Datex-Ohmeda

S/5™ Airway Module, G-AO (rev. 06)
S/5™ Airway Module, G-AiO (rev. 05)
S/5™ Airway Module, G-AiOV (rev. 04)
S/5™ Airway Module, G-AOV (rev. 04)

S/5™ Gas Interface Board, B-GAS (rev. 01)

Technical Reference Manual Slot

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TABLE OF CONTENTS

S/5 Airway modules and S/5 Gas Interface Board, B-GAS

TABLE OF CONTENTS i

TABLE OF FIGURES iii

INTRODUCTION 1

1 Specifications 2

1.1 General specifications 2
1.2 Typical performance 2
1.2.1 CO_2 2
1.2.2 Respiration rate 2
1.2.3 O_2 2
1.2.4 N_2O 2
1.2.5 Hal, Iso, Enf 2
1.2.6 Sev 2
1.2.7 Des 3
1.2.8 Agent identification 3
1.2.9 Patient Spirometry 3
1.2.10 Airway Pressure (Paw) 3
1.2.11 Tidal Volume (TV) 3
1.2.12 Minute Volume (MV) 3
1.2.13 Airway flow 3
1.3 Technical specification 4
1.3.1 CO_2 4
1.3.2 O_2 4
1.3.3 N_2O 4
1.3.4 AA 4

2 Functional Description 5

2.1 Measurement principle 5
2.1.1 CO_2, N_2O and Agent measurement 5
2.1.2 O_2 measurement 6
2.1.3 Agent identification 7
2.1.4 Patient Spirometry 8
2.2 Main components 9
2.2.1 Gas sampling system 10
2.2.2 ACX-200 measuring unit 16
2.2.3 OM measuring unit 17
2.2.4 ACX measuring board 18
2.2.5 ASX agent identification bench 20
2.2.6 ASX measuring board 20
2.2.7 PVX board 22
2.2.8 Gas mother board 24
2.2.9 Gas interface board 26
2.3 Connectors and signals 26
2.3.1 Module bus connector 26

2.3.2 Gas mother board connectors 27

3 Service Procedures 31

3.1 General service information 31
3.2 Service check 32
3.2.1 Recommended tools 32
3.2.2 Recommended parts 32
3.3 Disassembly and reassembly 41
3.4 Adjustments and calibrations 42
3.4.1 Gas sampling system adjustment 42
3.4.2 Flow rate measurement 42
3.4.3 Oxygen measurement unit adjustments 44
3.4.4 Flow calibration 46

4 Troubleshooting 47

4.1 Troubleshooting chart 47
4.1.1 Supply voltage troubleshooting 48
4.2 Gas sampling system troubleshooting 49
4.2.1 Sampling system leak test 49
4.2.2 Water separation 49
4.2.3 Steam test for the special tubes 49
4.3 OM measuring unit troubleshooting 50
4.4 ACX troubleshooting 50
4.4.1 Cleaning the measuring chamber of ACX measuring unit 50
4.5 ASX agent identification unit troubleshooting 52
4.6 PVX board troubleshooting 53
4.7 Gas mother board troubleshooting 53
4.7.1 Instructions after replacing the software or Gas mother board 53
4.8 Error messages 54

5 Service menu 55

5.1 Gas mother board 56
5.2 ACX service menu 59
5.3 PVX service menu 61
5.3.1 Flow calibration 62
5.3.2 Temp & Hum service menu 63
5.4 ASX service menu 64

6 Spare parts 65

6.1 Spare parts list 65
6.1.1 G-AO rev. 01, G-AiO rev. 00 65
6.1.2 G-AO rev. 02, G-AiO rev. 01, G-AOV rev. 00, G-AiOV rev. 00 66
6.1.3 G-AO rev. 03, G-AiO rev. 02, G-AOV rev. 01, G-AiOV rev. 01 66
6.1.4 G-AO rev. 04, G-AiO rev. 03, G-AOV rev. 02, G-AiOV rev. 02, G-O rev. 00, G-OV rev. 00 67
6.1.5 G-AO rev. 05, G-AiO rev. 04, G-AOV rev. 03, G-AiOV rev. 03, G-O rev. 01, G-OV rev. 01 67
6.1.6 S/5 G-AO rev. 06, G-AiO rev. 05, G-AOV rev. 04, G-AiOV rev. 04 67
6.1.7 Panel stickers 67
6.1.8 S/5 panel stickers 68
6.1.9 Planned Maintenance (PM) Kits: 69
6.1.10 Gas Interface Board, B-GAS 69

7 Earlier Revisions 70

APPENDIX A **71**

Service check FORM **A-1**

TABLE OF FIGURES

Figure 1 CO_2/N_2O/AA gas absorption spectra....5
Figure 2 O_2 measurement principle....6
Figure 3 Anaesthetic Agents gas absorption spectra....7
Figure 4 Airway module block diagram....9
Figure 5 Gas sampling system block diagram....12
Figure 6 Gas sampling system layout....13
Figure 7 Gas sampling system block diagram....13
Figure 8 Gas sampling system layout....14
Figure 9 ACX photometer (ACX-200 measuring unit)....16
Figure 10 CO_2/N_2O/AA measurement block diagram....17
Figure 11 ACX measuring board block diagram....19
Figure 12 ASX measuring unit....20
Figure 13 ASX measuring board block diagram....21
Figure 14 PVX board block diagram....23
Figure 15 Gas mother board block diagram....25
Figure 16 Gas sampling system adjustment chart....43
Figure 17 O_2 measuring unit adjustments....46
Figure 18 ASX troubleshooting flowchart....52
Figure 19 PVX board troubleshooting flowchart....53

INTRODUCTION

The S/5 Airway Modules, G-AO, G-AiO, G-AOV and G-AiOV are designed for use with the S/5 Anesthesia Monitor and provide airway and respiratory parameters. Later in this manual modules can be called w/o system name S/5.

This Technical Reference Manual Slot provides information for the maintenance and service of the airway modules. Please see also related *Technical Reference Manual* for information related to system e.g. related documentation, conventions used, symbols on equipment, safety precautions, system description, system installation, interfacing, functional check and planned maintenance.

Letters in the name stand for:
G = Side mountable gas module
O = CO_2, Patient O_2, and N_2O
V = Patient Spirometry
A = Anesthetic agents
i = Agent identification

Table 1 Options of Parameter Modules

	CO_2	N_2O	Patient O_2	Agents	Agent id	Spirometry
G-AO	•	•	•	•		
G-AiO	•	•	•	•	•	
G-AOV	•	•	•	•		•
G-AiOV	•	•	•	•	•	•

NOTE: The Airway Modules and Compact Airway Modules cannot be used simultaneously in the same monitor.

Gas Interface Board

Gas Interface Board, B-GAS is used for connecting the airway module to the central unit. The connection can also be made through the Interface Board, B-INT.

1 SPECIFICATIONS

1.1 General specifications

Module size, W × D × H	135 × 410 × 135 mm/5.3 × 15.0 × 5.3 in
Module weight	6 kg/13 lbs.

1.2 Typical performance

Sampling rate	200 ml/min nominal (180...220 ml/min)
Display update rate	breath-by-breath

Automatic compensation for pressure, CO_2-N_2O, and CO_2-O_2 collision broadening effect.
Warm-up time 3 min for operation, 30 min for full specifications.

Auto-zeroing is performed at start-up, after 5 min + 5 min + 5 min + 15 min + 15 min + 15 min, and after that every 60 min at regular intervals.

1.2.1 CO_2

Measurement range	0 to 10 %, (0 to 10 kPa), (0 to 76 mmHg)
Extended range	10 to 15 %, (10 to 15 kPa), (76 to 114 mmHg) (unspecified)

If CO_2 concentration is below 0.1 %, 0.0 % is displayed.

1.2.2 Respiration rate

Breath detection	1 % change in CO_2 level
Measurement range	4 to 60 breaths/min

1.2.3 O_2

Measurement range	0 to 100 % O_2

1.2.4 N_2O

Measurement range	0 to 100 % N_2O

1.2.5 Hal, Iso, Enf

Measurement range	0 to 5 %
Extended range	5 to 15 % (unspecified)

1.2.6 Sev

Measurement range	0 to 8 %
Extended range	8 to 15 % (unspecified)

1.2.7 Des

Measurement range	0 to 18 %
Extended range	18 to 30 % (unspecified)
Resolution	two decimals when the AA concentration below 1.0 %

If AA concentration is below 0.10 %, 0.00 % is displayed.

1.2.8 Agent identification

Identified agents	HAL, ENF, ISO, SEV, DES
Identification time	30 seconds (typical value with pure agents)
Identification threshold	0.15 vol% (typical)

Mixture warning when minor component concentration > 0.3 vol% and > 15 %of total agent concentration

1.2.9 Patient Spirometry

Values are valid when:

Respiratory rate	adult 4...30	pedi 4...50 breaths/min
I:E ratio	1:3 - 1:0.5	

Inner diameter of ET tube is ≥ 5.5 mm (adult) or 3 to 6 mm (pediatric).

1.2.10 Airway Pressure (Paw)

Accuracy	±1.5 cmH_2O
Resolution	1 cmH_2O
Measuring range	-20 to +80 cmH_2O

1.2.11 Tidal Volume (TV)

Accuracy	±6 % or 30 ml (adult); ±6 % or 4 ml (ped)
Resolution	1 ml
Measurement range	150 to 2000 ml (adult) 15 to 300 ml (ped)

1.2.12 Minute Volume (MV)

Resolution	0.1 l/min
Measurement range	2 to 15 l/min (adult) 0.5 to 5 l/min (ped)

1.2.13 Airway flow

Measurement range	1.5 to 100 l/min for both directions (adult) 0.25 to 25 l/min for both directions (ped)

1.3 Technical specification

1.3.1 CO_2

Measurement rise time	<360 ms (from 10 to 90 %)
Gain stability	≤0.2 %CO_2/24 h (0 to 8 %)
	≤0.4 %CO_2/24 h (8 to 10 %)
Gain temperature drift	≤0.2 %CO_2/10 °C (0 to 8 %)
	≤0.4 %CO_2/10 °C (8 to 10 %)
Nonlinearity error	≤0.2 %CO_2 (0 to 8 %)
	≤0.4 %CO_2 (8 to 10 %)

1.3.2 O_2

Measurement rise time	<480 ms (from 10 to 90 %)
Gain drift	≤2 % O_2/24 h
Gain temperature drift	≤3 % O_2/10 °C
Nonlinearity error	≤2 % O_2

1.3.3 N_2O

Measurement rise time	<360 ms (from 10 to 90 %)
Gain drift	≤2 % N_2O/24 h
Gain temperature drift	≤3 % N_2O/10 °C
Nonlinearity error	≤2 % N_2O

1.3.4 AA

Measurement rise time	<520 ms (from 10 to 90 %)
Gain drift	≤0.4 % AA/24 h
Gain temperature drift	≤0.4 % AA/10 °C
Nonlinearity error	≤0.2 % AA

Protection against electrical shock
Type BF

2 FUNCTIONAL DESCRIPTION

2.1 Measurement principle

2.1.1 CO_2, N_2O and Agent measurement

The CO_2, N_2O, and anesthetic agent gas measurements are based on absorption of infrared light as it passes through the gas sample in measuring chamber in the photometer. The light absorption is measured at three wavelengths using an infrared detector. One of the wavelengths is that of the CO_2 absorption peak at 4.3 micrometers, the second is that of the N_2O absorption peak at 3.9 micrometers, and the third is that of the anesthetic agent absorption peak at 3.3 micrometers. The signal processing electronics receive the signals from the IR detector and demodulate it to get DC components out of these signals which correspond to the content of each gas in the sample.

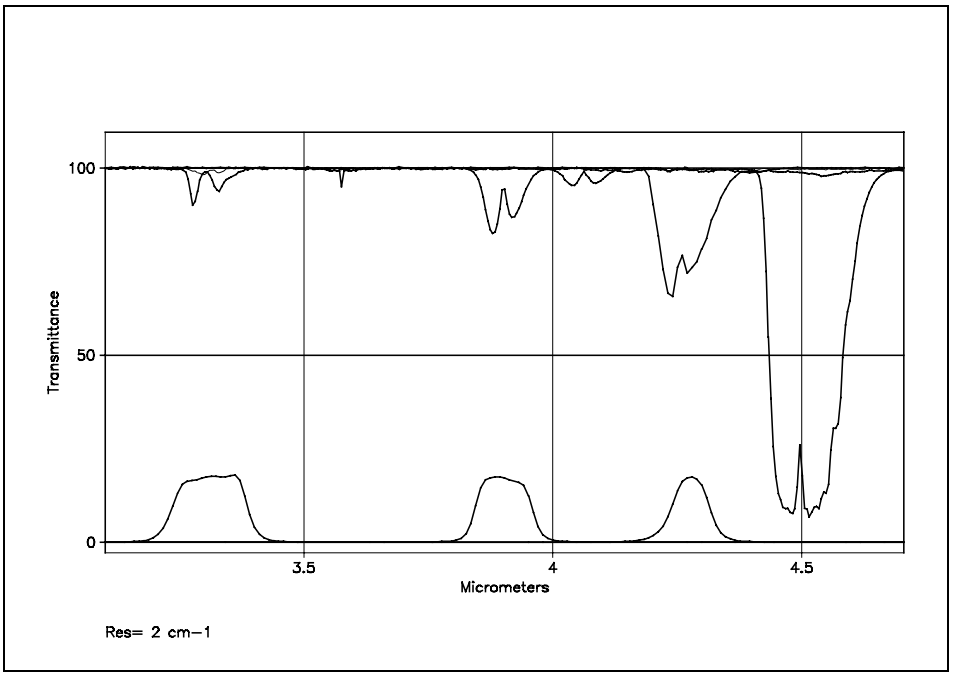


Figure 1 CO_2 / N_2O / AA gas absorption spectra

2.1.2 O_2 measurement

The differential oxygen measuring unit uses the paramagnetic principle in a pneumatic bridge configuration. The signal picked up with a differential pressure transducer is generated in a measuring cell with a strong magnetic field that is switched on and off at a frequency of 110 Hz. The output signal is a DC voltage proportional to the O_2 concentration difference between the two gases to be measured.

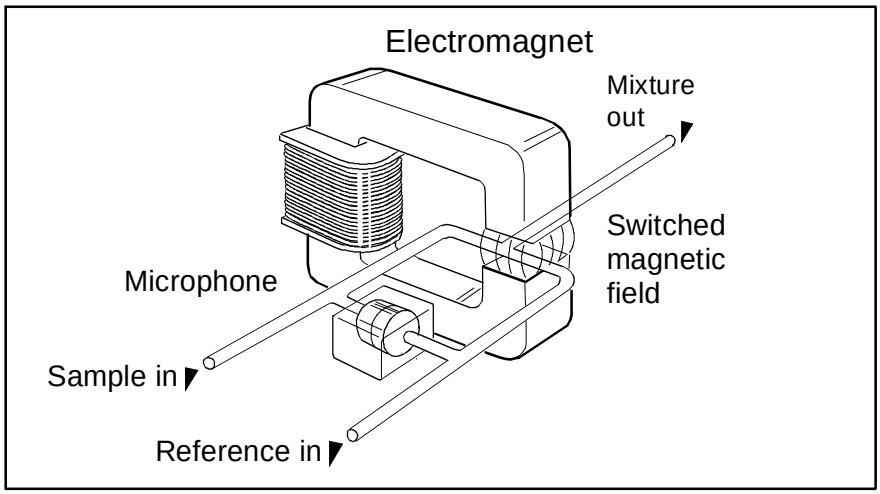


Figure 2 O_2 measurement principle

2.1.3 Agent identification

The anesthetic agent identification bench identifies Halothane, Enflurane, Isoflurane, Desflurane and Sevoflurane.

The bench measures the spectrum of the gas between 3.24 µm and 3.39 µm. Because the spectrum of each of the anaesthetic agents is different it is possible to identify them.

The bench consists of an infrared source, a measuring chamber, a rotating filter and a detector. The peak wavelength of the narrow bandpass filter changes when the angle between the light path and the filter is changed. When the filter rotates the required spectrum is scanned through. The agent or a mixture of agents is identified by comparing the measured spectrum with stored reference spectra.

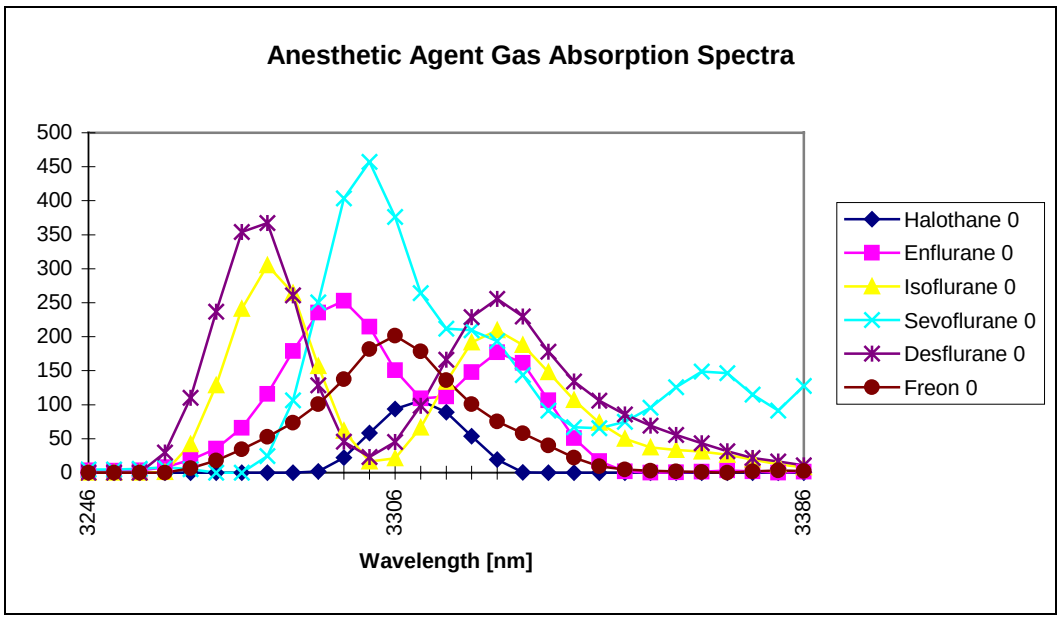


Figure 3 Anaesthetic Agents gas absorption spectra

2.1.4 Patient Spirometry

In anesthesia, CMV (Controlled Mechanical Ventilation) is the mostly used ventilation mode. In this mode, mechanical breaths are delivered to the patient by a ventilator with a proper tidal volume (TV), respiration rate (RR), and inspiration/expiration ratio in time (I:E) determined by the settings of the ventilator.

