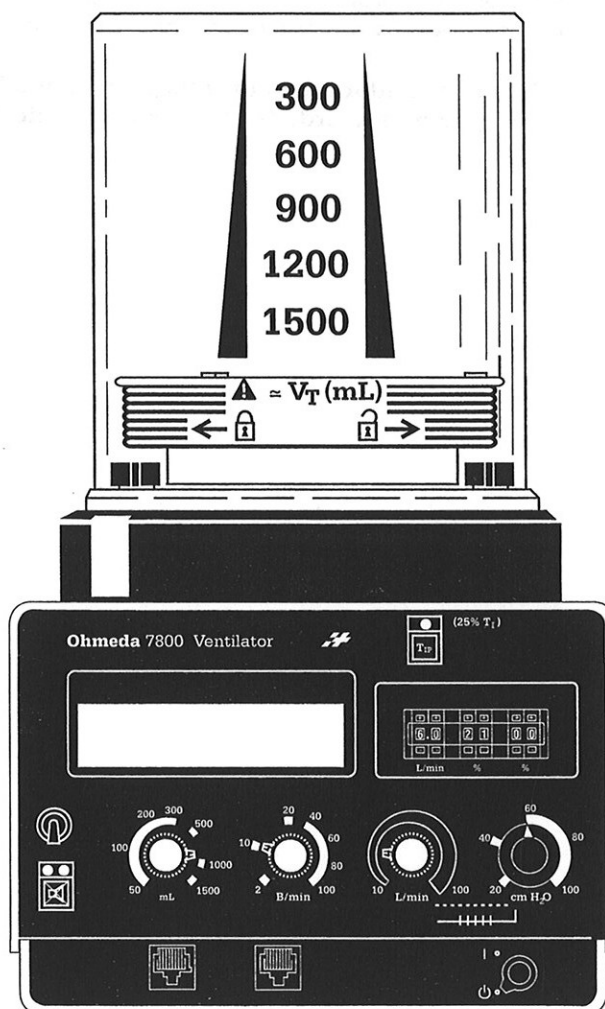




7800 Ventilator

Operation and Maintenance Manual

Software Revision 4.XX



AA.10.132



User Responsibility

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 such repair or replacement become necessary, Ohmeda recommends that a telephonic or written request for service advice be made to the nearest Ohmeda Regional Service Center. This Product or any of its parts should not be repaired other than in accordance with written instructions provided by Ohmeda and by Ohmeda trained personnel. The Product must not be altered without the prior written approval of Ohmeda's Safety 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 Ohmeda.



CAUTION: Federal law in U.S.A. and Canada restricts this device to sale by or on the order of a licensed medical practitioner.

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



















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1/Introduction

This instrument combines an electronically-controlled, pneumatically-driven ventilator with built-in monitoring for exhaled volume, inspired-oxygen concentration, and airway pressure. The ventilator also features controls with clinically significant ranges, selectable inspiratory pause, and an adjustable inspiratory pressure limit control. The Ohmeda 7800 Ventilator may be used in a variety of applications; on older anesthesia systems as a stand-alone ventilator; or as an integrated part of the Ohmeda Excel Anesthesia System; or retrofitted into the Ohmeda Modulus® II Anesthesia System.

The following symbols are used on Ohmeda products and technical manuals. No one product or manual has every symbol listed. Refer to this listing concerning symbols found on various products and manuals.

	On (power)		Lamp, lighting, illumination
	Off (power)		Movement in one direction
	Standby		Movement in both directions
	Standby or preparatory state for a part of the equipment		Lock
	"ON" only for part of the equipment		Unlock
	"OFF" only for part of the equipment		Non-autoclavable
	Direct Current		Type B equipment
	Alternating Current		Type BF equipment
	Protective earth ground		Type CF equipment
	Earth Ground		Warning ISO 7000-0085
	Frame or chassis ground		Caution, ISO 7000-0434
	Alarm silence button		Attention, consult accompanying documents, IEC 601-1
	Equipotential		This way up
	Variability		Dangerous Voltage
	Variability in steps		Input
	Plus, positive polarity		Output
	Minus, negative polarity		

What warning and caution statements in this manual indicate

No matter which part of the manual you are using, always be familiar with the **⚠ CAUTIONS** and **⚠ WARNINGS** that appear. **WARNINGS** alert you to conditions or actions that may cause harm to humans. **CAUTIONS** alert you to conditions or actions that may result in damage to equipment.

Pay special attention to the **WARNINGS** and **CAUTIONS** as they appear in this manual and on the equipment.

1/Introduction

Read the user responsibility statement; it describes what is expected of you to maintain the ventilator. Read the warranty; it describes Ohmeda's responsibility in case of a functional defect.

Keep this manual with the system for answering questions that arise about the ventilator's operation, maintenance or, if necessary, repair.



WARNING: Before using the Ohmeda 7800 Ventilator, familiarize yourself with the equipment by reading through this entire manual. As with all medical equipment, attempting to use this device without a thorough understanding of its operation may result in injury to the patient.

1.0 How to use this manual

Use this manual as a guide to follow when learning to operate the Ohmeda 7800 Ventilator, and as a reference tool once you are familiar with the system.

If you are setting up the system for the first time, thoroughly read all of the manual sections. The Ohmeda 7800 is available in three configurations: for use as a stand-alone device, or as an integrated component of either an Ohmeda Excel Anesthesia System or an Ohmeda Modulus II Anesthesia System. Refer to the specific section in "Getting Started" that tells you how to make the basic connections for your configuration.

If the system is already in place, but you haven't used it, pay particular attention to all of the sections starting with Section Three: "General Information."

If you have used the Ohmeda 7800 Ventilator before, but need reminding about details of using the instrument, refer to Sections Four: "Preoperative Setup Procedures" and Section Five: "Operating the Ventilator."

Section Six: "Maintaining the System" and Section Seven: "Service Procedures," are included to inform you about routine maintenance of the ventilator and to help you solve problems that might occur with the instrument.

Throughout this manual we have provided step-by-step instructions to simplify the ventilator's operation. To further clarify the instructions, we have used a special dot-matrix typeface to identify messages that appear on the ventilator's screen. A simulated low minute volume alarm message looks like this:

LOW MINUTE VOL!

In addition, the system's alarm silence key is represented an icon similar to the one printed on the key itself. An instruction to push the key looks like this:

Press:

What the manual's symbols mean

A number of **Warnings** and **Cautions** are used throughout this manual to draw attention to the possible hazards and/or adverse conditions which may occur if the information and instructions provided are not strictly observed. The Caution symbol when indicated on the equipment means text is elaborated upon in this manual or associated documents.

1/Introduction

WARNINGS are used to draw attention to a condition which can endanger either the patient or operator. **CAUTIONS** are used to draw attention to a condition which can result in damage to the equipment. Special attention must be paid to each Warning and Caution as it appears in the manual.

We have also used—both in the manual and on the device itself—symbols to represent some common terms. These symbols include:

T_{IP}	Inspiratory pause
25% T_I	Enable inspiratory pause at 25% of inspiratory time
V_E	Minute volume
V_T	Tidal volume
f	Frequency
I:E	Inspiratory to Expiratory ratio
E	Expiratory time
I	Inspiratory time
C	Compliance
PIP	Peak Inspiratory Pressure

What we mean by
"powering on" the
control module

In this manual, when we say "power ON" the control module, we mean turn ON control module's power switch or the anesthesia system's master switch, depending on your ventilator's configuration.

Notes

2/Getting Started

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2/Getting Started

2.0 General

Many of the following steps are performed when the ventilator is installed. However, during use, maintenance, or sterilization, ventilator components may be left disconnected or may be reconnected incorrectly. Read through the steps in each section to confirm that the system is set up properly. Perform any steps necessary to correctly connect your system's components.



WARNING: To avoid explosion hazard, flammable anesthetic agents such as ether and cyclopropane must not be used in this machine. Only anesthetic agents which comply with non-flammable anesthetic agent standards are suitable for use in this machine.

WARNING: As this machine is not suitable for use with flammable anesthetic agents such as ether and cyclopropane, the use of antistatic breathing tubes and face masks is not necessary. The use of antistatic or electrically conductive breathing tubes when utilizing high frequency electric surgery equipment may cause burns and is therefore not recommended in any application of this machine.

The following sections, 2.1 through 2.6, explain how to set the a-c voltage (~), how to install the ventilator's bellows assembly and control module, how to install the monitoring sensors, and how to charge the battery. Although these steps are straightforward, they should be performed only by someone experienced in working with anesthesia and monitoring equipment.

Because the Ohmeda 7800 is available in three configurations—for use as a stand-alone device, as a component of an Ohmeda Excel Anesthesia System, or as a component upgrade of an Ohmeda Modulus II Anesthesia System—we have provided three separate sets of instructions for making some of the system's connections. Refer to the specific section in "Getting Started" that tells you how to make the basic connections for your configuration.

- 2.7 "Setting up the control module when the ventilator is used as a stand-alone device,"
- 2.8 "Setting up the control module with an Ohmeda Excel Anesthesia System," and
- 2.9 "Setting up the control module with an Ohmeda Modulus II Anesthesia System."

Then, for all configurations, refer to

- 2.10 "Connecting the bellows assembly to an absorber,"
- 2.11 "Making the monitoring connections," and
- 2.12 "Charging the battery."

2/Getting Started

2.1 Unpacking

Upon delivery, inspect the ventilator and its accessories for damage that may have occurred during shipment. If you detect any damage, immediately notify the transportation company and file a damage claim. Save the original shipping container and materials.

The Ohmeda 7800 Ventilator's functions should be completely checked as soon as possible. Follow the instructions in this section to install the ventilator. Then, after you have used this manual to familiarize yourself with the ventilator, confirm that it is working correctly by performing the checkout described in "4/Preoperative Checkout Procedures."

2.2 Checking the a-c (~) voltage

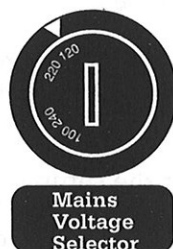


CAUTION: The Ohmeda 7800 Ventilator can be set to operate on 100, 120, 220, or 240 volts a-c (~). Either 50 or 60 Hertz supplies are acceptable and do not have to be set manually. Make sure the ventilator is set for the voltage used at your location.

To change the ventilator's operating voltage

1. Turn the control module upside down (disconnect any cables that interfere).
2. Pull out the preoperative checklist. This exposes the voltage selector, which you should be able to see through the hole labeled "Mains Voltage Selector."
3. Use a large, flat-blade screwdriver to align the arrow on the voltage selector to the correct voltage.
4. Make sure an appropriate power connector is installed.

Figure 2-1
Changing the control module's operating voltage with the voltage selector switch



AA-10-113

2.3 Adjusting the altitude or changing the language

When to set the altitude compensation


Normally the altitude compensation needs to be set only when the system is first installed.

1. Set the mechanical ventilation switch and the control module power to OFF. With the Excel and Modulus anesthesia machines set the system master switch to OFF.
2. Hold down the inspiratory pause button and power ON the control module. With the Excel and Modulus anesthesia machines move the

2/Getting Started


system master switch to ON. Turn the flow control to set the altitude (meters).

FLOW KNOB TO SET
ALTITUDE: 1300 m

3. Press  to display the language page. Turn the Flow control to select language.

FLOW KNOB TO SET
ENGLISH

2.4 Setting the reverse flow alarm, sigh, contrast, audio volume


1. Move the mechanical ventilation switch to OFF.
2. Power ON the control module. With the Excel, move the system master switch to ON.
3. Press and continue to hold down the alarm silence button, , then press in the inspiratory pause button. Release both buttons. The ventilator displays:

1	2	3
7800 REV 4. XX /O		
ENGLISH 1300 m		
4	5	

1 meter = (3.28 feet)

1. Ventilator Model
2. Software Version
3. Ventilator Supply Gas (A=Air; O=O₂; E=Error)
4. Language
5. Altitude

WARNING: Pay attention to the information on the setup page. If the model number or supply gas is incorrect, have a trained Ohmeda service representative service the ventilator.

To exit the setup pages at any step, repeatedly press , do not adjust a control for 30 seconds, or set the mechanical ventilation switch to ON. All previous changes will be saved in the ventilator memory.

4. Press . The ventilator displays:

FLOW KNOB TO SET
REV FLOW ALM ON or OFF


Turn the flow control to switch the alarm selection ON or OFF. If the volume sensor is at the proximal end of the Y connector, select OFF to disable the alarm. If the volume sensor is at the expiratory port of the absorber, select ON to enable the alarm.

2/Getting Started

5. Press . The ventilator displays:


FLOW KNOB TO SET
SIGH ON or OFF

Turn the flow control to switch sigh breaths ON or OFF. When sigh is "On", the ventilator delivers one and a half times the tidal volume (up to a maximum 1.5 L) once every 64 breaths.

6. Press . The ventilator displays:

FLOW KNOB TO SET
CONTRAST: XX

Turn the flow control to adjust the contrast (XX) from 1 (lowest contrast) to 10 (highest).

7. Press . A tone sounds and the ventilator displays:

FLOW KNOB TO SET
AUDIO VOLUME: XX

Turn the flow control to adjust the volume (XX) from 1 (lowest) to 10 (highest). Tone volume changes to the selected level.

8. Press . The ventilator beeps once and displays:

CHECK SETTINGS!

2.5 Checking the supply gas




WARNING: If the supply gas displayed is other than the supply gas you are using (" O " for oxygen or " A " for air), have an Ohmeda trained service representative reset the ventilator. Using a supply gas that does not match the displayed supply gas will result in operational errors.


Either clean oxygen or clean medical-grade air may be used to power the ventilator. However, before changing from one supply gas to another, a qualified service person must set up the ventilator to operate correctly with the new supply gas.

How to determine your ventilator's drive-gas setting

On the first line of ventilator's setup page a character is displayed that indicates the current supply-gas setting. " O " indicates oxygen and " A " indicates medical-grade air.

Note:

To enter the setup page: make sure the mechanical ventilation switch is OFF, press and continue to hold down the  button, press the inspiratory pause button, then release both buttons.

To return to normal operations press the  button to move through the menu or, leave the Setup Page display on without parameter changes for 30 seconds.

2/Getting Started

2.6 Matching the ventilator to anesthesia systems

The Ohmeda 7800 Ventilator can be purchased in three configurations:

- as a component addition to an Ohmeda Modulus® II Anesthesia System or replacement for the Ohmeda Modulus II Anesthesia System Ohmeda 7000 ventilator:
- an added integral component to an Ohmeda Excel Anesthesia System:
- as a stand-alone ventilator for use with virtually any other anesthesia system.

All of the configurations include the ventilator's two basic units:

- the bellows assembly, containing the bellows and bellows housing, and
- the control module, containing the ventilator's control valves, processing circuits, controls, and display screen.

Differences in these configurations affect how you switch ventilator's control module between ON and STANDBY, where the control module and bellows assembly are located, how the control module connects to the bellows assembly and anesthesia machine, and how the monitoring devices connect to the control module.

Using the ventilator as a stand-alone device

When the Ohmeda 7800 Ventilator is used as a stand-alone device, the control module can be mounted on an optional bracket or arm, or on an optional stand. The bellows assembly can be mounted on top of the control module or directly to an Ohmeda GMS absorber (using an interface manifold). A switch on the control module powers the ventilator ON. The supply gas connection is made to the rear panel of the control module. Monitoring devices connect directly to the control module interface panel.

Using the ventilator with an Ohmeda Excel Anesthesia System

Ohmeda 7800 Ventilators that are used with Ohmeda Excel Anesthesia Systems can be set up two ways:

- with the control module mounted on an optional arm
- with the control module mounted on the system's shelf.

Included with the ventilator configuration for Ohmeda Excel Anesthesia Systems are extra components that serve two functions: they let the anesthesia system's master switch power ON the ventilator's control module and they connect the control module to the sensor interface panel, to which the oxygen and volume sensors connect.

When the control module is mounted on the anesthesia system's shelf, it will appear in one of two locations, depending on the specific type of Ohmeda Excel Anesthesia System. On systems with a lower shelf that extends over the flow meters, the control module is hung directly from the shelf, over the flow meters. On systems with flow meters that extend all the way to the top shelf, the control module is hung from a bracket on the right side of the shelf.

Using the ventilator with an Ohmeda Modulus II Anesthesia System

Ohmeda Modulus II Anesthesia Systems can be upgraded (by a trained technician) to include the Ohmeda 7800 Ventilator as an integrated component of the system. When the ventilator is installed as an integrated component, the ventilator's control module is mounted over the flow meters. In this configuration the anesthesia system's master switch powers the control module ON and OFF, supply gas is connected internally, and the control module is wired to the system's sensor interface panel, to which the oxygen and volume sensors connect.

2/Getting Started

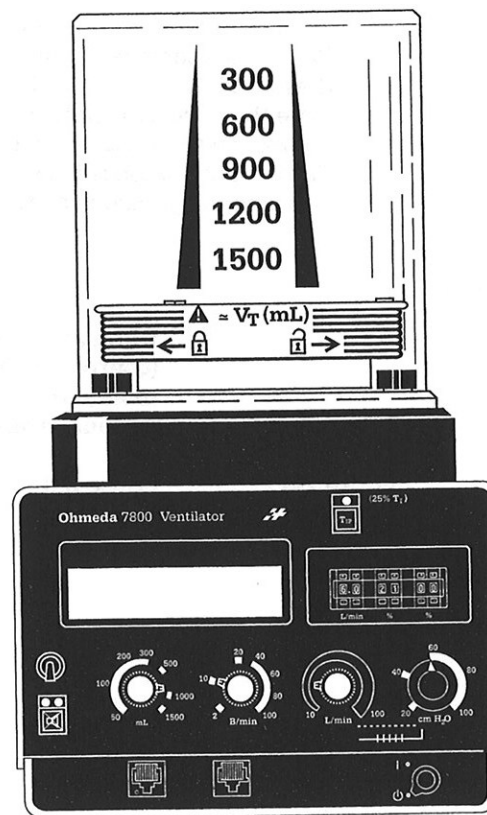
The following chart describes how certain components of the Ohmeda 7800 Ventilator's three configurations are installed, connected, or controlled. Some of these attributes, such as the placement of the bellows assembly, are optional, so more than one can apply to a configuration. Attributes are marked with figure numbers referring to relevant illustrations following this chart. (The Ohmeda Excel configuration is listed twice because the control module can be installed in two different positions on the anesthesia machine.)

Figure 2-2
Possible configurations
of the Ohmeda 7800
Ventilator

Attributes of configurations	Stand-alone	Ohmeda Excel (control module mounted on optional arm)	Ohmeda Excel (control module hung from shelf)	Ohmeda Modulus II upgrade
Bellows assembly on control module	figure 2-3	figure 2-4		
Bellows assembly on optional arm or bracket			figure 2-5	figure 2-6
Bellows assembly mounted to Ohmeda GMS Absorber using interface manifold		figure 2-7	figure 2-8	figure 2-9
Connect monitor devices to sensor interface panel on anesthesia machine		figure 2-10	figure 2-10	figure 2-11
Connect monitor devices to control module	figure 2-12			
Use master ON/OFF switch to power ON ventilator		figure 2-13	figure 2-13	figure 2-14
Use control module power switch to power ON ventilator	figure 2-15			
Supply gas connected externally	figure 2-16	figure 2-16	figure 2-16	
Supply gas connected internally				figure 2-17

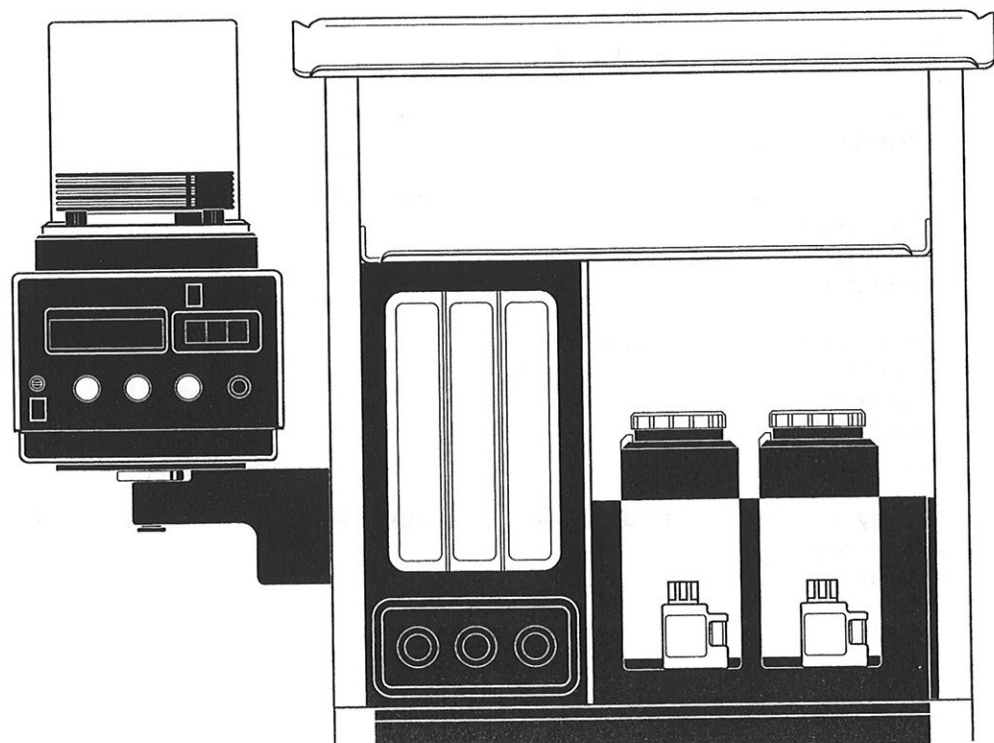
2/Getting Started

Figure 2-3
Bellows assembly
mounted on control
module



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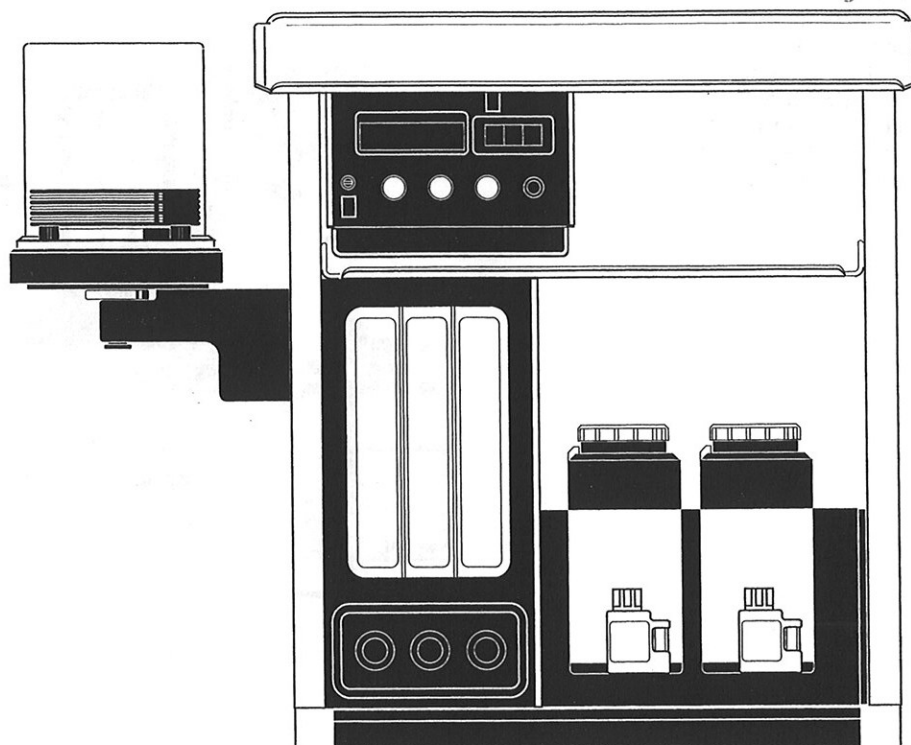
Figure 2-4
Bellows assembly
mounted on control
module attached to an
arm on an Ohmeda
Excel Anesthesia
System



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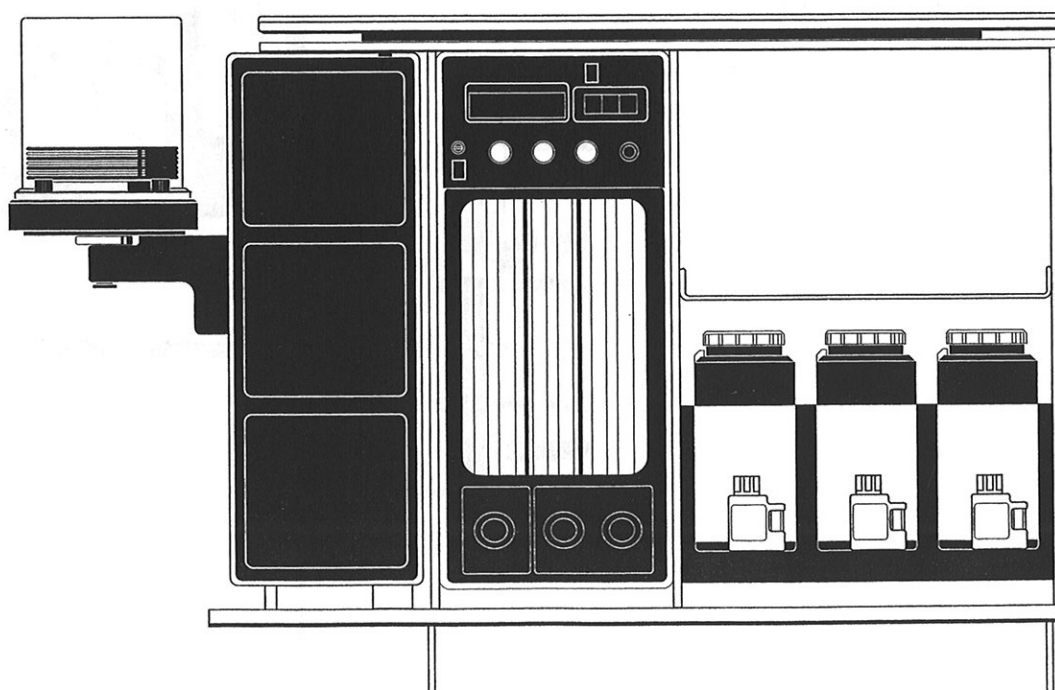
2/Getting Started

Figure 2-5
Bellows assembly on
optional arm on
Ohmeda Excel
Anesthesia System



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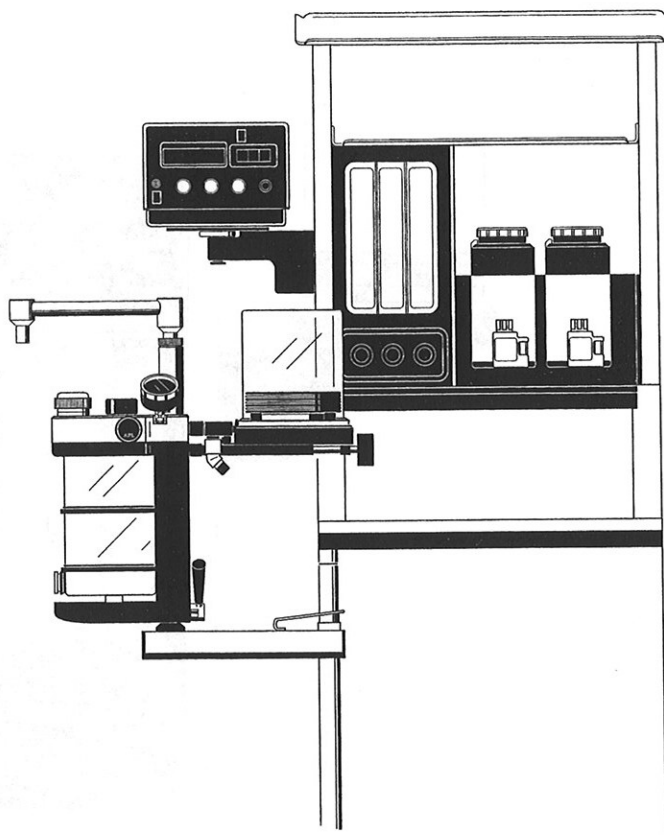
Figure 2-6
Bellows assembly on
optional bracket of
Ohmeda Modulus II
Anesthesia System



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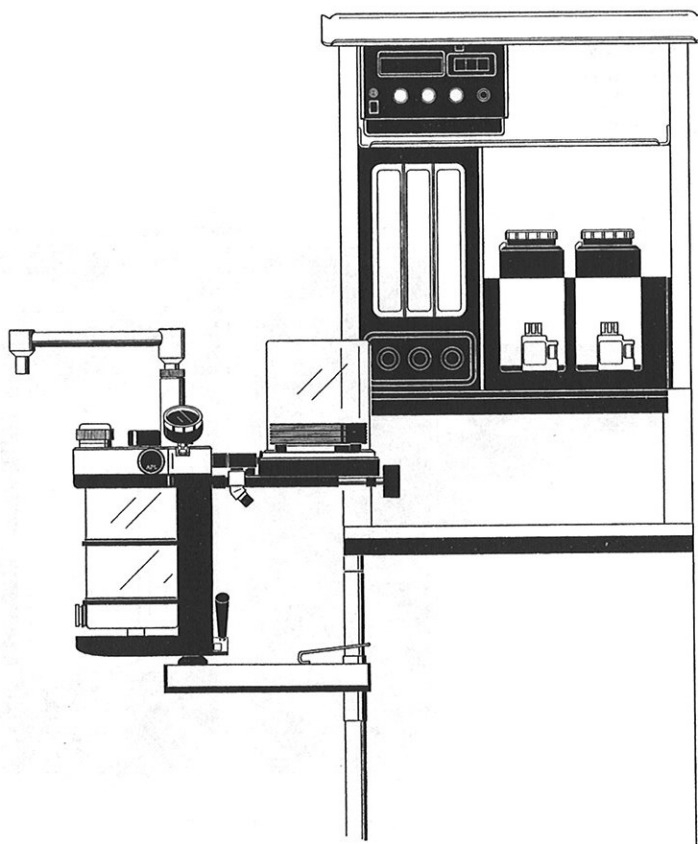
2/Getting Started

Figure 2-7
Control module
mounted on optional
arm of an Ohmeda
Excel Anesthesia
System with bellows
assembly mounted on
Ohmeda GMS Absorber
with interface manifold



AA.10.021

Figure 2-8
Control module hung
from shelf of Ohmeda
Excel Anesthesia
System with bellows
assembly mounted on
Ohmeda GMS Absorber
with interface manifold

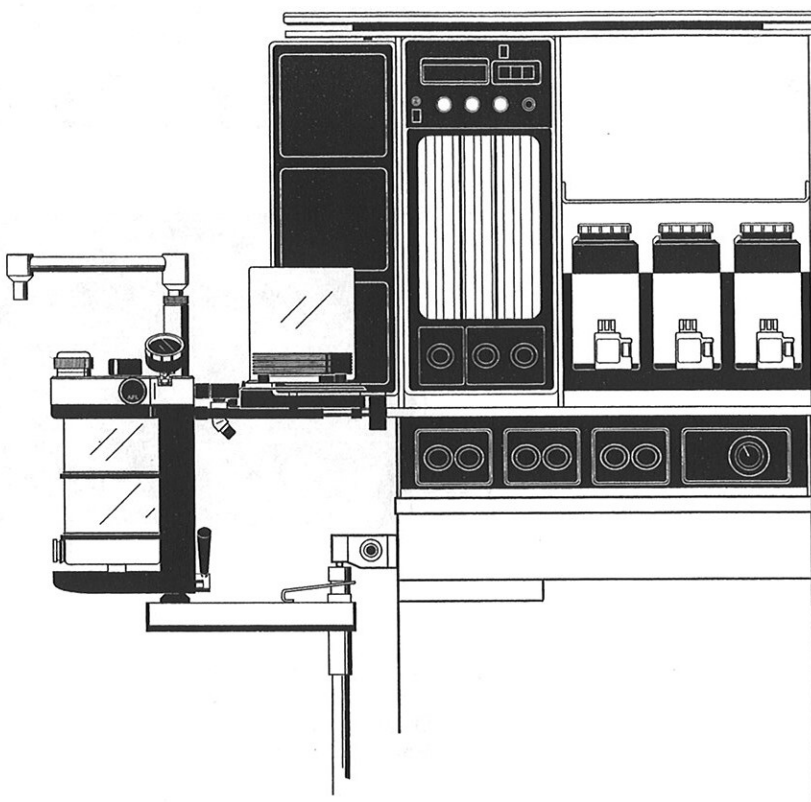


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2/Getting Started

Figure 2-9

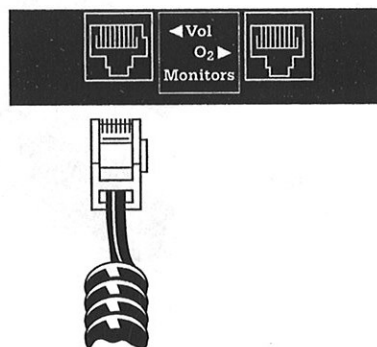
Control module
installed in Ohmeda
Modulus II Anesthesia
System with bellows
assembly mounted on
Ohmeda GMS Absorber
with interface manifold



AA.10.030

Figure 2-10

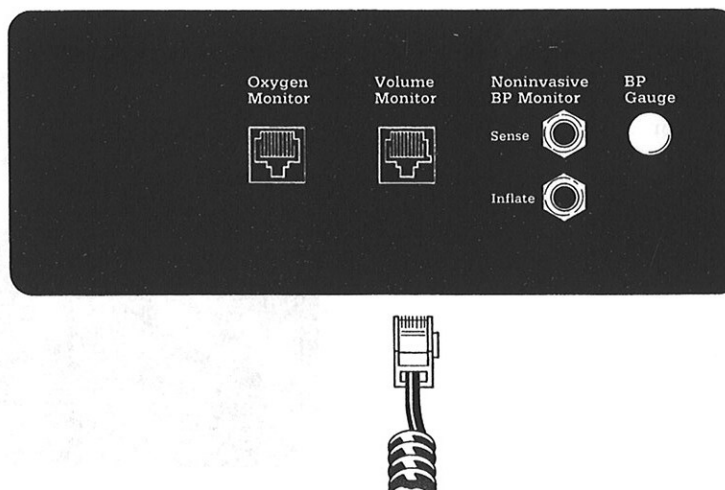
Sensor interface panel
on Ohmeda Excel
Anesthesia System



AA.32.008

Figure 2-11

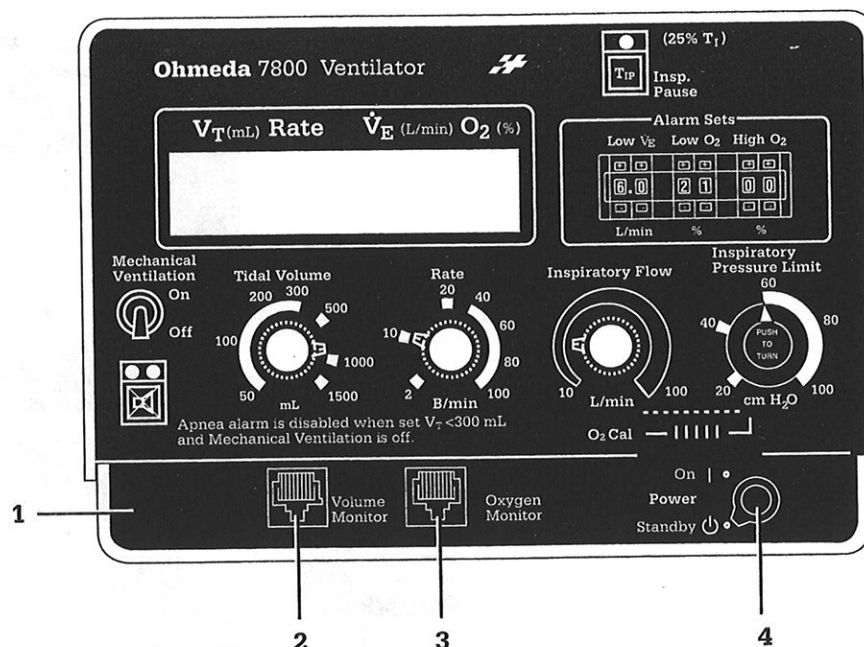
Sensor interface panel
on Ohmeda Modulus
Anesthesia System



