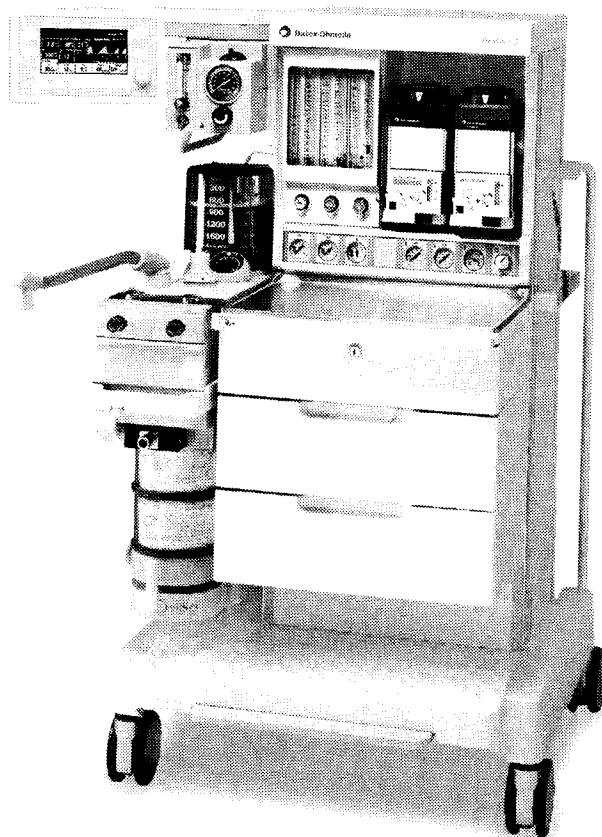


**Aestiva**

## Operation Manual—Part 2

*Software Revision 3.X*

Setup, Cleaning and Sterilization, Maintenance and Troubleshooting



**Datex-Ohmeda**

*Devoted to caring for life*

This Product will perform in conformity with the description thereof contained in this operating manual and accompanying labels and/or inserts, when assembled, operated, maintained, and repaired in accordance with the instructions provided. This Product must be checked periodically. A defective Product should not be used. Parts that are broken, missing plainly worn, distorted, or contaminated should be replaced immediately. Should repair or replacement become necessary, Datex-Ohmeda recommends that a telephonic or written request for service advice be made to the nearest Datex-Ohmeda Field Service Support center. This Product or any of its parts should not be repaired other than in accordance with written instructions provided by Datex-Ohmeda and by Datex-Ohmeda trained personnel. The Product must not be altered without the prior written approval of Datex-Ohmeda's Quality Assurance Department. The user of this Product shall have the sole responsibility for any malfunction which results from improper use, faulty maintenance, improper repair, damage, or alteration by anyone other than Datex-Ohmeda.

**⚠ Caution** U.S. Federal and Canadian law restrict this device to sale by or on the order of a licensed medical practitioner. Outside the U.S.A. and Canada, check local laws for any restriction that may apply.

Datex-Ohmeda products have unit serial numbers with coded logic which indicates a product group code, the year of manufacture and a sequential unit number for identification.

AAA A 12345



This alpha character indicates the year of product manufacture and when the serial number was assigned; "Y" = 1995, "Z" = 1996, "A" = 1997, etc. "I" and "O" are not used.



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# Introduction

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How to use this manual


This is part two of the Aestiva operation and maintenance manual. It tells you how to:

- Remove and clean parts
- Set up the system
- Identify and replace worn or damaged parts
- Calibrate the O<sub>2</sub> sensor



The second half of this chapter is a maintenance schedule.

The last section, troubleshooting, tells you what causes each alarm and what you can do about it.

Use this manual together with part 1, which includes the operating instructions and preoperative checkout.

 **WARNING** If an alarm occurs, safeguard the patient first, before troubleshooting or repair procedures.

























Symbols used in the manual or on the equipment

 Warnings and  Cautions tell you about dangerous conditions that can occur if you do not follow all instructions in this manual.

Warnings tell about a condition that can cause injury to the operator or the patient.

Cautions tell about a condition that can cause damage to the equipment. Read and follow all warnings and cautions.

Other symbols replace words on the equipment or in Datex-Ohmeda manuals. No one device or manual uses all of the symbols. These symbols include:

|   |  |   |   |
|---|--|---|---|
|    | On (power)   |    | Not autoclavable                                    |
|    | Off (power)  |    | Type B equipment                                    |
|    | Standby  |    | Type BF equipment                                   |
|   | Standby or preparatory state for part of the equipment |   | Type CF equipment                                   |
|  | "ON" only for part of the equipment                    |  | Caution, ISO 7000-0434                              |
|  | "OFF" only for part of the equipment                   |  | Attention, refer to product instructions, IEC 601-1 |
|  | Direct current   |  | This way up   |
|  | Alternating current                                    |  | Dangerous Voltage                                   |
|  | Protective earth ground                                |  | Input   |
|  | Earth ground   |  | Output  |
|  | Frame or chassis ground                                |  | Stock Number  |
|  | Alarm silence button                                   |  | Serial Number                                       |

|  |                              |  |  |
|--|------------------------------|--|--|
|  | Equipotential                |  | Systems with this mark agree with the European Council Directive (93/42/EEC) for Medical Devices when they are used as specified in their Operation and Maintenance Manuals. The xxxx is the certification number of the Notified Body used by Datex-Ohmeda's Quality Systems. |
|  | Variability                  |  | Read top of float.   |
|  | Variability in steps         |  | Vacuum inlet   |
|  | Plus, positive polarity      |  | Suction bottle outlet  |
|  | Minus, negative polarity     |  | O2 Flush button  |
|  | Lamp, lighting, illumination |  | Cylinder   |
|  | Movement in one direction    |  | Isolation transformer  |
|  | Movement in two directions   |  | Linkage system   |
|  | Lock                         |  | Risk of Explosion.   |
|  | Unlock                       |  | Low pressure leak test   |
|  | Autoclavable                 |  |  |

|  |  |  |   |
|--|--|--|---|
|  | Bag position/ manual ventilation                           |  | Mechanical ventilation                                      |
|  | Open drain (remove liquid)                                 |  | Close drain   |
|  | Inspiratory flow   |  | Expiratory flow   |
|  | O2 sensor connection.                                      |  | End case  |
|  | The primary regulator is set to pressure less than 345 kPa |  | The primary regulator is set to pressure less than 414 kPa. |
|  | CE European Union Representative                           |  |   |

Maintenance summary and schedule

These schedules show the minimum frequency. You will have to service the equipment more frequently if you use it:

- In unusual conditions (dirty gas supplies, high temperature, high humidity, etc.)
- More frequently than normal.

Operator maintenance

Examine all components and do the maintenance procedures more frequently if necessary.



| Minimum Frequency         | Maintenance   |
|---------------------------|---|
| Daily                     | <ul style="list-style-type: none"><li>▪ Clean the external surfaces.</li><li>▪ 21% O<sub>2</sub> calibration (circuit O<sub>2</sub> sensor).</li><li>▪ Flow sensor calibration</li></ul>  |
| Two weeks                 | <ul style="list-style-type: none"><li>▪ Drain the vaporizers and discard the agent. This is not necessary for Tec 6 vaporizers.</li></ul>   |
| Monthly                   | <ul style="list-style-type: none"><li>▪ 100% O<sub>2</sub> calibration (circuit O<sub>2</sub> sensor).</li><li>▪ Put Krytox (or a lubricant approved for use with 100% O<sub>2</sub>) on all tee handle threads.</li></ul>  |
| During cleaning and setup | <ul style="list-style-type: none"><li>▪ Inspect the parts for damage. Replace or repair as necessary</li></ul>  |
| Annually                  | <ul style="list-style-type: none"><li>▪ Replace the external o-rings on the vaporizer ports.</li></ul>  |
| As necessary              | <ul style="list-style-type: none"><li>▪ Install new cylinder gaskets on cylinder yokes.</li><li>▪ Replace the absorbent in the absorber.</li><li>▪ Drain the breathing system.</li><li>▪ Drain the breathing circuit module.<sup>1</sup></li><li>▪ Drain the overflow trap on the optional suction regulator.</li><li>▪ Replace the circuit O<sub>2</sub> sensor.</li><li>▪ Replace the disposable flow sensors (plastic) <sup>2</sup></li><li>▪ Replace the autoclavable flow sensors (metal)<sup>3</sup>.</li><li>▪ Replace the receiver filter (active gas scavenging only).</li></ul> |

1. This is included in the preoperative test procedure.  
2. Under typical use the sensor meets specifications for 3 months  
3. Under typical use the sensor meets specifications for 1 year.

Datex-Ohmeda approved service

| Minimum Frequency | Maintenance   |
|-------------------|---|
| 6 months          | Have an approved service person do the service tests and scheduled service maintenance. |

# Cleaning and sterilization

-  **WARNING** Obey applicable safety precautions:
- Read the material data sheet for each cleaning agent.
  - Read the operation and maintenance manual for all sterilization equipment.
  - Wear gloves and safety glasses. A damaged O<sub>2</sub> sensor can leak and cause burns (contains potassium hydroxide).
  - Do not breathe the fumes.
-  **CAUTION** To prevent damage:
- Refer to the manufacturer's data if you have questions about a cleaning agent.
  - Do not use organic, halogenated, or petroleum based solvents, anesthetic agents, glass cleaners, acetone, or other harsh cleaning agents.
  - Do not use abrasive cleaning agents (such as steel wool, silver polish or cleanser).
  - Keep all electronic parts away from liquids.
  - Do not permit liquid to go into the equipment housings.
  - Do not soak synthetic rubber parts for more than 15 minutes. Swelling or faster aging can occur.
  - Only autoclave parts that are marked 134°C.

In this section

|   |      |
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| Disassemble the patient path .....                | 2-7  |
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Summary

Patient path

The parts in Figure 2-1 send exhaled gas back to the patient. They may require more frequent cleaning/sterilization than parts in Figure 2-2. Refer to your hospital's infection control policy.

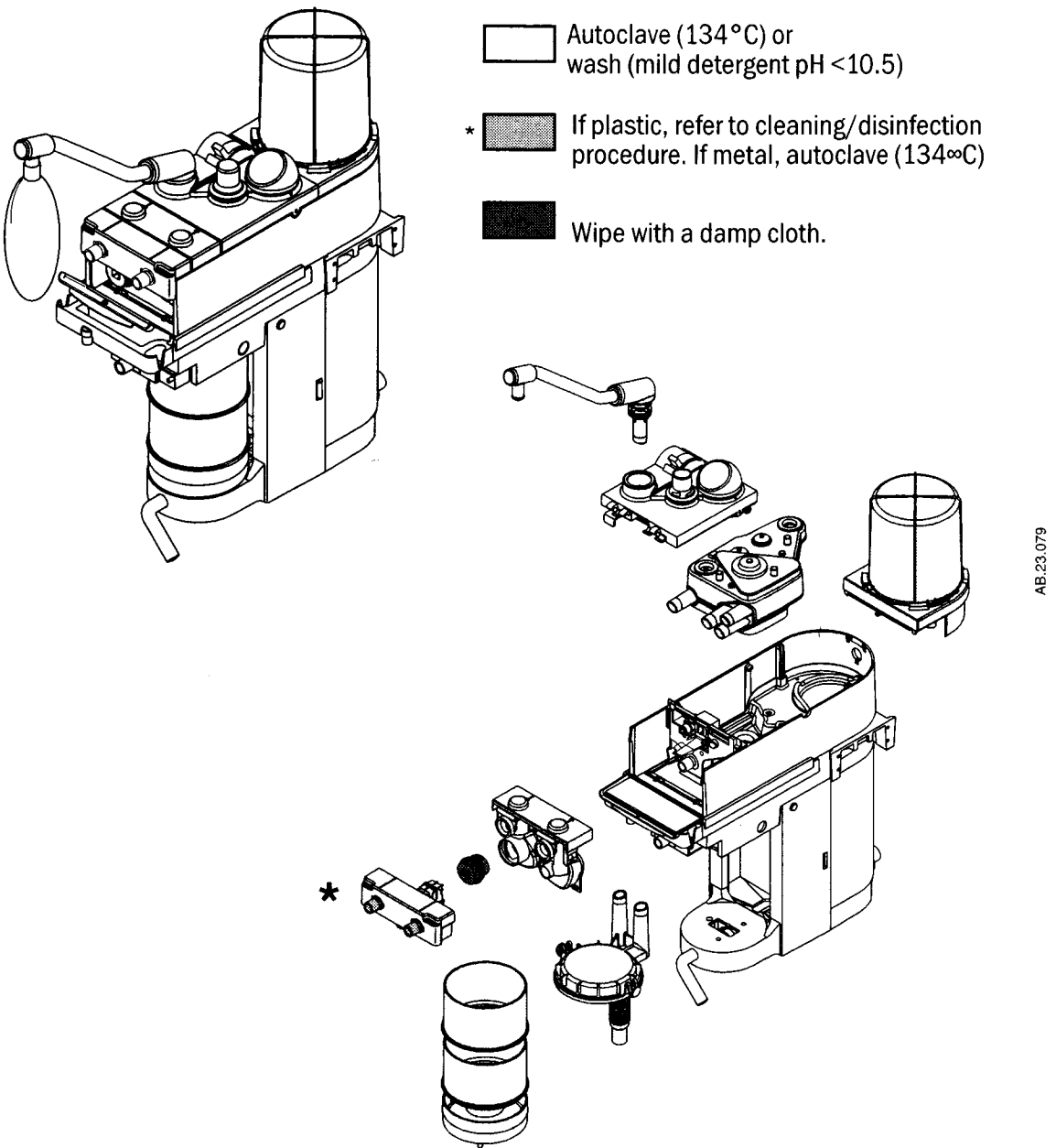


Figure 2-1 ▪ These parts return exhaled gas to the patient

Scavenging path

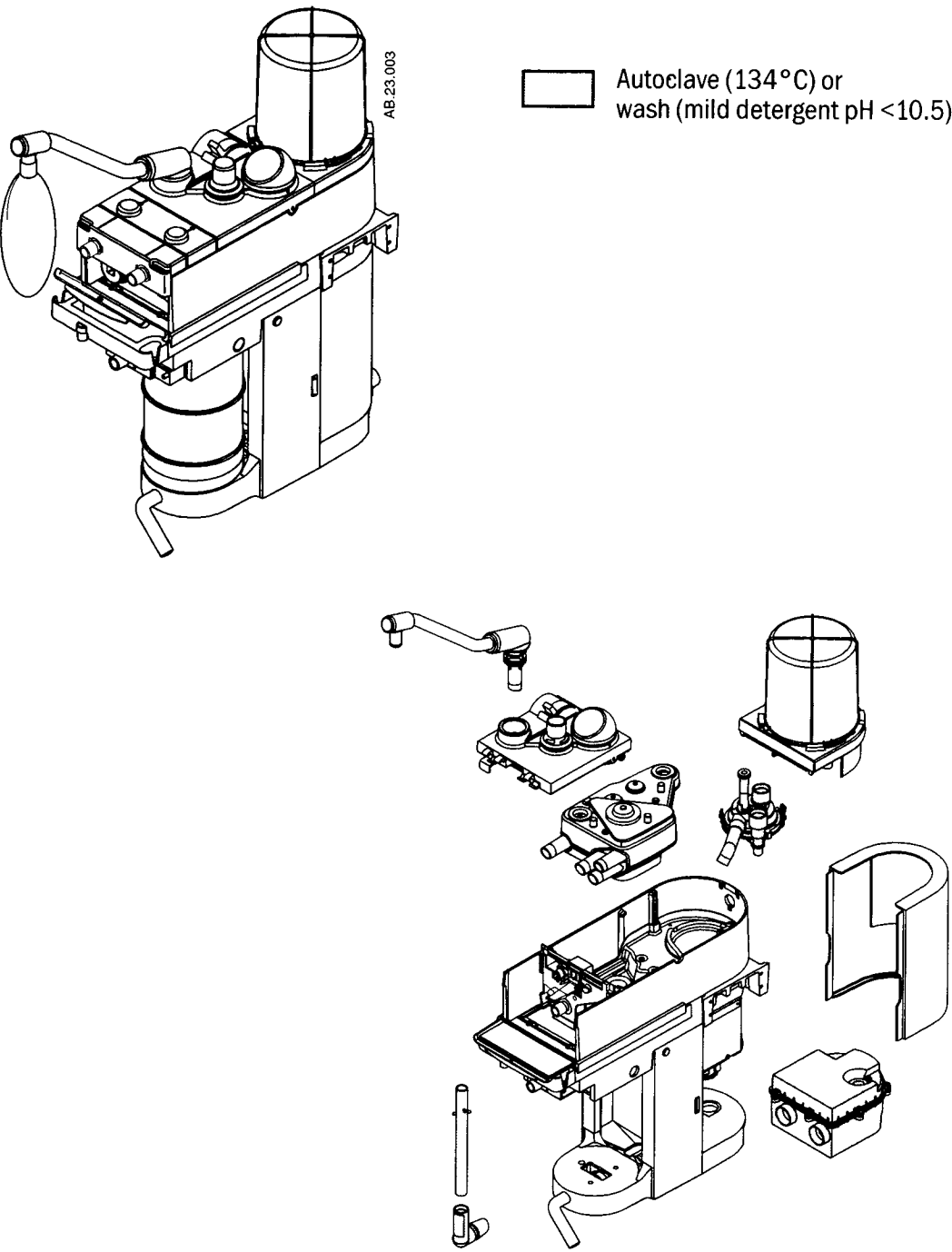
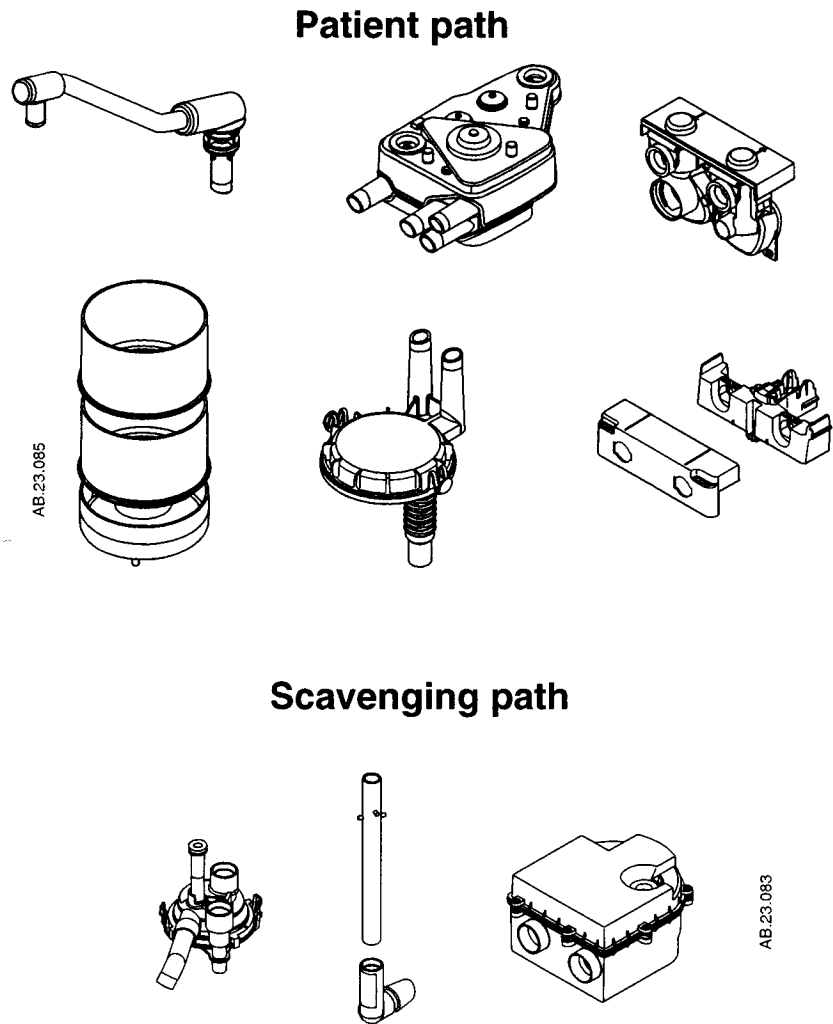


Figure 2-2 ▪ These parts do not send gas back to the patient

Clean and sterilize

The Disassembly part of this section tells you how to remove parts for cleaning

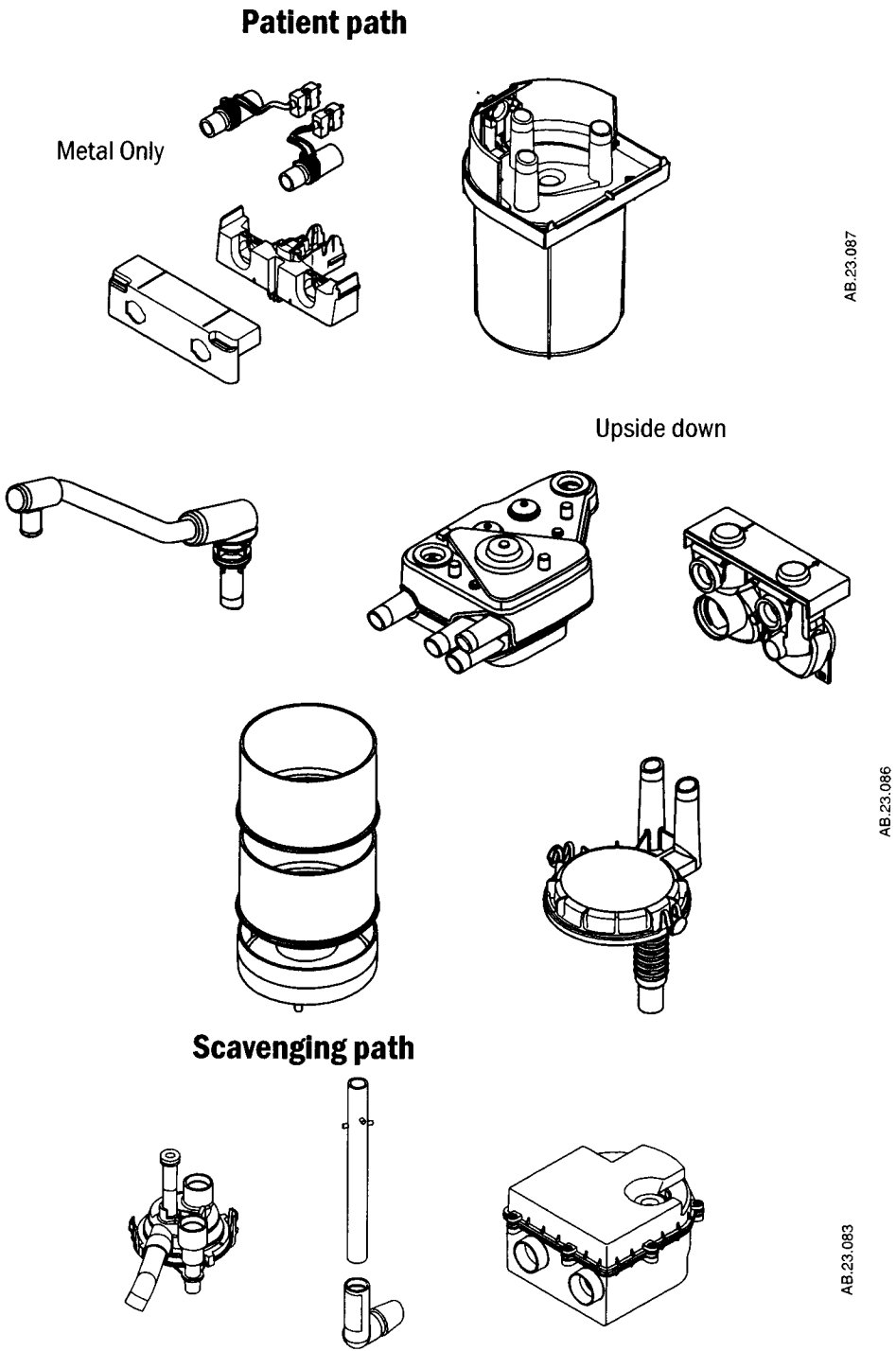
To wash (by hand or machine)



Use a mild detergent (pH <10.5). Then, rinse and dry completely. All parts except the O<sub>2</sub> sensor, and flow sensors can be washed.

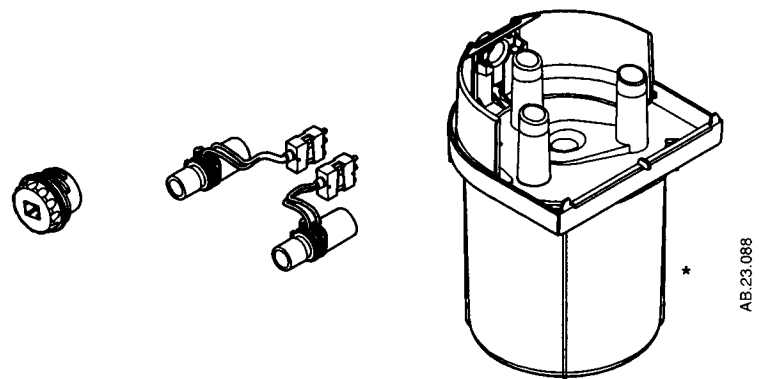
User maintenance tells you how to disassemble parts and clean inside them if necessary.

Autoclave



Autoclave at 134°C. Inspect the parts for deterioration. The user maintenance section tells you how to do this.

Special requirements



\* Hang the bellows upside down (extended) to dry. If not, the convolutions can stick together.

- To clean the circuit O<sub>2</sub> sensor, wipe it with a damp cloth. Do not put the sensor in liquid.
- To clean/disinfect metal/or plastic flow sensors, use the flow sensor cleaning procedure. Do not get the connectors wet
- Disassemble the bellows before you wash it. If not, it will take a very long time to dry. Hang the bellows upside down to dry.
- Assemble the bellows before you autoclave. Autoclave the bellows upside down.

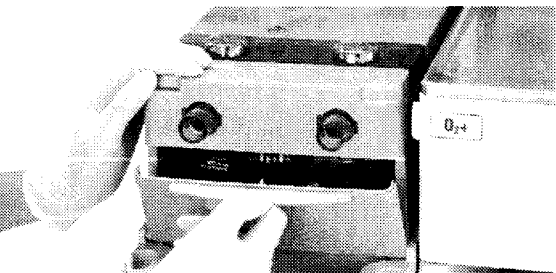
- ⚠ **WARNING** Do not use talc, zinc stearate, calcium carbonate, corn starch or equivalent materials to prevent tackiness. These materials can go into the patient's lungs and airways and cause irritation or injury.
- ⚠ **CAUTION** Do not put the circuit O<sub>2</sub> sensor or flow sensor connector in liquid.
- ⚠ Do not autoclave the Circuit O<sub>2</sub> sensor or the plastic flow sensors.
- ⚠ Do not clean the interior surfaces of the flow sensors. Use a damp cloth on external surfaces only.

**Assemble** The Set-up section tells you how to assemble the breathing system. Inspect all parts for deterioration. Replace them if necessary.

The Preoperative tests in part 1 (the first half of this manual), tell you how to test the system for correct operation.

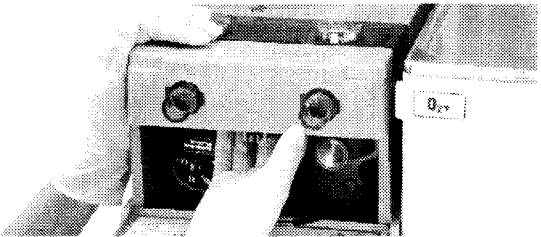
Disassemble the patient path

**Step 1**  
Open the access panel.



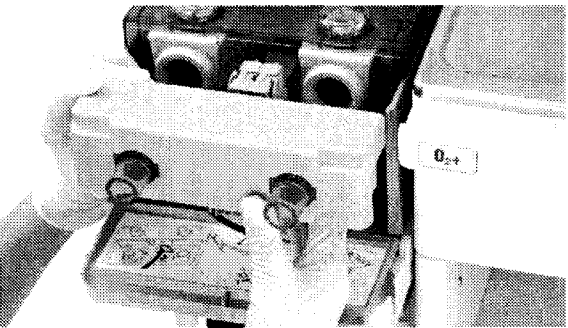
AA.96p.009

**Step 2**  
Push up on the latch located under the flow sensor module.



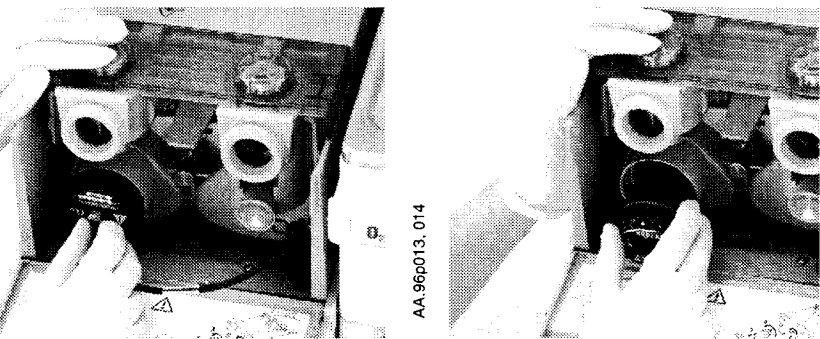
AA.96p.010

**Step 3**  
Remove the flow sensor module. You will feel some resistance. Continue to pull.



AA.96p.011

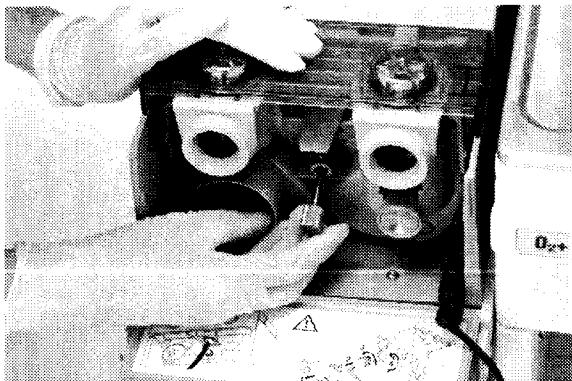
**Step 4**  
Disconnect the cable and remove the O<sub>2</sub> sensor.