Delivery of life support gases is based on pressure. However, without knowing volume measured of exhalation, one cannot be sure that a breath occurred. The ultimate goal of ventilation is to use the least amount of pressure to generate the most appropriate volume for each breath.

The Patient Spirometry monitors ventilation in anesthesia. Both patient breathing circuit and the function of the ventilator are monitored. The following parameters are displayed:

Expiratory and inspiratory tidal volume (TV) in ml.
Expiratory and inspiratory minute volume (MV) in l/min.
Expiratory volume in first second (V1.0) in per cent for adults and in 0.5 seconds for children.
Inspiration/expiration ratio in time (I:E)
Airway pressures: Peak pressure (P_{peak}), End inspiratory pressure (P_{plat}), Positive end expiratory pressure (PEEP), Real time airway pressure waveform (P_{aw})
Flow: Real time flow waveform (V')
Compliance (C)
Pressure volume loop
Flow volume loop

Airway pressure

PEEP, P_{peak}, and P_{plat} are measured by pressure transducer on the PVX board. Atmospheric pressure is used as a reference in measurement. The pressure measurement is made from the airway part that is closest to the patient between patient circuit and intubation tube.

Airway flow

The measurement is based on measuring the kinetic gas pressure and is performed using Pitot effect. Pressure transducer is used to measure the Pitot pressure. The obtained pressure signal is linearized and corrected according to the density of the gas. Speed of the flow is calculated from these pressure values and TV value is then integrated. MV value is further calculated and averaged using TV and RR (respiratory rate) values.

Patient Spirometry sensor, D-lite

Patient Spirometry is measured with a specific sensor, D-lite or Pedi-lite.

D-lite and Pedi-lite sensors are designed to measure kinetic pressure by two-sided Pitot tube. The pressure reduction caused by measuring cross is taken into account, too, especially in small flows.

Velocity is calculated from pressure difference according to Bernoulli's equation. Flow is then determined using the calculated velocity.

$$v = \sqrt{\frac{2 \times dP}{\rho}}$$ (from Bernoulli's equation)

$$F = v \times A,$$

where,
F=flow (l/min)
v=velocity (m/s)
A=cross area (m^2)
dP=pressure difference (cmH_2O)
ρ=density (kg/m^3)

Finally the volume information is obtained by integrating the flow signal.

2.2 Main components

The airway modules consist of ACX-200 and OM-101 gas measuring units, ASX-200 agent identification unit (G-AiO/AiOV), PVX board (G-OV/AiOV/AOV), gas sampling system, ACX measuring board and gas mother board.

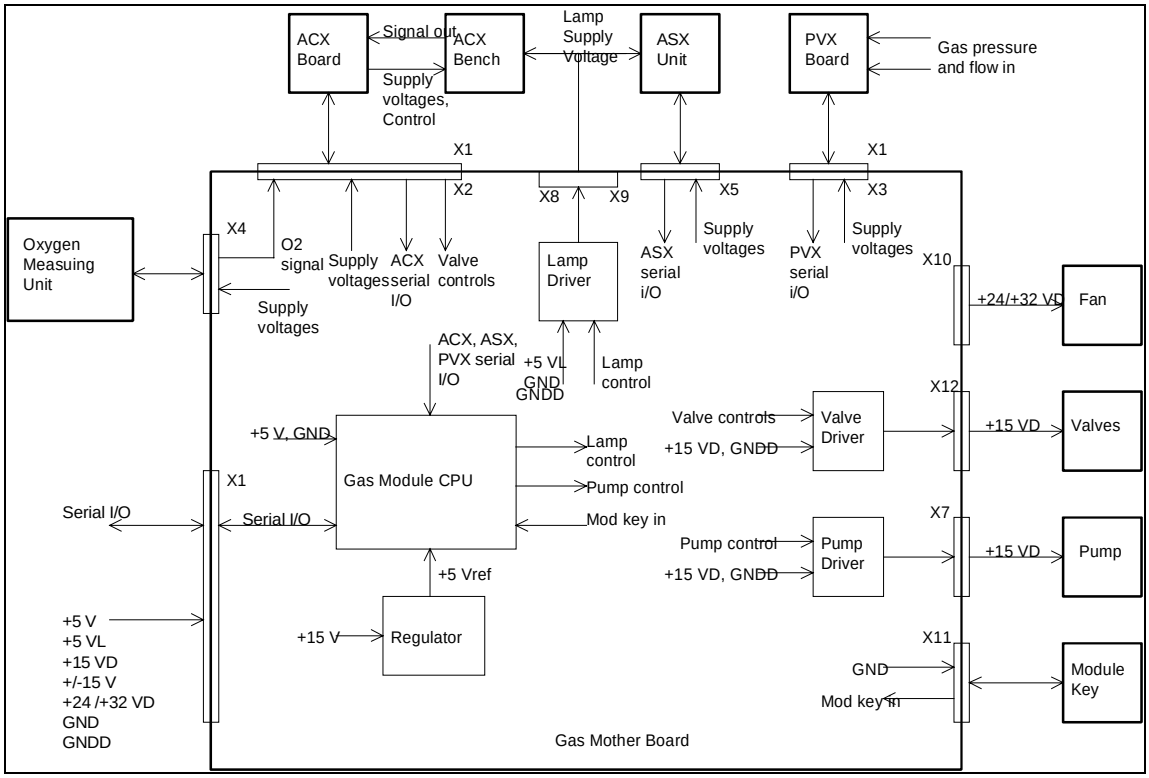


Figure 4 Airway module block diagram

2.2.1 Gas sampling system

The gas sampling system samples the measured air to the module, and removes water and impurities from it. A sampling line is connected to the water trap on the front panel. The pump draws gas through the sampling line to gas measuring units. After the measurements, the gas is exhausted from sample gas out connector on the rear panel of the module.

Water trap, D-fend

The gas sample enters the monitor through the water trap, where it is divided into two flows, main flow and side flow (see Gas sampling system block diagram). The main flow goes into the measuring system through a hydrophobic filter.

The side flow creates a slight sub-atmospheric pressure within the water trap container. This facilitates gathering the fluid removed by the hydrophobic filter.

Sampling line

The sampling line is an integral part of the total sampling system. The resistance established by the sampling line is significant when the software determines the occlusion and air-leak alarm limits during the turn-on sequence.

The small inner diameter causes fluids such as blood or mucus not to propagate within the tube, so that when the line is clogged, it is replaced.

The Nafion™ tube [1)]

A nafion tube (tubes A or B, and C: see figure 5) is used to balance the sample gas humidity with that of ambient air. The tube will prevent errors caused by the effect of water vapor on gas partial pressure when humid gases are measured after calibration with dry gases. It is inserted between the water trap and the zero valve (G-AiO/AiOV) or between the zero valve and ACX-200 measuring unit (G-O/OV/AO/AOV). The tube is also inserted between the CO_2 absorber and the zero valve.

Zero valve

The main flow passes through a solenoid valve before proceeding to the ACX-200 measuring unit. This valve is activated to establish the zero points for the ACX-200 and O_2 measuring units at start-up, at 5 minutes, and after that at regular intervals. After 1-hour monitoring, the auto-zeroing is performed once an hour. When the valve is activated, room air is drawn through the CO_2 absorber into the internal system and the gas sensors.

[1)] Nafion is a trademark of Du Pont

Gas measuring units, ACX-200 and O_2 unit

After the zero valve, the gas passes through the ACX-200 and O_2 measuring units. In the ACX-200 measuring unit, infrared light is passed through chambers containing the main flow gas (measurement) and a chamber containing reference gas. The measurement is made by determining the ratio between the two light intensities.

The oxygen sensor has two inputs. One input accepts the main flow and the other draws in room air for reference. The sensor uses a differential pressure transducer to compare the pressure gradient produced when both gases are exposed to an oscillating magnetic field. Both gas flows exit from a single port.

In i model, the ASX agent identification unit is installed in parallel with the oxygen sensor. The task of the ASX unit is to identify anesthesia agents by infrared light method used also in the ACX-200 unit.

Pressure valve

The pressure valve is used to measure the pressure gradient between the O_2 measurement flow and the O_2 reference flow. This pressure gradient reflects the condition of the D-fend water trap filter.

Normally the pressure gradient between the O_2 measurement flow and the reference flow is approximately +8 mmHg. If the software detects the gradient to be between 0 and -5 mmHg, the pressure valve will initiate pressure measurement of the reference flow. If the gradient is greater than -5 mmHg, the software triggers the message 'Replace Trap'.

Flow cassettes

The internal flow rates are set using flow cassettes. These cassettes are used to set the side flow rate and the O_2 reference flow rate, the flow rates through the measuring units and the total flow rate of the sampling system.

Sampling pump and damping chamber

The sampling pump is a vibrating membrane pump driven by a 50 Hz/12 V/0.4 A square wave current.

The damping chamber is used to even out the pulsating flow and silence the exhaust flow.

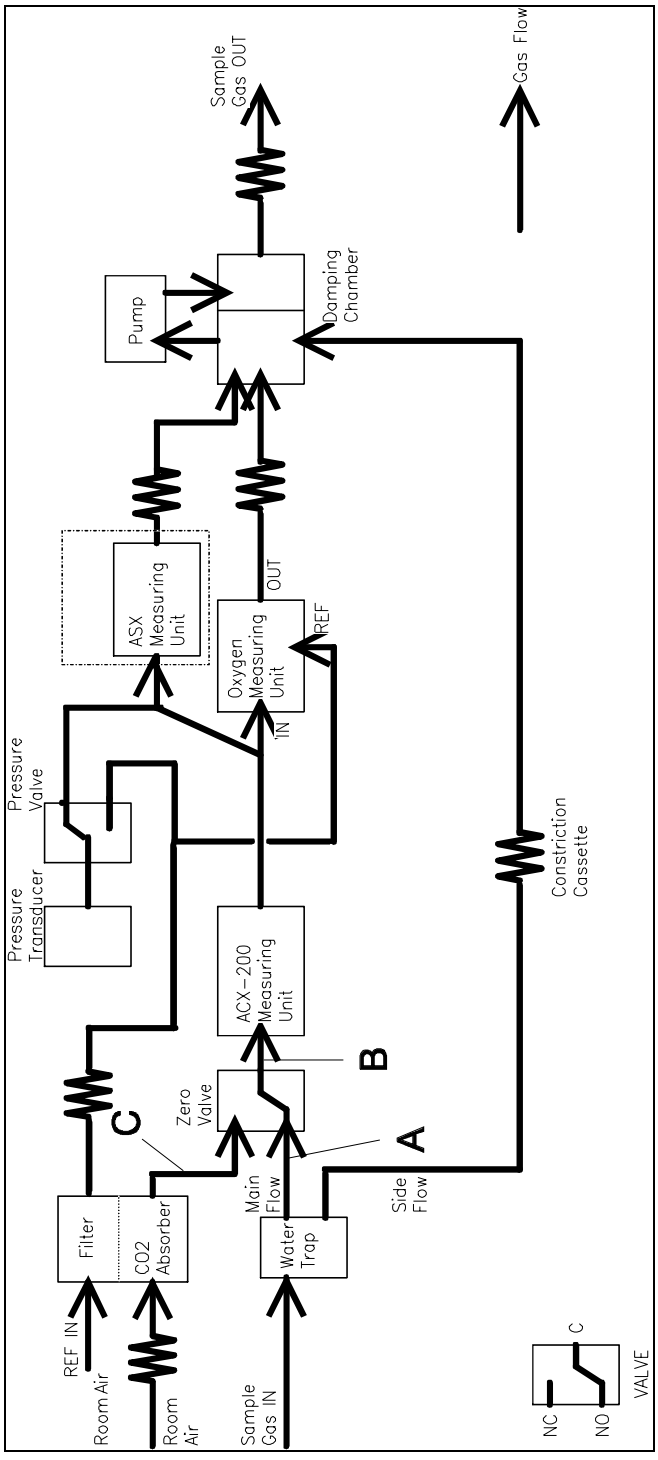


Figure 5 Gas sampling system block diagram

In G-AO, -AOV models, tube A is Teflon, B and C Nafion. In G-AiO, -AiOV models, tubes A and C are Nafion, B is Teflon.

See new tubing since autumn 1998 in figure 7.

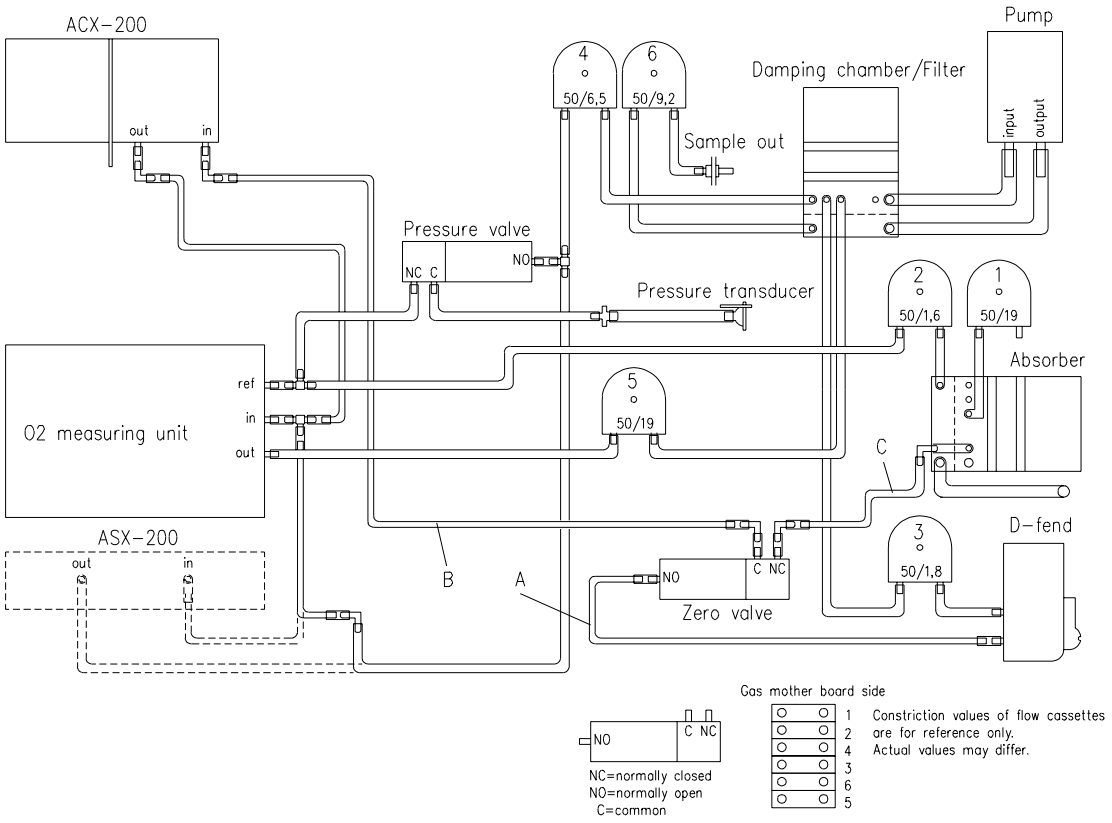


Figure 6 Gas sampling system layout

See new sampling system layout since autumn 1998 in figure 8.

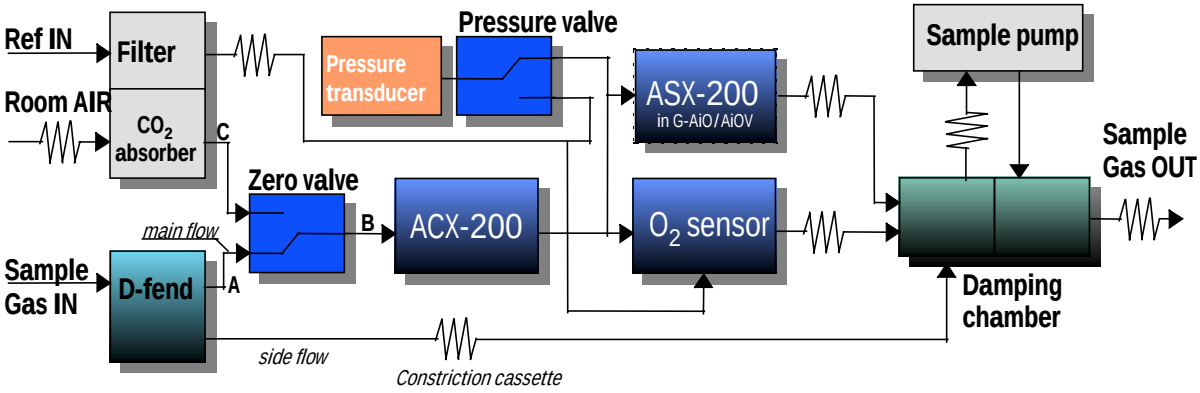


Figure 7 Gas sampling system block diagram

In G-AO, -AOV models, tube A is Teflon, B and C Nafion. In G-AiO, -AiOV models, tubes A and C are Nafion, B is Teflon. Figure 7 is valid for modules manufactured since autumn 1998.