AA.04.051

2/Getting Started

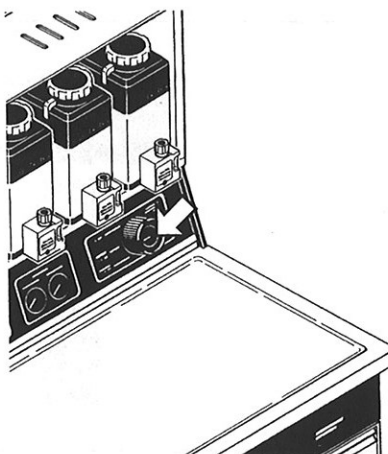
Figure 2-12
Sensor interface panel
on stand-alone Ohmeda
7800 Ventilator



1. Sensor interface panel
2. Volume monitor port
3. Oxygen monitor port
4. Power switch

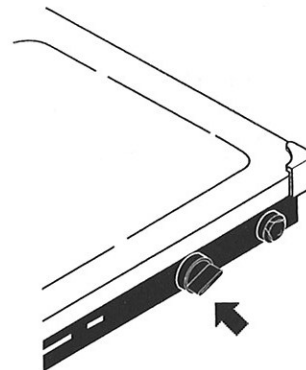
AA.10.107

Figure 2-13
System master switch
on Ohmeda Modulus
Anesthesia System



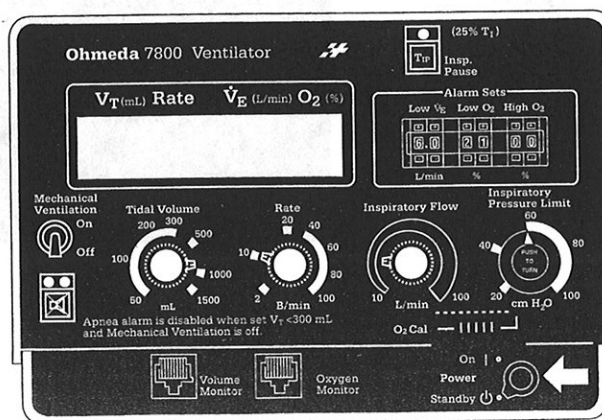
AA.04.048

Figure 2-14
System master switch
on Ohmeda Excel
Anesthesia System



AA.11.279

Figure 2-15
Power switch on stand-
alone Ohmeda 7800
Ventilator

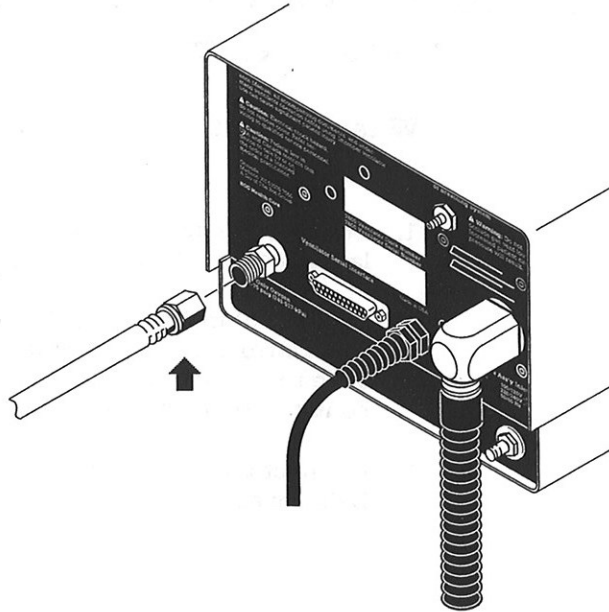


AA.10.107

2/Getting Started

Figure 2-16

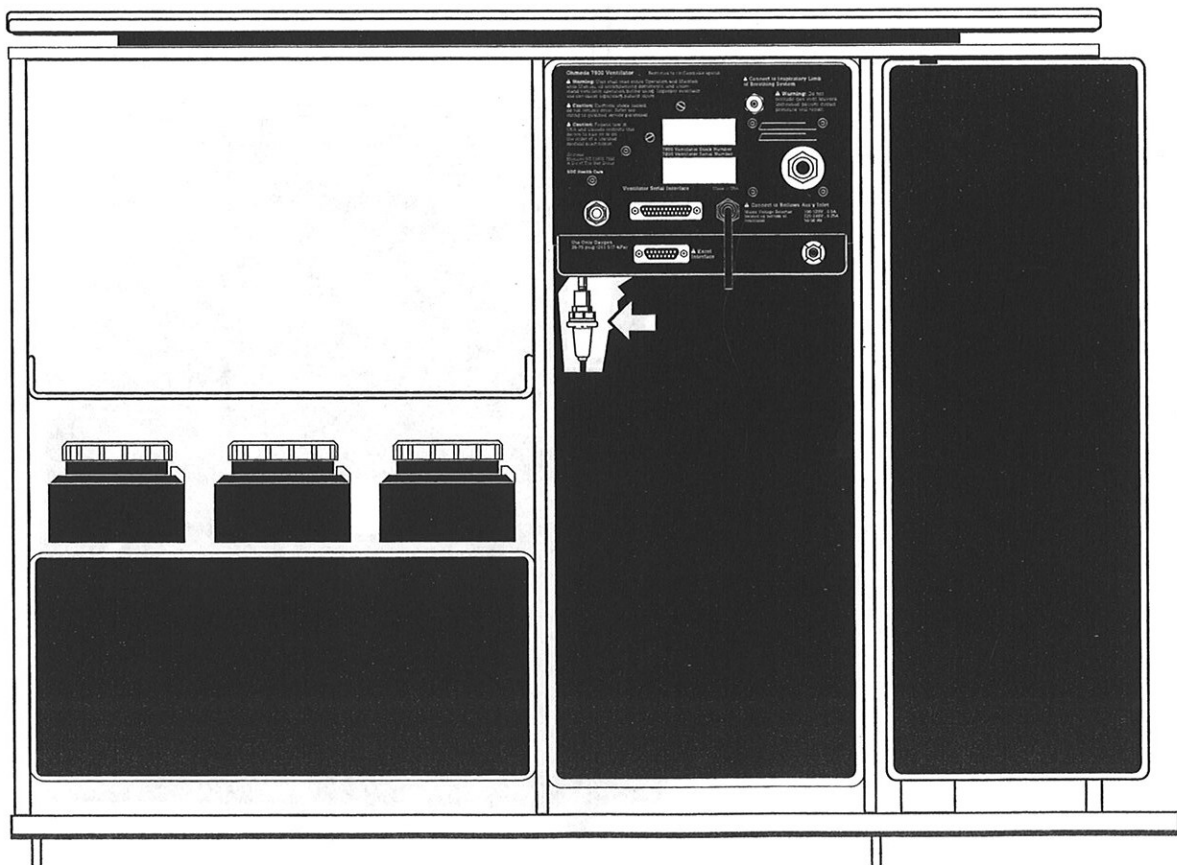
Supply gas connection
on configurations for
stand-alone use and
Ohmeda Excel
Anesthesia Systems



AA.10.016

Figure 2-17

Supply gas connection
on control module
installed in an Ohmeda
Modulus II Anesthesia
System



AA.10.047

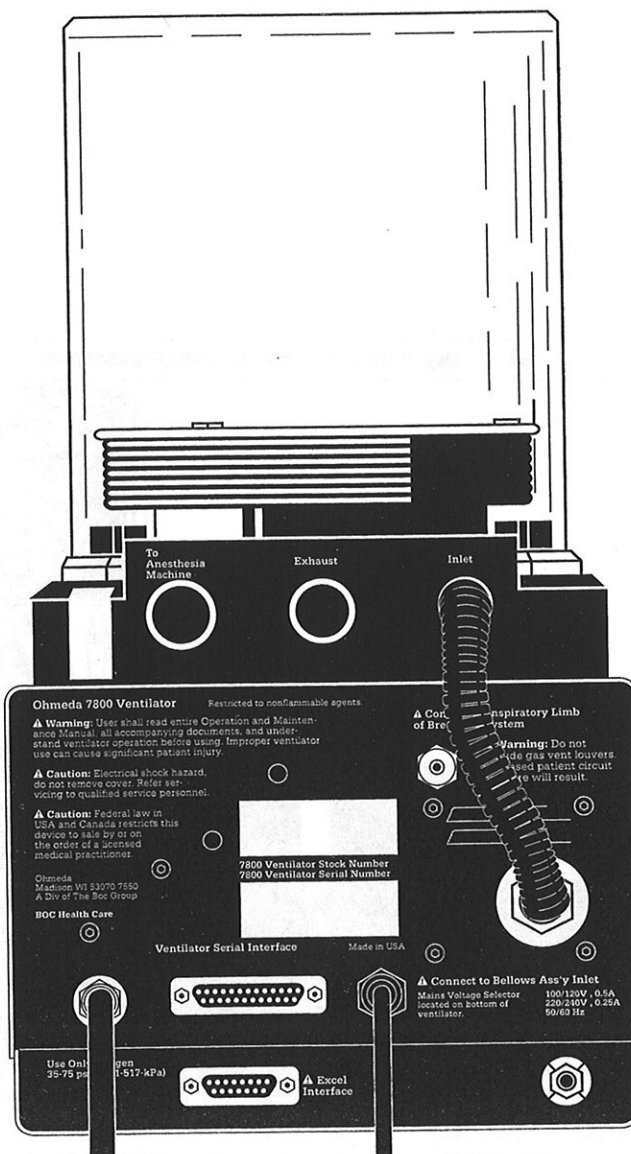
2/Getting Started

2.7 Setting up the control module when the ventilator is used as a stand-alone device

When the bellows assembly is mounted on the control module

1. Connect the supply gas hose to the control module's connector labeled either "use only oxygen" or "use only medical grade air."
2. A 23-cm (9-inches) long, 17-mm diameter tube carries drive gas from the control module to the bellows assembly. Connect one end of this tube to the connector labeled "connect to bellows ass'y inlet" on the control module's rear panel.
3. Connect the free end of the drive gas tube to the 17-mm inlet on the bellows assembly.

Figure 2-18
Connecting the drive-gas tube to a control module that has a bellows mounted on top



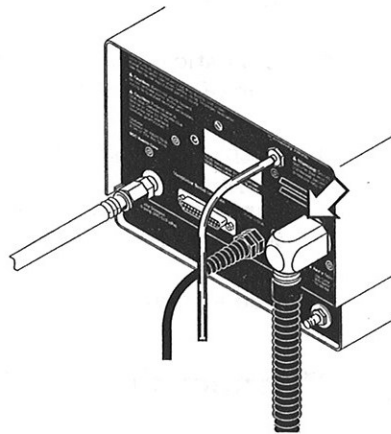
2/Getting Started

When the bellows assembly is mounted on an Ohmeda GMS Absorber

If the bellows assembly is mounted on the absorber, you'll need one of the optional kits listed as "Accessories" in the appendix to make these connections.

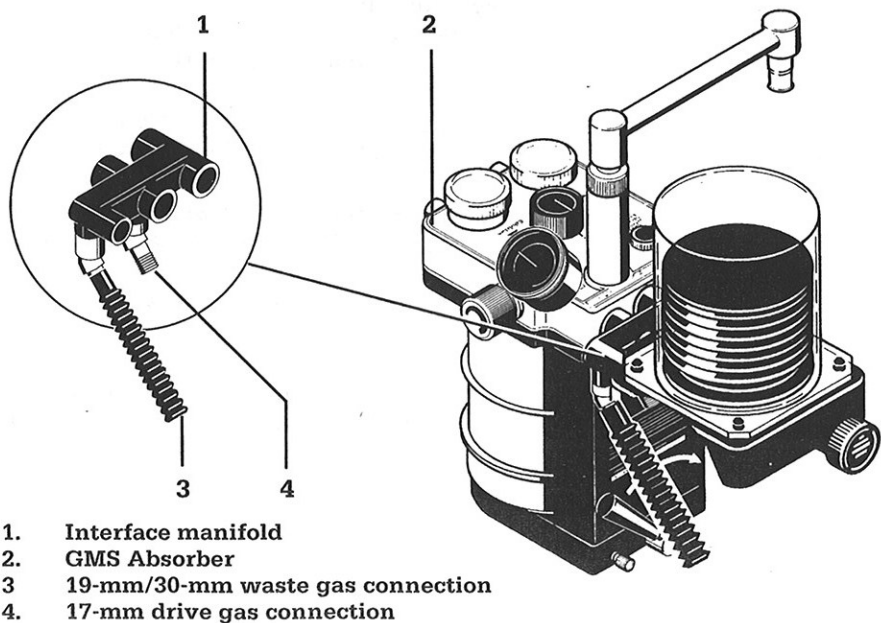
1. Connect the supply gas hose from the anesthesia system to the control module's connector labeled either "use only oxygen" or "use only medical grade air."
2. An optional, 195-cm (77-inches) long 17-mm diameter corrugated tube carries drive gas from the control module to the bellows assembly. Connect one end of this tube to the optional 90-degree adapter that connects to the control module. The 90-degree adapter has an internal O-ring; make sure it is in place.
3. Use the set screws on the 90-degree adapter to attach the adapter to the connector labeled "connect to bellows ass'y inlet" on the control module's rear panel.
4. Connect the free end of the 17-mm diameter corrugated tube to the absorber interface manifold's 17-mm, barbed connector.

Figure 2-19
Connecting the drive-
gas tube to the control
module for remote
bellows mount or Excel
Anesthesia system



AA.10.041

Figure 2-20
Connecting the drive-
gas tube to an Ohmeda
GMS Absorber
interface manifold



AA.10.046

AA.15.002

2/Getting Started

2.8 Setting up the control module with an Ohmeda Excel Anesthesia System

For the ventilator to function as an integrated component of an Ohmeda Excel Anesthesia System, the anesthesia system must contain internal wiring designed to accommodate the 7800 Ventilator. All Excel systems built since November 1989 contain this wiring. Older Excel systems must be modified by trained service personnel to work with the 7800 Ventilator.

Connect the Excel sensor interface

Sensors for the oxygen and volume sensors connect to the sensor interface panel — a small box that attaches to a "D" connector under the anesthesia system's table. You will need a small screwdriver to install this component.

1. Check the left side of the anesthesia machine, under the table, to see if the sensor interface is already installed. If the panel is not present, contact your Ohmeda service representative. The sensor interface is a small box that includes two connectors labeled "Vol" and "O₂." If the sensor interface is already in place, move on to "installing the interface cable."
2. A plastic cover protects the 15-pin, female "D" connector on the left side of the anesthesia machine, under the table. Remove this cover.
3. Align the 15-pin, male "D" connector on the interface box with the 15-pin, female connector on anesthesia machine. Make sure the two captive bolts in the box align with the corresponding threaded posts in the anesthesia machine. Press up gently.
4. Use a small screwdriver to tighten the two screws.

Connect the Excel sensor interface cable

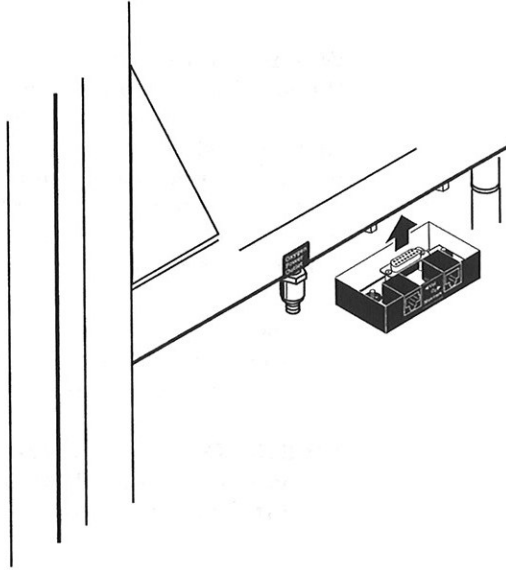
Signals from the sensor interface panel and the system master switch are routed to a 25-pin male "D" connector at the rear of the anesthesia system. This connector is labeled "ventilator/monitor pod interface." The Excel interface cable carries these signals from the 25-pin connector to the 15-pin connector on the ventilator's Excel interface panel.

1. Route the interface cable from the rear of the ventilator to the lower right of the anesthesia machine's back.
2. Insert the 15-pin male "D" connector on the cable into the 15-pin female "D" connector labeled "Excel interface" on the ventilator.
3. Tighten the two screws that hold the connector in place.
4. A plastic cover protects the 25-pin, male "D" connector (labeled "ventilator/monitor pod interface") mounted vertically at the lower right of the anesthesia machine's back. Remove this cover.

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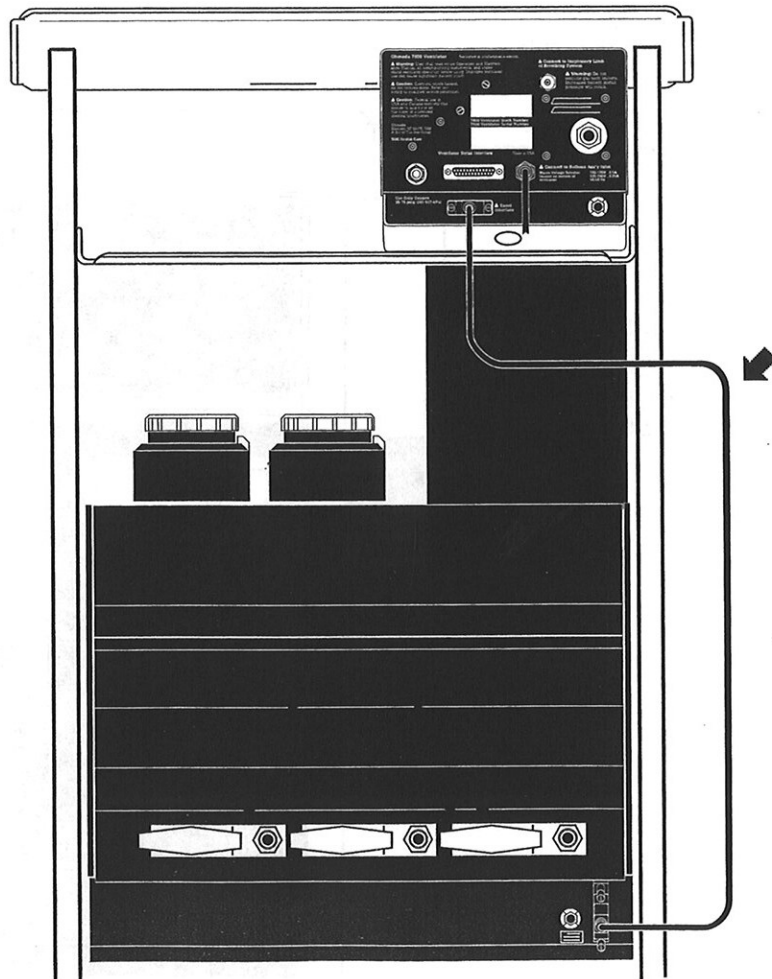
5. Insert the 25-pin, female "D" connector on the cable into the 25-pin, male "D" connector on the anesthesia machine.
6. Tighten the two screws that hold the connector in place.

Figure 2-21
Installing the Excel
sensor interface panel



AA.11.009

Figure 2-22
The Excel
interface cable



AA.10.043

2/Getting Started

The control module's location in an Ohmeda Excel Anesthesia System

On an Ohmeda Excel Anesthesia System, the ventilator's control module can be mounted on a shelf or on an optional arm installed in the dovetail mounting groove.

The control module's location on a shelf

When mounted from an Ohmeda Excel Anesthesia System's top shelf, the ventilator's control module will be in one of two locations, depending on the specific type of anesthesia machine you are using. On all Ohmeda Excel Anesthesia Systems sold in North America and Canada, and on many Ohmeda Excel Anesthesia Systems sold elsewhere, the control module is hung from the left side of the shelf. On some systems, however, the flow tubes extend into this area, so the control module instead is hung—using an optional bracket—from the right side of the shelf.

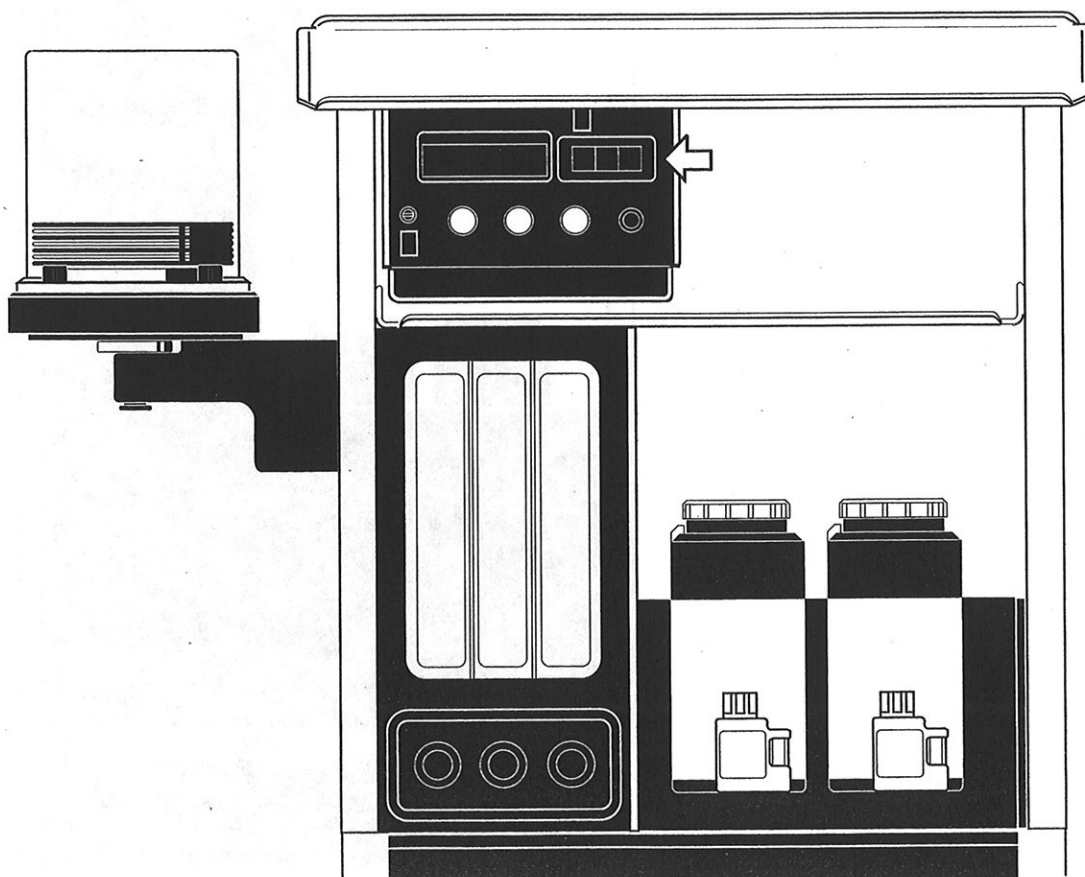
The control module on an arm

You can use an optional arm to mount the ventilator's control module to the dovetail groove on any Ohmeda Excel Anesthesia System. Instructions for installing the arm are included with the device.



WARNING: When the ventilator is mounted on a dovetail groove on an Ohmeda Excel Anesthesia Machine, extra weight must be added to the machine's base to reduce the possibility of the machine tipping over.

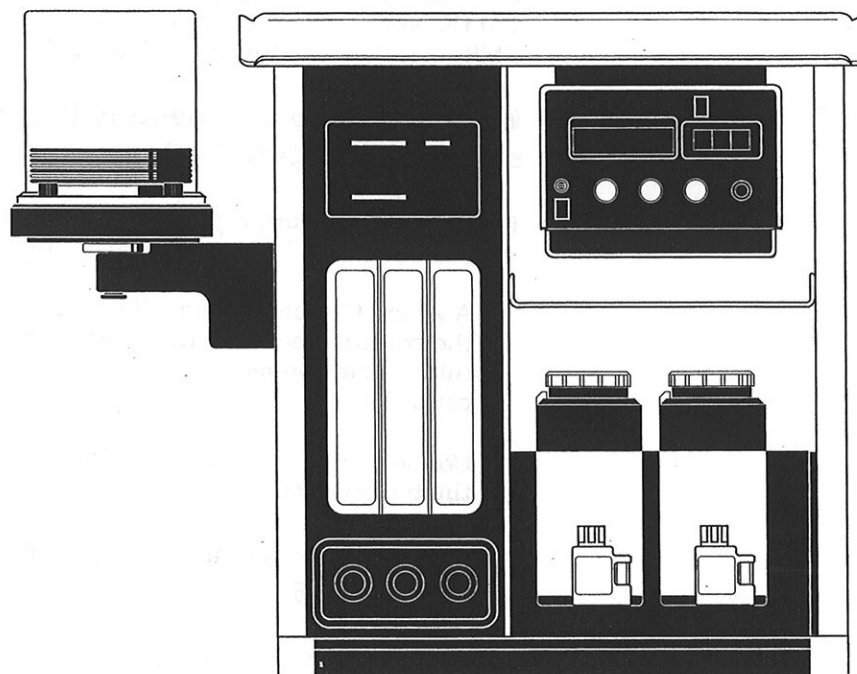
Figure 2-23
Control module
mounted on Ohmeda
Excel Anesthesia
System, over flow tubes



AA.10.018

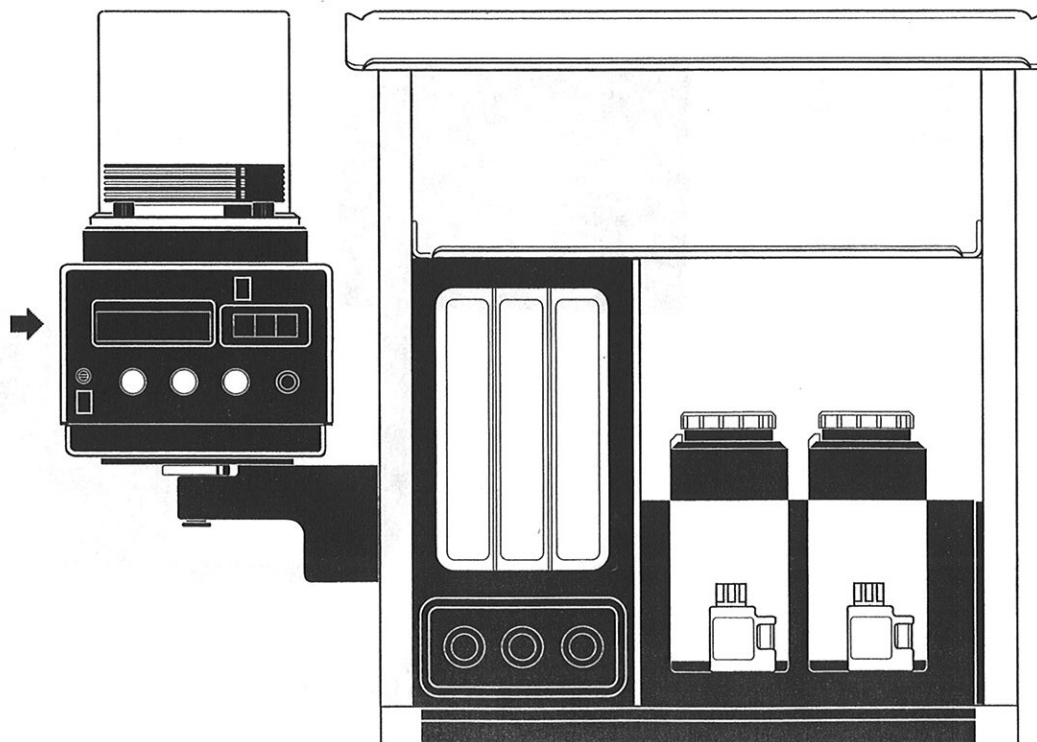
2/Getting Started

Figure 2-24
Control module
mounted on Ohmeda
Excel Anesthesia
System, next to flow
tubes



AA.10.138

Figure 2-25
Control module
mounted on arm on
dovetail groove track



AA.10.017

2/Getting Started

Connecting the control module to the bellows assembly

This section describes the connections between the bellows assembly and the ventilator's control module, for systems that include an Ohmeda GMS Absorber and for those that don't.

When the bellows assembly is mounted on the control module, see figure 2-18

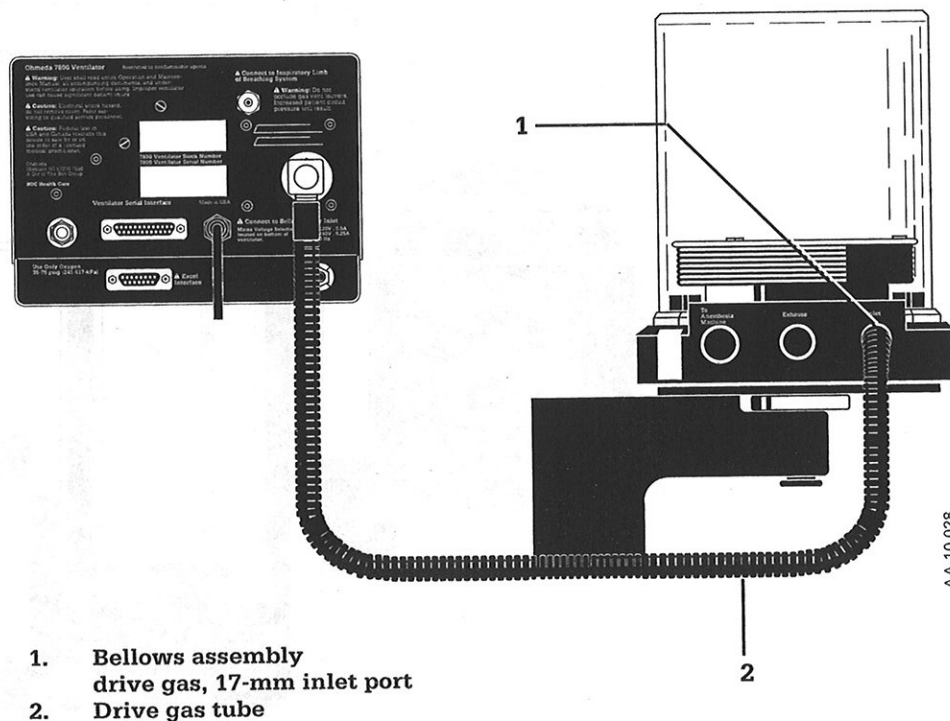
1. Connect the supply gas hose to the control module's connector labeled either "use only oxygen" or "use only medical grade air."
2. A 23-cm (9-inches) long, 17-mm diameter tube carries drive gas from the control module to the bellows assembly. Connect one end of this tube to the connector labeled "connect to bellows ass'y inlet" on the control module's rear panel.
3. Connect the free end of the drive gas tube to the 17-mm inlet port on the bellows assembly

When the bellows assembly is remotely located on an arm, see figure 2-26

To make these connections you'll need one of the optional kits listed as "Accessories" in the appendix.

1. Connect the supply gas hose to the control module's connector labeled either "use only oxygen" or "use only medical grade air."
2. An optional 100-cm (39-inches) long, 17-mm diameter corrugated tube carries drive gas from the control module to the bellows assembly. Connect one end of this tube to the optional 90-degree adapter that connects to the control module. The 90-degree adapter has an internal O-ring; make sure it is in place.

Figure 2-26
Connecting the drive-gas tube to a bellows assembly mounted on an arm



2/Getting Started

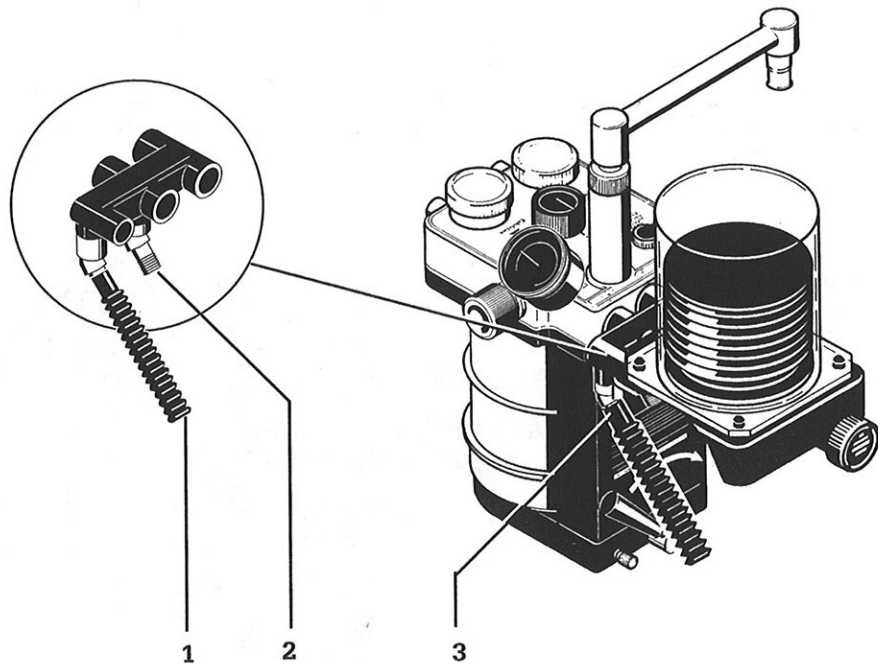
3. Use the set screws on the 90-degree adapter to attach the adapter to the connector labeled "connect to bellows ass'y inlet" on the control module's rear panel.

When the bellows assembly is mounted on an Ohmeda GMS Absorber, see figure 2-27

If the bellows assembly is mounted on the absorber, you'll need one of the optional kits listed as "Accessories" in the appendix to make these connections.

1. Connect the supply gas hose from the anesthesia system to the control module's connector labeled either "use only oxygen" or "use only medical grade air."
2. An optional, 195 cm long 17-mm diameter corrugated tube carries drive gas from the control module to the bellows assembly. Connect one end of this tube to the optional 90-degree adapter that connects to the control module. The 90-degree adapter has an internal O-ring; make sure it is in place.
3. Use the set screws on the 90-degree adapter to attach the adapter to the connector labeled "connect to bellows ass'y inlet" on the control module's rear panel.
4. Connect the free end of the 17-mm diameter corrugated tube to the absorber interface manifold's 17-mm, barbed connector.