AA.96p013, 014

Step 5

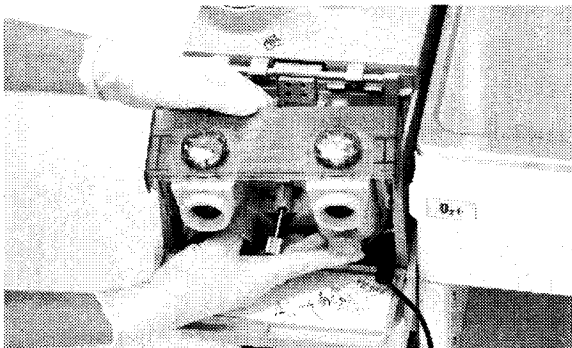
Completely loosen the thumbscrew on the breathing circuit module.



AA 96p016

Step 6

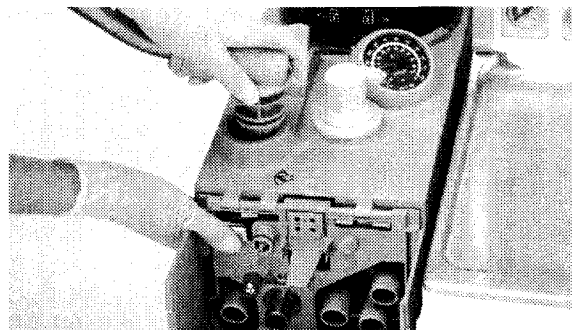
Remove the module. You will feel some resistance. Continue to pull.



AA 96p017

Step 7

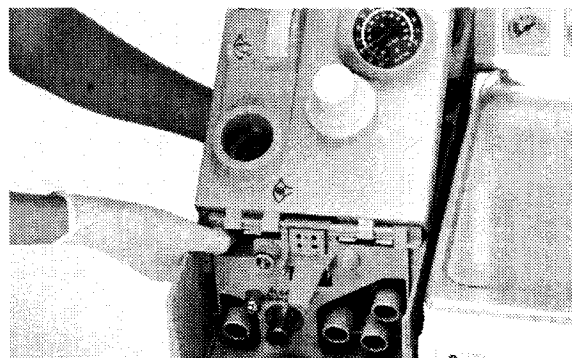
Push the metal button to the first stop. Pull out the bag arm.



AA 96p018

Step 8

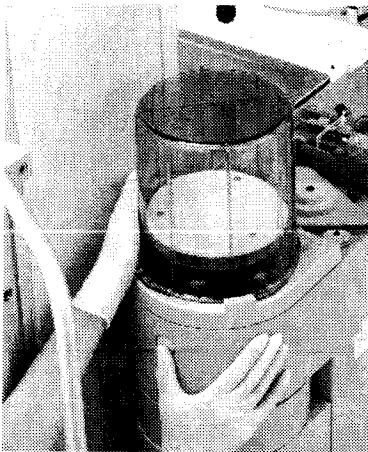
Push the metal button to the second stop and open the top panel.



AA 96p020

Step 9

Push the release button and remove the bellows assembly (pull up).

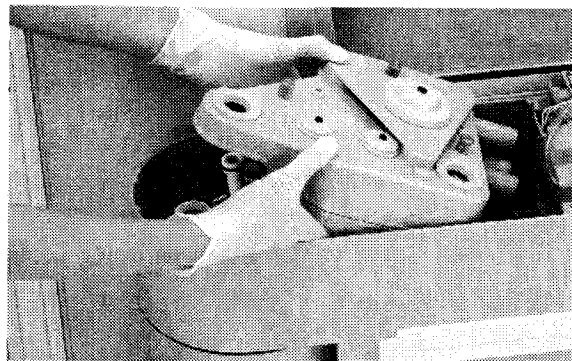


AA 96p021, 23



Step 10


Remove the main manifold.



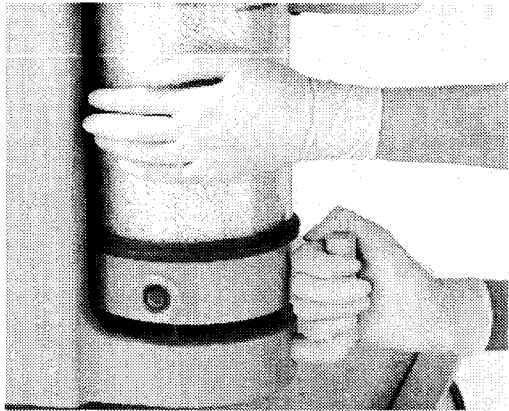
AA 96p024

Autoclave assemblies marked 134°C. Refer to the Section “Clean and sterilize” for complete instructions. To assemble the circuit refer to the Setup Section.

Canister disassembly

 **CAUTION** To prevent damage, pull the release handle forward. Then turn the handle

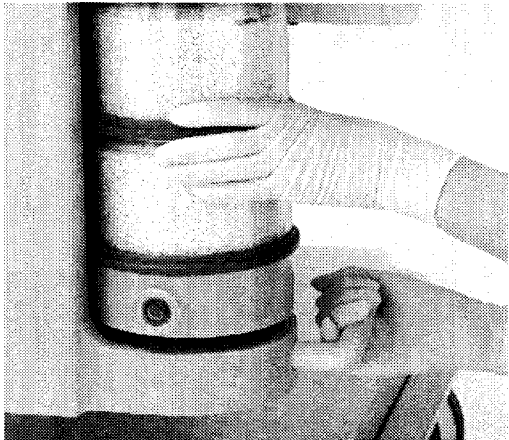
**Step 1**  
Pull the release forward.



AA.96p026

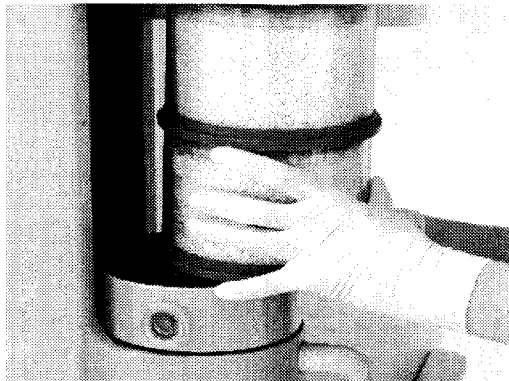


**Step 2**  
Turn the release clockwise.



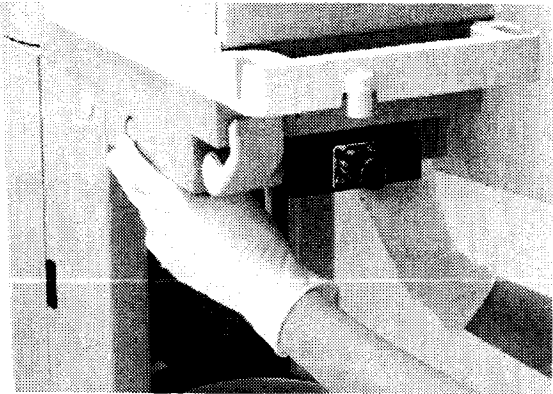
AA.96p028

**Step 3**  
Pull down and out on the canisters.



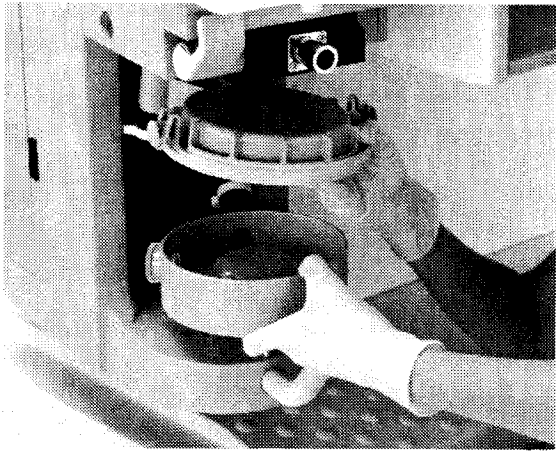
AA.96p029

**Step 4**  
Push in the buttons on each side of the top dish.



AA.96p053

**Step 5**  
Lift up the drain dish.  
Remove the top dish and drain dish.



AA.96p054

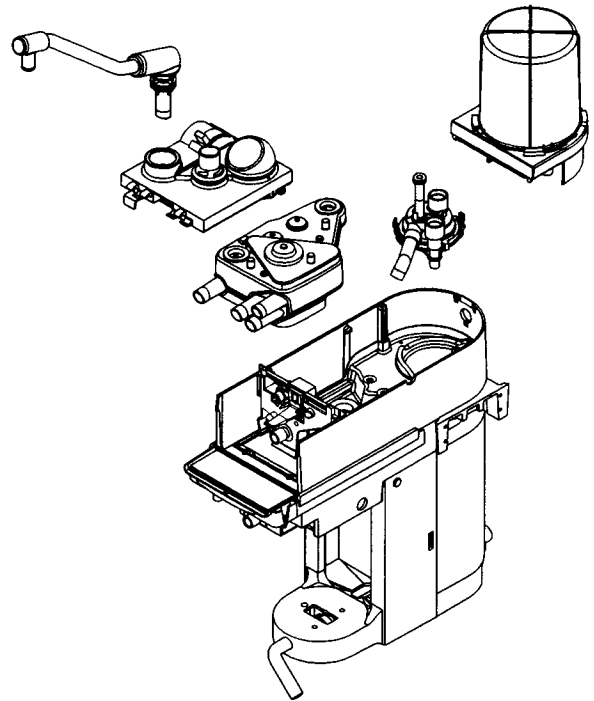
Continue with the next section or go to Cleaning and sterilization. To assemble, refer to the Setup Section.

Disassemble the scavenging path

These parts send exhaled gas to the disposal system, not the patient.

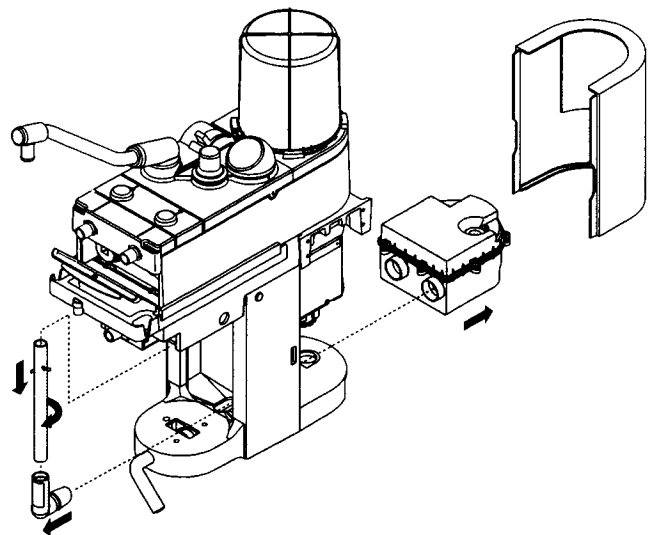
Exhalation valve

Complete the basic disassembly procedure.  
Push in the latches and pull out the exhalation valve.



Scavenging reservoir

Loosen the knob and remove the rear cover.  
Pull the reservoir up and to the rear.  
Twist and pull down to remove the tube.



How to clean and disinfect the flow sensors

- ⚠ CAUTION Do not autoclave plastic flow sensors.
- ⚠ Do not use high pressure gas, or brushes to clean the flow sensors.
- ⚠ Do not use cleaning solvents that are not approved for use with Polycarbonates (e.g. CIDEX Plus).

CIDEX sterilization

- Both Datex-Ohmeda and the manufacturer of CIDEX (Johnson & Johnson) have tested this procedure.
- CIDEX must be 14 day mixture, with activator vial REF REORDER # 2245
  - One liter of this solution cleans four (4) flow sensors

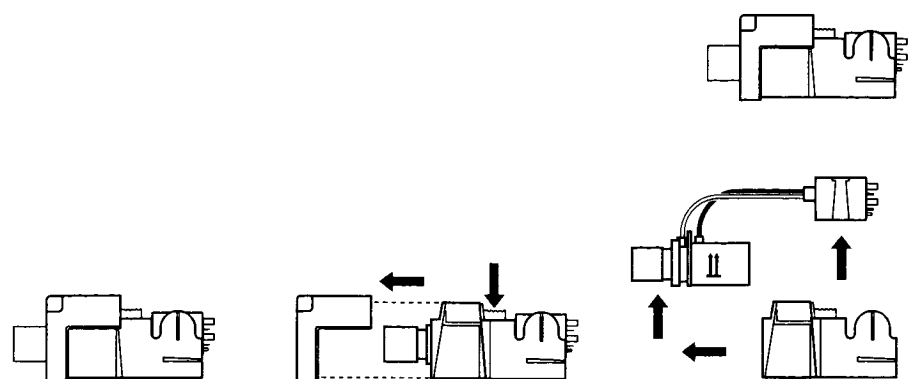
Procedure (Figure 2-3)

1. Remove the flow sensor module from the absorber. Refer to "Disassemble the patient path" in this chapter.
2. Remove the flow sensors from the module.
  - Push in the latch.
  - Pull off the cover.
  - Remove the flow sensors.
3. Submerge the flow sensor and tubes in activated CIDEX solution. Keep the connector dry.
4. Keep the solution in the tubes for the sterilization period.
5. Submerge the flow sensor and tubes in distilled water. Again, do not get the connector wet.
6. Rinse as indicated in CIDEX instructions.
7. Do steps 5 and 6 again to remove all CIDEX.
8. COMPLETELY dry the flow sensor and the tubes before you use the sensor.

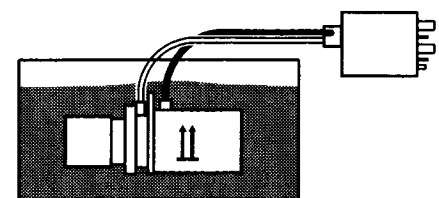
- Use a dry syringe, or connect vacuum or pressure to remove all liquid from the sensor (sensor, tubes, and connector):
- Minimum time: 1 min
  - Maximum vacuum: 30 in Hg
  - Maximum flow: 10 l/min flow
  - Maximum pressure: 345 kPa (50 psi).

# Setup and Connections

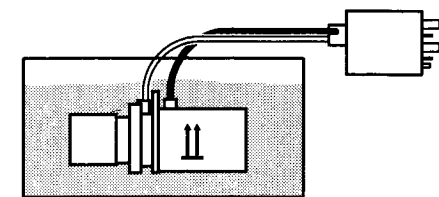
Step 2



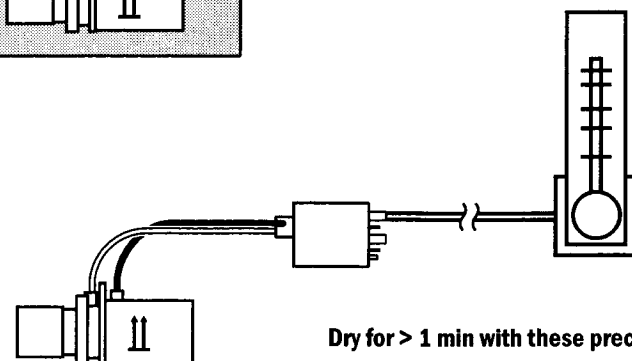
Steps 3 and 4



Steps 5, 6 and 7



Step 8



Dry for > 1 min with these precautions:

- Maximum vacuum 30 in Hg
- Maximum flow 10 l/min
- Maximum pressure 345 kPa (50 psi)

Figure 2-3 • Steps 2-8

- Important** Datex-Ohmeda strongly recommends that you use O<sub>2</sub> monitoring with this equipment. Refer to local standards for mandatory monitoring.
- Important** European Standard EN 740 requires anesthetic agent monitoring when anesthetic vaporizers are in use.
- Important** European Standard EN 740 requires CO<sub>2</sub> monitoring during ventilation.

- ⚠ WARNINGS** Always make sure that the pipeline supply hoses and the breathing circuit components are not toxic and will not:
- Cause an allergic reaction in the patient.
  - React with the anesthetic gases or agent to produce dangerous by-products.
- ⚠** To prevent incorrect values or equipment malfunction, use only Datex-Ohmeda cables, hoses and tubing.
- ⚠** This system operates correctly at the electrical interference levels of IEC 601-1-2. Higher levels can cause nuisance alarms that may stop mechanical ventilation.
- ⚠** To help prevent false alarms from devices with high-intensity electrical fields:
- Keep the electrosurgical leads away from the breathing system and the flow and oxygen sensors.
  - Do not put the electrosurgical leads on any part of the anesthesia system.
- ⚠** To protect the patient when electrosurgical equipment is used:
- Monitor the correct operation of all life support and monitoring equipment.
  - Keep backup manual ventilation available in case the electrosurgical equipment prevents safe use of the ventilator.
  - Do not use conductive masks or hoses.

## In this section

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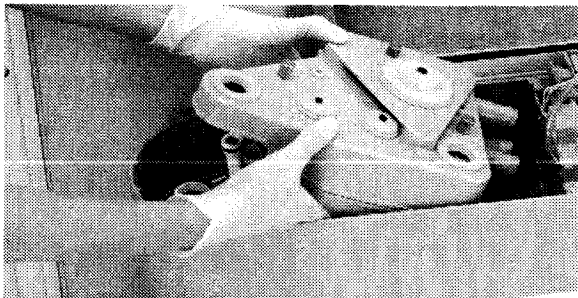


Breathing system setup

To assemble the patient circuit, start at step 5.

Step 1

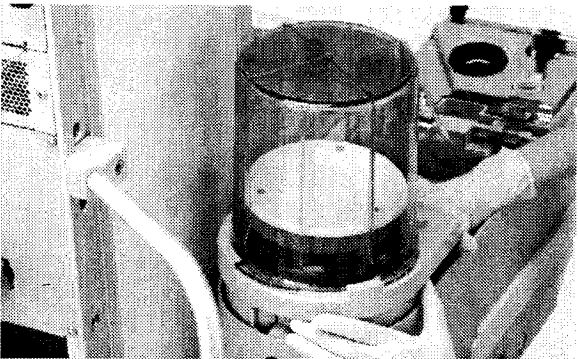
Install the main manifold.



AA 96p024

Step 2

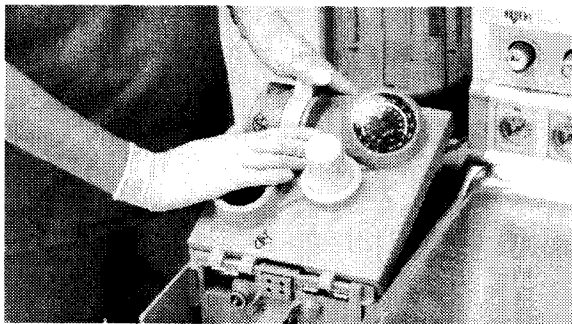
- Install the Bellows.
- Make sure the release button aligns correctly.



AA 96p022

Step 3

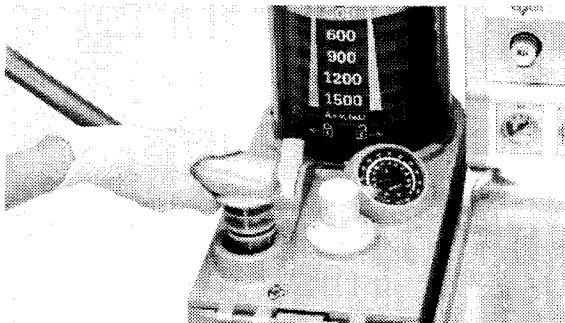
Gently close the control panel.



AA 96p012

Step 4

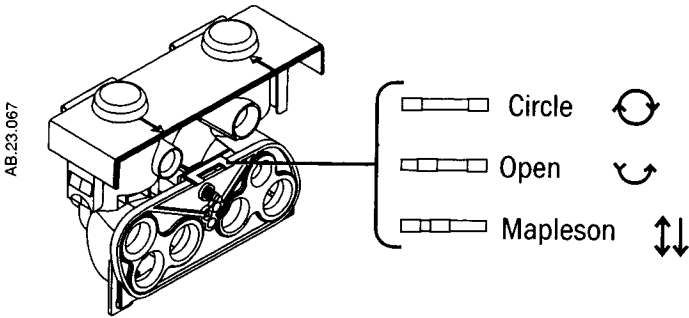
- Install the bag arm.
- Install a rebreathing bag on the bag arm.



AA 96p019

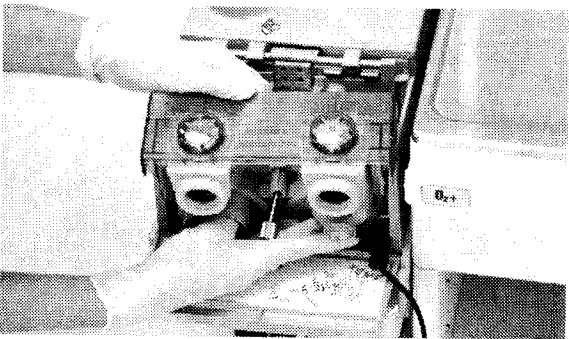
Step 5

Identify the breathing circuit module (Circle, Mapleson, or Open).  
Look at the tabs on the rear or the label on the front.



Step 6

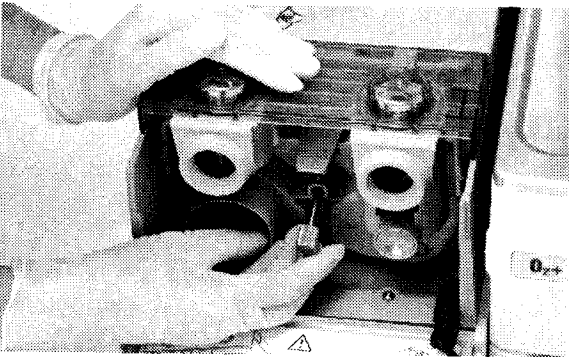
Install the breathing circuit module. You will feel some resistance. Continue to push.



AA 96p017

Step 7

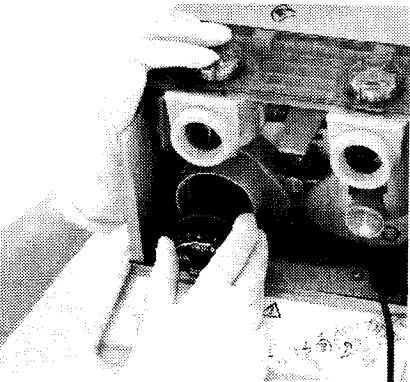
Completely tighten the thumbscrew



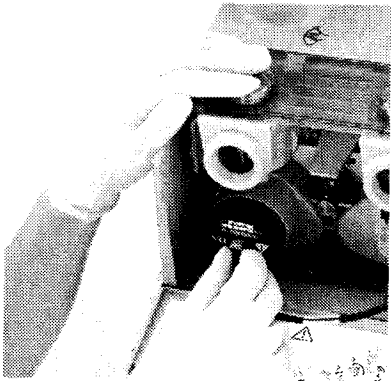
AA 96p016

Step 8

- Install the O<sub>2</sub> sensor.
- Completely tighten the sensor.
  - Connect the cable.



AA 96p013, 014

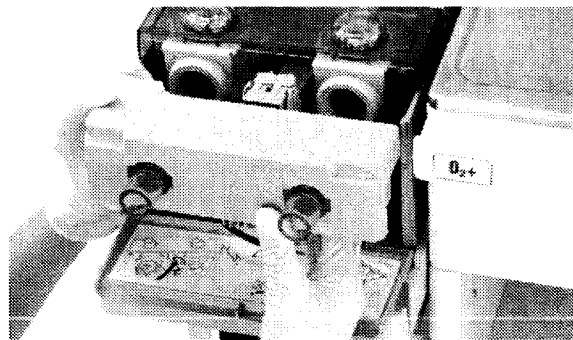




Step 9

Install the flow sensor module.

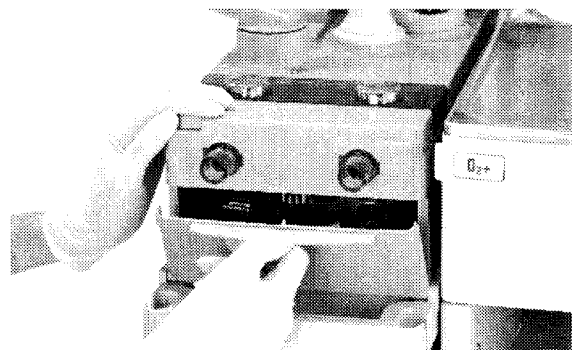
- You will hear a “click” when it locks into position.
- Refer to note 1 or the user maintenance section.



AA.96p011

Step 10

Close the front panel.

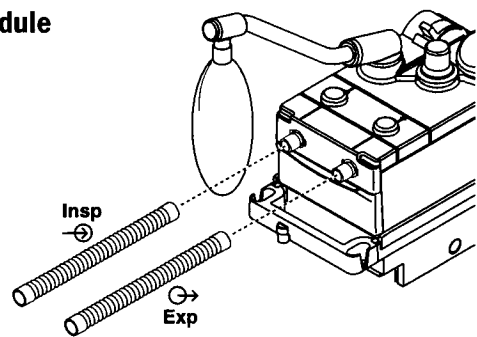


AA.96p009

Step 11

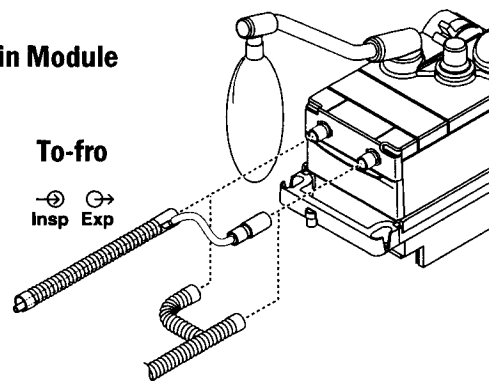
Connect the patient circuit.

Circle or Open Module



AB.23.104

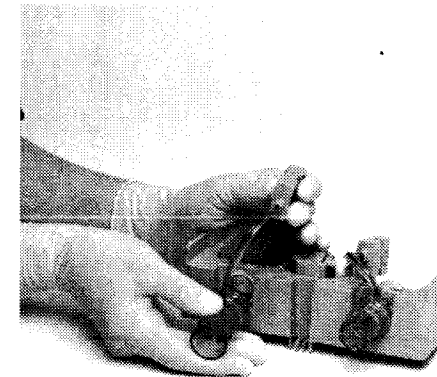
Mapleson D / Bain Module



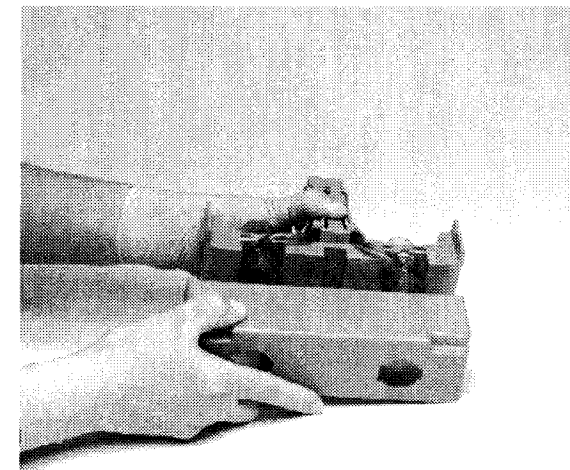
AB.23.152

Note 1

Flow sensor assembly



AA.96p039



AA.96p038

Canister Setup

Each canister holds 1.35 kg of loose absorbent or 1.13 kg of commercially packaged (pre-pack) absorbent. Datex-Ohmeda recommends Sodium or Barium hydroxide based absorbent.

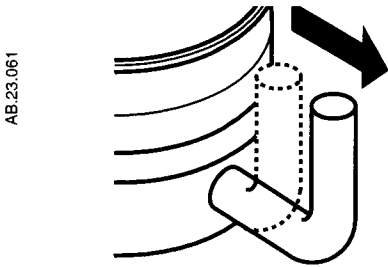
**⚠ WARNING** Change absorbent often to prevent the build up of non-metabolic gases when the system is not in use.

Inspect absorbent at the end of a case. During non-use, absorbent can go back to the original appearance. Refer to the absorbent labeling for more information about color changes.

If the absorbent completely dries out, it may give off CO (carbon monoxide) the next time you use it. For safety, replace the absorbent.

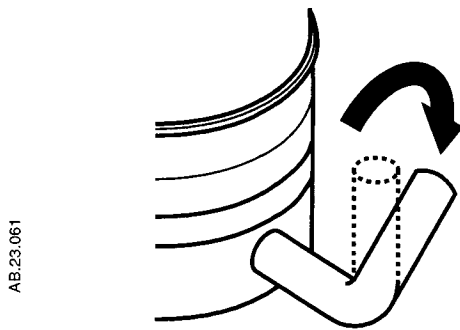
Step 1

Pull the release forward.



Step 2

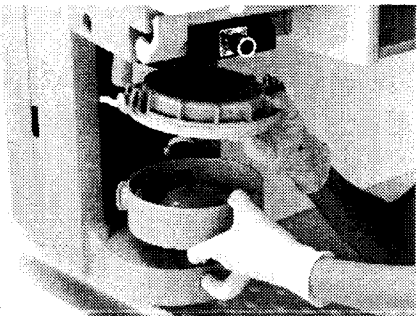
Turn the release clockwise



Step 3

Push in the buttons and install the top dish and drain dish.

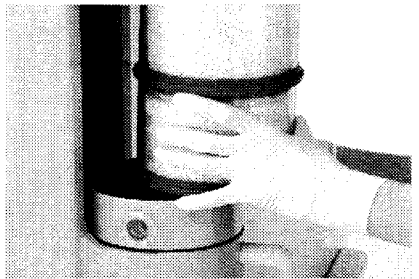
Pull down to make sure the top dish is locked in place.



AA.96p054

Step 4

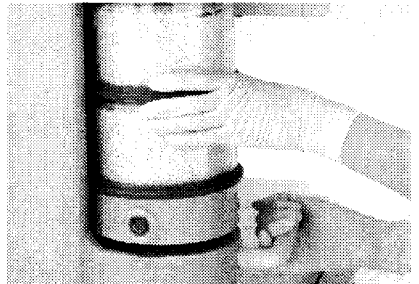
Fill the canisters with absorbent and install them. Push down on the drain dish if necessary.