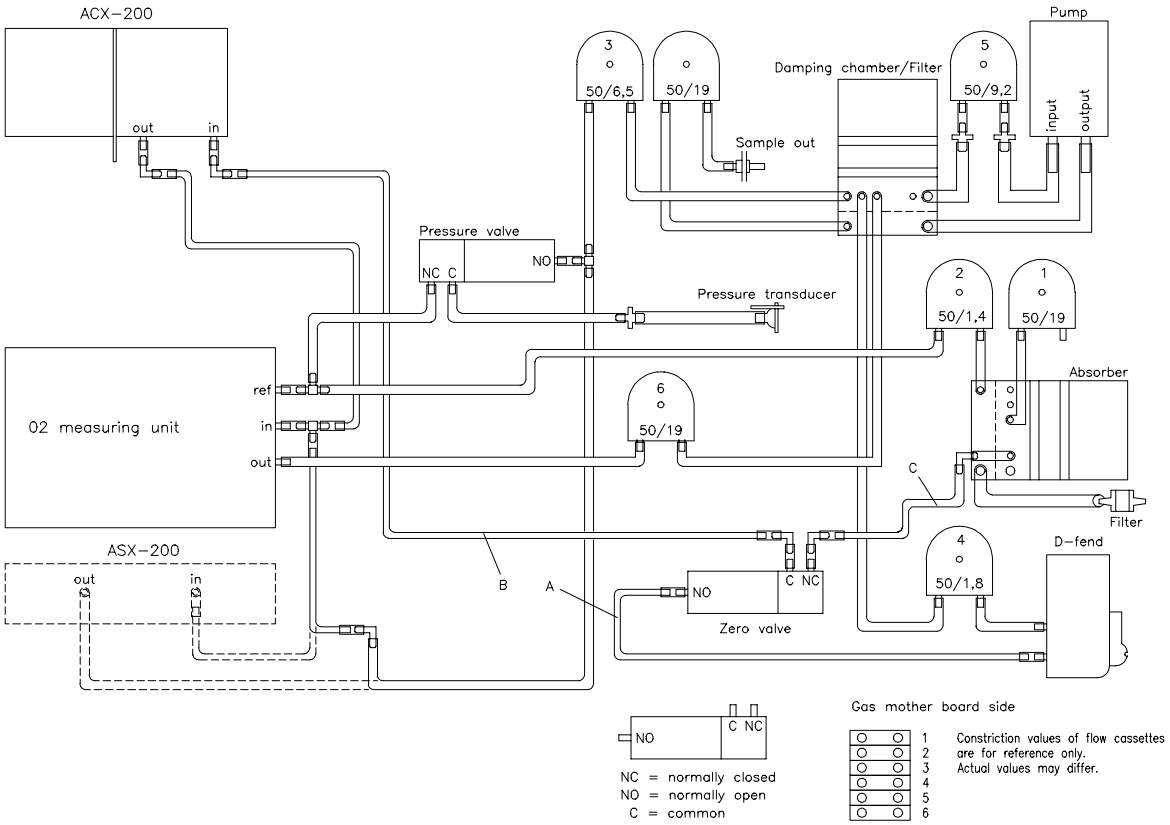


Figure 8 Gas sampling system layout

Figure 8 is valid for modules manufactured since autumn 1998.

Table 2 Flow cassettes

Flow cassette	Code
50/26.0	878048
50/19.0	873800
50/16.3	878047
50/15.3	873801
50/14.1	878046
50/13.1	873802
50/12.4	878045
50/11.2	874770
50/10.4	873803
50/9.2	874509
50/8.7	873804
50/7.4	873805
50/6.5	878044
50/5.8	873806
50/5.1	878043
50/4.4	873807
50/3.8	878042
50/3.2	873808
50/3.0	878040
50/2.8	878039
50/2.5	878038
50/2.3	873809
50/2.0	878037
50/1.8	873810
50/1.6	878036
50/1.4	873811
50/1.1	873812

NOTE: The number on the cassette represents relative flow when a specific pressure is applied. Therefore 50/26.0 presents the least resistance and 50/1.1 the most.

2.2.2 ACX-200 measuring unit

The ACX photometer is of dual path type. The infrared light beam passes through a measuring chamber containing the gas to be analyzed, and a reference chamber, which is free of CO_2, N_2O, and AA. The measurement is made by determining the ratio between the two light intensities.

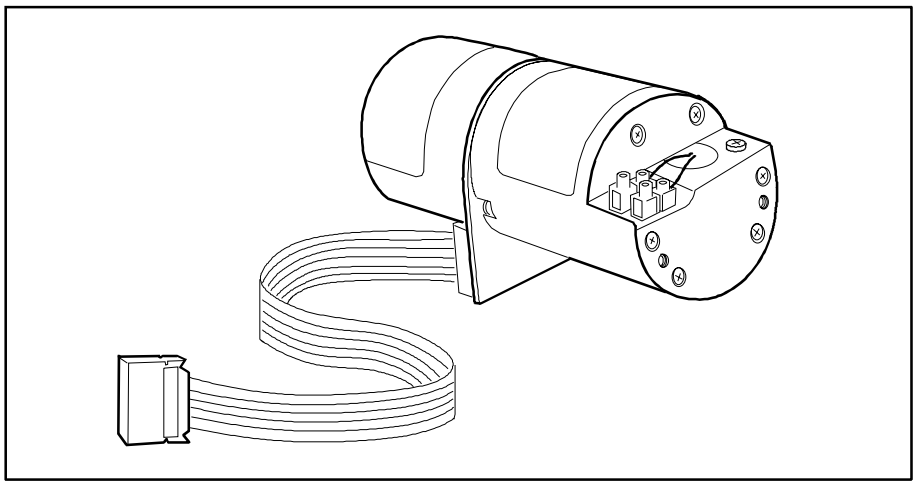


Figure 9 ACX photometer (ACX-200 measuring unit)

A filter wheel is used to control the light from an incandescent lamp that passes through the photometer. The filters are arranged so that the light is passed sequentially:

- first at the CO_2 absorption wavelength through the reference chamber
- then through the measuring chamber
- finally it is blocked completely

The same sequence is repeated at the N_2O and anaesthetic agent gas absorption wavelengths.

After passing through the filters the light is reflected and focused by a mirror onto the infrared detector. This detector measures the three light levels for each gas described above.

There is an optical sensor incorporated in the photometer which detects light from a reflective surface on the filter wheel once every revolution. The pulses from this sensor are used to synchronize the electronics to the signal from the infrared detector. A stabilizing diode measures the temperature, which is needed to compensate for thermal drifts. The infrared detector, the optical sensor and the stabilizing diode are mounted on the preamplifier board.

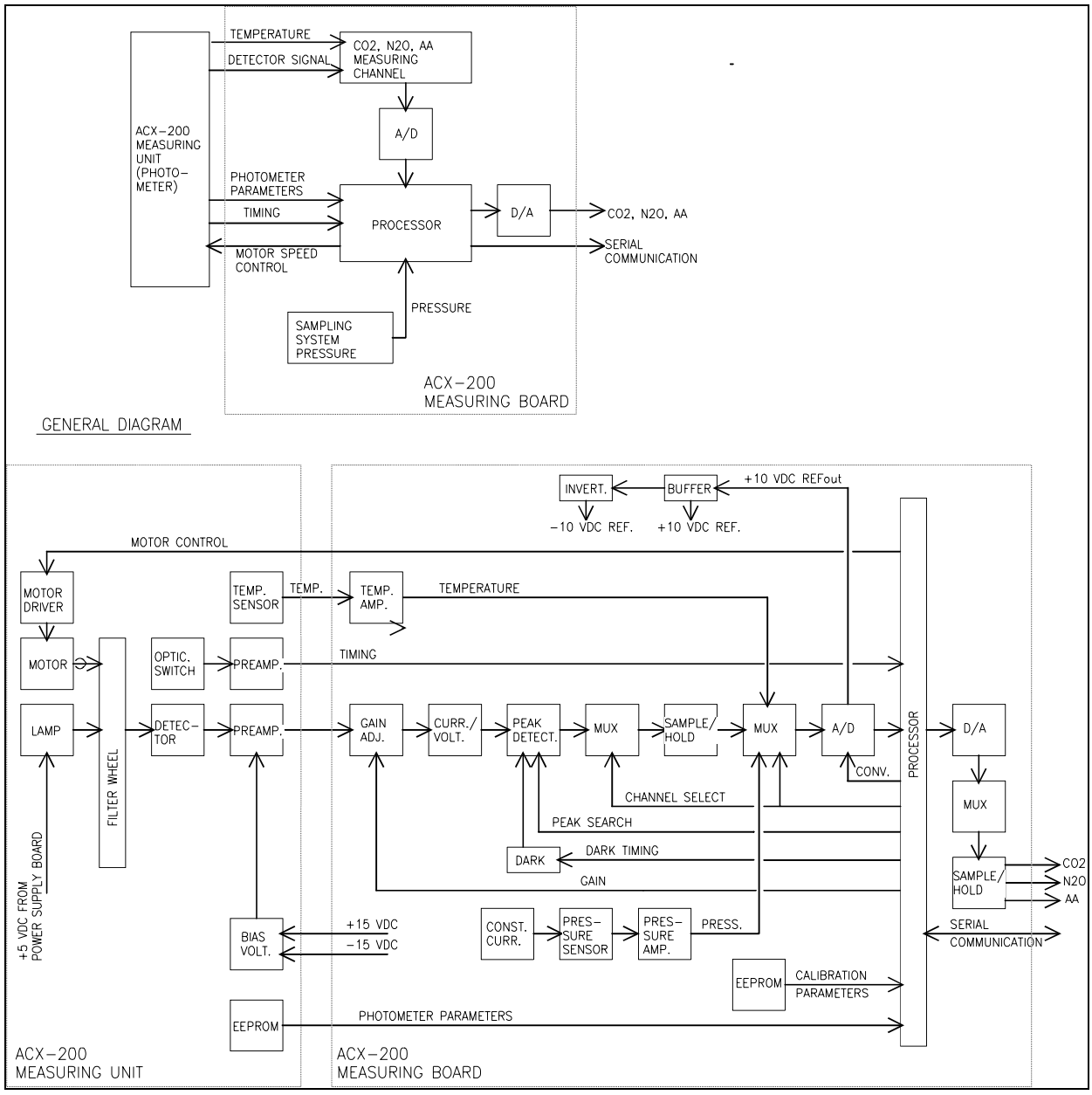


Figure 10 CO_2 / N_2O / AA measurement block diagram

2.2.3 OM measuring unit

The oxygen measurement is based on the paramagnetic susceptibility, which is a unique property of oxygen among all gases generally present in a breathing gas mixture. The gas to be measured and the reference gas, which usually is room air, are conducted into a gap in an electromagnet with a strong magnetic field switched on and off at a frequency of approximately 110 Hz.

An alternating differential pressure is generated between the sample and reference inputs due to forces acting to the oxygen molecules in a magnetic field gradient.

The pressure is measured with a sensitive differential transducer, rectified with a synchronous detector and amplified to produce a DC voltage proportional to the oxygen partial pressure difference of the two gases.

2.2.4 ACX measuring board

The measuring electronics can be divided into a few functional blocks, which are described below (see the block diagram in figure 11).

The ACX Measuring board controls gas measurements. It converts the photometer signal into digital data, calculates results and transmits it to Gas mother board. The board contains, in addition to the 80C51FA processor, EPROM, RAM, and EEPROM, several analog and digital I/O functions.

Internal and external bus

The processor has access to the Measuring board peripherals (memory, A/D converter, D/A converters, etc) via an internal bus. For communication between the Gas mother board and the Measuring board, there is an external bus in connector X1.

Memory

Memory components include 64k × 8 bit EPROM program memory, 32k × 8 bit low current CMOS RAM, and EEPROM for permanent calibration values and setup memory.

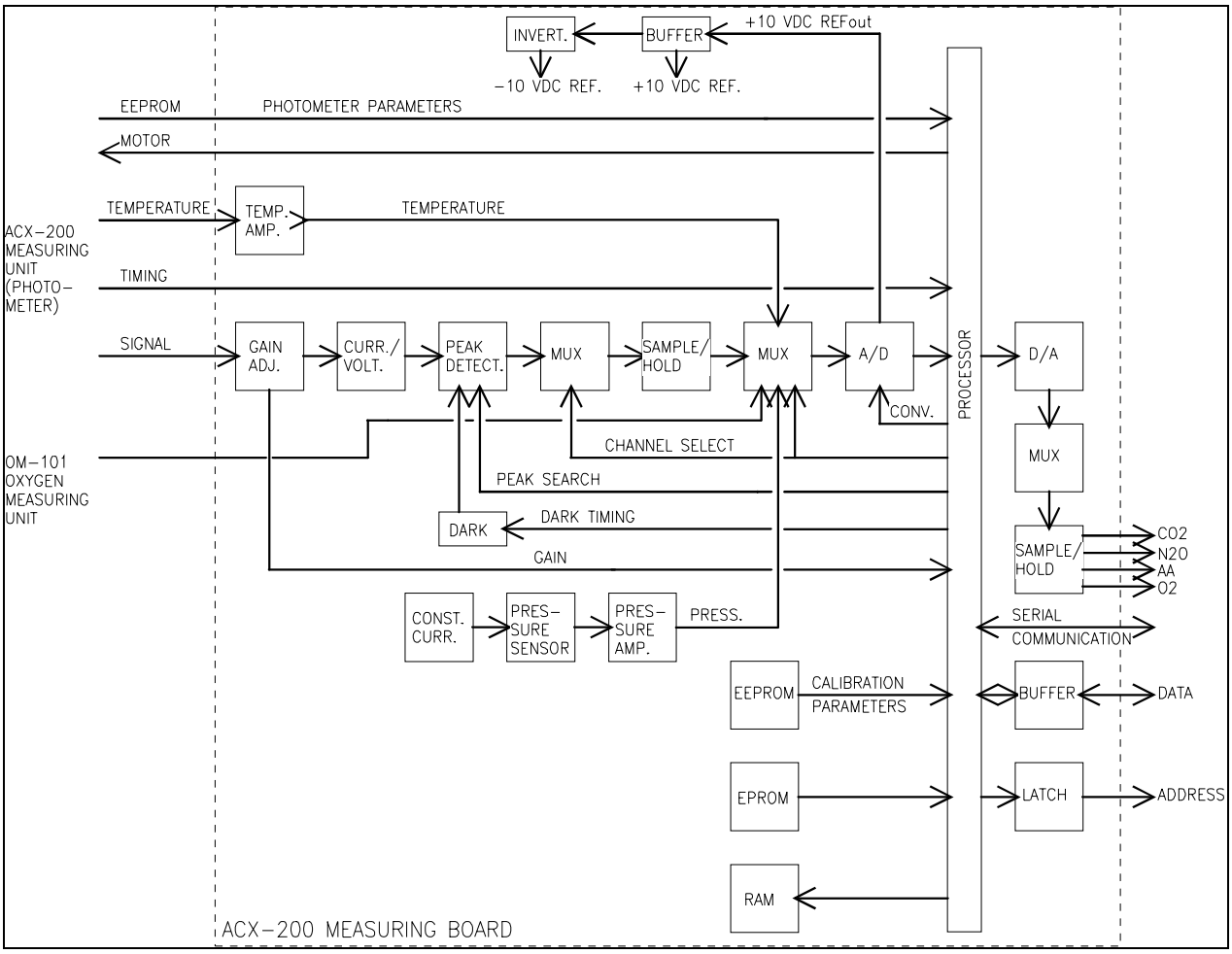


Figure 11 ACX measuring board block diagram

2.2.5 ASX agent identification bench

The ASX-200 agent identification bench has one measuring chamber. Background compensation is done by subtracting the background spectrum from the measured signal. Background spectrum is measured simultaneously with the zeroing of the ACX-200 unit. The resulting spectrum is analyzed to identify the agent.

The ASX unit requires two calibrations. One is the time between synchronization pulse and measured spectrum (time offset) of the ASX-200 and the other is the peak wavelength of the narrow bandpass filter. The former is calibrated automatically together with the gas calibration of the ACX and the latter is calibrated at the factory.

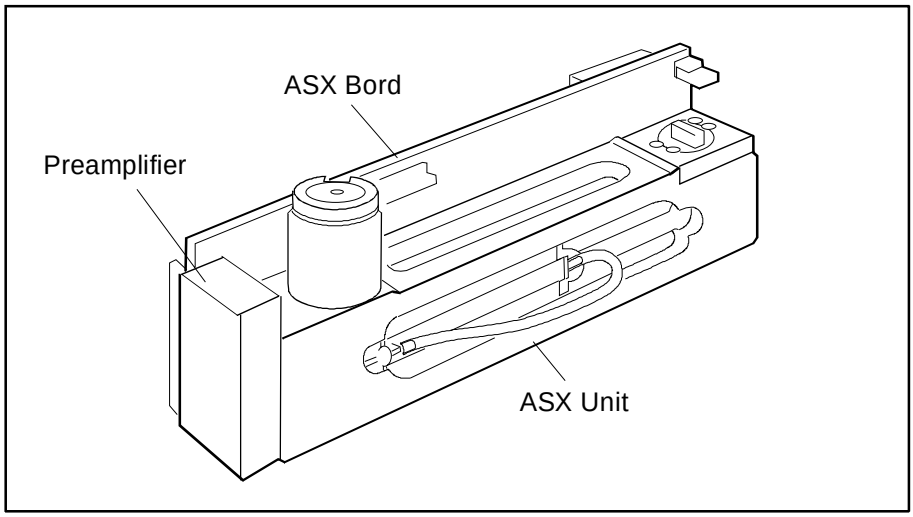


Figure 12 ASX measuring unit

ASX preamplifier board

The absorption of infrared light is measured with a lead selenide detector. The signal is amplified and then led to the measuring board.

2.2.6 ASX measuring board

The measuring electronics can be divided into a few functional blocks, which are described below (See the block diagram in figure 13).

The ASX measuring board controls the measurement. It converts the ASX photometer signal to digital data, calculates results and communicates with the main CPU through a serial channel. The board contains, in addition to the 80C196 processor, EPROM, RAM, and EEPROM, several analog and digital I/O functions.

Processor section

Processor is a 80C196 and works at 12 MHz. It has an internal A/D-converter with a multiplexer. One channel is used for converting temperature signal. Two others are for the measurement signal from preamplifier board.

The processor uses an internal bus to access EPROM (64k x 8 bit), SRAM (8k x 8 bit) and two D/A-converters. It communicates with the Gas mother board through a serial channel (RXD, TXDB).

EEPROM is a 64 x 16 bit serial chip. It is partly protected so that if jumper X1 is installed the processor can erase or write the protected registers by serial communication commands. The protected section contains permanent factory calibrations.

