectors. The direction of flow of the sampling gas is indicated by arrows on the housing adjacent to the connectors.

For absorption reasons the distance between the light emitter window and the detector window is 6 mm.

3.2.6 Multispectrum detector

In the multispectrum detector the optical beam path is distributed across the four measuring channels and routed to the relevant detector chip by infrared narrow-band filters.

The optical beam enters the multispectrum detector through a hermetically sealed window. On the floor of its housing is a matrix-style array of four-sided reflective pyramids with a side length of 0.15 mm x 0.15 mm (beam splitters). The optical beam entering through the window hits this beam splitter and is split by each individual pyramid in pixel style into four separate beams. The pixel-style design results in a genuine beam mix, which is insensitive to partial contamination in the beam path. The housing also contains four infrared optical narrow-band filters and four pyroelectric detector chips. These components are arranged such that one infrared filter detector combination is illuminated by each of the four beam paths emitted from the beam splitter. Each of the four beam paths represents a measuring channel. The basic design of the multispectrum detector is shown in the following diagram:

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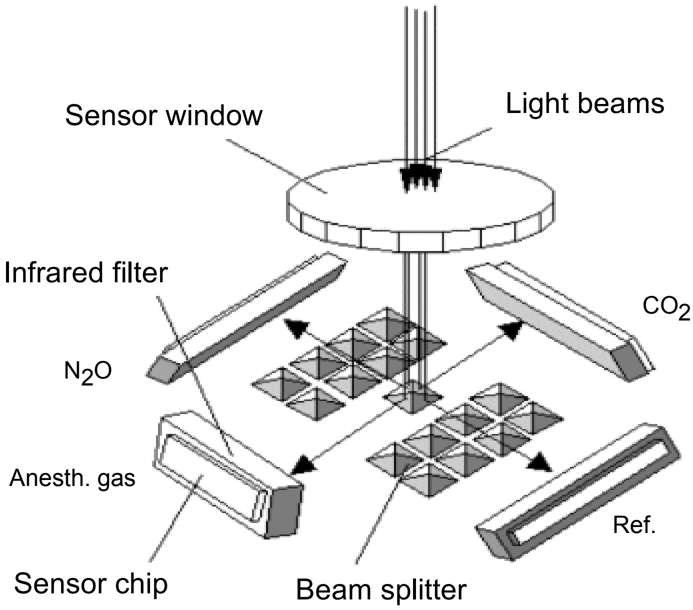

Fig. 7: Basic design of the multispectrum detector

The infrared optical filters (band-pass filters) are dimensioned in terms of their wavelength such that light is transmitted in three channels at the wavelength of the sampled gases. The remaining spectrum is blocked by these three filters. When a gas is present light is absorbed and the resultant change of intensity measured in the respective channel is a measure of the concentration of the gas.

The fourth channel (reference channel) measures at a wavelength at which none of the sampled gases absorbs. With the reference signal, ambient influences such as temperature fluctuations, cuvette contamination, and light emitter aging are compensated and corrected.

The detector elements and the upstream filters are tilted 30°. As a result, the reflected beam strikes perpendicular to the filter plane and the detector plane.

3.2.7 Pressure sensor

The ILCA sensor head delivers its measured values as partial pressures or as the non-pressure-dependent unit vol.%. Fluctuations in cuvette pressure have no effect on the measured values. An absolute pressure sensor measures the pressure in the cuvette and, where appropriate, the ambient pressure (e.g. during zeroing).

The pressure measurement is fast enough to represent fluctuations in respiratory pressure (T_{90} better than 200 ms).

Measuring range:

The sensor head is able to measure at ambient pressures between 670 mbar and 1100 mbar. For the measuring range of the pressure sensor it should be considered that the pressure in the cuvette may be as much as 200 mbar below ambient pressure (vacuum in the suction system).

3.2.8 Sensor heating (FET)

An insulated power FET which is screwed onto the cuvette is used for temperature stabilization of the cuvette (setpoint temperature 58 °C). The drain source resistor of the FET is controlled via a control voltage and is used as sensor heating. The current that flows through the FET determines the heating output with the voltage drop across the FET.

The setpoint of the temperature is specified by the MOPS software. The micro-controller on the MOPS PCB control a digital potentiometer located on the AMO ILCA PCB power module. Its output voltage is routed to the FET via an impedance converter. The temperature is monitored by an NTC.

3.2.9 Memory for calibration data

All calibration data, serial numbers, and settings required to operate the sensor head are stored in an EEPROM on the Base PCB in the sensor head.

3.3 Sensor head operation

The sensor head attains its full accuracy when it has reached its operating temperature and a stable temperature distribution. The time from power-on until ready-to-measure is determined by the duration of the warm-up phase. The warm-up phase is dependent on the temperature distribution when the sensor is powered up. The sensor software optimizes the starting behavior. In the worst case the sensor head attains its specified accuracy no later than 4 minutes after power-on.

3.3.1 Self test

The sensor head software performs a self-test when the system starts up and continuously during measurement operation. In the event of an error the sensor software generates the relevant status message and shuts down the system if necessary.

3.3.2 Zeroing

The measurement signals of the sensor head may drift over a lengthy period in operation (due to aging, temperature fluctuations, etc.). Contamination of the cuvette can also impair signal intensity. Consequently, a reset to zero is performed on completion of the warm-up phase and then every 2 hours. Ambient air (as reference gas) is present in the cuvette during zeroing.

During operation, system states may occur (such as sudden contamination of the cuvette) which necessitate an additional zeroing. The sensor software detects such states automatically.

3.4 Measured value units

The measured values of the ILCA sensor head are produced from the measured values in the cuvette. There is no conversion to the conditions at other points in the system, such as in the Y-piece or the patient's lung.

3.4.1 General remarks on the concentration figures

The concentration of the anesthetics is calculated by referencing the measured partial pressures of the gas components to the overall pressure in the cuvette.

The concentrations can be scaled in two different ways. As a physical unit, the standard representation is in percent by volume [vol.%], i.e. referred to 100%.

Conversely, for some gases medical experts apply a reference to 760 Torr. This figure in a pressure unit is not a pressure, however, but a concentration, and must not be confused with a partial pressure!

The concentrations are converted from vol.% to Torr as follows:

100 Vol.% = 760 "Torr"

1 vol.% * (760 /100 Torr/vol.%) = 7.6 Torr
1 Torr * (100/760 vol.%/Torr) = 0.1316 vol.%

It is essential that this conversion of the concentrations should be distinguished from conversion of the pressures!

3.5 Pneumatic system

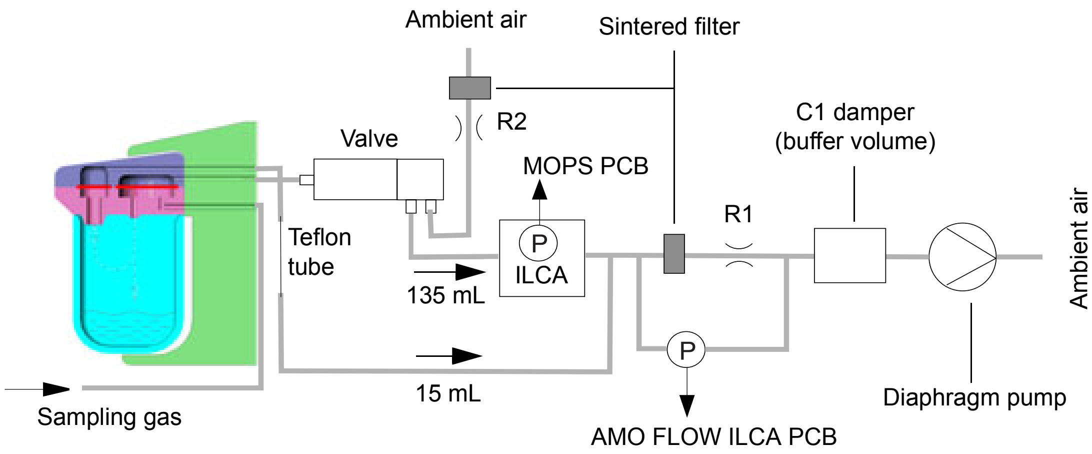

Fig. 8: ILCA pneumatics diagram

The pneumatic system of the ILCA module comprises the following components:

- A DC diaphragm pump
- A valve
- An "AMO FLOW ILCA PCB"
- A pneumatic low-pass filter, at least one filter, and the associated anesthetic-resistant tubing
- A water trap and a Teflon hose

3.6 Tubing

The pressure surges generated by the pump are minimized by a pneumatic low-pass filter consisting of a restrictor (R1) and a damper (C1). These components are mounted in the module housing of ILCA.

Dimensioning of R1:

R1 is small enough for the pump not to be placed under unnecessary strain. However, an inadequate input load may make it impossible to set the target flow of 150 mL/min.

R1 is large enough so that the pressure surges occurring in the cuvette do not impair the signal ratio and noise ratio in gas sampling.

Dimensioning of R2:

In a zeroing operation, the valve switchover is also tested based on the pressure drop. In this case the pressure drop via the restrictor R2 and the ambient air filter is significantly less than the minimum pressure drop via the water trap and the suction tubing to the patient.

3.7 Pump

The pump flow is 150 mL/min ± 20 mL/min. The supply voltage is in the range from 2.5 V to 7.5 V DC at a current of up to 150 mA.

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3.8 MOPS PCB

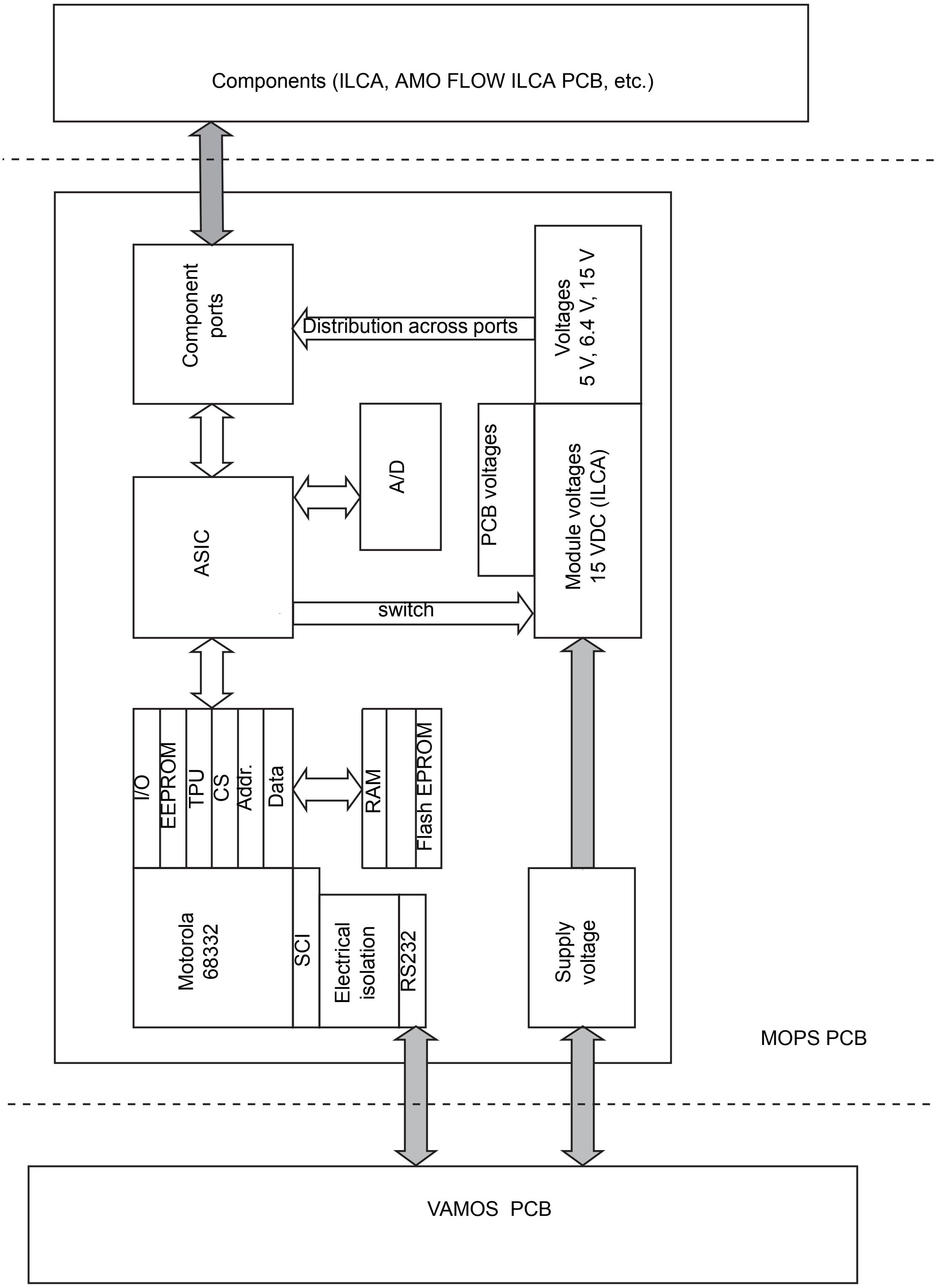

Fig. 9: Block diagram, MOPS PCB

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“"MOPS" stands for "Modular Platform for Sensors". A modular concept by which suitable sensor components (pneumatic and mechanical components) can be operated together by way of a processor board. The resultant arrangements are operated by a software program with a unified communications interface. In this way, the user is provided with a uniform view of the measurement parameters on offer, irrespective of the components deployed. The software is automatically configured for the connected components when the system starts up.

With this concept, different gas sampling modules (for example ILCA and IRIA) can be configured for specific customer needs using standard components.

The MOPS PCB calculates values of the patient parameters and controls the sensor head signals.

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3.9 AMO FLOW ILCA PCB (flow controller)

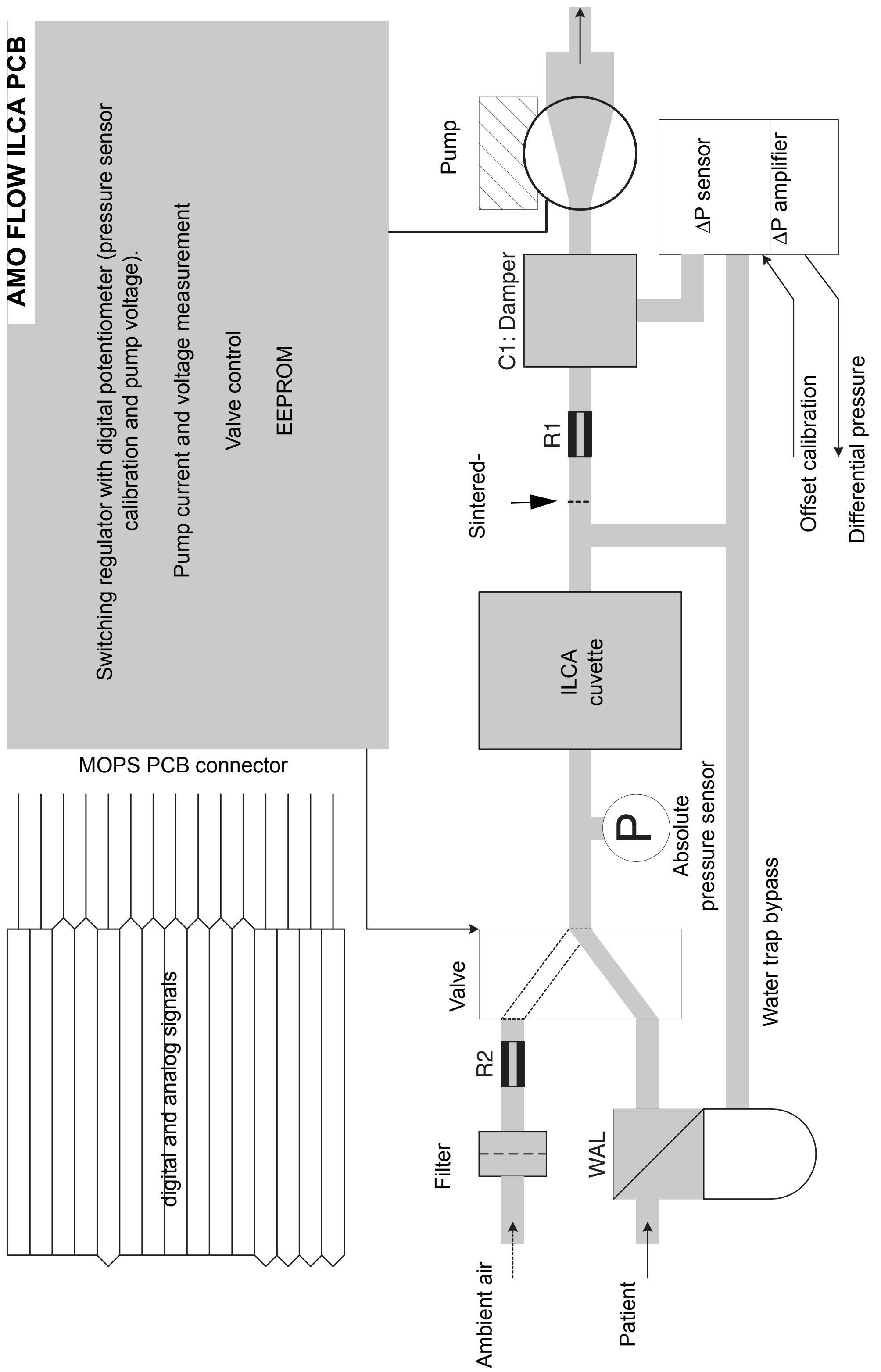

Fig. 10: Connection diagram, AMO FLOW ILCA PCB

The AMO FLOW ILCA PCB controls the pump and the valves of ILCA. The PCB is controlled and powered by the MOPS PCB. The actual regulation of the pump flow is handled by the software of the controller on the MOPS PCB.

The "AMO FLOW ILCA PCB" holds the following components:

- A DC/DC converter generates the pump voltage (2.5 - 7.5 V/DC). The output voltage of the DC/DC converter is controlled through a serial digital potentiometer on the PCB and set by the controller of the MOPS PCB.
- Analog electronics for evaluation of the pump voltage, pump current, valve current, and differential pressure.
- The power output elements of the valves.
- Service LEDs for the pump voltage, the valves, and the supply voltage.
- A temperature-compensated differential pressure sensor for flow metering. The sensor offset is corrected with a serial digital potentiometer.

The flow is measured by way of the differential pressure of restrictor R1 plus the upstream sintered-metal filter. The measuring range is 0 to 350 mbar.

The AMO FLOW ILCA PCB is connected directly to a 60-pin connector on the MOPS PCB and is detected automatically by the MOPS PCB.

3.9.1 EEPROM of AMO FLOW ILCA PCB

The serial EEPROM contains the following information:

- Serial Number
- Hardware revision
- Software revision
- Product name (AMO FLOW ILCA PCB)
- Control parameters
- Position of the digital potentiometer at which the differential pressure output DIFFDRUCK = 2.0 V
- The voltage setpoint value at which the flow is 150 mL/min
- OCCLUDED detection value

3.9.2 Safety concept

The following voltages are routed via the AD converter of the MOPS PCB to the switch-mode regulator in order to monitor limits and regulate the flow:

- the differential pressure
- the pump voltage
- a voltage proportional to the pump current
- a voltage proportional to the total valve current

3.9.3 Valve

The valve at X4 switches between ambient air and patient air. An optional valve at X5 is possible (is not mounted in VAMOS).

The valve is non-polarized. There is no preferred position for the plug connector. A mechanical lock prevents the valves from detaching from the connector.

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4 AMO O2 GRAF PCB

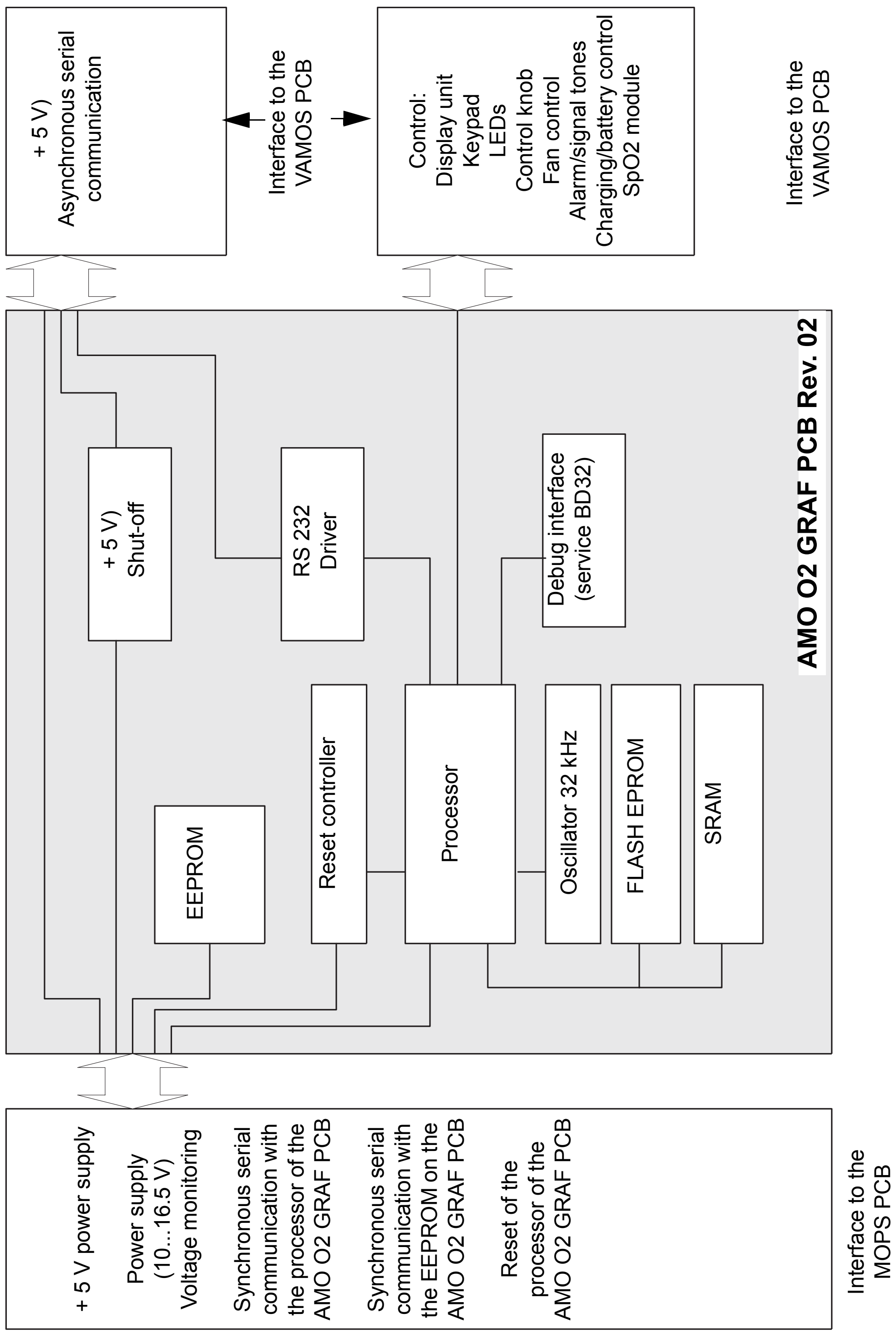

Fig. 11: Block diagram, AMO O2 GRAF PCB

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On the AMO O2 GRAF PCB the screen data are processed by a co-processor. The PCB controls and monitors the complete monitor function including the keypad, control knob, indicator lamps (LEDs), and SpO2 sensors.