AA.96p029

Step 5

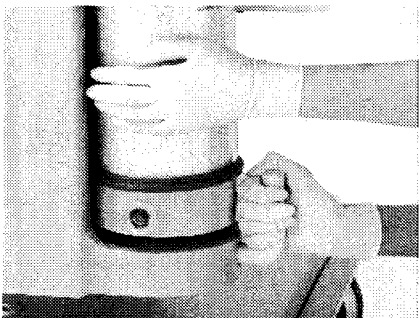
Turn the release counter-clockwise.



AA.96p028

Step 6

Push in the release.



AA.96p026

Pneumatic and electrical connections

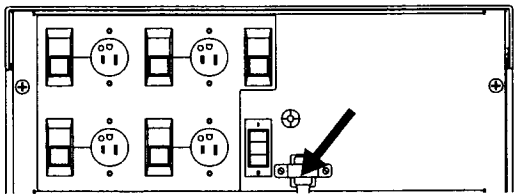
**⚠ WARNING** Equipment connected to the electrical outlets can increase the leakage current. Regularly test the leakage current.

**⚠ CAUTION** Use only medical grade gas supplies. Other types of gas supplies may contain water, oil, or other contaminants.

The Aestiva gas supplies also supply these devices through internal connections:

- The venturi suction regulator (optional)
- The external O<sub>2</sub> flowmeter (optional)
- Ventilator drive gas
- Pneumatic outlets

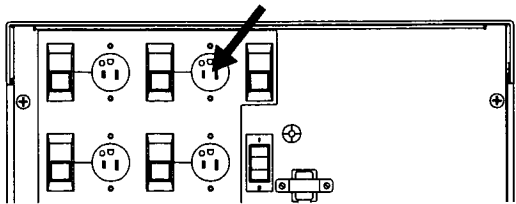
Mains inlet



AA.96.116

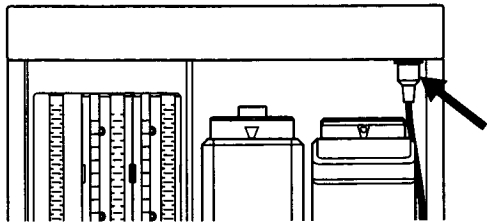
Outlets

Labels show **outlet voltage** ratings and circuit breaker amp ratings.



AA.96.116

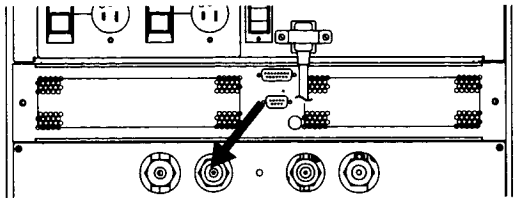
Tec 6 power



AA.96.095

Pipeline Inlets

Label identifies the gas.

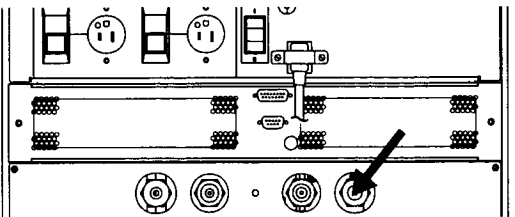


AA.96.116

Pneumatic outlet

Labels identify the gas.

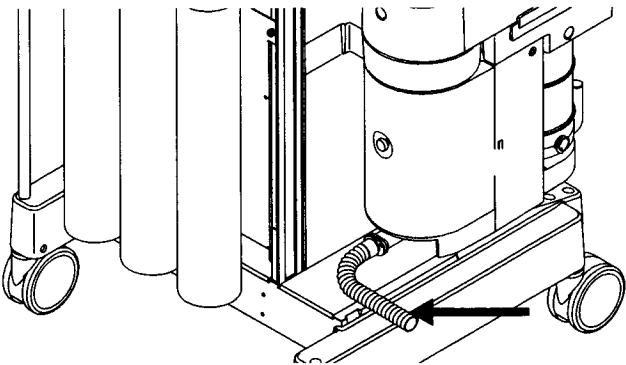
**Note:** The outlet pressures range from pipeline pressure to 550-690 kPa when cylinder supplies are used.



AA.96.116

Scavenging

Adapters may be necessary. Refer to the Illustrated parts section.

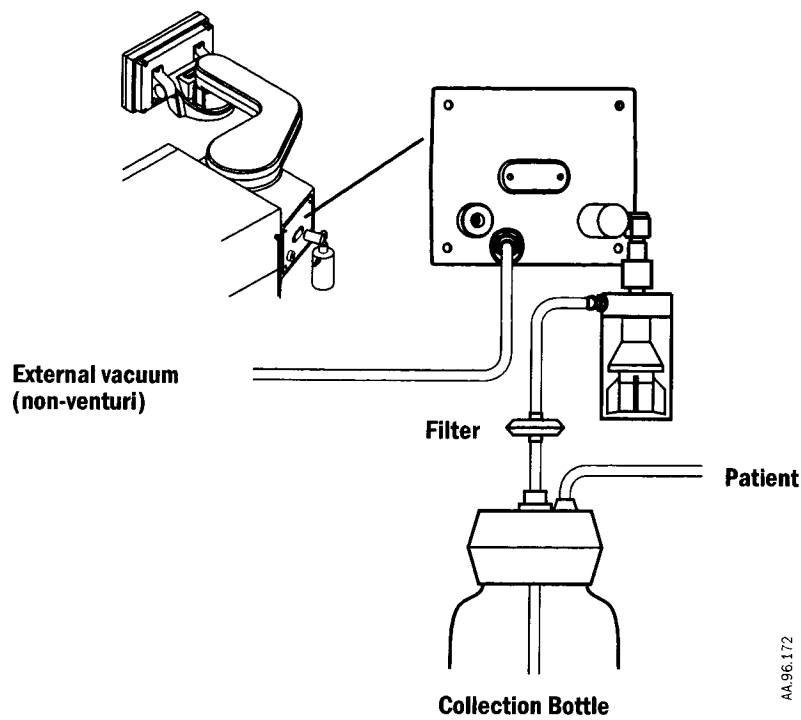


AA.96.137

Suction regulator

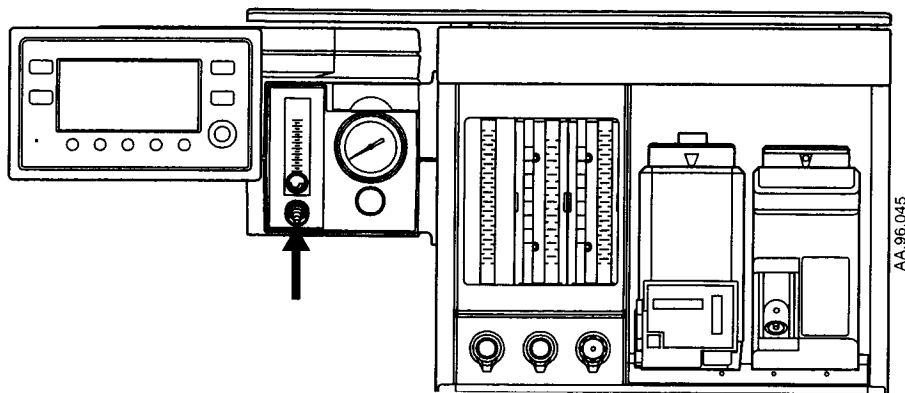
Optional item.

**Note:** Venturi regulators use the system air or O<sub>2</sub> supply. Standard regulators must be connected to an external vacuum supply.



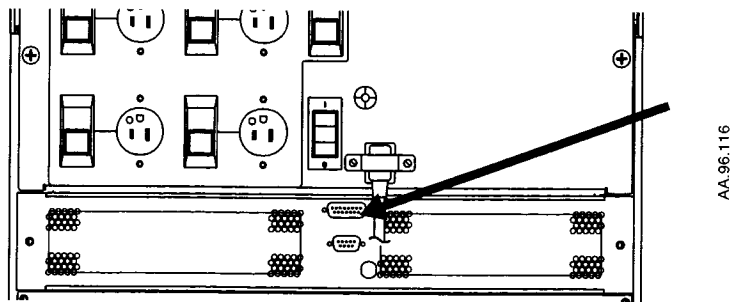
External O<sub>2</sub> flowmeter

Optional item.



Serial port

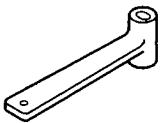
Refer to the communications appendix for command and data formats.



How to install gas cylinders (high pressure leak test)

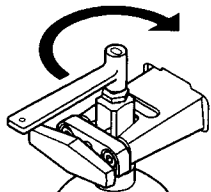
Cylinder yokes

- 1. Find the cylinder wrench.



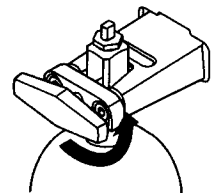
AA.96.123

- 2. Close the cylinder valve on the cylinder to be replaced.



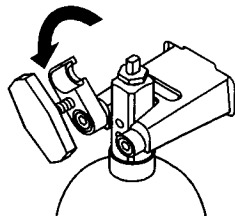
AA.96.122

- 3. Fully loosen the tee handle.



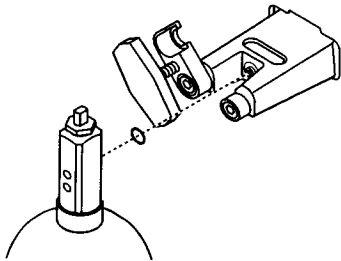
AA.96.124

- 4. Open the cylinder yoke.



AA.96.125

- 5. Remove the used cylinder and the used gasket.



AA.96.126

- 6. Remove the cap from the cylinder valve on the new cylinder.
- 7. Point the cylinder valve away from all flammable items and items that can be damaged by a release of pressure.
- 8. Quickly open and close the cylinder valve. This removes dirt from the cylinder outlet.

**⚠ CAUTION** No gasket or more than one gasket can cause a leak.

- 9. Install a new gasket.
- 10. Align the cylinder post with the index pins.
- 11. Close the yoke gate and tighten the tee handle.
- 12. Install a cylinder plug and gasket in all empty cylinder yokes.
- 13. Do a high pressure leak test:
  - Disconnect pipeline supplies.
  - Disconnect all equipment from the pneumatic outlet and turn OFF the auxiliary flowmeter.
  - Set the system switch to Standby.
  - Open the cylinder.
  - Record the cylinder pressure.
  - Close the cylinder.
  - If the cylinder pressure decreases more than 690 kPa in one minute, there is a leak.

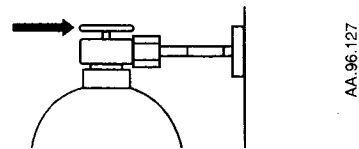
To repair a leak:

- Install a new cylinder gasket and tighten the tee handle.
- Do this step again. If the leak continues, do not use the system.

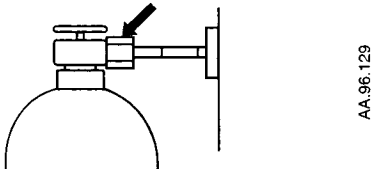
**⚠ WARNING** Do not leave gas cylinder valves open if the pipeline supply is in use. Cylinder supplies could be depleted, leaving an insufficient reserve supply in case of pipeline failure.

**DIN connections**

- 1. Close the cylinder valve on the cylinder to be replaced.



- 2. Loosen the adapter and remove the cylinder.



- 3. Remove the cap from the cylinder valve on the new cylinder.
- 4. Point the cylinder outlet away from all items that can be damaged by a release of high pressure gas.

- 5. Open and immediately close the cylinder valve to remove dirt or contaminants.
- 6. Do a high pressure leak test:
  - Disconnect pipeline supplies.
  - Disconnect all equipment from the pneumatic outlet and turn OFF the auxiliary flowmeter.
  - Set the system switch to Standby.
  - Open the cylinder.
  - Record the cylinder pressure.
  - Close the cylinder.
  - If the cylinder pressure decreases more than 690 kPa in one minute, there is a leak.

To repair a leak:

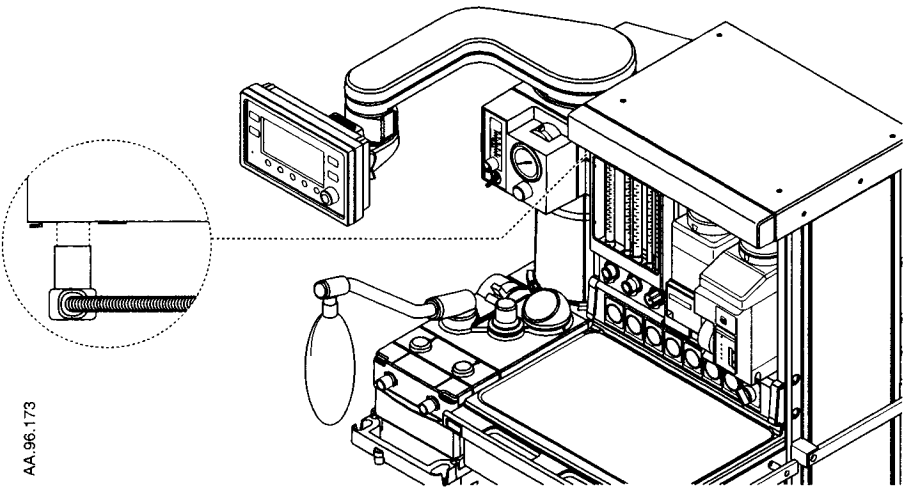
- Install a new cylinder gasket and tighten the tee handle.
- Do this step again. If the leak continues, do not use the system.

**⚠ WARNING** Do not leave gas cylinder valves open if the pipeline supply is in use. Cylinder supplies could be depleted, leaving an insufficient reserve supply in case of pipeline failure.

How to install the gooseneck lamp (12 V)

**⚠ WARNING** Use ONLY 2.4 Watt bulbs. Higher wattage bulbs can get hot enough to burn you.

- 1. Align the connector with the cable towards you.



- 2. Push the connector firmly into the socket until you hear a click.
- 3. Move the light into position.

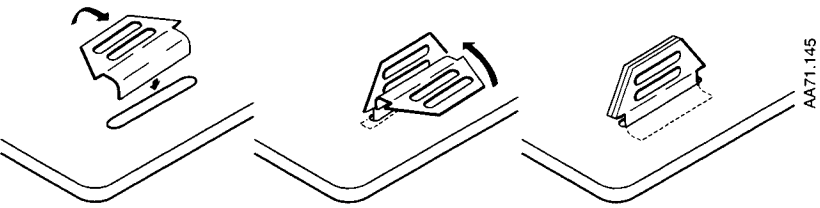
How to attach equipment to the top shelves

The basic system has two straps for equipment. Accessory shelves use clips and straps.

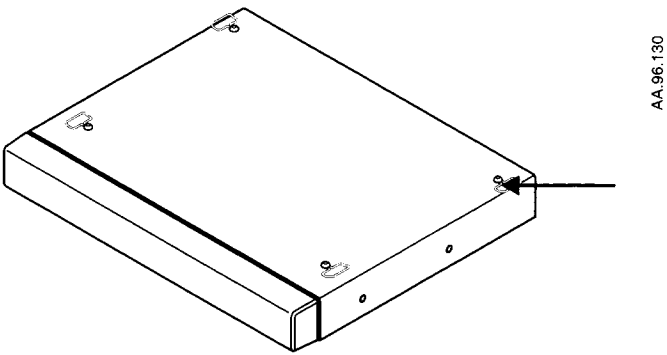
**⚠ CAUTION** Each accessory shelf has a weight limit of 23 kg (50 lbs).

**⚠** Systems without accessory shelves have a weight limit of 23 kg (50 lbs).

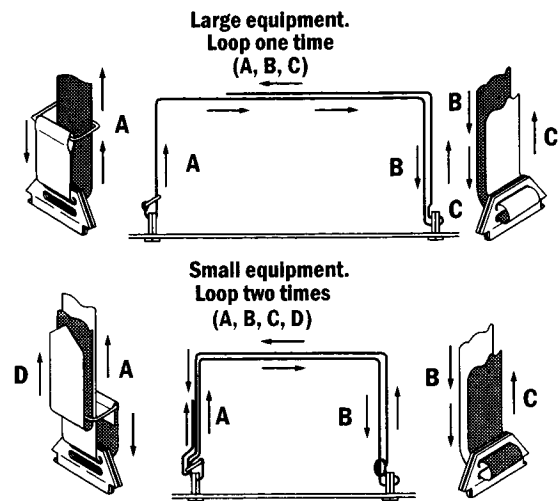
- 1. Install or find the clips:
  - With an accessory shelf, install the clips in the two slots nearest to the equipment.



- Systems without accessory shelves have the clips attached.

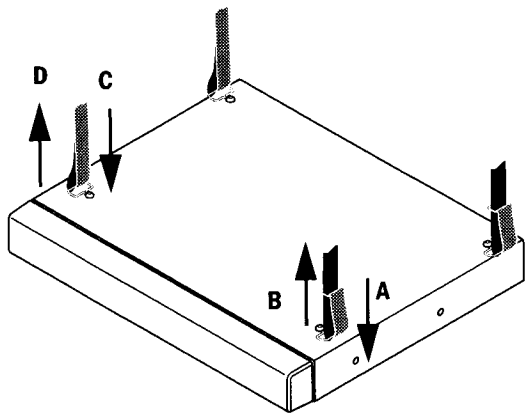


- 2. Install the straps:
  - With an accessory shelf:



AA-50.015

- Without an accessory shelf:



AA-96.135

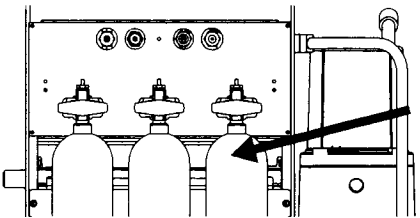
- Fully tighten the straps.
- Make sure that the straps hold the equipment in position.

**⚠ WARNING** If you do not fully tighten the strap, equipment can fall off the shelf.

### How to install equipment on the foldout shelf

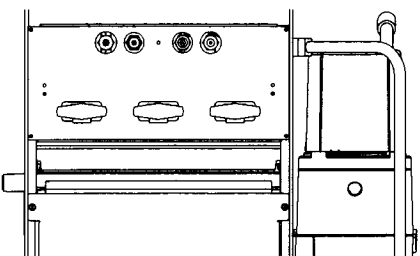
This is a hidden shelf for equipment that you do not need to look at, adjust, or touch. To access the shelf, you must remove the cylinders.

- Make sure you have a cylinder wrench (if necessary).
- Close the valves on all gas cylinders.
- Remove all gas cylinders.

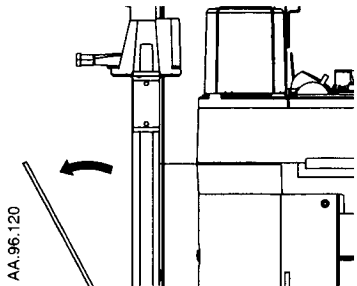


AA-96.118

- Loosen the thumbscrews and open the rear door.

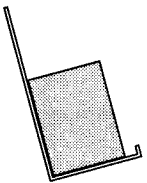


AA-96.119

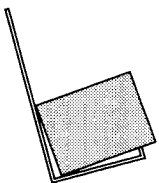


AA-96.120

- Put the equipment on the shelves.
- Make sure the item does not hang over the raised edge.



OK



AA-96.114

- Connect all cables and route them through the cutouts in the door.
- Close the door.
- Test the equipment
- Install the cylinders.

**⚠ WARNING** Items that hang over the raised edge can fall off.

Installation Notes

When the system is installed the service representative will check these settings and change them if necessary.

**⚠ WARNING** These settings can only be changed by Qualified Service personnel.

- Language
- Power up defaults: When you turn the system off, should it save the current settings or go back to the facility defaults.
- Automatic calculation of V<sub>E</sub> alarm limits during mechanical ventilation.
- Altitude
- Ventilator drive gas
- Heliox mode availability.

User Maintenance

- ⚠ WARNING**
- TO PREVENT FIRES:
- Use lubricants approved for anesthesia or O<sub>2</sub> equipment, such as Krytox<sup>®1</sup>.
  - Do not use lubricants that contain oil or grease. They burn or explode in high O<sub>2</sub> concentrations.
  - All covers used on the system must be made from antistatic (conductive) materials. Static electricity can cause fires.

**⚠ WARNING**

Obey infection control and safety procedures. Used equipment may contain blood and body fluids.

|                        |   |      |
|------------------------|---|------|
| <b>In this section</b> | Repair policy .....   | 4-2  |
|                        | Manifold maintenance .....                                    | 4-3  |
|                        | Expiratory valve maintenance .....                            | 4-6  |
|                        | Receiver maintenance (Filter) .....                           | 4-8  |
|                        | Flow sensor maintenance .....                                 | 4-9  |
|                        | Breathing circuit maintenance .....                           | 4-10 |
|                        | Bellows maintenance .....                                     | 4-12 |
|                        | Bellows tests .....   | 4-15 |
|                        | O <sub>2</sub> sensor calibration - 21% O <sub>2</sub> .....  | 4-18 |
|                        | O <sub>2</sub> sensor calibration - 100% O <sub>2</sub> ..... | 4-21 |
|                        | Flow sensor calibration .....                                 | 4-24 |
|                        | How to prevent water build-up .....                           | 4-25 |

<sup>1.</sup>    © Krytox is a registered trademark of Dupont de Nemours E.I. & Company Inc



Repair policy

Do not use malfunctioning equipment. Make all necessary repairs or have the equipment serviced by an authorized Datex-Ohmeda service representative. After repair, test the equipment to ensure that it is functioning properly, in accordance with the manufacturer's published specifications.

To ensure full reliability, have all repairs and service done by an authorized Datex-Ohmeda service representative. If this cannot be done, replacement and maintenance of those parts listed in this manual may be undertaken by a competent, trained individual having experience in the repair of devices of this nature.

**CAUTION** No repair should ever be attempted by anyone not having experience in the repair of devices of this nature.

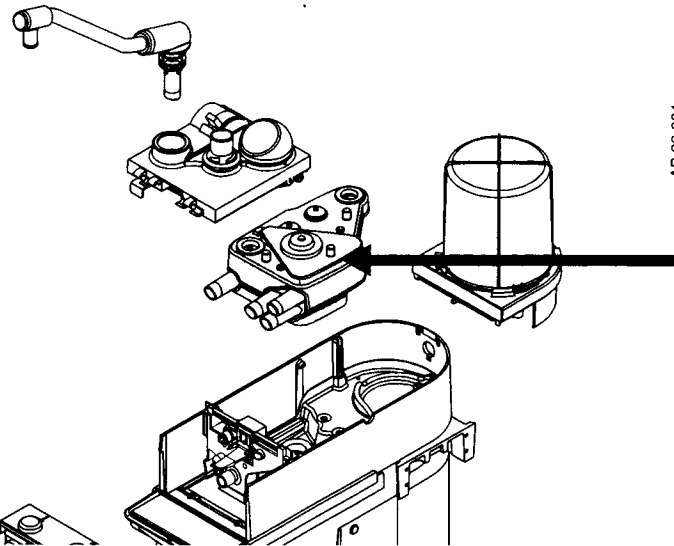
Replace damaged parts with components manufactured or sold by Datex-Ohmeda. Then test the unit to ascertain that it complies with the manufacturer's published specifications.

Contact the Datex-Ohmeda Field Service Support Center for service assistance. In all cases, other than where Datex-Ohmeda's warranty is applicable, repairs will be made at Datex-Ohmeda's current list price for the replacement part(s) plus a reasonable labor charge.

Manifold maintenance

Step 1

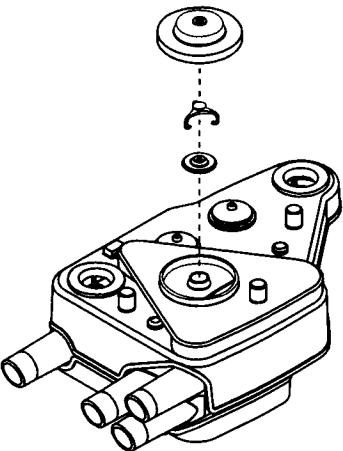
Complete the Basic disassembly (Refer to the Cleaning and sterilization section).



Step 2  
(APL valve)<sup>1</sup>

Remove the diaphragm.  
Replace it if:

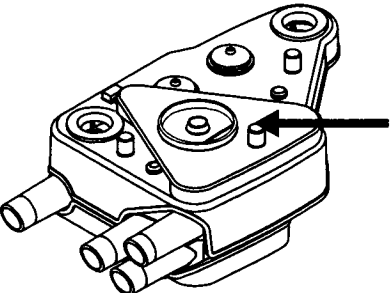
- The disk, cage, or diaphragm is damaged.
- The diaphragm looks worn.
- The diaphragm fits over the rim.



Step 3  
(Seals)

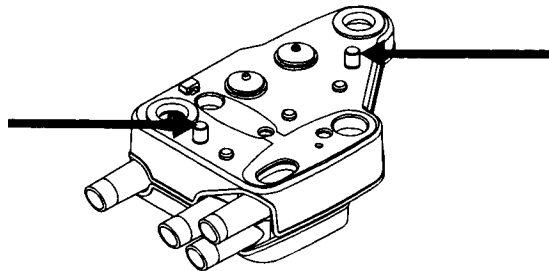
Loosen the thumbscrew and remove the plate.

- Replace the seal if damaged or worn.



**Step 4  
(Seals con.)**

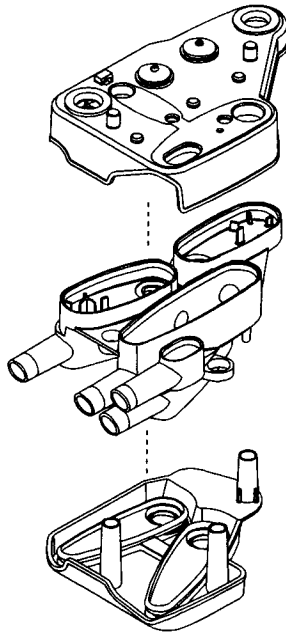
Loosen the thumbscrews.



AB 23.073

**Step 5  
(Seals con.)**

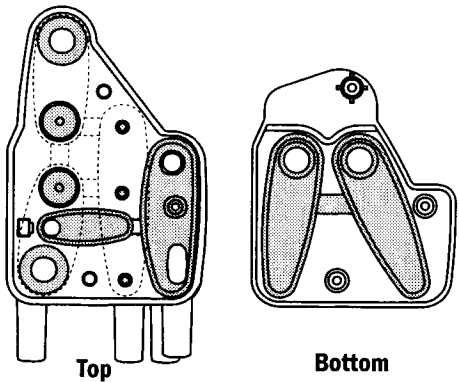
Open the manifold (top middle, and bottom parts).



AB 23.074

**Step 6  
(Seals con.)**

Replace the parts if they are damaged or worn.

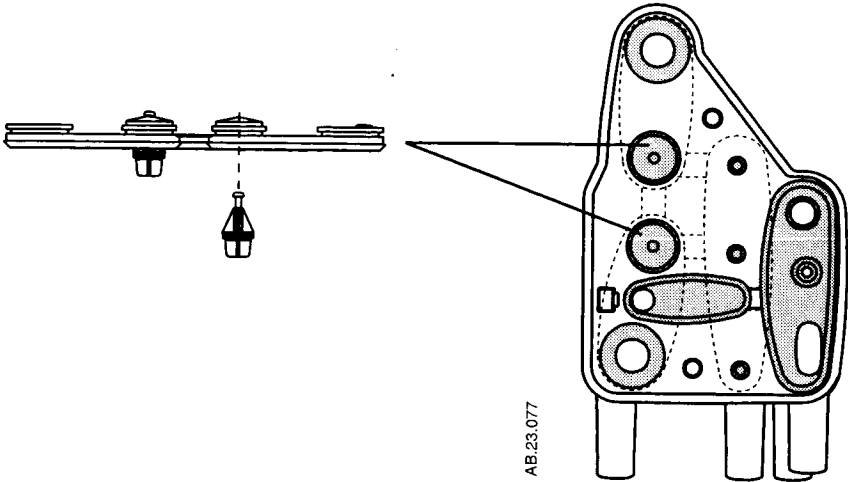


Side

AB 23.071

**Step 7  
(Bag/Vent)<sup>2</sup>**

Replace the parts if they are damaged or worn.



AB 23.077

**Step 8**

- Put the parts together
- Make sure all gaskets are fully seated.
  - Fully tighten the thumb-screws.



OK



AB 23.075

1. When you turn the APL knob, you change the pressure that is necessary to push the disk up and permit gas to exit.
2. The Bag/Vent switch pushed down plungers to close the other path. In the Bag position, the vent path is closed, etc

Before you use the system, complete the preoperative test procedure. Refer to the Appendix of the System controls, operation, and checkout manual.

Expiratory valve maintenance

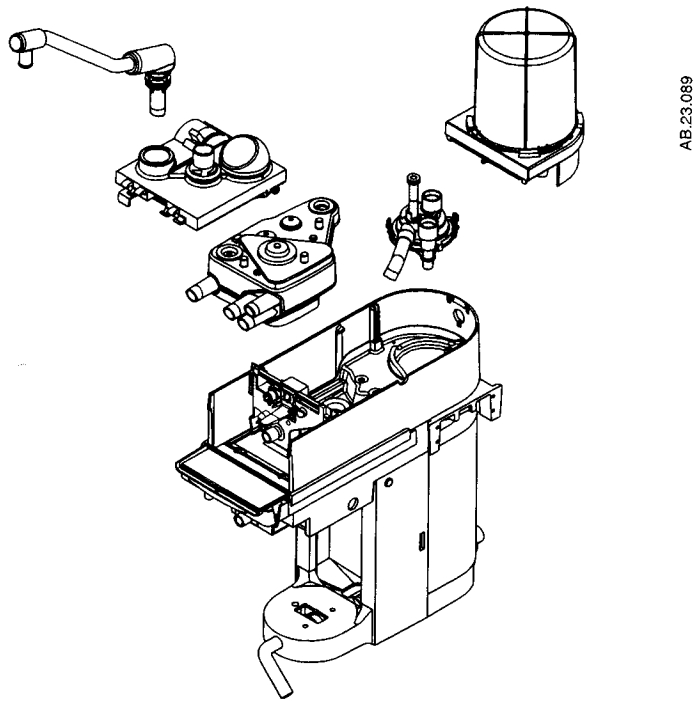
Disassemble the manifold and examine the seals at 12 autoclave cycles.