Figure 2-27
Connecting the drive-
gas tube to the
absorber interface
manifold

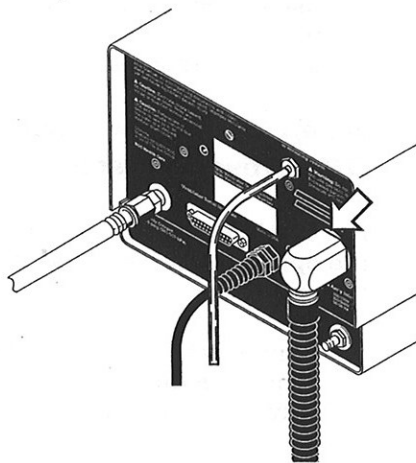


1. 17-mm manifold inlet port
2. 19-mm/30-mm manifold waste gas port
3. 17-mm drive gas tube from control module "Connect to bellows ass'y inlet"

2/Getting Started

Figure 2-28

Connecting the drive-gas tube to the control module



AA.10.041

2.9 Setting up the control module with an Ohmeda Modulus II Anesthesia System

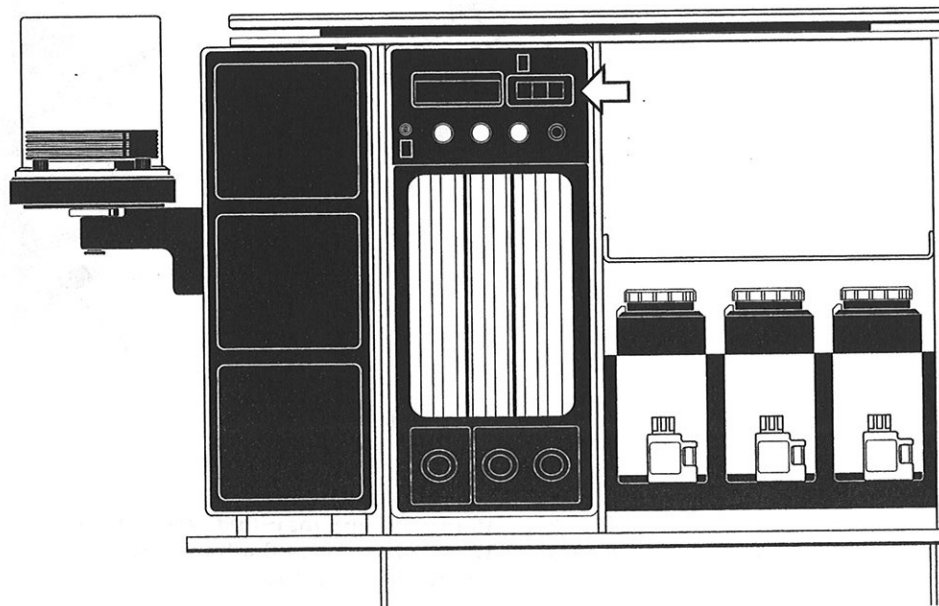
The control module's location on an Ohmeda Modulus® II Anesthesia System

One of the Ohmeda 7800 Ventilator's three configurations is designed so that the ventilator's control module can be installed as an integrated part of an Ohmeda Modulus II Anesthesia System. When the anesthesia system is retrofitted with an Ohmeda 7800 Ventilator, the supply gas is connected internally, monitoring signals are routed internally from the anesthesia machine's sensor interface panel to the control module, and the control module is connected so that it is powered ON and OFF by the anesthesia machine's master switch.

Removing and reinstalling the control module

Only a trained service representative can modify an Ohmeda Modulus II Anesthesia System to include an Ohmeda 7800 Ventilator as an integrated component.

Figure 2-29
Control module's location in an Ohmeda Modulus II Anesthesia System



AA.10.020

2/Getting Started

Connecting the control module to the bellows assembly

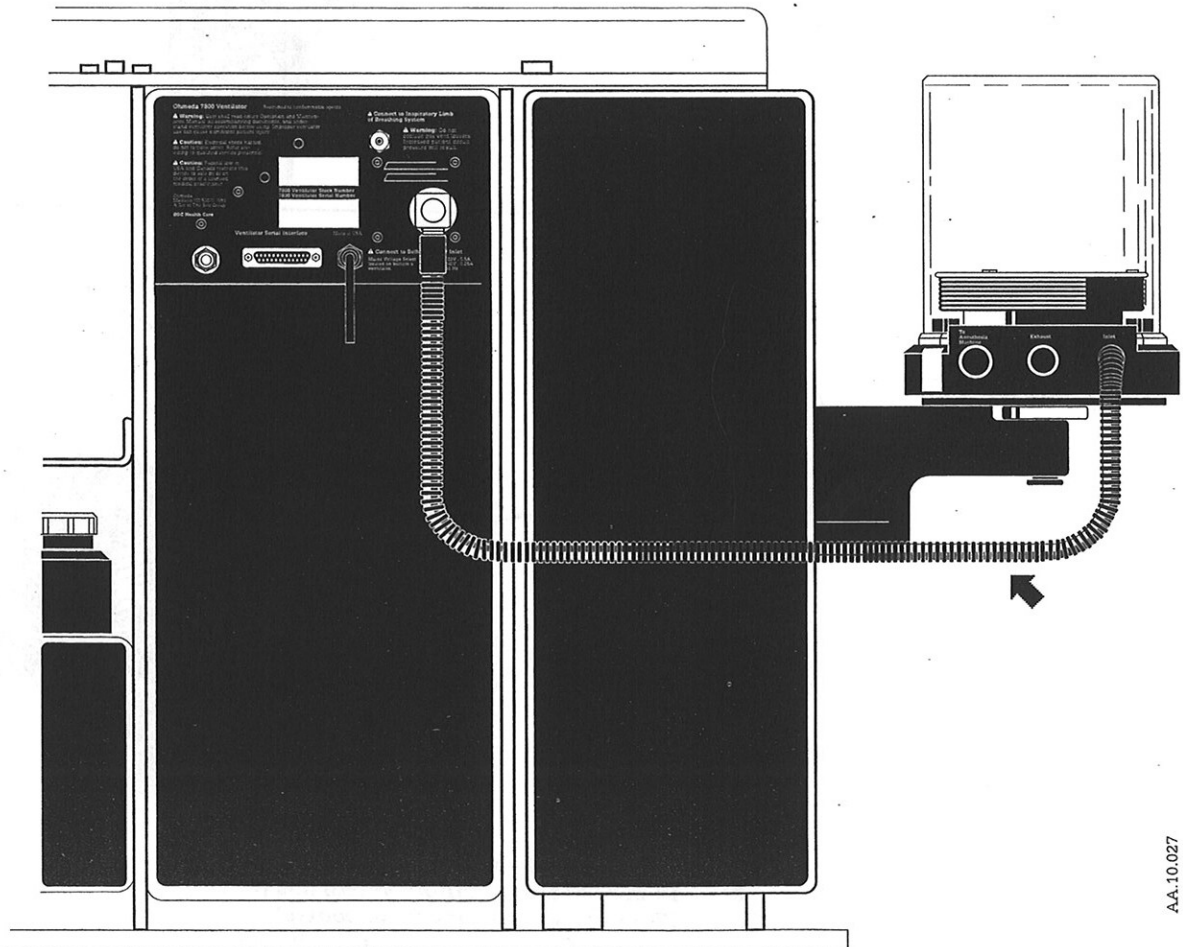
When the bellows assembly is remotely located on a bracket

To make these connections you'll need one of the optional kits listed as "Accessories" in the appendix.

1. An optional, 100-cm (40-inches) long 17-mm diameter corrugated drive gas tube carries drive gas from the control module to the bellows assembly. Connect one end of this tube to the optional 90-degree adapter that connects to the control module. The 90-degree adapter has an internal O-ring; make sure it is in place.
2. Use the set screws on the 90-degree adapter to attach the adapter to the connector labeled "connect to bellows ass'y inlet" on the control module's rear panel.
3. Connect the free end of the 17-mm drive gas tube to the 17-mm port on the bellows assembly.

Figure 2-30

Connecting the drive-gas tube to a bellows assembly mounted on a bracket on an Ohmeda Modulus II Anesthesia System



AA-10.027

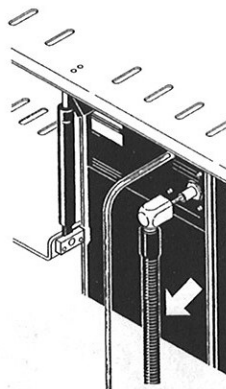
2/Getting Started

When the bellows assembly is mounted on an Ohmeda GMS Absorber

If the bellows assembly is mounted on the absorber, you'll need one of the optional kits listed as "Accessories" in the appendix to make these connections.

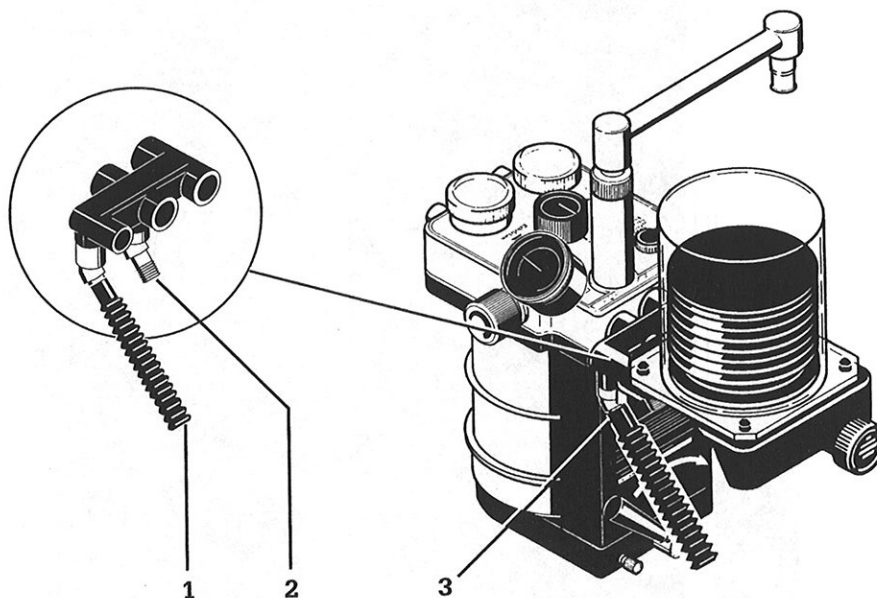
1. Connect the supply gas hose from the anesthesia system to the control module's connector labeled either "use only oxygen" or "use only medical grade air."
2. An optional, 195-cm (77-inches) long 17-mm diameter corrugated tube carries drive gas from the control module to the bellows assembly. Connect one end of this tube to the optional 90-degree adapter that connects to the control module. The 90-degree adapter has an internal O-ring; make sure it is in place.
3. Use the set screws on the 90-degree adapter to attach the adapter to the connector labeled "connect to bellows ass'y inlet" on the control module's rear panel.
4. Connect the free end of the 17-mm supply gas tube to the absorber interface manifold's 17-mm, barbed connector.

Figure 2-31
Connecting the drive-
gas tube to the control
module



AA.15.008

Figure 2-32
Connecting the drive-
gas tube to the
absorber interface
manifold



1. 17-mm manifold inlet port
2. 19-mm/30-mm manifold waste gas port
3. 17-mm drive gas tube from control module "Connect to bellows ass'y inlet"

AA.10.046

AA.15.002

2/Getting Started

2.10 Connecting the bellows assembly to an absorber

As with the control module, the location of the bellows assembly depends on the type of anesthesia system you use and the way it is set up. On systems that include an Ohmeda GMS Absorber, an interface manifold can be used to mount the bellows assembly directly to the absorber. (Several interface manifold kits are available; see "Accessories" on the appendix.) On other systems the bellows assembly can either be mounted on a special bracket or attached to the top of the control module.

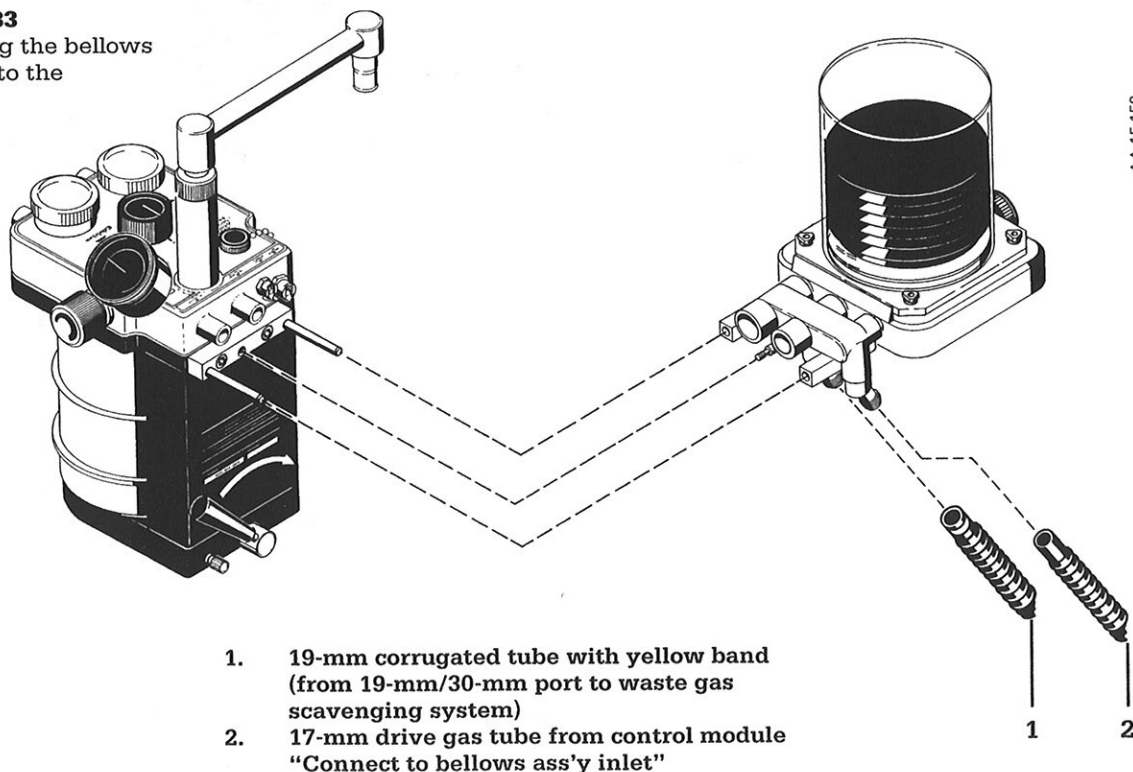
Connecting the bellows assembly directly to an Ohmeda GMS Absorber using the absorber-interface manifold

To make these connections you'll need one of the optional kits listed as "Accessories" in the appendix.

Connecting the bellows assembly to the absorber

1. Align the two square-shaped support guides on the bottom of the bellows assembly with the two support pins on the back of the absorber.
2. Insert the support pins into the support guides and slide the bellows assembly toward the absorber until the interface manifold touches the absorber's ports.
3. Align the bellows assembly's locking rod with the threaded hole between the two screws on the absorber's support-pin block.
4. Turn the bellows assembly's locking knob clockwise until the absorber interface manifold is securely connected to the absorber and the knob won't turn further.

Figure 2-33
Connecting the bellows assembly to the absorber



2/Getting Started

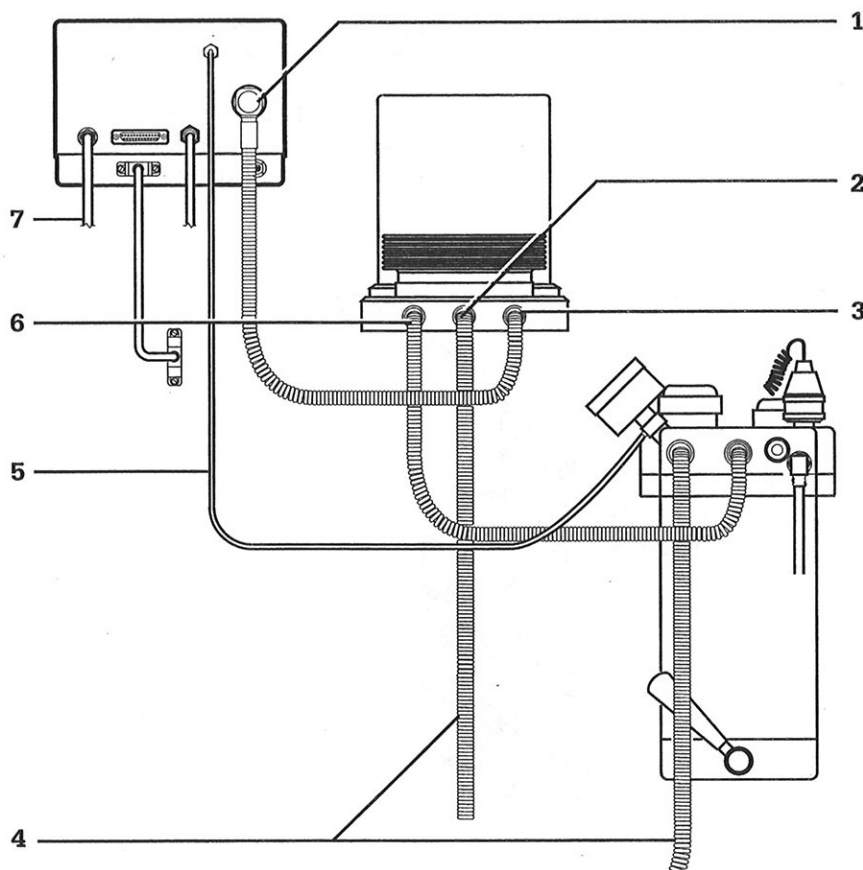
5. Connect the 17-mm barbed connector on the interface manifold to the tube fitted to the 90-degree adapter on the control module. This adapter is connected to the control module connector labeled "connect to bellows ass'y inlet" on the module's rear panel.
6. Connect one end of a yellow-banded, corrugated 19-mm diameter tube to the connector labeled "excess gas outlet 19-mm/30-mm" on the absorber manifold.
7. Connect the other end of the 19-mm diameter tube to a waste gas scavenging system.

Connecting the bellows assembly without an absorber-interface manifold

If you do not use an Ohmeda GMS Absorber, or you do not use the absorber-interface manifold to mount the bellows assembly to the Ohmeda GMS Absorber, you must use tubing to connect the absorber to the bellows assembly.

1. Use 22-mm diameter, corrugated tubing to connect the bellows assembly's left most port (22-mm), facing the ventilator port connections, to the absorber's ventilator port (22-mm).

Figure 2-34
Connections between
an absorber and a
bellows assembly



- | | |
|---------------------|-----------------------------------|
| 1. Drive gas tube | 4. To waste gas scavenging system |
| 2. 19-mm/30-mm port | 5. Pressure sensing line |
| 3. 17-mm port | 6. 22-mm port |
| | 7. Supply gas |

2/Getting Started

2. Use 19-mm diameter tubing to connect the bellows assembly's middle port (19-mm/30-mm) to the scavenging system.
3. Connect one end of another yellow-banded, corrugated 19-mm diameter tube between the absorber's excess gas outlet and a waste gas scavenging system.

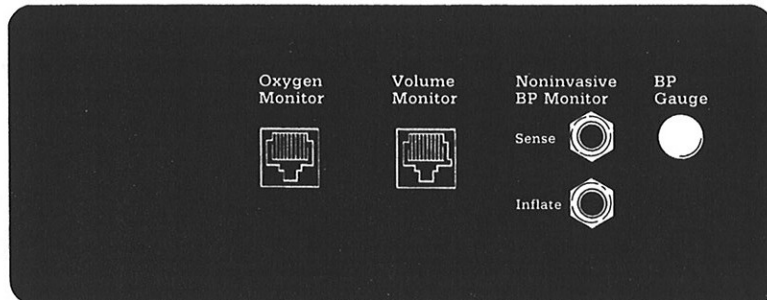
2.11 Making the monitoring connections

Where monitors connect

How you make the monitoring connections depends on the type of anesthesia system and absorber you use. Both the Ohmeda Modulus II Anesthesia System and the Ohmeda Excel Anesthesia System include a sensor interface panel that connects the ventilator's oxygen- and volume-sensor cables to the control module. On other systems, all of which use the stand-alone configuration, these cables connect directly to the lower front of the control module. At the sensor end of the connections, the Ohmeda GMS Absorber provides ports that connect the oxygen sensor and pressure-sensing tube to the inspiratory side of the breathing circuit. To provide these ports for other types of absorbers use the adapters that are provided with the ventilator.

Figure 2-35

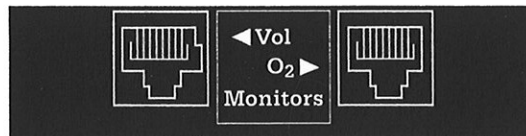
Sensor interface panel on Ohmeda Modulus II Anesthesia System



AA.04.051

Figure 2-36

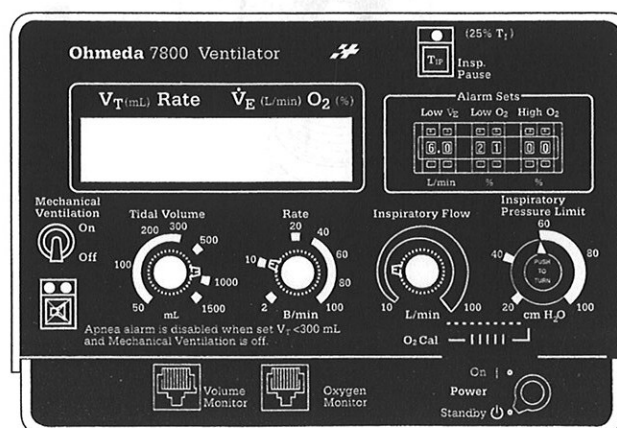
Sensor interface panel on Ohmeda Excel Anesthesia System



AA.32.041

Figure 2-37

Sensor interface panel on stand-alone ventilator



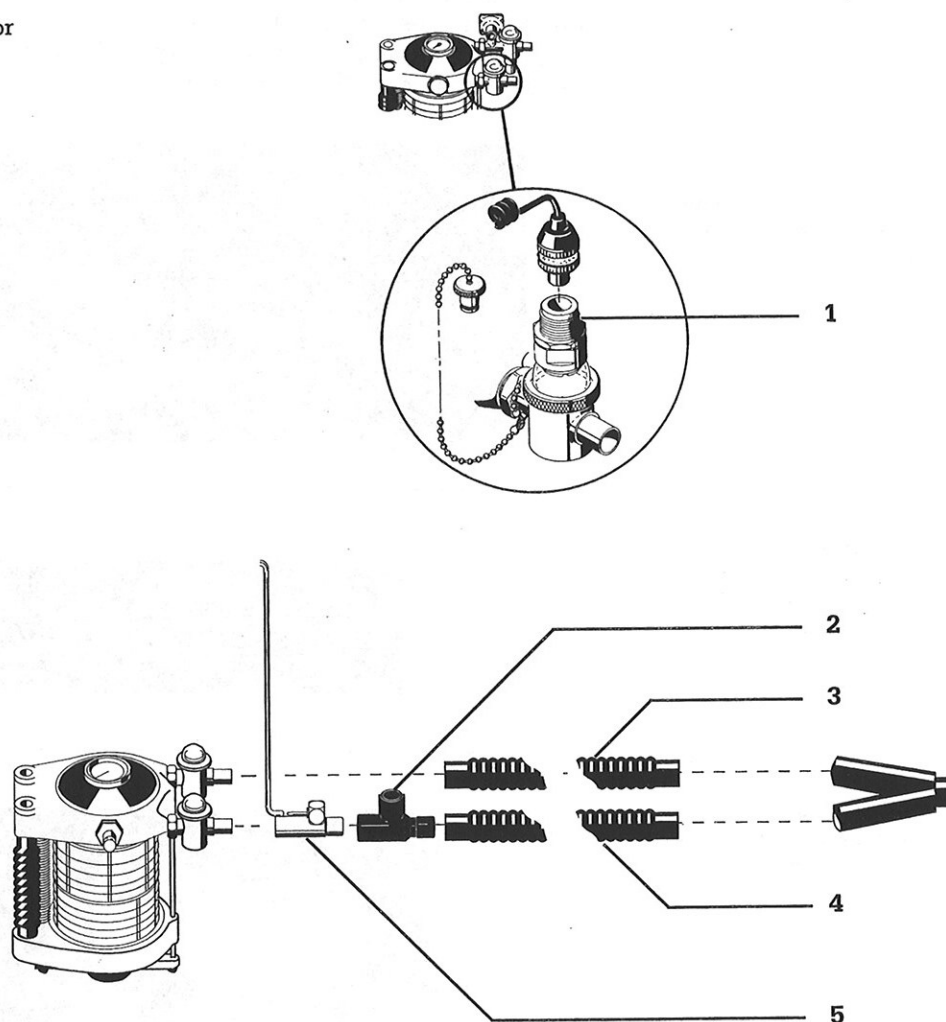
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Inserting the monitoring adapters for systems that do not include an Ohmeda GMS Absorber

The Ohmeda GMS Absorber includes ports that connect both the oxygen sensor and the pressure-sensing tube directly to the inspiratory side of the breathing circuit. If your system does not include an Ohmeda GMS Absorber, use the adapters that are included with the ventilator to connect these devices to the breathing circuit's inspiratory limb. To provide a tap into the inspiratory limb for the pressure monitoring, use a patient-circuit pressure-sensing tee. To provide a port for the oxygen sensor, use an oxygen-sensing tee. If your system includes either an Ohmeda Model 20 and 21 absorber, you may install—in place of the oxygen-sensing tee manifold—an optional dome adapter kit, which provides a direct tap to the inspiratory side of the breathing circuit for the oxygen sensor.

Figure 2-38
Monitoring adapters for
systems that do not
include an Ohmeda
GMS Absorber



1. Oxygen port
2. Oxygen sensing tee
3. Expiratory limb
4. Inspiratory limb
5. Pressure sensing tee

AA.15.022

AA.15.104

2/Getting Started

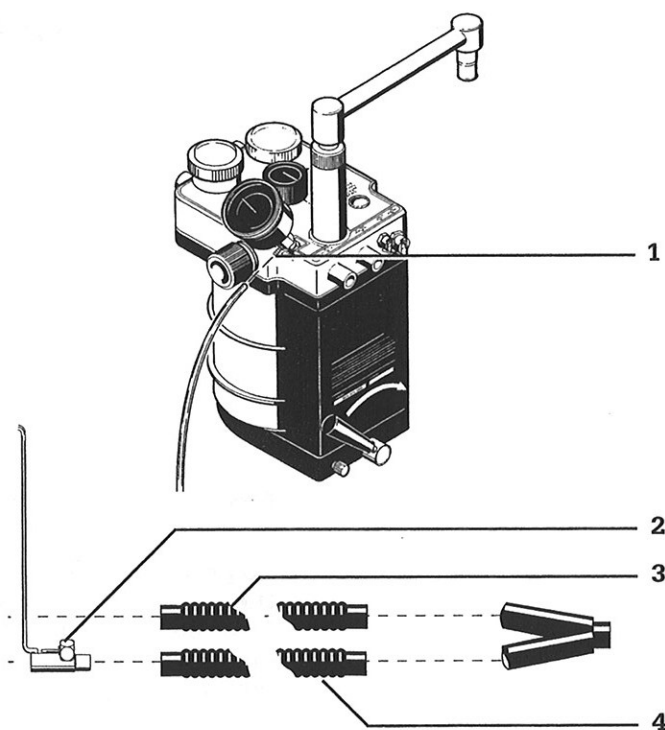
Connecting the pressure sensing tube

The airway-pressure sensor is housed in the control module. A clear, 3-mm (1/8-inch) tube connects between the control module and the distal sensing tee, into the inspiratory limb of the breathing circuit between the absorber and the absorber's pressure gauge. This tee can also be installed on older Ohmeda GMS Absorbers. If you want to use the ventilator without an Ohmeda GMS Absorber, you must first install an in-line, pressure-sensing tee in the inspiratory limb of the breathing circuit (see "Inserting the monitoring adapters for systems that do not include an Ohmeda GMS Absorber").

Correct location of the pressure gauge and distal sensing tee on the absorber

For pressure monitoring to function correctly, the distal-sensing tee must connect to the inspiratory side of the breathing system. If you are not sure that your absorber's pressure gauge (and distal sensing tee) is connected to the inspiratory side of the breathing system, perform the test described in "Checking the absorber pressure gauge location" in the appendix.

Figure 2-39
Connecting the pressure-sensing tube to the absorber or pressure-sensing tee



1. Barbed connector
2. Pressure sensing tee
3. Expiratory flow
4. Inspiratory flow

1. A barbed connector on either the absorber's pressure gauge (on Ohmeda GMS Absorbers) or the patient-circuit adapter provides the distal-sensing tee for the ventilator's pressure sensor. Install one end of the sensing tube onto the barbed fitting.
2. Install the tube's free end onto the barbed connector labeled "connect to inspiratory limb of breathing circuit" on the control module's rear panel.

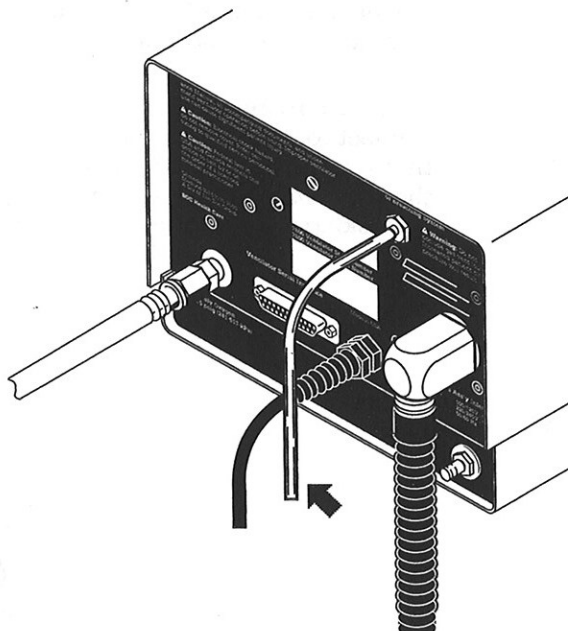
2/Getting Started



WARNING: Position the pressure-sensing tube so that the absorber arm cannot pinch the tube. If the tube is pinched, the system's pressure monitoring will not function correctly.

WARNING: When used, the oxygen-sensor adapter and the pressure-sensor's patient-circuit adapter must be connected to the inspiratory side of the patient breathing system. If these devices are not correctly connected to the inspiratory side of the patient breathing system, oxygen and pressure monitoring and related alarms will not function properly.

Figure 2-40
Connecting the
pressure-sensing tube
to the ventilator



AA.10.041

Connecting the volume sensor

To provide information about the volume of each exhaled patient breath, the ventilator measures the amount of gas that passes through a sensor inserted in the breathing circuit. The ventilator makes calculations based on this measurement, and then displays the calculated tidal volume, minute volume, and breath rate on the control module's front panel.

The volume sensor assembly includes a cartridge with a vane whose rotational speed varies depending on the gas flow rate, and a sensor clip that translates the direction and speed of the vane's rotation into electrical pulses. This cartridge must be placed in the expiratory limb of the breathing circuit, either in the distal or proximal position. Placing the cartridge at the distal position in the expiratory limb lets the system detect reverse flow and generate reverse flow alarms. You may also place the volume sensor cartridge at the proximal end of the "Y" connector; however, you then must use the setup page to disable the reverse flow alarms that would otherwise be generated when the patient inhales.

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WARNING: When the volume sensor is in the distal position of the breathing circuit, confirm that the reverse-flow alarm is enabled. Do not use the system with the reverse-flow alarm disabled if the volume sensor is in the distal position.

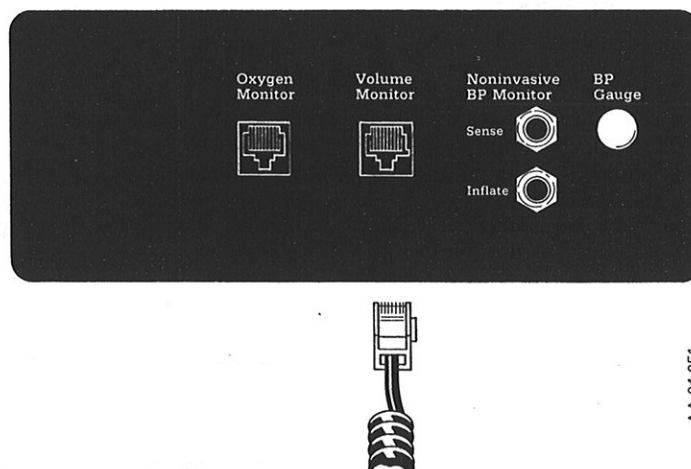
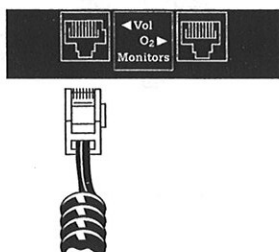
To install the volume sensor assembly:

1. Insert the sensor cable plug into the receptacle marked "volume monitor" on either the anesthesia machine's sensor interface panel or the ventilator's control module.
2. Install the sensor cartridge between the absorber's exhalation port and the expiratory limb of the breathing circuit. You may also install the cartridge at the proximal end of the "Y" connector.

If you are using a Bain circuit

If you connect a Bain circuit and Bain circuit adapter to the Ohmeda 7800 Ventilator, you must place the volume sensor assembly in the proximal position, between the end of the Bain circuit and the patient connector to the ET tube or mask. (See "Using a Bain circuit" in the appendix.)

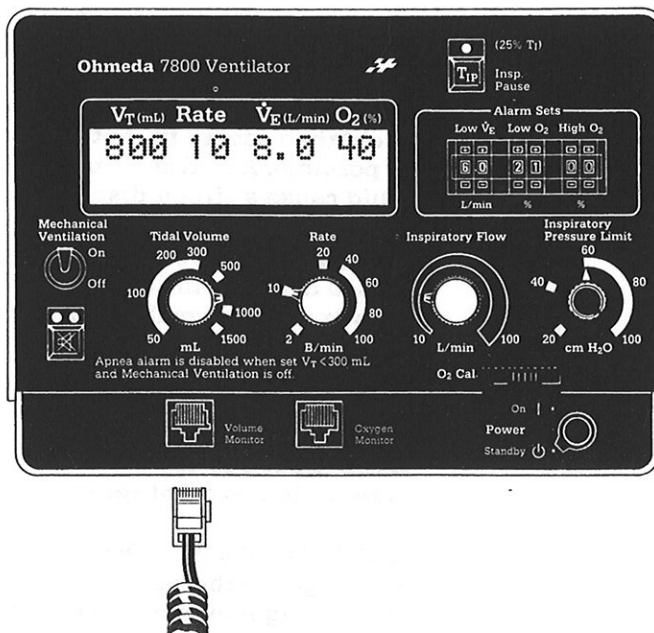
Figure 2-41
Connecting the volume sensor to an anesthesia machine's sensor interface panel



AA.04.051

AA.32.008

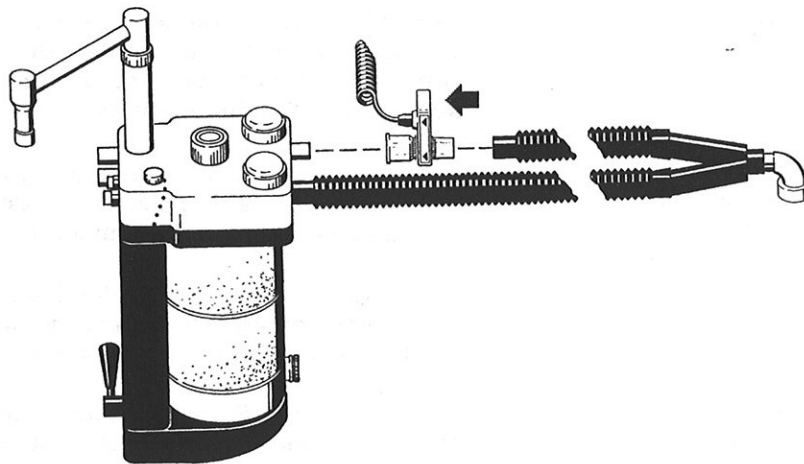
Figure 2-42
Connecting the volume sensor to the control module



AA.10.015

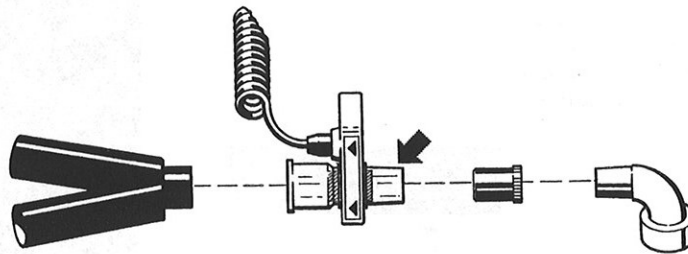
2/Getting Started

Figure 2-43
Inserting the volume
sensor into the distal
location in the
breathing circuit



AA.15.010

Figure 2-44
Inserting the volume
sensor into the
proximal location in the
breathing circuit



AA.10.015

3. Clip the sensor over the cartridge. The arrows on the sensor must point in the direction of gas flow during expiration; toward the absorber and away from the patient.
4. Check the volume sensor as described in "Checking the volume sensor" section "6/Maintaining the Ventilator." Replace the volume sensor cartridge at least every thirty days.