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5 VAMOS PCB

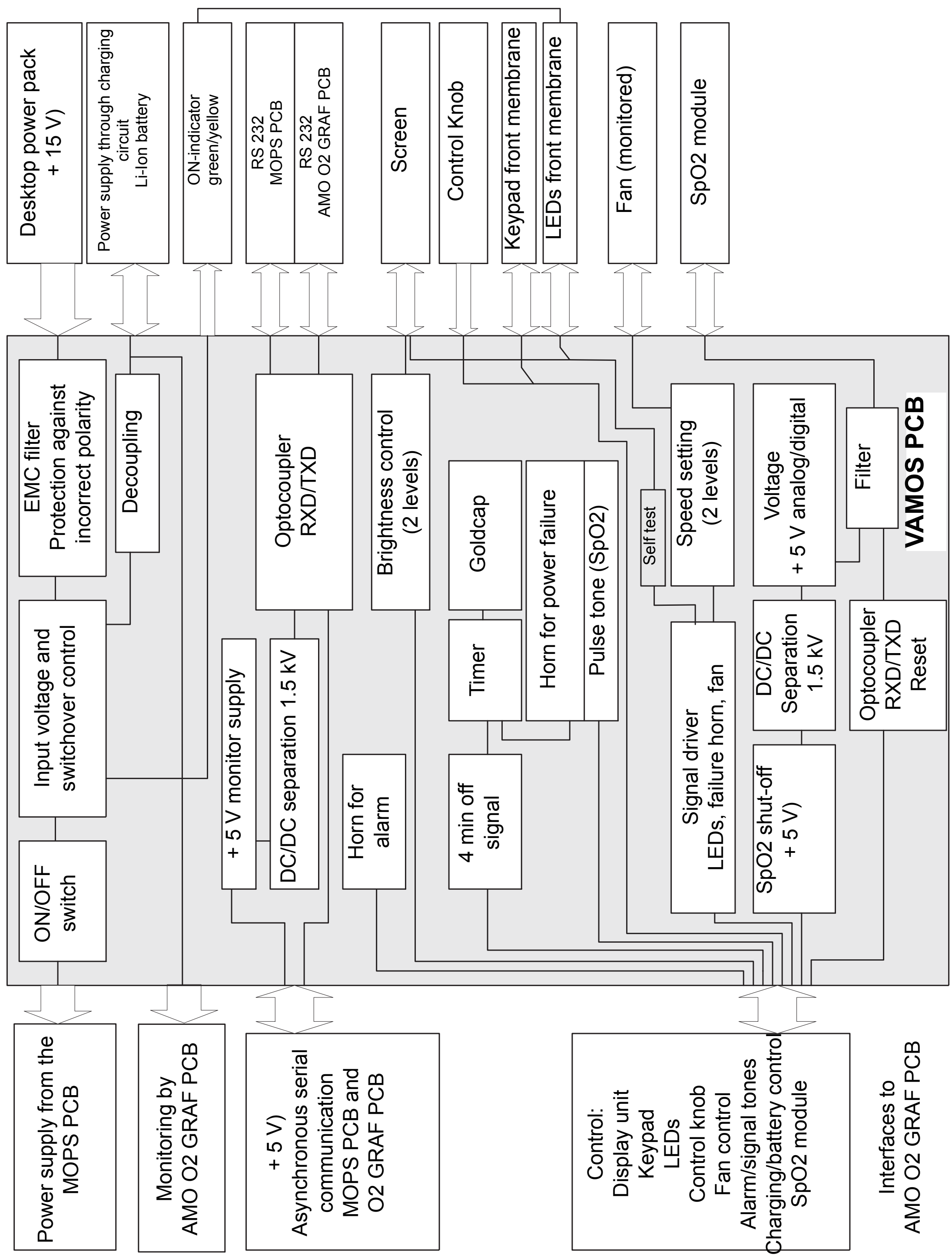

Fig. 12: Block diagram, VAMOS PCB

The VAMOS PCB is the connecting element between the user interface and other PCBs.

This PCB holds the following components:

– Serial RS 232 interfaces.
– ON/OFF switch.
– Horns (alarm and power failure alarm).
– Connection for the built-in SpO2 module
– Socket for power supply to VAMOS.
– Protection against incorrect polarity and control circuit for the input voltage.
– (The charging circuit for the optional rechargeable battery is connected to the PCB via a connector).

6 SpO2 PCB

The PCB used is supplied by Nellcor. A SpO_2 sensor is connected to this PCB with no pre-amplifier. The PCB communicates via a serial port with the MOPS PCB. The PCB is electrically isolated from the rest of the system to 1.5 kV on the VAMOS PCB.

The socket for the SpO_2 sensor is mounted on the internal frame.

7 Screen

Electroluminescence display with 240 x 128 pixels. A direct voltage of 150 V/DC is generated on the PCB for the display control.

8 Water trap

The function of the water trap is to remove the water contained in the sampling gas. This function is performed by Gore-Tex membranes. No liquid can pass through the membranes.

Water containers and Gore-Tex membranes are permanently interconnected in the water trap. The water trap can be emptied as often as required within one month using a disposable syringe. To do this, it must first be removed from the water trap holder. It should be disposed of after one month.

In the water trap there are two Gore-Tex membranes which protect the path to the cuvette (135 mL/min) as well as protecting the bypass branch (15 mL/min) against water incursion. A filling level detector is therefore no longer necessary. The restrictor in the bypass branch is created with a 9 cm long Teflon tube that acts as a resistor.

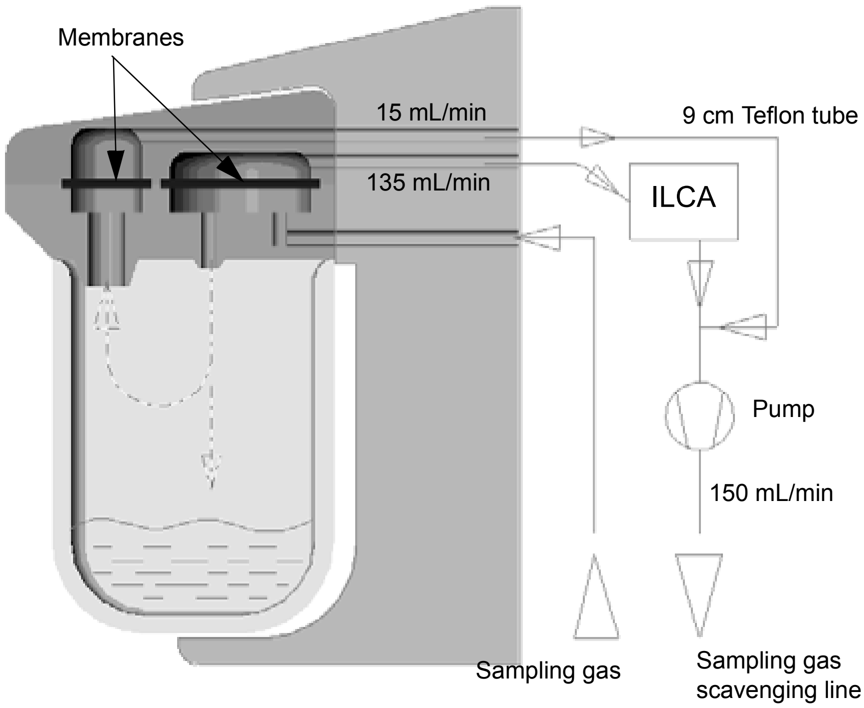

Fig. 13: Water trap function principle

If the water in the water container is at the level of the membranes, these are sealed by the water and an error message ("CO_2 line!?") is displayed on the screen.

9 Desktop power pack

- Input: 100 - 240 V AC
- Output: 15 VDC, 2 A (4 kV separation)
- Fuses: 2x 2 AT (Pico, internal)

10 Starting the release mode

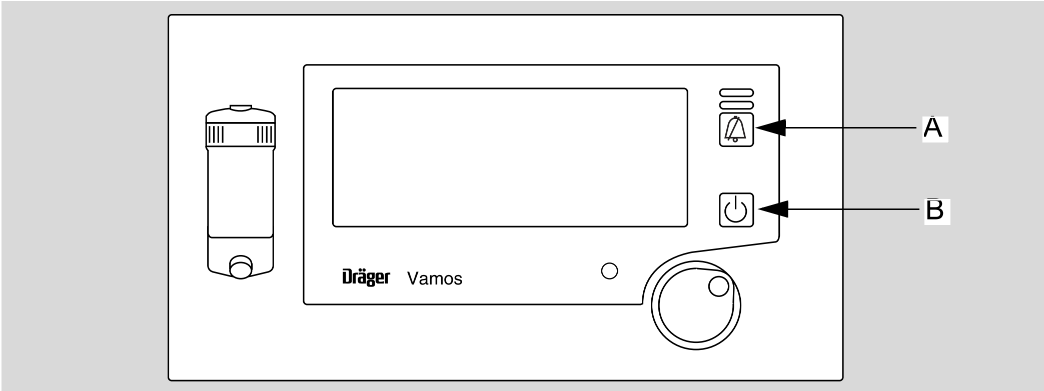

Fig. 14: Starting the release mode using keys

The device is in standby mode.

Note that the key operation sequence is important for the start procedure.

- First press and hold key **A**, then press and hold key **B**, and finally release key A and then key **B**.

10.1 Screen content release mode

The following window will be shown with software version 2.0 or higher:

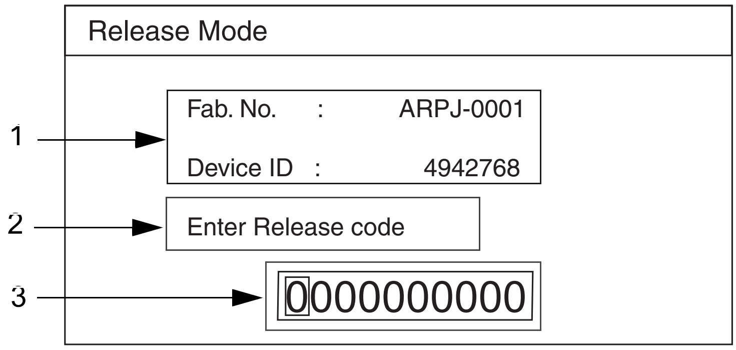

Fig. 15: Release mode window

Legend to Fig. 15: Release mode window

1 Device no. with device ID generated thereof (7 to 8 places)

2 Dialog window

3 Input window (10 places) for release code

10.2 Entering the release code

The release codes vary with the device number of Vamos.

After replacing the complete ILCA module or the AMO O2 GRAF PCB DrägerService must store the device no. in Vamos (Visia software). If available, also release (activate) the SpO2 function.

Only then will the release code be recognized as valid.

There are currently release codes for the anesthetic agent function and for the N2O function.

If release code ”0000000000” is confirmed by accident, the AGAS option will be activated (applies to software version < 2.0 only).

Therefore, the AGAS option needs to be reactivated.

If you have received a release code, proceed as follows:

- Use the control knob (clockwise = number ↑, counter-clockwise = number↓) to select the specified number, then press the control knob to confirm. The cursor jumps automatically to the next place.

After confirming the last number, the message "Verifying code" is displayed in the dialog window (for approx. 5 seconds). During this time, the system checks whether the release code is valid or not. The result is displayed in the dialog window.

- **Wrong code:** In this case exit the window using the alarm silence key and start the release mode again. Enter the correct release code.
- **Valid code:** A message appears in the dialog windows depending on the option released, e.g. "Agent option released".

- Switch off Vamos and then on again.
- Check whether the option has been activated.

Service Mode

1 Starting the service mode

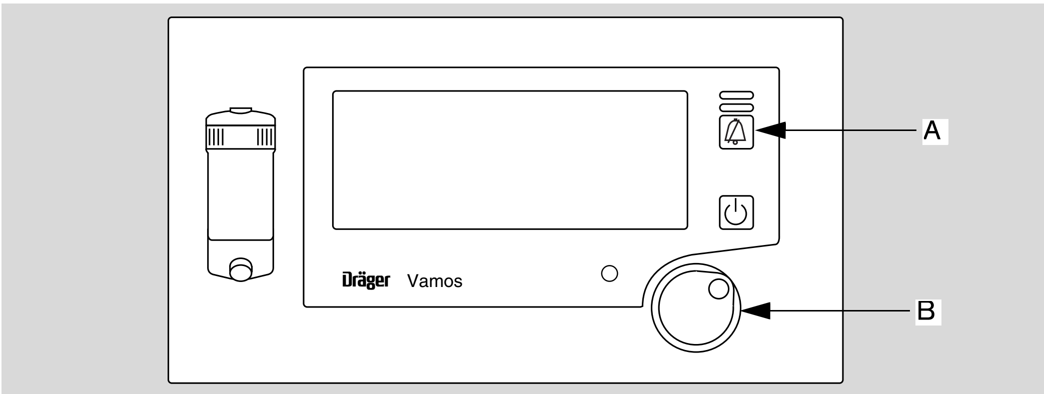

Fig. 1: Starting the service mode using keys

- While in standby mode, first press and hold key A and then press control knob B.

1.1 Explanation of screen content

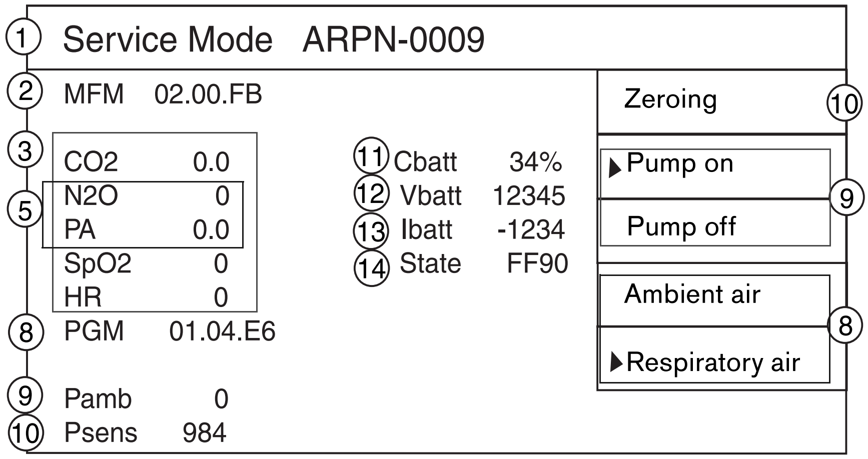

Fig. 2: Screen content

Legend to Fig. 2:

1 Device no.

2 Version no. of the MFM software (MFM = **m**ulti**f**unction **m**odule). The number is stored on the ILCA module which is located on the AMO O2 GRAF PCB.

3 Real-time readings

4 Options with release code:
N2O = nitrous oxide
PA = primary anaesthetic gas

5 Version no. of the PGM software (PGM = **p**atient **g**as **m**odule). The number is stored on the ILCA module which is located on the MOPS PCB.

6 Ambient pressure (value in hPa only visible after zeroing (10)).

7 Sensor pressure (value in hPa only visible after zeroing (10)).

8 Pump status of ILCA module. Select desired status using control knob and confirm.

9 Valve status of ILCA module. Select desired status using control knob and confirm.

10 Zeroing of ambient pressure and sensor pressure

11 Remaining battery capacity (in %)

12 Battery voltage (in mV)

13 Battery current (in mA). When the battery is being charged, the value has a positive sign. When VAMOS is powered from the battery, the value has a negative sign.

14 Battery status (the status can be entered in VISIA, version 1.06 or higher, and is decoded there)

- Exit service mode using the standby key.

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Repair Instructions

1 Service strategy

	Test	Test equipment	Repair
Inspection	Measurement accuracy check. Pressure sensor check, VDE test according to PMS procedure.	Standard tools, disposable syringe, pressure gauge, test gas (mixture?), SpO_2 sensor dummy, VISIA software, laptop computer, adapter cable.	Minor repair
Repair in the field	Leak test. VDE test, function test according to PMS procedure.		Board/component replacement (printed circuit boards, pump, ILCA sensor head, valve), complete ILCA module replacement, RAT-refurbish.
Subsidiary workshop	Leak test. VDE test, function test according to PMS procedure.		Board/component replacement, complete ILCA module replacement, RAT-refurbish
Lübeck workshop	Leak test. VDE test, function test according to PMS procedure, re-calibration (if necessary)	Calibration bench	Repair of components, if useful

2 VAMOS service programs

Two DrägerService programs are relevant to VAMOS:

– Download program
– VISIA program

Both programs communicate with VAMOS via the RS 232C service interface and the RS 232 cable (7901808).

2.1 Download program

The download program can be found in the "Download" menu of the DrägerService software.

Two download procedures are available for VAMOS:

– Download of VAMOS firmware – Medibus (MFM)
– Download of ILCA firmware – RS 232C (PGM)

The software is described under chapter Software download .

2.2 VISIA program

The software is described under chapter VISIA program .

The release codes vary with the device number of Vamos.

If the complete ILCA module or the AMO O2 GRAF PCB is replaced, DrägerService must first store the device no. in Vamos (Visia software). If available, also release (activate) the SpO2 function.

Release SpO_2 via ”Config” Page/Info tree/”Set SpO_2 ”.

Release the serial no. via ”Config” Page/Info tree/”Set Fab. No”.

Only then will the release code be recognized as valid.