These conditions indicate a possible leak in the exhalation valve:

- A decrease in airway pressure during the inspiratory pause in the volume control mode of ventilation.
- Alarms for low tidal volume.
- The ventilator circuit has a leak, but the bellows pass the bellows tests in this section.

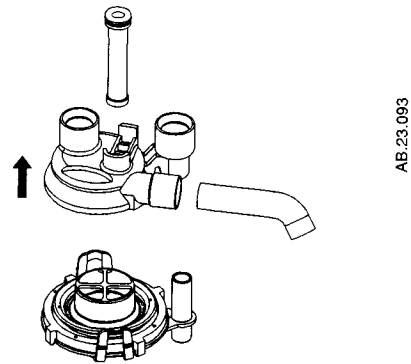
Step 1

Remove the exhalation valve (Cleaning and sterilization section).



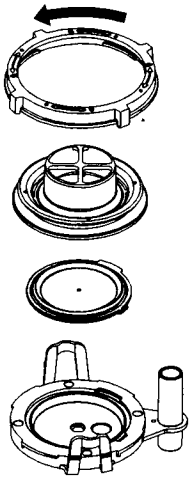
Step 2

Remove the top cover.



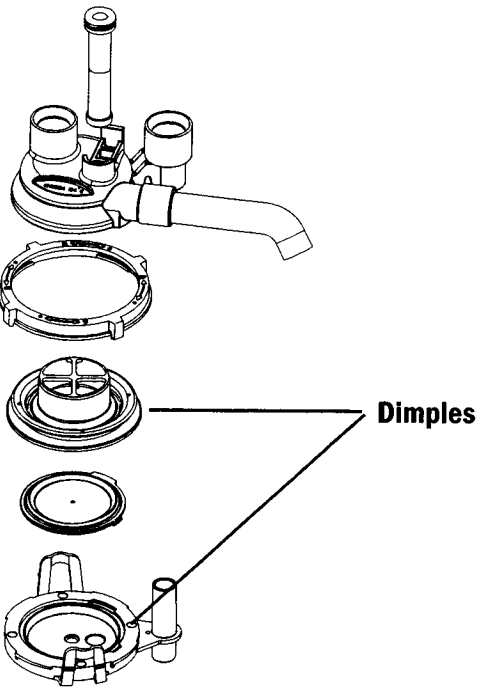
Step 3

Unscrew the lock ring (one quarter turn) and remove the cap.



Step 4

- Put the parts together
- Align the dimples in the cap with the valve seat.
  - To install the top, align it with the base and push down.



Before you use the system, complete the preoperative test procedure. Refer to the Appendix of the System controls, operation, and checkout manual.

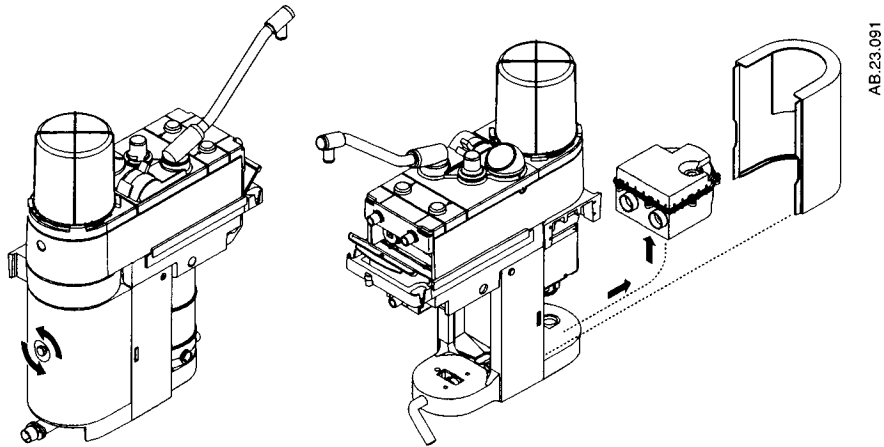
Receiver maintenance (active gas scavenging only)

A blocked filter decreases flow through the scavenging system. In extreme cases this can open the high pressure relief valve and vent to room air.

Note: Passive gas scavenging does not require maintenance.

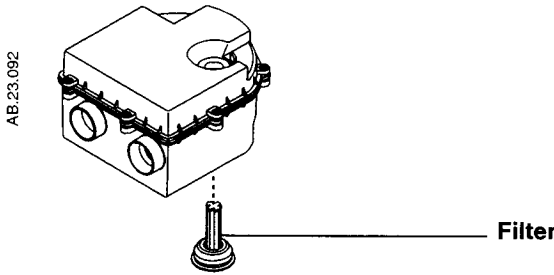
Step 1

- Remove the receiver:
- Loosen the thumbscrew.
  - Remove the rear cover
  - Pull out and up on the receiver.



Step 2

Replace the filter (friction fit with gasket.)



**⚠ WARNING** This system operates correctly at the electrical interference levels of IEC 601-1-2. Higher levels can cause nuisance alarms that may stop mechanical ventilation.

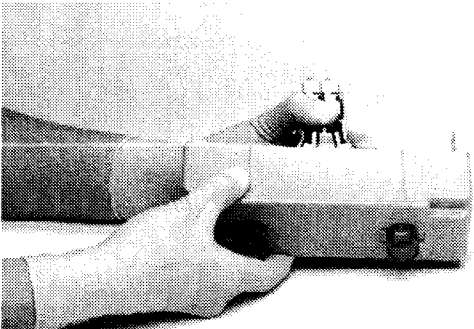
- Always make sure that the rear cover is installed.
- Completely tighten the thumb screw.

Before you use the system, complete the preoperative test procedure. Refer to the Appendix of the System controls, operation, and checkout manual.

Flow sensor maintenance

Step 1

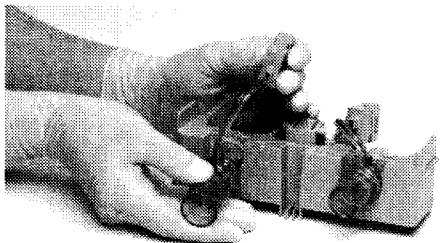
Remove the flow sensor module (Cleaning and sterilization section). Push in the tab and remove the cover.



Step 2

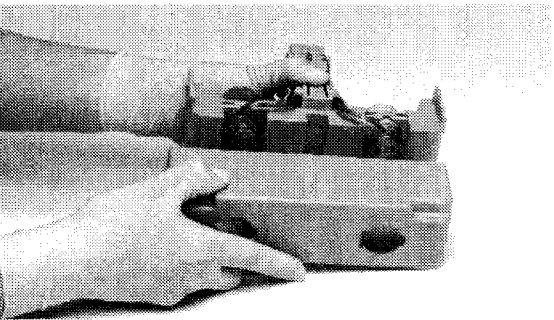
Install the new sensor with the arrows up.

Keep the tubes straight.



Step 3

Slide on the cover. Do not pinch the tubes.



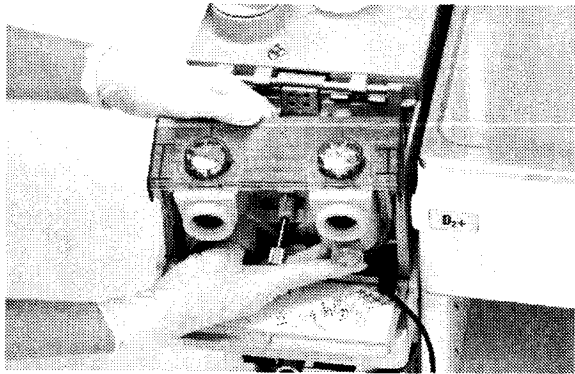
Before you use the system, complete the preoperative test procedure. Refer to the Appendix of the System controls, operation, and checkout manual.

Breathing circuit maintenance

Disassemble the patient circuit module to replace check valves or seals.

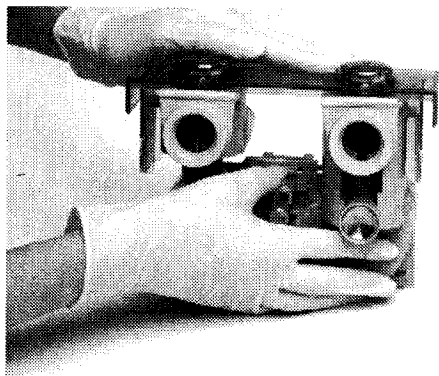
Step 1

Remove the patient circuit module (Cleaning and sterilization section).



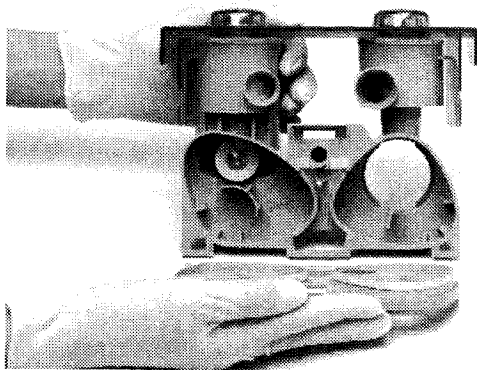
Step 2

Hold in the tab.



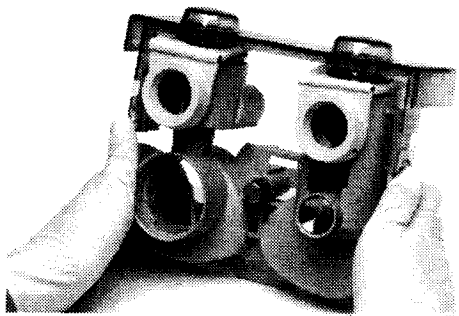
Step 3

Remove the rear cover. Note the rear seal is keyed to fit a specific module.



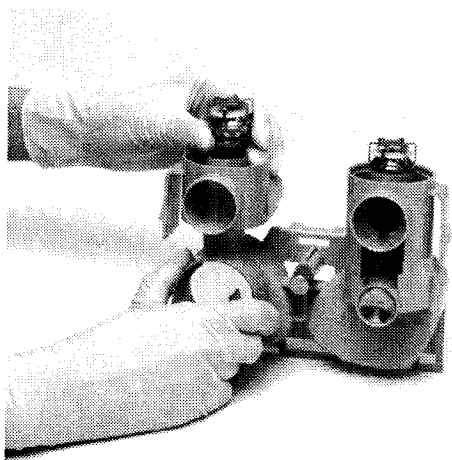
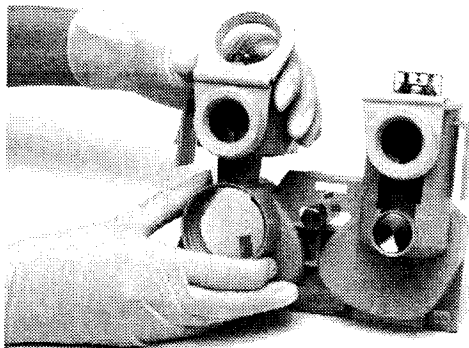
Step 4

Push in the tabs and remove the top cover.



Step 5

Remove the seals. Turn and pull to remove the check valves.

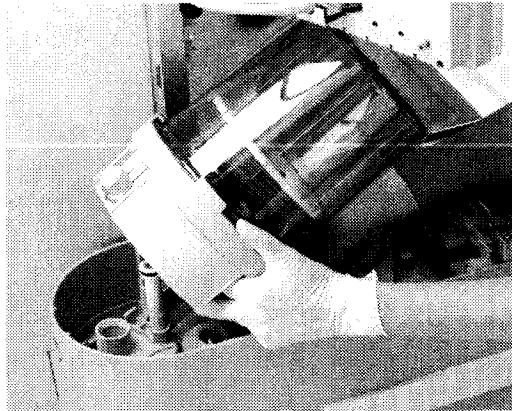


Do the steps in the opposite order to assemble the module.  
Before you use the system, complete the preoperative test procedure. Refer to the Appendix of the System controls, operation, and checkout manual.

Bellows maintenance

Step 1

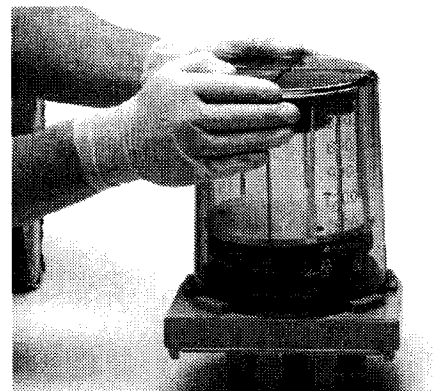
Remove the bellows from the breathing system.



AA.96p.023

Step 2

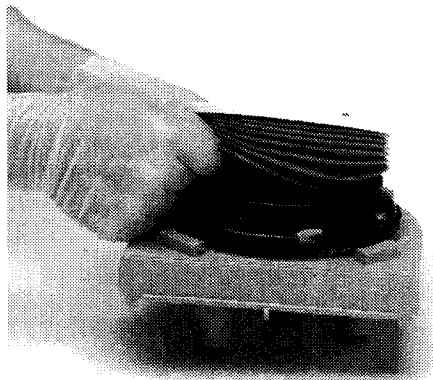
Turn the housing counter-clockwise and lift.



AA.96p.051

Step 3

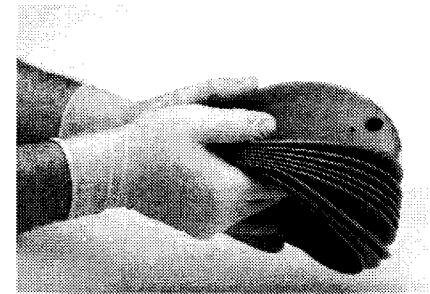
Remove the bottom edge of the bellows from the rim.



AA.96p.052

Step 4

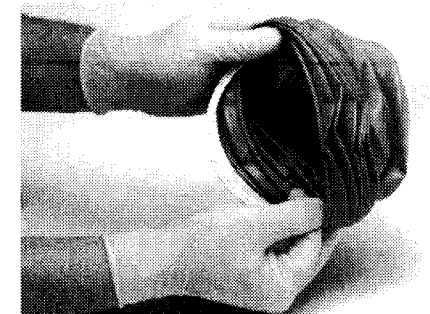
Remove the disk from the bellows.



AA.96p.031

Step 5

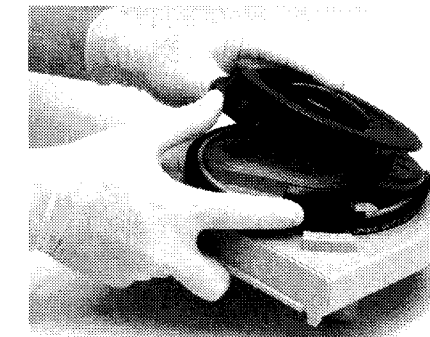
Remove the ring from inside the top of the bellows.



AA.96p.032

Step 6

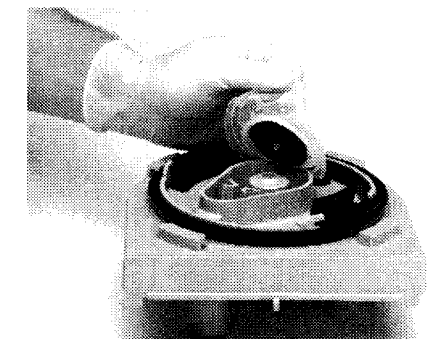
Push the latch toward the center and remove the rim.



AA.96p.033

Step 7

Remove the pressure-relief assembly.

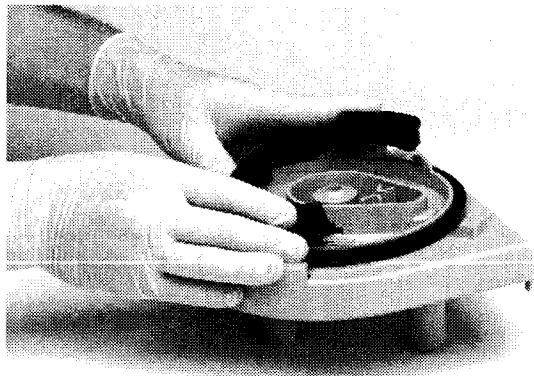


AA.96p.034

**⚠ WARNING** Do not disassemble the pressure relief valve. This can damage the seat or diaphragm and cause injury to the patient.

Step 8

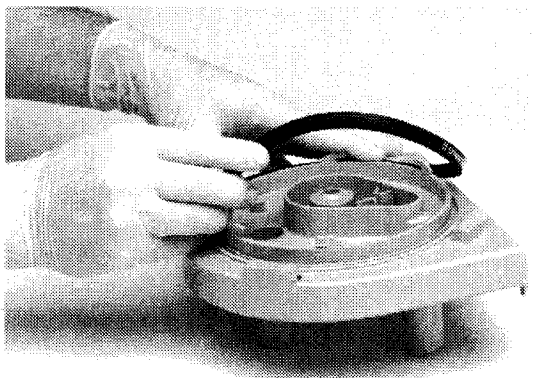
Push the latch towards the center and remove the locking tabs.



AA.96p.035

Step 9

Remove the seal.



AA.96p.036

Do these steps in the opposite order to assemble the bellows. If you see a dust like powder on the housing or the bellows, apply a thin layer of KRYTOX lubricant to the ribs of the bellows housing. Make sure the lubricant is applied smoothly and there are no lumps.

Make sure that:

- The arrow on the seal points up.
- You hear a double click when you install the rim.
- The rim is locked in position.
- The inner ring is correctly installed inside the top of the bellows.
- Only the bottom ring of the bellows fits over the rim.
- The housing is locked in position. You cannot lift it off.

Bellows tests

**⚠ WARNING** Objects in the breathing system can stop gas flow to the patient. This can cause injury or death:

- Do not use a test plug that is small enough to fall into the breathing system.
- Make sure that there are no test plugs or other objects caught in the breathing system.

**⚠ WARNING** The bellows assembly test does not replace the preoperative tests. Always complete the tests in the section Preoperative tests before you use the system with a patient.

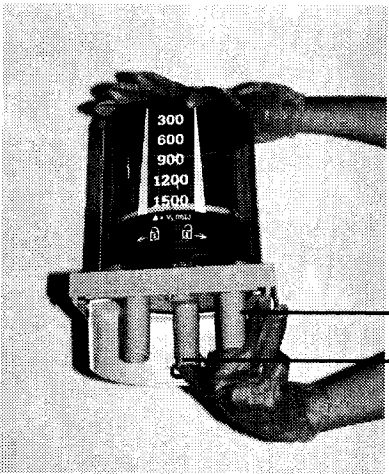
This test makes sure that all components are correctly assembled. It is not an alternative to a complete system checkout.

If the bellows operates correctly, install it in the system.

If there is a problem, disassemble the bellows. Look for and replace damaged parts.

Step 1

Hold the bellows assembly vertical and close the ports (A and B).



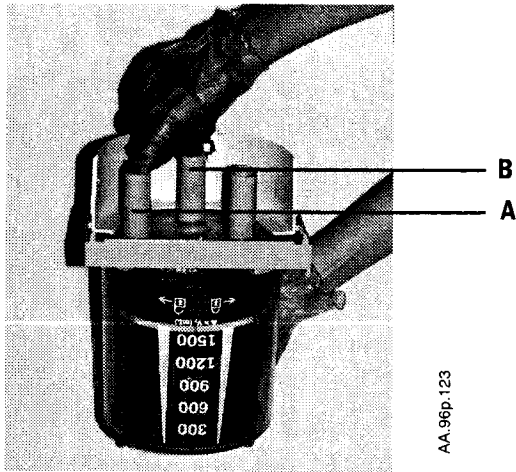
AA.96p.125

Step 2

Invert the bellows. They must not fall more than 100 ml/min.

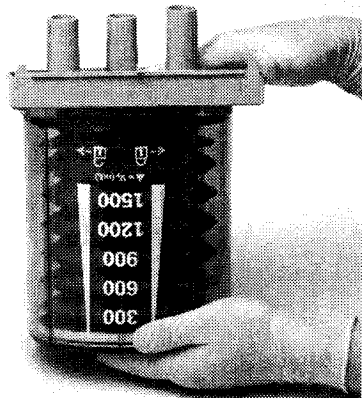
If it does:

- The ports are not tightly sealed.
- The bellows is incorrectly installed.
- The seal inside the bellows is not correctly installed (with its groove pointed up).
- Parts are damaged.



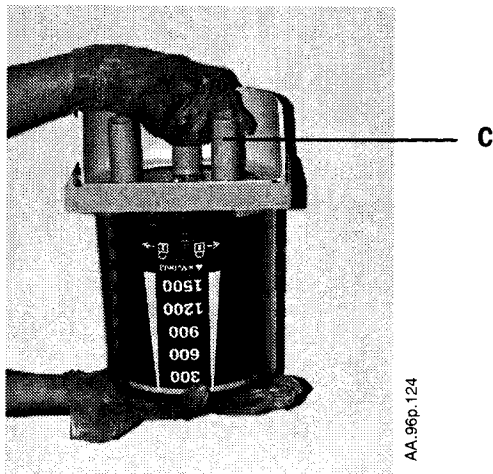
Step 3

Remove the plugs from the ports. Permit the bellows to fully extend.



Step 4

Close port C.

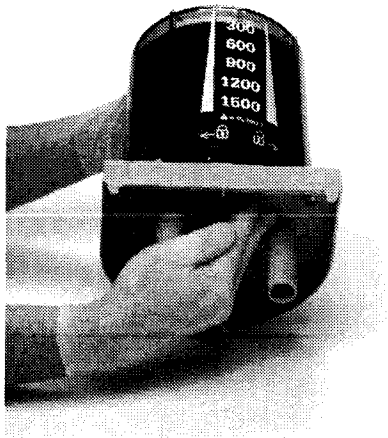


Step 5

The bellows must not fall more than 100 mL/min.

If it does:

- The port is not tightly sealed.
- The bellows or the pressure relief valve is not correctly installed.
- Parts are damaged.



If the result for all the bellows tests was “passed,” install it in the system.

Before you use the system, complete the preoperative test procedure. Refer to the Appendix of the System controls, operation, and checkout manual.



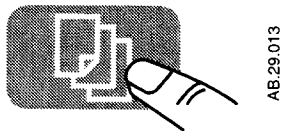
O<sub>2</sub> sensor calibration - 21% O<sub>2</sub>

This procedure takes three minutes or less.

You must do the 21% O<sub>2</sub> calibration before the 100% O<sub>2</sub> calibration. During O<sub>2</sub> calibration the screen replaces O<sub>2</sub> data with - - .

Step 1

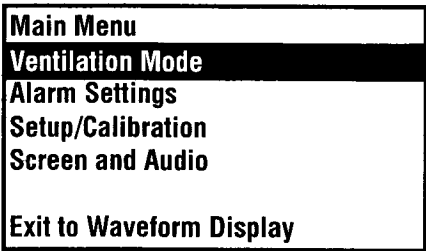
Push the menu key.



AB 29.013

Step 2

Turn the knob to select Setup/Calibration (highlight).



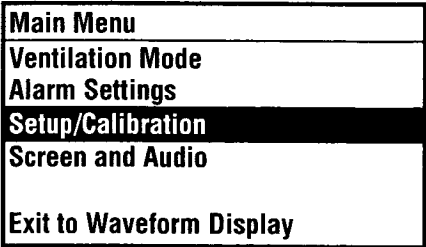
AB 48.072



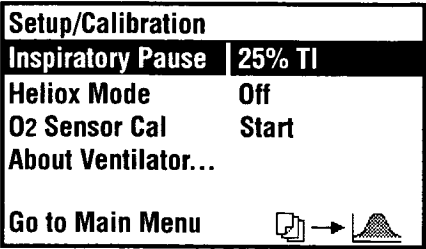
AB29.002

Step 3

Push the knob to show the next screen.



AB 48.073

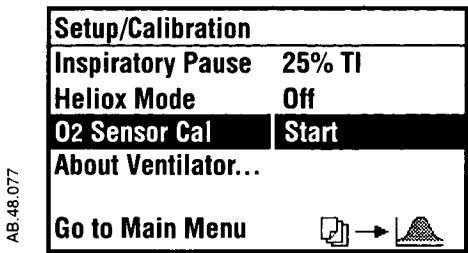


AB 48.076

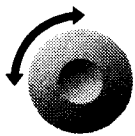


Step 4

Turn then push the knob to select O<sub>2</sub> Sensor Cal.



AB 48.077



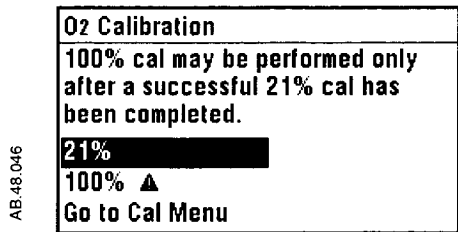
AB29.002



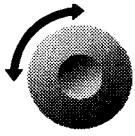
AB 29.012

Step 5

Select 21%. Then, push the knob.

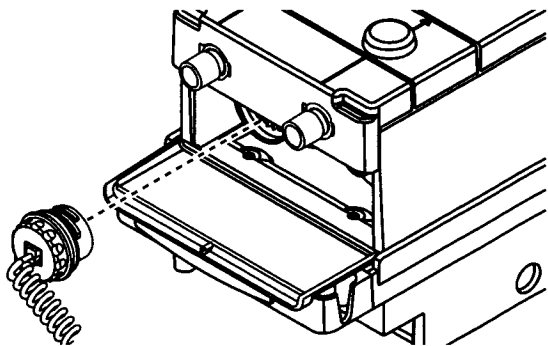


AB 48.046



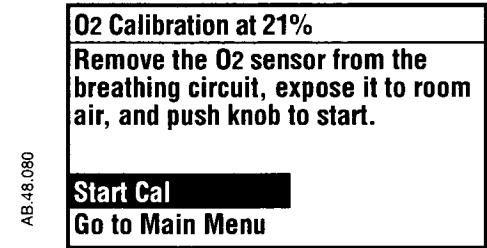
Step 6

- Complete the steps shown on the screen.
- Remove the O<sub>2</sub> sensor from the circuit.
  - Do not twist or stress the cable.
  - Make sure the cable is connected.



Step 7

Select Start Cal. Then, push the knob.



AB 48.080



The screen shows “Calibrating”, followed by the result (“Complete” or “Failure”).


After a successful calibration, the screen prompts you to put the O2 sensor back in the circuit.

If the calibration fails:

- Do the calibration again.
  - If it still fails do a 100% O2 sensor calibration. If this passes, calibrate at 21% again.
- After repeated failures, make sure that the altitude is correct (About Ventilator screen). Then, replace the O<sub>2</sub> sensor.
- If the calibration passes, install the O<sub>2</sub> sensor. If necessary, do the 100% O<sub>2</sub> calibration.
- Before you use the system, complete the preoperative test procedure. Refer to the Appendix of the System controls, operation, and checkout manual.

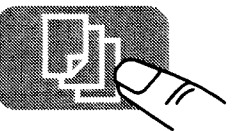
# O<sub>2</sub> sensor calibration - 100% O<sub>2</sub>

This procedure takes three minutes or less.

If  appears on the screen, you must complete the 21% calibration before you can select the 100% calibration.

## Step 1

Push the menu key.



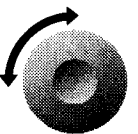
AB 29.003

## Step 2

Turn the knob to select **Setup/Calibration** (highlight).

AB48.072

|                          |  |
|--------------------------|--|
| Main Menu                |  |
| Ventilation Mode         |  |
| Alarm Settings           |  |
| Setup/Calibration        |  |
| Screen and Audio         |  |
| Exit to Waveform Display |  |



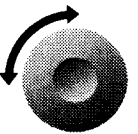
AB29.002

## Step 3




Push the knob to show the next screen.

AB48.073

|                          |  |
|--------------------------|--|
| Main Menu                |  |
| Ventilation Mode         |  |
| Alarm Settings           |  |
| Setup/Calibration        |  |
| Screen and Audio         |  |
| Exit to Waveform Display |  |



AB48.076

|   |        |
|---|--------|
| Setup/Calibration   |        |
| Inspiratory Pause   | 25% TI |
| Heliox Mode   | Off    |
| O2 Sensor Cal   | Start  |
| About Ventilator...   |        |
| Go to Main Menu    |        |



Step 4

Turn then push the knob to select **O<sub>2</sub> Sensor Cal.**

AB48.077

|                                 |              |
|---------------------------------|--------------|
| Setup/Calibration               |              |
| Inspiratory Pause               | 25% TI       |
| Heliox Mode                     | Off          |
| <b>O<sub>2</sub> Sensor Cal</b> | <b>Start</b> |
| About Ventilator...             |              |
| Go to Main Menu                 |              |

AB29.002

AB29.046

Step 5

Select 100%. Then, push the knob.

AB29.056

|   |  |
|---|--|
| O <sub>2</sub> Calibration  |  |
| 100% cal may be performed only after a successful 21% cal has been completed. |  |
| 21%   |  |
| <b>100%</b>   |  |
| Go to Cal Menu  |  |

Step 6

With the O<sub>2</sub> sensor in the circuit, fill the circuit with 100% O<sub>2</sub>:

- Push the flush button.
- Then flow 100% O<sub>2</sub> at 5 L/min.

or

AA.96.113

Step 7

Select **Start Cal.**  
Then, push the knob.

AB48.081

|   |  |
|---|--|
| O <sub>2</sub> Calibration at 100%  |  |
| With O <sub>2</sub> sensor in the breathing system, flow 100% O <sub>2</sub> and then push knob to start. |  |
| <b>Start Cal</b>  |  |
| Go to Main Menu   |  |

The screen shows “**Calibrating ...**”, followed by the result (“**Complete**” or “**Failure**”).

If the calibration fails,

- do it again. or,
- decrease the airway pressure. Then try again.

After repeated failures, make sure that the altitude setting is correct (About Ventilator screen). Then, replace the O<sub>2</sub> sensor.

Before you use the system, complete the preoperative test procedure. Refer to the Appendix of the System controls, operation, and checkout manual.