WARNING: Take care not to crack or break the volume sensor cartridge. When you are placing the cartridge on the absorber, be certain to obtain a secure fit, but do not force the cartridge in place as tightly as possible. Avoid striking the cartridge. A broken or cracked cartridge could cause a circuit disconnection and a break in the breathing circuit.

WARNING: The volume cartridge and sensor must be correctly installed at either the distal location in the patient circuit's expiratory limb or the proximal end of the "Y" connector. If the cartridge and sensor are installed incorrectly, volume data will be inaccurate and associated alarms, including the apnea and low-minute-volume alarms, will not function properly.

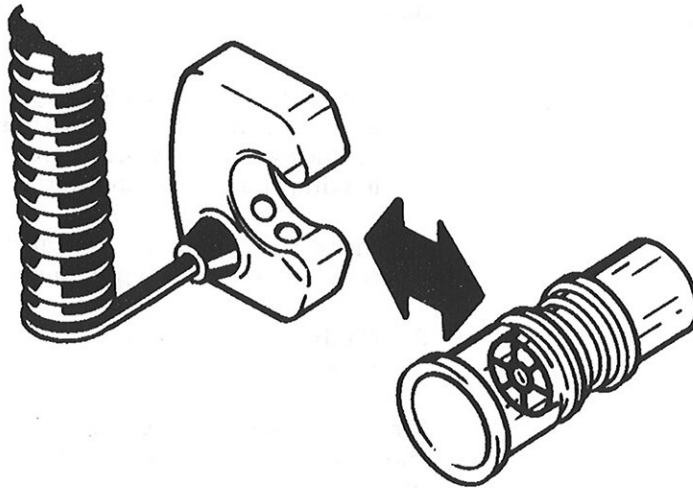
WARNING: Destroy old or malfunctioning volume sensor cartridges to prevent inadvertent reuse.

WARNING: Position the volume sensor's cable so that the absorber arm cannot pinch the cable. If the cable is pinched, the system's volume monitoring may not function correctly.

2/Getting Started

Figure 2-45

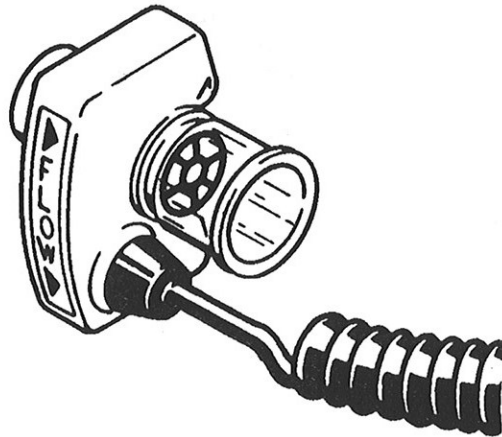
Attaching the volume clip to the volume sensor cartridge



MD.10.016

Figure 2-46

Volume clip correctly installed on volume sensor cartridge



MD.10.017

Connecting the oxygen sensor

General



WARNING: Disconnecting the O₂ sensor without removing and shorting the sensor cartridge can cause false high O₂ readings that may take hours to stabilize.



CAUTION: The cable on the O₂ sensor must point up to help keep the contacts and the front of the cartridge free of condensate.

A newly installed O₂ sensor cartridge needs five minutes of connection time to stabilize. This waiting period has nothing to do with the sensor response time which is much faster.

When installing a new O₂ sensor cartridge retain the shorting clip or disk to reuse if the cartridge must be removed for maintenance.

2/Getting Started

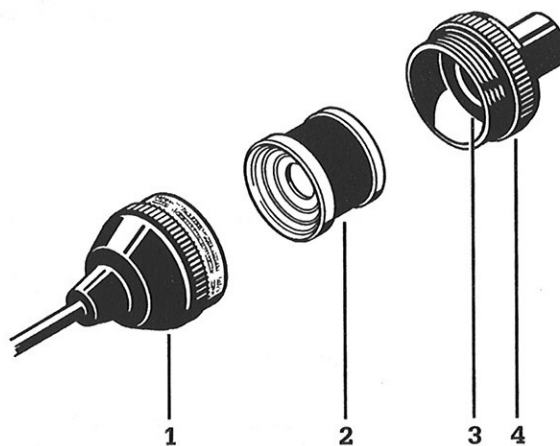
See "6/Maintaining the Ventilator." for information on sensor housing disassembly and reassembly as well as maintaining and replacing the oxygen sensor cartridge.

1. Insert the sensor cable plug into the oxygen monitor receptacle marked either on the anesthesia machine's sensor interface panel or on the ventilator's control module. To reduce cartridge wear, avoid leaving the sensor unplugged.
2. Insert the sensor into either the absorber's sensor port or the port provided by the oxygen-sensor tee in the inspiratory limb.
3. Calibrate the oxygen sensor as described in "6/Maintaining the Ventilator."

If any part of the sensor assembly is damaged or malfunctions, replace the entire assembly. In addition, the oxygen cartridges wear out and must be periodically replaced. See "6/Maintaining the Ventilator." for information about maintaining and replacing the oxygen sensor cartridge.

If, during operation, the sensor's temperature is lower than or equal to the breathing gas dew point temperature, water vapor will condense on the sensor's sensor screen. This condensate may reduce the amount of oxygen reaching the sensor's screen, causing the ventilator to display lower than actual oxygen-concentration values.

Figure 2-47
Oxygen sensor,
exploded view



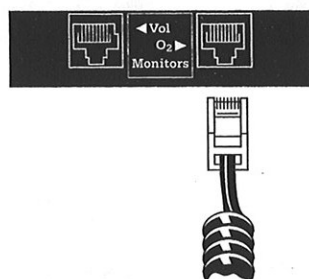
1. Sensor Housing
2. Oxygen sensing cartridge
3. Inner O-ring
4. Outer O-ring

MD-02.032

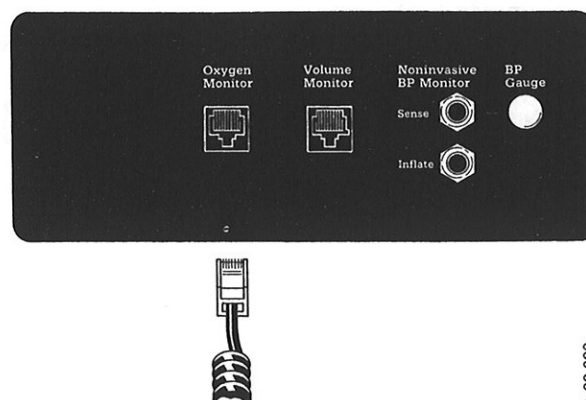
2/Getting Started

Figure 2-48

Connecting the oxygen sensor to an anesthesia machine's sensor interface panel



Excel interface panel

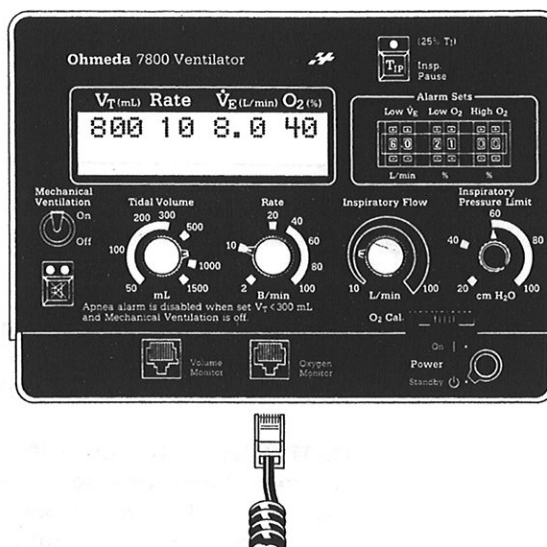


Modulus II interface panel

AA.32.029
AA.04.053

Figure 2-49

Connecting the oxygen sensor to the ventilator's interface panel on a stand alone ventilator.



AA.10.026



WARNING: Position the oxygen sensor's cable so that the absorber arm cannot pinch the cable. If the cable is pinched, the system's oxygen monitoring may not function correctly.

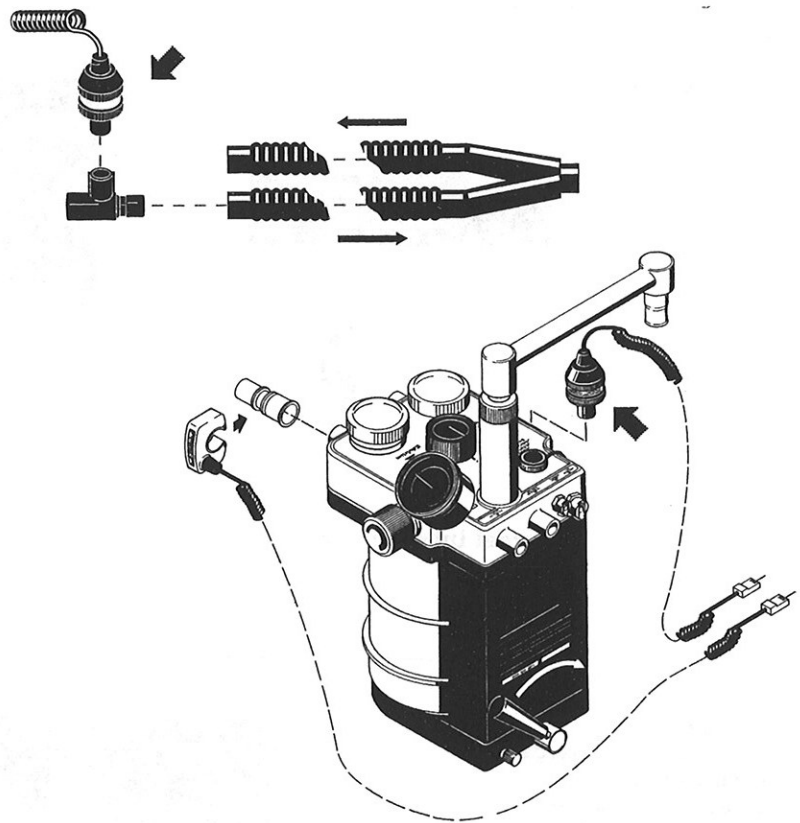
WARNING: When used, the oxygen-sensor adapter and the pressure-sensor's patient-circuit adapter must be connected to the inspiratory side of the patient breathing system. If these devices are not correctly connected to the inspiratory side of the patient breathing system, oxygen and pressure monitoring and related alarms will not function properly.



CAUTION: When in use, the oxygen sensor should always point down to reduce condensation collecting on the sensor surfaces.

2/Getting Started

Figure 2-50
Oxygen sensor
locations, see
"Accessories and
Replaceable parts for
oxygen sensor tee part
number



AA.04.053

AA.04.053

2.11 Charging the battery

A built-in rechargeable battery provides backup power to the ventilator. This battery is shipped uncharged. Before using the ventilator on a patient, plug the control module into an energized a-c ~ outlet and turn it on for at least 24 hours to charge the battery.



CAUTION: If the integrity of the protective earth ground is in question, the ventilator may be run on its fully charged battery. However, this internal battery is for backup and not intended to operate the ventilator unless there is an emergency situation.

Long Term Ventilator Storage

It is not necessary to disconnect the rechargeable battery before long term storage.

If the ventilator is to be stored for an extended period of time (greater than 3 months), the batteries will eventually discharge. This is not destructive to the ventilator or the batteries, however, the batteries must be fully recharged before putting the ventilator into service.

3/General Information

In this section

- 3.0 The controls, connectors, and display 3-1
 - The ventilator control module's front panel 3-1
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- 3.1 The ventilator's modes 3-7
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 - Oxygen monitoring 3-18
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3.0 The controls, connectors, and display

The Ohmeda 7800 Ventilator consists of two basic units: the bellows assembly, which contains the bellows and bellows housing, and the control module, containing the ventilator's control valves, processing circuits, controls, and display screen.

The control module serves three functions:

- it controls mechanical ventilation;
- it contains the ventilator's integrated monitors, which provide oxygen, airway-pressure, and exhaled-volume monitoring;
- it supplies the ventilator's alarm system.

By using the control module's front panel dials, push-wheels, and display, you can set and view the ventilator's operating parameters and alarm limits, view output from the integrated monitors, and initiate mechanical ventilation. Switching ON the ventilator's power (with either the control module's power switch or the anesthesia system's master switch, depending on your system's configuration) enables the ventilator's monitors and alarm system, even if the mechanical ventilation switch is OFF.

The ventilator control module's front panel

Display screen

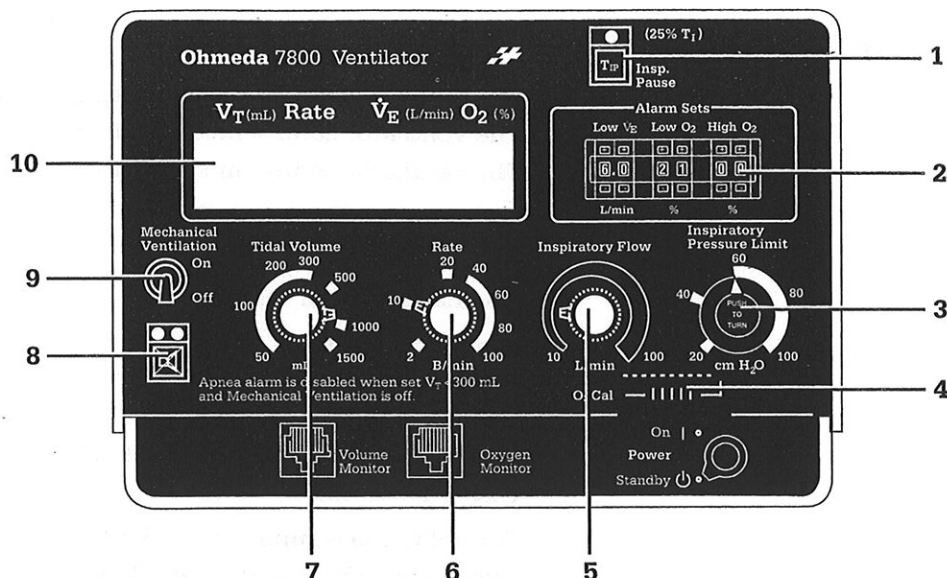
The ventilator's Liquid Crystal Display screen serves three functions:


- on its top line it provides numeric readouts for expired tidal volume, breath rate, expired minute volume and inspired oxygen concentration;
- on its bottom line it displays messages such as alarms and control settings.
- For certain functions, such as the setup page, the ventilator will display instructions on both lines of the screen.

3/General Information

Figure 3-1

The control module's front panel controls



1. Inspiratory pause button
2. Alarm set push-wheels
3. Inspiratory pressure limit
4. Oxygen calibration
5. Inspiratory flow
6. Breath rate
7. Tidal volume
8. Alarm silence button 
9. Mechanical ventilation switch
10. Screen

Tidal volume dial

The tidal volume dial lets you set the tidal volume at levels from 50 mL to 1.5 liters. As you turn the dial, the ventilator displays the tidal volume setting as well as the resulting I:E ratio. The resolution in this setting varies within four ranges, depending on the tidal volume dial's position. In the range from 50 mL to 100 mL, the tidal volume can be set in 2-milliliter increments. In the range from 100 mL to 250 mL, the tidal volume can be set in 5-milliliter increments. In the range of 250 mL to 1 liter, the tidal volume can be set in 10-milliliter increments. And in the range of 1 liter and up, the tidal volume resolution is 20-mL.

To check the tidal volume setting without changing its value, just touch the front of the dial; the ventilator will then display the current tidal volume setting and I:E ratio.

Breath rate dial

Turning the rate dial changes the breath rate used for mechanical ventilation. The ventilator displays the rate as it changes as well as the resulting I:E ratio. The rate is adjustable from 2 breaths per minute to 100 breaths per minute in whole number increments. Touching the rate dial will display the current rate and I:E ratio setting on the screen.

Inspiratory flow dial

The inspiratory flow dial lets you set the inspiratory flow rate, which is variable from 10 liters per minute to 100 liters per minute in increments of 1. Whenever you adjust or just touch the inspiratory flow dial, the ventilator will display the current I:E ratio, which it calculates based on the set inspiratory flow, tidal volume, breath rate, and the inspiratory pause status. Because the inspiratory flow is variable within its range, the ventilator's actual I:E ratios are variable from 1:0.5 to 1:999. Rather than display I:E ratios in non-standard increments, such as 1:2.13 or

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1:1.97, the ventilator displays the I:E ratio rounded to the nearest 0.5. For example, when the ventilator uses a ratio of 1:2.13, it displays 1:2. And when it uses 1:1.97, it displays 1:2.

Inspiratory pressure limit dial

Both the maximum inspiratory pressure and sustained-pressure alarm limits are set by the inspiratory pressure limit dial, which must be pushed in while turning to change the settings; the ventilator sets the sustained pressure limit to correspond to the inspiratory pressure limit dial setting. The maximum inspiratory pressure limit range is 20 to 100 cm H₂O with a resolution of 1 cm. For inspiratory pressure limits of 20 cm H₂O to 60 cm H₂O, the ventilator sets the sustained pressure limit to one-half the inspiratory pressure limit. Any inspiratory pressure limit setting higher than 60 cm H₂O will result in a sustained pressure limit of 30 cm H₂O.

As you push and turn the inspiratory pressure limit dial, the ventilator will display both the maximum-pressure-limit and sustained-pressure-limit settings. However, unlike the other three control dials, just touching this dial will not generate a display.

During mechanical ventilation, the maximum inspiratory pressure limit you set is used by the ventilator's electronically-controlled, automatic, high-pressure-relief system to manage excessive airway pressure. If, while the mechanical ventilation switch is ON, the ventilator detects airway pressure higher than the limit you set, it generates a high pressure alarm and terminates the inspiratory cycle.

The ventilator also displays a message if you set the inspired pressure limit to more than 60 cm H₂O. This message is displayed in the non-mechanical ventilation mode only.

Inspiratory pause button

Pressing the inspiratory pause button adds an inspiratory pause—an inflation hold—to the inspiratory cycle. When the inspiratory pause function is active, the ventilator adds an inspiratory pause equal to 25 percent of the set inspiratory time. The ventilator, to maintain the original breath rate, then decreases the expiratory time by the same amount that the inspiratory time is increased; pressing the inspiratory pause button alters the I:E ratio.

After you press the inspiratory pause button, the ventilator displays the new I:E ratio and lights the green indicator on the button to indicate that the inspiratory pause function is active. To disable the inspiratory pause, press the button again; the ventilator will switch OFF the indicator light and display the I:E ratio, which is calculated from the other front-panel control settings.

You can continue to adjust the ventilator's front panel controls even when the inspiratory pause function is active. If, while the function is on, you adjust a front panel control, the instrument takes the inspiratory pause formula into account when it calculates and displays a new I:E ratio.

Mechanical ventilation ON/OFF switch

The mechanical ventilation switch controls mechanical ventilation only. When the switch is OFF, the monitors still function and the alarm system is still active, although certain alarms are enabled only during mechanical ventilation. When you want to start mechanical ventilation, move the switch to ON.

Always switch ON the ventilator's power (using either the power switch or the anesthesia system's master switch, depending on your system's configuration) and set the ventilator's controls before switching ON mechanical ventilation.

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Alarm set push-wheels

Use the three alarm-set push-wheels to change the low-minute-volume, low-oxygen and high-oxygen alarms' set points. To increase the value of an alarm set point, push the button directly over the digit you want to change. To decrease the value, push the button under the digit you are changing.

Anytime you change the value of an alarm set point, the ventilator displays, for a few seconds, that alarm's value. Although all of the digits can be set to zero, the ventilator will not accept certain oxygen alarm settings, and will generate warning messages for others.


The system will not accept low oxygen alarm limits of less than 18 percent. The system also warns you if you set a high oxygen alarm limit below or equal to the low oxygen alarm limit. Setting the high oxygen alarm limit to 00 disables the high O₂ alarm.

The oxygen alarm limits are 18 percent to 99 percent in one percent increments. The low minute volume alarm limits are zero liters per minute to 9.9 liters per minute in 0.1 liters per minute increments.


Oxygen calibration thumb-wheel

The oxygen calibration thumb-wheel is used to calibrate the oxygen monitor's sensor. Use this thumb-wheel during the oxygen monitor calibration procedure only.


Alarm silence button

To silence an audible alarm, press the alarm silence  button. If that alarm condition continues, the alarm will sound again in 30 seconds. If, however, a new alarm condition occurs, its audible alarm sounds immediately. Certain alarms can be silenced permanently, even if the alarm conditions continue. These permanently silenceable alarms include power failure, oxygen sensor failure, low battery, ventilator failure, oxygen calibration error, and volume sensor failure.

When the mechanical ventilation switch is OFF—when the ventilator is in its monitoring mode—pressing the alarm silence button cancels and resets the apnea and low minute volume alarms; the VOL MON STANDBY message will be displayed and the two alarms will not sound again even if the alarm conditions continue. However, if the ventilator senses another breath, the alarm timers and sensor circuits will again be activated and any alarm condition that occurs will trigger an appropriate alarm.

The alarm silence button  — combined with the inspiratory pause button— also provides a way to enter and step through the setup page mode. To enter the setup page, move the mechanical ventilation switch to OFF, hold down the alarm silence button, then press the inspiratory pause button. Once the setup page is displayed, press the alarm silence button again to move from step to step.

Alarm indicator LEDs

The two light emitting diodes (LEDs) embedded in the alarm silence  button indicate the status of alarms. When an alarm condition first occurs, a message appears on the screen, a tone sounds, and an LED flashes. Once the alarm silence button is pressed, the ventilator will light the LED continuously to remind you that the alarm condition still exists. The red LED is lighted during alarm conditions that require immediate operator response. The yellow LED indicates alarm conditions that require prompt operator response or operator awareness.

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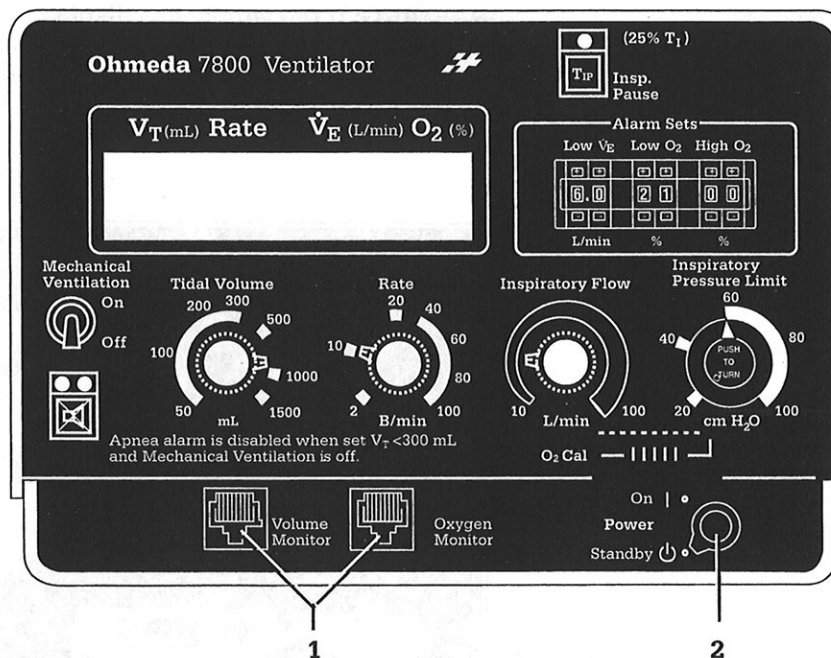
Stand-alone power switch



The ventilator's control module has two power modes: ON and STANDBY. The power switch determines whether the ventilator is ON or in STANDBY. For the ventilator to operate, the control module must be ON (in STANDBY, electrical power is delivered to the module but all of the module's functions are disabled).

WARNING: Switching ON the ventilator before setting the controls may result in inappropriate ventilation of the patient and may activate alarms.

Figure 3-2
Stand-alone configuration power switch and sensor connectors



1. Sensor connectors
2. Power switch

Powering ON configurations other than the stand-alone ventilator

How you power ON the control module depends upon your system's configuration. If your ventilator is a stand-alone device, use the power switch on the lower panel of the control module to power ON the ventilator. If, however, your ventilator has been installed in either an Ohmeda Modulus II Anesthesia System or an Ohmeda Excel Anesthesia System, your control module doesn't have a power switch; instead use the anesthesia system's master switch to power ON the module. When you turn the master switch to ON, the control module is also powered ON.

When the ventilator is powered ON, electrical power is delivered to all of the control module components. In standby, the control module is not active.

3/General Information

The ventilator control module's rear panel

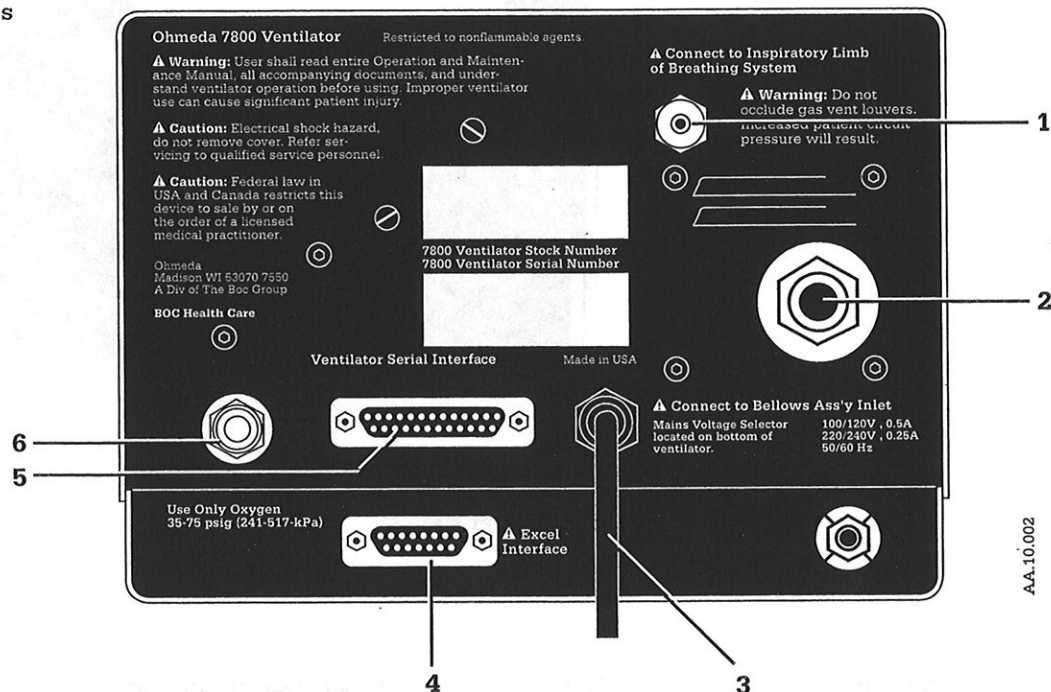
The supply
gas input



Supply gas can be introduced to the ventilator from two different connectors, depending on the configuration of your system. On Ohmeda Modulus II Anesthesia System's that have been modified to include an integrated control module, the supply gas input is on the underside of the control module, and not externally visible when installed. On other systems, the supply gas is on the rear panel of the control module.

WARNING: If the supply gas displayed is other than the supply gas you are using ("O" for oxygen or "A" for air), have an Ohmeda trained service representative reset the ventilator. Using a supply gas that does not match the displayed supply gas will result in operational errors.

Figure 3-3
The control module's
rear panel



1. Pressure sensing input
2. Drive gas output
3. Power cord
4. Excel interface connector
5. Serial interface connector
6. Supply gas input

Either oxygen or medical-grade air can be used as a supply gas to the ventilator. Before changing from one supply gas to another, however, qualified service personnel must set the ventilator's software to operate correctly with the new supply gas. (See "Setting the supply gas" in "2/ Getting Started.")

Drive gas output

The ventilator bellows' driving gas supply is delivered from the connector labeled "Connect to Bellows Ass'y Inlet."

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Pressure
sensing input

A 3-mm (1/8-inch) inside diameter tube connects to the distal-sensing tee located in the inspiratory limb of the breathing system the connector marked "Connect to Inspiratory Limb of Breathing System" on the control module's rear panel.

Serial interface
connector

For remote recording, a 25-pin female "D" type connector that is labeled "Ventilator Serial Interface" provides access to the ventilator's RS232C serial port, which conforms to the Ohmeda standard communications protocol (see the appendix).



WARNING: When specific DIP switches are set, writing to the ventilator's RS232 port can alter the operation of the ventilator's software, which may result in unpredictable performance. Do not alter the ventilator's hardware or software.

The Excel interface connector

The Excel interface, which is a 15-pin female "D" connector, appears in only the Excel configuration. Mounted on the back of the control module's lower panel, the interface connects to the anesthesia machine's power switch and sensor interface panel, which provides inputs for the volume and oxygen sensors.

3.1 The ventilator's modes

The Ohmeda 7800 Ventilator uses three basic modes:

- **setup page mode,**

The setup page groups parameters not normally adjusted during a case, such as the screen contrast and the alarm volume.

- **mechanical ventilation mode,**

when the mechanical ventilation switch is ON—patient monitoring and alarms are active, and the control module is driving the bellows assembly.

- **monitoring mode.**

when the mechanical ventilation switch is OFF—mechanical ventilation is OFF, but all patient monitors still function and the alarm system is still active, however certain alarms are enabled only during mechanical ventilation.

When you first enter the setup page, the ventilator displays the ventilator model, the software version number it is using, the supply gas setting, the selected language and selected altitude compensation. The ventilator then lets you enable or disable the reverse flow alarm and sigh function, and adjust the screen contrast and audio alarm volume. These parameter settings are stored in the ventilator's memory even when the system's power is disconnected; if you are satisfied with these parameter settings, you can skip past the setup page.

In both the non-mechanical ventilation mode and the mechanical ventilation mode, the patient monitoring and the alarms systems are active.

The sigh function

When the sigh function is selected, the ventilator delivers 150 percent of the set tidal volume once every 64th breath. The ventilator accomplishes this by adding 50 percent to the inspiratory and expiratory times while maintaining the set inspiratory flow and I:E ratio. The maximum sigh breath is limited to 1.5 liters. For example, if the set tidal volume is 1 liter, the sigh breath will be 1.5 L (1 L plus 50 percent). But if the set tidal volume is 1.4 L, the sigh breath will still be 1.5 L, because the inspiratory flow decreases to maintain the I:E and limits the V_T to 1.5 L.

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To turn ON the sigh function, select "sigh on" from the setup page. Once the sigh function is ON, the ventilator will display "sigh on" on the bottom line of its screen. When the ventilator actually delivers the sigh breath, the ventilator will display "sigh breath." These messages will alternate with other messages the ventilator displays.

When using the sigh function, pay particular attention both to the high pressure alarm setting and to apnea alarms. Because circuit pressure is higher during the sigh breath than during normal cycles, you must set the inspiratory pressure limit dial to compensate for the sigh breath. Also, at low rates the sigh function can cause apnea alarms. The apnea alarm will be triggered if the ventilator does not sense a complete breath in a 30-second period. At a breath rate of two, the sigh function increases the breath period from 30 seconds to 45 seconds, triggering the apnea alarm.

3.2 The alarm system


When the ventilator senses an alarm condition, it displays an appropriate message, which is updated every one-and-a-half seconds until the condition is resolved (apnea alarms are updated at one-second intervals). If a second alarm condition occurs before the first is resolved, the ventilator alternates the messages for each condition. The ventilator alternates the alarm messages for as many alarm conditions as exist at one time, at one-and-one-half-second intervals.

Audible alarms


Although, when more than one alarm is active, the ventilator displays the messages for all of the alarms (by alternating the messages), it sounds the audible alarm for only the highest priority alarm. If that condition is resolved, the ventilator will then sound the alarm for the next highest priority alarm that occurred. The priority of the audible alarms, from high to low, is:

- Warble
- Intermittent
- Continuous
- Single beep

What the LEDs indicate

The two light emitting diodes (LEDs) embedded in the alarm silence  button indicate the status of alarms. When an alarm condition first occurs, a message appears on the screen, a tone sounds, and an LED flashes. Once the alarm silence button is pressed, the ventilator will light the LED continuously to remind you that the alarm condition still exists. The red LED is lighted during alarm conditions that require immediate operator response. The yellow LED indicates alarm conditions that require prompt operator response or operator awareness.

Silencing alarms

To silence an audible alarm, press the alarm silence button . If that alarm condition continues, the alarm will sound again in 30 seconds. If, however, a new alarm condition occurs, its audible alarm will sound immediately. Certain alarms can be silenced permanently, even if the alarm conditions continue. These permanently silenceable alarms include power failure, oxygen sensor failure, low battery, ventilator failure, oxygen calibration error, and volume sensor failure.

The ventilator's built-in computer must be functioning correctly for the alarm system to work correctly. If the ventilator's computer fails, the screen may flash erratically and an intermittent tone will sound; the alarm silence button will not terminate the alarm if the ventilator's computer fails. Do not attempt to continue using the ventilator if this failure occurs.