3 Repair information list

new	Repair Information	Described in:
	General	
	Retrofitting of battery option	Repair instructions, chapter 6.1 "Optional battery".
X	Vamos disassembly	Repair instructions, chapter 8 "Vamos disassembly"

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4 Hardware configuration of VAMOS

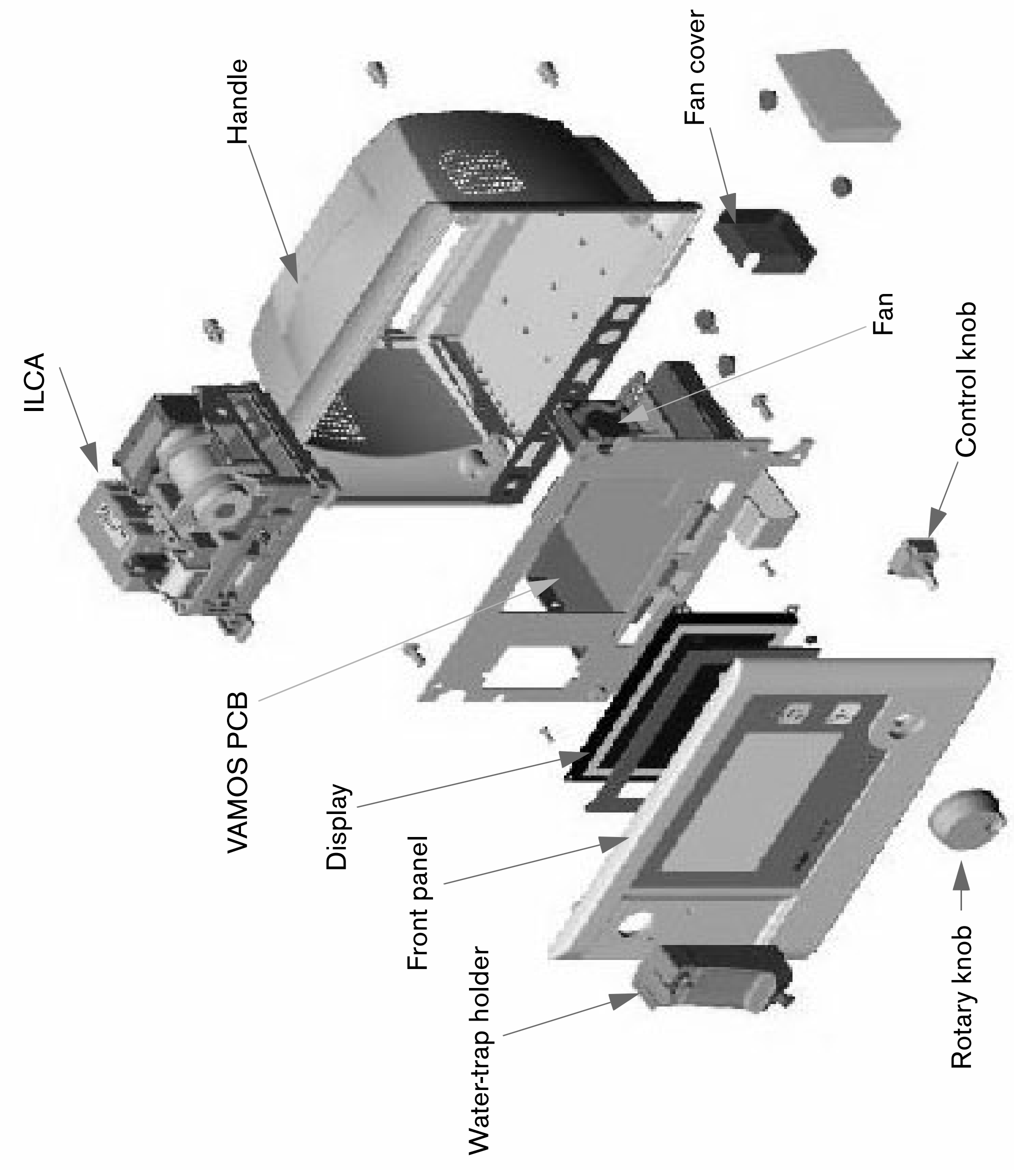

Fig. 1: Exploded view of VAMOS

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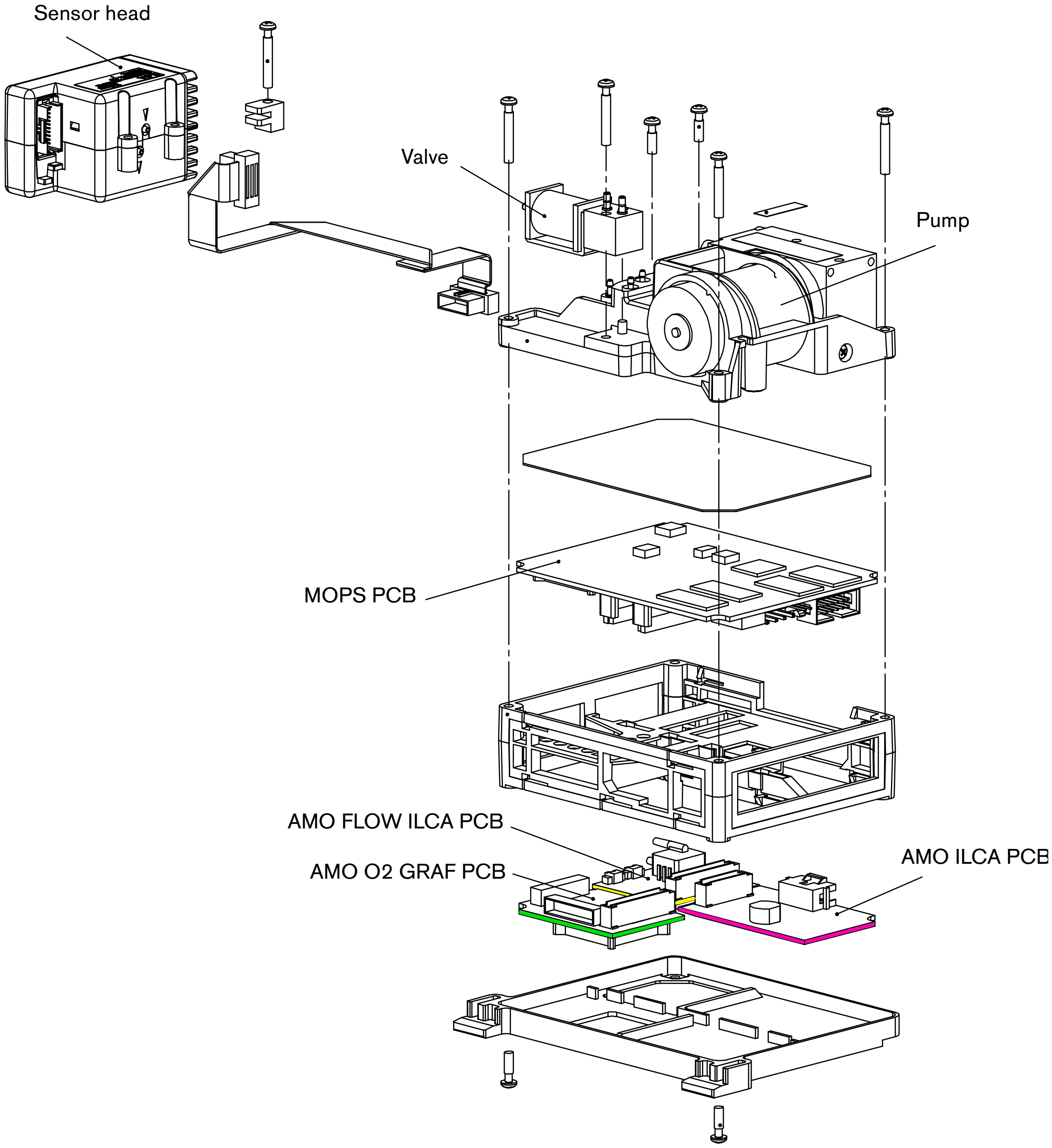

Fig. 2: Components of the ILCA module

4.1 Repair components

The following components are the spare items of Vamos:

ILCA module

The release codes vary with the device number of Vamos.

If the complete ILCA module or the AMO O2 GRAF PCB is replaced, DrägerService must first store the device no. in Vamos (Visia software). If available, also release (activate) the SpO2 function.

Release SpO_2 via "Config" Page/Info tree/"Set SpO_2 ".

Release the serial no. via "Config" Page/Info tree/"Set Fab. No".

Only then will the release code be recognized as valid.

The ILCA module needs to be removed from VAMOS to be able to replace ILCA components.

– Pump
  Unscrew the fixing screw of the pump. Disconnect the power cable and, if necessary, the tubing. Pull out the pump from the plastic frame.
– Sensor head
  The sensor head must not be disassembled, it must be replaced as it is. The cuvette is an integral part of the sensor head.
– MOPS PCB
– AMO FLOW ILCA PCB
– AMO O2 GRAF PCB
– AMO ILCA PCB
– Valve

VAMOS basic unit

– SpO2 PCB
– Fan
– VAMOS PCB
– Water trap
– Rotary knob
– Screen (display)

5 ILCA

5.1 Electrical data of ILCA sensor head

Supply voltage: nominal 12.0 V, permissible range: 10,0 V to 17.0 V

ILCA sensor head power consumption (heater and light emitter off): < 0.1 W

Maximum heat output = 7.5 W during the start-up phase

Typ. heat output = 1.2 W at ambient temperature = 25 °C

Light emitter output = 0.255 W $_{\text{effective}}$, tolerance ± 3%

(Light emitter with R_{hot} = 13.78 ohms ± 3%, duty cycle = 22% high, Imax = 0.291 A)

5.1.1 Multispectrum detector

If the multispectrum detector needs to be replaced in the repair workshop, then the sensor head must be recalibrated.

5.1.2 Cuvette

The specified flow direction of the sample gas must be observed, input and output sockets must not be mixed up when connecting the patient gas module tubes.

The cuvette is not replaceable. If the cuvette is contaminated, the sensor head must be replaced. There is no clear status display of the sensor system which indicates a contamination of the cuvette.

5.1.3 Pressure sensor

Absolute pressure sensor with a pressure measuring range of 370 to 1100 mbar.

Notice:

The ILCA pressure sensor is very sensitive to excess or low pressures outside the specified ranges. Even a short overload could cause irreversible damage. Therefore, observe the specified ranges when handling pneumatic elements such as syringes or pumps.

The pressure in the cuvette chamber may be up to 200 mbar below the ambient pressure (low pressure in suction system).

The pressure sensor is calibrated once for its entire service life in the production line. Pressure measurement cannot be recalibrated in the field.

Display of pressure values in [Torr] (default) or in [mbar].

Pressure values can be converted from mbar to Torr using the following conversion equation:

1013 mbar = 760 Torr

1 Torr * 1013/760 mbar/Torr = 1.333 mbar
1 mbar * 760/1013 Torr/mbar = 0.7502 Torr

5.1.4 Memory for calibration data

All calibration data and settings required to operate the sensor head are stored in an EEPROM on the Base PCB in the sensor head. This enables the sensor head to be replaced independent of other components of the patient gas module. The EEPROM is written only in the production line. During normal operation, it is only possible to read data on the EEPROM in order to avoid unintentional damage to these important data. As an additional safety against faulty components, all data are secured with a checksum which is checked prior to use. A checksum error leads to an INOP condition of the sensor function affected, mostly to an INOP condition of the complete sensor head, thus including all ILCA readings.

5.1.5 Tubing

Only special tubing material may be used. If inadequate tubing material is used, adsorption effects at the tubing walls may lead to corrupt readings and slurred measuring curves.

Use only the types of tubing specified in the tubing diagram.

5.1.6 Flow resistance

The cuvette of the ILCA sensor head generates a pressure drop of max. 2.5 mbar at a suction flow of 150 mL/min. Make sure not to expose the ILCA sensor head to pressures outside the specified range. Avoid also short pressure peaks. Otherwise the pressure sensor could be damaged or the cuvette could become leaky.

5.1.7 Sensor head start behavior

The sensor head attains its full accuracy when it has reached its operating temperature and a stable temperature distribution. In the worst case (start at lowest specified ambient temperature) the sensor head attains its specified accuracy no later than 4 minutes after power-on.

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The first measured values are available at the latest 2 minutes after power-on, these values, however, have a reduced accuracy. The sensor head contains no other components which have an effect on the start behavior and the time until readiness for measurement.

5.1.8 Self test

Once during system start and continuously during measurement, the sensor software of the sensor head carries out all self-test functions which ensure that the specified measurement accuracy is met, generate status messages in case of malfunctions, and switch off the system, if necessary.

5.1.9 Light emitter control loop

During the high phase the light emitter is controlled with a constant current of 0.291 A = I_On;

default: 22% light emitter on, 78% light emitter off (duty cycle d = 0.22)

Modulation frequency = 22.0 Hz

Peak power = 0.291 A * 0.291 A * 13.78 ohms = 1.16 W

The IR light emitter is operated with a square-wave modulated constant current of 290 mA at 22.0 Hz. The constant current is monitored by the MOPS software via an A/D converter and measured via a R_{shunt} of 0.5 ohms.

The supply voltage of the light emitter current control loop is also monitored. This voltage is generated by the ILCA power module (AMO ILCA PCB) using a DC/DC converter. The target value is set via a digital serial potentiometer controlled by the MOPS PCB.

The supply voltage is measured correctly only when the light emitter is off, that is during the low phase of light emitter modulation.

5.2 Pneumatic system

The pneumatics of the ILCA module contains a DC pump, a valve, the control board "AMO FLOW ILCA PCB", a pneumatic low-pass filter, at least one additional filter, as well as the associated anesthetic-resistant tubing.

The complete system additionally includes a water trap and/or Teflon tube.

5.2.1 Tubing, restrictors, and dampers

A pneumatic low-pass filter, located between pump inlet and cuvette, containing one restrictor R1 (see the following figure) with a pressure drop of 60 mbar ± 10 mbar plus a sintered filter with a pressure drop of 10 mbar at a flow of 150 mL/min and a damper C1 of approx. 12 cm^2, makes sure that pressure surges have no noticeable effect on the S/N of the sampling gas channels.

Within one pump rotation the pressure varies by max. ± 5 mbar, the flow then varies by approx. ± 4 mL/min on the inlet side. The additional normal input load of a water trap plus the sampling tube reduce the flow fluctuations by a factor of 2.

Typical data of the sampling hose:

Length = 2.2 m , ID = 1 mm, pressure drop at 150 mL/min air: 35 mbar ± 7 mbar

Typical pressure drop of the new Dräger water trap WAL: 25 mbar ± 10 mbar at 150 mL/min air

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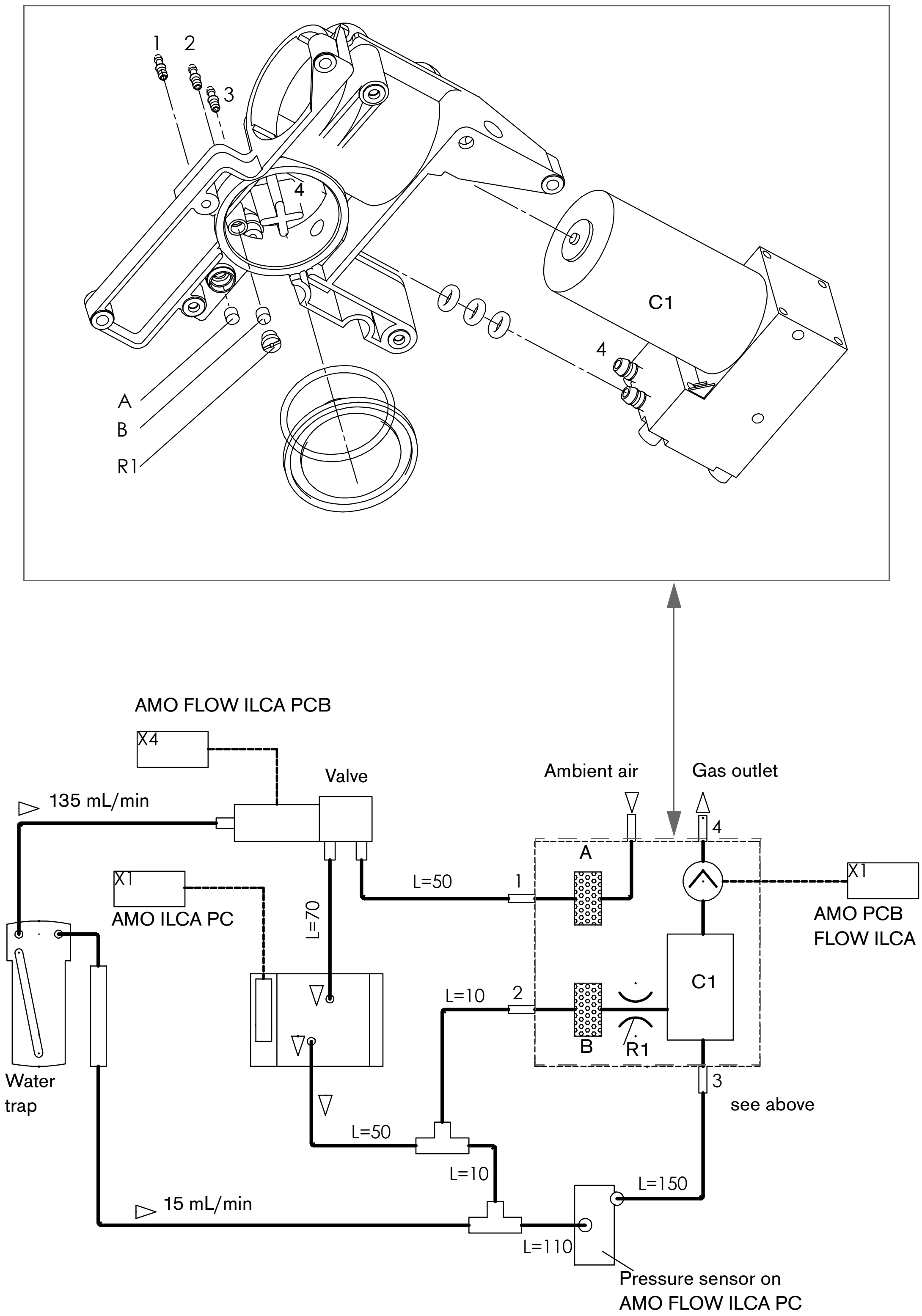

Fig. 3: Pneumatics connection diagram

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5.2.2 Pump

The supply voltage of the ILCA lies in the range of 10 V to 16.5 V. Therefore, a DC/DC converter is used to generate the pump voltage. The output voltage of the DC/DC converter is controlled via a serial digital potentiometer on the AMO FLOW ILCA PCB and set by the MOPS controller.

Specification of the pump:

– Power supply: DC voltage = max. 7.5 V
– Normal operation: Current = max. 200 mA_{eff}; max. output 1.5 W
– Pump blockage: Current = max. 350 mA_{eff}; max. output 2.6 W
– Operating temperature 0 °C to 45 °C, storage temperature - 40 °C to 70 °C

The following values refer to 20 °C and 1013 hPa. In addition, a damper volume of 12 cm^2 is present at the inlet of the pump:

– Flow 150 mL/min ± 20 mL/min. Flow under max. load (input - 360 hPa) greater 150 mL/min at ≤ Umax 7.5 V.
– At a pressure of – 50 mbar against ambient pressure, a flow of 150 mL/min should be adjustable using a voltage in the range of 2.5 V to 5.0 V.
– At a low pressure of 200 hPa, the pump leak rate may be max. 3 mL*mbar/s. Connect the inlet of the pump to the outlet during measurement.

5.2.3 Zeroing behavior

A sinter filter with a pressure drop of typically 10 mbar at 150 mL/min air is located at the ambient air inlet of the valve. The following happens during zeroing

– the pump is switched off
– the valve is switched to ambient air
– the ambient pressure is measured after a delay of approx. 2 seconds
– the pump is switched on again and set to 200 mL/min by a P controller
– the gas values are zeroed
– the valve is switched to patient
– the pump is set to 150 mL/min again by the PID controller

5.3 AMO FLOW ILCA PCB

The AMO FLOW ILCA PCB controls the pump and the valve(s). The PCB is controlled and powered by the MOPS PCB. The actual control of the pump flow is handled by the software of the controller on the MOPS PCB.

The flow controller includes:

– A DC/DC converter whose output voltage is set with a serial digital potentiometer via software on MOPS PCB in order to set the pump voltage and control the flow.
– The power output elements of the solenoids
– Service LEDs for the pump voltage, the valves, and the supply voltage
– A temperature-compensated differential pressure sensor for flow measurement; the sensor offset is corrected using the serial digital potentiometer.
– Analog electronics for evaluation of the pump voltage, pump current, valve current ,and differential pressure.

5.3.1 Performance data

Power consumption

Specification	**+5 V**	**+12 V**
Tolerance	±500 mV	-2 V, +5 V
typ. continuous current	1 mA	60 mA
max. continuous current	5 mA	350 mA
peak current	10 mA	400 mA

Valves are powered through the +12 V supply.

Notes:

DGND, AGND, and VGND are not connected on the AMO FLOW ILCA PCB in order to avoid ground loops with the measuring system (ILCA).

6 Options

6.1 Optional battery

When retrofitting the optional battery in the first batch of 400 units (up to and including serial no. ARRF-0026) pay attention to the following:

- For the charging circuit to function properly, you need to replace the AMO O2 GRAF PCB (for location, see Fig. 2: Components of the ILCA module).

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6.2 SpO2 option

The SpO2 option can be retrofitted in all units.

A new Dura sensor always comes with a new SpO2 PCB to be installed.

Dräger cannot order the PCB alone. Old Dura sensors might also not work with a new SpO2 PCB.

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7 Alarms and their meaning

7.1 Behavior of Vamos in case of alarms

Alarms are presented in three different ways:

- one of the two alarms LEDs flashes or is continuously lit,
- a characteristic alarm sound is generated
- an alarm-specific message appears on one of the alarm windows (see the following chapter).

The characteristic behavior of the alarm devices in case of alarms is shown in the table below.

The alarm method varies with the alarm priority. There are three main groups:

Alarm priority	Alarm tone	LED
Alarm = !!! (highest priority)	intermittent	The red (top) LED flashes accompanied by a tone sequence at 2.5-second intervals.
Caution = !! (medium priority)	intermittent	The yellow (bottom) LED flashes accompanied by a tone sequence at 30-second intervals.
Advisory = ! (lowest priority)	once	The yellow (bottom) LED comes on accompanied by a single tone.

Alarm messages are shown in the two alarm windows from left to right. Messages with a higher priority level push messages with a lower priority level to the right.

If, for example, both alarm windows are full and a new alarm occurs, this alarm will be inserted according to its priority level and the alarm with the lowest priority is deleted from the display. If the new alarm is the one with the lowest priority level, it will not be displayed, but only announced once by the characteristic tone sequence for this type of alarm.

If the alarm is generated because the upper or lower alarm limit of a parameter has been exceeded, another mechanism becomes effective. The parameter affected shows this event by flashing (the value is shown alternately in normal and inverted video). If the limits of more than one parameter have been exceeded, then the respective parameter(s) will flash.

7.2 General alarms

Battery capacity is too low

Message	Batt. low!!
Priority	Level 2; caution
Cause	The battery capacity is < 10%
Further effects	None

7.3 SpO2 measurement alarms

no pulse signal

Message	Pulse ? !!!
Priority	Level 1; alarm
Cause	No pulse signal detected for 10 seconds.
Further effects	SpO2 and HR values are replaced with "–".

SpO2 sensor not connected.

Message	SpO2 sensor ? !
Priority	Level 3; advisory
Cause	No SpO2 sensor connected.
Further effects	SpO2 and HR values are replaced with "–".

SpO2 measurement faulty

Message	SpO2 INOP !
Priority	Level 3; advisory
Cause	SpO2 measurement faulty
Further effects	SpO2 and HR values are replaced with "INOP".