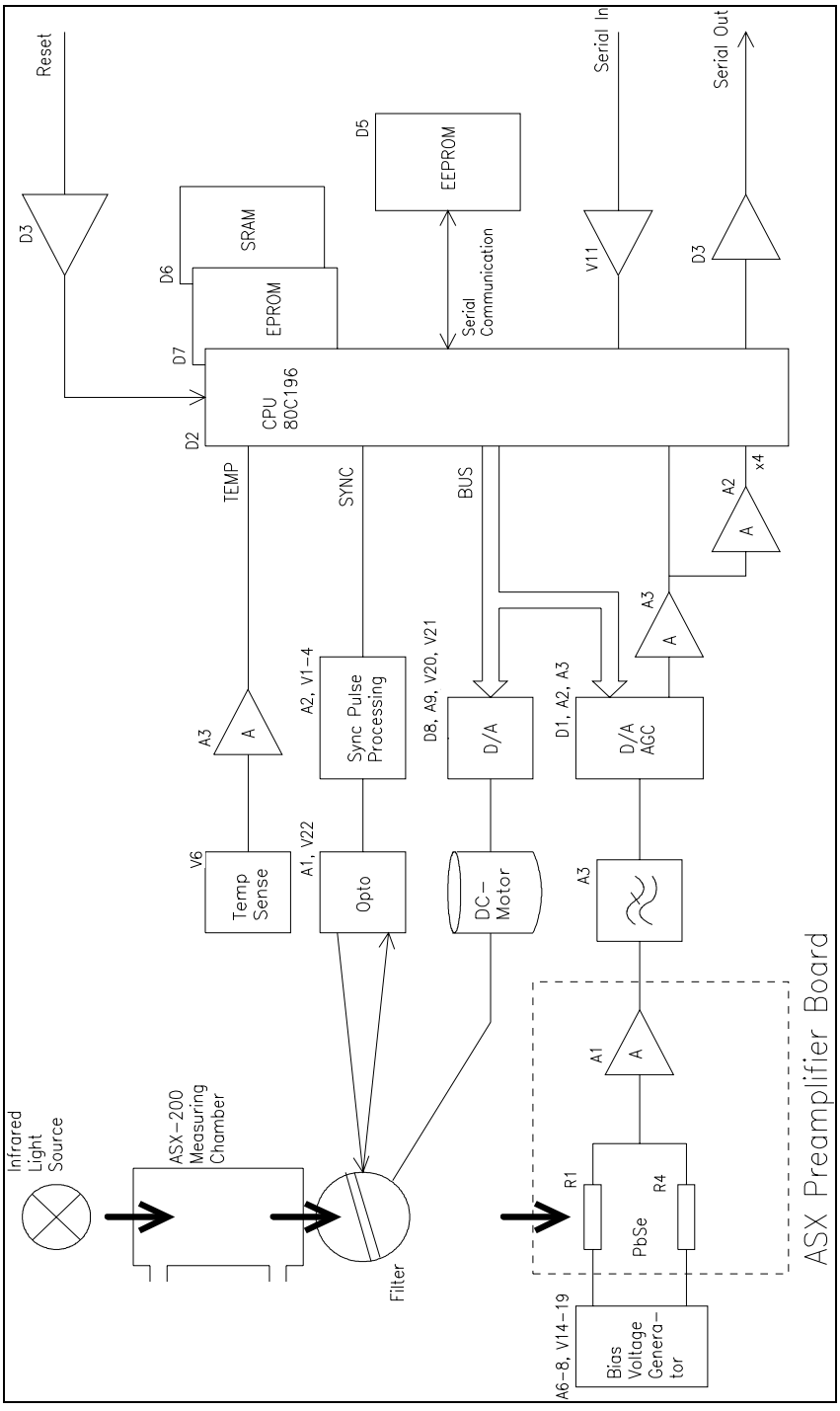


Figure 13 ASX measuring board block diagram

2.2.7 PVX board

When Patient Spirometry is used, special sensors, D-lite or Pedi-lite, replaces the normal airway adapter in the patient circuit. The spirometry tubing is attached to the two connectors on the sensor and on the module front panel.

NOTE: Overpressure or negative pressure of more than 300 cmH_2O to the flow and volume tubing should never be applied.

The board is intended to perform the following tasks

- Measure the pressures in airways and the speed of breathing flow.
- Calculate tidal volume, minute volume, compliance and other useful information on patient lungs.

Pressure transducers

There are two pressure transducers on the PVX board for airway pressure measuring purposes.

The breathing flow of a patient passing through D-lite adapter creates pressure difference. This pressure difference is measured by pressure transducer, B1. Overpressure and negative pressure in airways are measured by another pressure transducer B2.

NOTE: Never apply DIFFERENTIAL pressure higher than 25 cmH_2O to the spirometry tubing. Make sure that both spirometry tubes are always connected.

Temperature compensation

Temperature is measured by B1. This signal is used only for temperature compensation of the pressure transducer B1 on the PVX board.

Data processing

After the multiplexer, the signals, PRESS, FLOW0, FLOW1, and TEMP are A/D converted for data processing.

External communication

Communication between the PVX board and the Gas mother board is established in serial form, using the serial channel (pins 10 and 11) of CPU on the PVX board.

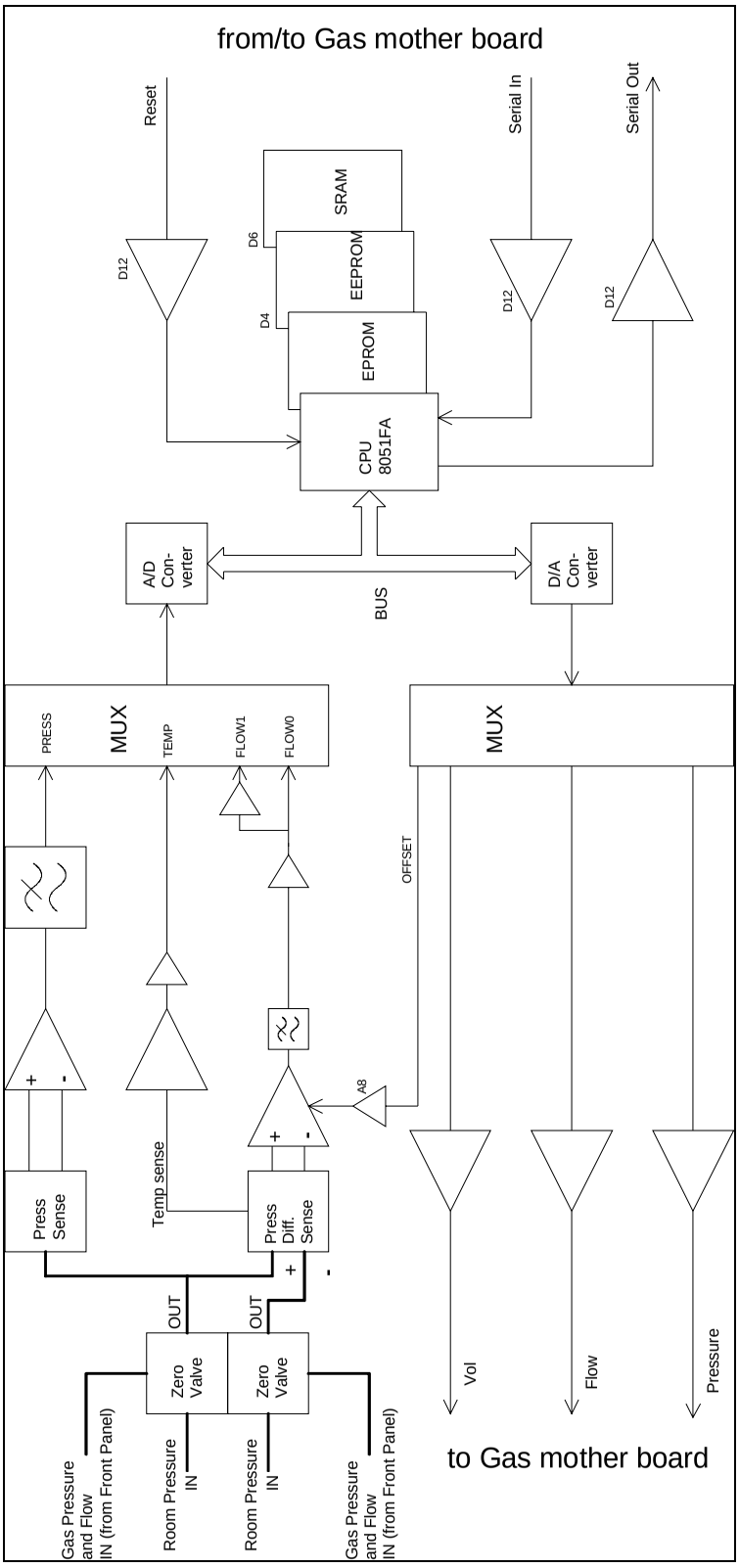


Figure 14 PVX board block diagram

2.2.8 Gas mother board

The Gas mother board controls power supply to each measuring unit, as well as the serial communication between the units and the module processor. There are connectors for the pump, valves and gas measuring units on the board. The board contains a processor which controls the functions within the module.

The tasks of the module processor are:

- to receive commands from the main CPU board and pass them on to Measuring boards.
- to gather measurement results from the Measuring boards, analyze them, and transmits data to the main CPU board.
- to control the valves and pump based on the data which ACX Measuring board transmits.

Main parts

- Module processor 80C196KC/16 MHz
- 16 MHz oscillator
- EPROM program memory
- External RAM memory
- EEPROM
- Address and data bus latch
- Address decoding GAL-circuit
- 4-channel serial communication IC (QUART, D4)

External communication

Serial communication bus inside the module processor is used. The bus is connected to module bus via RS-485 buffer. Transmit and reception controls of buffer are controlled by the processor.

Connections to measuring boards

Data collection from the measuring units takes place in serial communication bus. Serial communication lines of the measuring units are connected to QUART IC on the Gas mother board; Channel 1 - ACX, channel 2 - ASX, channels 3 - PVX, channel 4 - not in use). The transmit side of QUART has a buffer IC and the receipt side has a pull-up resistor.

Valves, pump and infrared lamps control

Valves are controlled by ACX Measuring board from which the control signals are ran through buffer IC to the valve connector. OCCLUS signal controls the pressure (occlusion) valve and ZERO signal controls the zero valve.
Control signal for the pump comes from the module processor. The signal is 50 Hz pulse-width modulated square wave. Control command is received from ACX Measuring board in serial communication.
Control command (LAMP) of the infrared lamps of the chambers comes from the module processor.

Key push reading

CPU reads the front panel key pushes.

Reset

Voltage supervising circuit performs power-on reset. Reset from the module bus is connected via RS-485 buffer.

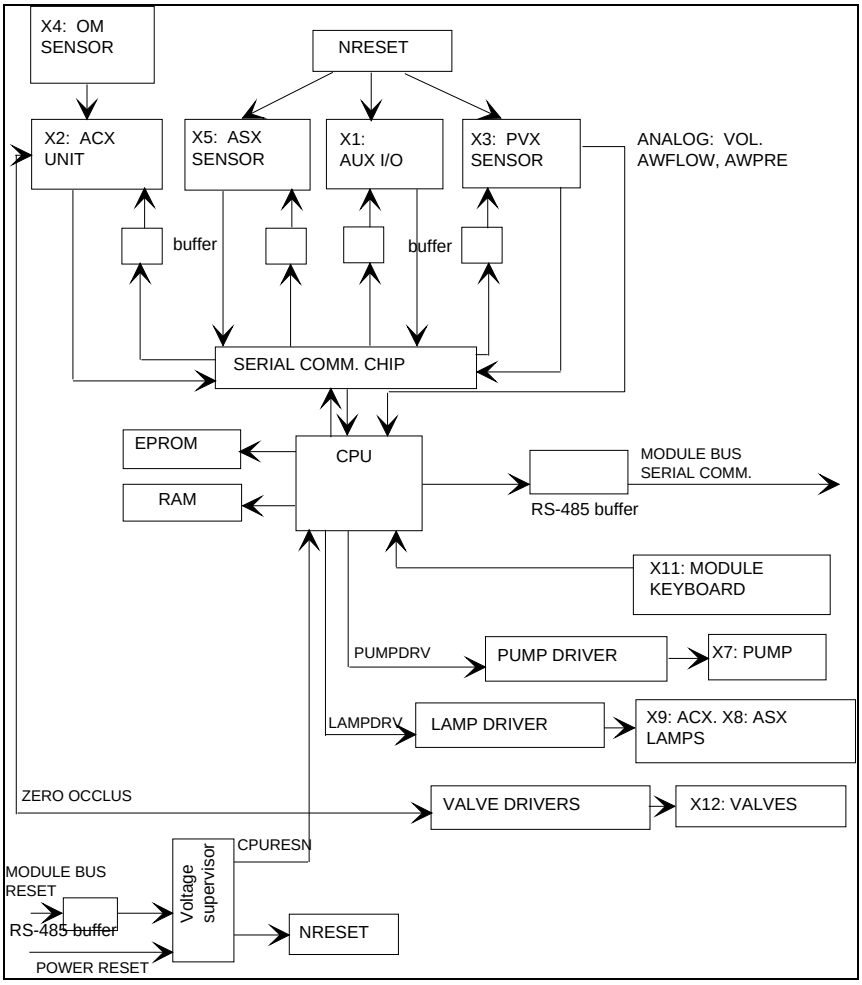


Figure 15 Gas mother board block diagram

2.2.9 Gas interface board

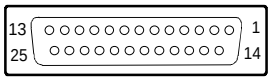
The Gas interface board, B-GAS is used for connecting an Airway Module to the Central Unit.

The board connects Airway Module signals to the module bus and supplies voltages from the module bus to the Airway Module.

On the board there is a fuse (T4A) and some capacitors to regulate the power supply.

2.3 Connectors and signals

2.3.1 Module bus connector



Pin No	I/O	Signal
1	I	RESET RS485
2	I	-15 VDC
3	I	+15 VDIRTY
4	I	+15VDC
5	I/O	-DATA RS485
6	I/O	DATA RS485
7		Ground and Shield
8	I	-RESET RS485
9		n/c
10		n/c
11		n/c
12		n/c
13		Ground and Shield
14	I	+24/+32 VDIRTY Depends on power supply
15	I	Ground DIRTY
16		n/c
17		n/c
18		n/c
19		n/c
20	I	GASFR (not used)
21	I	CTSD (not used)
22	I	TXDD (not used)
23	O	RXDD (not used)
24	I	+5 VDC
25	I	+5 VDC DIRTY, for infrared lamps

For B-GAS CPU Mother Board connector, see CPU Bus Connector in the Central Unit Section.

2.3.2 Gas mother board connectors

X1	Module connector. Serial communication bus to the main CPU board. Supply voltages.
X2	ACX Measuring board
X3	PVX board
X4	Oxygen measuring unit
X5	ASX Measuring board
X7	Sampling pump
X8, X9	Power supply for infrared lamps (ACX, ASX)
X10	Fan
X11	Module front panel keys
X12	Valves

ACX measuring board (X1) - Gas mother board (X2)

Pin No.	a	b	c
1	+15 V	NC	AGND
2	-15 V	NC	+10 VREF
3	AOUT6	NC	AOUT5 AA
4	AOUT4 VL	NC	AOUT3 CO_2
5	AOUT2 O_2	NC	AOUT1 N_2O
6	DAC1 FLOW	NC	DAC0 PRES
7	AIN7 SAL	NC	ADC6 VOUT R
8	ADC5 AWL	NC	ADC4 VOUT IR
9	ADC3 O_2	NC	ADC2
10	ADC1 AWP	NC	AIN4 SSIGN
11	NC	AGND	NC
12	NC	AGND	NC
13	NC	LAMP	NC
14	NC	PB5	NC
15	NC	SSYNC	NC
16	RBD2	SMOTOR	NC
17	-RESET	-PC0	TO RTSO
18	SEROUT 0	NC	SERIN 0
19	P1.1	PC2 FGAIN 1	P1.0
20	OP0 RTSA	PC3 FGAIN 2	INT0
21	SEROUT 1	PC4 OCCLUS	SERIN 1
22	OP1 RTSB	PC5 PUMPON	IP2 TIMERIN 0
23	SEROUT 2	PC6 ZERO	SERIN 2
24	NC	PC7 RTS0	NC
25	NC	PA0	NC
26	NC	PA1	NC
27	NC	PA2	NC
28	INT1	PA3	INT3
29	+5 V DRV	PA4	+5 V
30	+15 VDIRTY	PA5	+5 V
31	+12 V	PA6	21 VAC
32	GND DIRTY	PA7 ALR CALL	DGND

NC = not connected
AIN is an AD-converter and AOUT is a DA-converter in ACX board.
ADC is an AD-converter and DAC is a DA-converter in the Gas mother board.

ASX board (X5) - Gas mother board (X5)

Pin No.	Signal
1	Analog ground
2	N/C
3	N/C
4	N/C
5	+15 V
6	-15 V
7	DIRB (not used)
8	RXD
9	TXDB
10	N/C
11	-RESET
12	+5 V
13	+15 VDIRTY
14	Digital ground

PVX board (X1) - Gas mother board (X3)

Pin No.	a	b	c
1	+15 V	NC	AGND
2	-15 V	NC	+10 VREF
3	NC	NC	NC
4	NC	NC	NC
5	NC	NC	NC
6	DAC1 FLOWY	NC	DAC0 PRES
7	VOL	NC	NC
8	FLOW	NC	NC
9	NC	NC	NC
10	PRESS	NC	NC
11	NC	NC	NC
12	NC	NC	NC
13	NC	NC	NC
14	NC	NC	NC
15	NC	NC	NC
16	NC	NC	NC
17	-RESET	NC	NC
18	NC	DIR	NC
19	NC	NC	NC
20	NC	NC	NC
21	RxD	NC	TxDP
22	NC	NC	NC
23	NC	NC	NC
24	NC	NC	NC
25	NC	NC	NC
26	NC	NC	NC
27	NC	NC	NC
28	NC	NC	NC
29	NC	NC	+5 V
30	+15 VDIRTY	NC	+5 V
31	NC	NC	NC
32	GND DIRTY	NC	DGND

3 SERVICE PROCEDURES

3.1 General service information

Field service of the airway modules is limited to replacing faulty circuit boards or mechanical parts. The circuit boards should be returned to Datex-Ohmeda for repair.

Datex-Ohmeda is always available for service advice. Please provide the unit serial number, full type designation, and a detailed fault description.

CAUTION Only trained personnel with appropriate equipment should perform the tests and repairs outlined in this section. Unauthorized service may void warranty of the unit.