3/General Information

Alarm quick reference charts

Alarm Message	Alarm Condition	LED	Tone
APNEA **	Insufficient tidal volume measured in greater than 120-second period	Red, flashing	Continuous warble
APNEA ALARM OFF! (Active during non-mechanical ventilation only.)	Tidal volume set to less than 300 mL and mechanical ventilation switch set to OFF	Yellow, continuous	One beep, silences automatically
APNEA xxx SEC	Insufficient tidal volume measured in a greater than 30-second period	Yellow, flashing	Staged: 30 seconds—one warble; 60 seconds—two warbles; 90 seconds—three warbles
CHECK O ₂ SENSOR! alternating with CHECK GAS SUPPLY	Measured oxygen less than five percent	Yellow, flashing	Continuous, permanently silenceable
CHECK SETTINGS!	Displayed when setup page is exited	None	One beep, silences automatically
DRIVE CKT OPEN!	Incorrect exhalation valve feedback or pressure switch engaged	Yellow, flashing	Continuous, permanently silenceable
HARDWARE ERROR X	Hardware malfunction	Yellow, flashing	Continuous, permanently silenceable
HIGH OXYGEN!	Oxygen concentration greater than or equal to set limit	Yellow, flashing	Intermittent beep
HIGH PRESSURE!	Circuit pressure above set limit	Red, flashing	Warble per occurrence
LIMIT SET ERROR!	High oxygen alarm limit below or same as Low O ₂ alarm limit. Or Low O ₂ alarm limit less than 18 percent	Yellow, flashing	Continuous
LOW BATTERY!	Insufficient battery charge	Yellow, flashing	Continuous, permanently silenceable
LOW MINUTE VOL!	Minute volume below set limit	Yellow, flashing	Intermittent beep
LOW OXYGEN!	Oxygen concentration below set limit	Red, flashing	Continuous warble
LOW PRESSURE! (Active during mechanical ventilation only)	Pressure change less than threshold for at least 20 seconds	Red, flashing	One warble per breath

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Alarm Message	Alarm Condition	LED	Tone
LOW SUPPLY PRES!	Internal, regulated supply gas pressure less than 152 kPa (22 psig)	Yellow, flashing	Intermittent beep
MAX PRES=xxx cm (Active during non-mechanical ventilation only.)	Pressure limit set to more than 60 cm H ₂ O	Yellow, continuous	One beep, silences automatically
O2 CAL ERROR!	Measured oxygen greater than 109 percent	Yellow, flashing	Continuous, permanently silenceable
POWER FAIL!	a-c power failure	Yellow, flashing	Continuous, permanently silenceable
REVERSE FLOW! (Active during non-mechanical ventilation only.)	Flow in wrong direction equals volume of more than 100 mL or 20 mL (when tidal volume knob set below 300 mL)	Yellow, flashing	Continuous
REV FLOW ALM OFF	Reverse flow alarm disabled on setup page	Yellow, continuous	None
SIGH ON (Active during mechanical ventilation only.)	Sigh feature on	Yellow, continuous	None
SIGH BREATH (Active during mechanical ventilation only.)	Sigh breath delivered continuous	Yellow,	None
SOFTWARE ERROR X	Invalid data or malfunctioning alarm system	N/A	Tone, permanently silenceable
SUB-ATMOS PRES!	Pressure less than -10 cm H ₂ O	Red, flashing	Continuous warble
SUSTAINED PRES!	Pressure exceeds set limit for 15 seconds or more	Red, flashing	Continuous warble
VENT FAIL xx!	Ventilator hardware failure, see Vent Fail definition	Yellow, flashing	Continuous, permanently silenceable
VENT SET ERROR!	Combination of settings of ventilator controls out of range	Yellow, flashing	Continuous
VOL MON STANDBY!	System waiting for first breath to activate volume monitoring and apnea timer	Yellow, continuous	One beep, silences automatically
VOL SENSOR FAIL!	Volume sensor disconnected or defective	Yellow, flashing	Continuous, permanently silenceable
----- ????????	No volume measured during mechanical ventilation	None	None

3/General Information

Alarm definitions

Apnea

If the ventilator doesn't detect a sufficient breath for 30 seconds, an apnea alarm will be generated. The alarm message indicates the number of seconds that have passed since the last sufficient breath was detected. The tone will warble once at 30 seconds, twice at 60 seconds, and three times at 90 seconds. At 120 seconds the tone will warble continuously and the alarm message will be APNEA ** only.

The ventilator uses the volume-sensing circuits to activate the apnea alarm. When the ventilator is first powered ON it displays the VOL MON STANDBY message to indicate that a set threshold of flow is not being sensed and the apnea alarm is not activated. Then, once the ventilator senses a sufficient volume level, it removes the VOL MON STANDBY message and starts a timer that controls the apnea alarm. Each time the ventilator senses sufficient volume, it resets this apnea timer.

The actual volume threshold required to start or reset the apnea timer varies depending on the level you set on the tidal volume dial. For tidal volume settings between 180 mL and 400 mL, the threshold varies linearly from 20 mL to 100 mL. For tidal volume settings below 180 mL, the threshold is always 20 mL. And for tidal volume settings above 400 mL, the threshold is always 100 mL. In the manual mode, however, once the apnea timer starts, the volume threshold required to reset the timer is 20-mL.

For example, if the tidal volume dial is set to 250 mL, and mechanical ventilation is switched ON, the timer starts and is reset when the ventilator senses a breath of at least 46 mL. If you then increase the tidal volume dial to 320 mL, the ventilator will increase the threshold to 71 mL. In either case, if the timer reaches 30 seconds (because the ventilator didn't sense enough volume to indicate a breath), the first in the series of four apnea alarms will sound.

Apnea alarm OFF

Because very low flow levels that are not sufficient to trigger the volume-sensing circuits may occur in spontaneously breathing patients, the ventilator disables the apnea alarm when the tidal volume dial is set to less than 300 mL and mechanical ventilation is switched OFF.

Whenever tidal volume is set to less than 300 mL and the mechanical ventilation switch is OFF, the ventilator, once it has detected a breath, will display APNEA ALARM OFF. To enable the apnea alarm while the patient is breathing spontaneously, increase the tidal volume dial to 300 mL or more. Although you should always carefully set the low minute volume push-wheel to enable the low minute volume alarm at an appropriate level, the low minute volume alarm is especially important when the tidal volume dial is set to less than 300 mL, disabling the apnea alarm.

Check O2 sensor/ check gas supply

If the ventilator detects less than five percent oxygen, it assumes that either the oxygen sensor has failed or that insufficient oxygen is in the breathing system, and it generates an alarm. A check O₂ sensor/check gas supply alarm will also be generated if the sensor isn't connected correctly, if the sensor is broken, or if no oxygen is in the area of the sensor.

3/General Information

Check settings


In the setup page the front panel controls are used to set parameters not normally adjusted during a case, such as the screen contrast and the alarm volume. Before you use the ventilator on a patient, you must readjust any controls you used in the setup page. To remind you to check your control settings, when you exit the setup page the ventilator displays the "check settings" message.

Drive circuit open

One type of ventilator failure—exhalation valve failure—does not display a numbered message; instead DRIVE CKT OPEN is displayed. This message can also appear if, during mechanical ventilation, the absorber's Bag/APL-ventilation switch is in the "BAG/APL" position. During this alarm, the ventilator will attempt to continue monitoring and mechanical ventilation.

1. Check the patient.
2. If mechanical ventilation is ON, make sure the absorber's Bag/APL-ventilation switch is in the "ventilator" position, if applicable.

Hardware error

This display (error A, B, and C) and alarm should not occur unless there is a problem with the ventilator control module hardware. The alarm is silenceable with the alarm silence  button. Mechanical ventilation does not shut down.



WARNING: Do not use the ventilator if this display and alarm occur.

High oxygen

If the ventilator detects an oxygen concentration equal to or higher than the one you set using the high-O₂ push-wheel, the ventilator generates a high oxygen alarm.

High pressure


If, during mechanical ventilation or while in the monitoring mode, the ventilator detects airway pressure higher than the limit you set using the inspiratory pressure limit control, the ventilator will generate a high pressure alarm. In addition, during mechanical ventilation only, the ventilator uses automatic, high-pressure relief to manage excessive airway pressure. If, while the mechanical ventilation switch is ON, the airway pressure rises to a level that causes a high pressure alarm, the ventilator will release the remaining drive gas into the atmosphere and end inspiration.

Limit setting error

If you attempt to set the high oxygen alarm limit for a level below or equal to the low oxygen limit, the ventilator generates a limit setting error alarm. This alarm is also generated if you attempt to set the low oxygen alarm limit for less than 18 percent.

Low battery

Two sources can power the control module: the ventilator's power supply and the ventilator's backup battery. If the power supply fails, either because of an electronic failure or because a-c power is lost, the backup battery takes over.

If the battery's voltage discharges below a set threshold, the ventilator generates a "low battery" alarm. Pressing the alarm silence  button permanently silences the alarm tone. To remind you of the condition the LED remains lighted and the alarm message will still appear.

3/General Information

Low minute volume

If the ventilator detects that the minute volume is less than the level you set using the low minute volume push-wheel, the ventilator will generate an alarm. To reduce nuisance alarms that can be generated when control settings are changed, whenever you adjust the tidal volume dial or the rate dial, move the mechanical ventilation switch to ON, or exit the volume monitor standby condition, the ventilator will disable the low minute volume alarm for 40 seconds.



WARNING: Always correctly set the low minute volume alarm and use CO₂ monitoring to aid in the detection of breathing system disconnection's.

Low oxygen

If the ventilator detects an oxygen concentration lower than the one you set using the low-O₂ push-wheel, the ventilator generates a low oxygen alarm.

Low pressure

The ventilator generates a low pressure alarm if, for at least 20 seconds, the airway pressure fails to change by a value that varies proportionally to the setting of the inspiratory flow dial. To determine the change in airway pressure, the system compares the airway pressure at a point 50 milliseconds after the peak pressure to a point at the end of patient exhalation. The amount of change required to prevent an alarm from triggering varies between 4 cm H₂O to 9 cm H₂O to correspond to the inspiratory-flow range of 10 liters per minute to 100 liters per minute. For example, if the inspiratory flow is set to 30 liters per minute, the low pressure alarm will activate if the pressure doesn't change by at least 5.1 cm H₂O. But if the inspiratory flow is set to 80 liters per minute, the change must be at least 7.9 cm H₂O to keep the alarm from activating.

Unlike other alarms, the low pressure alarm is active only when mechanical ventilation is switched ON.

Low supply pressure

If the ventilator's internal, regulated supply gas pressure is less than 150 kPa (22 psig), the ventilator generates a low supply pressure alarm.

Oxygen calibration error

Some oxygen sensors may deliver a signal that is out of the ventilator's range. If the ventilator senses too large of a sensor signal, it displays the O₂ CAL ERROR message. To remove the message, continue to turn the O₂ calibration dial.

Power failure

If the a-c power to the ventilator is interrupted, the ventilator generates a power failure alarm.

Pressure limit

Anytime you adjust the inspiratory pressure limit dial, the ventilator briefly displays the pressure limit in centimeters of water. However, if the ventilator is in the non-mechanical ventilation mode and the inspiratory pressure limit is set to more than 60 cm H₂O, the ventilator also lights the yellow alarm LED and continuously displays the MAX PRES=XXX CM reminder. The pressure limit reminder is displayed in the non-mechanical ventilation mode only; during mechanical ventilation this reminder is disabled.

Reverse flow

If the ventilator senses reverse flow of an unacceptable volume, it generates an alarm. The volume that triggers a reverse flow alarm depends on the tidal volume set. If you set the tidal volume dial for less than 300 mL, then 20 mL or more triggers an alarm. However, if you set the tidal volume dial for 300 mL or more, the ventilator allows up to 100 mL before triggering an alarm. Once the alarm has been triggered, two forward breaths must be sensed before the ventilator automatically switches OFF the alarm.

3/General Information

The reverse flow alarm is intended to warn you of inadvertent reverse flow conditions, such as those caused by a defective or sticking exhalation check valve. These kinds of conditions will be detected only when the volume sensor is correctly placed at the distal position of the expiratory limb of the breathing system. If you place the volume sensor at the proximal end of the "Y" connector, volume monitoring will still function. However, when the volume sensor is located at the proximal position, a reverse flow condition exists each time the patient inhales and the reverse flow alarm activates for each breath. To disable the reverse flow alarm, select REV FLOW ALM OFF from the setup page (see "Using the setup page" in section 5).



WARNING: The reverse flow alarm will function correctly only if the volume sensor cartridge is working correctly and is properly placed in the distal position of the expiratory limb of the breathing system.

WARNING: When the volume sensor is in the distal position of the breathing system, check the ventilator's setup page to confirm that the reverse flow alarm is enabled. Do not use the system with the reverse flow alarm disabled if the volume sensor is in the distal position.

Reverse flow
alarm OFF


To advise you that the reverse flow alarm is disabled, in the non-mechanical ventilation mode the ventilator repeatedly flashes this message. If you power ON the control module with the alarm disabled and mechanical ventilation ON (although you should always have the mechanical ventilation switch set to OFF when you power ON), the message will be displayed once.

Placing the volume sensor cartridge at the distal position in the expiratory limb lets the system detect reverse flow and generate reverse flow alarms. You may also place the volume sensor cartridge at the proximal end of the "Y" connector; however, you then must use the setup page to disable the reverse flow alarms that would otherwise be generated when the patient inhales.

Sigh alarms

Sigh breath replaces sigh on until the next breath is delivered

Software error

This display (error A through F) and alarm should not occur unless there is a problem with the ventilator software programs. The alarm is silenceable with the alarm silence  button. Mechanical ventilation does not shut down.



Sub-atmospheric
pressure

If the ventilator detects airway pressure of less than -10 cm H₂O, it generates a subatmospheric pressure alarm. For example, airway pressure of -12 cm H₂O causes an alarm.

Sustained pressure

The ventilator sets the sustained pressure limit to correspond to the inspiratory pressure limit dial's setting. For maximum inspiratory pressure limits of 20 cm H₂O to 60 cm H₂O, the ventilator sets the sustained pressure limit to one-half the inspiratory pressure limit.

For example, if the inspiratory pressure limit is 42 cm H₂O, the sustained pressure limit will be 21 cm H₂O. However, any inspiratory pressure limit setting of more than 60 cm H₂O will result in a sustained pressure limit of 30 cm H₂O. For example, inspiratory pressure limits of 65 cm H₂O and 80 cm H₂O will both result in a sustained pressure limit of 30 cm H₂O.

3/General Information

Anytime the airway pressure exceeds—for 15 seconds or more—the sustained pressure limit set by the inspiratory pressure limit dial, the ventilator generates a sustained pressure alarm.

Ventilator failure

Ventilator failure messages can indicate anything from a defective IC chip to excessive pressure in the ventilator's gas supply. However, some ventilator problems may not generate any ventilator failure message, even though the ventilator may not be functioning correctly.



WARNING: Do not attempt to use the ventilator while a ventilator failure message is displayed. And, even if no ventilator failure message is displayed, do not use the ventilator if you suspect a malfunction has occurred.

IMPORTANT

If the ventilator experiences extreme electrical interference, it may interrupt mechanical ventilation. If this interruption occurs, the ventilator generates an internal reset function and resumes normal operation after two (2) seconds. For situations where continuous electrical interference is experienced by the ventilator, causing a continuous interruption, the ventilator's internal reset repeats until the interference ceases.

If the electrical interference is continuously present and mechanical ventilation is interrupted for approximately 30 seconds, the ventilator produces a continuous beeping audio alarm. Manual ventilation of the patient must be performed while the mechanical ventilation is interrupted. When the electrical interference ceases, the continuous beeping audio alarm can be silenced only by turning, as applicable, the ventilator or anesthesia machine power switch OFF and after five seconds back ON.



WARNING: Manual ventilation must be performed when electrical interference causes interruption of ventilator delivered mechanical ventilation. Manual ventilation must be continued until the ventilator resumes normal operation or an alternate ventilator/anesthesia system can be used.

See the "7/Service Procedures" for descriptions of specific ventilator failure messages.



WARNING: The use of electrosurgical units or other devices that radiate high-intensity electrical fields can affect the operation of the ventilator and monitors attached to the patient. Maintain as much distance as possible between the electrosurgical leads and the cables to the flow and oxygen sensors.

Do not drape the electrosurgical leads across the absorber or the anesthesia machine. Do not let the electrosurgical leads rest on any surface of the anesthesia system. Constant surveillance of all monitoring and life support equipment is mandatory whenever electrosurgical devices are in operation, on, or in the vicinity of the patient.

Ventilator setting error

If you attempt to set a combination of the inspiratory-flow, tidal-volume, rate, and inspiratory-pause that results in a level the ventilator is not designed to deliver, the ventilator will continue to use the most recent acceptable settings, and generates a "VENT SET ERROR" alarm until the control combination is corrected. For example, a tidal volume of 500 mL, combined with a rate of 20 B/min, and an inspiratory flow of 10 liters per minute will trigger a ventilator setting error. To remove the error, either decrease the tidal volume setting, or decrease the rate setting, or increase the flow setting.

3/General Information



WARNING: Do not use the ventilator while the "vent set error" message is displayed—when this message is displayed, the control settings do not reflect the settings the ventilator is using. If the "vent set error" message is displayed during mechanical ventilation, the system will use the most recent acceptable settings. If, however, the ventilator is powered ON in the "vent set error" condition, moving the ventilation switch to ON will not start mechanical ventilation until the controls are moved to an acceptable setting.

Volume monitor
standby

When the ventilator is first powered ON, or when the ventilator is switched from mechanical ventilation to the monitoring mode, or when—while the ventilator is in the monitoring mode—the alarm silence button is pressed, the ventilator displays the VOL MON STANDBY message to indicate that the alarm system is waiting for a sufficient breath. Once the ventilator senses a sufficient volume level, it removes the VOL MON STANDBY message and starts the timers that control the apnea alarms.

Volume sensor failure

This message will be displayed if the volume sensor's heater voltage is too low, which can happen if the volume sensor clip is broken or disconnected.

Dashes displayed in
place of readings

If the system doesn't measure any volume during mechanical ventilation, it will display dashes in place of the volume and rate data.

Question marks
displayed in place of
readings

Certain combinations of ventilator front panel control settings can result in ventilation conditions the ventilator can deliver but the volume sensor cannot measure. If you set a control combination the ventilator can deliver, but the volume monitor cannot measure, or if—in the monitoring mode—breathing occurs that the monitor cannot measure, the ventilator displays question marks in place of the V_T , \dot{V}_E , and rate readings.

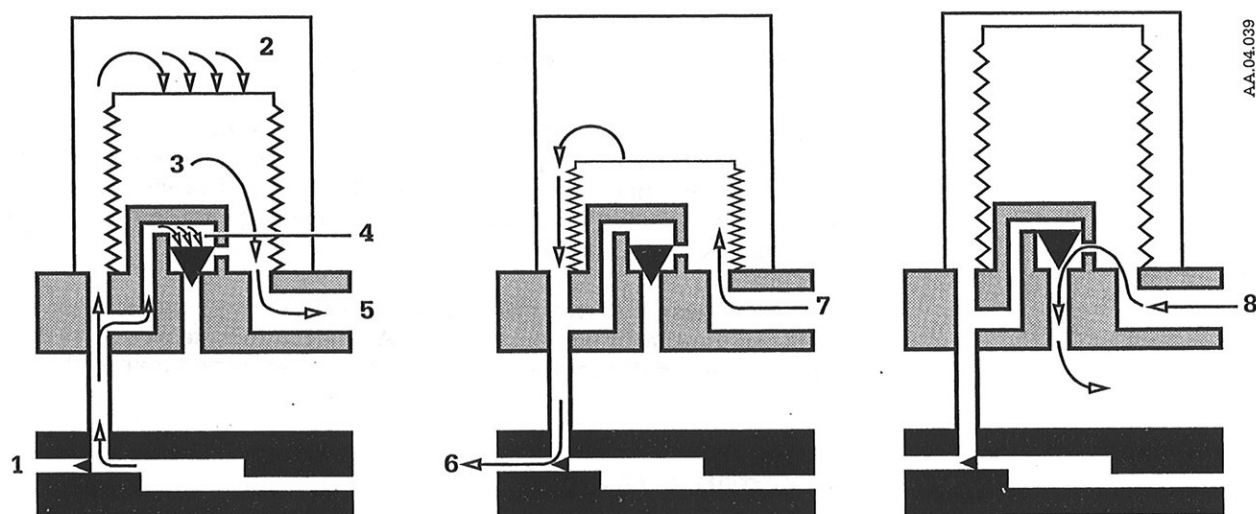
3/General Information

3.3 Theory of operation

The ventilation cycle

The bellows assembly is the interface between the control module's driving-gas circuit and the patient breathing system. During inspiration, driving gas from the control module compresses the bellows; during expiration, breathing system gas fills the bellows, forcing it to rise. As the ventilator cycles from inspiration to expiration, a set of valves controls the pressure in the two circuits.

Figure 3-4
Ventilation cycle



- 1. Exhalation valve
- 2. Driving gas
- 3. Patient circuit gas
- 4. Pop-Off (pressure relief) valve
- 5. To patient circuit

- 6. Driving gas
- 7. From patient circuit

- 8. Excess patient circuit gas

Inspiration starts when the ventilator's control module closes the exhalation valve (1) and delivers driving gas (2) to the bellows housing. As the driving-gas pressure increases, the pressure relief valve (4) closes and the bellows is compressed. This bellows compression forces gas (3) out of the bellows, into the patient-circuit (5), breathing system, and into the patient's lungs. The control module computes the volume, rate, and timing of driving gas needed, and delivers driving gas until it reaches the calculated gas volume; then flow stops. If the ventilator detects airway pressure higher than the limit you set using the inspiratory pressure limit control, the ventilator generates a high pressure alarm, opens the exhalation valve, and ends inspiration.

At the start of expiration, the exhalation valve opens and the gas-flow direction in driving gas (6) and the patient-circuit (7) breathing system reverses. Fresh gas from the anesthesia machine and exhaled gases from the breathing system enter the bellows' interior, forcing the bellows to expand; the extending bellows displaces the driving gas (6), which is released to the atmosphere.

If the pressure inside the bellows exceeds about 2.5 cm H₂O during the expiratory cycle (when the bellows has extended completely), the pressure relief valve opens and releases any excess breathing system gas (8) through the bellows assembly exhaust port.

3/General Information

Volume monitoring

Two volume measurements—tidal volume (V_T) and expired minute volume (v_E)—and the breath rate (Rate) are displayed on the ventilator's front panel. The ventilator measures all of these displayed values directly, based on the readings of a single volume sensor in the breathing system. Because of compliance losses and fresh gas gains in the breathing system, these measured and displayed values may be different than the values you set using the ventilator's front panel controls.

To measure the exhaled patient volume, the ventilator uses a volume sensor cartridge containing a vane that is forced to rotate by gas traveling through the breathing system. A clip-on, optically coupled sensor translates the direction and speed of the vane's rotation into electrical pulses for the ventilator's microprocessor to analyze. The sensor clip also contains a heater, which is used to help prevent condensation in the transducer cartridge. Anytime the control module is on, the heater is on.

Airway pressure monitoring

The Ohmeda 7800 Ventilator continuously monitors airway pressures in the patient breathing system and then uses this information to generate alarms and manage airway pressure. This airway pressure monitoring information is used only internally by the ventilator; the ventilator does not display this information.

The ventilator's airway pressure monitoring uses a transducer located inside the ventilator control module. A flexible tube fastened to a sensing port in the breathing system connects to this transducer in the control module.

Oxygen monitoring

The Ohmeda 7800 Ventilator uses a galvanic fuel cell to measure the concentration of inspired oxygen. In addition to displaying the oxygen concentration, the ventilator uses this information to generate high-oxygen and low-oxygen alarms based on the levels set using the front panel push-wheels.

Oxidation gradually consumes the electrode inside the oxygen sensor, so it must be calibrated periodically and occasionally replaced (See Section 6, "Maintaining the Oxygen Sensor").

3.4 Control range computation

The control module establishes four operating parameters directly from the settings of the four front panel controls:

- The tidal-volume dial sets (V_T), the volume of each breath in mL.
- The rate dial sets (R), the number of breaths per minute.
- The inspiratory flow dial sets (F), the instantaneous gas flow in liters per minute. However, the ventilator doesn't display this flow; instead it calculates and displays the I:E ratio.
- The inspiratory pause button determines the status of the inspiratory pause function, which adds an inspiratory pause—an inflation hold—to the inspiratory cycle.

3/General Information

Then, based on the settings of the tidal volume, rate, and inspiratory flow dials, the control module calculates three more operating parameters (these calculations assume that the sigh and inspiratory pause functions are OFF):

$$I = \frac{V_T \times 60}{F \times 1000}$$

$$E = \frac{60}{R} - I$$

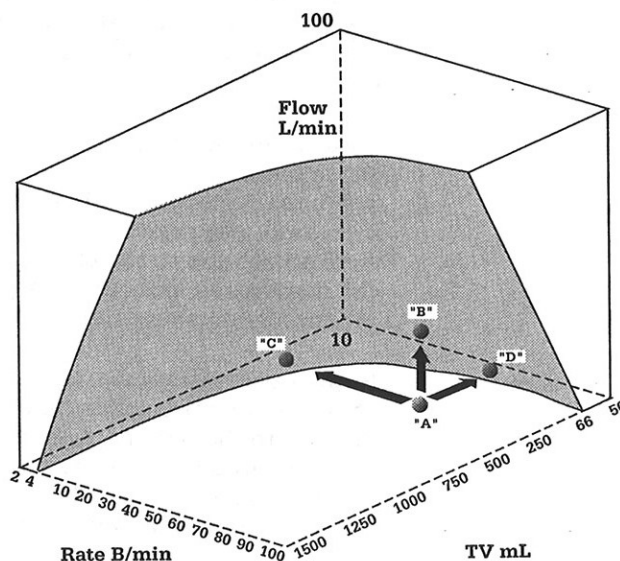
$$I:E = \frac{I}{E}$$

- Inspiratory time (I), in seconds, is derived from the tidal-volume and flow settings.
- Expiratory time (E), in seconds, is derived from the inspiratory time and the rate setting.
- I:E ratio (I:E), is the ratio of the inspiratory time to the expiratory time. The inspiratory side of the ratio is always expressed as "1." Whenever the inspiratory flow dial is touched, the control module displays the approximated I:E ratio. Because the inspiratory flow is continuously variable within its range, the ventilator's actual I:E ratios are continuously variable from 1:0.5 to 1:999. However, the ventilator displays the I:E ratio rounded to the nearest 0.5.

Although all of the front panel dials can be set independently to their full-scale limits, certain combinations of the tidal-volume, rate, and inspiratory-flow dials will result in I:E ratios the ventilator is not designed to deliver. The control module will not accept I:E levels less than 1:0.5. Instead, the ventilator continues to use the most recent acceptable settings, and displays the ventilator setting error message until the I:E ratio is corrected.

For example, if the tidal volume is set to 250 mL, the rate is set to 40 BPM, and the flow is set to 10 liters per minute, the I:E ratio will be only 1:0.33. To increase the I:E ratio to 1:0.5 or more, you must either decrease the tidal volume, decrease the rate, or increase the inspiratory flow. Once the ventilator senses an acceptable control combination, it removes the VENT SET ERROR message and implements the new settings.

Figure 3-5
Diagram of the
ventilator's range



This diagram illustrates the ranges of front-panel control combinations the ventilator is designed to deliver. Control combinations that result in I:E ratios the ventilator can deliver are represented as the solid area at the back of the cube; the cutaway area at the cube's front represents I:E ratios that are out of the ventilator's range. A control combination—as in the example above—of 250 mL tidal volume, 60 BPM rate, and 10 liters per minute flow sets the I:E ratio at point "A," which is in the cutaway area. Increasing the flow moves the point up and out of the cutaway area to point "B." Decreasing the rate moves the point to the left and out of the cutaway area to point "C." And, decreasing the tidal volume moves the point to the right and out of the cutaway area to point "D."

3/General Information

Tidal volume compensation

You may notice that the exhaled tidal volume (V_T) the ventilator measures and displays usually does not match the setting on the tidal volume dial. In most cases this is normal: the ventilator measures the patient's actual exhaled volume, which—because of a number of factors—will usually be different than the set tidal volume; use the measured volume as a guide when setting tidal volume. Factors contributing to differences between the set tidal volume and the measured tidal volume include breathing system compliance, fresh gas flow, breathing system leakage, the location of the volume sensor within the breathing system, and airway resistance.

Compliance

Because of the compressibility of gases and the expansion of some breathing system components under pressure, not all of the gas delivered from the ventilator enters the patient's lungs. Instead of reaching the patient, some of the gas the ventilator delivers is needed to raise the breathing system pressure to the peak inspiratory pressure. Higher peak inspiratory pressures results in greater tidal-volume losses.

Fresh gas flow

Any fresh gas flow the anesthesia machine introduces to the breathing system during inspiration will be delivered to the patient in addition to the gas the ventilator delivers. Higher fresh gas flows result in greater tidal volumes.

Leakage

Breathing system leakage during inspiration reduces the delivered tidal volume. In a properly maintained breathing system, leakage is usually small enough to ignore when calculating tidal volume compensation.

Location of the volume sensor

When the volume sensor is in the proximal location—on the patient side of the "Y" connector—the ventilator measures only the patient's exhaled tidal volume. If the volume sensor is placed in the distal location—at the absorber's exhalation check-valve port—the ventilator measures the patient's exhaled tidal volume plus the compliance volume in a portion of the patient circuit that is between the absorber's inhalation and exhalation check valves and the patient; this compliance volume is not delivered to the patient.

Tidal volumes measured distally will always be artificially higher than those measured proximally; the difference between the measurements will usually be small (about 2 to 3 mL/cm H₂O) when standard, 30-to-40-inch-long, patient-circuit tubing is between the absorber and the patient. Adding volume to the circuit, for example by connecting a humidifier in the inspiratory limb, increases the differences between distally and proximally-measured tidal volumes.

Airway resistance

High airway resistance, such as caused by a small endotracheal tube or other airway obstruction, may reduce the tidal volume the ventilator delivers to the patient. A tidal volume delivered at a high inspiratory flow may be partially restricted from reaching the lungs, causing a larger-than-normal portion of that tidal volume to remain in the breathing system. You can determine if airway resistance is a factor in your system: if reducing the inspiratory flow or enabling the inspiratory pause function increases the measured tidal volume, then high airway resistance is a factor.

These breathing system factors may cause the measured tidal volume indicated on the screen to be different than the level you set on the tidal volume dial. During operation compensate for these factors by adjusting the ventilator controls so the measured-and-displayed tidal volume indicates the ventilation level you want to use. Occasionally, however, you may want to calculate an expected tidal volume.

3/General Information

$$V_T = V_s + V_{fgf} - V_c$$

The exhaled tidal volume you would expect to measure (V_T) equals the tidal volume set on the ventilator (V_s) plus the tidal volume fresh gas flow adds (V_{fgf}) minus the tidal volume lost to breathing system compliance (V_c).

The equation above doesn't account for leakage or high airway resistance. You can compensate for high airway resistance by reducing inspiratory flow or using the inspiratory pause function.

Step One, calculating V_{fgf} , the total volume of fresh gas delivered during inspiration.

$$V_{fgf} = \frac{FGF}{R \left(1 + \frac{E}{I}\right)}$$

- FGF= total fresh gas flow from the anesthesia system, in mL per minute.
- R = breathing rate from the ventilator, in breaths/minute
- $\frac{E}{I}$ = inverse I:E ratio from the ventilator

Step Two, calculating V_c , the volume lost to breathing system compliance.

$$V_c = C \times PIP$$

C = compliance factor
in mL/cm H₂O.

When the volume sensor is in the distal position, the compliance factor (C) for the Ohmeda GMS Absorber is about 8 mL/cm H₂O with adult bellows and about 6 mL/cm H₂O with pediatric bellows; because the volume sensor is located distally, however, actual patient volume will be somewhat less than the tidal volume the ventilator measures and displays. When the volume sensor is in the proximal position, the compliance factor is about 10 mL/cm H₂O for the Ohmeda GMS Absorber with adult bellows, 60-inch-long, disposable, patient-circuit tubes, and no humidifier. If your system includes components different from these, see step three to calculate your system's compliance factor.

PIP = peak inspiratory pressure, as shown on the breathing system's pressure gauge, in cm H₂O.

For example, to verify the volume reading of a system connected to either a patient or a test lung: assume that the ventilator settings are V_s = 750 mL (on the tidal volume dial), R = 10/min (on the rate dial), and the inspiratory flow is set so that I:E = 1:3. Assume also that fresh gas flows total 3 liters per minute (3000 mL per minute), that PIP = 30 cm H₂O (peak inspiratory pressure as shown on the breathing system's pressure gauge), and that the volume sensor is located in the distal position.

$$V_{fgf} = \frac{FGF}{R \left(1 + \frac{E}{I}\right)}$$

$$\text{so } V_{fgf} = \frac{3000 \text{ mL per minute}}{10/\text{min.} \left(1 + \frac{3}{1}\right)} = 75 \text{ mL}$$

$$V_c = C \times PIP$$

$$\text{so } V_c = (8 \text{ mL/cm H}_2\text{O}) \times (30 \text{ cm H}_2\text{O}) = 240 \text{ mL}$$

$$V_T = V_s + V_{fgf} - V_c$$

$$\text{so } V_T = 750 \text{ mL} + 75 \text{ mL} - 240 \text{ mL} = 585 \text{ mL}$$

The expected tidal volume (V_T) is 585 mL. Because of the number of variables in the equations above, measured tidal volumes within about 15 percent of the calculated value represent a reasonable correlation to the set tidal volume of 750 mL. Leakage will further reduce the measured value.

3/General Information

Determining the breathing system compliance factor when the volume sensor is in the proximal position

Step Three, determining the compliance factor. The calculations above use an approximate compliance factor. Occasionally, you may want to determine the compliance for a specific breathing system.

1. Connect the ventilator's control module and bellows assembly to the breathing system as if ready for use.
2. If applicable, ensure that the absorber is full of absorbent as if ready for use.
3. If applicable, ensure that the absorber's Bag/APL-Ventilator switch is in the "ventilator" position.
4. Connect all of the breathing system components—such as a humidifier, if included in the system, and patient-circuit tubing—as if ready to use.
5. Occlude the patient circuit at the "Y" connector.



WARNING: When occluding the breathing system for test purposes, do not use any object small enough to slip completely into the system. Objects in the breathing system can interrupt or disrupt the delivery of breathing-system gases, possibly resulting in injury to the patient. Before using the breathing system on a patient, always check the breathing system components for foreign objects.

6. Move the ventilator's mechanical ventilation switch to OFF.
7. Turn all of the fresh-gas flow controls fully clockwise.
8. Power the ventilator ON.
9. Set the tidal volume to 200 mL.
10. Set the rate to 10 B/min.
11. Turn the inspiratory flow dial completely counter-clockwise to 10 liters per minute.
12. Inflate bellows using O₂ flush button.
13. Activate the inspiratory pause function.
14. Move the ventilator's mechanical ventilation switch to ON.
15. Adjust the tidal volume dial until the peak inspiratory pressure—shown on the system's pressure gauge—reads exactly 30 cm H₂O.
16. Move the ventilator's mechanical ventilation switch to OFF.
17. Touch the tidal volume dial to display the tidal volume that was required to achieve a peak inspiratory pressure of 30 cm H₂O. Note the displayed value.
18. $C = \frac{V_s}{PIP}$.
Divide the tidal volume value you noted by 30 cm H₂O to calculate the compliance of your system.
19. Power the ventilator OFF.
20. Remove the occlusion from the patient circuit.

4/Preoperative Checkout Procedures

4.0 Checking the ventilator connections 4-1

4.1 Checking the monitoring connections 4-1

4.2 Testing the bellows assembly 4-4

4.3 Testing the ventilator alarms 4-5

Testing the low and high oxygen alarms 4-5

Testing the low minute volume, reverse flow, and apnea alarms 4-6

Testing the high, low, and sustained pressure alarms 4-8

4.0 Checking the ventilator connections



WARNING: Always perform the preoperative checkout procedures before using the system. Failure to ensure proper setup and operation prior to use may result in patient injury.

WARNING: Ensure that all hoses, tubing, and other circuit connections are made properly before using any anesthesia system. Failure to do so may result in patient injury. Refer to the operation manuals for these devices.

Before you use the ventilator on a patient, check that all of the ventilator connections are correct and secure.

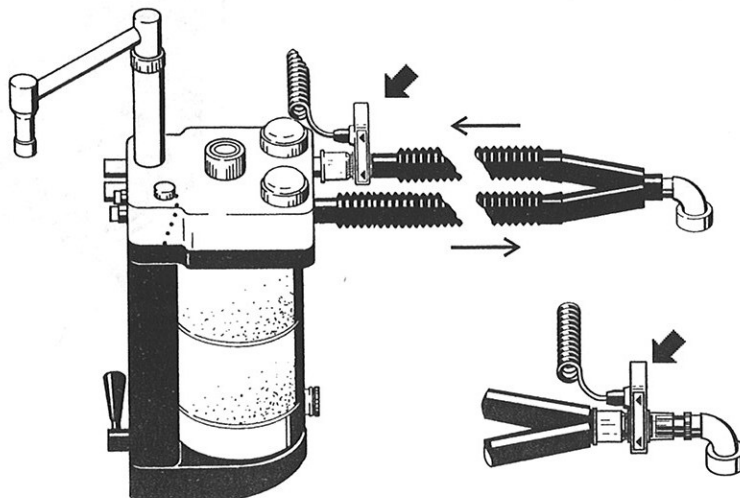
Verify that —

1. proper hose connections have been made between the bellows assembly and the control module.
2. proper hose connections have been made between the bellows assembly and the patient breathing circuit.
3. correct driving gas is securely connected to the control module.
4. the electrical power cord is plugged into a properly grounded outlet.
5. a properly functioning scavenging system is connected to the ventilator's 19/30-mm exhaust port. Do not connect the ventilator exhaust directly to a vacuum source.