Flow sensor calibration

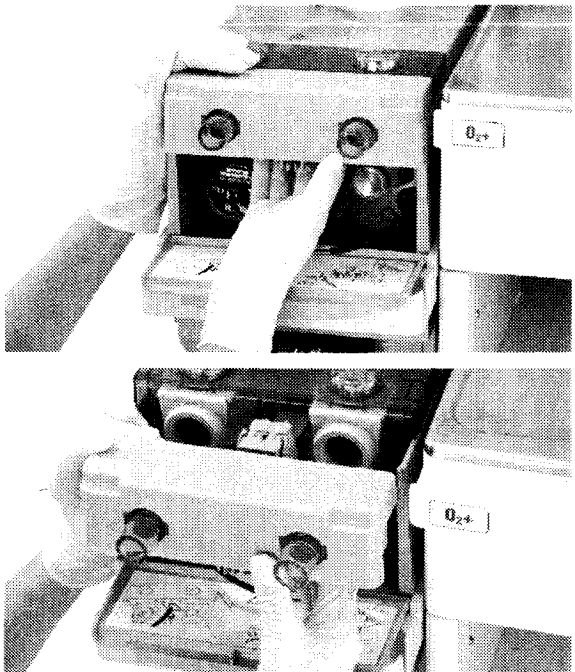
Minimum Frequency: Weekly

The system automatically corrects for zero offset when you unplug the flow sensor connectors with power on. You must stop mechanical ventilation before you calibrate the flow sensors.

Step 1

Push up on the latch under the flow sensor module.

Remove the flow sensor module. You will feel some resistance. Continue to pull.



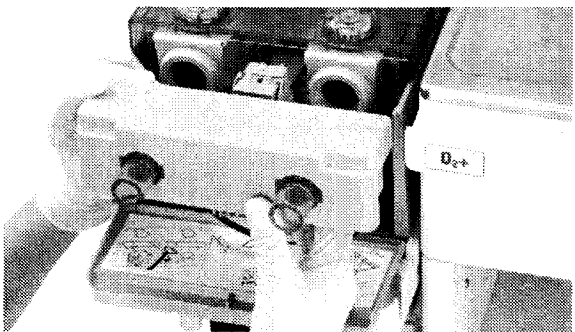
Step 2

When calibration is complete, the screen shows, "No Insp flow sensor" and "No Exp flow sensor"

No Insp Flow Sensor  
No Exp Flow Sensor

Step 3

- Install the flow sensor module



How to prevent water build-up

Why is water buildup a problem?

Pooled water in the sensor or water in the sensing lines causes false alarms.

How much water is too much?

A thin layer of water or a foggy look in the flow sensors is OK. Drops of liquid water is too much.

Where does the water come from?

Water comes from exhaled gas and a chemical reaction between CO<sub>2</sub> and the soda lime in the absorber.


At lower fresh gas flows more water builds up because less gas is scavenged and:

- More CO<sub>2</sub> stays in the absorber to react and produce water.
- More moist, exhaled gas stays in the absorber

Solutions:

- Drain the absorber each morning.
- Drain all hoses as necessary.
- Flow sensor tubes must point up so that they do not collect water.
- With a circle breathing circuit, push the drain button before every case (listed in pre-operative procedures).
- If check flow sensor alarms occur during a VERY LONG case, replace the flow sensors. Allow the original flow sensors to dry before you use them again.

# Alarms and Troubleshooting

 **CAUTION** No repair should ever be attempted by anyone not having experience in the repair of devices of this nature.

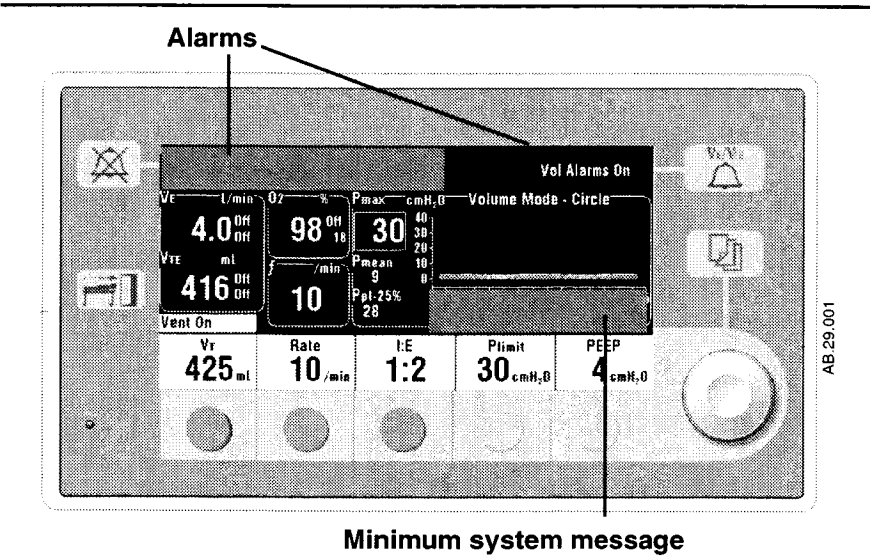
|                        |   |      |
|------------------------|---|------|
| <b>In this section</b> | About alarms .....                              | 5-2  |
|                        | Alphabetical list .....                         | 5-4  |
|                        | Breathing system problems (no alarm) .....      | 5-16 |
|                        | Electrical problems (power failure, etc.) ..... | 5-17 |
|                        | Pneumatic problems .....                        | 5-19 |

About alarms

**⚠ WARNING** If an alarm occurs, safeguard the patient first, before troubleshooting or repair procedures.

Two areas on the screen show alarms. The area at the top of the display shows most alarms. If there are more than 4 alarms at the same time, the lower priority alarms cycle every two seconds.

During severe malfunctions that prevent mechanical ventilation and/or monitoring, the area under the waveform shows minimum system messages. During normal operation, this area shows instructions (push the knob, etc.)



Alarm priority depends on the level of danger to the patient. High priority alarms require immediate attention. If an alarm is related to control settings, the limits flash and a box appears around the parameter.

| Priority | Alarm tone                     | Alarm silence                     | Note                                     |
|----------|--------------------------------|-----------------------------------|--|
| High     | 10 tones, 10 sec pause, repeat | 120 Seconds or cannot be silenced | Reverse video. Screen shows elapsed time |
| Medium   | 3 tones, 25 sec pause, repeat  | 120 Seconds                       | ----                                     |
| Low      | Single tone                    | Tone does not repeat              | ---                                      |

Alarm messages have three general causes:

- Malfunctions. Some malfunctions cause reduced function (for example no PEEP). Others prevent mechanical ventilation (Minimum shutdown).
- Patient monitoring. These are high and low limit settings that you adjust.
- Informational. Control settings or system conditions can change operation. For example, if the audible circuit leak alarm is Off, the screen shows "Circuit leak audio Off" as a low priority alarm.

Alphabetical list

The instructions in this section tell you what you can do:

- During a case to protect the patient
- After the case to repair a problem

This table does not include operator instructions.

There are two special types of alarms:

- Minimum monitoring alarms stop mechanical ventilation.
- Minimum shutdown alarms stop mechanical ventilation and monitoring.

| Message                   | Priority             | Cause   | Action/Concerns  | Repair                                      |
|---------------------------|----------------------|---|--|---|
| +15V Analog Out-of- Range | Min. shutdown (High) | Ventilator malfunction  | Ventilate manually. Monitoring is not reliable.  | Contact a qualified service representative. |
| -15V Analog Out-of-Range  | Min. shutdown (High) | Ventilator malfunction  | Ventilate manually. Monitoring is not reliable.  | Contact a qualified service representative. |
| 12 Hour Test              | Low                  | System in use for more than 12 hours without a power-up self test.    | To do the test, move the system switch from Standby to On.   | Not necessary. Informational                |
| Absorber canister open    | Medium               | The canister release is open (large leak) without a bypass mechanism. | Close the canister release.  | A switch checks the release position        |
| ✕ Absorber top panel open | Medium               | The top panel is not completely closed                                | Close the panel.   | ---   |
| A/D Converter Failure     | Min. shutdown (High) | Ventilator malfunction  | Ventilate manually. Monitoring is not reliable.  | Contact a qualified service representative. |
| All Vent modes Available  | Low                  | A condition that prevented one of the ventilation modes has cleared.  | None. Indicates a return to normal operation. Select pressure control of volume control ventilation. | ---   |

| Message                | Priority                        | Cause   | Action/ Concerns   | Repair  |
|------------------------|---------------------------------|---|--|---|
| Apnea Alarm in Standby | Low                             | Normal condition after End Case, power-up, or ACGO change from On to Off                              | Monitoring resumes after first breath (mechanical) or 2 breaths within 30 sec (non-mechanical).  | ---   |
| Apnea Alarm Off        | Low                             | The cardiac bypass option is selected (alarm limit menu)  | Apnea alarms are normally turned off when this option is selected  | ---   |
| Aux Comm Gas Outlet On | Medium (low after acknowledged) | The outlet selection switch is set to the auxiliary common gas outlet.                                | Connect the patient circuit to the auxiliary outlet. For mechanical ventilation or manual ventilation with monitoring, select the common gas outlet. | ---   |
| Battery Charger Fail   | Low                             | The current in the battery charging circuit is too high.  | The system is operational, but may fail later depending on what caused this alarm.   | Contact a qualified service representative                                    |
| Battery Charging       | Low                             | The battery is not fully charged. If power fails, the total backup time will be less than 30 minutes. | Leave the system plugged in to charge the battery.   | ---   |
| Battery Current High   | Low                             | Battery current > 6 amps for 10 seconds   | The system continues to operate but may fail   | Contact a qualified service representative                                    |
| Battery Failure High   | Low                             | Battery voltage > 16 V for 10 seconds   | The system continues to operate but may fail   | Contact a qualified service representative                                    |
| Battery Failure Low    | Low                             | The battery voltage is too low (<7 V) to supply the system if power fails.                            | The battery does not have enough charge to power the equipment if power fails. Leave the system plugged in to charge the battery.                    | If the battery does not charge in 24 hours, contact a service representative. |

| Message                           | Priority                        | Cause   | Action/Concerns  | Repair  |
|-----------------------------------|---------------------------------|---|--|---|
| Calibrate Flow Sensors            | Low                             | The last flow sensor calibration failed.  | Calibrate the flow sensors. Look for water in the flow sensor tubes. Dry if necessary. | Contact a qualified service representative.   |
| Calibrate O <sub>2</sub> Sensor   | Low                             | O <sub>2</sub> %>110%   | Does the sensor measure 21% O <sub>2</sub> in room air?                                | Calibrate O <sub>2</sub> sensor.  |
| Cardiac Bypass                    | Low                             | The alarm limit settings are set for a patient on cardiac bypass. Apnea alarms are off.   | Use the alarm limits menu to change this setting.                                      | - - -   |
| Check Flow Sensors                | Medium (low after acknowledged) | No flow or negative flow on inspiratory sensor during inspiration in a circle system or negative flow on expiratory sensor in expiration ( for 6 breaths in a row). | Are the flow sensors correctly installed?  | Inspect one way valves (breathing circuit module.)  |
|                                   |                                 |   | Water build up in the flow sensor tubes?   | Replace flow sensor module with the spare. Check the condition of the flow sensor and its tubing. |
|                                   |                                 |   | Is a flow sensor tube cracked or broken?   |   |
| Circuit Leak Audio Off            | Low                             | Control setting on the Alarm limit menu.  | This message tells you that the audio alarm for circuit leaks was turned off.          | - - -   |
| Connect O <sub>2</sub> Sensor     | Low                             | The O <sub>2</sub> sensor is not connected to the cable.  | Connect the sensor.  | Contact a qualified service representative to replace the cable.                                  |
| Control Settings Input has Failed | Min. monitoring (Medium)        | Ventilator malfunction  | Ventilate manually. Monitoring is still available.                                     | Contact a qualified service representative.   |
| CPU Failure                       | Min. shutdown (High)            | Ventilator malfunction  | Ventilate manually. Monitoring is not reliable.  | Contact a qualified service representative.   |

| Message  | Priority  | Cause  | Action/Concerns  | Repair                                      |
|--|---|--|--|---|
| CPU Internal Error                                       | Min. shutdown (High)  | Ventilator malfunction   | Ventilate manually. Monitoring is not reliable.  | Contact a qualified service representative. |
| Display Voltage Out Of Range                             | Min. shutdown (High)  | Ventilator malfunction   | Ventilate manually. Monitoring is not reliable.  | Contact a qualified service representative. |
| Exp Flow Sensor Fail                                     | Low   | The system cannot read the calibration data stored in the sensor.                | Operation continues with default values. Replace the flow sensor.                        | - - -                                       |
| Exp reverse flow   | Medium (low after acknowledged)                               | Flow through the expiratory sensor during inspiration ( for 6 breaths in a row). | Look at the check valves   | Replace the expiratory check valve.         |
|  |   |  | Water build up in the flow sensor tubes?<br><br>Is a flow sensor tube cracked or broken? | Check the condition of the flow sensor.     |
| Flow Valve Failure (DAC)<br>Flow Valve Failure (current) | Min. monitoring (Medium)                                      | Ventilator malfunction   | Ventilate manually. Monitoring is still available.                                       | Contact a qualified service representative. |
| Gas Inlet Valve Failure                                  | Min. monitoring (Medium) or Min. shutdown (High) <sup>1</sup> | Ventilator malfunction   | Ventilate manually. Monitoring is still available.                                       | Contact a qualified service representative. |
| Hardware Watchdog Failure                                | Min. shutdown (High)  | Ventilator malfunction   | Ventilate manually. Monitoring is not reliable.  | Contact a qualified service representative. |
| Heliox Mode is On  | Low   | Control setting on ventilation setup menu.                                       | When heliox is used, the ventilator must adjust volume calculations.                     | - - -                                       |



| Message                     | Priority                        | Cause   | Action/Concerns  | Repair  |
|-----------------------------|---------------------------------|---|--|---|
| High O <sub>2</sub>         | Medium                          | O <sub>2</sub> % > alarm high limit setting   | Is the limit set correctly? What is the O <sub>2</sub> flow?<br>Did you just push Flush? Does the sensor see 21% O <sub>2</sub> in room air? | Calibrate O <sub>2</sub> sensor.<br>Replace O <sub>2</sub> sensor.                  |
| High Paw                    | High                            | Paw is greater than Plimit. The ventilator cycles to expiration.  | Are Plimit and other controls set correctly? Look for blockages.<br>Check the patient connection.  | Calibrate the flow sensors.<br>Replace the receiver filter.                         |
| High Pressure Limit Reached | Min. monitoring (Medium)        | A pressure safety switch activated at a Paw <90 cm H <sub>2</sub> O   | Ventilate manually. Monitoring is still available. Extreme control combinations may cause this alarm. Check control settings.                | Contact a qualified service representative.   |
| High Ve                     | Medium                          | The minute volume is greater than the set high limit. This alarm is suspended for 9 breaths after you change the ventilator settings. | Check patient for spontaneous breathing. Adjust control settings   | ---   |
| High Vte                    | Medium                          | VTE is greater than high alarm limit. This alarm is suspended for 9 breaths after you change the ventilator settings.                 | Check patient for spontaneous breathing. Check ventilator and alarm settings.  | ---   |
| Insp Flow Sensor Fail       | Low                             | The system cannot read the calibration data stored in the sensor.   | Operation continues with default values. Replace the flow sensor.  | ---   |
| Insp Reverse Flow           | Medium (low after acknowledged) | Flow through the inspiratory sensor during expiration ( for 6 breaths in a row).  | Look at the check valves<br><br>Water build up in the flow sensor tubes?<br><br>Is a flow sensor tube cracked or broken?                     | Replace the inspiratory check valve.<br><br>Check the condition of the flow sensor. |

| Message                            | Priority                        | Cause  | Action/Concerns  | Repair   |
|------------------------------------|---------------------------------|--|--|--|
| Inspiration Stopped                | High                            | Drive gas safety switch activated (high pressure)  | Adjust controls. Check systems for blockages.  | ---  |
| Internal Ventilator Clock Too Fast | Min. shutdown (High)            | Ventilator malfunction   | Ventilate manually. Monitoring is not reliable.  | Contact a qualified service representative.  |
| Internal Ventilator Clock Too Slow | Min. shutdown (High)            | Ventilator malfunction   | Ventilate manually. Monitoring is not reliable.  | Contact a qualified service representative.  |
| Invalid Circuit Module             | Low                             | The system does not recognize the type of circuit module installed. Normally the system used the ID tabs to identify circuits. | Make sure the module is correctly installed. Look for broken ID tabs or tape on the tabs | Contact a qualified service representative   |
| Limit Task Light Use               | Low                             | The system is running on battery power. Turn off the light to save power.  | Turn off the light to extend battery backup.   | ---  |
| Loss of Backup Audio               | Medium (low after acknowledged) | The audio alarm will not sound for a CPU failure   | Monitor system operation   | Contact a qualified service representative   |
| Low Battery Voltage                | Medium                          | Voltage is <11.65V while using battery power   | Manually ventilate the patient to save power.  | Make sure power is connected and circuit breakers are close. Check ventilator fuse.                |
| Low Drive Gas Pressure             | Medium                          | The ventilator did not detect a rise in internal pressure when the flow valve opened.  | Manually ventilate the patient.  | Make sure that the appropriate gas supplies (O <sub>2</sub> or air) are connected and pressurized. |

| Message                          | Priority                 | Cause   | Action/Concerns  | Repair  |
|----------------------------------|--------------------------|---|--|---|
| Low O <sub>2</sub>               | High                     | O <sub>2</sub> % < alarm low limit setting  | Is the limit set correctly? Is the O <sub>2</sub> flow sufficient? Does the sensor see 21% O <sub>2</sub> in room air? | Calibrate O <sub>2</sub> sensor.<br>Replace O <sub>2</sub> sensor.<br>As sensors wear out, the measured % O <sub>2</sub> decreases. |
| Low Paw                          | Medium                   | Paw does not rise at least 4 cm from the lowest pressure measured during the last20 sec   | Are circuit connections Ok? Look at the Paw gauge on the absorber.   | Look for circuit disconnection.   |
| Low Ve                           | Medium                   | Exhaled minute volume <low limit alarm setting. This alarm is suspended for 9 breaths after you change the ventilator settings. | Check patient condition.<br>Check tubing connec-tions.<br>Check alarm settings.  | ---   |
| Low Vte                          | Medium                   | Exhaled tidal volume <low limit alarm setting. This alarm is suspended for 9 breaths after you change the ventilator settings.  | Check patient condition.<br>Check tubing connections.<br>Check alarm settings.   | ---   |
| Manifold Pressure Sensor Failure | Min. monitoring (Medium) | Ventilator malfunction  | Ventilate manually   | Contact a qualified service representative  |
| Memory (EEPROM) Fail             | Low                      | The system cannot access some stored values.  | Default settings are used. Ventilation is still possible but service is necessary.                                     | Contact a qualified service representative.   |
| Memory (flash) Failure           | Min. shutdown (High)     | Ventilator malfunction  | Ventilate manually. Monitoring is not reliable.  | Contact a qualified service representative.   |
| Memory (RAM) Failure             | Min. shutdown (High)     | Ventilator malfunction  | Ventilate manually. Monitoring is not reliable.  | Contact a qualified service representative.   |

| Message  | Priority                             | Cause   | Action/Concerns   | Repair   |
|--|--------------------------------------|---|---|--|
| Memory (Redundant Storage) Fail                | Min. monitoring (Medium)             | Ventilator malfunction  | Ventilate manually. Monitoring is still available.  | Contact a qualified service representative.  |
| Memory (video) Failure                         | Min. shutdown (High)                 | Ventilator malfunction  | Ventilate manually. Monitoring is not reliable.   | Contact a qualified service representative.  |
| Minimum Monitoring                             | Medium                               | A severe malfunction prevents mechanical ventilation.Other alarms may also occur.                       | Ventilate manually. Cycle system power (On- Standby-On). If the alarm clears, restart mechanical ventilation                            | Contact a qualified service representative.  |
| Minimum system shutdown                        | High                                 | A severe malfunction prevents mechanical ventilation and monitoring. Other alarms may also occur.       | Ventilate manually. Use a stand-alone monitor. Cycle system power (On- Standby-On). If the alarm clears, restart mechanical ventilation | Contact a qualified service representative   |
| No Circuit Module                              | Low                                  | The patient circuit module is not installed.  | Install a module. Refer to the setup section.   | Optical sensors look for tabs on the back of the module. Is the module assembled? are the sensors dirty? |
| No CO <sub>2</sub> absorption                  | Medium (low after acknow-<br>ledged) | The canisters are open (out of the circuit) but the bypass mechanism prevents a leak (optional feature) | User setting. Close the canister release to remove CO <sub>2</sub> from exhaled gas   | ---  |
| No Exp Flow Sensor;<br><br>No Insp Flow Sensor | Medium (low after acknow-<br>ledged) | Electrical signals show the flow sensor is not connected  | Connect the flow sensors. Make sure the flow sensor module is on all the way.   | ---  |

| Message                              | Priority                          | Cause   | Action/Concerns  | Repair  |
|--------------------------------------|-----------------------------------|---|--|---|
| No O <sub>2</sub> pressure           | High<br>(cannot be silenced)      | The O <sub>2</sub> supply has failed.   | Air flow will continue. Ventilate manually if necessary. Connect a pipeline supply or install an O <sub>2</sub> cylinder | ---   |
| O <sub>2</sub> Flush Failure         | Low                               | The pressure switch that detects flush flow has seen a very long flush (≥30 sec).                               | This alarm occurs if you hold down the Flush button for more than 30 seconds.  | If the alarm occurs when flush is not in use, contact a qualified service representative.                         |
| O <sub>2</sub> sensor out of circuit | Low                               | O <sub>2</sub> sensor not installed in breathing circuit module; sensor not measuring gas in breathing circuit. | Install a breathing circuit module and an O <sub>2</sub> sensor.   | ---   |
| On Battery-Check Power               | Medium<br>(low after acknowledge) | The mains supply is not connected or has failed and the system is using battery power                           | Ventilate manually to save power. At full charge, the battery permits approx. 30 min of mechanical ventilation.          | Make sure power is connected and circuit breakers are closed. Check ventilator fuse.                              |
| Patient Circuit Leak                 | Medium                            | Exhaled volume <50% of inspired volume for at least 30 seconds (mechanical ventilation).                        | Check breathing circuit and flow sensor connections.   | ---   |
| Paw < -10 cmH <sub>2</sub> O         | High                              | Subatmospheric pressure (<-10 cm H <sub>2</sub> O)  | Check patient condition, spontaneous activity? Increase fresh gas flow. Look for high flow through gas scavenging.       | Calibrate the flow sensors. <sup>2</sup> With active scavenging, check the negative relief valve on the receiver. |
| Paw/manifold mismatch                | Medium                            | The airway pressure and an internal ventilator pressure do not track.   | Ventilate manually.  | Contact a qualified service representative.   |

| Message                         | Priority                               | Cause  | Action/Concerns   | Repair   |
|---------------------------------|--|--|---|--|
| PEEP Not Achieved               | Low                                    | Pmin does not reach within 2 cm H <sub>2</sub> O of PEEP by the end of mechanical expiration for 6 consecutive breaths.                          | Check tubing connections. Rate and/or I:E ratio may prevent ventilator from reaching desired PEEP level                 | ---  |
| Positive SIB Vref Out-of- Range | Min. shutdown<br>(High)                | Ventilator malfunction   | Ventilate manually. Monitoring is not reliable.   | Contact a qualified service representative.                        |
| Pres Control Available          | Low                                    | The ventilator is not fully functional but pressure control mode is available.   | VT Compensation is Off. Ventilate manually or in the pressure control mode  | ---  |
| Pres Control Not Avail.         | Medium<br>(pressure control); else low | Ventilator not fully functional and pressure control mode not available.   | Ventilate manually or in the volume control mode  | Contact a qualified service representative.                        |
| Pres/Vol Mon Inactive           | Medium                                 | Outlet selection switch is set to aux. gas outlet  | Connect the patient circuit to the aux. gas outlet or set the switch to the common gas outlet for normal operation.     | ---  |
| Replace O <sub>2</sub> Sensor   | Low                                    | O <sub>2</sub> % < 5%  | Makes sure patient receives O <sub>2</sub> . Does the sensor see 21% O <sub>2</sub> in room air? Use different monitor. | Calibrate O <sub>2</sub> sensor. Replace O <sub>2</sub> sensor.    |
| Schedule Cal Due                | Low                                    | Internal calibrations are necessary for maximum accuracy.  | The system is operational   | Contact a qualified service representative.                        |
| Select Gas Outlet               | Medium                                 | Fresh gas may not flow to the patient Aux. gas outlet is On, but flow sensors have seen 3 breaths in patient circuit during the last 30 seconds. | Select the common gas outlet or connect the patient circuit to the aux. outlet.   | Note: the bag arm will not ventilate a patient at the aux. outlet. |

| Message                   | Priority             | Cause   | Action/Concerns  | Repair  |
|---------------------------|----------------------|---|--|---|
| Software Watchdog Failure | Min. shutdown (High) | Ventilator malfunction  | Ventilate manually. Monitoring is not reliable.  | Contact a qualified service representative.                                   |
| Sustained airway pressure | Min. shutdown (High) | Paw > 100 cm H <sub>2</sub> O for 10 sec.   | Check tubing for kinks, blockages, disconnects.  | Calibrate the flow sensors.   |
| Sustained Paw             | High                 | Paw > sustained pressure limit for 15 seconds <sup>3</sup>                          | Check tubing for kinks, blockages, disconnects.  | Calibrate the flow sensors.   |
| System Leak?              | Low                  | Delivered volumes do not match set volumes  | If you are using Heliox, select Heliox on the ventilator setup menu. Look for leaks in the manifold. Compare set to delivered volumes    | Calibrate the flow sensors.<br>Drain water buildup from the breathing system. |
| Unable to Drive Bellows   | Low                  | The internal manifold pressure is higher than Paw + tolerance.                      | Fill the bellows if empty.   | - - -   |
| Vaux_ref Out-of-Range     | Min. shutdown (High) | Ventilator malfunction  | Ventilate manually. Monitoring is not reliable.  | Contact a qualified service representative.                                   |
| Vext_ref Out-of-Range     | Min. shutdown (High) | Ventilator malfunction  | Ventilate manually. Monitoring is not reliable.  | Contact a qualified service representative.                                   |
| Verify Low VE Limit       | Low                  | The audible circuit leak alarm is Off (Alarm menu) but the low VE alarm is not set. | Set the low VE alarm.  | - - -   |
| Volume Apnea              | Medium               | No mechanical breaths or spontaneous breaths >20 mL in last 30 seconds.             | Check patient. Bag as needed. Check for disconnects. If the patient is on a heart lung machine, select Cardiac Bypass on the alarm menu. | - - -   |

| Message              | Priority                       | Cause   | Action/Concerns   | Repair  |
|----------------------|--------------------------------|---|---|---|
| Volume Apnea > 2 min | High                           | No mechanical breaths or spontaneous breaths >20 mL in last 120 seconds.  | See above   | - - -   |
| Vt Compensation Off  | Medium (low after acknowledge) | The system supplies the set breath but cannot adjust ventilation for compliance and resistance losses, etc.                       | Adjust VT manually and continue without compensation, or change to the pressure control mode. In pressure control set Pinspir | Replace the flow sensor module and select the mode again. If the problem stops, inspect the two flow sensors. |
| VT Not Achieved      | Low                            | Tidal volume measured by inspiratory flow sensor < set value 6 breaths in a row after the first minute of mechanical ventilation. | Adjust controls to supply adequate tidal volumes. Check I:E; PLimit; and volume settings.                                     | Possible leak.  |
| Vte > Insp Vt        | Low                            | Expired volume > inspired volume for 6 breaths with a circle module.  | Check patient condition.  | - - -   |

1. When power is first turned on.  
2. Flow sensors are also used to measure pressures.  
3. The sustained pressure threshold is calculated from the pressure limit setting. When mechanical ventilation is on, the sustained limit is calculated as follows: for pressure limits < 30 cm H<sub>2</sub>O, the sustained pressure limit is 6 cm H<sub>2</sub>O; for Plimit between 30 and 60 cm H<sub>2</sub>O, the sustained limit is 20% of the pressure limit (Plimit); for pressure limits >60 cm H<sub>2</sub>O, the sustained pressure limit is 12 cm H<sub>2</sub>O. If both PEEP and Mechanical ventilation are on, the sustained pressure limit increases by PEEP - 2 cm H<sub>2</sub>O (the compensated weight of the bellows). When mechanical ventilation is off, the sustained pressure limit is calculated as follows: for pressure limits ≤ 60 cm H<sub>2</sub>O, the sustained pressure limit is 50% of the pressure limit (Plimit); for pressure limits >60 cm H<sub>2</sub>O, the sustained pressure limit is 30 cm H<sub>2</sub>O.

Breathing system problems (no alarm)

| Symptom   | Problem  | Solution(s)   |
|---|--|---|
| Gas scavenging flow is too low.   | Suction supply problem.  | Use a different suction supply.   |
|   | Filter blockage. Active systems have a flow indicator to show this.        | Replace the filter. Refer to "Scavenging path disassembly" in Section2, Maintenance.            |
| The bellows fills when the Bag/Vent switch is set to Bag or the bag fills when the switch is set to Vent. | Leak through Bag/Vent switch. Causes include dirt or damage to the o-ring. | Refer to "Main manifold, APL Valve, and Bag/Vent switch maintenance" in Section 2, Maintenance. |
| The ventilator does not read the position of the Bag/Vent switch. Use manual ventilation, if necessary.   | Ventilator or absorber malfunction.  | Ventilate manually. Ask a qualified service representative to repair the system.                |
| The ventilator does not correctly identify the breathing circuit module.                                  | Broken identification tabs.  | Remove the module and look at the tabs on the rear. If there is damage, use a different module. |
|   | Dirt on the optical sensors that read the tabs.                            | Use a DAMP alcohol prep to gently clean. Squeeze dry the prep before you use it.                |
|   | Ventilator malfunction.  | Ask a qualified service representative to repair the system.                                    |
| APL valve does not operate correctly.   | APL valve problem  | Replace APL Valve seal and diaphragm - Refer to User Maintenance                                |

Electrical problems (power failure, etc.)