NOTE: After any component replacement see chapter *Adjustments and calibrations*

CAUTION The ACX-200 photometer and its components are repaired/calibrated at the factory. Attempts to repair/calibrate the unit elsewhere will adversely affect operation of the unit. Datex-Ohmeda supplies spare ACX-200 photometers. The information provided for the ACX-200 is for reference only.

CAUTION Due to the complicated and sensitive mechanical construction any service inside the O_2 measuring unit should not be attempted.

CAUTION The ACX-200 Measuring board can be repaired and calibrated only at the factory.

CAUTION The PVX-100 measuring unit can be repaired only at the factory.

3.2 Service check

These instructions include complete procedures for a service check. The service check is recommended to be performed after any service repair. However, the service check procedures can also be used for determining possible failures.

The procedures should be performed in ascending order.

The instructions include a check form (*Appendix A*) which should be filled in when performing the procedures.

The mark  in the instructions means that the check form should be signed after performing the procedure.

The procedures are designed for monitors with S/5 monitor software of revision 01. However, most of the procedures also apply to monitors, which contain some other monitor software type/revision.

3.2.1 Recommended tools

Tool	Order No.	Notes
Screwdrivers		
Tools for blocking internal tubes		
A glass of water		
Flowmeter		
Multimeter		
Gas Interface Cable 2.5 m	884299	
Sampling line 3.0 m	73319	
Spirometry tube	884101	
D-lite	733950	
Calibration gas	755582	

3.2.2 Recommended parts

Part	Order No.	Notes
Special tube	733383	
Special tube	733382	
OM ref. filter	86901	
Fan filter	871558	
Cable tie	64001	
D-fend O-ring (2 pcs)	65312	
D-fend (black)	876446	
Sampling line 3.0 m	73319	
Extra silicon tubing		
Spare constriction cassettes		

All modules

- Remove the airway module case, the top protection cover and the bronze plate from the side of the O_2 sensor, if installed.
- Detach the ACX measuring board and the PVX board with the support plate, if installed.

NOTE: Wear a static control wrist strap when handling PC boards. Electrostatic discharge may damage components on the board.

1. Check internal parts:
   - screws are tightened properly
   - cables are connected properly
   - all IC's that are on sockets are attached properly
   - tubes are not pinched and there are no sharp bends on them
   - tubes are connected properly
   - there are no loose objects inside the module

   NOTE: Make sure that none of the tubes is in contact with the sampling pump or the O_2 sensor.

2. Check external parts:
   - the module case is intact
   - the four rubber pads under the frame are all in place
   - the metal rear panel is intact
   - the equipotential tap and the sample gas out connector are tightened properly
   - the block screws for the gas interface cable are in place and are tightened properly
   - the D-fend latch is functioning properly

- Install the ACX measuring board.
- Detach the D-fend.

3. Check the condition of the rubber O-rings on the metal D-fend connectors, located inside the module front cover.

   If necessary, detach the connectors by first disconnecting the tubes, then removing the locking rings from the back of the front cover.

   NOTE: The O-rings are recommended to be replaced annually.

4. Check the OM ref. filter (order code 86901) visually, if installed.

   NOTE: The OM ref. filter is recommended to be replaced annually.

   If the module does not contain the OM ref. filter, install it to prevent dirt entering the O_2 sensor reference channel:

a) shorten the thick O_2 reference channel tube by 4 centimeters (the tube that is connected to the upper part of the CO_2 absorber)
b) connect the OM ref. filter to the loose end of the tube
c) fasten the filter to the outermost hole in the tubing plate (at the PVX board side) with a cable tie (order code 64001)

- Replace the D-fend and the sampling line.

  NOTE: Use only Datex-Ohmeda sampling lines in order to ensure proper functioning.

- Connect the module to the Central Unit with a long gas interface cable and switch the monitor on.

- Configure the monitor screen so that all the needed parameters are shown, for example as follows:
  Monitor Setup ***- Screen 1 Setup - Waveform Fields - Field 1 - Paw***
  Field 2 - Flow
  Field 3 - Off
  Field 4 - O2
  Field 5 - AA
  Field 6 - CO2
  Digit Fields - Field 1 - Gases

5. Check that the module fan is running.

6. Wait until the message 'Calibrating gas sensor' disappears from the screen, then enter the Service menu:

   Monitor Setup ***- Install / Service*** (password 16-4-34) ***- Service*** (password 26-23-8)

   Take down the information regarding Airway module software.

   NOTE: The PVX software string does not appear into the 'Sw version / Unit id' -list. Check PVX software from the sticker that is located on the PVX software EPROM (if the PVX board was installed originally).

7. Enter the ACX service menu:

   Parameters - Gas Unit - ACX

   Check that the 'Timeouts', 'Bad checksums' and 'Bad c-s by mod' -values are not increasing faster than by 50 per second. If one of the values is increasing faster, it indicates a failure in module bus communication.

8. If the module contains a membrane key on the front panel, press the key at least for one second and check that it is identified, i.e. the text for Button changes from OFF to ON in the menu.

- Select Halothane as anesthetic agent by first selecting AGENTS from the ACX service menu:

  Agents - Select Agent - Hal - Previous Menu

9. Check that the Calib zero -value for N_2O is less than 61000.

   If the value exceeds the limit, it indicates bad contamination in the ACX measuring chamber. The measuring chamber can be cleaned according to the special cleaning instructions found in the chapter Cleaning the measuring chamber of ACX measuring unit. However, if cleaning does not help, the whole ACX measuring unit should be exchanged.

   NOTE: If the ACX measuring chamber was cleaned or the unit was replaced, then also the tubing between the D-fend and the ACX measuring unit, including the zero valve, should be replaced. The mentioned parts should not be cleaned.

   NOTE: With monitor software S-___95 and S-___96 the Calib zero -value for N_2O is always shown as a negative value. The correct value can be calculated by adding the shown value to the value 65536.

10. Check that the Ambient -value corresponds with the current ambient pressure (±20 mmHg).

11. Perform the steam test for the special tubes (Nafion), or replace the tubes.

    NOTE: The special tubes are recommended to be replaced annually.

12. Check the CO_2 absorber.

    Keep the tip of the sampling line away from you and let the monitor draw in room air. Check the "Insp CO_2" -value from the ACX service menu. If the value is less than 4, replace the CO_2 absorber.

13. Check the zero valve.
    Feed calibration gas into the sampling line and check that the gas readings in the service menu correspond with the gas values on the calibration gas bottle. Keep feeding gas and activate the zero valve from the menu. The O_2 reading should drop back near 21 %, the other gas readings near 0 %. If the readings did not drop, replace the zero valve.

14. Perform the sampling system leak test.

15. Block the tip of the sampling line with your finger until the 'Amb-Work' -value becomes stable. If the value does not reach 110, replace the sampling pump and repeat the leak test.

16. Check the flow rates, adjust if necessary.

    NOTE: If any of the constriction cassettes is replaced, the leak test should be repeated.

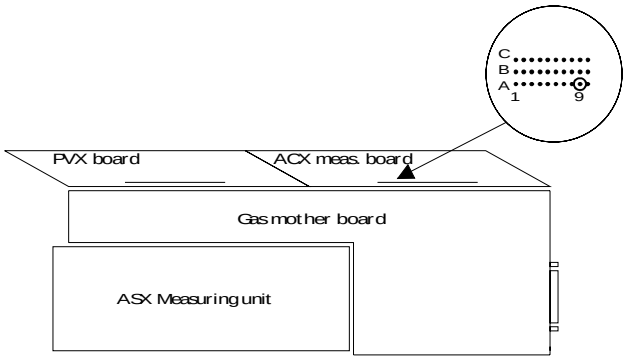
17. Check that the 'Amb-Work' -value is within 50... 75 and the OM (in-ref) -value is equal or higher than 0. If the values differ, readjust the flows.

18. Check the O_2 sensor output voltage.

    Feed calibration gas and check that the value OM volt: mV in the menu rises at least to 2800 (3500 nominal). Adjust the O_2 sensor output, if necessary.

    NOTE: The voltage measurement requires module software 884295 or 885388.

    If the value is not updated, measure the O_2 sensor output voltage from the ACX measuring board connector X1, pin A9.



    The output voltage should rise at least to 2.8 V (3.5 V nominal).

19. Perform gas calibration:
AIRWAY GAS - GAS CALIBRATION
NOTE: For maximum accuracy, a warm-up time of 30 minutes is recommended.

    NOTE: If the module contains the agent identification unit, the ASX-100 or ASX-200, keep feeding gas at least 15 seconds after the message 'Adjust' appears in the menu. This way the agent identification unit has enough time for calibration.

- Enter the ACX service menu:

  Monitor Setup ***- Install / Service*** (password 16-4-34) ***- Service*** (password 26-23-8) - ***Parameters - Gas Unit - ACX***

- Select Halothane as anesthetic agent:

  Agents - Select Agent - Hal - Previous Menu

20. Perform the fall time measurement in the ACX service menu.

    Check that the measured fall times are within the ranges that are given in the Technical Reference Manual.

    NOTE: The fall time measurement can be performed only with module software 884295 or 885388.

21. Perform the noise measurement.

    Check that the measured noise values are within the ranges that are given in the Technical Reference Manual.

    NOTE: The noise measurement can be performed only with module software 884295 or 885388.

Agent identification option

22. Check that the 'ACX_ASX Delay' -value in the ACX service menu is within 400-800.

    If the value is not within the range, readjust the flows and repeat the fall time measurement.

- Enter the ASX service menu:

  Gas Unit - ASX

  NOTE: The ASX service menu values are not updated with the anesthetic identification unit ASX-100.

23. Feed calibration gas. When proper absorption spectrum is shown in the menu check that the Peak normal value is close to 10.50 (±0.20). Check also that the difference between the "Peak normal" and "Peak mirror" values is not higher than 0.30.

    If the values do not meet the range, repeat the gas calibration.

- Set the AA identification to the automatic mode:

  Agents - Select Agent - Auto - Previous Menu

24. Feed calibration gas (order code 755583) and check that the message 'Desflurane' appears into the digit field for gases.

    NOTE: The ASX-100 is not capable of identifying Desflurane.

    NOTE: The ASX-100 with software 878364-1.1, or lower, is not capable of identifying calibration gas R23 (order code 755582). Therefore, the message 'Agent mixture' should appear instead.

Patient spirometry option

- Switch the monitor off and install the PVX board, then switch the monitor back on.
- Preset gas measurement settings:

  Airway Gas - Spirometry Setup - Paw Scale - 20
  Flow Scale - 15

1. Check that the patient spirometry connectors on the front panel are clean and intact.

2. Connect a clean spirometry tube to the module and a clean D-lite to the other end of the tube. Block the D-lite's sampling line port, for example with a luer stopper.
   Take the D-lite into your hand and occlude both ends tightly with your fingers (or with both hands). Pressing firmly with the fingers creates a pressure inside the D-lite. Check that a pressure of at least 5 cmH_2O is generated.

   NOTE: If the module has the male & female patient spirometry connectors (pediatric option), make sure that the date marking on the D-lite is 10/94 or newer.

   If the system leaks heavily, no pressure will be generated.
   If there is a small leak in the connections, the monitor will measure a pressure difference which is then interpreted as flow and seen on the monitor screen. The pressure waveform decreases slowly and the flow waveform either goes above, or below the zero line, depending on which of the connectors leaks.

   In case of leakage, check all connections and try again.

3. Remove the blockage from the sampling line port and connect the sampling line. Breath through the wider side of the D-lite. Check that the flow waveform moves downwards when you breath in, and upwards when you breath out.
   If the flow waveform moves in opposite manner, check the order of the PVX tubes inside the module.

4. If possible, check the patient spirometry measurement also with the spirometry tester (order code 884202). Follow the instructions that are supplied with the tester.

All Airway modules

- Switch the monitor off, disconnect the gas interface cable and reassemble the module.

  NOTE: When reassembling the module, make sure that the tubes and cables are not pinched between the PC boards and covers.

29. Clean, or replace the airway module fan filter.

30. Perform electrical safety check and leakage current test.

- Reconnect the gas interface cable and sampling line, switch the monitor on and wait until the message 'Calibrating gas sensor' disappears from the screen.

31. Block the tip of the sampling line with your finger and check that the message 'Sample line blocked' appears onto the monitor screen within 30 seconds.

32. Detach the D-fend and check that the message 'Check D-fend' appears onto the screen within 30 seconds.

    Reattach the D-fend.

- Simulate at least 5 breaths by feeding calibration gas into the sampling line.
  Check that the shown gas information is correct.

33. Check that the monitor activates the APNEA -alarm within 30 seconds after you have stopped feeding gas.

34. Switch the monitor off, disconnect the gas interface cable and clean the module.

- Fill in all necessary documents.

3.3 Disassembly and reassembly

The airway module (G-AiOV) is disassembled in the following way. See the exploded view.

1. Remove three screws from the rear panel.
2. Remove one thumb screw and one 5 mm cross recess screw from the bottom of the airway module case.
3. Slide the case rearward and detach it from the module.
4. Lift off the top protection cover.

The PVX board can be detached by pulling sideways after two tubes are disconnected from two valves.

The ACX measuring board can be detached by pulling sideways after a ribbon cable connector is disconnected and a tube is pulled off from pressure transducer.

5. Remove the bronze plate from the right side of the module by pulling it up.
6. To remove the gas mother board cover, remove two front panel screws from the side of the module, and the D-connector screws.
7. The front panel can be detached by removing three screws.
8. Tubing system plate with tubes and flow cassettes can be lifted off.
9. Fan can be lifted off after plastic pc board rail is detached.

Gas mother board is attached to the side of the module with screws.

The ASX unit, the ACX measuring unit, and the O_2 measuring unit are attached to the chassis with two screws each.

The pump and its magnetic shield can be removed from the chassis by unscrewing the two screws beneath two springs at the port side of the pump.

Damping chamber/filter case can be slid out of hooks.

Reassembling is essentially reversing what was described above.

CAUTION When reassembling the module, make sure that the tubes and cables are not pinched between the boards and the cover.

3.4 Adjustments and calibrations

See *User's Reference Manual* for normal gas calibration instructions.

3.4.1 Gas sampling system adjustment

Flow rates should be measured and possibly adjusted under the following conditions:

- After any part within the sampling system has been replaced
- Gas response is slow

NOTE: Adjust the flows with a new, clean D-fend water trap and original Datex-Ohmeda sampling line.

NOTE: Before adjusting the flows, make sure that there is no leakage in the sampling system.

NOTE: Let the monitor warm up for 30 minutes before measuring flow rates.

For the flow rate measurements a flowmeter with a low flow resistance and capability to measure low flow rates is required. A normal length of sampling line has to be connected to the monitor as it has a considerable effect on the flow.

The flow rates are adjusted by changing the flow resistance cassettes (constriction cassettes) in the sampling system. See Table 2 in chapter "*Gas sampling system"* for the alternative cassettes.

The adjustments and the respective constrictions to be adjusted are shown in the next figure, see also chapter *"Gas sampling system"* to see gas sampling system block diagrams for modules manufactured since autumn 1998.

3.4.2 Flow rate measurement

If any flow rates are not correct, first replace the D-fend water trap. Then recheck the incorrect flows before adjusting the flow rates.

The sampling flow rate is measured by a flowmeter at the sampling line. The rate should be between 180 and 220 ml/min.

The sampling flow rate is adjusted by changing the flow cassette which is located between the pump and the damping chamber.

Due to two different tubing layouts, if the described location does not contain a flow cassette, the sampling flow rate is adjusted by changing the flow cassette that is located between the pump and the sample gas out connector.

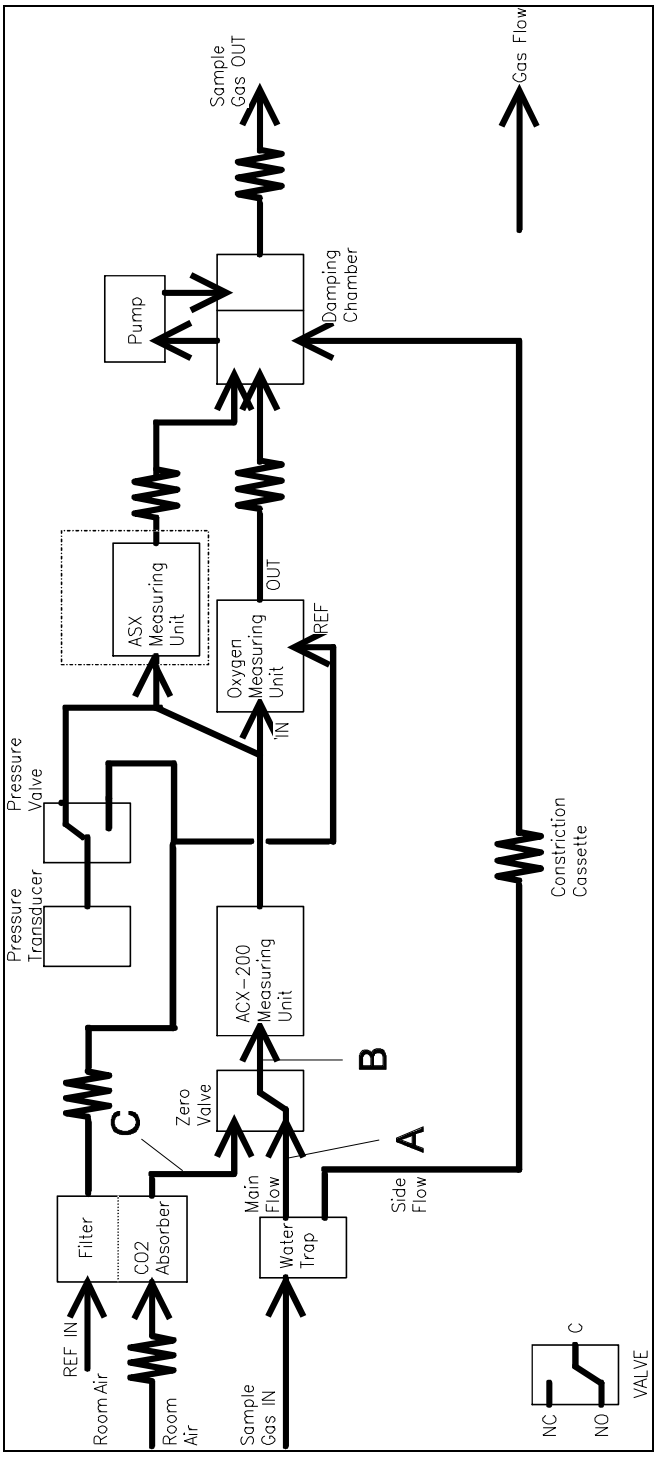


Figure 16 Gas sampling system adjustment chart

See also chapter *"Gas sampling system"* to see gas sampling system block diagrams for modules manufactured since autumn 1998.