4.1 Checking the monitoring connections

Before you use the ventilator on a patient, check that all of the monitoring connections are correct and secure.

Figure 4-1
The volume sensor cartridge must be correctly inserted in the breathing system and free of any obstructions.



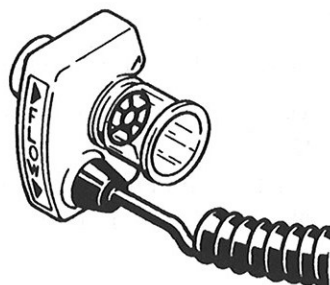
AA.15.046

AA.15.045

4/Preoperative Checkout Procedures

Figure 4-2

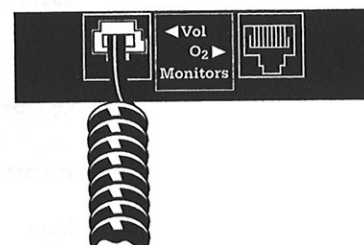
The volume sensor clip must be attached to the volume sensor cartridge with the arrows on the clip pointing in the direction of breathing system gas flow.



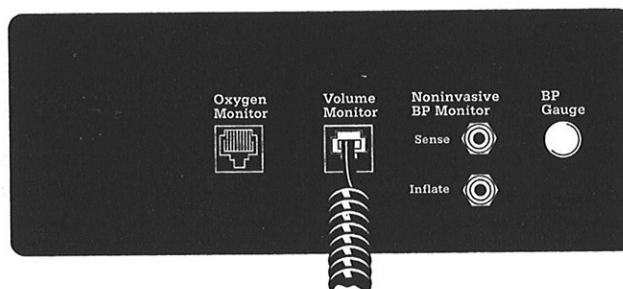
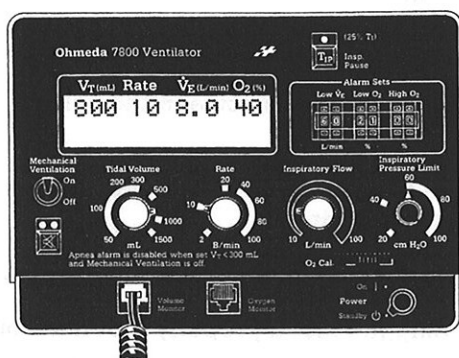
MD.10.017

Figure 4-2

The volume sensor clip's electrical cord must be plugged into the receptacle marked "volume monitor" on the sensor interface panel.



AA.11.014

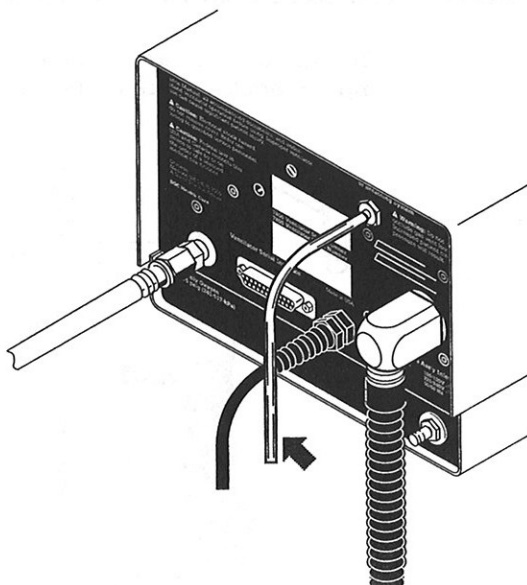


AA.04.054

AA.10.055

Figure 4-3

One end of the clear, 3-mm (1/8-inch) pressure sensor tube must connect to the barbed connector on the control module's rear panel labeled "connect to inspiratory limb of breathing system." This tube must be free of obstructions and kinks.

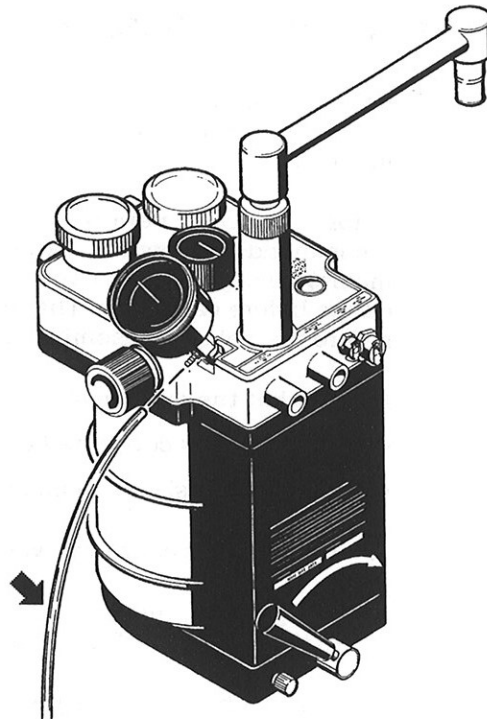


AA.10.041

4/Preoperative Checkout Procedures

Figure 4-4

The other end of the pressure sensor tube must connect to the barbed connector mounted under the pressure gauge on the absorber. (If you're using a non-GMS absorber, the tube may connect to an in-line sensing tee in the inspiratory side of the breathing system.)

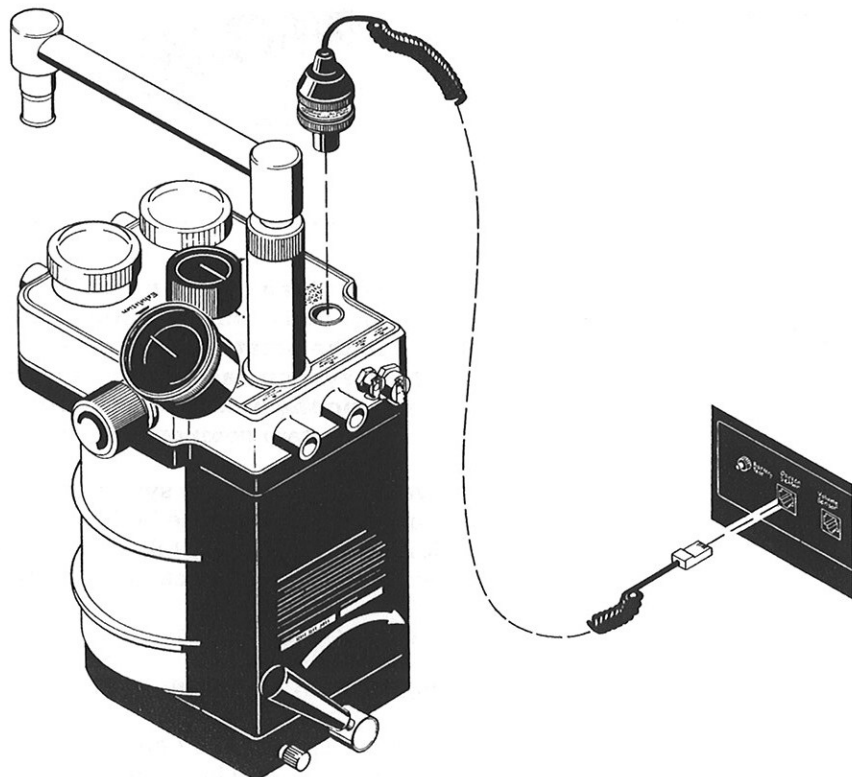


AA.15.007

Figure 4-5

The oxygen sensor's electrical cord must be connected to the receptacle labeled "oxygen monitor" on the sensor interface panel. If the sensor has been left unplugged, replace the oxygen sensor cartridge.

The oxygen sensor must be in the absorber's oxygen sensor port, which is labeled "oxygen sensor." To help prevent leaks, the sensor must fit in the port snugly. (If you're using a non-GMS absorber, the sensor may be inserted into in-line sensing tee in the inspiratory side of the breathing system.)



AA.15.011

4/Preoperative Checkout Procedures

4.2 Testing the bellows assembly

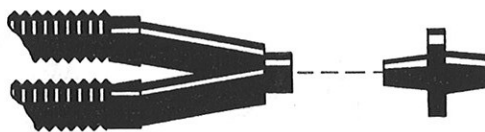
For more detailed maintenance, testing and exploded view with parts listed, see "Autoclavable bellows assembly," section 8 of this O&M manual.

Before each case, perform the preoperative checkout procedure that is recommended for your breathing system (check the operation and maintenance manual for your breathing system). Zero the pressure gauge before each case. The breathing system must pass its leak test before the bellows assembly can be tested.

Ensure that the anesthesia system is setup and ready for use —

- O₂ cylinder is connected and valve is open
 - The anesthesia machine power is applied
1. Turn all flow control valves to minimum flow.
 2. If applicable, turn the breathing system's Bag/APL-ventilator switch to the "ventilator" position.
 3. attach a breathing bag to the bag arm and a patient circuit to the inhalation and exhalation ports of the anesthesia system.
 4. Occlude the patient end—at the "Y" connector—of the patient circuit.

Figure 4-6
Occluding the
breathing system at the
"Y" connector



AA.12.031



WARNING: When occluding the breathing system for test purposes, do not use any object small enough to slip completely into the system. Objects in the breathing system can interrupt or disrupt the delivery of breathing-system gases, possibly resulting in injury to the patient. Before using the breathing system on a patient, always check the breathing system components for foreign objects.

5. Watch the breathing system's pressure gauge. Press the oxygen flush button to fill the bellows. When full the bellows may swell, but it must remain installed on the bellows base. The pressure gauge reading must not exceed 15 cm H₂O.
6. Examine the bellows and confirm that it is undamaged.
7. Release the oxygen flush button.
8. Watch the pressure gauge and adjust the oxygen flow from 200 mL per minute to 10 liters per minute and back. The pressure reading must stay within the range of 1.0 cm H₂O to 5.0 cm H₂O. This tests the bellows assembly's pressure relief valve.

4/Preoperative Checkout Procedures

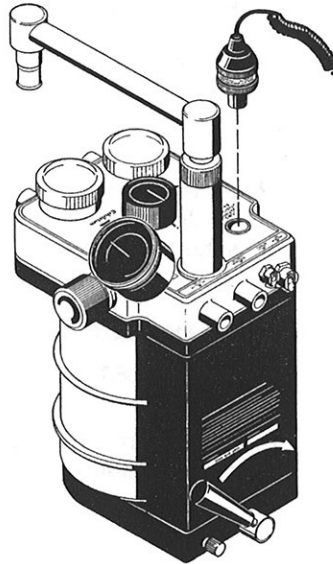
9. Switch OFF the anesthesia machine. The bellows must not drop more than 100 mL per minute. If the bellows drops more than 100 mL per minute, either the bellows is leaking or the pressure relief valve is not functioning properly.
10. If any leak cannot be corrected, do not use the ventilator; have a qualified service representative make repairs.
11. Remove any occlusions you have added to the circuit.

4.3 Testing the ventilator alarms

Testing the low and high oxygen alarms

1. Make sure the mechanical ventilation switch is set to OFF.
2. Power ON the ventilator.
3. Remove the oxygen sensor from the sensing port. Let the sensor sit in room air at least three minutes before you move to the next step.

Figure 4-8
Removing the oxygen
sensor from the
absorber



AA.15.043

4. Adjust the O₂ calibration knob until the O₂(%) display reads 21 percent. (If you can not calibrate to 21 percent replace the cartridge, see section 6/Maintaining the ventilator.)
5. Use the low-O₂ push-wheel to set the low O₂ alarm limit to 18 percent.
 - The ventilator displays: LOW O₂ LIMIT = 18%
6. Use the high-O₂ push-wheel to set the high O₂ alarm limit to 40 percent.
 - The ventilator displays: HI O₂ LIMIT = 40%
7. Use the low-O₂ push-wheel to readjust the low O₂ alarm limit to 22 percent.
 - The ventilator displays: LOW O₂ LIMIT = 22%
 - Within four seconds the ventilator sounds the warble tone, flashes the red LED, and displays the "low oxygen" message.
 - The ventilator displays: LOW OXYGEN!

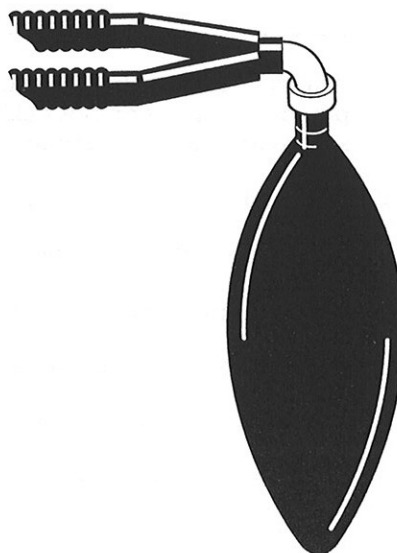
4/Preoperative Checkout Procedures

8. Now use the low-O₂ push-wheel to readjust the low O₂ alarm limit to 18 percent.
 - The ventilator displays: LOW O₂ LIMIT = 18%
 - Because you have resolved the alarm condition, the ventilator will cancel the low O₂ alarm within four seconds.
9. Use the high-O₂ pushwheel to readjust the high oxygen alarm limit to 20 percent.
 - The ventilator displays: HI O₂ LIMIT = 20%
 - Within four seconds the ventilator sounds the intermittent tone, flashes the yellow LED, and displays the "high oxygen" message.
 - The ventilator displays: HIGH OXYGEN!
10. Use the high-O₂ pushwheel to readjust the high oxygen alarm limit to 40 percent.
 - The ventilator displays: HI O₂ LIMIT = 40%
 - The ventilator cancels the high oxygen alarm within four seconds.
11. Return the oxygen sensor to the sensing port.
12. At least once a month perform the 100 percent calibration procedure as described in "6/Maintaining the Ventilator." If you don't know when the sensor was last calibrated, do it now.

Testing the low minute volume, reverse flow, and apnea alarms

1. Add a breathing bag to the patient circuit at the patient end of the "Y" connector.

Figure 4-9
Adding a breathing bag
to the patient circuit



AA.15.093

4/Preoperative Checkout Procedures


2. Make sure that inspiratory pause is off.
3. Set the tidal volume to 500 mL.
 - The ventilator displays: 500 mL I:E 1:X.X
 - X.X represents the current I:E depending upon the present flow setting.
4. Set the rate to 10 breaths per minute.
 - The ventilator displays: 10/min I:E 1:X.X
5. Set the inspiratory flow to 30 liters per minute to change the I:E ratio to 1:5.0.
 - The ventilator displays: I:E = 1:5.0
6. Set the inspiratory pressure limit to 40 cm H₂O.
 - The ventilator displays: P_{MAX}=40 SUST=20
7. Use the low \dot{V}_E pushwheel to set the low \dot{V}_E alarm limit to 0.0 liters per minute.
 - The ventilator displays: VE LIMIT = 0.0 L/min
8. Set the anesthesia system's oxygen flow to 2 liters per minute.
9. Ensure that the volume sensor cartridge is in the expiratory limb of the breathing system. Make sure that the arrows on the sensor clip point in the direction of exhaled gas flow.
10. Move the absorber's bag/ventilator switch to "ventilator, if applicable."
11. Use the anesthesia machine's oxygen flush button to fill the bellows.

Note:

Ignore any low pressure alarms that may occur while testing the low minute volume, reverse flow and apnea alarm, in steps 12 through 29.

12. Switch ON mechanical ventilation, then wait 40 seconds. The displayed \dot{V}_E should be between 3.3 and 4.3 liters per minute.
13. Use the low \dot{V}_E pushwheel to readjust the low \dot{V}_E alarm limit to 9.9 liters per minute.
 - The ventilator displays: VE LIMIT = 9.9 L
 - Then the ventilator sounds the intermittent tone, flashes the yellow LED and displays: LOW MINUTE VOL!
14. Use the low \dot{V}_E pushwheel to set the low \dot{V}_E alarm limit to 0.0 liters per minute.
 - The ventilator cancels the low minute volume alarm.
15. Remove the volume-sensor clip from the volume-sensor cartridge.
16. After 30 seconds the ventilator flashes the yellow LED, sounds the warble tone once, and displays: APNEA 31 SEC.
 - From this point on the ventilator displays the number of seconds since apnea was detected.

4/Preoperative Checkout Procedures

17. In 30 more seconds the tone warbles twice and the ventilator displays: APNEA 60 SEC.
18. Thirty seconds later the tone warbles three times and the ventilator displays: APNEA 90 SEC.
19. Wait until the ventilator displays APNEA 120 SEC.
 - The tone warbles continuously, the ventilator flashes the red LED, and the ventilator displays: APNEA **
20. Push the alarm silence button . The ventilator silences the audio alarm and holds the red LED on.
21. Put the volume sensor clip back on the volume cartridge. Make sure the arrows point in the direction of exhaled gas flow.
22. After one more ventilation cycle the ventilator clears the apnea alarm and extinguishes the red LED.
23. Move the mechanical ventilation switch to OFF.
24. Use the setup page to verify the reverse flow detection is enabled. If reverse flow detection is off, switch it on.
25. Remove the volume sensor clip from the volume cartridge.
26. Reinstall the volume sensor clip backwards (so the arrows point in the opposite direction of the exhaled gas flow) on the volume cartridge.
27. Switch ON mechanical ventilation.
 - The ventilator sounds a continuous tone, flashes the yellow LED, and displays: REVERSE FLOW!
28. Correctly reinstall the volume sensor clip back on the volume cartridge. Make sure the arrows point in the direction of exhaled gas flow.
 - After two ventilation cycles the ventilator clears the reverse flow alarm.
29. Move the mechanical ventilation switch to OFF.

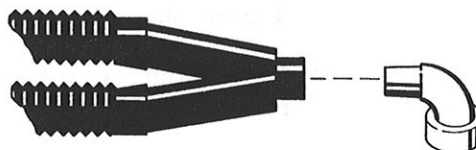
Testing the high, low, and sustained pressure alarms

1. Make sure that inspiratory pause is off.
2. Set the tidal volume to 500 mL.
 - The ventilator displays: 500 mL I:E 1:X.X
3. Set the Rate to 10 breaths per minute.
 - The ventilator displays: 10/min I:E 1:X.X
4. Set the inspiratory flow to 30 liters per minute to change the I:E ratio to 1:5.0.

4/Preoperative Checkout Procedures

- The ventilator displays: I:E = 1:5.0
- 5. Set the inspiratory pressure limit to 40 cm H₂O.
 - The ventilator displays: P_{MAX}=40 SUST=20
- 6. Set the anesthesia machine's oxygen flow to 2 liters per minute.
- 7. Make sure the pressure sensing tube is securely connected between the control module's connector marked "Connect to Inspiratory Limb of Breathing System" and the distal-sensing tee on the inspiratory side of the breathing system.
- 8. Move the absorber's bag/APL-ventilator switch to "ventilator", if applicable.
- 9. Connect the common gas outlet to the breathing system.
- 10. Open the breathing system at the "Y" connector.
- 11. Move the mechanical ventilation switch to ON. After 20 seconds of mechanical ventilation, the ventilator sounds the warble tone once, flashes the red LED, and
 - The ventilator displays: LOW PRESSURE!

Figure 4-8
Opening the patient
circuit at the "Y"
connector



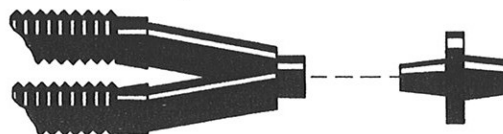
AA.15.037

12. Move the mechanical ventilation switch to OFF. Within five seconds the ventilator cancels the low pressure alarm.
13. Occlude the patient end of the "Y" connector.



WARNING: When occluding the breathing system for test purposes, do not use any object small enough to slip completely into the system. Objects in the breathing system can interrupt or disrupt the delivery of breathing-system gases, possibly resulting in injury to the patient. Before using the breathing system on a patient, always check the breathing system components for foreign objects.

Figure 4-9
Occluding the patient
circuit at the "Y"
connector



AA.12.031

4/Preoperative Checkout Procedures

14. Wait for the bellows to inflate. When the bellows are completely extended, move the mechanical ventilation switch to ON. Within two seconds the ventilator warbles once, flashes the red LED, and displays: HIGH PRESSURE!
15. Move the mechanical ventilation switch to OFF. Within ten seconds the ventilator clears the high pressure alarm.
16. Perform this APL valve test, if applicable to your system.
 - a. Maintain the occlusion in the breathing circuit.
 - b. Turn the APL valve fully clockwise.
 - c. Connect a three-liter bag to the bag port.
 - d. Move the Bag/APL-Ventilator switch to "bag/APL." (Maintain the occlusion in the breathing system.)
 - e. As you press the anesthesia system's oxygen flush button, watch the absorber's pressure gauge until the system pressure reaches at least 20 cm H₂O. Release the flush button and wait 15 seconds more. Because the pressure still exceeds 20 cm H₂O, the ventilator now sounds the warble tone continuously, lights the red LED, and displays: SUSTAINED PRES!
 - f. Slowly open the APL valve to release the pressure in the system. The ventilator silences the sustained pressure alarm when the pressure falls below 20 cm H₂O and extinguishes the red LED.
17. Remove the occlusion from the "Y" connector.
18. If applicable, set the "bag/APL-ventilator" switch to the position you plan to use.



WARNING: After completing the preoperative checkout procedures, and before starting any procedure during which this device will be used, confirm that all hoses, tubing, and other circuit components are connected properly. Failure to do so may result in patient injury. Refer to the operation manuals for all devices in the system to confirm that they are setup and connected correctly.

5/Operating the Ventilator

5.0 Using the setup page 5-1

5.1 Setting the alarm limits 5-3

5.2 Setting the ventilation parameters, beginning ventilation 5-5

5.3 Responding to alarms 5-8

5.0 Using the setup page

In the setup page mode the front panel controls are used to set parameters normally not adjusted during a case, such as

- screen contrast,
- alarm volume.
- reverse flow detection
- sigh on/off

When you first enter the setup page, the ventilator displays

- ventilator model,
- software version number it is using,
- selected supply gas,
- and selected language and current altitude setting in meters.

The ventilator then lets you enable or disable the reverse flow alarm and sigh function, and adjust the screen contrast and audio alarm volume. These parameter settings are stored in the ventilator's memory even when the system's power is OFF. To adjust the setup parameters, turn the flow knob. To move from one parameter display to the next, press a alarm silence button.

To exit the setup page, repeatedly press the alarm silence button to move through all the steps; make no changes to any parameters for 30 seconds; or, before you reach the final setup page step, move the mechanical ventilation switch to ON. When the ventilator exits the setup page, it stores any changes you've made, exits the setup page and begins normal operation. As the ventilator exits the setup page it beeps once and displays "CHECK SETTINGS." Although you must press the inspiratory pause button to begin using the setup page, the ventilator retains the inspiratory pause function's setting; you do not have to manually reset the inspiratory pause function when you are finished using the setup page.

To use the setup page

1. Move the mechanical ventilation switch to OFF.
2. Power ON the control module.

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3. Press and continue to hold down the alarm silence button Δ , then press the inspiratory pause button. Release both buttons.

The ventilator displays:

1	2	3
7800	REV 4.XX	/O
ENGLISH	1300	m
4	5	

1 meter (3.28 feet)

1. Ventilator Model
2. Software Version
3. Ventilator Drive Gas (A=Air; O=O2)
4. Language
5. Altitude



WARNING: Pay attention to the model, software revision number, ventilator supply gas, language and altitude setting shown on the setup page. If the language displayed is other than the appropriate language, or if the altitude setting is incorrect, refer to section 2, "Getting Started, Checking and setting altitude compensation." If model is other than "7800," or if the drive gas abbreviation is incorrect ("/O" indicates oxygen, "/A" indicates air), have an Ohmeda-trained service representative reset the ventilator. Other languages, models, and drive gases have associated operating parameters that are not described in this manual.;

4. Press:

The ventilator displays:

FLOW KNOB TO SET
REV FLOW ALM ON (or) OFF

5. If you are using the volume sensor at the proximal end of the "Y" connector in the patient breathing system, you may want to disable the reverse flow alarm, which, in that position, can be triggered by normal breathing. Do not disable the reverse flow alarm if the sensor is mounted in the distal position of the expiratory limb; in this position the alarm provides valuable information about possible breathing-system malfunctions. (See "Connecting the volume sensor" in "2/Getting Started" for information about installing the volume sensor.

To change the status of the reverse flow alarm, turn the flow knob until the display changes to either ON or OFF. When you are ready to move to the next step,

Press:

The ventilator displays:

FLOW KNOB TO SET
SIGH ON (or) OFF

6. When the sigh function is selected, the ventilator delivers 150 percent of the set tidal volume once every 64th breath.

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Note:

The ventilator can only deliver a maximum 1500 mL per breath.

To change the status of the sigh function, turn the flow knob until the display changes to either ON or OFF. When you are ready to move to the next step.

7. Press: 

The ventilator displays:

FLOW KNOB TO SET
CONTRAST: xx

If you want to adjust the LCD screen's contrast, turn the flow knob. As you turn the knob, the ventilator shows a one-to-ten scale that indicates the screen contrast that will be used during normal operation. For best results, set the room lighting to the level that will be used while you are operating the ventilator. When you are ready to move to the next step,

8. Press: 

The audio alarm sounds continuously and the ventilator displays:

FLOW KNOB TO SET
AUDIO VOLUME: xx

If you want to adjust the audio alarm's volume level, turn the flow knob. The displayed number represents, on a scale of one to ten, the current volume level, which is also sounding. As you turn the knob, the ventilator changes the tone's volume and the displayed number to indicate the level that will be used during normal operation. When you are ready to move to the next step,

9. Press: 

The ventilator silences the alarm, beeps once, clears the top display row and displays:

CHECK SETTINGS!

Any changes you selected are now saved and will be implemented (the inspiratory pause button remains in the state it was in when you selected the setup page).

5.1 Setting the alarm limits

Use the three alarm-set push-wheels to change the low-minute-volume, low-oxygen and high-oxygen alarms' set points. To increase the value of an alarm set point, push the button directly over the digit you want to change. To decrease the value, push the button under the digit you are changing. Use the inspiratory pressure limit knob to set the inspiratory pressure limit and the sustained pressure limit. To adjust these limits, press the inspiratory pressure limit knob as you turn it.

Anytime you change the value of an alarm set point, the ventilator displays that alarm's value on the screen.

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To set the alarm limits

1. Move the mechanical ventilation switch to OFF before powering ON the ventilator.
2. Power ON the ventilator, if it is not ON already.

Because the monitoring is active whenever the ventilator's power is ON, some alarms may sound.

3. Use the low- \dot{V}_E pushwheel to set the low minute volume alarm limit. The low minute volume alarm limits are 0.1 liters per minute to 9.9 liters per minute in 0.1 liter per minute increments. Setting 0.0 on the pushwheel disables low minute volume alarms.



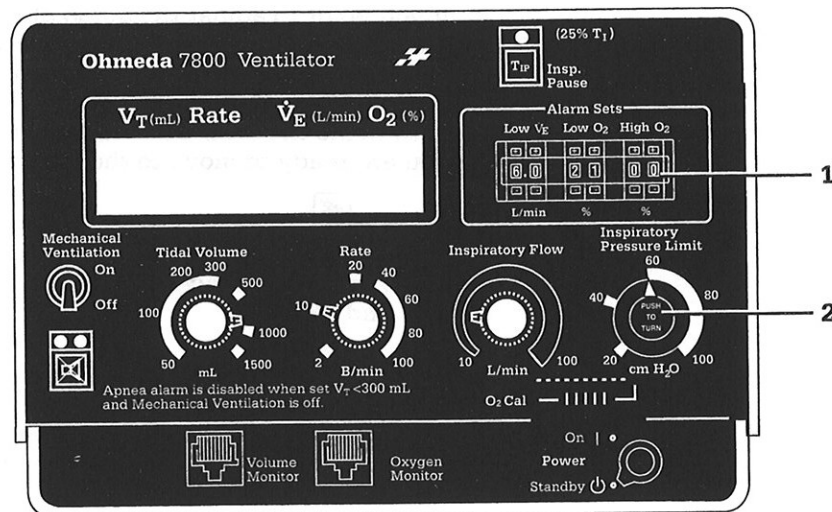
WARNING: Always correctly set the low minute volume alarm and use CO₂ monitoring to aid in the detection of breathing system disconnection's.

4. Use the low-O₂ pushwheel to set the low oxygen alarm limit. The low oxygen alarm limits are 18 percent to 99 percent in one percent increments.

Although all the digits can be physically set to zero, the ventilator will not accept low oxygen alarm limits of less than 18 percent.

Figure 5-1

Alarm push wheels and inspiratory pressure limit knob on a stand-alone ventilator. Controls are the same for an Excel system ventilator.



1. Alarm push-wheels
2. Inspiratory limit knob

If you set the low oxygen alarm pushwheel to less than 18 percent, the ventilator will continue to use 18 percent for the low oxygen alarm's set point; and the ventilator displays a "LIMIT SET ERROR" message.

5. Use the high-O₂ pushwheel to set the high oxygen alarm's limit. The high oxygen alarm's limits are 18 percent to 99 percent in one percent increments.

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If you set the high-O₂ pushwheel to a level lower than or equal to the limit set by the low-O₂ pushwheel, the ventilator displays a "LIMIT SET ERROR" message.

To disable the high oxygen alarm, set the high-O₂ pushwheel to "00"; setting the high-O₂ pushwheel to "00" will not generate a "LIMIT SET ERROR" message.

6. Use the inspiratory pressure limit knob to set the inspiratory pressure limit and the sustained pressure limit. If the sigh function is enabled, be sure to compensate for the additional pressure that will occur during the sigh breath.

Both the maximum inspiratory pressure and the sustained pressure alarm limits and pressure-release points are set by the inspiratory pressure limit knob, which must be pushed in while turned to change the settings; the ventilator sets the sustained pressure limit to correspond to the inspiratory pressure limit knob setting. For inspiratory pressure limits of 20 cm H₂O to 60 cm H₂O, the ventilator sets the sustained pressure limit to one half the inspiratory pressure limit. For example, if the inspiratory pressure limit is 42 cm H₂O, the sustained pressure limit will be 21 cm H₂O. However, any inspiratory pressure limit setting higher than 60 cm H₂O will result in a sustained pressure limit of 30 cm H₂O. For example, inspiratory pressure limits of 65 cm H₂O and 80 cm H₂O will both result in a sustained pressure limit of 30 cm H₂O.

As you push and turn the inspiratory pressure limit knob, the ventilator displays both the maximum pressure limit and the sustained pressure limit settings. However, unlike the other three control knobs, just touching this knob will not generate a display.

If, while the mechanical ventilation switch is OFF, you set the inspired pressure limit for more than 60 cm H₂O, the ventilator beeps, lights the yellow LED, and continually displays the maximum pressure setting. This pressure limit message is displayed in the non-mechanical ventilation mode only; during mechanical ventilation this reminder is disabled.

In addition to the three alarms set by the push-wheels and the two alarms set by the inspiratory pressure limit knob, the ventilator also sets trigger points for certain alarms based on the positions of other front panel controls. These alarms include the low pressure alarm, the apnea alarm, and the reverse flow alarm.



WARNING: The reverse flow alarm only works when the volume sensor cartridge is mounted at the distal end of the expiratory limb, reverse flow is ON and the volume sensor is working properly.

5.2 Setting the ventilation parameters, beginning ventilation

Set the ventilation parameters before moving the mechanical ventilation switch to ON. Because we recommend that you set the ventilator's controls starting on the left and moving to the right, these instructions describe setting the ventilator's controls in that order. If you adjust either the tidal volume knob or rate knob after you have set the inspiratory flow knob, you may need to readjust the inspiratory flow to maintain the desired I:E ratio.

It is possible to adjust the controls for a combination of settings that will result in a level the ventilator cannot deliver. If the combination of settings results in a level the ventilator is not designed to deliver, a

5/Operating the Ventilator


"VENT SET ERROR" alarm is displayed. (See "Control range computation" in "3/General Information" for a description of the range of control settings.)

The measured tidal volume indicated on the screen may be different than the level you set on the tidal volume knob. Under pressure, gases compress and certain breathing system components expand, which results in some loss of tidal volume in the breathing system. Also, any fresh gas introduced to the system is measured by the volume sensor in addition to the gas the bellows assembly delivers. For instructions on calculating these breathing system losses and gains, see "Tidal volume compensation" in "3/General Information."

You don't, however, have to manually calculate the compliance affect to compensate for compliance losses. With the volume sensor correctly connected in the breathing system, adjust the tidal volume knob until the tidal-volume reading on the ventilator's screen indicates the level you want to use.

To set the ventilation parameters and begin mechanical ventilation

1. Before connecting the ventilator to a patient, perform the preoperative checkout procedures described in "4/Preoperative Checkout Procedures."
2. Move the mechanical ventilation switch to OFF.
3. Power ON the control module, if it is not ON already.

The ventilator enters the non-mechanical ventilation mode. Because the monitoring is active whenever the ventilator's power is ON, some alarms may sound. To silence any alarms, press .

4. Set the alarm limits. Be sure to set the ventilation controls before moving the mechanical ventilation switch to ON.
5. Use the tidal volume knob to set the tidal volume.

The tidal volume knob lets you set the tidal volume from 50 mL to 1500 mL. As you turn the knob, the ventilator will display the tidal volume setting. To check the tidal volume setting without changing its value, just touch the knob; the ventilator will then display the current tidal volume setting. Since changing the tidal volume may change the I:E ratio, the I:E ratio is displayed along with the tidal volume as a reminder. If the resulting I:E ratio is not as desired, be sure to readjust the inspiratory flow to maintain the desired I:E ratio.

Until the ventilator senses sufficient volume to indicate a breath, it displays "VOL MON STANDBY." Once the ventilator senses a sufficient volume level, it removes the "VOL MON STANDBY" message and starts the timer that controls the apnea alarm.

If, however, while the mechanical ventilation switch is OFF, you set the tidal volume to less than 300 mL, the ventilator will disable the apnea alarm. Once the ventilator removes the "VOL MON STANDBY" message—after an activation breath—the ventilator will display the "APNEA ALARM OFF" message. If you want the apnea alarm enabled when the ventilator is in the non-mechanical ventilation mode, set the tidal volume knob to 300 mL or higher.

Note:

When switching from mechanical to non-mechanical ventilation mode and the VOL MON STANDBY is displayed, the apnea timer does not begin until an initial breath is sensed.

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6. Use the rate knob to set the mechanical breath rate.

Turning the rate knob changes the breath rate used for mechanical ventilation and displays the rate. The rate's range is from 2 breaths per minute to 100 breaths per minute in whole number increments. Touching the rate knob will display the current rate on the screen. Since changing the breath rate may change the I:E ratio, the I:E ratio is displayed along with the breath rate as a reminder. If the resulting I:E ratio is not as desired, readjust the inspiratory flow to maintain the desired I:E ratio.

7. If you want to enable the inspiratory pause function, press the inspiratory pause key.
8. Set the desired I:E ratio by adjusting the inspiratory flow rate.