SpO2 value low

Message	SpO2 ⧗ !!!
Priority	Level 1; alarm
Cause	Oxygen saturation is below the set limit value.
Further effects	None
Adjustment range	50-99,–, maximum upper limit -1
Increment	1
Factory Default	92

Pulse value low

Message	Pulse ⧗ !!!
Priority	Level 1; alarm
Cause	Pulse rate is below the set limit value.
Further effects	None
Adjustment range	30-299,–, maximum upper limit -1
Increment	1
Factory Default	80

Pulse value high

Message	Pulse ⧗ !!
Priority	Level 2; caution

Cause	Pulse rate exceeds the set limit value.
Further effects	None
Adjustment range	31-300,–, at least lower limit +1
Increment	1
Factory Default	150

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7.4 Gas measurement alarms

Sampling gas inlet line or sampling gas outlet line obstructed

Message	Gas line !
Priority	Level 3; advisory
Cause	Sampling gas inlet line or sampling gas outlet line obstructed
Further effects	Values for CO2, N2O, anesthetic gas are replaced with "–".
	If this alarm occurs, alarm monitoring for CO2, anesthetic gases, and apnea will be switched off.

CO2 measurement INOP

Message	CO2 INOP !
Priority	Level 3; advisory
Cause	CO2 measurement faulty
Further effects	Values for CO2 are replaced with "INOP".
	If this alarm occurs, alarm monitoring for CO2, and apnea will be switched off.

Anesthetic gas measurement INOP

Message	Hal INOP ! Iso INOP ! Enf INOP ! Sev INOP ! Des INOP !
Priority	Level 3; advisory
Cause	Anesthetic gas measurement faulty
Further effects	Values for anesthetic gas are replaced with "INOP".
	If this alarm occurs, alarm monitoring for the anesthetic gas will be switched off.

N2O measurement INOP

Message	N2O INOP !
Priority	Level 3; advisory
Cause	N2O measurement faulty
Further effects	Values for N2O are replaced with "INOP".

Gas analyzer INOP

Message	Gas INOP !
Priority	Level 3; advisory
Cause	Gas measurement faulty
Further effects	Values for anesthetic gas, N2O, and CO2 are replaced with "INOP".

etCO2 high

Message	FetCO2 ▲ !!		
Priority	Level 2; caution		
Cause	etCO2 value exceeds limit value		
Further effects	None		
	mmHg	kPa	vol.%
Adjustment range	1-75, –	0.1-9.8, –	0.1-9.8, –
	at least lower limit +1	at least lower limit +0.1	at least lower limit +0.1
Increment	1	0.1	0.1
Factory Default	50	7	7

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etCO2 low

Message	FetCO2 ⧗ !!		
Priority	Level 2; caution		
Cause	etCO2 value below limit value		
Further effects	None		
	mmHg	kPa	vol.%
Adjustment range	–, 0-74	–, 0-9.7	–, 0-9.7
	maximum upper limit -1	maximum upper limit -0.1	maximum upper limit -0.1
Increment	1	0.1	0.1
Factory Default	–	–	--

FiCO2 high

Message	FiCO2 ⧗ !!		
Priority	Level 2; caution		
Cause	FiCO2 value exceeds limit value		
Further effects	None		
	mmHg	kPa	vol.%
Adjustment range	–, 1-20	–, 0.1-2.6	--, 0.1-2.6
Increment	1	0.1	0.1
Factory Default	5	0.7	0.7

Apnea

Message	Apnea !!!
Priority	Level 1; alarm
Cause	Stop of breathing/ventilation; no breath has been detected by CO2 measurement for 30 seconds.

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Further effects	"Fi, Fet" texts in parameter field disappears, real-time values are displayed for all parameters instead of Fi values, the Fet values are no longer displayed, monitoring of alarm limits for anesthetic gases and CO2 is switched off.

Fi anesthetic gas high

Message	FiHal ⧗ !!!	FiEnf ⧗ !!!	FiIso ⧗ !!!	FiSev ⧗ !!!	FiDes ⧗ !!!
Priority	33; Level 1; alarm				
Cause	The inspiratory value of the set anesthetic gas exceeds the upper limit value.				
Further effects	None				
	Hal	Enf	Iso	Sev	Des
Adjustment range	0.1-7.0	0.1-7.0	0.1-7.0	0.1-9.9	0.1-21.9
	at least lower limit +0.1	at least lower limit +0.1	at least lower limit +0.1	at least lower limit +0.1	at least lower limit +0.1
Increment	0.1	0.1	0.1	0.1	0.1
Factory Default	1.5	3.4	2.3	3.4	12.0

Fi anesthetic gas low

Message	FiHal ⧗ !!	FiIso ⧗ !!	FiEnf ⧗ !!	FiSev ⧗ !!	FiDes ⧗ !!
Priority	15; Level 2; caution				
Cause	The inspiratory value of the set anesthetic gas is below the lower limit value.				
Further effects	None				
	Hal	Iso	Enf	Sev	Des
Adjustment range	–, 0-6.9	–, 0-6.9	–, 0-6.9	–, 0-9.8	–, 0-21.8
	maximum upper limit -0.1	maximum upper limit -0.1	maximum upper limit -0.1	maximum upper limit -0.1	maximum upper limit -0.1
Increment	0.1	0.1	0.1	0.1	0.1
Factory Default	–	–	–	–	–

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8 Vamos disassembly

Since the Vamos is a very compact device, some components or cables are not easily accessible.

When disassembling the Vamos, it is necessary to remove the top assemblies first.

The Vamos contains the following subassemblies:

- **Front, complete**
- **Rear panel**
- **Basic frame**
  - VAMOS PCB
  - Fan
  - optional SpO_2 PCB
  - ILCA module
    - ILCA sensor head
    - Pump
    - Solenoid valve
    - Set of PCBs
      - MOPS PCB (processor)
      - AMO FLOW PCB (flow measurement)
      - AMO ILCA PCB (sensor-head control)
      - AMO O2 GRAF PCB (display control)
- **Options**:
  - Rechargeable battery
  - Rechargeable battery charge circuit

8.1 Housing rear panel disassembly

- Disconnect from power supply and remove external cables.
- Remove the four fixing screws.
- Remove the rear panel.
- Re-assemble the device using the reverse (logical) sequence of that used for disassembly.

8.2 Basic frame disassembly

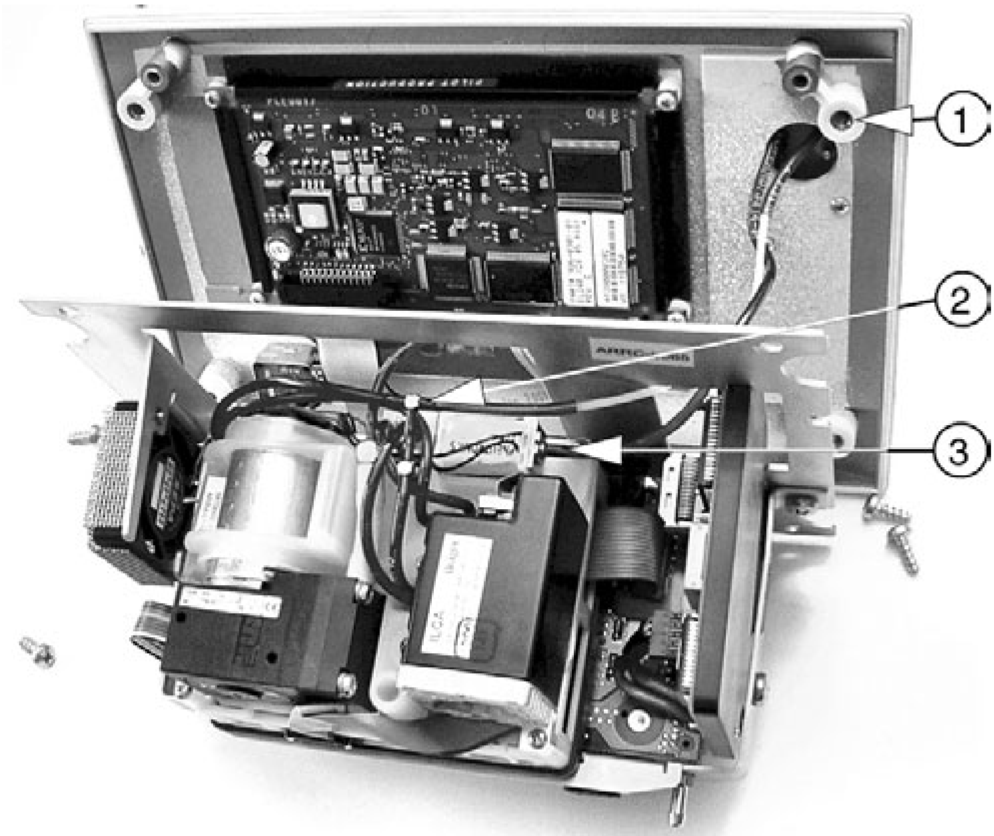

Fig. 4 Basic frame and components

- Remove the four external fixing screws (Fig. 4/1).
- Remove the basic frame.
- Disconnect the water-trap hose and Teflon part from the T-piece (Fig. 4/2).
- Disconnect the red water-trap hose (Fig. 4/3) from the solenoid valve.

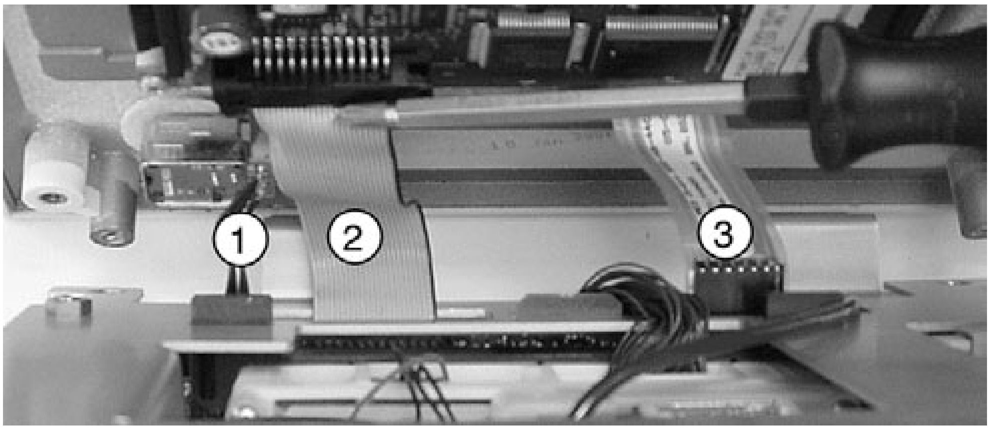

Fig. 5 Basic frame and components

- Disconnect the control-knob cable (Fig. 5/1) from the underside of the VAMOS PCB.
- Disconnect the display ribbon cable (Fig. 5/2) from the display.
- Disconnect the membrane-keypad ribbon-cable (Fig. 5/3).
- Re-assemble the device using the reverse (logical) sequence of that used for disassembly.

8.3 ILCA module disassembly

- Prerequisite: see chapter 8.2 Basic frame disassembly.

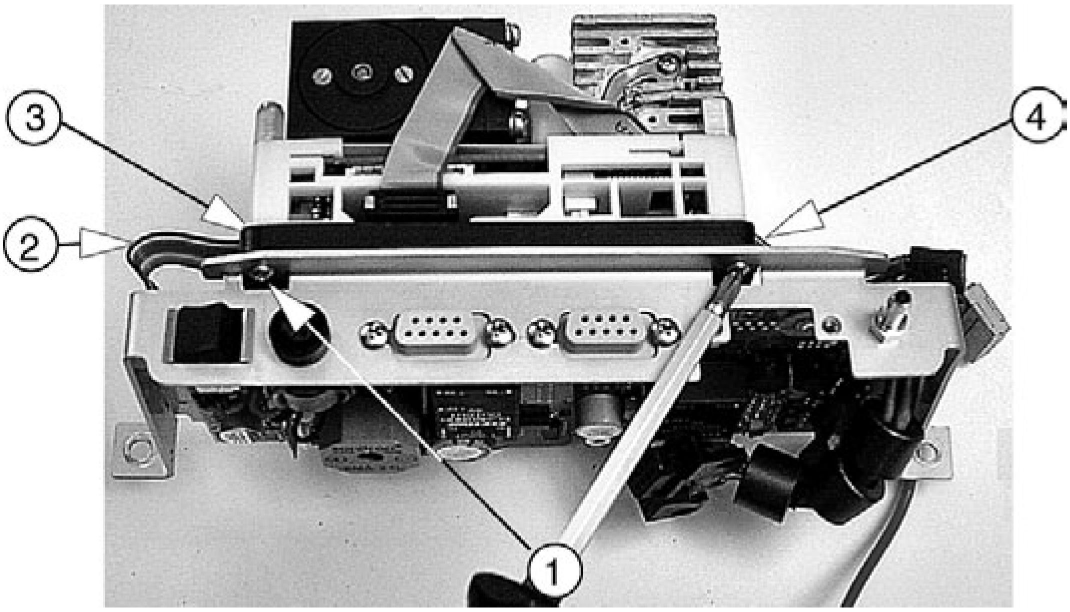

Fig. 6 ILCA module, fixing screws and cables

- Remove the two fixing screws (Fig. 6/1) from the VAMOS PCB. If necessary, remove the SpO_2 socket beforehand.
- The power supply cable (Fig. 6/3) is located next to the RS232 ribbon cable. Disconnect the power supply cable from the ILCA module.
- Disconnect the RS232 ribbon cable (Fig. 6/2) from the ILCA module.
- Disconnect the ribbon cable (Fig. 6/4) from the VAMOS PCB. If necessary, remove the SpO_2 PCB beforehand.

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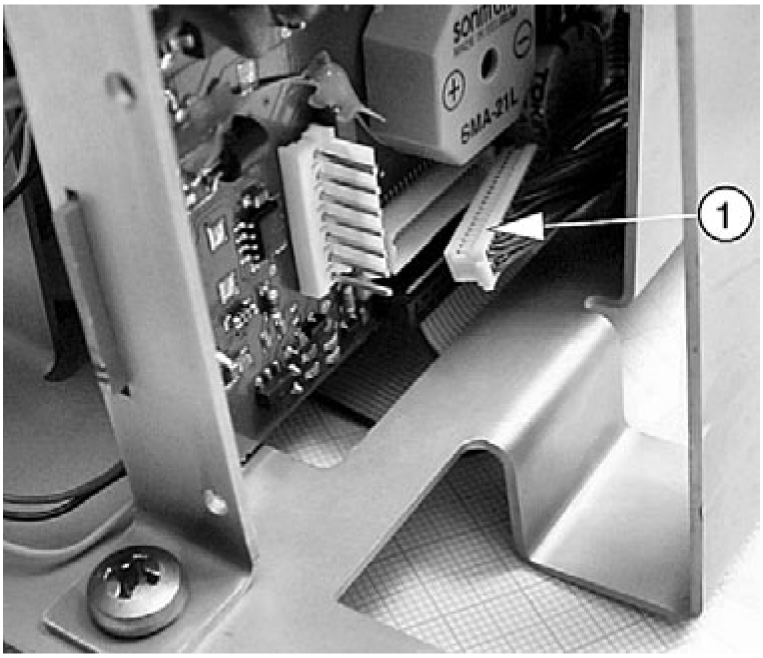

Fig. 7 ILCA module, cable harness (1) consisting of individual blue wires

- Pull the ILCA module slightly to the front and disconnect the cable harness (Fig. 7/1) consisting of individual blue wires from the underside of the VAMOS PCB (not easily accessible).
- Disconnect the hose from the anesthetic gas return line.
- Re-assemble the device using the reverse (logical) sequence of that used for disassembly.

8.4 PCB-set disassembly

- Prerequisite: see chapter 8.2 Basic frame disassembly.
- Prerequisite: see chapter 8.3 ILCA module disassembly.

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Fig. 8 ILCA module, sensor-head holder

- Remove the sensor-head holder (Fig. 8/1).
- Remove the remaining three fixing screws from the top side of the ILCA module.
- Fold down the top part.
- Remove the yellow insulating paper.

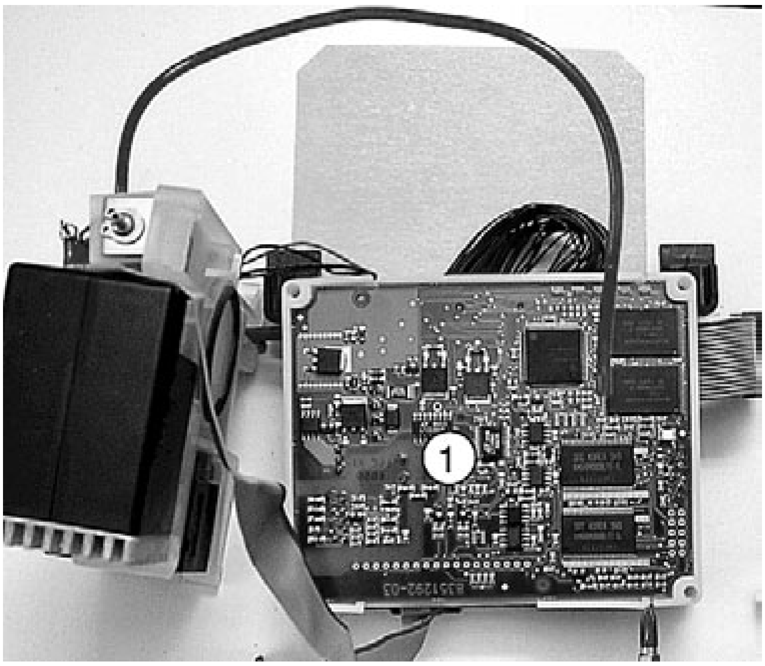

Fig. 9 ILCA module, MOPS PCB

- Remove the MOPS PCB (Fig. 9/1).

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The other PCBs become accessible after removing the black cover at the bottom (see Fig. 10).

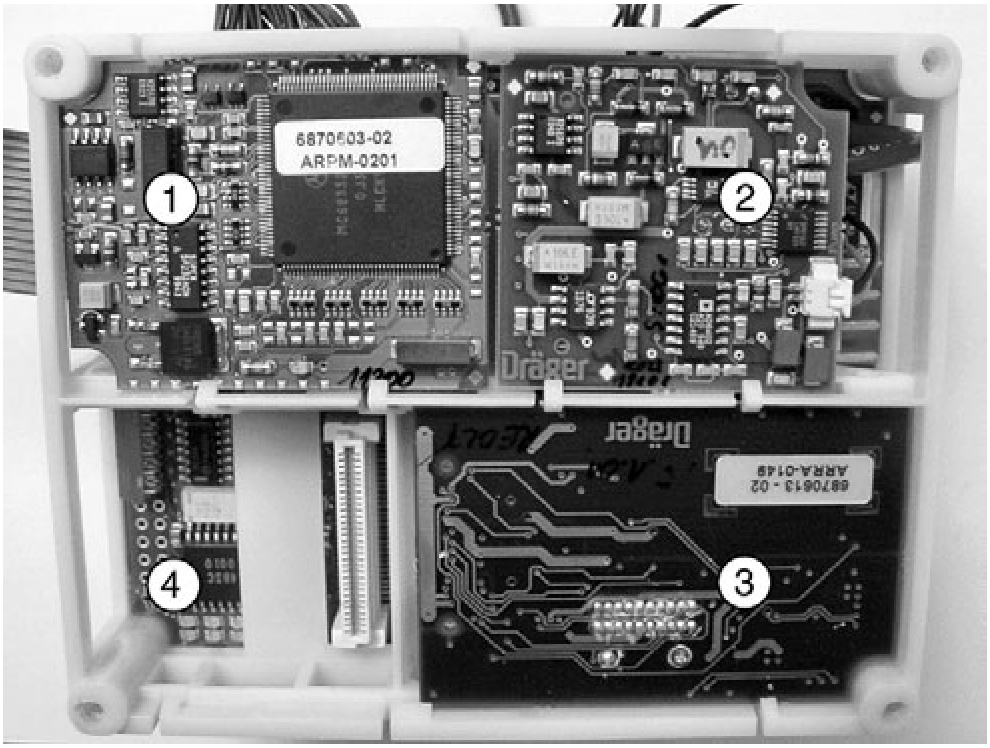

Fig. 10 ILCA module, PCBs

Table 1: Legend to Fig. 10

Pos.	Designation
1	AMO O2 GRAF PCB
2	AMO FLOW ILCA PCB
3	AMO ILCA PCB
4	MOPS PCB

- Re-assemble using the reverse (logical) sequence of that used for disassembly.

Notice:

When mounting the ILCA module, make sure that the two catches (see Fig. 11/1) point towards the frame.

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Fig. 11 ILCA module, catches

8.5 VAMOS PCB disassembly

- Prerequisite: see chapter 8.2 Basic frame disassembly.
- Disconnect the hoses from the water trap, if applicable.
- Remove the two fixing screws at the side.
- Disconnect the cable harness consisting of individual blue wires (Fig. 7/1).
- Disconnect the cable harness of the fan (on the right-hand side).
- Remove the entire VAMOS PCB including ILCA module and, if applicable, also the SpO_2 PCB.
- Now refer to chapter 8.3 ILCA module disassembly.
- Re-assemble using the reverse (logical) sequence of that used for disassembly.

8.6 ILCA sensor-head disassembly

It is not necessary to remove the basic frame.

- Remove the fixing screw from the sensor-head holder.
- Remove the two fixing screws near the cuvette.
- Note the position of the two red hoses, then remove the red hoses.
- Disconnect the ribbon cable from the sensor head.
- Re-assemble using the reverse (logical) sequence of that used for disassembly.

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8.7 Pump disassembly

- Prerequisite: see chapter 8.3 ILCA module disassembly.
- Prerequisite: see chapter 8.4 PCB-set disassembly.
- Remove the fixing screw from the left-hand side of the pump.
- Pull out the pump at the rear panel.
- Remove the hoses.
- Disconnect the power cable.
- Re-assemble using the reverse (logical) sequence of that used for disassembly.

Replace the 3 O-rings if there are leaks in the pump area.