**⚠WARNING** If a circuit breaker opens frequently, do not use the system. Have an approved service representative repair the system

| Symptom   | Problem  | Solution  |
|---|--|---|
| Mains indicator is not ON.  | The electrical power cable is not connected.   | Connect the power cable.                                |
|   | The inlet circuit breaker (toggle switch) is open.   | Close the circuit breaker (Figure 5-1).                 |
|   | The power cable is damaged.  | Replace the power cable.                                |
|   | The electrical socket the power cable connects to has no power.                                      | Use a different electrical socket.                      |
|   | An internal fuse is open.  | Have a service representative repair the system.        |
| The electrical outlets do not have power but the mains indicator is ON. | The main outlet circuit breaker is open.   | Close the circuit breaker.                              |
| One electrical outlet does not have power.                              | The outlet circuit breaker is open.  | Close the circuit breaker.                              |
| A circuit breaker opens frequently.                                     | Equipment connected to the outlet(s) uses more current than the circuit breaker rating (Figure 6-1). | Use a different power supply for some of the equipment. |
|   | The equipment connected to the outlet has a short.   | Do not use the equipment until it is repaired.          |
| Tec 6 has no power.   | Not plugged into outlet.   | Connect power cable.                                    |

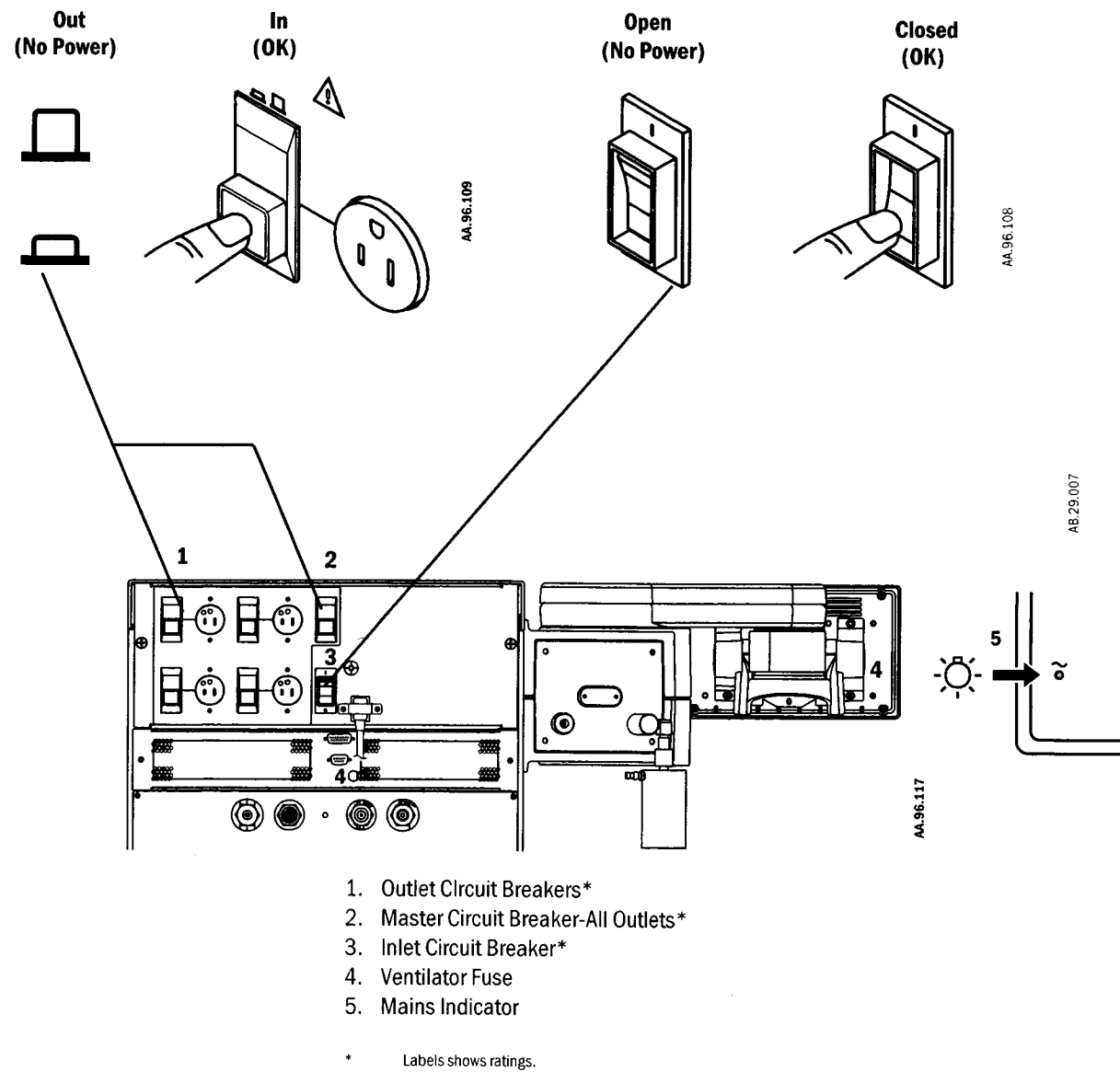


Figure 5-1 • Circuit breakers, fuse, and the mains indicator

Pneumatic problems

| Symptom                                | Problem   | Solution  |
|--|---|---|
| High-pressure leak.                    | Controls are not set correctly.   | Set the system switch to Standby and the auxiliary flowmeter to OFF.  |
|  | Equipment connected to pneumatic outlet.  | Disconnect the equipment.   |
| High-pressure leak.                    | Incorrect cylinder connection (cylinder yokes).   | Make sure that there is only one cylinder gasket, the gasket is in good condition, and the T handle is tight. |
|  | Incorrect cylinder connection (DIN connection.)   | Make sure the nut is tight.   |
| Low-pressure leak with a vaporizer ON. | The vaporizer is not correctly installed.   | Correctly install the vaporizer.  |
|  | The vaporizer fill spout is loose (fill port type vaporizer).   | Tighten the fill spout.   |
|  | Vaporizer port o-rings (external) are damaged or not installed.   | Install new o-rings.  |
|  | A vaporizer malfunction (the leak stops if you use a different vaporizer in the same position).               | Send the vaporizer to a Datex-Ohmeda Service Center.  |
|  | A port valve malfunction (the leak continues if you use a different vaporizer in the same manifold position). | Have an approved service person repair the vaporizer manifold.  |

**CAUTION:** No repair should ever be attempted by anyone not having experience in the repair of devices of this nature.

# Illustrated parts

**In this section**

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    Top level .....6-2

    Main manifold ..... 6-5

    Exhalation valve .....6-7

    Bellows .....6-9

    Test tools and system parts .....6-10

Breathing system parts

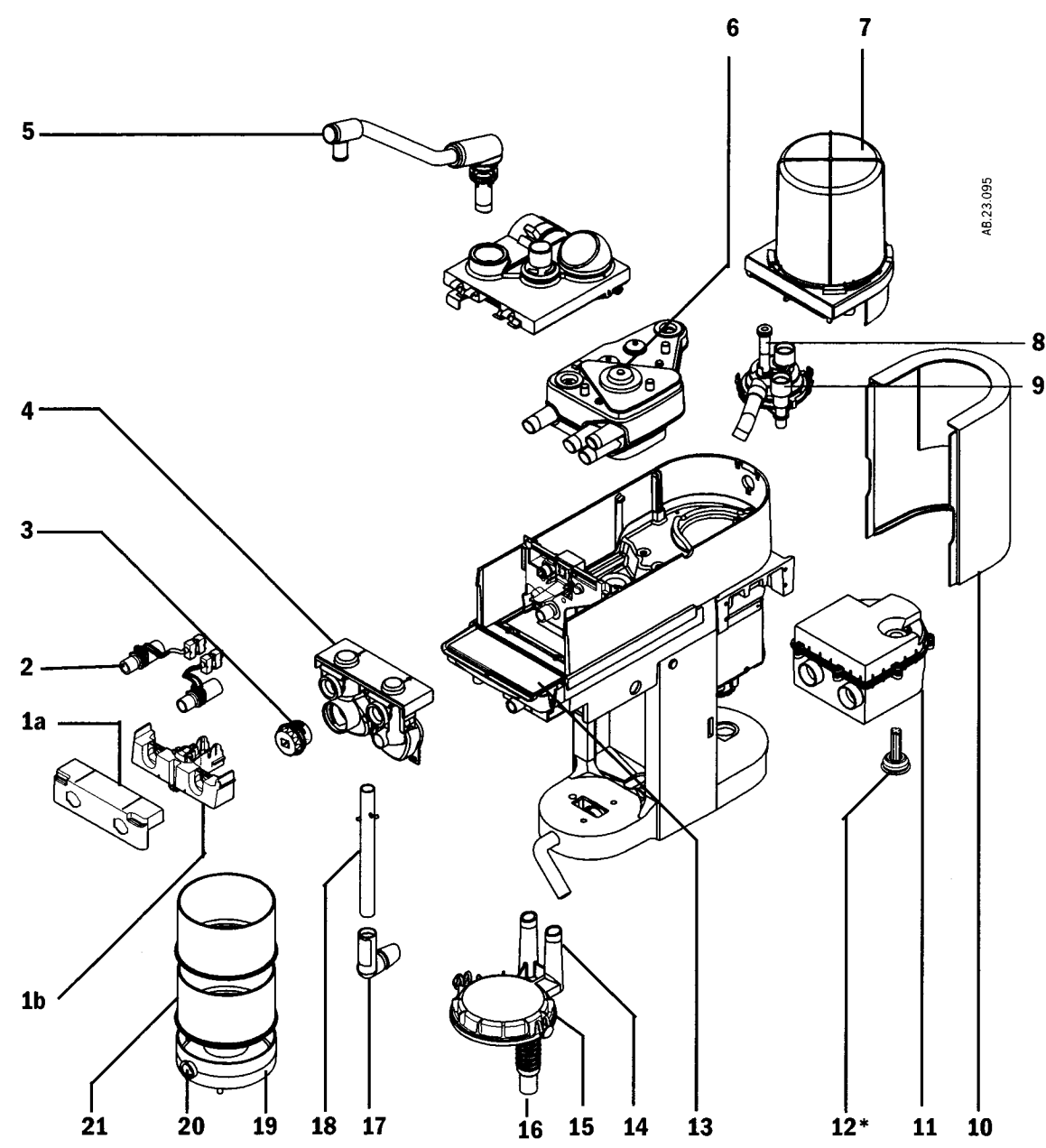
Top level

| Item | Description (Figure 6-1)   | Stock Number  |
|------|--|---------------|
| 1    | Flow sensor module (cover & holder)                                    | 1406-8208-000 |
| a.   | Cover only   | 1406-3401-000 |
| b.   | Holder only  | 1406-3400-000 |
| 2    | Flow sensor (plastic)  | 1503-3220-000 |
|      | Flow sensor (metal - autoclavable)                                     | 1503-3244-000 |
| 3    | O <sub>2</sub> sensor, cell  | 6050-0004-110 |
|      | O-ring   | 1406-3466-000 |
| 4    | Breathing circuit module, circle                                       | 1406-8102-000 |
|      | Breathing circ. module, mapleson/Bain                                  | 1406-8211-000 |
|      | Breathing circuit module, open   | 1406-8212-000 |
| 5    | Bag arm long (adjustable)  | 1406-3350-000 |
|      | Bag arm short (not adjustable)   | 1406-3380-000 |
| 6    | Main manifold assembly   | 1406-8209-000 |
| 7    | Autoclavable Bellows Assembly  | 1406-8105-000 |
| 8    | Blank, pop-off valve   | 1406-3240-000 |
| 9    | Exhalation valve assembly  | 1503-8114-000 |
| 10   | Rear column cover  | 1406-3455-000 |
| 11   | Gas scavenging (4 options)   | -----         |
|      | Active gas scavenging assembly, 6.35 mm (ANSI, Not European Community) | 1406-8216-000 |
|      | Active gas scavenging assembly, 30 mm threaded outlet                  | 1406-8214-000 |
|      | Passive gas scavenging assembly, 30 mm ISO taper                       | 1406-8215-000 |
|      | Passive gas scavenging assembly, 25 mm taper (DEU)                     | 1406-8217-000 |
| 12   | AGSS nylon filter, 225 μ,  | 1406-3521-000 |
| 13   | Door Front, sensor   | 1406-3214-000 |

Illustrated Parts

| Item | Description (Figure 6-1)                                  | Stock Number  |
|------|---|---------------|
| 14   | Upper dish (2 options)                                    | -----         |
|      | Upper dish absorber plastic (seal not included)           | 1406-3413-000 |
|      | CO <sub>2</sub> bypass assembly metal (seal not included) | 1406-3500-000 |
| 15   | Upper seal  | 1406-3414-000 |
| 16   | Tube corrugated 210 mm                                    | 1400-3009-000 |
| 17   | Elbow transfer tube                                       | 1406-3576-000 |
| 18   | Transfer tube   | 1406-3575-000 |
| 19   | Drain dish assembly                                       | 1406-8218-000 |
| 20   | Plug, sight glass-drain                                   | 0229-2080-100 |
|      | O-ring, plug  | 0210-0594-300 |
| 21   | Canister  | 0229-3015-800 |
| ---  | Not Shown   | Stock Number  |
|      | Upper seal, upper dish, corr. tube, drain dish, canisters | 1406-8207-000 |
|      | Barb cap, passive scavenging                              | 1406-3542-000 |

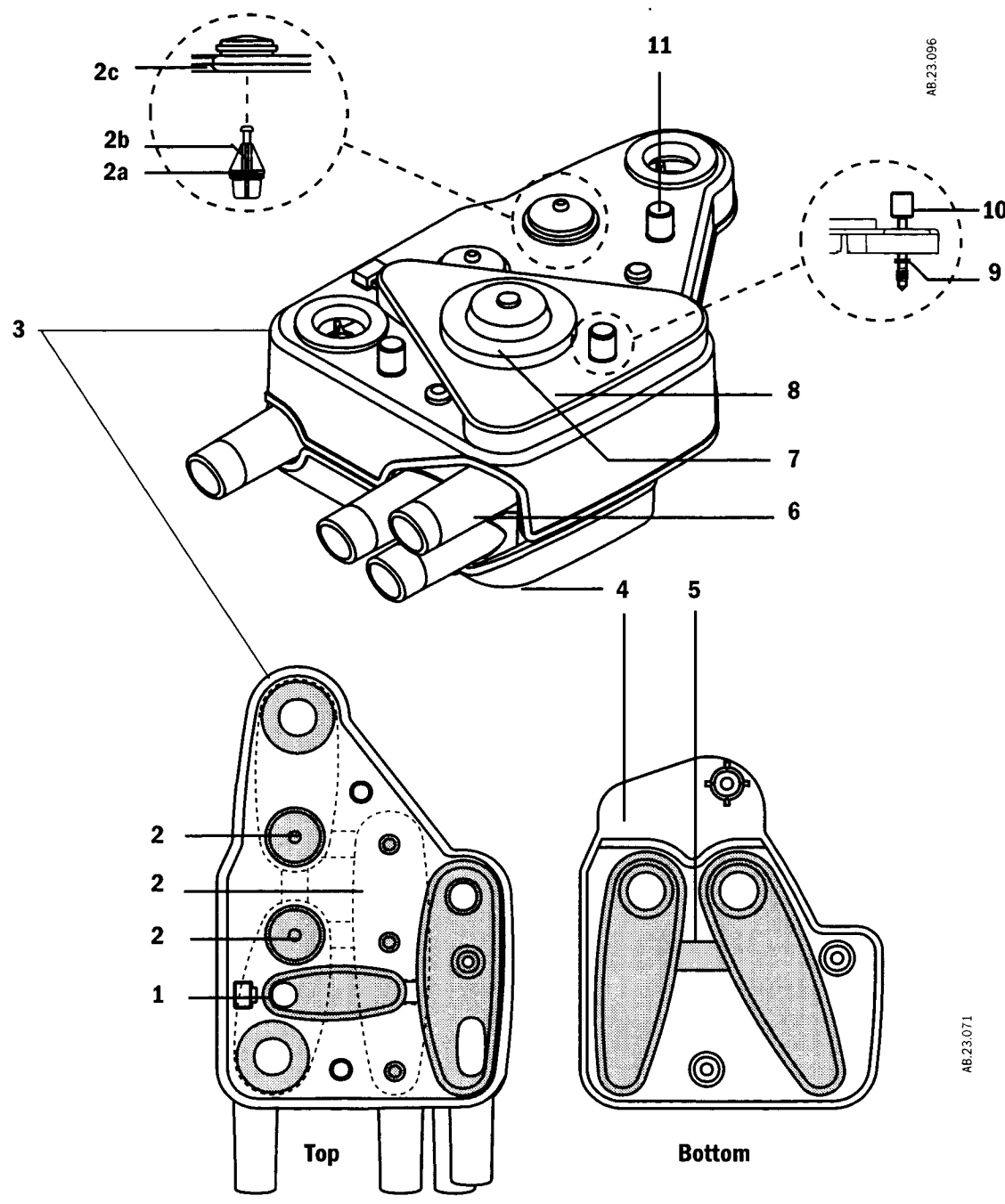




\* Active scavenging systems only

Figure 6-1 • Breathing system top assemblies

Main manifold



Top Bottom

Figure 6-2 • Main manifold

| Item | Description (Figure 6-2)       | Stock Number  |
|------|--------------------------------|---------------|
| 1    | Seal, main manifold, APL/AGSS  | 1406-3316-000 |
| 2    | Seal, bag/vent assy (a, b, c)  |               |
|      | a.O-ring (Qty 2)               | 1406-3278-000 |
|      | b.Poppet (Qty 2)               | 1406-3279-000 |
|      | c. Seal only                   | 1406-3314-000 |
| 3    | Plate, top, main manifold      | 1406-3300-000 |
| 4    | Plate, bottom main manifold    | 1406-3303-000 |
| 5    | Seal, Main Manifold, Absorber  | 1406-3315-000 |
| 6    | Body manifold, main            | 1406-3301-000 |
| 7    | APL diaphragm assembly         | 1406-3331-000 |
| 8    | Manifold APL/AGSS              | 1406-3302-000 |
| 9    | Split ring (Qty 3)             | 1406-3319-000 |
| 10   | M6x43 mm Thumbscrew            | 1406-3304-000 |
| 11   | M6 x28.5 mm Thumbscrew (Qty 2) | 1406-3305-000 |

Exhalation valve

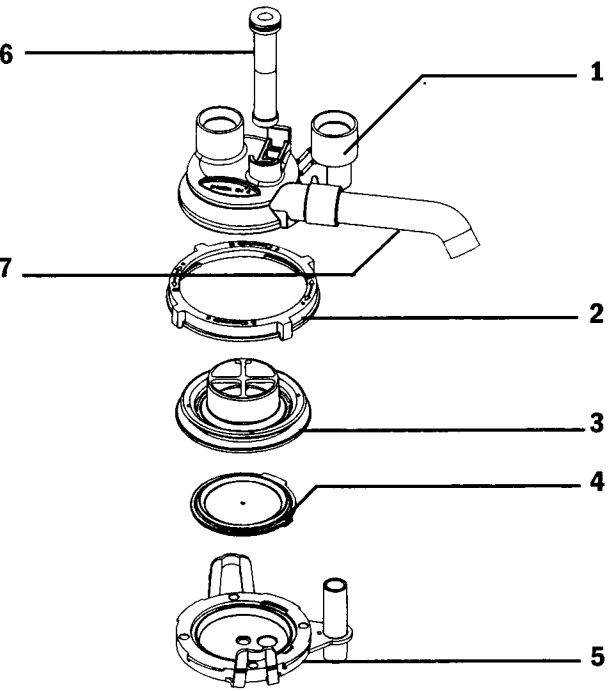


Figure 6-3 • Ventilator expiratory valve

|   | Description            | Stock Number  |
|---|------------------------|---------------|
| 1 | Exhalation valve cover | 1503-3583-000 |
| 2 | Lock ring              | 1503-3588-000 |
| 3 | Seat exhalation valve  | 1503-3584-000 |
| 4 | Diaphragm assy         | 1503-8121-000 |
| 5 | Base, exhalation valve | 1503-3585-000 |
| 6 | Blank, pop-off valve   | 1406-3240-000 |
| 7 | Tube exhalation valve  | 1406-3566-000 |

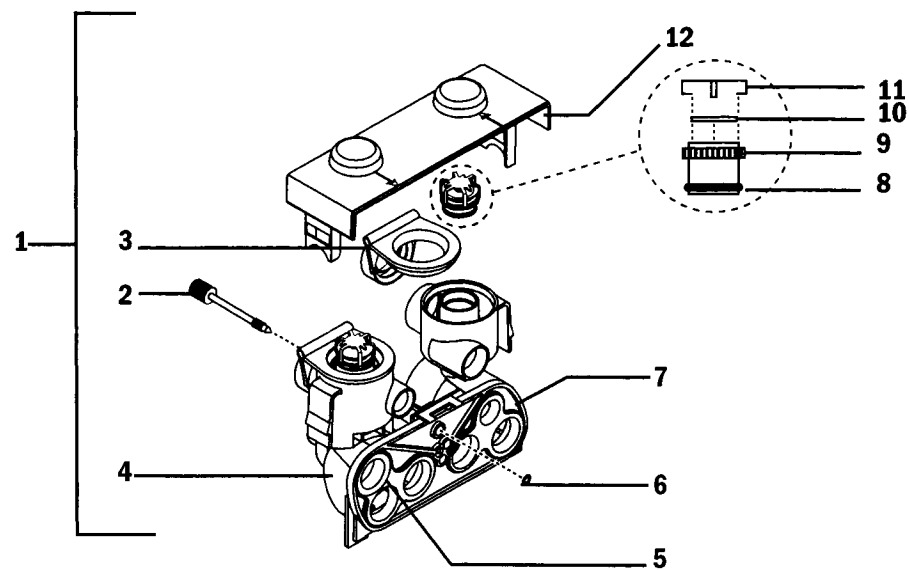


Figure 6-4 • Breathing circuit modules

| Description |                        | Circle        | Bain-<br>Mapleson D | Open          |
|-------------|------------------------|---------------|---------------------|---------------|
| 1           | Assy (items 2-12)      | 1406-8102-000 | 1406-8211-000       | 1406-8212-000 |
| 2           | M6-1x23 Thumb Screw    | 1406-3304-000 | 1406-3304-000       | 1406-3304-000 |
| 3           | Seal lens, flow sensor | 1406-3395-000 | 1406-3395-000       | 1406-3395-000 |
| 4           | Module Body            | -----         | 1406-3467-000       | 1406-3480-000 |
| 5           | Seal module cover      | 1406-3317-000 | 1406-3463-000       | 1406-3318-000 |
| 6           | Split Ring             | 1406-3319-00  | 1406-3319-000       | 1406-3319-000 |
| 7           | Back plate             | 1406-3391-000 | 1406-3391-000       | 1406-3391-000 |
| 8           | O-Ring Check Valve     | 1406-3397-000 | Not Used            | 1406-3397-000 |
| 9           | Valve Seat Check Valve | 1406-3396-000 | Not Used            | 1406-3396-000 |
| 10          | Disc Check Valve       | 0210-5297-100 | Not Used            | 0210-5297-100 |
| 11          | Retainer Check Valve   | 1400-3017-000 | Not Used            | 1400-3017-000 |
| 12          | Lens                   | 1406-3394-000 | 1406-3461-000       | 1406-3394-000 |

AB.23.102

Bellows

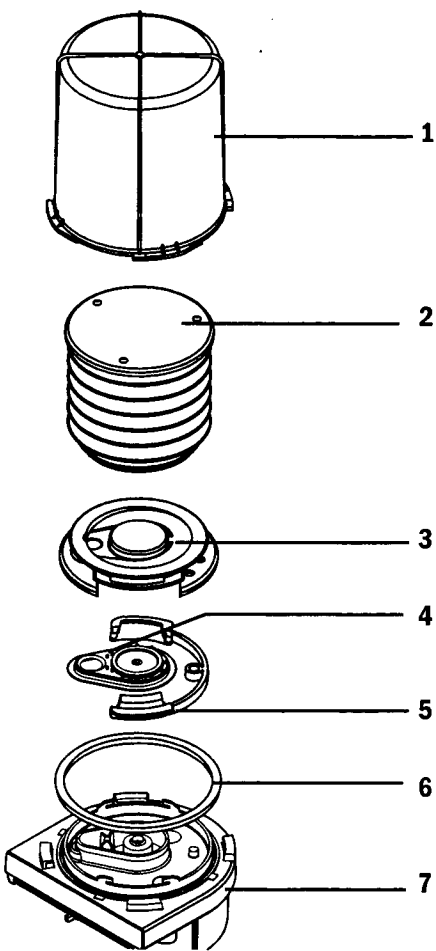


Figure 6-5 • Bellows parts

| Item | Description                | Stock Number  |
|------|----------------------------|---------------|
| 1    | Bellows housing            | 1500-3117-000 |
| 2    | Bellows                    | 1500-3378-000 |
| 3    | Rim                        | 1500-3351-000 |
| 4    | Pressure relief valve assy | 1500-3377-000 |
| 5    | Latch, base                | 1406-3318-000 |
| 6    | Seal, base                 | 1500-3359-000 |
| 7    | Base, bellows              | 1406-3313-000 |

AB.23.055

Test tools and system parts

| Description  | Stock Number  |
|--|---------------|
| Vaporizer port o-rings, external (Qty 6)             | 1102-3016-000 |
| Cylinder gasket                                      | 0210-5022-300 |
| Handle for yoke tee                                  | 0219-3372-600 |
| Yoke plug  | 0206-3040-542 |
| Din O <sub>2</sub> plug (cylinder connection)        | 1202-7146-000 |
| Positive-low -pressure leak test device (BSI)        | 1001-8975-000 |
| Positive-low -pressure leak test device (ISO)        | 1001-8976-000 |
| Negative- low-pressure leak test device              | 0309-1318-800 |
| Test lung  | 0219-7210-300 |
| Krytox   | 1001-3854-000 |
| Touch-up paint, flint (medium) gray, 18 ml           | 1006-3851-000 |
| Touch-up paint, quartz (light) gray, 18 ml           | 1006-3852-000 |
| Touch-up paint, light aqua, 18 ml                    | 1006-3853-000 |
| Touch-up paint,Artic-white, 18 ml                    | 1006-3363-000 |
| Touch-up paint, Neutral Gray N7 (Medium Dark), 18 ml | 1006-4198-000 |
| Touch-up paint, Neutral Gray N8 (Medium), 18 ml      | 1006-4199-000 |
| Touch-up paint, Neutral Gray N8 (Light), 18 ml       | 1006-4200-000 |
| Bulb, 2.4 watts, gooseneck lamp                      | 1006-3673-000 |
| Gooseneck lamp assembly                              | 1006-3026-000 |
| Communication port cable                             | 1105-0512-000 |

External Communications

|                 |   |
|-----------------|---|
| In this section | This section describes how to communicate between the ventilator and a data collection system or an external monitor. It also tells you what data can be sent and received. |
|                 | External communications . . . . . 7-2   |
|                 | Protocol Description (Datex-Ohmeda Com 1). . . . . 7-3  |

External communications

The ventilator has electrical interfaces (RS-232C) on each of two connectors. The 9-pin connector labeled port 1 is a proprietary channel and should only be used by qualified service personnel. The 15-pin connector labeled port 2 is a public channel. Always connect the cable from the monitor to the 15-pin connector (port 2).

| Service Mode Confirmation     |                  |
|-------------------------------|------------------|
| Altitude                      | 300m             |
| Language                      | English          |
| Serial Connection             | Datex-Ohmeda RGM |
| Service Mode Normal Operation |                  |

AB-48.082

| Protocol Selection | Application   | Model /Version   |
|--------------------|---|--|
| Datex-Ohmeda RGM   | Ohmeda RGM Resp. Gas. Monitor.                                | Version 3.0-5.1 (w/o gas comp data)<br>Version 6.0 and later (includes gas composition data) |
| 7800 Emulation     | Monitors programmed to communicate with 7800                  | HP ACMS with compatible software. Use Datex-Ohmeda Cable 1503-3077-000                       |
| Datex-Ohmeda COM 1 | HP ACMS Vue Link; monitors programmed for 7900 communication) | VueLink model M1032A with compatible driver and cable  |
| Datex-Ohmeda COM 2 | HP ACMS   | HP ACMS with compatible software. Use Datex-Ohmeda Cable 1503-3077-000                       |

Protocol Description (Datex-Ohmeda Com 1)

- Electrical Interface**
- RS-232C signal standards
  - 15 pin female D connector (Port 2) - Data Communications Equipment configuration (DCE)
    - pin 6 - receive data
    - pin 13 - transmit data
    - pin 5 - signal ground

- Serial Communication Parameters**
- Baud: 19.2K

Byte format: Start bit + 7 data bits + parity bit + stop bit

Parity: ODD

**Software Interface**

Ohmeda Com 2.0 Waveform Communication Protocol

**Command Headers:**

|           |                               |
|-----------|-------------------------------|
| <ESC>VTD  | DISABLE CHECKSUM              |
| <ESC>VTE  | ENABLE CHECKSUM               |
| <ESC>VTQ  | ENABLE COMPRESSED MODE        |
| <ESC>VTS  | SLAVE MODE (RESETS AUTO MODE) |
| <ESC>VTX  | AUTO MODE                     |
| <ESC>VT\$ | SEND SETUP DATA               |
| <ESC>VT?  | SEND ALL DATA                 |
| <ESC>VTW  | ENABLE WAVEFORM DATA          |

**Response Headers:**

|      |                                       |
|------|---------------------------------------|
| :VTD | MEASURED DATA RESPONSE                |
| :VTM | SETUP DATA RESPONSE                   |
| :VTN | NACK (negative acknowledge)           |
| :VTQ | STATUS DATA RESPONSE                  |
| :VTW | WAVEFORM DATA RESPONSE                |
| :VTR | ALARM SILENCE SWITCH PRESSED RESPONSE |
| :VTY | ACK (positive acknowledge)            |

DEVICE COMMANDS Sent  
By External  
Device

Data Transmit Mode Select Commands

<ESC>VTXc<CR>Auto Mode

<ESC>VTSc<CR>Slave Mode

Data Format Mode Select Commands

<ESC>VTQc<CR>Compressed Format

Data Request Command

<ESC>VT?c<CR>Send All Data (Valid in Slave Mode only)

<ESC>VT\$c<CR>Send Setup Data

Enable Waveform Data Mode

<ESC>VTWabc<CR>Send Waveform Data

<ESC>VTW<CR>=header

a & b = any one of the following:

(note 1: order determines order of data in response packet)

(note 2: b valid only if a!= 0)

|      |                        |
|------|------------------------|
| 0    | turn waveform data OFF |
| P    | include Pressure Data  |
| F    | include Flow Data      |
| V    | include Volume         |
| c    | checksum               |
| <CR> | terminator             |

Checksum Control Commands

|               |   |
|---------------|---|
| <ESC>VTEc<CR> | Enable Checksum Mode  |
| <ESC>VTDc<CR> | Disable Checksum Mode (checksum byte ignored in this command, but cannot be <CR>) |

DEVICE  
RESPONSES Sent Back By  
Ventilator

ACK Response

:VTYc<CR>Positive Acknowledge Response

NAK Response

:VTNc<CR>Negative Acknowledge Response

Alarm Silence Switch Pressed Response

:VTRc<CR>Alarm Silence Switch Press Response (if no alarms are on or all displayed alarms are silenced)

Compressed-Data Measured Data Response

In auto mode, the Measured Data Response will be transmitted at the end of a breath or 10 seconds from the last transmission, whichever occurs first.