The inspiratory flow knob lets you set the inspiratory flow rate, which is variable from 10 liters per minute to 100 liters per minute. Whenever you adjust or just touch the inspiratory flow knob, the ventilator displays the current I:E ratio, which the ventilator calculates based on the set inspiratory flow, tidal volume, inspiratory pause status, and breath rate. Adjusting any of these parameters changes the I:E ratio. However, you should use the inspiratory flow knob to adjust the I:E ratio once the tidal volume and breath rate have been correctly set. To check the current I:E ratio, touch the inspiratory flow knob.

9. Move the absorber's Bag/APL-Ventilator switch to "ventilator," if applicable.
10. Use the anesthesia system's oxygen flush valve to fill the bellows. Set the oxygen flow to a level that keeps the bellows fully extended.
11. To start mechanical ventilation, move the mechanical ventilation switch to ON.

The mechanical ventilation switch controls mechanical ventilation only. When the switch is OFF, the monitors still function and the alarm system is still active. When you want to start mechanical ventilation, move the switch to ON.

Always turn ON the anesthesia system and set the control module's front panel controls before switching ON mechanical ventilation. Starting mechanical ventilation before setting the controls may result in inappropriate ventilation of the patient and may trip alarms that relate to mechanical ventilation.

12. Once the ventilator is mechanically ventilating the patient, check the tidal volume. (See "3/General Information" for information about tidal volume compensation.) If necessary, adjust the front panel controls to modify the ventilator's operating parameters. You can adjust any of the front panel controls while the ventilator is ON, see the preceding parameter setting steps.

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5.3 Responding to alarms

For detailed descriptions of the ventilator's alarms, see "The alarm system" in "3/General Information."



WARNING: Always respond to alarms promptly. Failure to respond to alarms may result in injury to the patient.

APNEA xxx SEC

If for 30 seconds the ventilator doesn't detect enough exhaled volume in the breathing system, an apnea alarm will be generated. The alarm message will indicate the number of seconds that have passed since sufficient flow was last detected.



WARNING: If you remove the sensor clip from the volume sensor cartridge before switching ON the anesthesia system, the apnea alarms will be inoperative. Do not use the ventilator without the sensor clip properly attached to the volume sensor cartridge.

Note:

If a sigh breath occurs when a breath rate setting of two breaths per minute is set, the apnea alarm is triggered during the sigh breath.

1. Check the patient.
2. Check for disconnections in the patient breathing system.
3. Check for excessive moisture in the volume sensor cartridge.
4. If so equipped, check for excessive moisture in the absorber's check valves.
5. Make sure the volume sensor clip is connected securely to the volume sensor cartridge.
6. Make sure the arrows on the volume sensor clip point toward the direction of exhaled gas flow.
7. Make sure the volume sensor clip is connected into the sensor interface.
8. Replace the volume sensor cartridge. It may be worn out if its rotor is turning too slowly or not at all. (See "Checking the volume sensor" in "6/Maintaining the Ventilator.")
9. Replace the volume sensor clip.

APNEA ALARM OFF!

Whenever tidal volume is set to less than 300 mL and the mechanical ventilator switch is OFF, the ventilator, once it has detected a breath, will display "APNEA ALARM OFF." To enable the apnea alarm system while the patient is breathing spontaneously, increase the tidal volume knob to 300 mL or more.

- The "APNEA ALARM OFF" message is normal if the tidal volume knob is set below 300 mL and the mechanical ventilation switch is set to OFF.

CHECK O2 SENSOR!
CHECK GAS SUPPLY

If the ventilator doesn't detect at least five percent oxygen, it assumes the oxygen sensor has failed, and generates an alarm. An alarm will also be generated if the sensor isn't connected correctly, if the sensor is broken, or if no oxygen is in the area of the sensor.

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1. Check the oxygen supply.
2. Make sure the oxygen sensor is plugged into the anesthesia system's sensor interface.
3. Check the oxygen-sensor cartridge's surface for excessive moisture.
4. Has the oxygen sensor been left unconnected from the sensor interface? If it has, see "Maintaining, Replacing and Calibrating the Oxygen Sensor" in 6/Maintaining the Ventilator.
5. Replace the oxygen-sensor cartridge. It may be worn out. (See "Replacing the oxygen sensor" in "6/Maintaining the Ventilator.")

DRIVE CKT OPEN!

One type of ventilator failure—exhalation valve failure—does not display a numbered message; instead "DRIVE CKT OPEN" is displayed. This message can also appear if, during mechanical ventilation, the absorber's Bag/APL-Ventilation switch is in the "Bag/APL" position. During this alarm, the ventilator will attempt to continue monitoring and mechanical ventilation.

1. Check the patient.
2. If mechanical ventilation is ON, make sure the absorber's Bag/APL-Ventilation switch is in the "ventilator" position, if applicable.

HARDWARE ERROR X

This display (error A, B, and C) and alarm should not occur unless there is a problem with the ventilator control module hardware. The alarm is silenceable with the alarm silence  button. Mechanical ventilation does not turn OFF.



WARNING: Do not use the ventilator if this display and alarm occur.

HIGH OXYGEN!

If the ventilator detects an oxygen concentration equal to or higher than the one you set using the high-O₂ pushwheel, the ventilator generates a high oxygen alarm.

1. Check the high-O₂ alarm limit. Is it set correctly?
2. Check the anesthesia system settings.
3. Has the oxygen sensor been left unconnected from the sensor interface? If it has, see "Maintaining, Replacing and Calibrating the Oxygen Sensor" in 6/Maintaining the Ventilator.

HIGH PRESSURE!

If the ventilator detects airway pressure higher than the limit you set using the inspiratory pressure limit knob, the ventilator generates a high pressure alarm. And, during *mechanical ventilation only*, the ventilator also terminates inspiration.

1. Check the patient.
2. Check for a blockage in the patient breathing system.
3. Check the inspiratory pressure limit knob. Is it set correctly?
4. Check for moisture in the pressure sensing tube that connects the breathing system to the ventilator's control module.
5. Check for kinks in the pressure sensing tube.

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LIMIT SET ERROR!

If you attempt to set the high oxygen alarm limit for a level below or equal to the low oxygen limit, the ventilator generates a limit setting error alarm. This alarm will also be generated if you attempt to set the low oxygen alarm limit for less than 18 percent.

Reset the alarm limits to acceptable values.

LOW BATTERY!

If the battery's voltage drops to an unacceptable level, the ventilator generates a "LOW BATTERY" alarm.

Leave the ventilator powered ON and connected to ~ power for at least 24 hours to recharge the battery.

LOW MINUTE VOL!

If the ventilator senses that the minute volume is less than the level you set using the low- \dot{V}_E pushwheel, the ventilator generates an alarm.

1. Check the patient.
2. Check the low- \dot{V}_E alarm limit. Is it set correctly?
3. Check for breathing tube disconnections.
4. Check for excessive moisture in the volume sensor cartridge.
5. Check for excessive moisture in the absorber's check valves.
6. Make sure the volume sensor clip is connected securely to the volume sensor cartridge.
7. Make sure the arrows on the volume sensor clip point in the direction of exhaled gas flow.
8. Make sure the volume sensor clip is plugged into the sensor interface.
9. Replace the volume sensor cartridge. It may be worn out if its rotor is turning too slowly or not at all. (See "Checking the volume sensor" in "6/Maintaining the Ventilator.")
10. Replace the volume sensor clip.

LOW OXYGEN!

If the ventilator detects an oxygen concentration lower than the one you set using the low- O_2 pushwheel, the ventilator generates a low oxygen alarm.

1. Check the patient.
2. Check the anesthesia system's flow meter settings. Are they set correctly?
3. Check the anesthesia system's pressure gauges.
4. Check the low- O_2 alarm limit. Is it set correctly?
5. Check the oxygen supply.
6. Check the oxygen sensor assembly for damage.
7. Make sure the oxygen sensor is inserted securely into the oxygen sensing port.

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8. Make sure the oxygen sensor is connected into the sensor interface.
9. Check the oxygen-sensor cartridge's surface for excessive moisture.
10. Has the oxygen sensor been left unconnected from the sensor interface? If it has, see "Maintaining, Replacing and Calibrating the Oxygen Sensor" in 6/Maintaining the Ventilator.
11. Replace the oxygen-sensor cartridge. It may be worn out. (See "Replacing the oxygen sensor cartridge" in "6/Maintaining the Ventilator.")

LOW PRESSURE!

The ventilator generates a low pressure alarm if, for at least 20 seconds, the airway pressure fails to change by a value that varies proportionally to the setting of the inspiratory flow knob. The low pressure alarm is active only when mechanical ventilation is switched ON.

1. Check the patient.
2. Check the breathing system for leaks or disconnections.
3. Check for moisture in the pressure sensing tube that connects the breathing system to the ventilator's control module.
4. Check for kinks in the pressure sensing tube.
5. Is the patient breathing spontaneously? During mechanical ventilation spontaneous breathing may trip this alarm.

LOW SUPPLY PRESS!

If the ventilator's regulated supply gas pressure is less than 22 psig, (155 kPa) the ventilator generates a low supply pressure alarm. Low supply pressure will reduce delivered tidal volumes during mechanical ventilation.

1. Check the supply pressure.
2. Switch to cylinder use, if applicable.
3. Switch to manual ventilation, if necessary.

MAX PRES =xxx cm

Anytime you adjust the inspiratory pressure limit knob, the ventilator briefly displays the pressure limit in centimeters of water. If, however, the ventilator is in the non-mechanical ventilation mode and the inspiratory pressure limit is set to 60 cm or more, the ventilator will also light the yellow alarm LED and continually display the "MAX PRES=XXX CM" message. This pressure limit reminder is displayed in the non-mechanical ventilation mode only.

O2 CAL ERROR!

If the oxygen sensor delivers a signal that is out of the ventilator's range, the ventilator generates an oxygen-calibration-error alarm.

- Calibrate the oxygen sensor as described in "Calibrating the oxygen sensor" in "6/Maintaining the Ventilator."

POWER FAIL!

If ~ power to the ventilator is lost, the ventilator generates a power-failure alarm.

1. Continue normal operation; a fully charged backup battery will allow you to continue for about 20 minutes with mechanical ventilation. To extend the monitoring time, discontinue mechanical ventilation, and manually ventilate the patient.

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2. Make sure the system power cord has not been disconnected.
3. Resolve the cause of the power failure.

REVERSE FLOW!

If the ventilator senses reverse flow of an unacceptable volume, it generates a "Reverse Flow" alarm. For tidal volumes less than 300 mL, the reverse flow limit is 20 mL. For tidal volumes greater than 300 mL, this limit is 100 mL.

1. Make sure the volume sensor assembly is in the expiratory limb of the patient breathing system. If the sensor is in the expiratory limb, check the exhalation valve; its disk may be sticking.
2. Make sure the arrows on the volume sensor clip point in the direction of exhaled gas flow.

REV FLOW ALM OFF

To advise you that the reverse flow alarm is disabled, in the non-mechanical ventilation mode the ventilator repeatedly flashes this message. If you power ON the control module with the alarm disabled and mechanical ventilation ON (although you should always have the mechanical ventilation switch set to OFF when you power ON), the message will be displayed once.

- If you want the reverse flow alarm enabled, use the setup page to set the reverse flow alarm status to ON.

SOFTWARE ERROR X

This display (error A through F) and alarm should not occur unless there is a problem with the ventilator software programs. The alarm is silenceable with the alarm silence button. Mechanical ventilation does not turn OFF.



SUB-ATMOS PRES!

WARNING: Do not use the ventilator if this display and alarm occur.

If the ventilator detects airway pressure of less than minus (-)10 centimeters of water, it generates a sub atmospheric pressure alarm.

1. Check patient.
2. Check for inadvertent vacuum hook-ups to the patient breathing system.
3. Check for kinks or occlusions in the breathing system.
4. The inspiratory check valve in the absorber may be stuck. Check the inspiratory check valve.
5. Is the patient breathing spontaneously? Spontaneous breathing may trip this alarm.
6. Check the gas-scavenging system for excessive vacuum.
7. Check for moisture in the pressure sensing tube that connects the breathing system to the ventilator's control module.
8. Check for kinks in the pressure sensing tube.

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SUSTAINED PRES!

Anytime the sustained airway pressure exceeds—for 15 seconds or more—the sustained pressure limit set by the inspiratory pressure limit knob, the ventilator generates a sustained pressure alarm.

1. Check the patient.
2. Check for kinks or blockages in the breathing system.
3. Check to make sure the absorber's Bag/APL-Ventilator valve is in the correct position.
4. Check for moisture in the pressure sensing tube that connects the breathing system to the ventilator's control module.
5. Check for kinks in the pressure sensing tube.

VENT FAIL xx!

The number in the ventilator failure message, such as "VENT FAIL 8," corresponds to the specific type of failure occurring. Vent fail messages require that you take the ventilator out of service and call a qualified, trained Ohmeda Service Representative. If a ventilator failure alarm occurs, pressing the alarm silence button permanently silences the alarm tone, although the yellow LED and alarm message remains ON, and the ventilator may not function.



Electrical interference

WARNING: Do not use the ventilator if this display and alarm occur.

Some ventilator failure alarm conditions may be caused by transitory electrical interference that devices such as electrocautery instruments can generate. Although the ventilator will disable mechanical ventilation during most ventilator failure alarms, during certain of these alarms, whose causes may be transitory, the ventilator attempts to maintain mechanical ventilation.

See the "7/Service Procedures" for descriptions of specific ventilator failure messages.



WARNING: The use of electrosurgical units or other devices that radiate high-intensity electrical fields can affect the operation of the ventilator and monitors attached to the patient. Maintain as much distance as possible between the electrosurgical leads and the cables to the flow and oxygen sensors. Do not drape the electrosurgical leads across the absorber or the anesthesia machine. Do not let the electrosurgical leads rest on any surface of the anesthesia system. Constant surveillance of all monitoring and life support equipment is mandatory whenever electrosurgical devices are in operation, on, or in the vicinity of the patient.

WARNING: Ventilator failure messages indicate that a problem exists in the ventilator. Do not attempt to use the ventilator while a ventilator failure message is displayed.

IMPORTANT

If the ventilator experiences extreme electrical interference, it may interrupt mechanical ventilation. If this interruption occurs, the ventilator generates an internal reset function and resumes normal operation after two (2) seconds. For situations where continuous electrical interference is experienced by the ventilator, causing a continuous interruption, the ventilator's internal reset repeats until the interference ceases.

If the electrical interference is continuously present and mechanical

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ventilation is interrupted for approximately 30 seconds, the ventilator produces a continuous beeping audio alarm. Manual ventilation of the patient must be performed while the mechanical ventilation is interrupted. When the electrical interference ceases, the continuous beeping audio alarm can be silenced only by turning, as applicable, the ventilator or anesthesia machine power switch OFF and after five seconds back ON.



WARNING: Manual ventilation must be performed when electrical interference causes interruption of ventilator delivered mechanical ventilation. Manual ventilation must be continued until the ventilator resumes normal operation or an alternate ventilator/anesthesia system can be used.

1. Manually ventilate the patient.
2. Have the ventilator checked by qualified service personnel.

Refer to "7/Service Procedures" for more information about ventilator failure messages.

VENT SET ERROR!

If you attempt to set a combination of the inspiratory-flow, tidal-volume, inspiratory pause, and rate controls that results in a level the ventilator is not designed to deliver, the ventilator continues to use the most recent acceptable settings, and generates a ventilator setting error alarm until the control combination is corrected.

- Readjust the ventilator's controls within the ventilator's operating limits.



WARNING: Do not use the ventilator while the "VENT SET ERROR" message is displayed; when this message is displayed, the control settings do not reflect the settings the ventilator is using. If the "VENT SET ERROR" message is displayed during mechanical ventilation, the system will use the most recent acceptable settings. If, however, the ventilator is powered ON in the "VENT SET ERROR" condition, moving the ventilation switch to ON will not start mechanical ventilation until the controls are moved to an acceptable setting.

VOL MON STANDBY!

Volume monitor standby indicates that, during mechanical or non-mechanical ventilation, either the ventilator has not sensed sufficient breaths to check for apnea and volume alarm conditions, or that, while the mechanical ventilation switch is OFF, the alarm silence button has been used to cancel and reset the apnea and low minute volume alarms. If these two alarms have been canceled, they will not sound again even if these alarm conditions continue. However, if the ventilator senses another breath, the alarm timers and sensor circuits will again be activated and any alarm condition that occurs will trigger an appropriate alarm.

VOL SENSOR FAIL!

A volume sensor failure alarm is displayed if the volume sensor's heater voltage is too low, which can happen if the volume sensor clip is broken or disconnected.

1. Check the connection between the volume sensor cartridge and the sensor clip.
2. Make sure the sensor clip is plugged into the sensor interface.
3. Replace the volume sensor clip.

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displayed in place of
readings

If the system doesn't measure any volume during mechanical ventilation, it will display dashes in place of the volume and rate data.

1. Check the patient.
2. Check the breathing system for disconnections.
3. Check for obstructions in the volume-sensor cartridge that may be preventing the cartridge vanes from spinning.
4. Replace the volume sensor cartridge.
5. Replace the volume sensor clip.


????????
is displayed in place of
 \dot{V}_E , V_T , or rate readings

Certain combinations of ventilator front panel control settings can result in ventilation conditions the ventilator can deliver but the volume sensor cannot measure. If you set a control combination the ventilator can deliver, but the volume monitor cannot measure, or if—in the non-mechanical ventilation mode — breathing occurs that the monitor cannot measure, the ventilator displays question marks in place of the V_T , \dot{V}_E , and rate readings.

If the alarm silence
button will not silence
the alarm

Certain electronic failures may be so significant as to cause the system to lose the ability to generate ventilator failure messages even though the ventilator has failed. If such a serious failure occurs, the alarm silence button will not silence the alarm. Do not attempt to use the ventilator if this type of failure occurs.



WARNING: Do not attempt to use the ventilator if the alarm silence button  will not silence alarms.

1. Ventilate the patient manually.
2. Switch to a functioning system.

Notes

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 - NiCad battery maintenance 6-2
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6.0 Maintenance schedule

The following schedule is a recommended minimum standard that is based on normal usage and environmental conditions. Higher frequencies of use or unusual environments may dictate more frequent maintenance.



CAUTION: No repair should ever be undertaken or attempted by anyone not having proper qualifications and equipment.

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

Full checkout and maintenance by trained service personnel	Every three months
Calibrate oxygen sensor	Daily
Replace oxygen sensor	As required at minimum yearly
Clean bellows assembly	See section 8
Clean or replace pressure sensing tube	As required
Replace volume sensor cartridge	As required at minimum monthly

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Long Term Ventilator Storage

It is not necessary to disconnect the rechargeable batteries before long term storage.

If the ventilator is to be stored for an extended period of time (greater than 3 months), the batteries will eventually discharge. This is not destructive to the ventilator or the batteries, however, batteries must be fully recharged before putting the ventilator into service.

6.1 Cleaning and sterilizing

This chart is provided for quick reference once you are familiar with the cleaning and sterilization of the system. Refer to the following sections for cleaning-and-sterilization details. Use a cleaning and sterilization schedule that conforms to your institution's sterilization and risk-management policies.

Item	To clean	To sterilize
Control module	mild detergent	n/a
Bellows assembly	see section 8 or 9	see section 8 or 9
Volume sensor assembly	damp cloth	disinfectant
Volume sensor cartridge	damp cloth	ethylene oxide or liquid sterilizing agent
Oxygen sensor housing (front section only)	damp cloth	ethylene oxide
Oxygen sensor cartridge	white vinegar	ethylene oxide
Clear plastic areas	damp cloth	n/a
Rubber, plastic	damp cloth, mild (pH less than 9), cold germicidal alkali detergent	detergent, ethylene oxide

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Cleaning the control module

Clean the exterior surfaces of the control module with a soft, lint-free cloth lightly moistened in a solution of mild liquid detergent.



CAUTION: Use cleaning solution sparingly. Do not saturate system components, excessive solution can damage internal devices.

CAUTION: Do not cover the system with any type of fabric or plastic covering. These types of coverings can generate static charges that may damage the equipment.

Cleaning and sterilizing the bellows assembly

See section 8 for Ohmeda Autoclavable Bellows Assembly or section 9 for Ohmeda Non-Autoclavable Bellows Assembly for disassembly, cleaning, sterilization, reassembly and checkout procedures.

Cleaning and sterilizing the volume sensor clip assembly

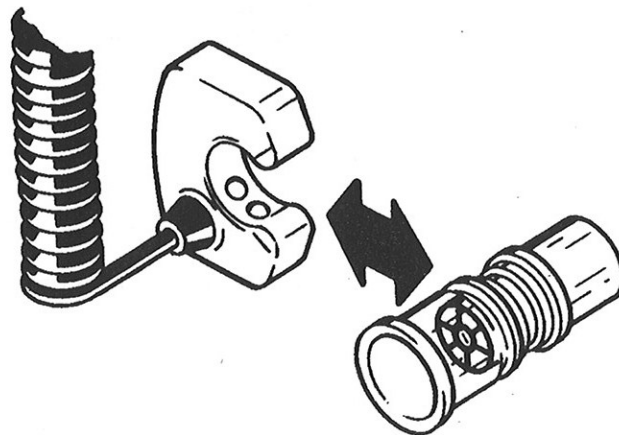
Because no part of the sensor assembly—which includes the clip, cable and plug—is exposed to the breathing system, usually no sterilization is required. If the clip, cable and plug do need cleaning:

1. Unplug the sensor from the sensor interface panel.
2. Remove the sensor clip from the volume cartridge.
3. Wipe the clip, cable and plug with a cloth moistened in disinfectant (liquid sterilizing).



CAUTION: Never immerse any part of the volume sensor assembly in cleaning solution. Immersion will destroy the clip's electrical contacts.

Figure 6-1
Disconnecting the
volume sensor
cartridge from its clip



MD-10-016

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Cleaning and sterilizing the volume sensor cartridge

Replace the sensor cartridge at least every thirty days, or when the volume sensor checkout (see "Checking the volume sensor") indicates the sensor has become inaccurate. If cleaning is required between replacements:

Note:

Be very careful while you are handling the volume cartridge. The cartridge is a precision device containing jeweled bearings. Do not drop the cartridge. Do not allow any contaminant, such as hair or dust, to enter the cartridge.

1. Remove the cartridge from the breathing system.
2. Unsnap the sensor clip from the cartridge.
3. Use an accepted gas or liquid sterilization technique to sterilize the sensor cartridge.



CAUTION: Never insert cleaning brushes or other foreign objects through the cartridge vanes. Contacting the sensor's moving vane may damage its precision movement.

CAUTION: Following ethylene oxide sterilization, quarantine the equipment in a well-ventilated area to allow dissipation of absorbed ethylene-oxide gas. In some cases, aeration periods of seven days or more may be required. Aeration time can be decreased when special aeration devices are used. Follow the sterilizer manufacturer's recommendations for aeration periods required.

CAUTION: Always perform the preoperative checkout procedures for volume sensing functions after cleaning or replacing the volume sensor cartridge, see section 4.

6.2 Checking the volume sensor

This volume-sensing checkout procedure, which you should perform before each case, tests both the sensor cartridge and the sensor assembly. If the checkout fails, replace the volume cartridge, then repeat the procedure. If the checkout still fails after you replace the cartridge, replace the sensor assembly and repeat the test again.

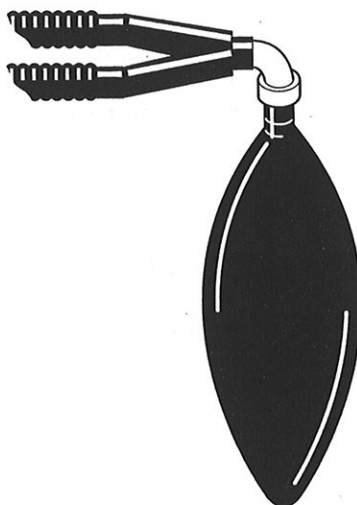
To check volume sensing

1. Add a bag to the patient circuit at the "Y" connector.
2. Set the tidal volume to 500 mL.
 - The ventilator displays: 500 mL I:E 1:XX
3. Set the rate to 10 breaths per minute.
 - The ventilator displays: 10/min I:E 1:XX
4. Using the inspiratory flow knob, set the I:E ratio to 5.0. This corresponds to a flow of 30 liters per minute.
 - The ventilator displays: I:E=1:5.0

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5. Set the inspiratory pressure limit to 40 cm H₂O.
 - The ventilator displays: P_{MAX}=40 SUST=20
6. Make sure that the ventilator's inspiratory pause function is off.
7. Set the low \dot{V}_E alarm limit to 0.0 liters per minute.
8. Set the anesthesia system's oxygen flow to 2 liters per minute.
9. Ensure that the volume sensor cartridge is on the exhalation side of the breathing system. Make sure that the arrows on the sensor clip point in the direction of exhaled gas flow.
10. Move the absorber's bag-to-ventilator switch to the ventilator position, if applicable.
11. Use the anesthesia machine's O₂ flush button to fill the bellows.

Figure 6-2
Adding a breathing bag
at the patient circuit's
"Y" connector



AA.15.093

12. Switch ON mechanical ventilation and wait 40 seconds. The displayed \dot{V}_E should be between 3.3 liters and 4.3 liters assuming that your system:
 - includes an adult bellows
 - includes 60-inch patient tubes
 - does not include a humidifier
 - has a peak inspiratory pressure of 15 cm H₂O

(If your system's components and peak inspiratory pressure are different than this, see "Tidal volume compensation" in section 3 to calculate the compliance factor of your system. Then use this factor to calculate the expected minute volume.)

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6.3 O₂ sensor maintenance

Maintenance schedule

Before each use

Monthly

Annually

- Preoperative checkout procedure (includes 21% O₂ calibration)
- 100% O₂ calibration
- Replace the O₂ sensor cartridge. Cartridge life expectancy is one year at 50% O₂ and 24°C (77°F). Different operating conditions (higher concentrations, high temperature, and elevated CO₂ concentrations) can shorten cartridge life expectancy. Freezing can destroy the sensor cartridge

6.4 Installing a cartridge or disassembling the O₂ sensor for cleaning

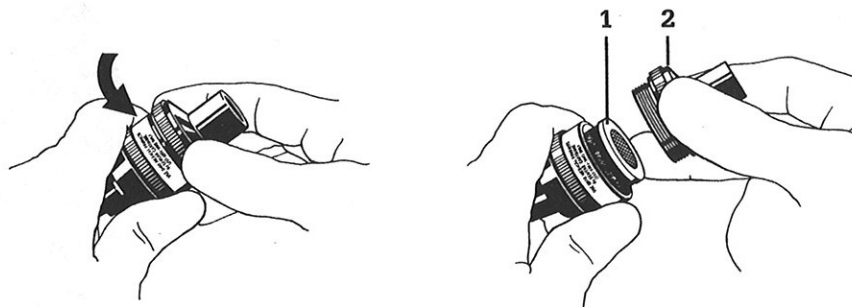


WARNING: Use protective gloves and eye-wear when you open the O₂ sensor in case the cartridge is leaking. The sensor cartridge contains potassium hydroxide (caustic).



CAUTION: Handle the cartridge with care to avoid damaging it. Always perform the calibration and preoperative checkout procedures for oxygen-sensing functions after replacing a new sensor cartridge or a recently cleaned and sterilized oxygen sensor.

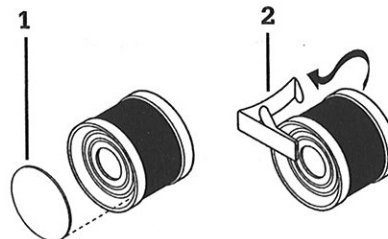
Figure 6-2
Open the sensor housing and remove the old cartridge



1. Sensor screen
2. Probe section of housing

MD-02.055.56; OT.01.022

Figure 6-3
Remove the metal disk or clip and retain for shorting the cartridge during future maintenance



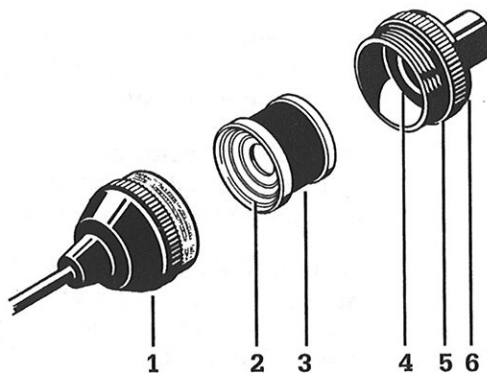
1. Shorting disk
2. Shorting clip

MD.12.011

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Figure 6-4

Install a new cartridge with circular contacts toward the cable end of the housing, screen facing out

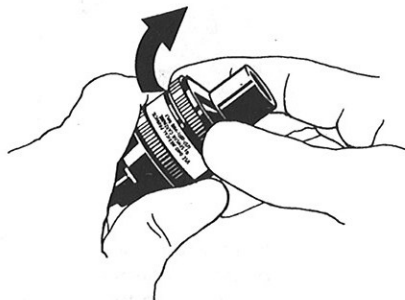


1. Cable section
2. Contact rings
3. Sensor cartridge
4. Inner O-ring
5. Outer O-ring
6. Probe section

MD.02.032

Figure 6-5

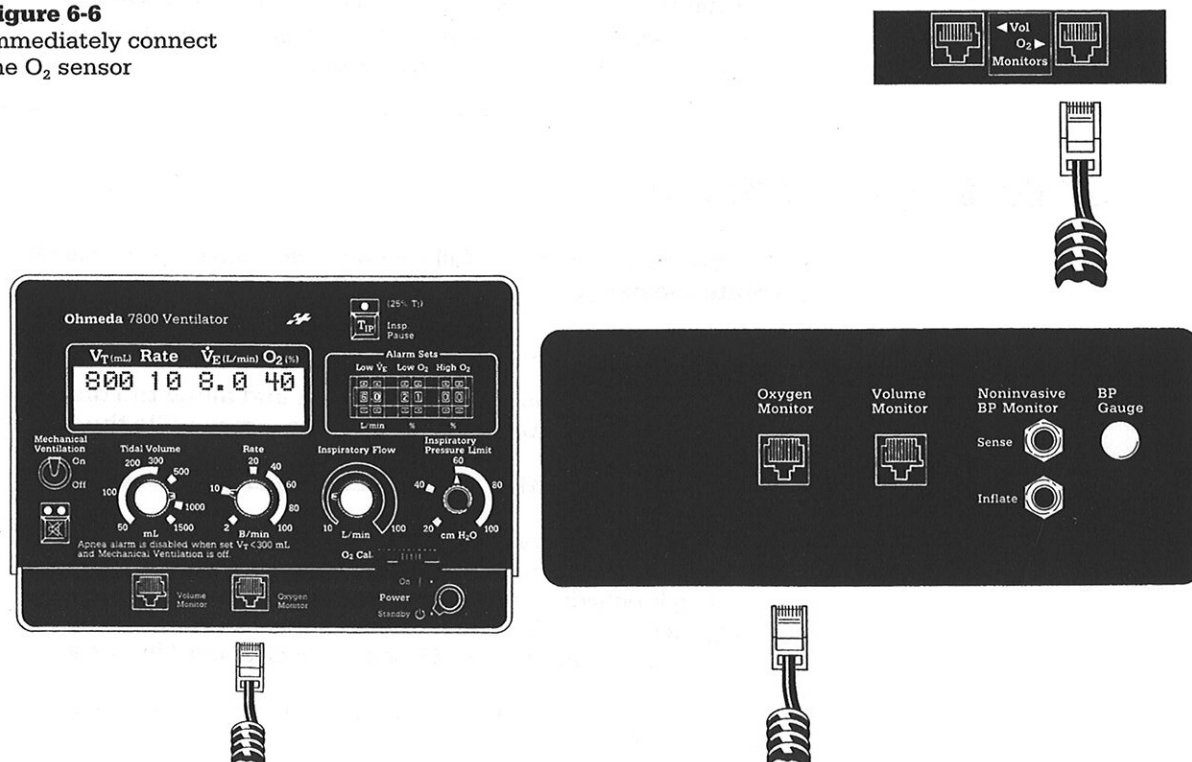
Finger tighten the housing to a gas tight seal



MD.02.055

Figure 6-6

Immediately connect the O₂ sensor



AA.11.272; AA.04.053; AA.10.026

6/Maintaining the Ventilator

Cleaning and sterilization



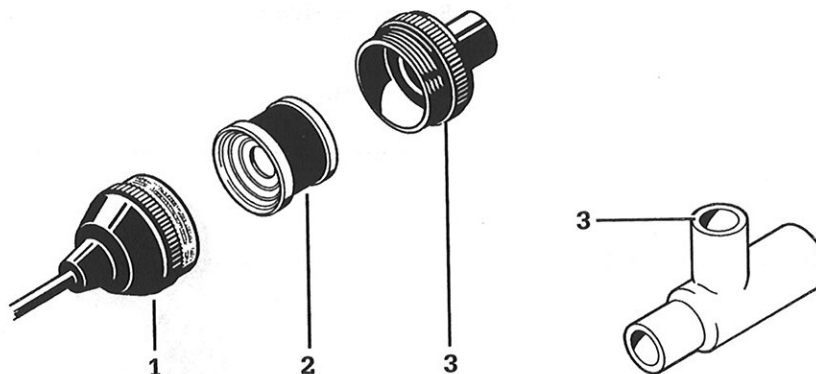
WARNING: Use protective gloves and eye-wear when you open the O₂ sensor in case the cartridge is leaking. The sensor cartridge contains potassium hydroxide (caustic).

WARNING: Do not inhale any fumes generated by the oxygen-sensor cleaning procedure. Such fumes can cause respiratory system or skin damage. This material is caustic.



CAUTION: Following ethylene oxide sterilization, quarantine the equipment in a well-ventilated area to allow dissipation of absorbed ethylene-oxide gas. In some cases, aeration periods of seven days or more may be required. Aeration time can be decreased when special aeration devices are used. Follow the sterilizer manufacturer's recommendations for aeration periods required.

Figure 6-6
Cleaning and
sterilization methods



1. Wipe with a damp cloth (liquid disinfectant, mild detergent, isopropyl alcohol); do not immerse, gas sterilize, or autoclave; remove oxide from leaked electrolyte under a fume hood with vinegar using eye and skin protection
2. Gas sterilize with ethylene oxide (ambient temperature, no vacuum or pressure) or wipe with a damp cloth (water, white vinegar, liquid disinfectant); do not immerse or autoclave; do not use alcohol
3. Gas sterilize with ethylene oxide or clean with liquid disinfectant, mild detergent solution or isopropyl alcohol

6.5 100% O₂ calibration

At least once a month and following sensor cartridge replacement, calibrate the oxygen sensor using 100% O₂.

1. Adjust the high O₂ alarm to 00% (alarm disabled).
2. Expose the O₂ sensor to pure oxygen and allow the display to stabilize for approximately two minutes as oxygen fills the patient circuit.
3. Adjust the calibration control until the display reads 99%.
4. Expose the O₂ sensor to room air and allow the display to stabilize for approximately two minutes as room air fills the sensor housing. If the final reading is outside the allowed range $21 \pm 3\%$ (18 to 24%), the sensor cartridge is no longer linear and must be replaced. Refer to "Installing a cartridge or disassembling the O₂ sensor for cleaning" in this section.
5. If the system will not be used immediately, switch the monitor or system OFF.

7/Service Procedures

In this section

7.0 Repair policy	7-1
7.1 Troubleshooting guide	7-2
Ventilator problems	7-2
Ventilator failure messages	7-5

7.0 Repair policy

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

To help ensure full reliability, have all repairs and service done by an authorized Ohmeda 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 the Ohmeda 7800 Ventilator and having appropriate test and calibration equipment.



CAUTION: No repair should ever be undertaken or attempted by anyone not having proper qualifications and equipment.