Rate of the side flow is checked by blocking the side flow after the water trap and measuring the flow rate as above. The rate should decrease by 10 to 27 ml/min.

Measurement flow and reference flow of the oxygen measuring unit are checked as follows:

1. Connect the flowmeter behind the flow cassette (no. 2) ahead of the oxygen measuring unit REF inlet. The flowmeter should show between 25 and 42 ml/min. The flow rate is adjusted by changing the cassette.
2. Connect the flowmeter between the oxygen measuring unit IN inlet and the tube which is connected to it. The flow rate should be between 18 and 25 ml/min **larger** than the REF flow. This is adjusted by changing the flow cassettes (no. 4 and 5) which are located between the IN and OUT inlets.
3. Flow rate of CO_2 absorber is measured by connecting the flowmeter to the unoccupied connector of the flow cassette (no. 1). Make sure that the monitor is in normal situation (APNEA text on the screen). The flow rate should be zero. When the gas zeroing takes place, the rate should be between 180 and 220 ml/min. The gas zeroing can be simulated in the ACX Service Menu manually (pump start, zero valve on). The flow rate is adjusted by changing the cassette (no. 1).

CAUTION When changing cassettes make sure that the tubes are reconnected properly.

Flow to be adjusted	**Constr. No. (see figure 16)**	**Nominal value (tolerance) ml/min**
sampling flow	6	200 (180 to 220)
side flow	3	10 to 27
O_2 measurement in	4 and 5	45 to 60
O_2 reference in	2	25 to 42
CO_2 absorber flow	1	180 to 220 when zeroing

NOTE: Changing any of the cassettes will have some effect on the other flow rates. After any adjustments check the other flow rates as well.

O_2 measurement flow pressure

Gradual decrease of main flow rate due to the water trap filter clogging can be checked by measuring pressure difference between the O_2 measurement flow and the O_2 reference flow. Remember that the sampling line should be attached to the water trap before starting the test.

The pressure difference is automatically checked after every gas zeroing.

See ACX Service menu chapter later in this manual for further information.

3.4.3 Oxygen measurement unit adjustments

The only field service procedures for the O_2 measuring unit are the offset (zero), gain, and frequency adjustments. In case of any other trouble, the measuring unit should be replaced and the faulty one sent to Datex-Ohmeda for repair.

Offset (zero) adjustment

Because the oxygen measuring unit is a differential sensor, which actually measures the difference between the O_2 concentrations in the sample and reference gases, its output must be adjusted to equal zero when atmospheric air is present at both inputs.

1. Connect a digital voltmeter to the output of the O_2 measuring unit at pin 7 of connector X4 on the Gas mother board.
2. Let the monitor draw in room air and adjust the voltage to zero with the O_2 measuring unit trim resistor designated 'ZERO' (see figure 17) in the O_2 module PC board. The potentiometers are located at the same side of the measuring unit as the tubing connectors.
3. Perform gas calibration (see *User's Reference Manual*).

Gain adjustment

1. Adjust the O_2 measuring unit offset as described in the previous section.
2. Sample 100 % oxygen and adjust the measuring unit output to between 7.7 V and 8.3 V with the trim resistor designated 'GAIN' (see figure 17). If the output will not exceed 7.7 V, it is acceptable that the output exceeds at least 5 V. At that level software is still able to compensate the output.
3. Check and if necessary readjust the offset and gain until the readings remain stable.
4. Perform gas calibration (see *User's Reference Manual*).

Temperature compensation adjustment

Factory calibrated.

Frequency adjustment

The switching frequency of the electromagnet of the O_2 measuring unit has been selected to be 110 Hz to avoid interference from harmonics of both 50 Hz and 60 Hz mains frequency.

Fine adjustment is seldom necessary. However, if you wish to reduce the effects of mechanical resonance peaks of the cabinet which appears as high noise level of the O_2 measuring unit analog output (above 20 mV peak to peak) it is worth of trying the fine frequency adjustment. One turn of trimmer 'FREQUENCY' will change the frequency by 1.5 Hz. Try to find minimum noise but do not deviate more than ±5 Hz.

Gas calibration

The gas calibration is performed in the Airway Gas -menu. Please see *User's Reference Manual* for calibration.

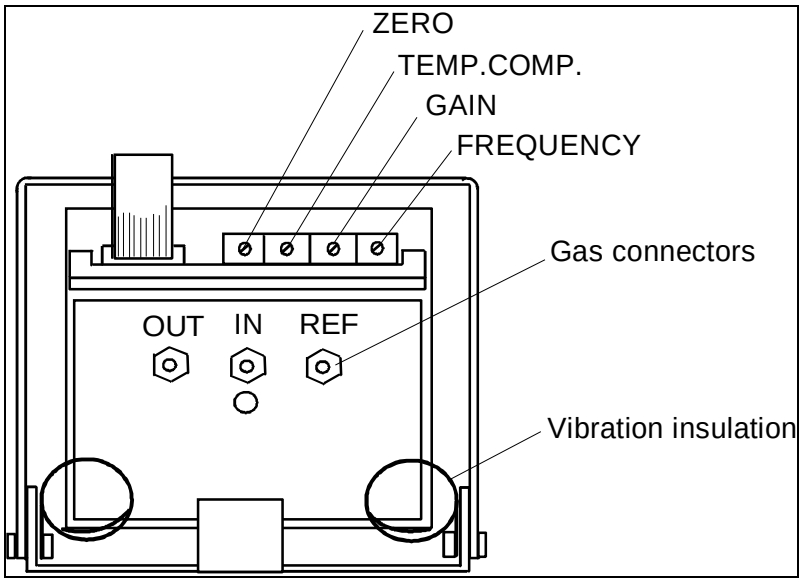


Figure 17 O_2 measuring unit adjustments

3.4.4 Flow calibration

PVX board is calibrated at the factory and due to the board's design calibration is not regularly needed. The calibration data is saved into the board's EEPROM memory and if the software EPROM of the board is changed the calibration must be performed. It is recommended to perform the calibration both with adult values using the D-lite, and with pediatric values using Pedi-lite.

1. Connect a spirometry tube with the D-lite sensor to the airway module. To improve the accuracy, the endotracheal tube and all accessories which are in normally use should be attached also during the calibration.
2. Enter service menu (Monitor Setup/Install Service/Service View/Modules).
3. Enter the PVX menu. After the flow is zeroed ('Zero OK' message displayed) attach calibration pump or spirometry tester to the flow sensor (D-lite or Pedi-lite). Select the sensor type.
4. Set the calibration volume for adult to 1000 ml and for pediatric to 300 ml.
5. Work on the calibration pump slowly, approximately 1 pump in 5 seconds, pump until 'adjust'-message appears. If you use the spirometry tester, perform the calibration according to the tester instructions.
6. Adjust the reading to match the calibration volume (1000 ml for the D-lite and 300 ml for the Pedi-lite).

4 TROUBLESHOOTING

4.1 Troubleshooting chart

Trouble	Possible Cause / Treatment
No response to breathing	Sampling line or water trap blocked or loose, or improperly attached. Water trap container full. Interface cable to monitor disconnected. See chapter "*Gas sampling system troubleshooting*."
SENSOR INOP. message	The temperature is too high, check fan and filter at the rear panel. Communication error, check timeout and bad checksum values at the service menu. Check Airway Module connection cable and supply voltages. Check ACX measuring board.
xx ZEROING ERROR-message	Gas zeroing failed. Condensation or residual gases are affecting zero measurement. Allow module to run drawing room air for half an hour and calibrate again.
AIR LEAK-message	Air leak in sampling system. Probably water trap or the sampling line is not attached properly. Gas zero valve failure. Pump failure or gas outlet blockage. Supply voltage missing
REPLACE TRAP-message	Flow resistance increased due to residue built-up on water trap membrane. Replace the water trap.
REBREATHING-message	CO_2 concentration in inspiratory air is too high. Possibly CO_2 absorber in ventilator is saturated. Change the absorber.
OCCLUSION-message	Sampling line or water trap is occluded. Water trap container is full. If occlusion persists check internal tubing for blockages. Check the power supply voltages.
SELECT AGENT-message	No anesthetic agent is selected though delivery is started. Vaporizer valve is broken. Traces of cleaning or disinfecting agent in the water trap container affecting the readouts. Replace the water trap.
No response to any gas	Sampling line, water trap, or internal tubing blocked or loose, or improperly attached. Pressure valve malfunction. Pump failure. Supply voltage missing. Serial communication error. Check those items.
Sudden increase in gas display	Measuring chamber contamination. ±15 V supply voltages missing. Water trap malfunction. Check all internal tubing and the interior of the water trap for occlusions or leaks. Replace water trap. Check flow rates.
Abnormally high response to all gases (or abnormally low) or sudden occlusion warning	Pressure transducer failure. Exchange the ACX Measuring board.
Random output (resembling noise)	Chopper motor timing pulses out of sync. Chopper motor not running, motor faulty or connection loose. Chopper motor driver transistor C-E open circuit or current limiter short circuit. Exchange the ACX measuring board.
Strong drift in all gases	Leakage in the sampling line or internal tubing (especially in conjunction with too low readings). Exchange the ACX measuring board.
No gas waveforms intermittently.	Gas waveforms are not shown during automatic zeroing, occlusion, or air leak. Check the monitor screen for possible messages and proceed accordingly.

4.1.1 Supply voltage troubleshooting

Trouble	Possible Cause	Treatment
"Gas module removed" No Gas module exists after turning the monitor on.	+5V lost	Gas module CPU not running. Check Gas Interface cable. Check +5V from module mother board and timeout value from module service page.
Random CO_2 value. No CO_2 or AA response. Abnormal AA mixture messages and AA selections. "Unknown Agent" "Zero error" after zeroing "Calibrate Agent ID" "Sensor Inop"	+5 Vdirty lost	Check the IR lamp resistance (approximately 4 Ohm)and the lamp voltage (module mother board connectors X8 and X9) X8 = ASX lamp(i-models) X9 = ACX lamp
"Continuous Occlusion" "Sensor Inop" Random curve trace and gas digit values(resembling noise). Pressure and flow curves extremely low.	+15 V lost	Check voltage from module mother board X1 pin 4, X2 pin 1a, X3 pin 1a, X4 pin 9 and X5 pin 5.
CO_2 value high. "Air leak" "Sensor Inop" Paw and Flow curves extremely high.	-15 V lost	Check voltage from module mother board X1 pin 2, X2 pin 2a, X3 pin 2a, X4 pin 6 and X5 pin 6.
"Air Leak"-message remains on the screen.	+15 V dirty lost	Check voltage from module mother board X1 pin 3, X2 pin30a , X3 pin 30a, X4 pin 1 and X5 pin 13.
Fan stopped.	+32 V lost	Check the fuse on Gas interface board. Check the fan and regulated fan supply voltage from module mother board connector X10.
"Calibrating gas sensor" remains on the screen.	One or more of the voltages lost: +5 Vdirty, +15 V,-15 V, +15 Vdirty ACX measuring board not communicating with the Gas mother board. ACX measuring unit badly contaminated.	Check those voltages as above. Check whether the ACX software version is available in the service menu. If not, replace the ACX measuring board. Replace the ACX measuring unit.

4.2 Gas sampling system troubleshooting

The faults which can occur in the sampling system are: leaks or blockages in the tubing, failure of the sampling pump or the magnetic valves, or diminishing of the flow rates because of pump aging or dirt accumulating in the internal tubing.

The following checks should help in localizing the fault. Whenever suspecting the sampling system and always after working on the sampling system check and if necessary adjust the flow rates.

The sampling system details are illustrated in figures 5, 6, 7 and 8.

CAUTION The special internal sample tube is mechanically fragile. Sharp bends will cause leaks.

NOTE: D-fend water trap should be replaced when the OCCLUSION message appears during the monitor startup.

NOTE: If any liquid has entered the ACX-200 measuring unit due to water trap filter failure, contact Datex-Ohmeda technical services.

4.2.1 Sampling system leak test

Connect power cord and sampling line. Turn the power on and wait until the initialization is over.

1. Choose ACX service data page in the Gas unit service menu.
2. Connect a tube to the sample out connector and drop its other end into a glass of water.
3. Block the sample inlet, reference flow of the oxygen measuring unit, and the CO_2 absorber port that draws room air in. Wait for one minute.
   There should be less than 1 bubble per 10 seconds coming out of the tube. Bubble should not move upwards more than 11 mm per 30 seconds inside the tube. If it does, there is a leak between the pump and the sample out connector.
4. Perform leak test to the CO_2 absorber by opening zero valve. The maximum permitted leakage is the same as above.

CAUTION Do not turn the pump off while performing the leak test. Negative pressure in the sampling system will suck water in the module.

4.2.2 Water separation

1. Dip the patient end of the sampling line into water quickly (about a half second) three times at 45 seconds' interval. After that drop the end into water and lift it up when the sampling line is totally filled with water.
2. Check that all the water goes into the trap container and not into the monitor.

4.2.3 Steam test for the special tubes

Choose Halothane as anesthetic agent and let the monitor sample room air. Then quickly feed air of 100 % relative humidity (for instance from a kettle in which you are boiling water) to the monitor. If the digital reading jumps as much as 0.1 % replace the special (Nafion) tubes.

4.3 OM measuring unit troubleshooting

Because of the complex and very sensitive construction of the oxygen measuring unit no repairs should be attempted inside the unit. Instead, if the fault has been found in the measuring unit itself, it should be replaced and the faulty unit be sent to Datex-Ohmeda for repair.

In cases of no response to O_2 or strong drift, check the tubing for loose connections, blockages and leaks.

CAUTION Never apply overpressure to the O_2 measuring unit as the pressure transducer may be permanently damaged.

If the message 'O_2 zero error' is displayed check the O_2 measuring unit output voltage on Gas mother board (see Section Offset adjustment).

If the adjustment range of the (software) calibration is insufficient check the O_2 measuring unit output voltage and adjust the gain if necessary (see Section Gain adjustment).

If there are problems with O_2 response time check the O_2 measurement flow rate and adjust it if necessary (see Section Gas Sampling System Adjustments).

If the O_2 signal is noisy, check the measurement unit suspension. Frequency adjustment may help in some cases (see Section Frequency adjustment).

4.4 ACX troubleshooting

CAUTION The measuring unit ACX-200 can be repaired and calibrated only at the factory.

The ACX troubleshooting is carried out in the General Troubleshooting scheme. The ACX testing is explained at the ACX service information section, please refer to it.

4.4.1 Cleaning the measuring chamber of ACX measuring unit

In case the N_2O "zero calibration constant" in Gas Service (ULT) or N_2O "calib zero" in ACX Service (AM/CCM) indicates contamination of the measuring chamber (value 61000 or more), or if the software will stuck to the "calibrating gas sensor" state due to contamination, it is possible to attempt the measuring chamber cleaning. However, Datex-Ohmeda recommend exchanging the measuring unit rather than cleaning.

The measuring chamber should first try to be cleaned by rinsing it with distilled water only. If rinsing alone is not sufficient the cleaning can be tried with Datex-Ohmeda Cleaning Fluid (85969).

NOTE: Do not use other cleaning agents such as blood gas electrode cleaners. These may damage the unit.

Cleaning procedure

Tools needed

- 10 ml syringe
- water glass
- 2 pcs 30 cm silicon tubes with inner diameter of 3 mm
- screwdriver

1. Detach the measuring unit from the monitor or gas module.
2. Attach the silicon tubes to the tube connector on the unit.
3. Attach the 10 ml syringe to one of the tubes.
4. Place the tip of the other tube into the water glass.
5. Pour some distilled water into the glass.
6. Suck the water into the tubing with the syringe.
7. Leave for 15 minutes.
8. Move the syringe piston in and out 10 times.
9. Detach the tubes from the unit and empty the water from the measuring chamber.
10. Attach one silicon tube to the unit and connect the other end of the tube to the gas outlet of the monitor or gas module.
11. Switch the monitor on and let the sample out flow dry out the unit at least for 15 minutes.
12. Attach the unit back to the monitor or gas module and switch the monitor on.
13. Let the monitor run at least 30 minutes before checking the calib zero in the service mode.
14. If the zero value is still more than 61000, repeat the procedure with the cleaning fluid.

NOTE: After cleaning with the cleaning fluid the measuring chamber must be well rinsed with distilled water.

NOTE: The monitor will stay in “Calibrating gas sensor” state until the measuring chamber is completely dry.

4.5 ASX agent identification unit troubleshooting

NOTE: Please read also troubleshooting section in *User's Reference Manual*.

CAUTION The agent identification bench ASX-200 can only be repaired and calibrated only at the factory.

Trouble	Possible Cause / Treatment
AGENT MIXTURE-message when calibration gas (Freon) is fed.	Repeat calibration. If the module contains ASX-100, it is not capable to identify calibration gas R23, therefore the message. However, the ASX-100 will still calibrate with R23.
No response from ASX.	Communication between ASX unit and Central Unit is lost. ASX bench disconnected or faulty. Check that the motor is running.

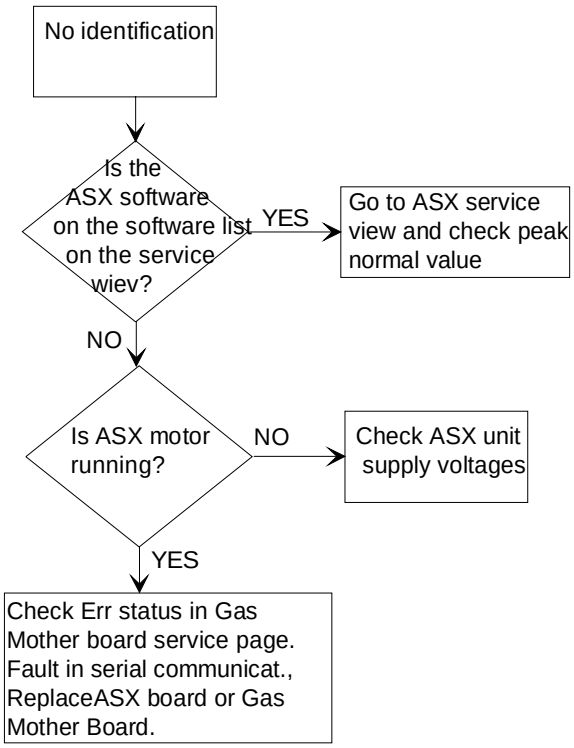


Figure 18 ASX troubleshooting flowchart

4.6 PVX board troubleshooting

CAUTION The measuring unit PVX-100 can be repaired and calibrated only at the factory.