1 Software download (PGM or MFM software)

1.1 Software download precautions

Notice:

Risk of damage to VAMOS downloader in the event of power failure. The VAMOS battery capacity is not sufficient for the duration of the download procedure.

During the download procedure, VAMOS must be powered from an AC outlet.

Notice:

Risk of damage to VAMOS downloader, if the power saving function is activated on your service laptop computer.

Before downloading, always connect your service laptop computer to an AC outlet. Configure the power saving function (for AC outlet operation) such that neither the hard disk nor the display is switched off automatically.

Notice:

Risk of damage to the VAMOS downloader if background programs are activated.

Before downloading, always deactivate all screensavers, virus scanners, or indexing functions (e.g. from Microsoft).

Read the "Questions/Answers" section under the service software "Help".

Notice:

Electrostatic discharge may damage the electronic components.
Use a static-dissipative mat and a wrist strap when handling electrostatic sensitive components.

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1.2 Test Equipment

RS232 extension (9-pin sub D female connector on 9-pin sub D male connector, length = 3 meters, with service coding)	79 01 808
Service PC (or service laptop computer)	
Doris-CD with service software, from version ≥ 9.3 with download version ≥ 4.0	
Downloadable operating software VAMOS for MFM and PGM (with current software version)	

1.3 Typographic Conventions

Typographic conventions used in the description of this download procedure:

"XX.X..." = stands for the respective version number.

For example "ENTER" = key on the service computer.

"Service" = text on the display or text to be entered with the service computer.

1.4 Software Download Procedure

Notice:

Risk of incorrect software download.

There are two totally different software downloads for Vamos. Each of these software downloads must only be carried out through the specified interface.

– **PGM software**: Downloading must only be carried out through the **RS 232 interface** (software is stored on the ILCA module which is located on the MOPS PCB).

– **MFM software**: Downloading must only be carried out through the **RS 232 Medibus interface** (software is stored on the ILCA module which is located on the AMO O2 GRAF PCB).

Notice:

Interruption of download.

When installing software version 2.01 on Vamos, the device must not be switched off between the installation of the PGM software (RS 232) and the installation of the MFM software (Medibus).

Otherwise the PGM software carries out a reset that interrupts the MFM software download.

Then the MFM software download would have to be restarted.

Notice:

Before downloading the software**, read and understand chapter** 1.1 "Software download precautions"**.**

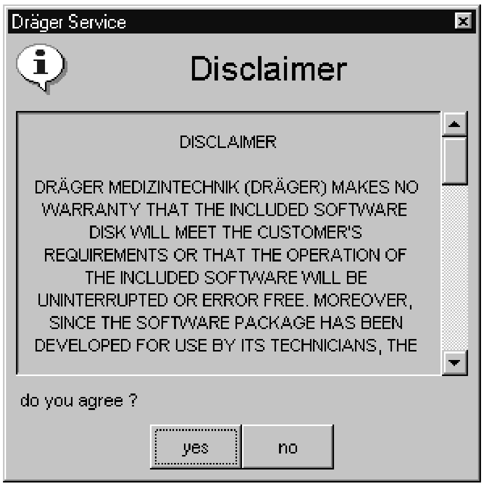
The current versions of the MFM and PGM software are displayed in service mode (see service mode description "Explanation of screen content").

VAMOS and service PC are switched off.

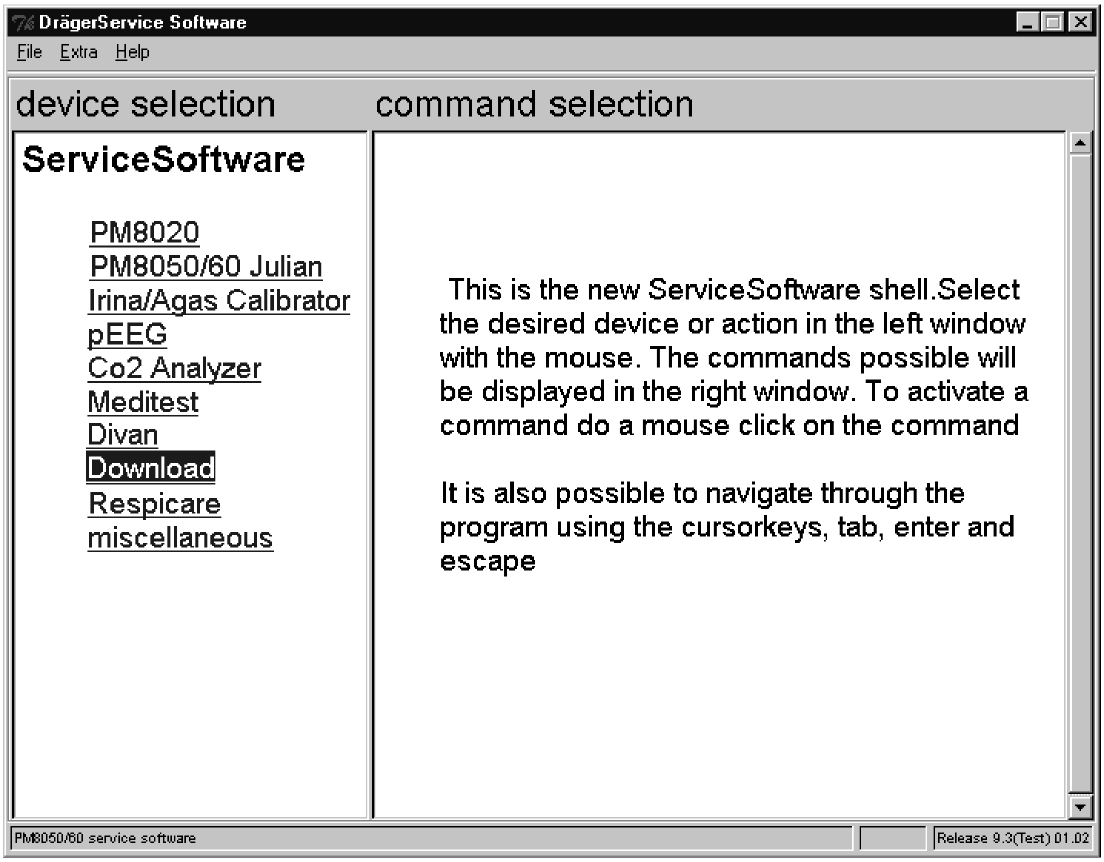
Procedure:

- Connect VAMOS and service PC to AC outlets.
- Interconnect VAMOS and service PC using the RS 232 extension. The interface on VAMOS for PGM is the **RS 232C** interface.

- Switch on the service PC.
- Activate the service software icon.
- Confirm the disclaimer information.



- Select "Download" from the device selection list.



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- If the desired software version (the diskette of the VAMOS software) is not installed on the service PC yet, insert the diskette with the VAMOS software in the disk drive of the service PC and select "Install new device software" from the command selection list.

The download software will be installed on the hard disk of your service PC. You will find the software in a directory with the device name and the version number.

- Select the desired software version "PGM Ver. XX.XX" or "MFM Ver. XX.XX" from the command selection list.
- Switch on VAMOS.
- After completion of the self-test, select standby mode on VAMOS.
- The following message will appear on PC screen: **"Connect PC." Then press the main switch**.
- Wait approx. 5 s.
- Exit all applications on the service computer and confirm exiting by pressing "ENTER" or by clicking on the "OK" button.

.

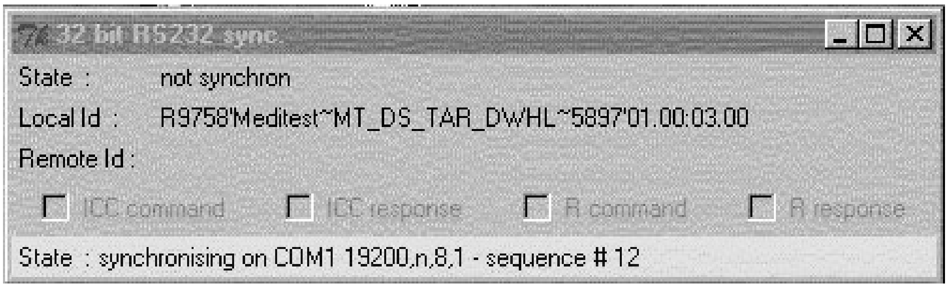
The service PC now tries to establish a connection to VAMOS through the RS 232C (Medibus) interface.

Note:

Should the connection be interrupted while transferring the download files, the service PC will attempt to re-establish the connection 10 times. Should these attempts fail, switch off VAMOS and restart the download procedure.

If 32-bit synchronization is activated in the menu line under "Extras", then the following message will appear:

.



The following message will appear on your service PC as soon as synchronization is complete: "Remote to..."

Note:

The product name "Julian" is shown in the following download windows. However, the software name "MFM" or "PGM" will be displayed on your laptop computer.

- Using the Page↑ (PGUP) or Page↓ (PGDW) keys, select the "downloadrequest" command and confirm by pressing "ENTER".

- Confirm the software version by pressing "ENTER (CR)".

Software downloads can be carried out individually. Select by pressing the key ↑ or ↓ or the "SPACE" bar on the service computer. A download file has been selected if an "X" appears under "selected".

- Select the download file.
- Press "ENTER".

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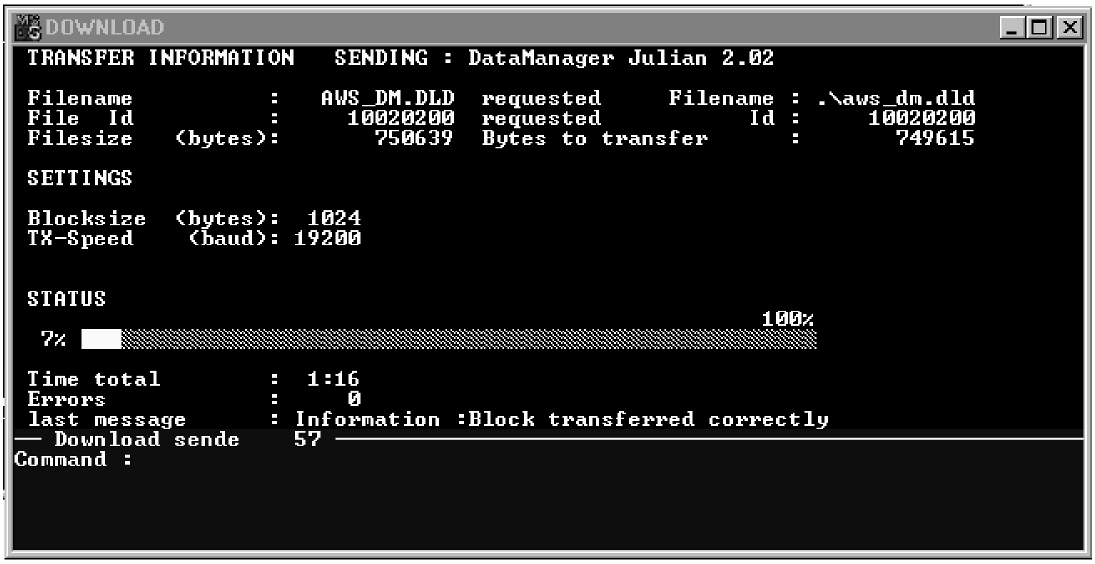
Download procedure starts. The service PC displays information about the download progress. The complete download procedure will take about 10 minutes.



The following message will appear as soon as the download procedure is complete:

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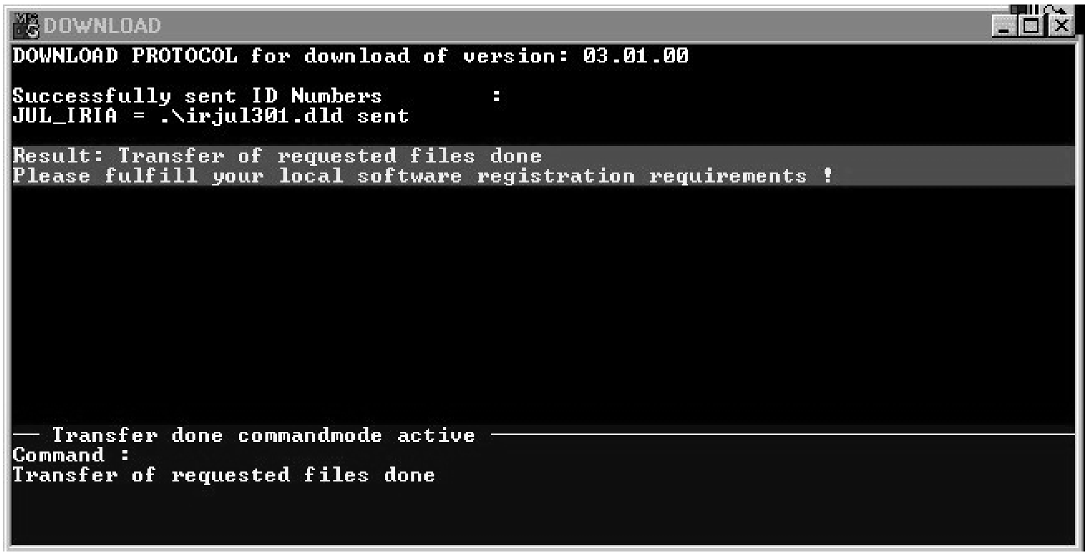

- If another download is required, exit from the menu by pressing the "ESC" key, and carry out the download. **Do not switch off the VAMOS in between!**
- If download was not completed successfully, try again. If this download also fails, check the interfaces using the VISIA program.
- If both downloads were successful, switch off the VAMOS.
- Remove the connection between the service PC and VAMOS.

1.4.1 Final test

- Switch on VAMOS and wait until the self-test is complete.
- MFM software. Does the number of the new MFM software version appear on the standby display of VAMOS?
- PGM software. Does the number of the new PGM software version appear in the service mode of VAMOS?

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VISIA program

1 VISIA program description

The VISIA program is a service program for VAMOS, ILCA, and IRIA > SW 3.0 (Julian SW 3.0). The VISIA program can be found in the "PM 8050/60 Julian" menu of the DräegerService software.

The program visualizes the hardware status, the configuration, the error log, and the measured parameters. It can be used to calibrate the sample rate, and to switch the pump and the valves on/off.

In the following window the software LEDs indicate the status of the respective function. Their colors have the following meaning:

– "Green" = the function is OK
– "Red" = the function is NOT OK
– "Yellow" = reduced status
– "White" = intermediate status
– "Blue" = start phase

The present documentation is not complete yet.

These are some windows from the software.

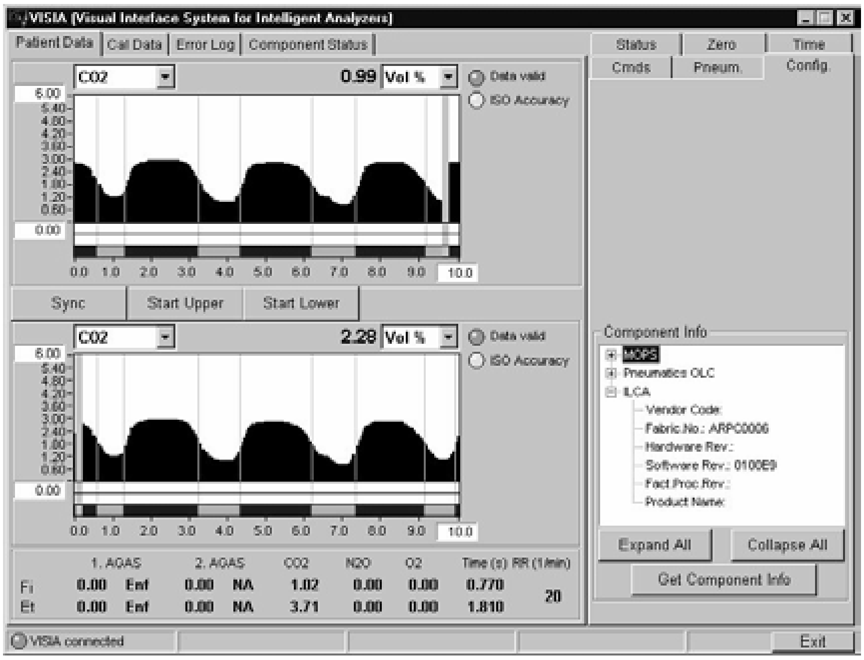

Fig. 1: Left window "Patient Data" CO2 (resolution). Right window "Configuration"