:VTDaaaabbbbddddeeefffggghhhiijc<CR>

Compressed Data Measured Data Response  
(each entry is zero filled and right justified--i.e. aaaa = 0095)  
“?” means bad data due to any technical problem(s);  
“-” means data not available due to system state

|      |                                   |  |
|------|-----------------------------------|--|
| aaaa | measured tidal volume             | mL, ?, -   |
| bbbb | measured minute volume            | L*100,?, - ; example: 1000 equals 10.00 L                  |
| ddd  | measured respiratory rate         | /min,?, -  |
| eee  | measured oxygen level             | % O <sub>2</sub> ,?, -                                     |
| fff  | measured max positive pressure    | cm H <sub>2</sub> O,?                                      |
| ggg  | measured inspiratory plateau pres | cm H <sub>2</sub> O,?                                      |
| hhh  | measured mean pressure            | cm H <sub>2</sub> O,?                                      |
| iii  | minimum pressure                  | cm H <sub>2</sub> O,?                                      |
| j    | measured data status              | 0100000x (bit 0=1=new breath data; bit 0=0=10 second data) |
| c    | checksum                          |  |

Compressed-Data  
Status Data Response

The Status Data Response will be transmitted every 1 second (if a change occurs in the status data) or a minimum of once every 10 seconds. Note that the status byte bit is set=1 for an active condition and 0 for an inactive condition.

:VTQaaaabbbddddeeffggghiiijjkkllmmnnnoooqrrrrrrrrc<CR>

Compressed Data Status Data Response

|            |   |                           |
|------------|---|---------------------------|
| aaaa       | set tidal volume  | mL                        |
| bbb        | set tidal volume  | /min                      |
| dddd       | set I:E ratio   | 1:eee.e                   |
| ee         | inspiratory pause   | % Pause                   |
| ff         | set PEEP  | cm H <sub>2</sub> O       |
| ggg        | set peak pressure limit   | cm H <sub>2</sub> O       |
| hh         | set inspired pressure   | cm H <sub>2</sub> O       |
| ii         | set sustained pressure alarm limit  | cm H <sub>2</sub> O       |
| jjj        | high minute volume alarm limit  | L*10 (e.g. 650 = 65.0 L)  |
| kkk        | low minute volume alarm limit   | L*10 (e.g. 050 = 5.0 L)   |
| lll        | high Vte limit  | mL/10 (e.g. 150 =1500 ml) |
| mmm        | low Vte limit   | mL/10 (e.g. 090 =900 ml)  |
| nnn        | high oxygen alarm limit   | % O <sub>2</sub>          |
| ooo        | low oxygen alarm limit  | % O <sub>2</sub>          |
| q          | ventilation mode: "v"=volume mode,'p'=pressure mode,'b'=Vt compensation off,'-'=bag mode only |                           |
| rrrrrrrrrr | status bytes (see bitmaps below)  |                           |
| c          | checksum  |                           |

Status Bytes Bitmaps

The status bytes are a string of 12 bytes, starting from the left (Byte 1) to the right (Byte 12). Each Byte has eight bits of data from D7 (MSB) to D0 (LSB).

bit byte 1

|                                       |
|---------------------------------------|
| Vent. Message                         |
| D0 - High O <sub>2</sub>              |
| D1 - Low O <sub>2</sub>               |
| D2 - 1                                |
| D3 - 1                                |
| D4 - 1                                |
| D5 - Check O <sub>2</sub> Sensor      |
| D6 - O <sub>2</sub> Calibration Error |

bit byte 2

|                               |
|-------------------------------|
| Vent. Message                 |
| D0 - High Paw                 |
| D1 - Low Paw                  |
| D2 - Sustained Paw (shutdown) |
| D3 - Sustained Paw            |
| D4 - Sub-Atmos Paw            |
| D5 - 1                        |
| D6 - 1                        |

bit byte 3

|  |
|--|
| Vent. Message                              |
| D0 - Pinspired Not Achieved                |
| D1 - PEEP Not Achieved                     |
| D2 - No Pressure Mode/PEEP                 |
| D3 - Manifold Pressure Sensor Failure      |
| D4 - Inspiratory Overshoot                 |
| D5 - Inspiration Stopped                   |
| D6 - High Pressure Limit Reached (min sys) |

bit byte 4

|                           |
|---------------------------|
| Vent. Message             |
| D0 - Low VE               |
| D1 - High VE              |
| D2 - Low Vte              |
| D3 - High Vte             |
| D4 - Vt Not Achieved      |
| D5 - Volume Apnea         |
| D6 - Volume Apnea > 2 min |

bit byte 5

|                           |
|---------------------------|
| Vent. Message             |
| D0 - No Insp Flow Sensor  |
| D1 - No Exp Flow Sensor   |
| D2 - Insp Reverse Flow    |
| D3 - Exp Reverse Flow     |
| D4 - Check Flow Sensors   |
| D5 - Insp Vt/Vte Mismatch |
| D6 - Vdel Mismatch        |

bit byte 6

|                                 |
|---------------------------------|
| Vent. Message                   |
| D0 - Bellows Empty              |
| D1 - Flow Valve Failure         |
| D2 - Gas Inlet Valve Failure    |
| D3 - 12 Hour Test               |
| D4 - "Bootup GIV Failure"       |
| D5 - No O <sub>2</sub> Pressure |
| D6 - No Fresh Gas Flow          |

bit    byte 7

| Vent. Message                     |
|-----------------------------------|
| D0 - +Vanalag Failure             |
| D1 - -Vanalag Failure             |
| D2 - +15V SIB Out-of-Range        |
| D3 - +15V Manifold Out-of-Range   |
| D4 - Display Voltage Out-of-Range |
| D5 - Vaux_ref Out-of-Range        |
| D6 - Vext_ref Out-of-Range        |

bit    byte 9

| Vent. Message                        |
|--------------------------------------|
| D0 - Software Watchdog Failure       |
| D1 - Hardware Watchdog Failure       |
| D2 - Internal Vent. Clock Too Fast   |
| D3 - Internal Vent. Clock Too Slow   |
| D4 - CPU Internal Error              |
| D5 - Memory (redundant storage) Fail |
| D6 - Flow Sensor Cal Data Corrupt    |

bit    byte 11

| Vent. Message                             |
|---|
| D0 - Circuit Auxiliary                    |
| D1 - Auxiliary Breathing Circuit          |
| D2 - "no confirmation of changed setting" |
| D3 - Control Settings Input Has Failed    |
| D4 - Heliox Mode is ON                    |
| D5 - Volume Compensation Off              |
| D6 - Mechanical Ventilation On            |

bit    byte 8

| Vent. Message                |
|------------------------------|
| D0 - A/D Converter Failure   |
| D1 - CPU Failure             |
| D2 - Memory (EEPROM) Failure |
| D3 - Memory (flash) Failure  |
| D4 - Memory (RAM) Failure    |
| D5 - Memory (video) Failure  |
| D6 - Bootup Memory Failure   |

bit    byte 10

| Vent. Message                      |
|------------------------------------|
| D0 - On Battery                    |
| D1 - No Battery                    |
| D2 - Low Battery Charge            |
| D3 - Low Battery                   |
| D4 - Low Battery (shutdown)        |
| D5 - Fail Batt. Volt. Out Of Range |
| D6 - Batt. Curr. Out Of Range      |

bit    byte 12

| Vent. Message             |
|---------------------------|
| D0 - Volume Mode Active   |
| D1 - Apnea Detect ON      |
| D2 - Apnea Alarm Silenced |
| D3 - Very Low VE Limit    |
| D4 - Alarms Silenced      |
| D5 - 1                    |
| D6 - Sensor(s) Cal Due    |

Setup Data Response :VTMaaaabddeffghc<CR>Setup Data Response

|      |                          |  |
|------|--------------------------|--|
| aaaa | software revision number | 0001-9999 = 0.01-99.99                         |
| b    | language (see note)      | 0-8  |
| dd   | display contrast setting | 1-10   |
| e    | alarm volume setting     | 1-5  |
| ff   | altitude setting         | -4 to 36, in 100's of meters                   |
| g    | drive gas                | 0 = oxygen, A = air                            |
| h    | ventilator model number  | 0 = 7800, 1 = 7810, 5 = 7850, 6 = 7900/Aestiva |
| c    | checksum                 |  |

note: language: 0=English; 1=Spanish; 2=German; 3=Kanji; 4=Dutch; 5=Swedish; 6=French; 7=Italian, 8=Danish

Waveform Data Response

If Waveform Data Mode is enabled, a Waveform Data Response will be transmitted every 240 ms. Up to 2 blocks of fifteen (15) data samples taken every 16 ms. will be sent with each message. Each data value is a 3-digit, zero filled, right justified ASCII Hex representation of a 12 bit binary value

:VTW[aaabbb...nnnooo][aaabbb...nnnooo]c<CR>  
Waveform Data Response for each [max. of 2] waveform signal selected

|     |   |
|-----|---|
| aaa | 1st 16 ms waveform sample (0 -> "000", 512 -> "200", 4095 -> "FFF") |
| bbb | 2nd 16 ms waveform sample   |
| ... |   |
| nnn | 14th 16 ms waveform sample  |
| ooo | 15th 16 ms waveform sample  |

Waveform Data shall be scaled as follows:

Pressure  
range: -20 - 120 cm H<sub>2</sub>O  
scale:

| raw | scaled | xmit. |
|-----|--------|-------|
| -20 | 0      | "000" |
| 0   | 512    | "200" |
| 120 | 3584   | "E00" |



**Flow**  
range: -100 - +100 L/M  
scale:

| raw  | scaled | xmit. |
|------|--------|-------|
| -100 | 512    | "200" |
| 0    | 2048   | "800" |
| +100 | 3584   | "E00" |

**Volume**  
range: 0 - 2 L  
scale:

| raw | scaled | xmit. |
|-----|--------|-------|
| 0   | 512    | "200" |
| 2   | 3584   | "E00" |

The Waveform Data will be sampled as follows:

**Pressure**

Samples will be every taken from the airway pressure sensor every 16 ms.

**Flow**

For each breathing system the samples will be every 16 ms. The flow may be sampled from the inspiratory flow sensor and/or the expiratory flow sensor, depending on the circuit type and the phase of the breath. The inspiratory flow sample will always be positive and the expiratory flow sample will always be negative.

**Circle Breathing System**

If inspiratory flow > threshold (start of inspiration)

If inspiratory flow is increasing

Use inspiratory flow 16 ms sample

Else if inspiratory flow is decreasing and expiratory flow > threshold

Use expiratory flow 16 ms sample

Else

Use inspiratory flow 16 ms sample

Else If expiratory flow > threshold (start of expiration)

Use expiratory flow 16 ms sample

Else

Use the 16 ms flow sample from the previously used flow sensor

**Volume** Circle Breathing System

Samples will be every 16 ms and will be based on integration of flow values. Inspiratory flow will increase volume, expiratory flow will reduce the volume. The volume will be reset to 0 at the start of a inspiration.

# Specifications and Theory of operation

In this section

Ventilation Theory . . . . .

Pneumatic circuits . . . . .

Suction regulators . . . . .

O<sub>2</sub> Flow meter . . . . .

Breathing system specifications . . . . .

Pneumatic specifications . . . . .

Flow specifications . . . . .

Electrical Power . . . . .

Electromagnetic compatibility . . . . .

Physical Specifications . . . . .

Environmental requirements . . . . .

Ventilation Operating Specifications . . . . .

Aestiva Ventilator Accuracy Data . . . . .

8-2

8-7

8-10

8-10

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8-15

8-16

8-17

8-18

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Ventilator Theory

**General** The ventilator pneumatics are at the rear of the breathing system.

A precision valve controls gas flow to the patient.

During inspiration, this gas flow closes the exhalation valve and pushes the bellows down.

During expiration, a small flow pressurizes the exhalation diaphragm to supply PEEP pressure.

Volume and pressure measurements come from flow sensors in the flow sensor module. Two tubes from each sensor connect to a transducer that measures the pressure change across the sensor, which changes with the flow. A third transducer measures airway pressures at the inspiratory flow sensor.

With circle and open circuit modules, volume monitoring uses the right (expiratory) flow sensor. The ventilator uses the other sensor to adjust its output for changes in fresh gas flow, small leaks, and gas compression upstream of the breathing circuit. There is no adjustment for compression in the patient circuit. If necessary, add the compression loss to the tidal volume setting (volume control mode). The average volume changes from compression in the breathing circuit is small (0.5 to 1.25 mL/cm H<sub>2</sub>O).

For better precision:

- When the fresh gas mixture includes Heliox, use the Heliox mode (Ventilation setup menu). Heliox, used on some ANSI Models of the Aestiva, changes the data collected by the flow sensors. When Heliox mode is selected, the ventilator adjusts the flow sensor data to correct for these changes.
- A small quantity of gas bleeds through a resistor to help keep the pressure on the exhalation valve constant. At high airway pressures, this can cause a slight hiss during inspiration.

**⚠WARNING** Do not try to silence the pneumatic resistor. If it is blocked, the ventilator can malfunction and cause patient injury.

Always connect the expiratory flow sensor. If it is not connected, the patient disconnect alarm can not operate correctly.

**Modes** The system has two modes of mechanical ventilation:

- Volume control mode
- Pressure control mode

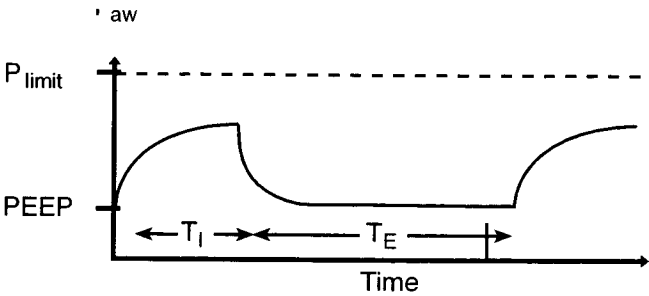
Use the main menu to set the mode.

| Main Menu                |                  |
|--------------------------|------------------|
| Ventilation Mode         | Volume Control   |
| Alarm Settings           | Pressure Control |
| Setup/Calibration        |                  |
| Screen and Audio         |                  |
| Exit to Waveform Display |                  |

AB 48.083

Figure 8-1 • Ventilation Setup Menu

Volume control mode



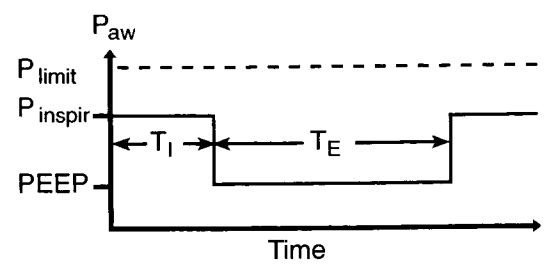
AB 29.068

Figure 8-2 • Volume control diagram

Typically a volume control mode waveform shows increasing pressure during inspiration. Volume control supplies the set tidal volume during inspiration. The ventilator calculates a set flow and the length of the inspiratory period from the I:E and frequency settings. An optional inspiratory pause can be set to improve gas distribution in the lungs.

- Volume control mode settings**
- V<sub>T</sub>(tidal volume),
  - Rate,
  - I:E,
  - P<sub>limit</sub>
  - PEEP

Pressure control mode



AB 29 069

Figure 8-3 • Pressure control diagram

- Pressure control supplies a constant set pressure during inspiration. The ventilator calculates the inspiratory time from the frequency and I:E ratio settings. A high initial flow pressurizes the circuit to the set inspiratory pressure. The flow then decreases to maintain the set pressure (P<sub>inspired</sub>).
- Pressure sensors in the ventilator measure patient airway pressure in the inspiratory limb and manifold pressure in the ventilator. These pressures permit the ventilator to adjust the flow to get set inspiratory pressure.

Pressure control mode settings

P<sub>insp</sub> (control pressure), Rate, I:E, P<sub>limit</sub> (pressure limit), and PEEP.

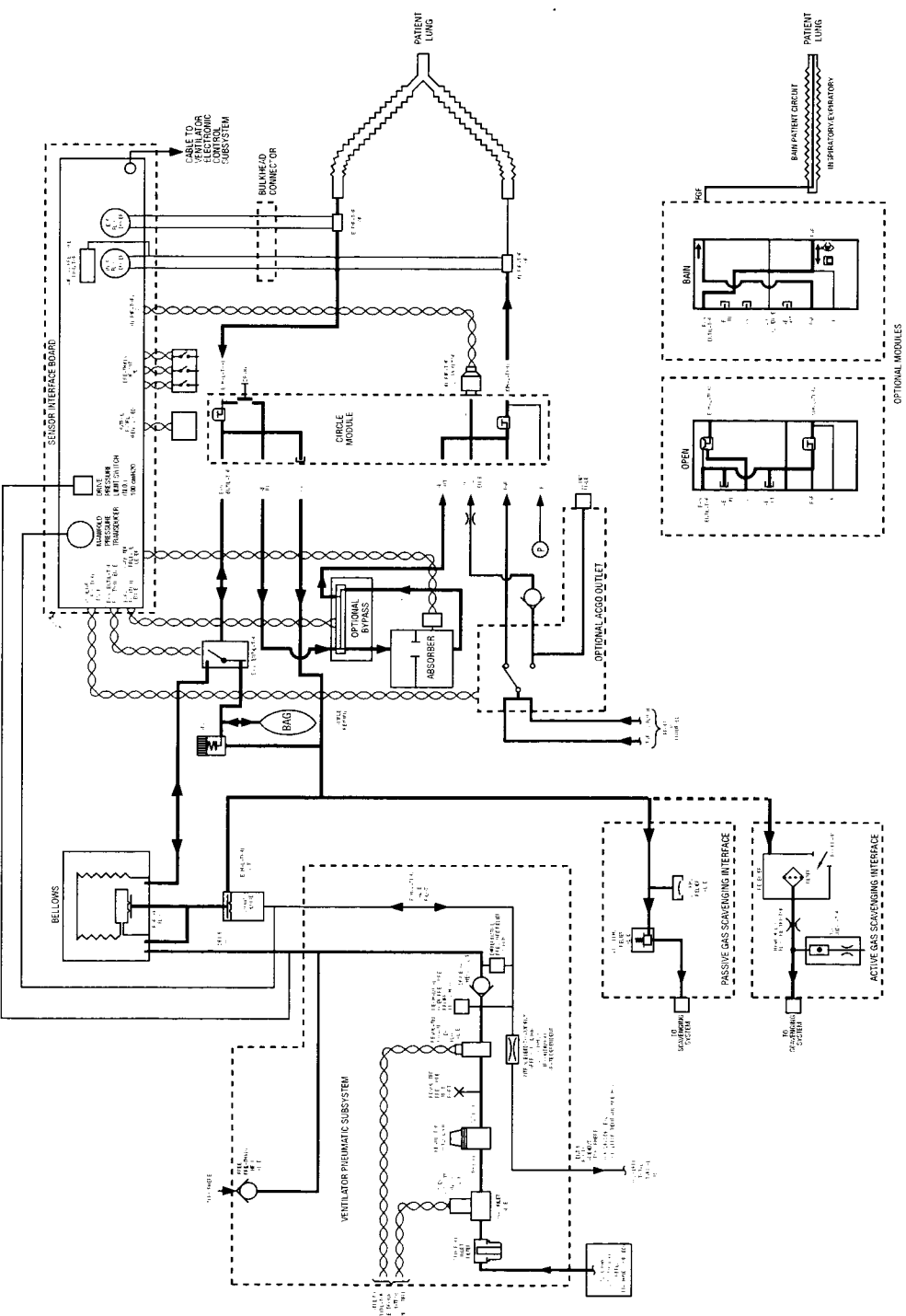
VT Comp Off

During some malfunctions, the ventilator automatically changes modes. Volume Compensation OFF supplies the set tidal volume. It cannot adjust the output to supply the set breath.

Minimum Monitoring

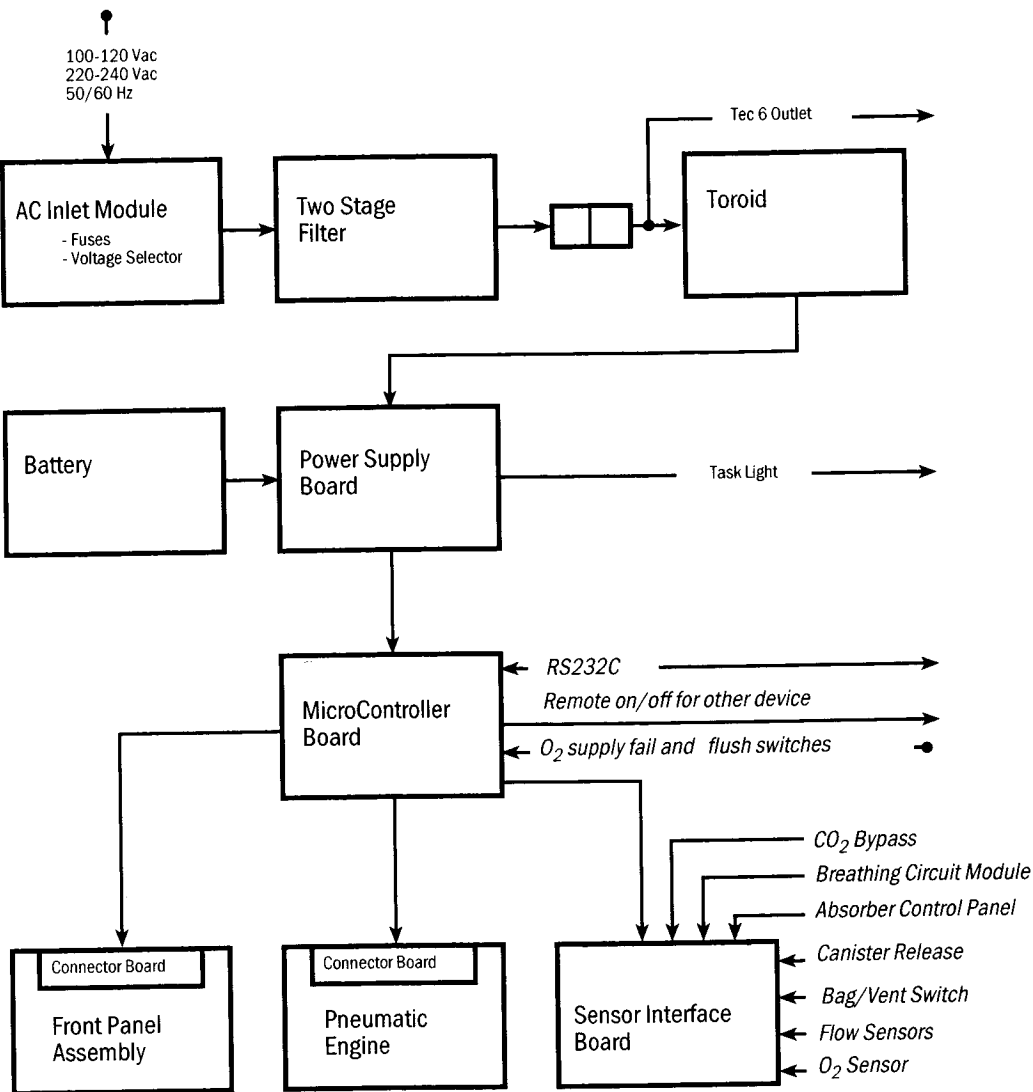
- Shows data
- No mechanical ventilation.
- “Monitoring Only” alarm message
- “Minimum System Failure” and specific failure message
- The software goes to minimum monitoring when a non-recoverable error occurs in boot-up or normal operations.

Breathing system schematic



Ab23106

Internal signal schematic



Pneumatic circuits

Gas supplies (items 1-6)

Gas goes into the system through a pipeline or cylinder connection. All connections have indexed fittings, filters, and check (one way) valves. Gauges show the cylinder and pipeline pressures.

A regulator decreases the cylinder pressures to the appropriate system pressure. A pressure relief valve helps protect the system from high pressures.

To help prevent problems with the gas supplies, install yoke plugs on all empty cylinder connections.

⚠ WARNING

Do not leave gas cylinder valves open if the pipeline supply is in use. Cylinder supplies could be depleted, leaving an insufficient reserve supply in case of pipeline failure.

O<sub>2</sub> flow (items 7-14, 27)

Pipeline or regulated cylinder pressure supplies O<sub>2</sub> directly to the pneumatic outlet and the ventilator (O<sub>2</sub> ventilators). A second regulator decreases the pressure for the flush valve and the auxiliary flowmeter.

The flush valve supplies high flows of O<sub>2</sub> to the fresh gas outlet when you push the flush button. The flush switch uses pressure changes to monitor the position of the flush valve. A message on the ventilator tells you when Flush is ON.

When the system switch is ON, O<sub>2</sub> flows to the rest of the system and there is a minimum flow of 25 to 75 mL/min through the O<sub>2</sub> flowmeter.

A secondary regulator supplies a constant O<sub>2</sub> pressure to the flow meter.

An electrical switch monitors the O<sub>2</sub> supply pressure. If the pressure is too low, an alarm appears on the ventilator.

Air, N<sub>2</sub>O, and third gas flow (items 7, 8, and 15-23)

Balance regulators control the flow of N<sub>2</sub>O and the optional gas (CO<sub>2</sub>, Heliox) to the flow control valves. Oxygen pressure at a control port adjusts the output of the regulator. This stops flow during an O<sub>2</sub> supply failure and makes sure that the hypoxic gas pressures increase and decrease with the O<sub>2</sub> supply pressure.

A chain linkage on the N<sub>2</sub>O and O<sub>2</sub> flow controls helps keep the O<sub>2</sub> concentration higher than 20% (approximate value) at the fresh gas outlet.

Pipeline or regulated cylinder pressure directly supply Air to the ventilator (Air Ventilators). When the system switch is ON, air flows to the rest of the system. A secondary regulator supplies the air flow control valve. Because there is no balance regulator, air flow continues at the set rate during an O<sub>2</sub> supply failure.

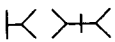
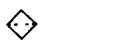


Mixed gas (Item 26)

The mixed gas goes from the flowmeter outlet through the vaporizer that is ON, to the fresh gas outlet, and into the breathing system. A pressure relief valve sets the maximum outlet pressure.