NOTE: Never apply DIFFERENTIAL pressure higher than 25 cmH_2O to the spirometry tubing. Make sure that both spirometry tubes are always connected.

NOTE: Never apply overpressure or negative pressure of more than 300 cmH_2O to the spirometry tubing.

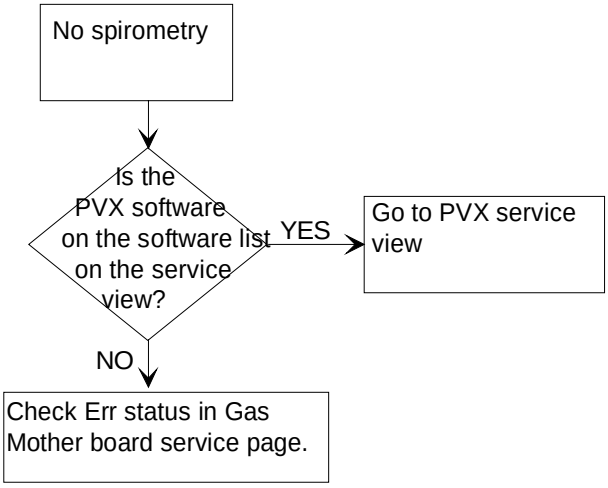


Figure 19 PVX board troubleshooting flowchart

NOTE: The PVX software string does not appear onto the list when using the combination of G-AOV module and monitor software S-___94.

4.7 Gas mother board troubleshooting

Due to the complexity of the LSI circuitry there are only a few faults in the CPU digital electronics that can be located without special equipment.

Check that the RAM, EPROM, CPU and other IC's that are on the sockets are properly attached.

See Gas mother board service pages for more information.

4.7.1 Instructions after replacing the software or Gas mother board

After replacing the software or Gas mother board:

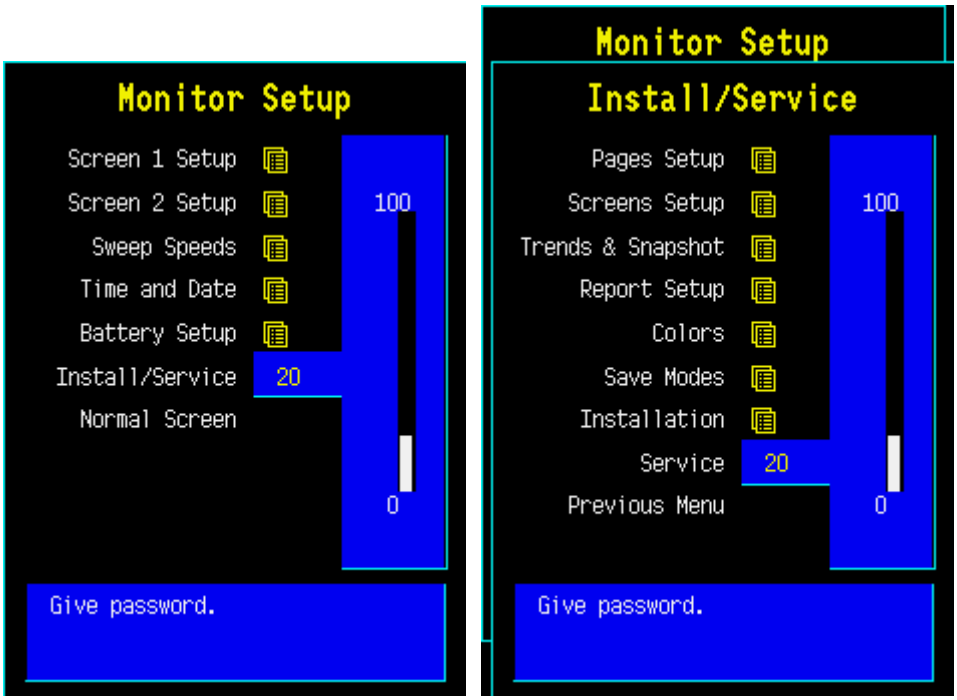
- perform the sampling system leak test
- check the flow rates
- perform the gas calibration

4.8 Error messages

Message	Explanation
Occlusion	The sample tube inside or outside the monitor is blocked or water trap is occluded. If occlusion persists, measured gas values disappear.
Air leak	- the water trap is not connected - the gas outlet is blocked - there is a leak in the sampling line inside the module. If air leak persists measured gas values disappear.
Replace trap	Indicates residue build-up on the water trap membrane. This decreases air flow.
Zero valve error	Opening the valve does not change working pressure enough.
Gas calibration is not available during the first 5 minutes/during occlusion/during air leak	Calibration not allowed during the first 5 minutes after power up and in mentioned situations.
Select agent	No agent selected.
Continuous occlusion. Check sampling line and water trap.	Occlusion over 40 seconds.
Air leak detected. Check water trap and sample gas out-flow. Press normal screen to continue.	Air leak over 40 seconds.

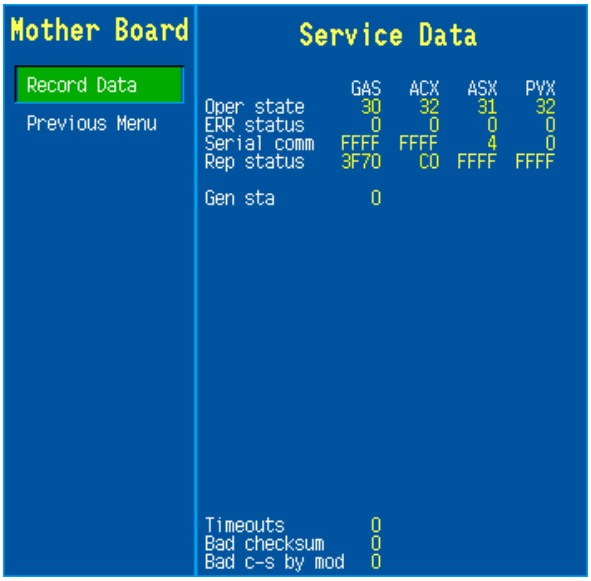
CO_2	
Zero error	Unsuccessful zeroing
Unstable	Unsuccessful calibration
CO_2 over scale	CO_2 signal exceeds the maximum waveform area
O_2	
O_2 zero error	Unsuccessful zeroing
O_2 over scale	O_2 signal exceeds the maximum waveform area
O_2 Unstable	Unsuccessful calibration
N_2O	
N_2O zero error	Unsuccessful zeroing
N_2O Unstable	Unsuccessful calibration
Ane agents	
AA zero error Zero error	Unsuccessful zeroing
AA unstable Unstable	Unsuccessful calibration
AA over scale	AA signal exceeds the maximum waveform area
Menu messages during calibration	
Zero error	Unsuccessful zeroing
Adjust	Calibration gas accepted and monitor is ready for adjusting the gas values to match the calibration gas concentration
Unstable	Unsuccessful calibration

5 SERVICE MENU



1. Press the **Monitor Setup** key.
2. Select ***Install / Service*** (password 16-4-34).
3. Select ***Service*** (password 26-23-8).
4. Select ***Parameters - Gas Unit***.

5.1 Gas mother board



Service Data

Oper State
Internal operation state of the module:

0...9	function performed, if staying on, failure is indicated
10...29	Initialization
30...39	Normal operation state
40...49	Zeroing
50...59	Calibrating

ERR status
Indicates measuring unit malfunction:

GAS:

0	no error
1	error in ACX measuring system
2	error in ACX communication
10	error in ASX measuring system
20	error in ASX communication
40	error in PVX measuring system
80	error in PVX communication

Possible failure source: Gas CPU, ACX, ASX or PVX.

ACX:

0	no error

if not 0, replace ACX unit

ASX:

0	no error

if not 0, replace ASX unit

PVX:

0	no error

if not 0, replace PVX unit

Serial Comm(unication)
Serial Communication indicates a state of serial communication between the module processor and a measuring unit.

GAS:	FFFF Continuously
ACX:	FFFF Continuously
ASX:	Value is for factory use only.
PVX:	Value is for factory use only.

Rep status
Rep status is a four-digit number, where all digits, abcd , can have different values.

Gas rep status:

a	
0	No sevoflurane or desflurane measurement available
3	ACX can measure sevoflurane and desflurane
b	
0	No gas measurements available
F	CO2, O2 N2O and AA measurements available
3	CO2 and O2 available
c	
0	No ACX, ASX, nor PVX board running
1	ACX board running
3	ACX and ASX board running
5	ACX and PVX board running
7	ACX, ASX and PVX board running
d	
0	Normal operation state
1	Occlusion
2	Air leak
4	Other sampling system error
8	Replace trap

ACX rep status:

a	
empty	Normal operation state
1	ACX initialization
b	
empty	Normal operation state
2	Occlusion
4	Air leak
c	
C	Normal operation state
others	values used in manufacturer's testing
d	
0	Normal operation state
others	values used in manufacture's testing

ACX rep status	FFFF continuously

PVX rep status	FFFF continuously

General Status

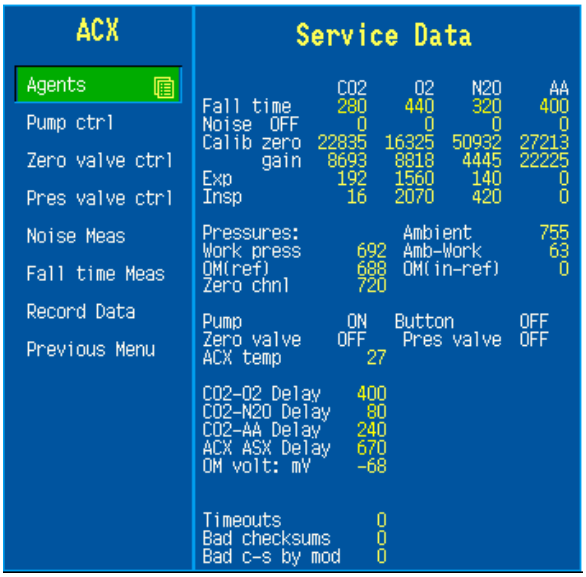
0	Normal operation state
8000	Initialization

If not 0 or 8000, replace the gas mother board.

Timeouts is a cumulative number that indicates how many times the module has not responded to the monitor's inquiry.
Bad checksums is a cumulative number that indicates how many times communication from the module to monitor broke down.
Bad c-s by mod is a cumulative number that indicates how many communication errors the module has detected.
The monitor starts counting these items at power up and resets to zero at power off. The nonzero values do not indicate a failure, but the continuous counting indicates either serial communication failure or module not in place.

The timeouts etc numbers should not grow faster than 50/s.

5.2 ACX service menu



Pump ctrl Turns pump on/off

Zero valve ctrl Turns zero valve on/off

Pres valve ctrl Turns pressure valve on/off

Noise Meas Noise measurement.

Fall time Meas Fall time measurement.

Service Data

Fall time

Fall time indicates the response time of the measuring units. Select 'Fall time meas' from the menu. Notice that text 'feed' appears under each gas. Feed the calibration gas until every 'feed' is replaced by 'start'. Remove the sampling line quickly from the gas source.

Check that fall times are:
O_2 < 480 ms
CO_2 < 360 ms
N_2O < 360 ms
AA < 520 ms

NOTE: The measurement can be performed only with the modules using module software 884295.

Noise measurement
O_2, CO_2 and N_2O

Feed the calibration gas until the gas values are stabilized on screen. Start the measuring by selecting 'Noise meas' from the menu. After 10 seconds stop measuring by reselecting 'Noise meas'. Close the gas source. Noise values should be: O_2< 100, CO_2 < 20, N_2O< 150.

AA

Select halothane for anesthetic agent. Feed the room air until gas values are stabilized. Perform the noise measuring as above, the value should be < 20.

NOTE: The measurement can be performed only with the modules using module software 884295.

Calib zero and gain
These values are calibration constants of zero and gain for each gas. The zero values may change at gas zeroing, the gain values at gas calibration.
When the monitor performs gas zeroing, the main software will write zero constants for the gases (CO_2, N_2O, AA, O_2) to the ACX memory. If some dust (or water) has entered the measuring chamber, zeroing of the gases require higher zero constants than before depending on the contamination level. If some gas requires higher value than 65536 the unit is not able to perform the zeroing and the message 'XXX ZERO ERROR' appears to the error list and the software recalls the previous zero constant for the concerned gas. If this happens at the initial start up the software will not pass the "calibrating gas sensor" state.
The N_2O zero point is very sensitive for the measuring chamber contamination. Therefore the zero constant of N_2O can be utilized in observing the contamination level of the ACX measuring chamber. The optimum value for the N_2O zero constant with new and clean measuring chamber is 45000 indicating the ratio of 1:1 between the measuring and reference channel signals. The maximum acceptable value for the N_2O zero constant is 51000, for a new measuring unit. The maximum value that the main software is able to set is 65536.

Exp, Insp
Gas concentration value from the ACX measuring unit.

Pressures
Ambient is the ambient pressure measured at the initialization. **Work press** is the internal pressure of sampling system measured by the ACX measuring board pressure transducer. The difference between these two pressures is **Amb-Work** and if the pump is functioning, it should normally be within 50...75.

OM(in-ref) is a pressure difference between the O_2 measurement flow and the O_2 reference flow. This pressure difference is automatically checked after every gas zeroing and it should be between 5 to 10 mmHg. If the pressure difference turns negative a message 'Replace trap' is displayed when the limit of -5 mmHg is exceeded.
In S-___97 and S-___98 software there is a software flaw in displaying the pressure difference, OM (in-ref). The flaw does not have any effect on the functioning of the ACX unit. The operational limit for the 'Replace Trap' message is -5 mmHg as in previous SW versions. The flaw is only in the displaying of the pressure difference value. With S-___97/98 software the pressure difference can be checked in a following way: turn the pressure valve ON for five seconds. This enables the updating of the OM (ref) value. Turn the pressure valve OFF and wait for five seconds. Now calculate the difference between Work press and OM (ref).

Pump, zero valve, and **pressure valve** are operated manually by highlighting and pushing the ComWheel. During patient monitoring, the valves are in OFF position

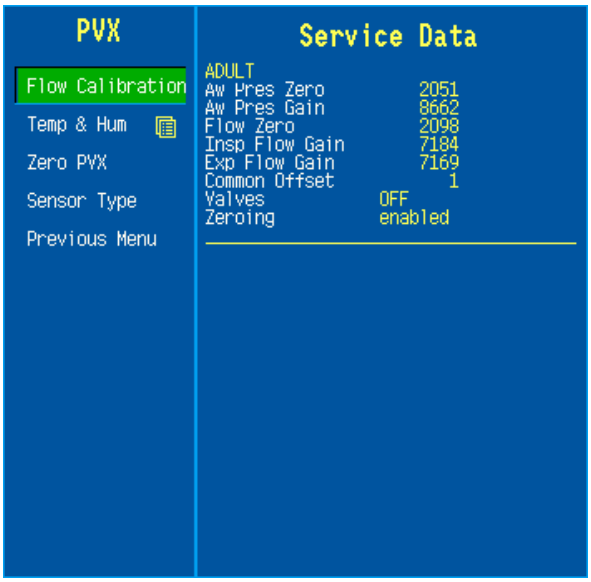
ACX temp indicates temperature inside the ACX bench, and the value is typically +10 °C higher than the prevalent room temperature.

Delays indicate the time delays within or between measurement units.
Delays are measured at the same time as fall times.
Check that the ACX_ASX delay is between 400-800.

NOTE: The measurement can be performed only with the modules using module software 884295.

Timeouts is a cumulative number that indicates how many times the module has not responded to the monitor's inquiry.
Bad checksums is a cumulative number that indicates how many times communication from the module to monitor broke down.
Bad c-s by mod is a cumulative number that indicates how many communication errors the module has detected. The monitor starts counting these items at power up and resets to zero at power off. The nonzero values do not indicate a failure, but the continuous counting (more than 50 per second) indicates either serial communication failure or module not in place.

5.3 PVX service menu



Service Data

Aw Pres Zero...The value of airway pressure zero is changing within the range of 1000 to 2400.

***) Aw Pres Gain**...Gain of pressure measurement. This value should be fixed to 8662.

Flow Zero....The value corresponds to the pressure transducer B1 output during PVX zeroing. Number 0 corresponds to 0 V and 4095 corresponds to 10 V. The value is typically within the range of 100 to 4000.

Insp Flow Gain...Gain of inspired gas volume. Typically the value is between 5000 and 9000 depending on which sensor is used (adult/pediatric).

Exp Flow Gain...Gain of expired gas volume. Typically the value is between 5000 and 9000 depending on which sensor is used (adult/pediatric).

***) Common Offset**...Cancels common error which is caused by pressure from the pressure transducers. This is a transducer's own constant. The value should be between -230 and +230.

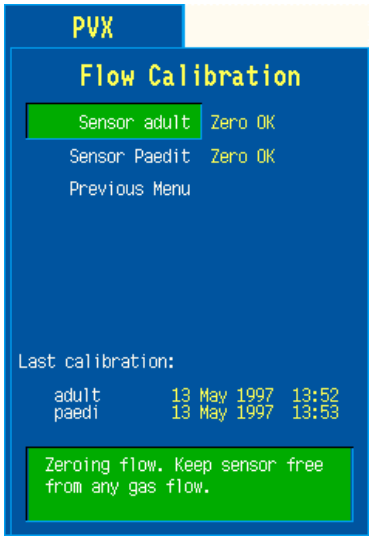
Valves...Position of zero valves.

Zeroing....Automatic zeroing is cancelled (disabled) or active (enabled).