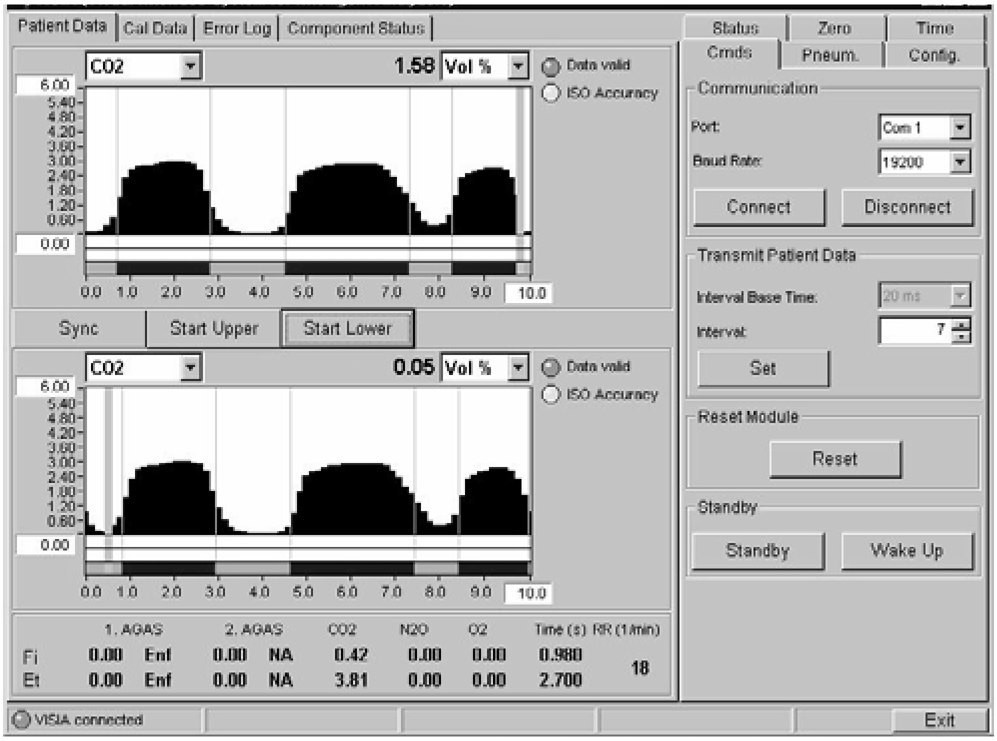

Fig. 2: Patient data CO2 (low resolution) and communication window

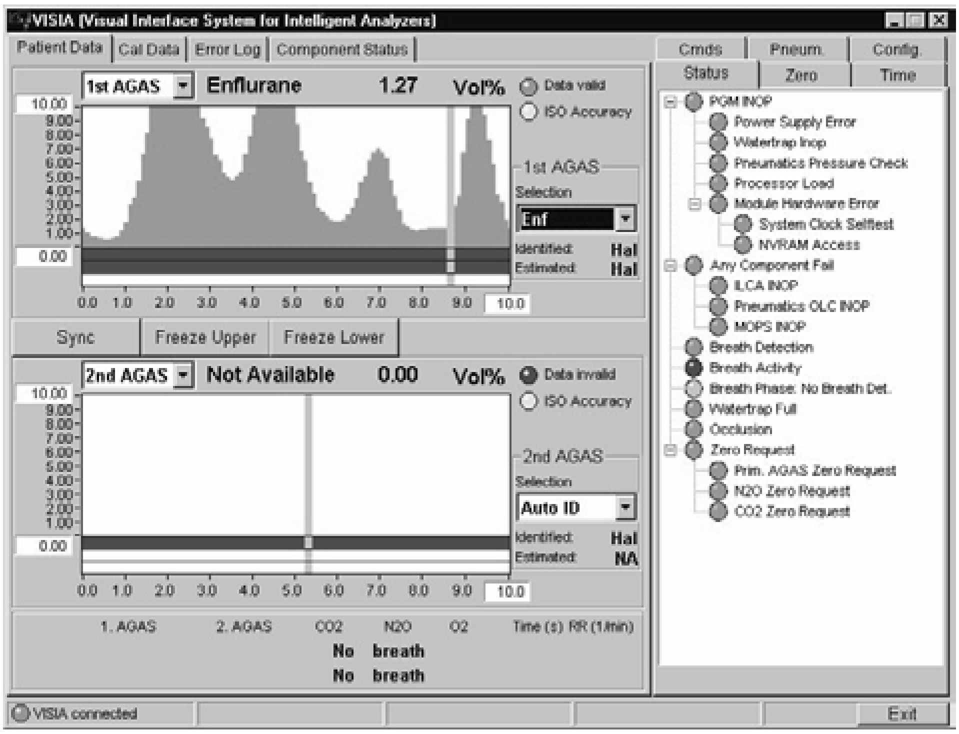

Fig. 3: Patient data anesthetic gas (AGAS) and status window

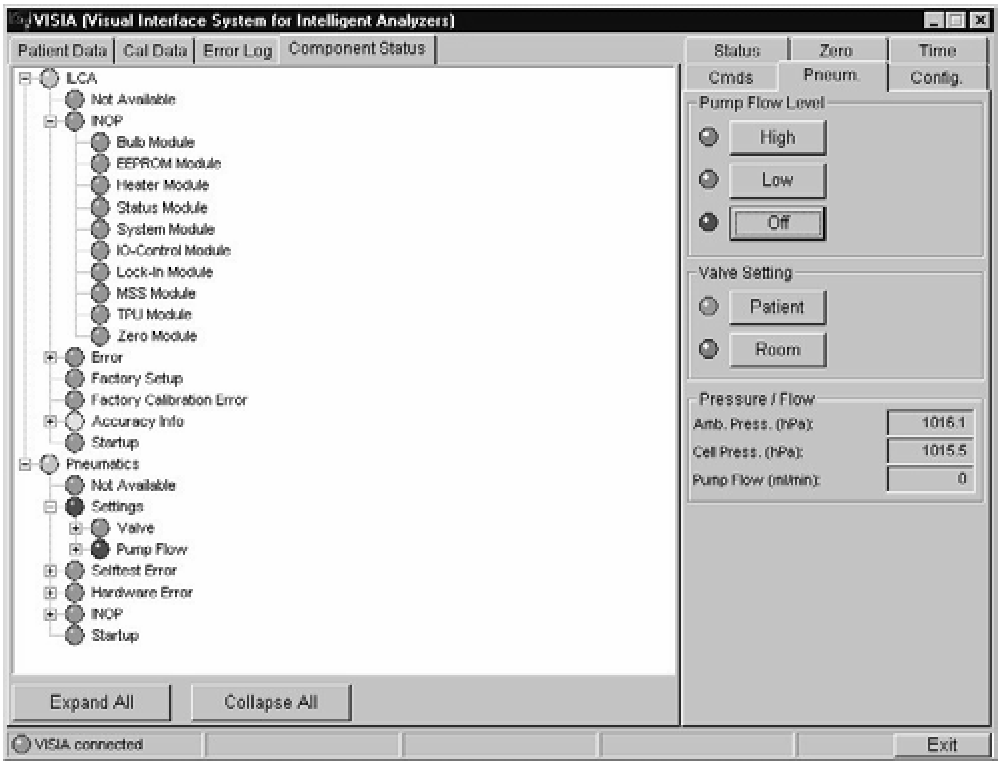

Fig. 4: Pneumatic components status window

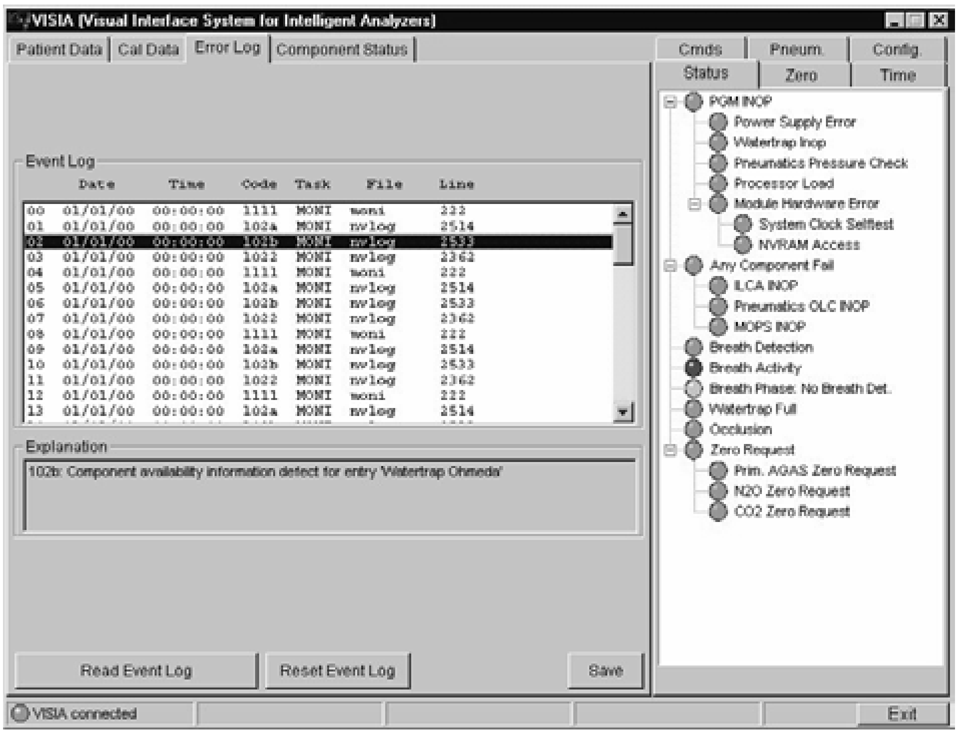

Fig. 5: Error log and status window

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1 Error list to function blocks

1.1 Monitor

1.1.1 **Monitor function**	Possible cause
No voltage at monitor front plate	Faulty socket-outlet <–> power pack cable.
	Socket-outlet <–> power pack cable not plugged or bad contact.
	Faulty power pack.
	Faulty fuse in power system.
	Faulty power pack <–> monitor cable.
	Power pack <–> monitor cable not plugged or bad contact.
Voltage at monitor is outside specified limits.	Faulty power pack.
	Bad contact in socket-outlet <–> power pack cable.
	Bad contact in power pack <–> monitor cable.
No voltage at MONI TRENNUNG PCB.	Faulty ON/OFF switch.
No voltage at MOPS PCB.	MONI TRENNUNG PCB <–> MOPS PCB cable connection not plugged, bad contact, open circuit, damaged soldering joint.
No signal transmission. AMO O2 GRAF PCB <–> MONI TRENNUNG PCB.	AMO O2 GRAF PCB <-> MONI TRENNUNG PCB cable connection not plugged, bad contact, open circuit, damaged soldering joint.

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1.1.1 Monitor function	Possible cause (cont'd)
No signal transmission. AMO O2 GRAF PCB <–> MOPS PCB.	Faulty AMO O2 GRAF PCB <–> MOPS PCB cable connection, bad contact.

1.1.2 Power LED does not come on or is faulty	Possible cause
No voltage supply to power LED (although voltage present at monitor).	MONI TRENNUNG PCB <–> membrane keypad plug-in contact not plugged, bad contact, open circuit.
Faulty power LED.	Faulty component or faulty power LED control.
Faulty control.	Fault on MONI TRENNUNG PCB or faulty membrane keypad.

1.2 Rechargeable battery

1.2.1 Rechargeable battery is not charged	Possible cause
No charging voltage at rechargeable battery.	MONI TRENNUNG PCB <–> AKKU LADUNG PCB connection is faulty, bad contact.
	AKKU LADUNG PCB <–> rechargeable battery connection is faulty, bad contact.
	Faulty AKKU LADUNG PCB.
Rechargeable battery temperature is too high.	Fan failed or ambient temperature is too high.

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1.2.1 **Rechargeable battery is not charged**	Possible cause (cont'd)
Charging voltage is not converted.	Charging controller stuck in continuous reset.
	Faulty rechargeable battery or charging voltage is outside specification.

1.2.2 **Rechargeable battery is overcharged**	Possible cause
Charging voltage is applied to rechargeable battery for too long a period.	Charging voltage is applied to rechargeable battery for too a long a period because the AKKU LADUNG PCB is faulty.

1.2.3 **No rechargeable battery operation possible**	Possible cause
Voltage selection failed.	Faulty MONI TRENNUNG PCB or faulty AKKU LADUNG PCB.
No voltage at MONI TRENNUNG PCB.	Rechargeable battery is flat or faulty.
Faulty rechargeable battery.	AKKU PCB <–> AKKU LADUNG PCB connection is faulty, bad contact.
	AKKU LADUNG PCB <–> MONI TRENNUNG PCB connection is faulty, bad contact.

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1.3 Measured value display

1.3.1 **Faulty SpO2/HR display**	Possible cause
Noise in SpO2 measured value.	External (electrocauterizer) or internal (ILCA pump, display) noise fields.
SpO2 module delivers faulty measurement data.	Faulty SpO2 sensor or incorrect data processing in SpO2 module.
Incorrect data processing on MOPS PCB.	Software error.

1.3.2 **SpO2/HR parameters / blinking heart not updated**	Possible cause
No SpO2 data available.	Faulty SpO2 sensor (faulty LED, bad soldering joint).
	Sensor <–> monitor cable not plugged or bad contact, open circuit.
	Monitor <–> SpO2 PCB cable not plugged, bad contact, open circuit.
No communication. SpO2 PCB <–> MONI TRENNUNG PCB.	SpO2 PCB <–> MONI TRENNUNG PCB cable not plugged, bad contact, open circuit.
	Faulty SpO2 PCB or faulty MONI TRENNUNG PCB.
No communication. MONI TRENNUNG PCB <–> O2 GRAF PCB	MONI TRENNUNG PCB <–> O2 GRAF PCB cable not plugged, bad contact, open circuit.
	Faulty MONI TRENNUNG PCB or faulty O2 GRAF PCB.
No communication. O2 GRAF PCB <–> MOPS PCB.	Bad contact in O2 GRAF PCB <–> MOPS PCB connection.
	Faulty O2 GRAF PCB or faulty MOPS PCB.

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1.3.3 Faulty CO2 parameters	Possible cause
Patient gas module delivers incorrect measured values.	Incorrect tubing between water trap and module.
Incorrect setting of the unit.	Software error.
Incorrect measured value processing on the O2 GRAF PCB.	

1.3.4 CO2 parameters not updated	Possible cause
No communication. O2 GRAF PCB <–> MOPS PCB.	Bad contact in O2 GRAF PCB <–> MOPS PCB connection.
	Faulty O2 GRAF PCB or faulty MOPS PCB.
	Software error.

1.3.5 Incorrect N2O parameters	Possible cause
Patient gas module delivers incorrect measured values.	Incorrect tubing between water trap and module.
Incorrect measured value processing on the O2 GRAF PCB.	Software error.

1.3.6 **N2O parameters not updated**	Possible cause
No communication. O2 GRAF PCB <–> MOPS PCB.	Bad contact in O2 GRAF PCB <–> MOPS PCB connection.
	Faulty O2 GRAF PCB or faulty MOPS PCB.
	Software error.

1.3.7 **Incorrect anesthetic gas parameters**	Possible cause
Patient gas module delivers incorrect measured values.	Incorrect water trap <–> module tubing .
Incorrect measured value processing on the O2 GRAF PCB.	Software error.

1.3.8 **Anesthetic gas parameters not updated**	Possible cause
No communication. O2 GRAF PCB <–> MOPS PCB.	Bad contact in O2 GRAF PCB <–> MOPS PCB connection.
	Faulty O2 GRAF PCB or faulty MOPS PCB.
	Software error.

1.3.9 **Incorrect real-time curve**	Possible cause
Patient gas module delivers incorrect measured values.	Incorrect water trap <–> module tubing.

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1.3.9 Incorrect real-time curve	Possible cause (cont'd)
Incorrect measured value processing on the O2 GRAF PCB.	Software error.
Incorrect setting of the unit.	
Incorrect setting of scaling.	

1.3.10 Real-time curve not updated	Possible cause
No communication. O2 GRAF PCB <–> MOPS PCB.	Bad contact in O2 GRAF PCB <–> MOPS PCB connection.
	Faulty O2 GRAF PCB or faulty MOPS PCB.
	Software error.

1.4 Text display

1.4.1 Incorrect CO2 unit, anesthetic gas type, or CO2 scale	Possible cause
Menu setting is not transferred to software.	Software error.

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1.4.2 **Display unit artifact**	Possible cause
Incorrect control of display unit pixels.	Error(s) in the display hardware/software.
	Software error.
Old texts are cleared only partly or are not cleared at all.	Software error.

1.4.3 **Alarm messages are not updated**	Possible cause
No processing of alarm monitoring.	Software error.

1.4.4 **Alarm are displayed in incorrect order**	Possible cause
Incorrect alarm priority stored.	Software error.

1.5 Menu

1.5.1 **All menus**	Possible cause
Time slot of 30 seconds is not effective.	
Timer is not started.	Software error.
Timer is not evaluated.	
Error in timing.	Error on O2 GRAF PCB or software error.

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1.5.1 All menus	Possible cause (cont'd)
Incorrect marker movement.	
Incorrect evaluation of control knob signals.	Software error.
Incorrect control knob signals.	Hardware error (control knob installed incorrectly, bad contact).
After confirmation, marker does not jump to return arrow.	
Incorrect evaluation of control knob signals.	Software error.
Incorrect control knob signals.	Hardware error (control knob installed incorrectly, bad contact).
Menu item displayed incorrectly.	
Text stored incorrectly.	Software error.

1.5.2 Alarm menu	Possible cause
Incorrect anesthetic gas type.	
Anesthetic gas selection is implemented but not displayed.	Software error.
Limit values do not match anesthetic gas entry.	
Anesthetic gas selection is displayed but not implemented.	Software error.
Anesthetic gas selection is implemented but not displayed.	
Limit value setting outside specification is possible.	

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1.5.2 Alarm menu	Possible cause (cont'd)
Faulty monitoring of minimum/maximum settings.	Software error.

1.5.3 Anesthetic gas menu	Possible cause
Incorrect anesthetic gas type.	
Selection is displayed but not implemented.	Software error.
Selection is implemented but not displayed.	

1.5.4 CO2 menu	Possible cause
Incorrect scale marked.	
Selection is displayed but not implemented.	Software error.
Selection is implemented but not displayed.	
Incorrect unit setting.	
Selection is displayed but not implemented.	Software error.
Selection is implemented but not displayed.	
Scale values do not match unit.	
Unit selection is not implemented.	Software error.

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1.5.5 SpO2 menu	Possible cause
Incorrect message marked.	
Selection is displayed but not implemented.	Software error.
Selection is implemented but not displayed.	

1.5.6 Sound menu	Possible cause
Value setting outside specification is possible.	
Faulty monitoring of minimum/maximum settings.	Software error.

1.5.7 Language menu	Possible cause
Incorrect language setting.	
Selection is displayed but not implemented.	Software error.
Selection is implemented but not displayed.	

1.5.8 Incorrect switching between two windows	Possible cause
Old texts are only partly cleared or not cleared at all.	Software error.
Window text does not match menu.	
Jump to wrong menu.	

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1.6 Keys

1.6.1 **Alarm silence key: Alarm tone is not activated or deactivated.**	Possible cause
Membrane keypad not connected.	Incorrect installation or connector fell off.
Membrane keypad connected incorrectly.	Incorrect installation.
Faulty membrane keypad.	Production fault.
Incorrect processing of keypad signals.	Error on MONI TRENNUNG PCB or software error.

1.6.2 **Standby key**	Possible cause
No function.	
Membrane keypad not connected.	Assembly fault or connector fell off.
Membrane keypad connected incorrectly.	Assembly fault.
Faulty membrane keypad.	Production fault.
Incorrect processing of keypad signals.	Fault on MONI TRENNUNG PCB or
Incorrect start values for parameters.	
Set values are not reset to start values on start.	Software error.
Anesthetic gas menu is not opened during power-on.	
Incorrect display control.	Software error.
Display is not switched off or on.	

1.6.2 **Standby key**	Possible cause (cont'd)
Incorrect display control.	Software error.
Incorrect evaluation of display control.	Error(s) in the display software/hardware.
Pump OFF/pump ON command is executed incorrectly.	
Incorrect evaluation of pump control.	Error in ILCA module.
Incorrect pump control.	Software error.

1.7 Control knob

1.7.1 **Control knob**	Possible cause
Display does not react to rotation.	
Control knob not connected.	Assembly fault or connector fell off.
Control knob connected incorrectly.	Assembly fault.
Mechanical fault in control knob.	Wear.
Incorrect processing of control knob signals.	Assembly fault or placement fault on MONI TRENNUNG PCB.
	Software error.
Display does not react when control knob is pressed.	
Control knob not connected.	Assembly fault or connector fell off.
Control knob connected incorrectly.	Assembly fault.

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1.7.1 Control knob	Possible cause (cont'd)
Mechanical fault in control knob.	Wear.
Incorrect processing of control knob signals.	Error on MONI TRENNUNG PCB or software error.

1.8 LEDs

1.8.1 LEDs on keys	Possible cause
LEDs do not come on.	
Membrane keypad not connected.	Assembly fault or connector fell off.
Membrane keypad connected incorrectly.	Assembly fault.
Faulty membrane keypad.	Wear.
Incorrect processing of keypad signals.	Error on MONI TRENNUNG PCB or software error.
Faulty LED.	Mechanical damage or production fault.
Incorrect alarm LEDs.	
Incorrect alarm priority stored.	Software error.
Incorrect LEDs control.	Error on membrane keypad, error on MONI TRENNUNG PCB, or software error.
Alarm LEDs are not updated.	
No processing of alarm monitoring.	Software error.

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1.9 Acoustic signal

1.9.1 **Pulse tone / alarm tone**	Possible cause
Faulty pulse tone.	
Incorrect piezo control.	Error on MONI TRENNUNG PCB or software error.
Incorrect piezo control.	
Pulse tone missing.	Faulty piezo or cold solder connection.
Incorrect alarm tone.	
Incorrect buzzer control.	Error on MONI TRENNUNG PCB or software error.
Alarm tone missing.	
Buzzer failure.	Buzzer faulty or not connected.
Incorrect buzzer control.	Error on MONI TRENNUNG PCB or software error.
Alarm silence key: Time slot of 2 minutes is not effective.	
Timer is not started.	Software error.
Timer is not evaluated.	
Error in timing.	Error on O2 GRAF PCB or software error.

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1.10 Serial communication

1.10.1 **RS232**	Possible cause
No communication with service interface.	Processor clock deviates from set value.
	Faulty component, quartz fitted incorrectly or faulty.
No signal transmission. MOPS PCB <–> MONI TRENNUNG PCB.	Bad contact in MOPS PCB <–> MONI TRENNUNG PCB control cable, open circuit, damaged soldering joint, or software error.
No signal transmission. MONI TRENNUNG PCB <–> RS232 interface	Fault on MONI TRENNUNG PCB.

1.11 Processor

1.11.1 **Communication with components**	Possible cause
Incorrect hardware control.	I/O ports or chip selects initialized incorrectly, incorrect software timing, hardware error.
Monitor failure.	Component fault, software error.
Incorrect timing, monitor failure.	Faulty component, quartz fitted incorrectly or faulty.

1.12 Software

1.12.1 **Software error**	Possible cause
Reset, single or multiple, reduced functionality.	
Spurious interrupt is not processed.	Software error
Incorrect task abortion.	
Incorrect task priorities, deadlock.	Incorrect software configuration.
Incorrect interrupt configuration.	
Reset, single or multiple, reduced functionality.	Incorrect interrupt configuration.
Incorrect operating system initialization in monitor task.	Incorrect software configuration.
Simultaneous access to different tasks or resources.	Software error.
Software generation.	
Incorrect memory allocation in sections, error in registration of functions in sections.	Incorrect software configuration.
Monitor failure.	
Timer signal is missing or configured incorrectly.	Component fault or incorrect software configuration.

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1.13 Fan

1.13.1 Fan does not rotate	Possible cause
No fan control.	MONI TRENNUNG PCB <–> fan cable connection not plugged, bad contact, cold solder connection, or software error.
No processing of fan control.	Faulty fan.

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MEDICAL

Schematics and Diagrams

1 VAMOS block diagram

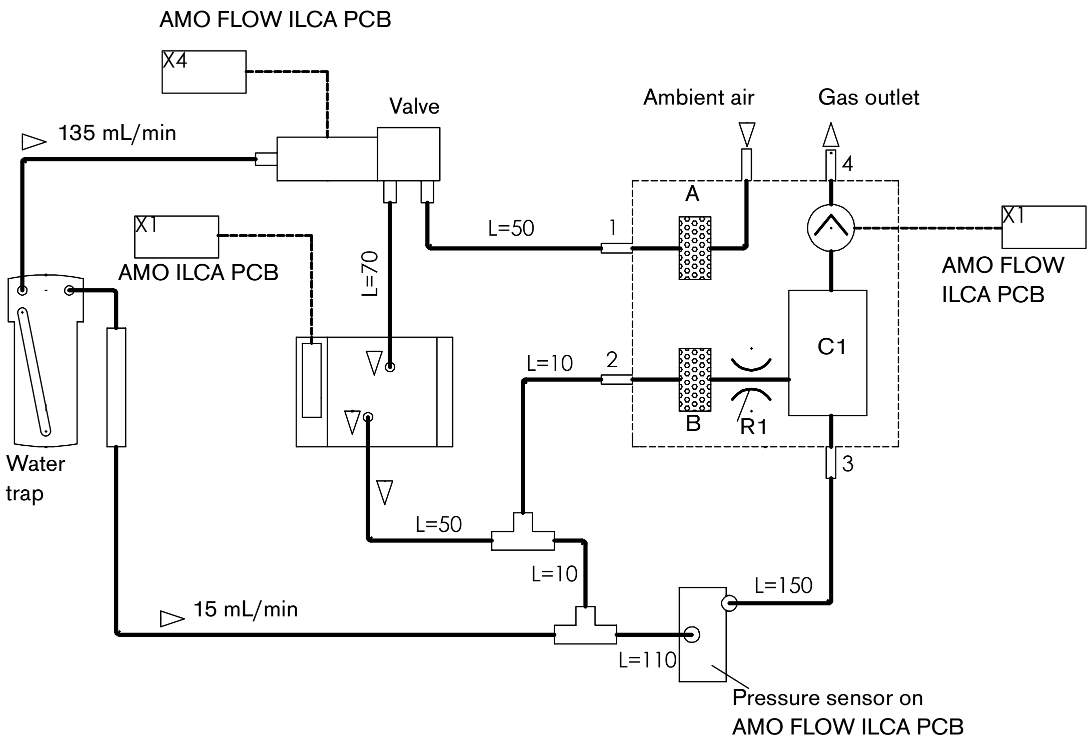


Fig. 1: VAMOS block diagram

Dräger MEDICAL

PMS

VAMOS

File no.: 6494.340
Edition 10.2001

DrägerService

Installation site: ____________________

Explanation of Symbols

—	OK	Z = Check condition
|	Defect/error/fault	F = Check function
◯	Spare parts used	D = Check for leaks
/	Report	P = Enter value
∩	Accessories missing	

Serial no.: ____________________

Date of delivery/ startup: ____________________

Invoice no. or delivery no.: ____________________

Other: ____________________

1. Unit, general

Composition of the inspection price:
VAMOS maximum configuration including the following options:

CO_2 measurement
Anesthetic gas measurement
SpO_2 measurement
but without optional rechargeable battery.