Key to Numbered Components

- 1. Pipeline pressure gauge
- 2. Pipeline connection
- 3. Cylinder pressure gauge
- 4. Cylinder connection
- 5. Cylinder pressure regulator
- 6. Pressure relief (opens at approx. 918 kPa)
- 7. Supply connections for the ventilator
- 8. System switch
- 9. Alarm for low O<sub>2</sub> supply pressure
- 10. Secondary O<sub>2</sub> regulator
- 11. O<sub>2</sub> flow control valve
- 12. O<sub>2</sub> flow tube
- 13. Flush regulator
- 14. O<sub>2</sub> Flush
  - a. Flush valve
  - b. Switch (used with the ventilator)
- 15. N<sub>2</sub>O balance regulator
- 16. N<sub>2</sub>O flow control valve
- 17. N<sub>2</sub>O flow tube
- 18. Air secondary regulator
- 19. Air flow control valve
- 20. Air flow tube
- 21. Optional gas balance regulator
- 22. Optional gas flow control valve
- 23. Optional gas flow tube
- 24. Vaporizer port valve
- 25. Vaporizer
- 26. Pressure relief (opens at approx. 38 kPa)
- 27. Aux. flowmeter (optional)

Key to Symbols

-  Pneumatic Connection
-  Filter
-  Direction of Flow
-  Check Valve (approx. 10 L/min reverse flow -STP)

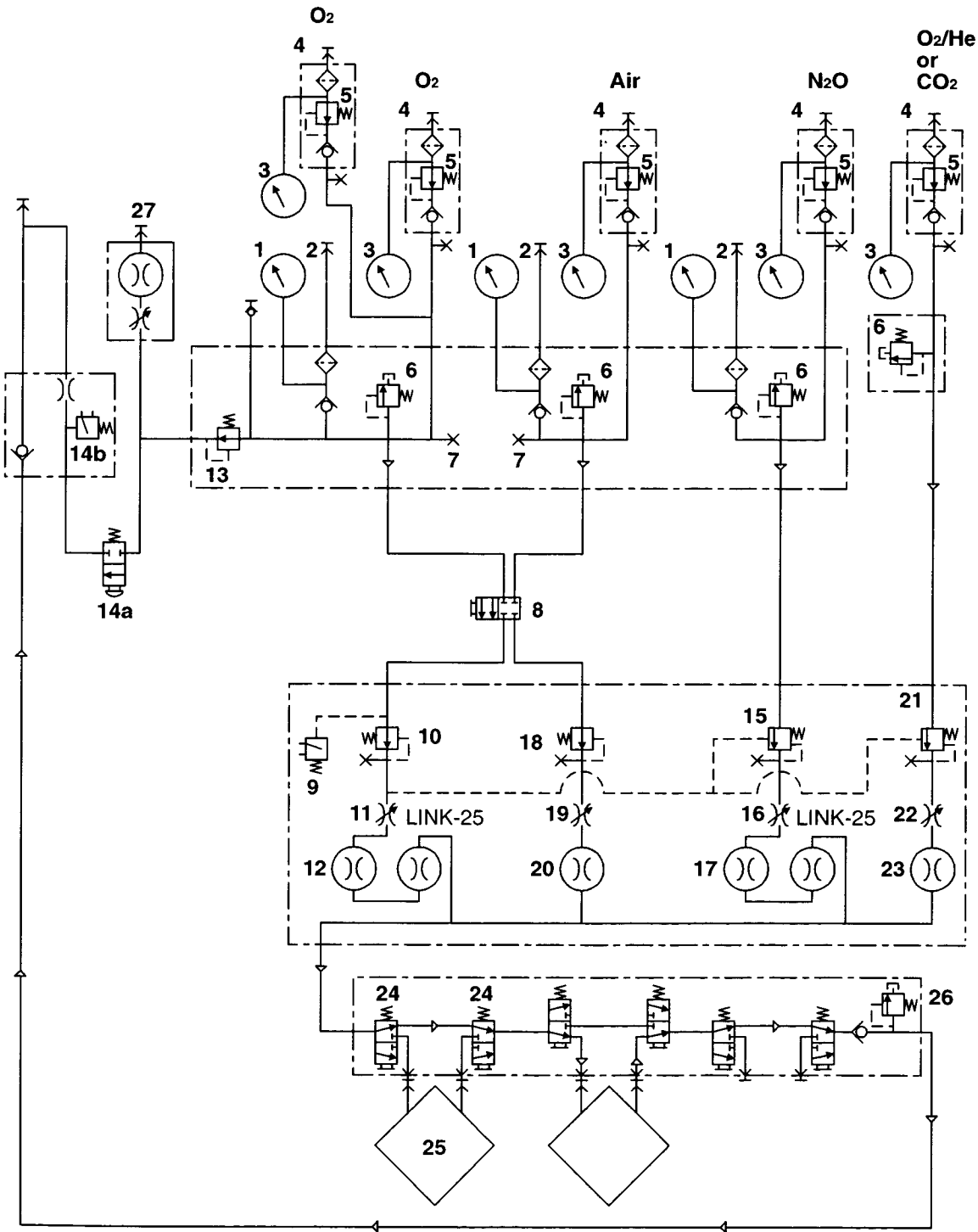


Figure 8-4 • Pneumatic circuit

Suction regulators (optional)

Venturi Suction Regulator

Supply: air or O2 from system gas supply.  
Drive gas consumption: 75 L/min  
Maximum Vacuum: 457 mm Hg with pipeline drive gas at 345 kPa.  
Minimum flow: 20 L/min  
Sound level 53 dBA  
Accuracy: 5% of full scale

Continuous Suction Regulator

Supply: External vacuum  
Vacuum levels: 0-200 mm Hg and full line vacuum  
Maximum flow: >20 L/min  
Accuracy: 5% of full scale

O2 flow meter (optional)

Supply: O2 from system gas supply.  
flow rates: 0-10 L/min  
Accuracy: 5% of full scale

Breathing system

There are three types of breathing circuit modules (Figure 8-5):

- 1. Circle
- 2. Mapleson D/Bain(With Mapleson D/Bain circuits one flow sensor measures Inspiratory and expiratory flows. The other measures fresh gas.
- 3. Open

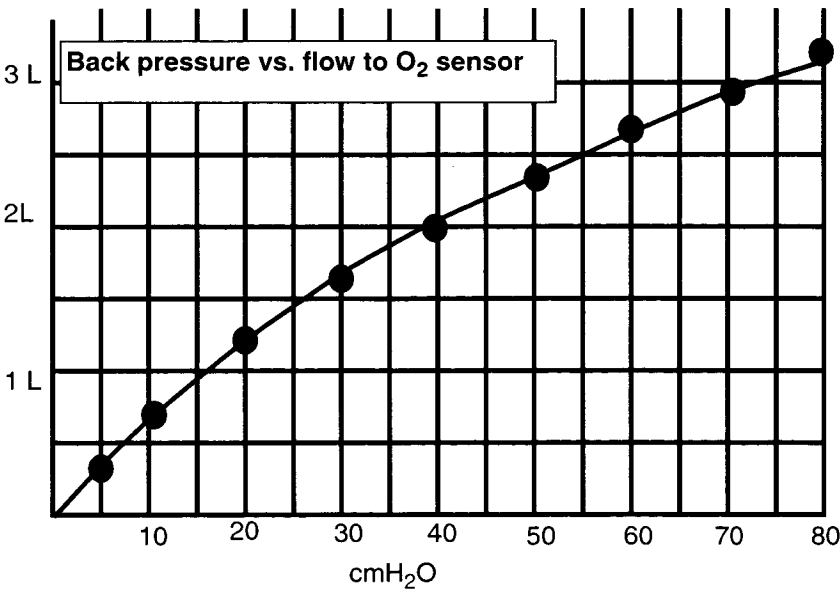
Tabs on the circuit modules fit into infra -red switches on the breathing system bulkhead. The ventilator uses these switches to identify the circuit module.

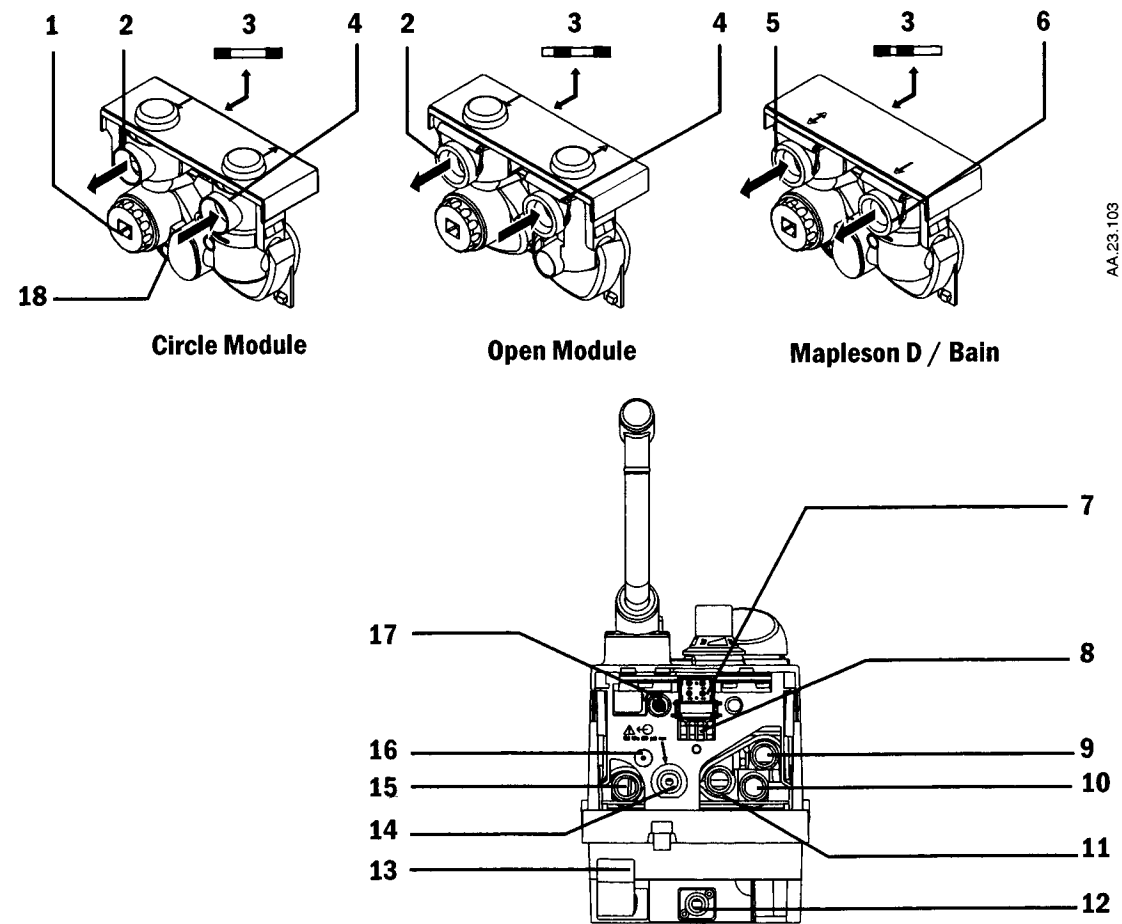
| Module           | Patient Circuit Connections            | One-Way Valves   |
|------------------|--|--|
| Circle           | Left: inspiratory<br>Right: expiratory | Inspir. & expir. check valves                              |
| Mapleson D/ Bain | Left: to-fro<br>Right: fresh gas       | None   |
| Open             | Left: inspiratory<br>Right: expiratory | Inspir. check valve. Pressure controlled expiratory valve. |

Direct fresh gas connections (common and auxiliary outlets)

When you make a direct connection to one of these outlets:

- Mechanical ventilation is not available
- The pressure gauge, Bag/Vent switch, APL valve, and bag arm are not part of the circuit.
- Volume and pressure monitoring are not available.
- Flow from the auxiliary outlet to the O2 sensor is:





1. O<sub>2</sub> Sensor (ventilator) Or Plug
2. Inspiratory Port
3. Tabs (Identify the Breathing Circuit Module to ventilator)
4. Expiratory Port
5. To-Fro Port
6. Fresh Gas Port
7. Flow Sensor Module Connector (Used with ventilator)
8. Optical Switches (Use Tabs To Identify Circuit Module)
9. Internal Connection (To Gas Scavenging System - Open Module Only)
10. Internal Connection (Exhaled gas flows to absorber during expiration)
11. Internal Connection (To Bag/Vent Switch)
12. Auxiliary Common Gas Outlet (Some Models)
13. Selector Switch (Auxiliary Common Gas Outlet)
14. Common Gas Outlet
15. Internal Connection (Mixed gas from absorber during inspiration)
16. Internal Connection (Aux. Com. Gas Outlet To O<sub>2</sub> Sensor)
17. Pressure Gauge Tap
18. Drain Valve (Push In To Drain water into the Drain Dish At Bottom Of Absorber)

Note: Items 12 and 14 are both called fresh gas outlets.

Figure 8-5 • Breathing circuit modules and connections

### Breathing system specifications

**Volume:** 5500 ml

**Absorbent:** 1.35 kg (400 ml) / canister

**Connections:**

Breathing circuit modules: Circle, open, or Bain modules

Common gas outlet: ISO 5356 type connector (Standard 22 mm OD or 15 mm ID conical friction fit connectors). Remove the breathing circuit module to access.

Auxiliary outlet: ISO 5356 type connector on the front of the breathing system (Standard 22 mm OD or 15 mm ID conical friction fit connectors) (Optional).

**System leakage:**

These values are for continuous pressure and are higher than those expected during mechanical ventilation.

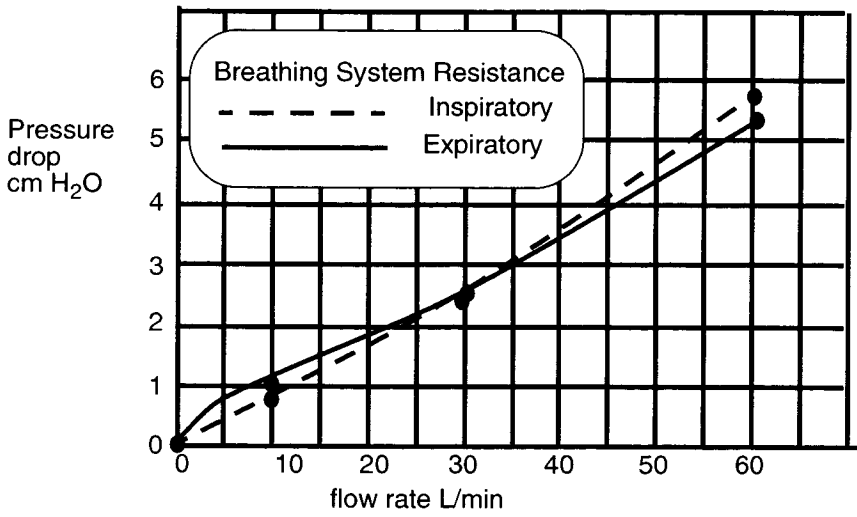
≤ 300mL/min total at 3 kPa; ≤75 ml/min for all connectors and two part tubes and ≤ 225 mL/min for all other breathing system assemblies.

**System compliance**

Volume of gas lost due to internal compliance (bag mode only) 5.15 mL/cm H<sub>2</sub>O

**Breathing system resistance**

Y piece or T piece adds ≤0.15 kPa expiratory resistance at 1 L/sec.





Pressure required to open inspiratory and expiratory valves:

Dry: 0.49 cm H<sub>2</sub>O  
Moist: 0.91 cm H<sub>2</sub>O

Breathing system leakage (average during use)

| Pressure               | Bag Mode (ml/min) | Vent Mode (ml/min) |
|------------------------|-------------------|--------------------|
| 30 cm H <sub>2</sub> O | 0.089             | 0.063              |
| 60 cm H <sub>2</sub> O | N/A               | 0.106              |
| 90 cm H <sub>2</sub> O | N/A               | 0.163              |

APL Valve:

Approximately 0 to 70 cm H<sub>2</sub>O

Pressure Flow Data (APL Valve Completely Open)

| Flow (L/min) | Flow (L/sec) | APL Pressure cm H <sub>2</sub> O |
|--------------|--------------|----------------------------------|
| 3            | 0.05         | 1.12                             |
| 10           | 0.17         | 1.26                             |
| 20           | 0.34         | 1.77                             |
| 30           | 0.51         | 2.36                             |
| 40           | 0.68         | 3.14                             |
| 50           | 0.83         | 4.06                             |
| 60           | 1.0          | 5.14                             |

System volume: 5500 mL

Gas scavenging

Passive scavenging:

Positive pressure relief: 10 cm H<sub>2</sub>O.  
Negative pressure relief: 0.5 cm H<sub>2</sub>O.  
Outlet connector: 30 mm male taper swivel.

Active scavenging:

Particle filter at the outlet has a pore size of 225 microns. All flow data uses a new filter.

| Disposal System Type  | Outlet Swivel Connector * | Flow Range                       | Pressure                             |
|-----------------------|---------------------------|----------------------------------|--------------------------------------|
| Low flow, high vacuum | DISS EVAC                 | 36 ±4 SLPM at 300 mmHg (12 inHg) | 300 mmHg (12 inHg)<br>Minimum vacuum |
| High flow             | BS6834                    | 50 - 80 SLPM                     | 1.6 kPa at 75 SLPM                   |
| Venturi/Ejector       | ½ in. hose barb           | 30 - 100 SLPM                    | n/a                                  |

\* Other market-specific connectors may be available.

Pneumatic specifications

Gas supplies:

Pipeline gases: O<sub>2</sub>, Air, N<sub>2</sub>O

Cylinder gases: CO<sub>2</sub>, Heliox, O<sub>2</sub>, N<sub>2</sub>O, Air (maximum: 2 cylinders of each gas; 4 cylinders total on narrow models; 5 cylinders total on the wide model.

Cylinder connections: Pin indexed (all gases); nut and gland DIN 477 (O<sub>2</sub>, N<sub>2</sub>O, Air); large cylinder kit available for O<sub>2</sub> and N<sub>2</sub>O.

Primary regulator output pressure:

- With a rear panel label:



The primary regulator is set to pressure less than 345 kPa.



The primary regulator is set to pressure less than 414 kPa.

- Without a rear panel label : approximately 587- 690 kPa

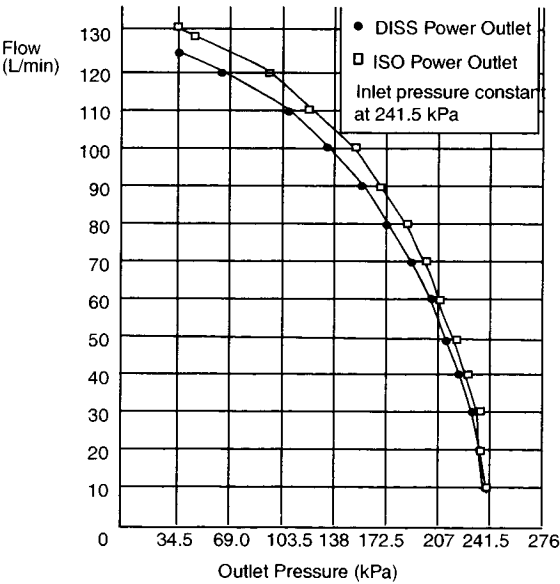
Pressure relief valve : approximately 883 kPa.

Pipeline connections (filtered): DISS-Male; DISS-Female; DIN 13252; AS 4059 (Australian); F90-116 (French Air Liquide); CEN (QPEN 737-6); or NIST (ISO 5359). All fittings available for O<sub>2</sub>, Air, and N<sub>2</sub>O.

Pressure displays: Color coded gauges

Pneumatic outlet

O<sub>2</sub> DISS or Mini schraeder connections



Common gas outlet relief:

Valve limits fresh gas to 138 kPa at the flush flow.

Flow specifications

Flow rates

Minimum O<sub>2</sub> flow: 25 to 75 mL/min

| Gas              | Flow Range              | Scale (One Flow Tube) | Scale (Two Flow Tubes)         |
|------------------|-------------------------|-----------------------|--------------------------------|
| O <sub>2</sub>   | 0.05-15 L/min           | -----                 | 0.05 -0.95 L/min<br>1-15 L/min |
| N <sub>2</sub> O | 0-10 L/min <sup>1</sup> | -----                 | 0.05 -0.95 L/min<br>1-10 L/min |
| Air              | 0-15 L/min              | 1-15 L/min            | 0.05 -0.95 L/min<br>1-15 L/min |
| He               | 0-15 L/min              | 0.5-15 L/min          | -----                          |
| CO <sub>2</sub>  | 0-0.5 L/min             | 0.05-0.5 L/min        | -----                          |

1. The link system sets the nominal O2 flow at 25% of the total O2 and N2O flow.

Accuracy

At 20°C with gas supply pressures at 345 kPa and an outlet pressure of 101.3 kPa (absolute) flowmeter accuracy agrees with VDE 3513 Part 3, Accuracy Class 2.5 or better.

Different breathing circuit pressures, barometric pressures or temperatures change the accuracy. With some conditions, these changes can be larger than the tolerances.

Flush flow

35-50 L/min

O<sub>2</sub> supply failure alarm and shutoff

|                                     | O <sub>2</sub> Pressure |
|-------------------------------------|-------------------------|
| O <sub>2</sub> supply failure alarm | 193 to 221 kPa          |
| N <sub>2</sub> O shutoff            | 3.5 kPa                 |
| CO <sub>2</sub> or Heliox shutoff   | 69 kPa                  |

Electrical power

Supply voltage

100-120 or 220-240 Vac ± 10% at 50 or 60 Hz

Electrical circuit breakers

Inlet Circuit Breakers

|              | 100-120 Vac | 220-240 Vac |
|--------------|-------------|-------------|
| No outlets   | 5A          | 3A          |
| With Outlets | 10A         | 6A          |

Master Circuit Breaker-All Outlets

|  | 100-120 Vac | 220-240 Vac |
|--|-------------|-------------|
|  | 5A          | 3A          |

Outlet Circuit Breakers

|            | 100-120 Vac      | 220-240 Vac      |
|------------|------------------|------------------|
| No outlets | (3) 2A<br>(1) 3A | (3) 1A<br>(1) 2A |

Circuit Breaker for Tec 6 Outlet (limited by master circuit breaker)

System leakage current limit - do not exceed

UL and CSA rated systems (USA and Canada) <300 μamps for the system and all systems connected to electrical outlets.

IEC rated systems (Not USA and Canada) <500 μamps for the system and all systems connected to electrical outlets

Note: Products connected to the electrical outlets may increase the leakage current above these limits.

Resistance to ground:

<0.2 Ω

Power cord

|                           |   |
|---------------------------|---|
| Length                    | 5 meters  |
| Voltage rating            | 125 to 264V ac at 10A, by country and/or translation                          |
| Current Carrying Capacity | 10A   |
| Type                      | Three conductor medical grade power supply cord by country and/or translation |

Electrical Fuses

T6.3L/250V.

Battery Information

A sealed lead acid battery supplies battery backup for the Aestiva. The Aestiva is not a portable unit. Batteries are used as back up power in case of a power failure. Thus the battery is in a float charge state most of the time. Batteries meet the following:

- 1. Capacity to operate for 30 minutes.
- 2. Unit functions to specifications through the transition to battery power.
- 3. Long float charge life.
- 4. Battery pack is internally fused - in line replaceable
- 5. Battery terminals and connecting wires are protected against short circuits.

Only Datex-Ohmeda service representatives are to replace the battery. Batteries must be disposed of in accordance with applicable regulatory requirements in effect at the time and place of disposal.

Electro-magnetic Compatibility

**Environment:**Suitable for use in the EM environment described in EN 60601-1-2

**Immunity Levels:** The Aestiva complies with the requirements of EN 60601-1-2 (Electromagnetic Compatibility - Requirements and tests). The following basic EMC standards were applied to verify conformance.

**Emissions** CISPR 11 Group 1 (EN 55011)

**Immunity** IEC 801-2, 8 kV air, 3 kV contact  
IEC 801-3, 3 V/m  
IEC 801-4, 2 kV power line  
IEC 801-5, 2 kV line to earth, 1 kV line to line

Physical specifications

All specifications are approximate values and can change without notice.

**Weight:** 2 vaporizer system: 136 kg  
3 vaporizer system: 154 kg

**Dimensions:** **2 vaporizer system**  
Height: 135.8 cm  
Width: 75.0 cm  
Depth: 83.0 cm  
Shelves:  
Number: 0, 1, or 2  
Size: 47.5 x 35 cm or 67.5 x 35 cm  
Usable height (2 shelves)<sup>1</sup>: 26 or 36 cm  
Weight Limit: 23 kg per shelf

**3 vaporizer system**  
Height: 135.8 cm  
Width: 93.0 cm  
Depth: 83.0 cm  
Shelves:  
Number: 0, 1, or 2  
Size bottom shelf: 87.5 x 35 cm or 67.5 x 35 cm  
Size top shelf: 47.5 x 35 cm or 67.5 x 35 cm  
Usable height (2 shelves)<sup>2</sup>: 26 or 36 cm  
Weight Limit: 23 kg per shelf

**Casters:** 12.5 cm with brakes on the front casters.

**Drawers:** Optional: 14.5 x 38.5 x 26.0 cm  
Standard drawer: 10.5 x 38.5 x 26 cm

**Ventilator display:** 7.6 x 15.2 cm

1. Flat or 10° angle shelves have the same usable height.  
2. Flat or 10° angle shelves have the same usable height.

Environmental requirements

Temperature

|           |   |
|-----------|---|
| Operation | 10 to 40 °C, (Oxygen cell operates to specifications at 10 to 40 °C)              |
| Storage   | -20 to 70 °C<br>Oxygen cell storage is -5 to 50°C, 10 to 95% Rh, 500 to 800 mm Hg |

Humidity

|           |                                   |
|-----------|-----------------------------------|
| Operation | 15 to 95% Rh, non-condensing      |
| Storage   | 10 to 100% Rh, include condensing |

Altitude

|                    |  |
|--------------------|--|
| Operation          | 500 to 800 mm Hg (3565 to -440 meters) |
| Storage            | 375 to 800 mm Hg (5860 to -440 meters) |
| Compensation range | 525 to 795 mmHg (3,000 to -100 meters) |

Ventilation Operating Specifications

Pneumatics

|                         |                                 |
|-------------------------|---------------------------------|
| Gas Source              | Anesthesia System               |
| Gas Composition         | Medical Air or O <sub>2</sub>   |
| Nominal Supply Pressure | 350 kPa                         |
| Pressure Range at Inlet | 240 to 700 kPa                  |
| Peak Gas Flow           | 120 L/m @ 240 kPa, 0.75 seconds |
| Continuous Gas Flow     | 80 L/m @ 240 kPa                |
| Flow valve range        | 1 to 120 L/min at 240kPa.       |

Fresh gas compensation

|                         |  |
|-------------------------|--|
| Flow Compensation Range | 200 mL/min. to 15 L/min.   |
| Gas Composition         | O <sub>2</sub> , N <sub>2</sub> O, N <sub>2</sub> Air, Heliox, CO <sub>2</sub> Anesthetic Agents |

Pressure

|                                |  |
|--------------------------------|--|
| Patient airway pressure range  | -20 to +120 cm H <sub>2</sub> O +/-2 cm H <sub>2</sub> O |
| High pressure alarm set range  | 12 to 100 cm H <sub>2</sub> O, 1 cm increment            |
| Sustained pressure alarm range | 6 to 30 cm H <sub>2</sub> O, 1 cm increment              |
| Display range                  | -20 to 120 cm H <sub>2</sub> O                           |

Volume

|                            |   |
|----------------------------|---|
| Tidal volume display range | 0 to 9999 mL, 1 mL resolution                       |
| Setting range              | 20 to 1500 mL                                       |
| Minute volume              | 0.0 to 99.9 liters, 0.1 liter resolution            |
| Breath rate                | 4 to 100 bpm (breaths per minute), 1 bpm resolution |
| Volume sensor type         | Variable flow orifice                               |

Oxygen

|                                   |   |
|-----------------------------------|---|
| Display range                     | 0 to 110% O <sub>2</sub>  |
| Display resolution                | 1% increments   |
| Sensor type                       | Galvanic fuel cell  |
| Measurement range                 | 0 to 100% O <sub>2</sub>  |
| Measurement accuracy              | Better than ± 3% of full scale  |
| Cell response time                | 35 seconds <sup>1</sup>   |
| Low O <sub>2</sub> alarm range    | 21% to 100%   |
| High O <sub>2</sub> alarm setting | 21% to 100%<br><b>Note:</b> Low O <sub>2</sub> limit may not be set above the high O <sub>2</sub> limit, nor may the high O <sub>2</sub> limit be set below the low O <sub>2</sub> limit. |
| Expected cell life                | Four months of shelf life (23 °C room air) and one year of normal operation.  |

1. Response time of cell and adapter as measured using the test method described in ISO 7767 (1988-12-15), clause 50.9

Aestiva Ventilator Accuracy Data

The following accuracy data are based on patient conditions and settings described in ASTM F1101. The ventilator is assumed to be operating in volume mode (Heliox OFF). For the following to be true, the ventilator is operating with 100 percent oxygen in the breathing system; or, it is connected to an anesthesia gas analyzer. If the ventilator is operating without being connected to an anesthesia gas analyzer, additional errors are described in the gas composition charts that follow.

Volume Mode  
(100%O<sub>2</sub>)

|                            |  |
|----------------------------|--|
| Volume delivery accuracy:  | > 210 mL tidal volume - accuracy better than 7%    |
|                            | < 210 mL tidal volume - accuracy better than 15 mL |
|                            | < 60 mL tidal volume - accuracy better than 10 mL  |
| Volume monitoring accuracy | > 210 mL tidal volume - accuracy better than 9%    |
|                            | < 210 mL tidal volume - accuracy better than 18 mL |
|                            | < 60 mL tidal volume - accuracy better than 10 mL  |

Pressure Mode  
(100% O<sub>2</sub>)

|  |  |
|--|--|
| Inspiratory pressure delivery accuracy | greater of ± 10% or ± 3 cm H <sub>2</sub> O        |
| PEEP delivery accuracy                 | ± 1.5 cm H <sub>2</sub> O                          |
| Pressure monitoring accuracy           | greater of ± 5% or ± 2 cm H <sub>2</sub> O         |
| Volume monitoring accuracy             | > 210 mL tidal volume - accuracy better than 9%    |
|  | < 210 mL tidal volume - accuracy better than 18 mL |
|  | < 60 mL tidal volume - accuracy better than 10 mL  |

**Note:** Gas composition errors may be in addition to the above normalized accuracy. When adding errors, positive errors can have the effect of nulling out negative errors.  
**Note:** Use of anesthetic agent could affect the errors by approximately -0.95%/volume agent in normal mode and roughly -2.5%/volume agent in Heliox mode. If the ventilator is connected to an Ohmeda RGM (Respiratory Gas Monitor), the affect of gas composition on volume data is corrected for automatically.

**Volume Compensation Off**

Delivered volume accuracy: greater of  $\pm 10\%$  or  $\pm 20$  mL  
(Open loop volume mode is not a normal user selectable ventilation mode. It is an uncompensated ventilation mode used when a possible inspiratory flow sensor problem has been detected. The delivery accuracy is evaluated at the ventilator drive gas outlet in this mode of operation.)

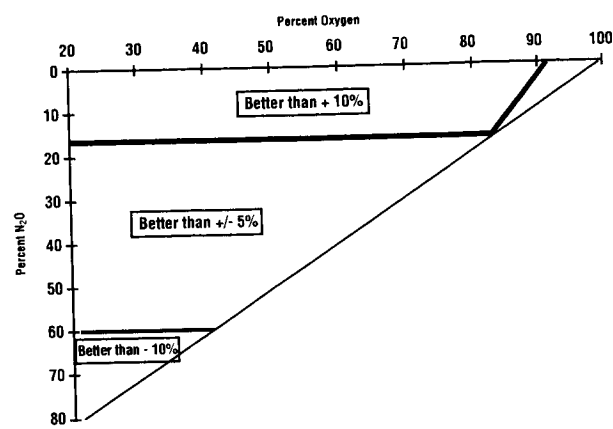


Figure 8-6 • Gas Composition Related Errors (Both Modes)

**Heliox Mode**

The effect on volume delivery and monitoring accuracies of Heliox mixtures is within +8% to -15% when operating the Aestiva Ventilator in the Heliox Mode.  
Open loop mode volume delivery accuracy:  $\pm 10\%$  of the set value under the following conditions:

1. Accuracy evaluated at the ventilator outlet.
2. This is not a normal operating mode. The ventilator is operating in an irregular condition.

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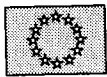
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