*) NOTE: Items marked with asterisk (*) are not to be changed.

NOTE: The shown values are for the Adult module only. Changing the mode does not change the values.

5.3.1 Flow calibration



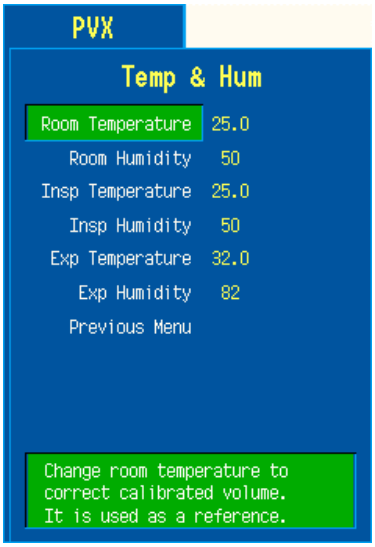
Flow calibration

PVX board is calibrated at the factory and due to the board's design calibration is not regularly needed. The calibration data is saved into the board's EEPROM memory and if the software EPROM of the board is changed the calibration must be performed. It is recommended to perform the calibration both with adult values using the D-lite, and with pediatric values using Pedi-lite.

1. Connect a spirometry tube with the D-lite sensor to the airway module. To improve the accuracy, the endotracheal tube and all accessories which are in normally use should be attached also during the calibration.
2. Enter service menu (**Monitor Setup** ***- Install Service - Service - Parameters***).
3. Enter the PVX menu. After the flow is zeroed ('Zero OK' message displayed) attach calibration pump or spirometry tester to the flow sensor (D-lite or Pedi-lite). Select the sensor type.
4. Set the calibration volume for adult to 1000 ml and for pediatric to 300 ml.
5. Work on the calibration pump slowly, approximately 1 pump in 5 seconds, pump until 'adjust'-message appears. If you use the spirometry tester, perform the calibration according to the tester instructions.
6. Adjust the reading to match the calibration volume (1000 ml for the D-lite and 300 ml for the Pedi-lite).

NOTE: The last calibration dates are saved into the main CPU board memories.

5.3.2 Temp & Hum service menu



If circumstances noticeably differ from normal, or additional accuracy is required, the use of Temp & Humidity menu may be advisable.

Especially small errors in tidal values may indicate that temperature and humidity settings of the monitor differ too much from the used system.

Room Temperature and Humidity
These are needed only in calibration procedure.

Insp Temperature
The setting regarding the temperature of inspired gas. The value is used in calculations. Change if necessary.

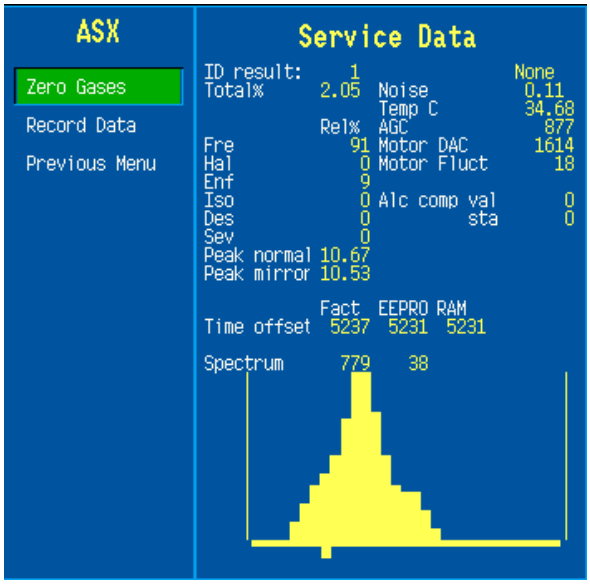
Insp Humidity The setting regarding the humidity of inspired gas. The value is used in calculations. Change if necessary.

Exp Temperature The setting regarding the temperature of expired gas. The value is used in calculations. Change if necessary.

Exp Humidity The setting regarding the humidity of expired gas. The value is used in calculations. Change if necessary.

5.4 ASX service menu

NOTE: The ASX service menu in monitor software S-xxx94 or newer supports only modules equipped with the ASX-200.



Service Data

ID result displays the identified gas or mixture

Total % is the anesthetic agent concentration measured by ASX bench.

Rel % is the relative percentage of each measured agent in the mixture.

Noise value should be less than 80. Check the value only when no gas is fed and after a minimum of one minute stabilization time.

Temp C is the temperature inside the ASX unit.

AGC (Automatic Gain Control) should be between 100 and 3500.

Motor DAC is a motor speed control voltage, 100...3900, and **Motor Fluct** is the speed fluctuation, should be < 200.

Alc comp val is the compensation factor for alcohol content measured during halothane, enflurane or isoflurane measuring. **Sta** shows the status of compensation, 0 means off, and 1 means on.

The value without a leading text is for factory use only.

Peak normal, Peak mirror give the place of the spectrum's peak in the channel numbers. The peak normal value should be 10.3- 10.7 with calibration gas R23, and 12.9-13.1 with R22. If the value is not within the range, the gas calibration must be performed (see User's manual for instructions).

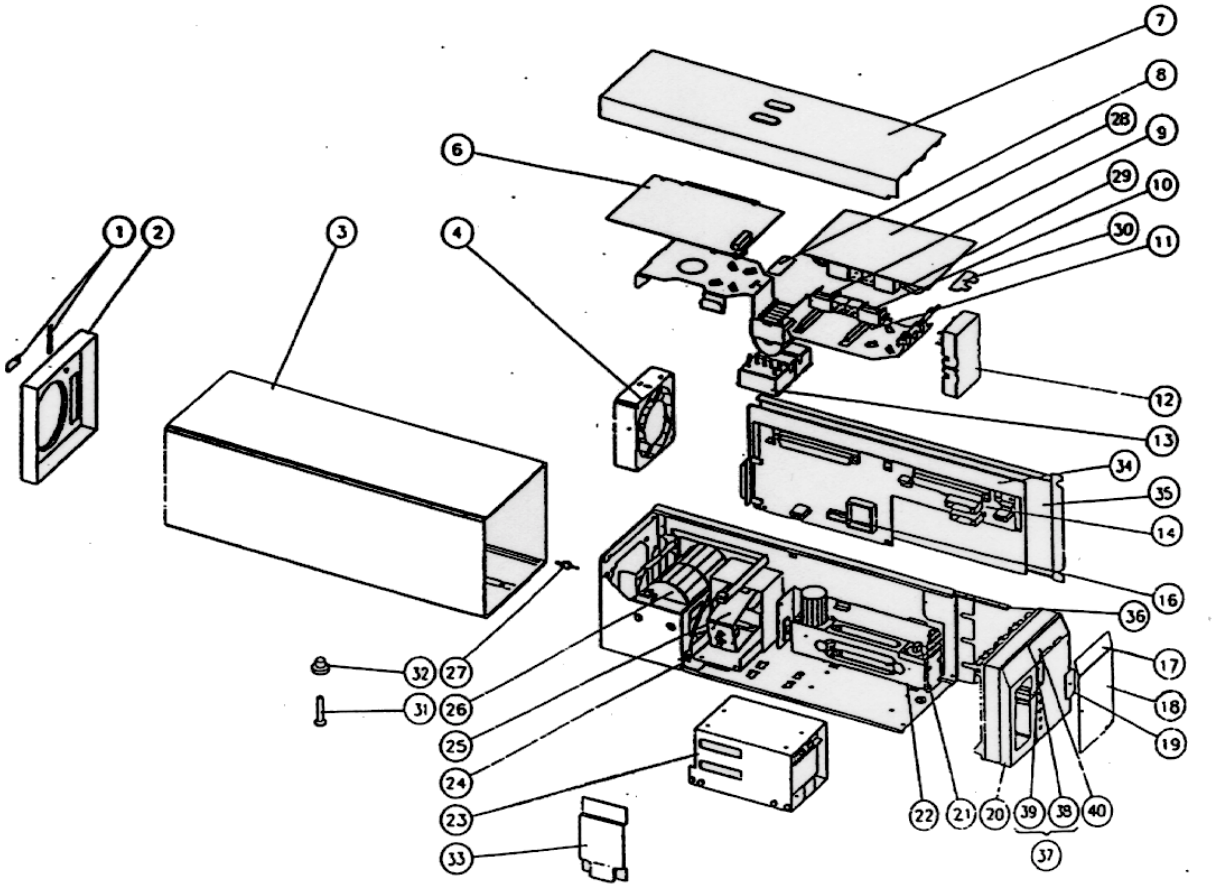
Time offset is the time between motor synchronization pulse and filter 0° angle. **Fact** is the factory value for it, **EEPRO** is the user calibration result, stored in the ASX, and **RAM** is the user calibration result, stored in the gas mother board.

Spectrum values tell about the scales of the spectrum display.

6 SPARE PARTS

6.1 Spare parts list

NOTE: Only changed part numbers are listed under later revisions. To find the desired part: check first the list of the revision that corresponds your device. If the part is not listed there, check the previous revision, etc. until you find the right number.



6.1.1 G-AO rev. 01, G-AiO rev. 00

Item	Item description	Order No.
-	Block screw for cables	546096
-	Nafion tube (A or B, 500 mm: see manual)	*733383
-	Nafion tube (C, 300 mm)	*733382
-	Spring for D-Fend	875598
-	Membrane keypad, G-AO / G-AOV	879371
-	Thumb screw, AS/3 Airway Module	879511
3	Case, Airway module	878864
4	Fan	880049
6	ACX-200 measuring board	*880270

Item	Item description	Order No.
7	Cover, top protection	878859
8	Latch for flow cassettes	880343
9	Valve, zero	58534
10	Valve, pressure	*58534
11	Internal sampling tubings incl. system plate	*880375
12	CO_2 Absorber, Airway Module	*880067
13	Damping chamber / Filter	880068
14	Gas mother board, G-AO / G-AiO	*(880352) Use 885174
19	Plug, tube connector	880294
20	Front panel unit, G-AO	(880374) Use 887477
20	Front panel unit, G-AiO	(881116) Use 887477
21	Lamp, ASX-100/200	*878756
22	ASX-100 agent identification unit	*881107
23	O_2 measuring unit	*(872898) Use 888511
24	Grommet for tubes	65094
25	Sample pump, (Airway module) AS/3 spare part	*(881298) Use 896238
26	ACX-200 measuring unit	*879849
27	Connector, sample gas out	871981
31	Cross recess screw M6x16	61678
32	Bushing, AS/3 Airway Module	879512
40	Fitting plate, G-AiO / G-AiOV / G-O / G-OV	880550

6.1.2 G-AO rev. 02, G-AiO rev. 01, G-AOV rev. 00, G-AiOV rev. 00

Item	Item description	Order No.
14	Gas mother board, G-AOV / G-AiOV	*(881775) Use 885174
20	Front panel unit, G-AOV	(880374) Use 888292 [1)]
20	Front panel unit, G-AiOV	(881116) Use 888292 [1)]
28	PVX-100 without software	*881444
29	PVX tubings	882723
30	PVX board support	880435
37	Repair set for spirometry connectors, AS/3	*886978

6.1.3 G-AO rev. 03, G-AiO rev. 02, G-AOV rev. 01, G-AiOV rev. 01

Item	Item description	Order No.
14	Gas mother board, AS/3 Airway module	*885174
35	EMC cover, Gas mother board	884116
33	Bronze plate	884117
34	Insulation plate for 884116	879914

6.1.4 G-AO rev. 04, G-AiO rev. 03, G-AOV rev. 02, G-AiOV rev. 02, G-O rev. 00, G-OV rev. 00

Item	Item description	Order No.
-	OM reference filter	86901
-	Cable tie	64001
20	Front panel unit, G-AO	(885280) Use 887477
20	Front panel unit, G-AiO	(885281) Use 887477
20	Front panel unit with metal SSS -connectors, AS/3	888292 [1)]
20	Front panel unit w/o SSS -connectors, AS/3	887477
22	ASX-200 agent identification unit	*882718
23	O_2 measuring unit	*888511
29	PVX tubings	885867
36	Grounding spring	885602
38	Spirometry connector, short male	886636
39	Spirometry connector, short female	886638

6.1.5 G-AO rev. 05, G-AiO rev. 04, G-AOV rev. 03, G-AiOV rev. 03, G-O rev. 01, G-OV rev. 01

Item	Item description	Order No.
3	Case, Airway module, white	893258

* this part is recommended for stock

[1)] NOTE: In case only the plastic spirometry connectors need repair, or compatibility with adult & pediatric Patient Spirometry accessories is needed, the **Repair set for spirometry connectors, order number 886978**, is recommend to be used.

The Front panel unit, order number 888292, does not contain a membrane keypad, fitting plate and small front panel sticker. Those should be added separately according to the Airway module type and revision.
The Flow cassette's and their order numbers can be found listed in the section Gas sampling system.

6.1.6 S/5 G-AO rev. 06, G-AiO rev. 05, G-AOV rev. 04, G-AiOV rev. 04

Item	Item description	Order No.
3	Case, Airway Module, S/5 white	898318

6.1.7 Panel stickers

Rear panel sticker set, item No. 1

Adaptation	all modules Order No.
All	894181

Front panel sticker (small), item No. 17

Adaptation	G-AO, G-AOV Order No.	other modules Order No.
-23- (Eng)	880376	880471
-26- (Fin)	888876	880471
-31- (Jpn)	888313	880471
-33- (Ger)	880546	880471
-40- (Spa)	884405	880471
-41- (Swe)	885843	880471
-42- (Dnk)	892221	880471
-43- (Fre)	880454	880471
-44- (Dut)	886065	880471
-46- (Ita)	886760	880471
-47- (Nor)	893574	880471
-48- (Por)	895256	880471

Front panel sticker (large), item No. 18

Airway Module	Order No.
G-AO	880377
G-AiO	880472
G-AOV (rev. 00-01)	880472
G-AOV (Jpn)	888314
G-AOV (rev. 02)	886980
G-AiOV (rev. 00-01)	881301
G-AiOV (rev. 02)	886981
G-AiOV (rev. 02, Jpn)	890710
G-O	885233
G-OV	886972
G-OV (Jpn)	890712

6.1.8 S/5 panel stickers

Rear panel stickers, item No. 1

Adaptation	all modules Order No.
All	8000246

Front panel sticker (small), item No. 17

Adaptation	S/5 G-AO, G-AOV Order No.	other modules Order No.
DA	8000202	8000204
DE	8000193	8000204
EN	8000192	8000204
ES	8000196	8000204
FI	8000199	8000204
FR	8000194	8000204
IT	8000197	8000204
JA	8000389	8000204
NO	8000201	8000204
NL	8000195	8000204
PT	8000198	8000204
SV	8000200	8000204

Front panel sticker (large), item No. 18

Airway Module	Order No.
G-AO	8000203
G-AiO	8000205
G-AOV	8000208
G-AOV (Jpn)	8000390
G-AiOV(Jpn)	8000391

6.1.9 Planned Maintenance (PM) Kits:

Airway Module, G-xxx	Order No.
all versions	8001762

6.1.10 Gas Interface Board, B-GAS

Item	Item description	Order No.
-	Fuse T4A 250V	*51134
-	Grounding plate	885404
-	Block screw for cables	546096

* this part is recommended for stock

7 EARLIER REVISIONS

This manual supports all the other Airway Module revisions except the following ones. For further information on those revisions see corresponding manual.

Revision	Manual slot / main manual	Note
G-AO Module revision 01 G-AiO Module revision 00	Service Manual p/n 880850	
G-AO Module revision 02 G-AiO Modules revision 01 G-AOV Module revision 01 G-AiOV Module revision 01	Service Manual p/n 882580	
G-OV Module revision 01 G-O Module revision 01	Technical Reference Manual 885944-6/896624	

APPENDIX A

SERVICE CHECK FORM

S/5 Airway modules

Customer					
Service		Module type		S/N	
Service engineer				Date	

☐ OK = Test OK ☐ N.A. = Test not applicable ☐ Fail = Test Failed

All modules

	OK	N.A.	Fail		OK	N.A.	Fail
1. Internal parts	☐	☐	☐	2. External parts	☐	☐	☐
2. D-fend O-rings	☐	☐	☐	3. OM ref. filter	☐	☐	☐

Notes _____

5. Fan	☐	☐	☐				
6. Module software	Gas Unit						
	ACX						
	PVX						
	ASX						
7. Module bus communication	☐	☐	☐	8. Membrane key	☐	☐	☐
8. N_2O calibration zero				< 61000			
9. Ambient pressure	☐	☐	☐	9. Special tubes	☐	☐	☐
10. CO_2 absorber				> 3			
11. Zero valve	☐	☐	☐	10. Leak test	☐	☐	☐
12. Sampling pump				> 109 mmHg			

16. Flow rates

Sampling flow		180-220 ml/min
Side flow		10-27 ml/min
O_2 meas. in flow		45-60 ml/min
O_2 ref. in flow		25-42 ml/min
CO_2 absorber flow		180-220 ml/min

17. Pressures

Amb-Work		50-75 mmHg
OM (in-ref)		> 4 mmHg

18. O_2 sensor output voltage		min. 2800 mV

	OK	N.A.	Fail
19. Gas calibration	☐	☐	☐

20. Fall time measurement

CO_2 fall time		< 360 ms
O_2 fall time		< 480 ms
N_2O fall time		< 360 ms
AA fall time		< 520 ms

21. Noise measurement

CO_2 noise		< 20
O_2 noise		< 100
N_2O noise		< 150
AA noise		< 20

AA ID option

22. ACX_ASX Delay		400-800 ms

23. Peak normal and Peak mirror

Peak normal		10.30-10.70
Difference		±0.30

	OK	N.A.	Fail		OK	N.A.	Fail
24. Calibration gas I.D.	☐	☐	☐				

Notes _____

Patient spirometry option

25. Spirometry connectors	☐	☐	☐	26. Spirometry leak test	☐	☐	☐
26. Flow waveform	☐	☐	☐	27. Spirometry tester	☐	☐	☐

Notes _____

All modules

29. Fan filter	☐	☐	☐	30. Electrical safety check	☐	☐	☐
30. Occlusion detection	☐	☐	☐	31. Air leak detection	☐	☐	☐
31. Apnea detection	☐	☐	☐	32. Final cleaning	☐	☐	☐

Notes _____

Used spare parts _____ _____ _____

Signature _____