1.1 Software version
Transfer from test step 4.2.5. P

1.2 Options as per rating plate P

Note: Enter options under 1.6.

1.3 Operating hours - not applicable -

1.4 General condition Z

1.4.1 Instructions for use and medical product logbook available according to operators. Z

1.4.2 Attachment of extension arm or device feet Z

1.5 Housing inspection Z

1.5.1 Visual inspection of sockets on rear panel no damage Z

1.5.2 Visual inspection of anesthetic gas return line

No damage Z

1.5.3 Visual inspection of power switch

No damage Z

1.5.4 Visual inspection of control knob

No damage Z

1.5.5 Visual inspection of water trap

No damage. Z

1.5.6 Visual inspection of keys

All markings are legible. Z

1.5.7 Visual inspection of SpO2 sensor and SpO2 cable

No damage. Z

1.6 Options

1.6.1 Rechargeable battery option Z

1.6.2 SpO2 Z

1.6.3 Anesthetic gas measurement Z

---

2. Spare parts used

2.1 Anesthetic gas return line and bacterial filter
Replace bacterial filter 84 02 868 every 6 months. Z

2.2 Replace dust filter 68 70 846 once a year.
Dust filter must not be pressed together.
For this step the device needs to be opened. Z

Date of next replacement ____________

2.3 * Replace the rechargeable battery, 18 454 46, (if present) every 2 years. Z

Date of next replacement ____________

3. Safety Checks

The following steps describe the safety checks according to VDE 751 and IEC 60601 (or UL 2601).

Perform electrical safety checks **either** according to VDE 751 (chapter 22.3) **or** IEC 60601 (chapter 22.4). The decision whether to carry out safety checks according to VDE 0751 or IEC 60601 should be based on national regulations and/or regulations made by the regions/countries, whichever is applicable (for example, VDE 751 applies to "Germany" region). Switching from one safety check method to the other should be avoided.

Note: How to use the test devices "Secutest", "GM50", and "NSE"/"Wison" is described in the DORIS documentation (5000.4 MT Test Equipment / Instructions for Use). The "Wison" tester can only be used for testing according to VDE 751.

3.1 Inspection

3.1.1 Power cable Z

3.1.2 Power pack with 15 V cable and connector. Z

Connect desktop power pack to VAMOS.
Switch on VAMOS.

3.2 Tests according to VDE 751

3.2.1 Protective earth test -not applicable- (no protective earth connected)

3.2.2 Equivalent leakage current measurement - not applicable - (no accessible metal housing parts available)

3.2.3 Patient leakage current measurement

Only if SpO_2 option is fitted. Use Nellcor shorting cable 7901068.

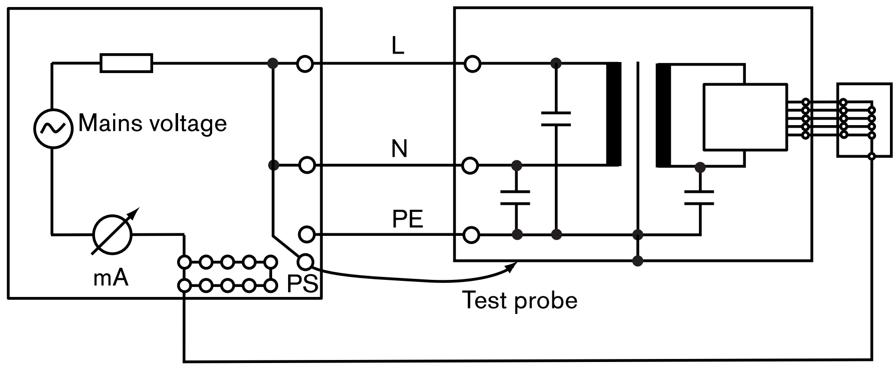


Fig. 1: Equivalent patient leakage current test

Description of illustration:

The mains voltage is present as test voltage at the mains connection of the test specimen. The current that flows from the live parts through the capacitors, the insulation, and the connected user connections is the equivalent patient leakage current.

Equivalent patient leakage current < 50 µA. Switch on the device; record the first test value; subsequent test values must not exceed the initial test value by more than 50% and must remain < 50 µA.

Note:
Always enter the first-measured value in a new Test Certificate.

First-measured value ☐ P ☐☐☐☐☐☐☐☐☐☐

3.3 Test according to IEC 60601

3.3.1 Protective earth test -not applicable-
(no protective earth connected)

3.3.2 Earth leakage current

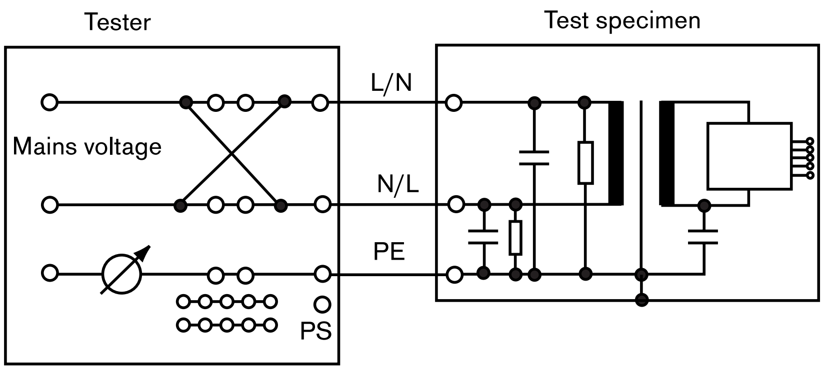


Fig. 2: Earth leakage current test

Description of illustration:

The mains voltage is present as test voltage at the mains connection of the test specimen. The test specimen is in operating mode. The current that flows from the live parts through the insulation and capacitors to the protective conductor is the earth leakage current.

The power conductor is interrupted in the event of a single-fault condition (SFC).

Normal condition (NC)
Test target: I_{earth} < 500 µA (according to UL 2601: I_{earth} < 300 µA). P

Single fault condition (SFC). Power conductor interrupted.
Test target: I_{earth} < 1 mA. P

In the following steps the test is repeated, but with the power plug turned over.

Normal condition (NC)
Test target: I_{earth} < 500 µA (according to UL 2601: I_{earth} < 300 µA). P

Single fault condition (SFC). Power conductor interrupted.
Test target: I_{earth} < 1 mA. P

3.3.3 Patient leakage current

Only if SpO_2 option is fitted. Use Nellcor shorting cable 7901068.

.

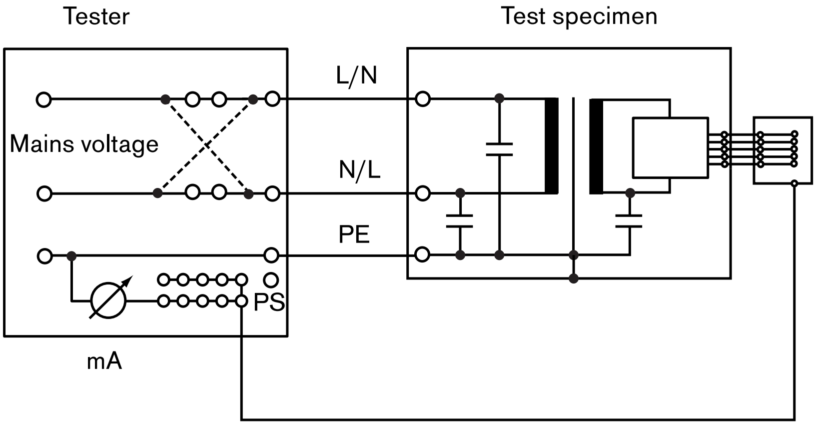


Fig. 3: Patient leakage current test

Description of illustration:

The mains voltage is present as test voltage at the mains connection of the tester. The current that flows from the connected connections of the applied part to the protective conductor is the patient leakage current.

The protective conductor is interrupted in the event of a single-fault condition (SFC).

Normal condition (NC)
Test target: I_{pat} < 100 µA. P

Single fault condition (SFC). Power conductor interrupted.
Test objective: I_{pat} < 500 µA. P

In the following steps the test is repeated, but with the power plug turned over.

Normal condition (NC)
Test objective: I_{pat} < 100 µA. P

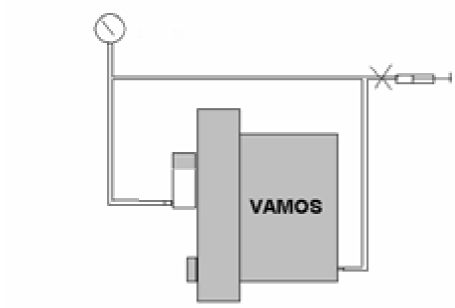
Single fault condition (SFC). Power conductor interrupted.

Test objective: I_{pat} < 500 µA. P

Remove the test set-up.

4. Test items

4.1	Connect the power pack. The power LEDs on the power pack and on VAMOS come on.	F
4.2	Switch on VAMOS. Check the function of the switch.	F
4.3	Power-on test	
4.3.1	A bleep can be heard.	F
4.3.2	All pixels on the display and all LEDs are triggered.	F
4.3.3	The fan is running.	F
4.3.4	The software version is displayed. Enter under test step 1.1.	F P
4.4	Functional check of key and control knob.	F
4.5	Power failure / internal battery test Unplug the power plug. Power LED on VAMOS goes off, audible power failure alarm sounds. LED turns yellow if the device is powered from the battery. Switch off the unit.	F
4.6	Leak test Refer to drawing for test set-up, for example, pressure measuring device 7910722. Use the disposable syringe to generate a vacuum of 200 mbar. Clamp the silicone hose.	



	The pressure must not increase by more than 20 mbar within 1 minute.	F
4.7	Water separator and pump test Switch on the unit. While in standby mode, access service mode by pressing the silence key and the control knob simultaneously. Remove sampling tube.	

4.7.1	Observe pressure displayed under "Psens". Disconnect water separator. Pressure must not increase by more than 70 mbar, otherwise, replace water trap.	Z
	Mount water separator.	
4.7.2	Pump test	
	Note: This test must not be performed in zeroing phase (EtCO2 and anesthetic gas indicate "CAL").	
	Seal the Luer-Lock connection.	
	Within 30 s, the value displayed under "Psens" must decrease by 200 mbar (compared to ambient pressure "Pamb"). The advisory message "Gas line!" is displayed. Remove blockage.	F
	Connect flowmeter block to water trap. Sampling rate is 150 ± 20 mL/min. Remove flowmeter block.	F
4.7.3	Pressure sensor test	
	Zero	
	Measure ambient pressure with digital barometer (7900217).	P
	Compare the ambient pressure measured with the digital barometer (7900217) with the VAMOS value displayed under "Pamb".	
	Deviation < 20 mbar	F
	Amplification	
	Pump is off, respiratory air is selected. Connect digital barometer to water trap. Pressure decreases.	
	Deviation between "Psens" and barometer value < 20 mbar	F
4.8	Measuring accuracy	
	Switch to measuring mode. Select desflurane. The selected CO_2 unit is vol.%. The following measurement can only be done at full accuracy (4 minutes after power-on):	

The following concentrations must be measured in ambient air once zeroing has been completed:

Des : 0,00 + 0.2 vol.% P

CO_2 : 0 + 0.5 vol.% P

N_2O : 0,0 + 2 vol.% P

CO_2/N_2O display accuracy

Connect test-gas cylinder (79 01 346) to sampling tube and open cylinder; (steep increase) wait until curve and digital values have stabilized.

Read CO_2 value off screen.
CO_2 value may differ by ± 0.8 vol.% from the calibration gas. P

Read N_2O value off screen.
N_2O value may differ by ± 8 vol.% from calibration gas. P

Read the desflurane value.
The value may differ by ± 0.6 vol.% from the calibration gas. P

4.9 Functional check of SpO_2 optional
Connect the Nellcor pulse oximeter tester (not the pocket tester) to the SpO_2 socket.

Pulse oximeter tester SRC 2:
Rate = 38
Light = High2
Modulation = Low
RCAL/Mode = LOCAL/RCAL63

SPO2 reading = 81 ± 2 F

♥ = **38 ± 1** F

4.10 Sensor test

Remove Nellcor tester.

Message under alarm info "SpO_2 sens.?!" after approx. 20 s	F										

Connect finger clip.

The message "SpO_2 sens.?" disappears.	F										

Measure your own oxygen saturation.

Reading > 90%	F										

Disconnect finger clip sensor from SpO_2 socket.

5. Supply unit to customer ready for operation.

6. Confirmation of test

Name:

Date:

Signature:

7. * These steps are regarded as repair work and are therefore not included in the inspection service price.

Report:

8. Annex

8.1 List of service equipment for PMS

Table 1: Test equipment

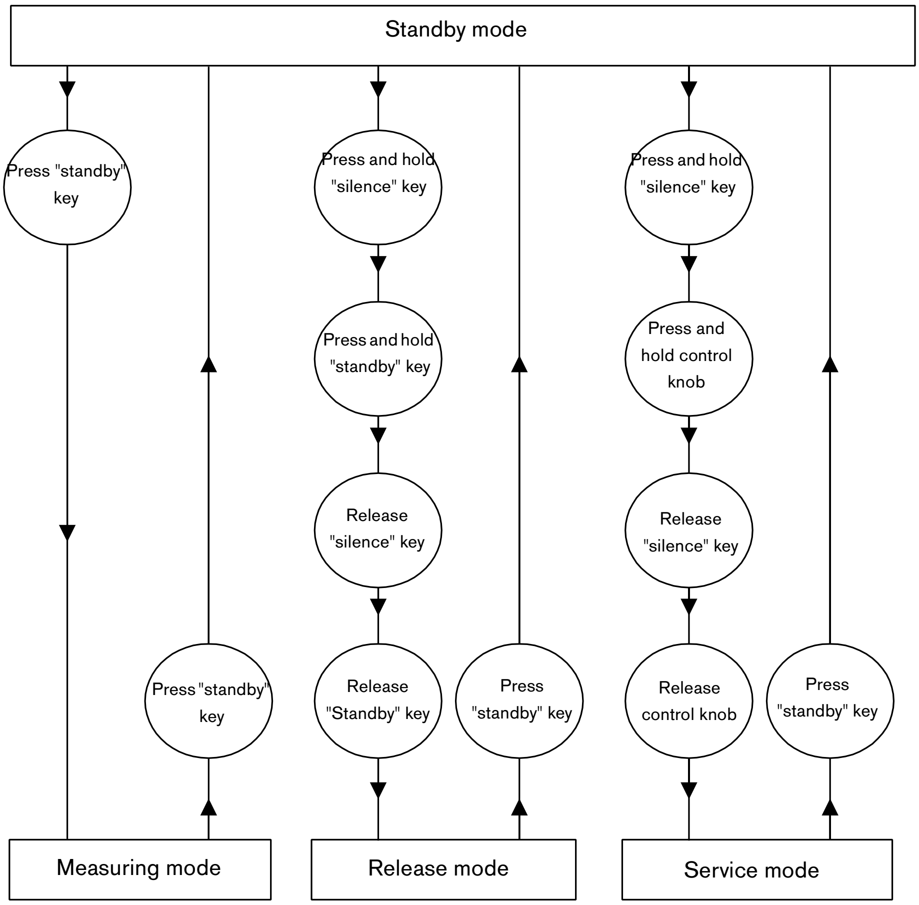
Designation	Order number
Digital pressure measuring device	e.g. 79 10 722
Digital barometer	79 00 217
VDE tester, complete	e.g. 79 00 234
Test gas desflurane	79 10 345
Flowmeter block	79 01 161
Pressure reducer for test gas	79 10 346
Nellcor pulse oximeter tester	79 01 069
Disposable syringe	
Silicone tubing 4 mm, approx. 1.2 m	

8.2 Required spare parts

Table 2: Required spare parts

Designation	Order number
Dust filter	68 70 846
Battery	2M86733
Bacterial filter	84 02 868
Sampling gas scavenging hose	11 90 520

8.3 Measuring mode, release mode, and service mode



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Schwenkarm (6870778)

Montageanweisung

Zweckbestimmung

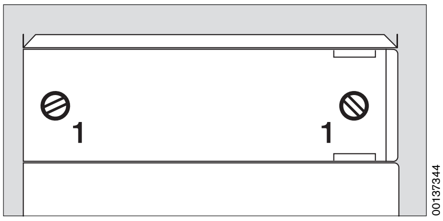
Schwenkarm – zur Befestigung des Monitors Vamos*, an den Anästhesiegeräten Fabius, Fabius GS oder an einer wandmontierten Normschiene 25 mm x 10 mm bzw. 30 mm x 10 mm. Der Aufnahmeteller des Schwenkarms ist kompatibel zum GCX-System.

Montage am Fabius

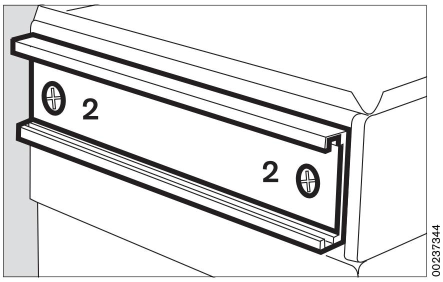
– Erforderliches Zubehör: Schiene MM15795, Fixierelemente müssen nicht verwendet werden.

Montage nur durch Fachleute!

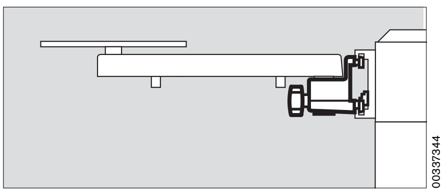
1 2 Seitenschrauben der Fabius Control Box abschrauben – vorzugsweise auf der linken Seite.



2 Schiene mit Kreuzschlitzschrauben M8x16 an die Control Box anschrauben, Anzugsmoment (10±2) Nm.



3 Schiebeblock des Schwenkarms in die Schiene bis zur gewünschten Position einschieben und die Befestigungsschraube im Uhrzeigersinn drehen – der Schwenkarm wird fixiert.



* Zur Befestigung ist die GCX-Adapterplatte (6870776) unbedingt erforderlich.

Swivel arm (6870778)

Installation instructions

Intended use

Swivel arm – for attaching the monitor Vamos* to the Fabius and Fabius GS anaesthetic workstations or to a wall-mounted standard rail 25 mm x 10 mm or 30 mm x 10 mm. The mounting plate of the swivel arm is compatible with the GCX system.

Attachment to Fabius

– Required accessories: Rail MM 15795, fixing elements are not required.

Only to be installed by an expert!

1 Unscrew two screws at the side of the Fabius Control Box – preferably at the left-hand side.

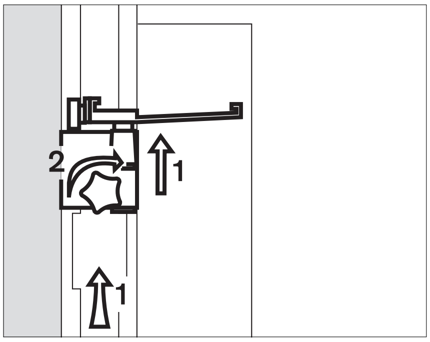
2 Screw rail to Control Box using recessed head screws M8x16, tightening torque (10±2) Nm.

3 Slide the block of the swivel arm into the rail as far as required and turn the locking screw clockwise to secure it – the swivel arm is now fixed.

* The GCX adapter plate (6870776) is essential for mounting.

Montage am Fabius GS

1 Schiebeblock des Schwenkarms durch die dafür vorgesehene Öffnung im unteren Teil der vertikalen Schiene einschieben.
2 In der gewünschten Position die Befestigungsschraube im Uhrzeigersinn drehen – der Schwenkarm wird fixiert.



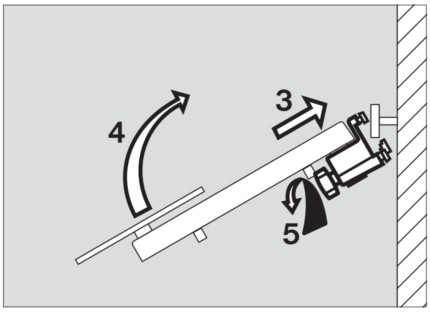
00437344

Attachment to Fabius GS

1 Slide the block of the swivel arm through the opening provided for this purpose in the lower part of the vertical rail.
2 When the required position is reached, turn the locking screw clockwise – the swivel arm is now fixed.

Montage an einer wandmontierten Normschiene

3 Schiebeblock des Schwenkarms von unten in die Normschiene einhaken.
4 Schwenkarm in die Waagerechte bringen und
5 in der gewünschten Position die Befestigungsschraube entgegen Uhrzeigersinn drehen – der Schwenkarm wird fixiert.



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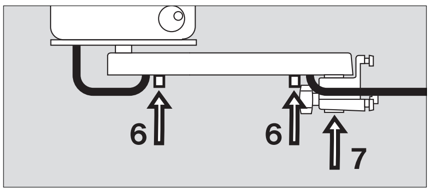
Installation on a wall-mounted standard rail

3 Hook the slide block of the swivel arm into the rail from below.
4 Move the swivel arm into a horizontal position and
5 turn the locking screw anticlockwise when the required position is reached – the swivel arm is now fixed.

Kabelführung

6 Kabel des Netzteils zwischen Monitor und Anästhesiegerät von unten in die Klammern im Schwenkarm einschnappen.



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Cable routing

6 Snap-fit the cable from the power pack between monitor and anaesthetic workstation into the clips in the swivel arm from below.

Beweglichkeit einstellen

7 Mit einem Innensechskantschlüssel 4 mm an der Unterseite des Drehgelenkes nach Wunsch einstellen.

Adjust mobility

7 Insert a 4 mm Allen key underneath the swivel joint and adjust as required.

Monitor befestigen

- GCX Adapterplatte an den Monitor schrauben und in den Aufnahmeteller schieben – mit der Arretierschraube befestigen.
  Arretierschraube sollte sich hinter dem Monitor befinden.

Secure monitor

- Screw GCX adapter plate onto monitor and slide it into the mounting plate – secure it with the locking screw.
  The locking screw should be behind the monitor.

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Zubehör

– Schiene MM15795,
  nur für die Befestigung am Fabius,
  nicht am Fabius GS.

Accessories

– Rail MM 15795,
  only for attachment to Fabius,
  not to Fabius GS.

Technische Daten

Traglast maximal:	7,5 kg
Schwenkbereiche	
des Aufnahmetellers:	360°
des Schwenkarms:	180°

Technical data

Maximum load capacity:	7.5 kg
Swivel range	
of the mounting plate:	360°
of the swivel arm:	180°

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10.10.00

Diese Ersatzartikelliste gilt für Sachnummer:
This spare parts list is valid for part no.:

Sach-Nr. **Part No.**	**Benennung** **Description**
6870750	VAMOS VAMOS

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Inhaltsverzeichnis der Bilder
Summary of pictures

Bild Picture	Bezeichnung Description	Sach-Nr. Part No .	E-Liste Spare parts list
1	VAMOS VAMOS	6870750	
2	GRUNDRAHMEN FRAME	6870705	
3	ILCA MODUL VAMOS ILCA MODUL VAMOS	6870660	
4	HALTEARM SUPPORT	6870778	

Zubehör ohne Abbildung:
Accessories without pictures:

Benennung **Description**	**Sach-Nr.** **Part No.**	**Bestell-Nr.** **Order-Code**	**Packung** **Quantity**
AKKU, LITHIUM-IONEN ACCU		2M86733	
NETZGERAET POWERSUPPLY		6870657	

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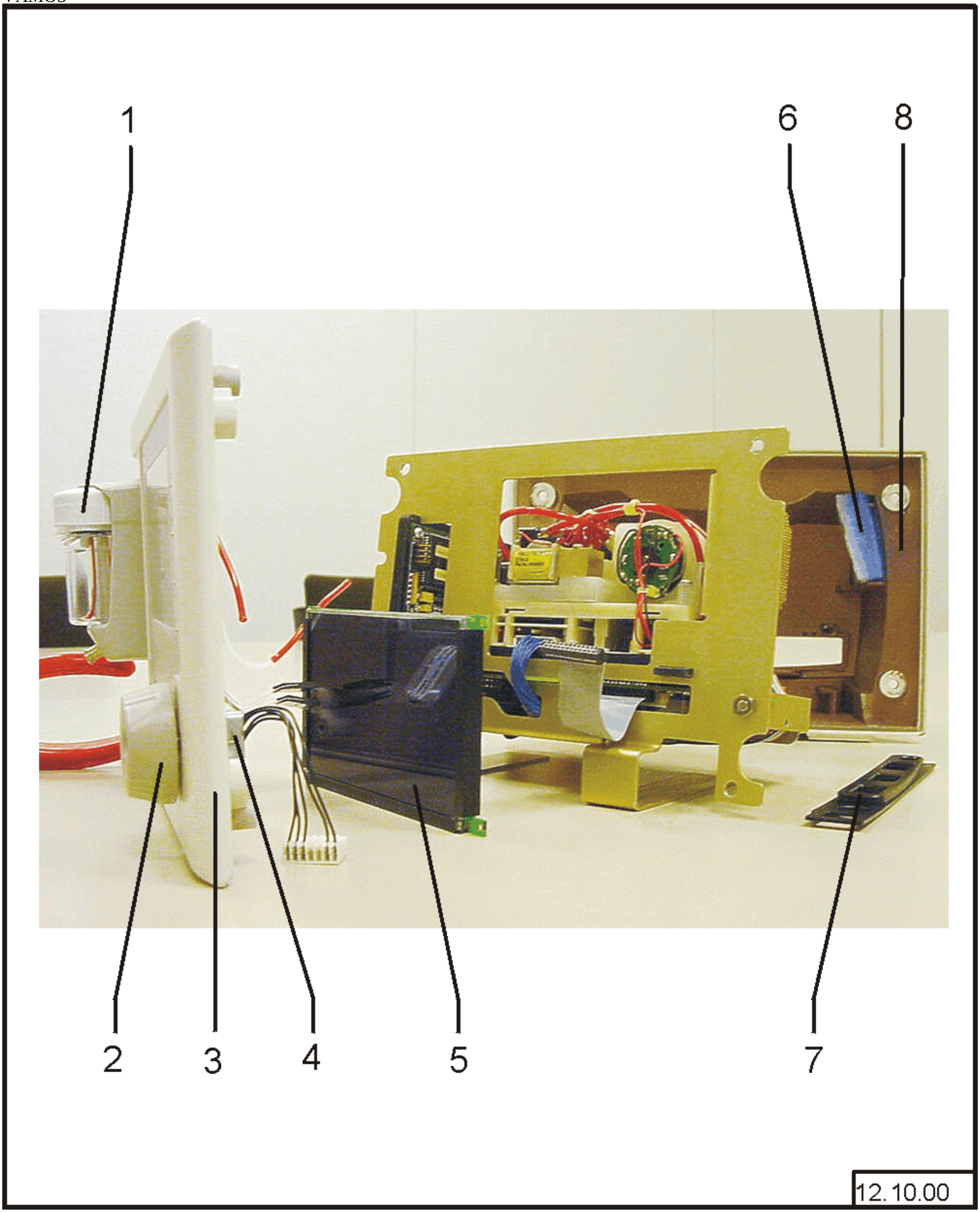
VAMOS
VAMOS

Bild/Picture 1



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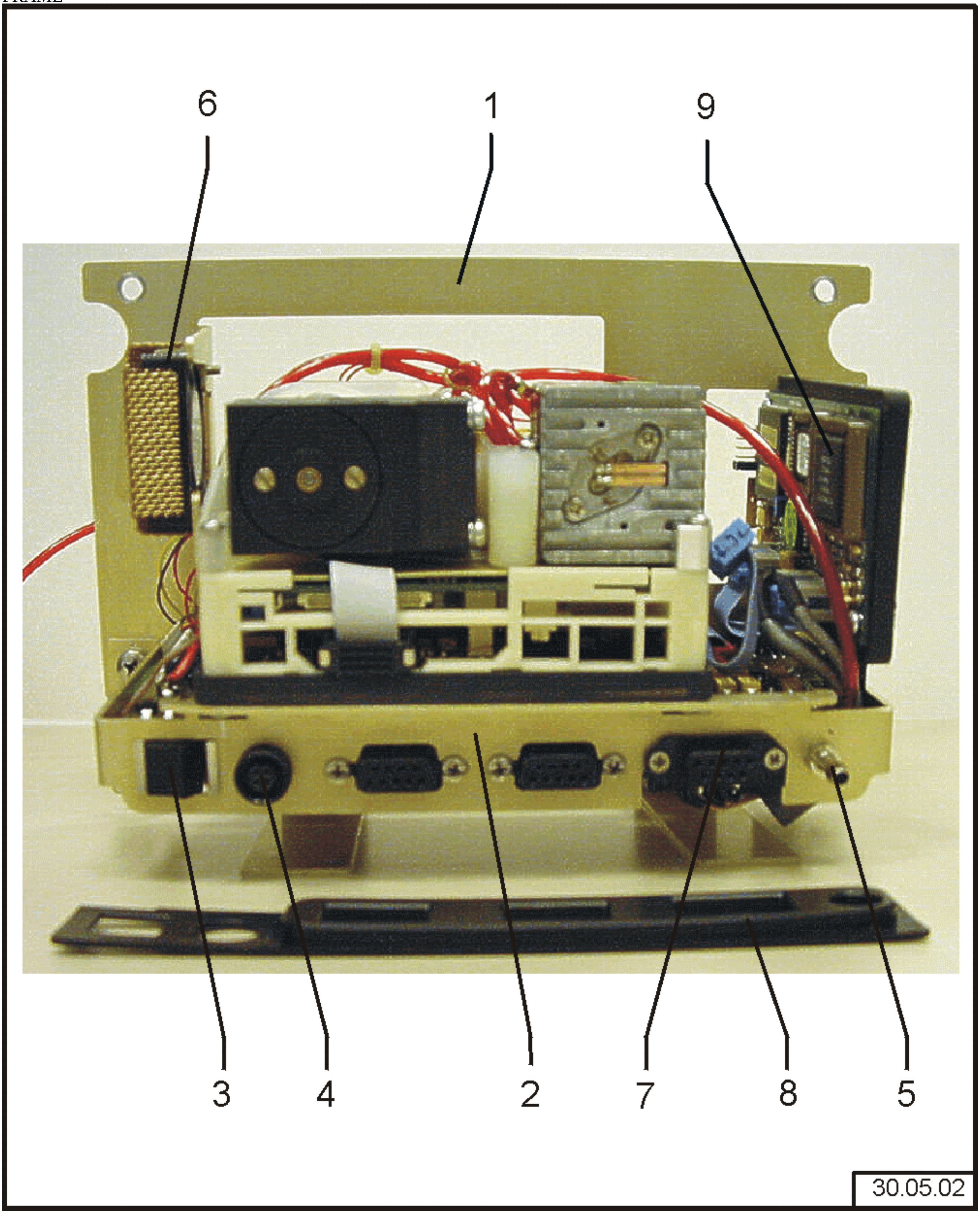
Position **Item No.**	**Benennung** **Description**	**Sach-Nr.** **Part No.**	**Bestell-Nr.** **Order-Code**	**Packung** **Quantity**
1-9	VAMOS VARIANTE 1 MIT A-GAS FUNKTION 6870712 UND SPO2-SET 6870706 VAMOS VARIANCE 1 WITH A-GAS FUNKTION 6870712 AND SPO2-SET 6870706		6870750	
	VAMOS VARIANTE 2 MIT A-GAS FUNKTION 6870712 VAMOS VARIANCE 2 WITH A-GAS FUNKTION 6870712		6870750	
	VAMOS VARIANTE 3 MIT SPO2-SET 6870706 VAMOS VARIANCE 3 WITH SPO2-SET 6870706		6870750	
1	WATERLOCK WATER LOCK M		6870511	
2	DREHKNOPF CONTROL KNOB		M29954	
3	FRONT,KOMPLETT HAUSING-FRONTSIDE		6870651	
4	DREHGEBER,KOMPL. SHAFT ENCODER,CPL.		8306565	
5	EL-DISPLAY 240X128 EL-DISPLAY 240X128		1845454	
6	FILTERMATTE FILTER		6870846	
7	ABDECKPLATTE COVER-PLATE		6870654	
8	BACK,KOMPLETT HAUSING-BACKSIDE		6870658	
9	RUESTSATZ ALLG. OHNE ABBILDUNG WATERTRAP UPGRADE KIT UNIVERS. WITHOUT ILLUSTRATION		6870564	

GRUNDRAHMEN
FRAME

Bild/Picture 2



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Position **Item No.**	**Benennung** **Description**	**Sach-Nr.** **Part No.**	**Bestell-Nr.** **Order-Code**	**Packung** **Quantity**
1,2-6	GRUNDRAHMEN FRAME	6870705		
2,3-5	LP VAMOS PCB VAMOS		6870855	
3	SCHALTER (ON NONE ON) SWITCH		6870782	
4	STECKVERBINDER PLUG CONNECTOR		6870800	
5	TUELLE SOCKET		8600512	
6	LUEFTER 5VDC 40X40X10 LV02903 FAN 5V DC 40X40X10		1846043	
7	KABELBAUM SPO2 CABLE HARNESS SPO2		6870779	
8	ABDECKPLATTE COVER-PLATE		6870654	
9	LP SPO2 MIT SENSOR PCB SPO2 WITH SENSOR		6870656	

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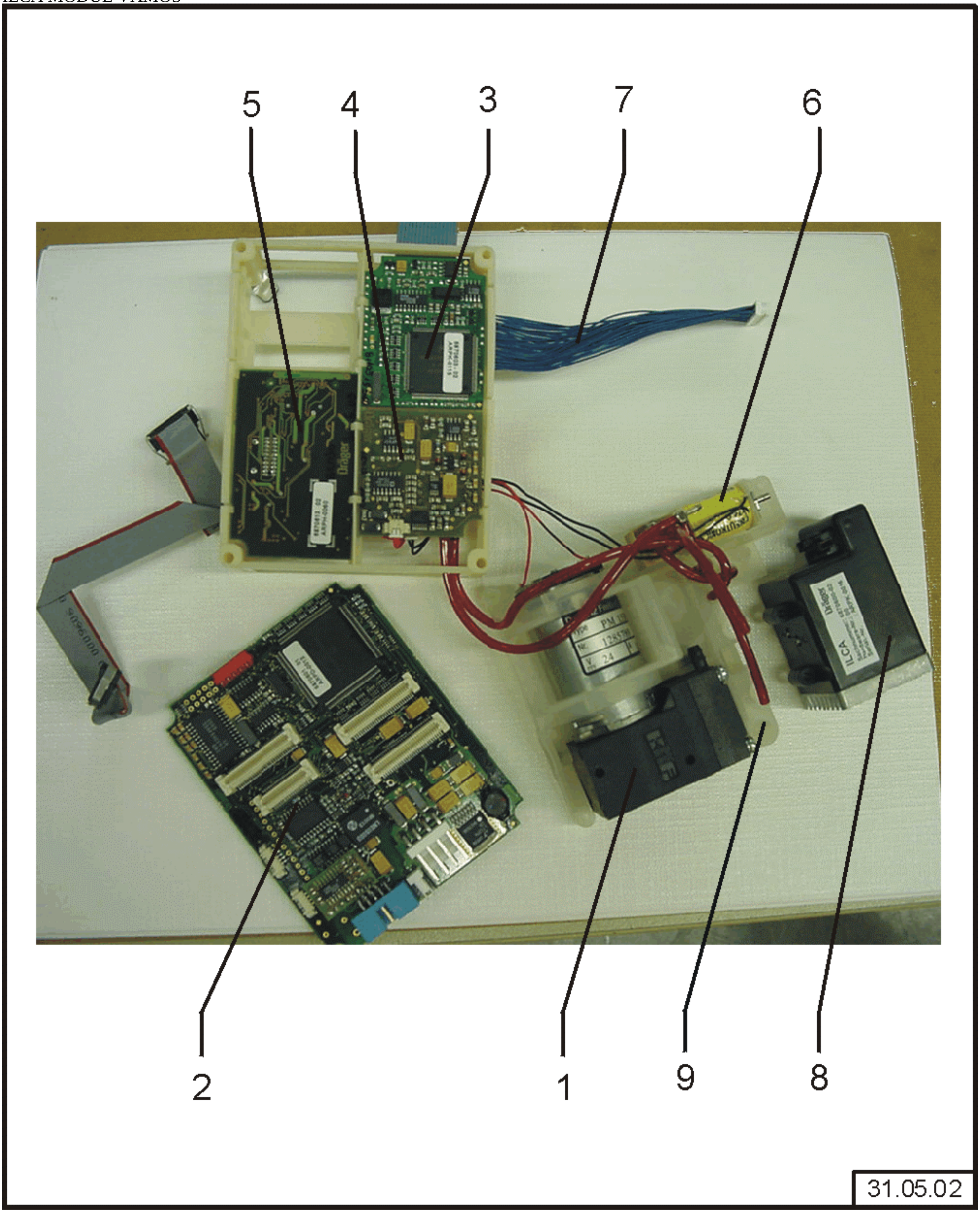
ILCA MODUL VAMOS
ILCA MODUL VAMOS

Bild/Picture 3



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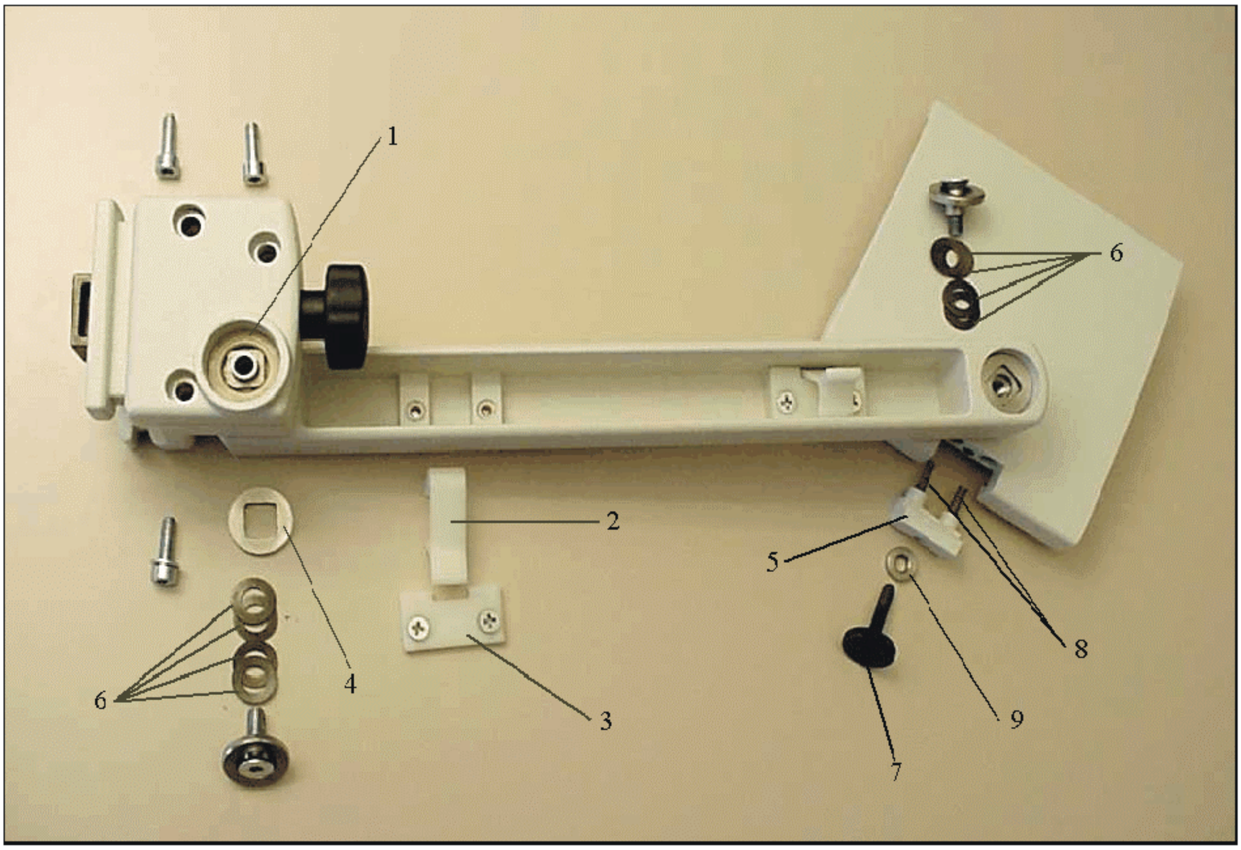
Position **Item No.**	**Benennung** **Description**	**Sach-Nr.** **Part No.**	**Bestell-Nr.** **Order-Code**	**Packung** **Quantity**
1-8	ILCA MODUL VAMOS ILCA-MODUL-VAMOS	6870660		
1	PUMPE KNF PUMP KNF		6870586	
1a	O RING (OHNE ABBILDUNG) O-RING SEAL (WITHOUT ILLUSTRATION)		6870630	
2	LP MOPS LP MOPS		6870601	
3	LP AMO O2 GRAF LP AMO O2 GRAF		6870603	
4	LP AMO FLOW ILCA BOARD AMO FLOW ILCA		6870605	
5	LP AMO ILCA LP AMO ILCA		6870613	
6	MAGNETVENTIL ILCA MAGNETIC VALVE ILCA		6870637	
7	KABELSATZ CABLEHARNESS		6870719	
8	SENSORKOPF ILCA SENSORHEAD, ILCA		6870600	
9	ILCA PNEUMATIK VOLLST. ILCA PNEUMATIC CPL.		6870635	
10	SW RÜSTSATZ MFM-2.X (OHNE ABBILDUNG) RS SOFTWARE MFM-2.X (WITHOUT ILLUSTRATION)		6871022	
11	SW RÜSTSATZ MFM 1.01 (OHNE ABBILDUNG) REPLACEMENT SET MFM 1.01 (WITHOUT ILLUSTRATION)		6871047	

HALTEARM
SUPPORT

Bild/Picture 4



30.05.02

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Position **Item No.**	**Benennung** **Description**	**Sach-Nr.** **Part No.**	**Bestell-Nr.** **Order-Code**	**Packung** **Quantity**
1-8	HALTEARM SUPPORT	6870778		
1	BUNDBUCHSE SOCKET		MX08084	
2	KABELKLEMME CABLE CLIP		MX08085	
3	KLEMMHALTER CLAMP HOLDER		MX08086	
4	BUCHSE F. TELLERFEDER SOCKET FOR SPRING WASHER		MX08087	
5	KLEMMSTÜCK CLAMPING DEVICE		MX08088	
6	TELLERFEDER SPRING WASHER		MX08089	
7	RÄNDELSCHRAUBE KNURLED SCREW		MX08090	
8	DRUCKFEDER PRESSURE SPRING		MX08091	
9	DISTANZHÜLSE DISTANCE CASE		MX08092	

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