We strongly recommend replacement of damaged parts with components manufactured and/or sold by Ohmeda. Then test the unit to ascertain that it complies with the manufacturer's published specifications.

In some cases, special diagnostic equipment may be required to properly service components of the Ohmeda 7800 Ventilator. The components must then be sent to the nearest Ohmeda Service Center.

Contact the nearest Ohmeda Service Center for service assistance. If you send any unit to an Ohmeda Service Center, package it securely in the original shipping container, if possible, and ship it prepaid. Enclose a letter with the unit providing a contact person's name, describing in detail any difficulties experienced and the repairs felt necessary. In all cases, other than where Ohmeda's warranty is applicable, repairs will be made at Ohmeda's current list price for the replacement part(s) plus a reasonable labor charge.

7/Service Procedures

7.1 Troubleshooting guide

This guide is divided into two sections: ventilator problems and ventilator failure messages.

Ventilator problems

Symptom	Possible cause	Recommended action
No display on the ventilator screen. No alarms sounding.	~ power has failed and backup battery is completely discharged.	Plug control monitor into working ~ source and power it ON for 24-hours to recharge battery.
	Excel to ventilator cable disconnected	Reattach and use screws to hold connector
Bellows does not expand during ventilation or tends to collapse.	Leak in the breathing system.	Check breathing system hoses and connections.
	Bellows not installed properly.	Check bellows to base attachment.
	Tear or leak in bellows.	Check the entire surface of the bellows. Pay close attention to the angles in the convolutions
	Insufficient fresh gas flow.	Check that settings on flowmeter are adequate.
Bellows does not descend during inspiration	Exhaust valve failed	Check exhaust valve
	Drive gas hose disconnected	Reconnect drive gas hose
	Ventilator switch in APL/Bag position	Place switch in Vent position
Bellow is bad, distended, or slips off the base.	Incorrect scavenging system pressure.	Check the scavenging system for vacuum or high pressure.
Low pressure alarm sounds continuously.	Leaks in pressure sensing tube.	Replace pressure sensing tube.
	Circuit disconnected.	Reconnect circuit.
	Circuit occluded.	Clear circuit.
Transient apnea alarm is triggered by sigh breath.	Breath rate is set to two (2), sigh function is enabled, and sigh breath occurring.	This is normal. No action is required.
System sounds alarms at incorrect pressures.	Liquid in pressure sensing tube	Drain the sensing tube.
	Tube disconnected.	Reconnect the tube.
	Kink in tube.	Replace the tube.

7/Service Procedures

Ventilator problems, continued

Symptom	Possible cause	Recommended action
Volume readings are consistently low.	Low oxygen supply pressure	Check, and repair, the oxygen supply.
	Failed volume sensor cartridge.	Replace the volume sensor cartridge.
	Breathing system leak.	Find and repair leaks.
	Control module's altitude compensation set incorrectly.	Reset the altitude compensation as described in "Setting the altitude compensation" in section "2/Getting Started."
Volume readings are high.	Control module's altitude compensation set incorrectly	Reset the altitude consistently compensation as described in "Setting the altitude compensation" in section "2/Getting Started."
Alarms sound without apparent cause and cannot be silenced.	Certain electronic failures may be so significant as to cause the system to lose the ability to generate ventilator failure messages even though the ventilator has failed. If such a serious failure occurs, the alarm silence button will not silence the alarm.	Do not use the ventilator.
Reverse flow alarm is activated. (While the volume sensor is in the distal position of the expiratory limb of the breathing circuit.)	Expiratory check valve on absorber is functioning incorrectly.	Replace check valve disk.
Reverse flow alarm is activated during every breath.	If the volume sensor is located in the proximal end of the "Y" connector in the patient circuit, the alarm may sound for each breath.	Either locate sensor in the distal position of the expiratory limb, (see "2/Getting Started") or use the setup page to disable the reverse flow alarm. (see section "5/Operating the Ventilator")
	Volume sensor cartridge is connected backwards to sensor clip.	Correctly connect the clip to the volume cartridge.(see "2/Getting Started")

Troubleshooting ventilator failure messages

Ventilator failure messages can indicate anything from a defective electronic chip to excessive pressure in the ventilator's driving gas supply. Do not attempt to use the ventilator while a ventilator failure message is displayed. And, even if no ventilator failure message is displayed, do not use the ventilator if you suspect a malfunction has occurred.

IMPORTANT

If the ventilator experiences extreme electrical interference, it may interrupt mechanical ventilation. If this interruption occurs, the ventilator generates an internal reset function and resumes normal operation after two (2) seconds. For situations where continuous electrical interference is experienced by the ventilator, causing a continuous interruption, the ventilator's internal reset repeats until the interference ceases.

If the electrical interference is continuously present and mechanical ventilation is interrupted for approximately 30 seconds, the ventilator produces a continuous beeping audio alarm. Manual ventilation of the patient must be performed while the mechanical ventilation is interrupted. When the electrical interference ceases, the continuous beeping audio alarm can be silenced only by turning, as applicable, the ventilator or anesthesia machine power switch OFF and after five seconds back ON.



WARNING: Manual ventilation must be performed when electrical interference causes interruption of ventilator delivered mechanical ventilation. Manual ventilation must be continued until the ventilator resumes normal operation or an alternate ventilator/anesthesia system can be used.

WARNING: The use of electrosurgical units or other devices that radiate high-intensity electrical fields can affect the operation of the ventilator and monitors attached to the patient. Maintain as much distance as possible between the electrosurgical leads and the cables to the flow and oxygen sensors. Do not drape the electrosurgical leads across the absorber or the anesthesia machine. Do not let the electrosurgical leads rest on any surface of the anesthesia system. Constant surveillance of all monitoring and life support equipment is mandatory whenever electrosurgical devices are in operation, on, or in the vicinity of the patient.

If your ventilator displays a ventilator failure message, please note the failure number, any other symptoms, and any corrective actions you took, then call trained service personnel.

7/Service Procedures

Ventilator failure messages

Vent fail message

Possible cause

VENT FAIL 0 !	Electronic failure
VENT FAIL 1 !	Electronic failure
VENT FAIL 2 !	Electronic failure
VENT FAIL 3 !	Electronic failure
VENT FAIL 4 !	Regulated gas pressure more than 30 psig (210 kPa)
VENT FAIL 5 !	~ power failure and backup-battery voltage low
VENT FAIL 6 !	Flow valve circuit failure
DRIVE CKT OPEN !	Exhalation valve circuit failure or Bag/APL switch in wrong position
VENT FAIL 8 !	Gas inlet circuit failure
VENT FAIL 9 !	Electronic failure
VENT FAIL 10 !	Electronic failure
VENT FAIL 11 !	Electronic failure
VENT FAIL 12 !	Electronic failure
VENT FAIL 13 !	Electronic failure
VENT FAIL 14 !	Electronic failure
VENT FAIL 15 !	Auxiliary port selected on Excel dual port system, but French language not selected
VENT FAIL 16 !	Electronic failure
VENT FAIL 17 !	Electronic failure
VENT FAIL 18 !	Electronic failure
VENT FAIL 19 !	Electronic failure
VENT FAIL 20 !	Electronic failure
VENT FAIL 21 !	Electronic failure
HARDWARE ERROR A	Electronic failure
HARDWARE ERROR B	Electronic failure
HARDWARE ERROR C	Electronic failure
SOFTWARE ERROR A	Invalid data detected
SOFTWARE ERROR B	Invalid data detected
SOFTWARE ERROR C	Invalid data detected
SOFTWARE ERROR D	Invalid data detected
SOFTWARE ERROR E	Invalid data detected
SOFTWARE ERROR F	Invalid data detected

Notes

8/Autoclavable Bellows Assembly

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8.2 Ventilator Connections	8-2
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8.0 Introduction

The Ohmeda Autoclavable Bellows Assembly (ABA) was specifically intended for use with Ohmeda 7000, 7800 ventilators; Modulus II Plus/7810 and Modulus CD/7850 Anesthesia systems. For detailed system information or information on setting up, theory of operation and preoperative checkout procedures, see the appropriate section of this O&M manual.

Special note: The ventilator manuals, anesthesia system manuals and the appendix of this manual may contain information that pertains to other versions of Ohmeda's bellows assemblies. The information contained in this section pertains only to the Ohmeda ABA and DOES NOT APPLY TO OTHER BELLOWS ASSEMBLY VERSIONS.

8.1 Getting started



WARNING: Disassembly, reassembly, cleaning and sterilization of the ABA should never be undertaken by any person who has not read this manual thoroughly and clearly understands the text. Failure to be totally familiar with the disassembly and reassembly of the ABA can result in equipment malfunction and injury to the patient.

This unit is not sterile as it is shipped from the factory.

The ABA mounting plate mounts on any Ohmeda 7000 or 7800 series ventilator control module, or in a remote mounting location using the four mounting screws provided. There are several possible orientations for the mounting plate and connection ports. See the exploded view illustrated parts list of the ABA at the end of this section.

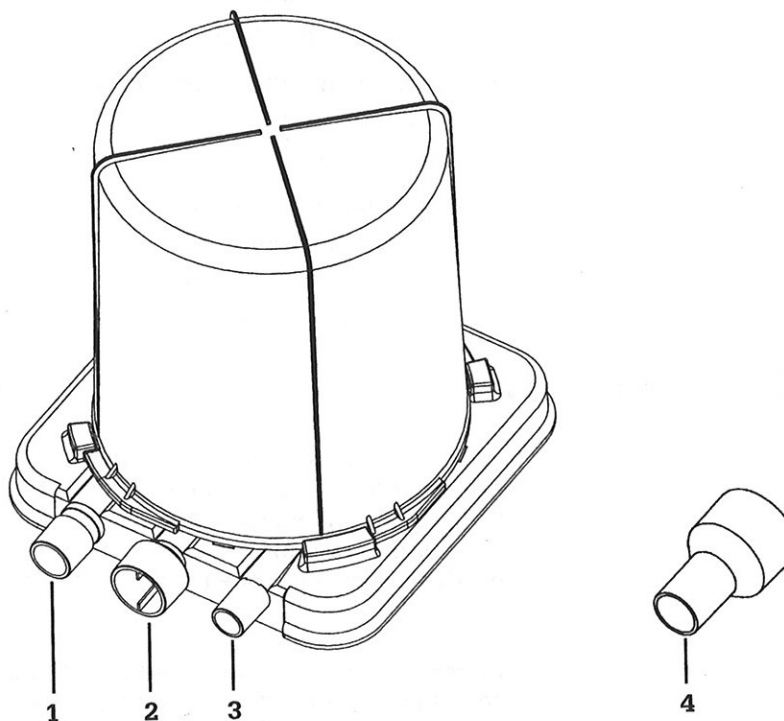
8/Autoclavable Bellows Assembly

8.2 Ventilator Connections



WARNING: Do not connect the 30-mm exhaust port directly to a high vacuum source. The vacuum may remove required gases from the breathing circuit

Figure 8-1
Port identification and
typical adapter



1. 22-mm port to breathing system
2. 30-mm port waste gas scavenging system
3. 17-mm port drive gas
4. 30-mm to 19-mm Adapter (see section 9.2)

Note: Territorial standards may dictate gas scavenging ports other than 30-mm (see section 9.2). Adapters may have been included with your system. Contact your local Ohmeda representative for port conversion information.



WARNING: Disassembly, reassembly cleaning and sterilizing of the ABA should never be undertaken by any person who has not read this section thoroughly and clearly understood the text. Failure to be totally familiar with disassembly and reassembly of the ABA can result in equipment malfunction.

WARNING: Always perform the preoperative checkout procedures before using the system. Failure to ensure proper assembly, setup and operation prior to use may result in injury to the patient.

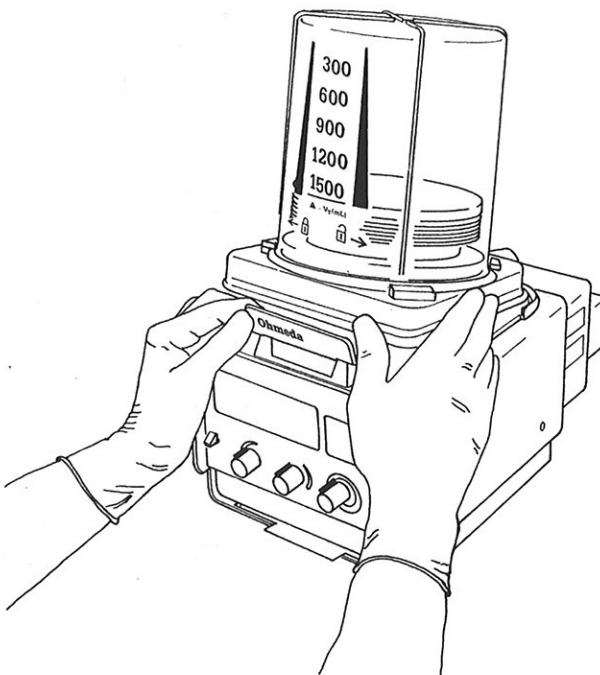
8.3 Disassembly

The sequence of the following illustrated procedure is for disassembly of the bellows assembly — reassembly is the reverse of this sequence.

8/Autoclavable Bellows Assembly

Figure 8-2

Depress lever, remove ABA.



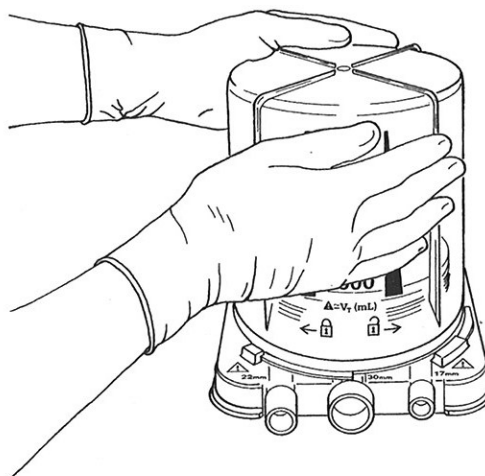
AA.51.006

Figure 8-3

Rotate housing counter-clockwise, lift to release.

Unlock 

Note: Upon reassembly, ensure that the housing tabs are locked onto the base. Insecure locking will cause unacceptable leaks.

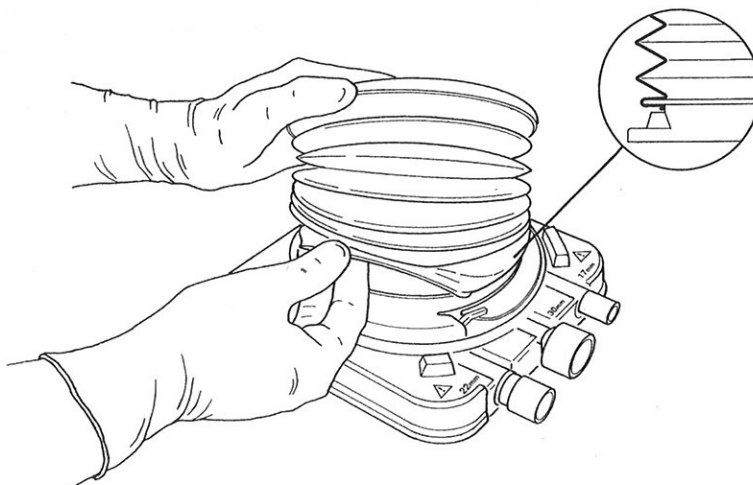


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Figure 8-4

Remove bottom convolution of bellows from rim.

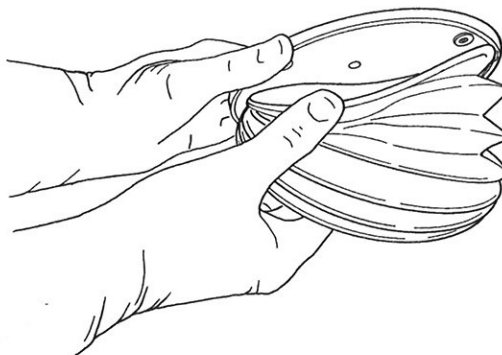
Note: Upon reassembly, pull up on the bellows so only one convolution is under the rim. Ensure that the inside ring is secure in the disk groove. Faulty operation could occur with more than one convolution under the rim.



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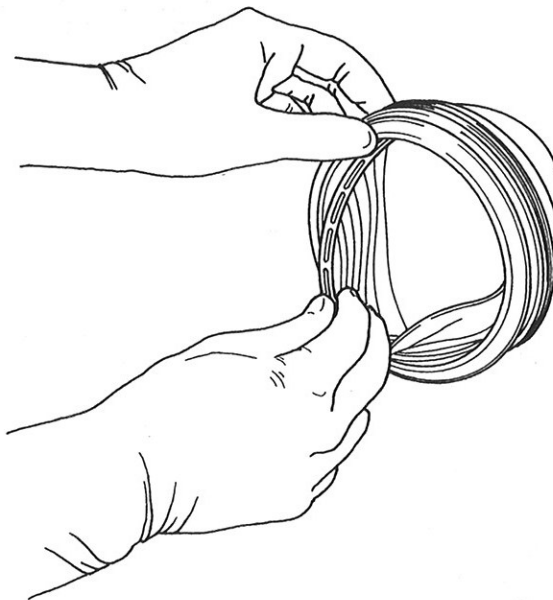
8/Autoclavable Bellows Assembly

Figure 8-5
Remove disk from
bellows.



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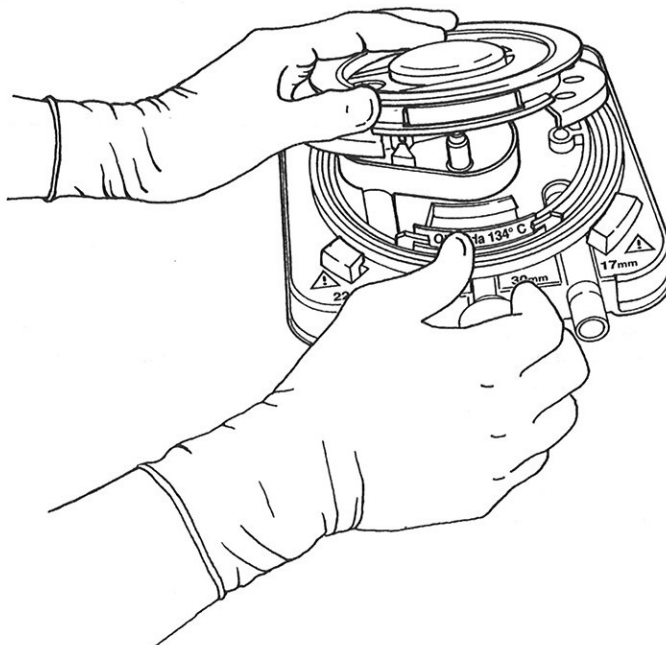
Figure 8-6
Remove inside ring
from the top
convolution.



AA.51.010

Figure 8-7
Push latch toward
center, remove rim.

Note: On reassembly
you will hear a "click/
click" sound, pull up on
the rim to ensure it is
locked.




AA.51.011


8/Autoclavable Bellows Assembly

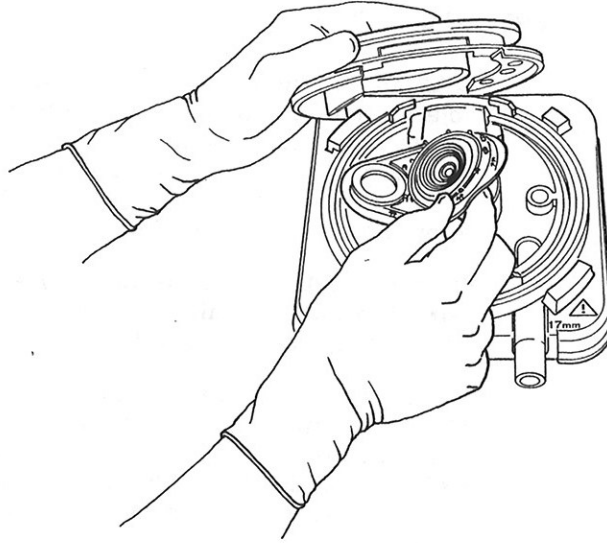
Figure 8-8

Remove pressure relief valve diaphragm and seat assembly. Protect valve seats. Handle the valve seats with care and protect them from damage.

 Do not remove seat from diaphragm.

Note: Reassemble to base with arrows

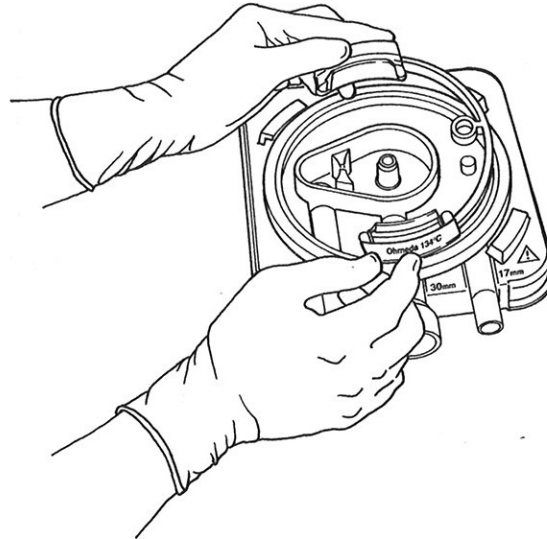
pointed up 



AA.51.012

Figure 8-9

Push latch tabs toward center—lift off.



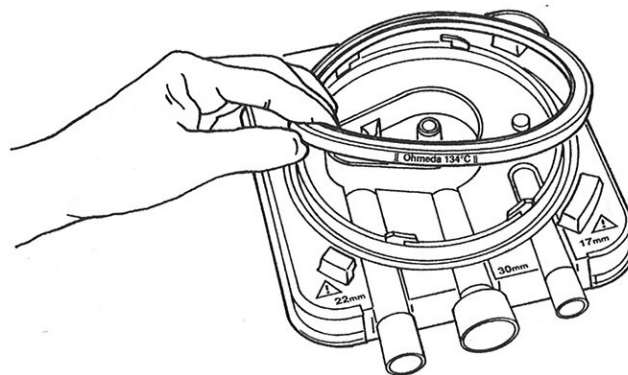
AA.51.013

Figure 8-10

Remove seal.

Reassemble to base with arrows pointed

up 



AA.51.014

8.4 Reassemble in reverse order

8/Autoclavable Bellows Assembly

8.5 Post Assembly Test



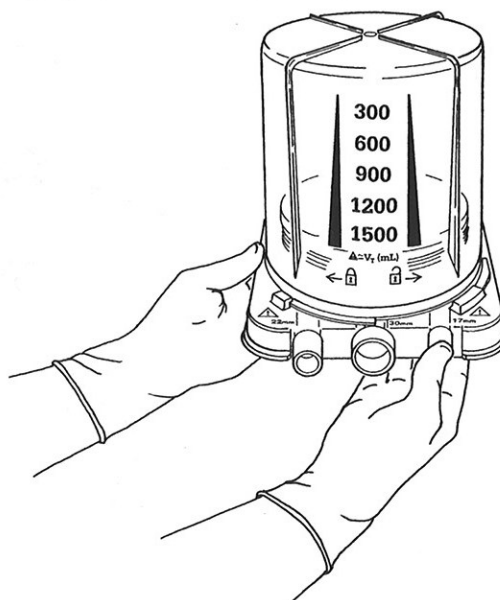
WARNING: When occluding the ABA ports for testing do not use any object small enough to slip completely into the system. Objects in the breathing system can interrupt or disrupt the delivery of breathing-system gases, possibly resulting in injury to the patient. Before using the breathing system on a patient, always check the breathing system components for obstructions

WARNING: Always perform the preoperative checkout procedures before using the system. Failure to ensure proper assembly, setup and operation prior to use may result in injury to the patient.

This post assembly test is intended as a quick check for personnel responsible for reassembly, to verify that all components are properly reinstalled after disassembly — IT IS NOT A SUBSTITUTE FOR A SYSTEM PREOPERATIVE CHECKOUT PROCEDURE. If the ABA meets the following post assembly test requirements, remount the ABA to the mounting plate in the system. If it does not, disassemble to ensure reassembly was correct, inspect and replace any damaged parts. See Illustrated Parts List for part numbers.

Figure 8-11

Prior to remounting, hold ABA upright — Occlude 17-mm port.



AA.51.015

Figure 8-12

Invert the ABA. Bellows should not fall at a rate of more than 100 mL/min.

If it does, the 17-mm port is not securely occluded, the bellows is not correctly installed, the seal is not properly installed with the groove up or other parts may be damaged.

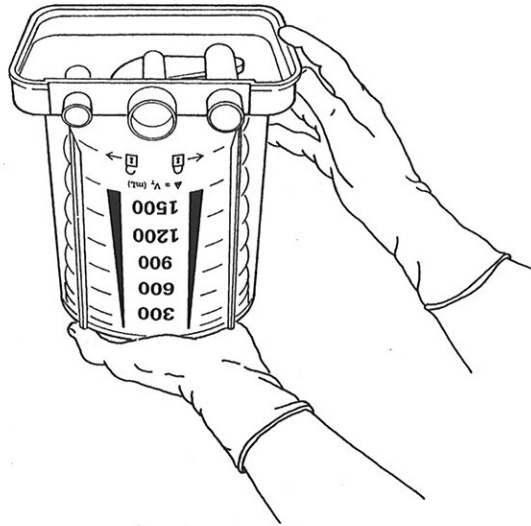


AA.51.016

8/Autoclavable Bellows Assembly

Figure 8-13

Remove occlusion from the 17-mm port, allow bellows to fully extend, then occlude 22-mm port.

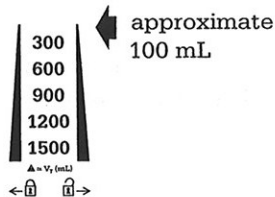


AA.51.017

Figure 8-14

Return ABA to upright position. Bellows should not fall at a rate of more than 100 mL/min.

If it does, the bellows or pressure relief valve are not properly installed or other parts may be damaged.



AA.51.018

If the ABA meets these post assembly test requirements, remount the ABA to the mounting plate in the system.

- Make Ventilator/Bellows Assembly and breathing system connections.
- Before use, perform preoperative checkout procedures.

8.6 Cleaning and Sterilization



WARNING: Disassembly, reassembly cleaning and sterilizing of the ABA should never be undertaken by any person who has not read this section thoroughly and clearly understood the text. Failure to be totally familiar with disassembly and reassembly of the ABA can result in equipment malfunction.

8/Autoclavable Bellows Assembly

Use the cleaning and sterilization schedule that is compatible with your institution's infection control and risk management policies. Use methods that are recommended and approved by the manufacturer of the washer and sterilizer.

Cleaning

1. Disassemble as explained in Disassembly section and figures 8-2 through 8-10.



WARNING: Do not remove seat from diaphragm of the pressure relief valve.

2. Protecting the parts from damage, gently hand wash or machine spray wash components in hot water using a mild detergent recommended for rubber and plastic. Use of enzyme disinfectant/sterilants are not recommended.



CAUTION: Do not submerge rubber goods for more than 15 minutes — swelling or premature aging could occur.

3. Rinse the assembly components in clean hot water and dry them.




CAUTION: Do not allow the bellows to dry with the convolutions collapsed, hang it up to dry with the convolutions extended by gravitational force. The bellows could be rendered inoperative due to the convolutions sticking together.

4. After the parts are completely dry, inspect them for any damage and reassemble as explained in Disassembly section, Reassembly section and figures 8-2 through 8-10. Perform the post assembly test as shown and explained in Post Assembly Test section and figures 8-11 through 8-14.
5. Connect the bellows assembly to the ventilator and breathing system as explained in the appropriate section of this O&M Manual.
6. Perform the preoperative system checkout procedure.

Sterilization



CAUTION: Only parts identified with 134°C markings are autoclavable. Temperatures that exceed 134°C are not recommended due to increased material deterioration caused by excessive heat. Parts that are not autoclavable are identified with the symbol .

The ABA mounting plate and some other components are not autoclavable.

1. Steam autoclaving is the only recommended means of sterilizing the Ohmeda Autoclavable Bellows Assembly.
2. The bellows assembly may be autoclaved as an entire assembly or partially disassembled with the housing removed, if it is inverted so the bellows is fully extended. Or, may be autoclaved disassembled as shown and explained in Disassembly section and figures 8-2 through 8-10.

8/Autoclavable Bellows Assembly

3. After the parts are sterilized, inspect them for any damage and reassemble as explained in Disassembly section, Reassembly section and figures 8-2 through 8-10. It is normal for the bellows and other rubber goods to change color somewhat from steam autoclaving.
4. Perform the post assembly test as shown and explained in Post Assembly Test section and figures 8-11 through 8-14
5. Connect the bellows assembly to the ventilator and breathing system, see the appropriate section of this O&M manual
6. Perform the preoperative system checkout procedure.

8.7 Periodic maintenance



WARNING: Do not, under any circumstances, perform any testing or maintenance on medical devices while they are being used on a patient. Possible injury could result.

At a minimum of every 30 days, perform the following to help ensure the timely replacement of components that may have degraded from use and daily cleaning, autoclaving and handling. All components of the Ohmeda ABA are considered expendable parts.

Visual inspection

1. Disconnect the ABA from the anesthesia machine.
2. Disassemble the ABA per Disassembly section and figures 8-2 through 8-10.



WARNING: Do not remove seat from diaphragm of the pressure relief valve.

3. Carefully inspect each component for signs of deterioration or damage such as cracks, warping, tackiness, swelling or other physical changes, and replace as necessary. It is normal for the bellows and other rubber goods to change color somewhat from steam autoclaving.
4. Reassemble and perform the Post Assembly Leak Test per Disassembly section, Reassembly section and Post Assembly Leak Test, see figures 8-2 through 8-14. Connect the ABA back into the anesthesia system and perform the appropriate preoperative checkout procedure.

Pressure leak test.

Checking the ABA for leakage under pressure (250 mL/min. at 60 cm H₂O) using the breathing system pressure gauge and the anesthesia machine flow meters. Breathing system leakage is determined prior to connecting the ABA. Repeating the test after the ABA is connected determines the leakage of the ABA unit.

8/Autoclavable Bellows Assembly

Test the breathing system — ABA out of the circuit.



WARNING: When occluding the ABA ports for testing do not use any object small enough to slip completely into the system. Objects in the breathing system can interrupt or disrupt the delivery of breathing-system gases, possibly resulting in injury to the patient. Before using the breathing system on a patient, always check the breathing system components for obstructions

1. Set the breathing system for the bag mode using the Bag/Ventilator switch if present. Remove the breathing bag and occlude the bag port. Remove any gas sampling adapters or tightly cap off connections.
2. Turn the APL valve fully closed. Turn OFF any other device in the circuit that may leak in this mode at a pressure of 60 cm H₂O. Consult your breathing system operation manual.
3. Turn ON the anesthesia machine and adjust O₂ to its minimum flow. Turn OFF all other gases.
4. Occlude the patient connection port, e.g. the "Y" piece, while you watch the pressure gauge. Ignore or silence any alarms that may occur during the test. But, quickly unplug the port if the pressure approaches 100 cm H₂O.
5. Using the O₂ flow control valve, increase the O₂ flow rate until the pressure approaches 60 cm H₂O. Then quickly reduce the flow rate to match the leak rate so that pressure is maintained at 60 cm H₂O. The pressure will continue to rise if the leak rate of the breathing system is less than the minimum O₂ flowmeter setting.
6. Remove the occlusion from the patient connection port and note the O₂ flowmeter reading as the breathing system's leak rate. Return the O₂ flow to its minimum setting and remove any occlusions made during the test.

Test the connected ABA and breathing system

7. Set the breathing system for the ventilator mode so the ABA is in the circuit. Disconnect the drive gas tube from the 17-mm port labeled "Connect to bellows assembly inlet," located on the rear of the ventilator control module, and occlude the disconnected tube.
8. Repeat previous steps 4, 5, and 6.
9. Adding the ABA to the circuit should not increase the leak rate noted in step 6 by more than an additional 250 mL/min.. Proceed to step 11 if the leakage is acceptable.
10. An unacceptable leak (higher than noted in step 9) requires repair, do not use the ABA until repairs are made.

Note:

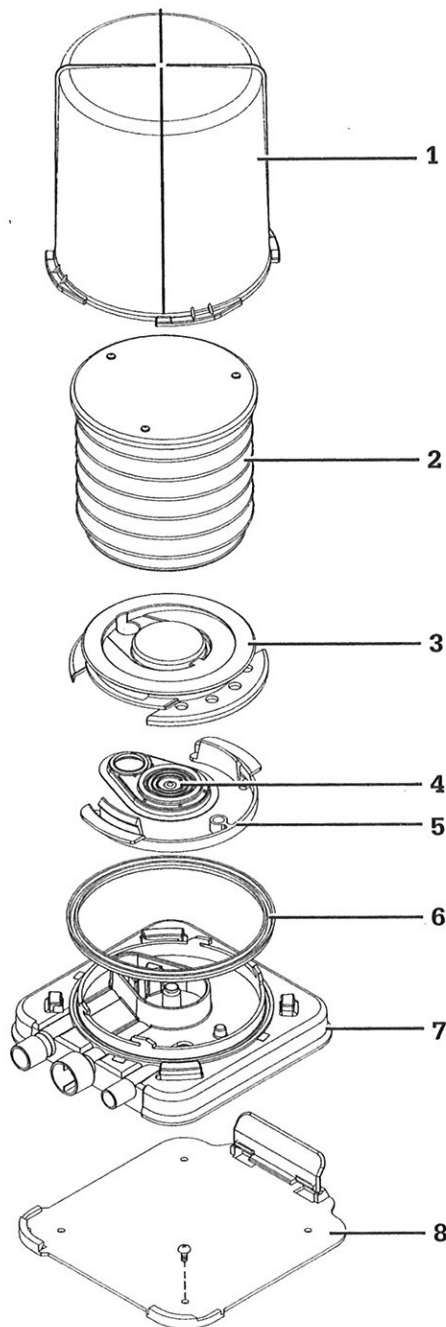
The housing seal, the pressure relief valve, base and tubing are the most likely areas to leak. Systematically replace these parts until the leak is corrected.

11. Remove the occlusion from the drive gas tube and connect it to the ventilator. Correct any alterations and remove any occlusions made to the breathing system during this test. Perform the Preoperative Checkout Procedure.

8/Autoclavable Bellows Assembly

8.8 Illustrated Parts List

Figure 8-15
Exploded view of ABA
assembly.



1. Housing (1500-3117-000)
2. Bellows (1500-3378-000)
3. Rim (1500-3351-000)
4. Pressure relief valve (Diaphragm and seat assembly — 1500-3377-000)
5. Latch (1500-3352-000)
6. Seal (1500-3359-000)
7. Base (1500-3350-000)
8. Mounting plate (1500-3379-000)

Not Shown

Mounting screws, 10-32 x 1/2 sst, 4 required, 0140-6631-109
Disc/ring/bumper ass'y for bellows (1500-3381-000)

AA.51.003

Notes

9/Appendix

In this section

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9.0 Specifications

Unless indicated otherwise, all specifications are nominal and subject to change without notice.

Electrical

Power Consumption:	60 VA at 120/240 V~
Power Supply:	Internal supply (electrical) User-selectable line voltage 100/120/220/240 V~ 50-60 Hz
Backup Battery:	4.8 V \equiv at 1.3 A.H.
Display Type:	Liquid Crystal Display
Circuitry:	Microprocessor-controlled RS232C serial output for remote recording.

9/Appendix

Controls

Control	Range	Display Resolution
Tidal Volume:	50-1500 mL	From 50 mL to 100 mL: 2-mL resolution
		From 100 mL to 250 mL: 5-mL resolution
		From 250 mL to 1000 mL: 10-mL resolution
		From 1000 mL to 1500 mL: 20-mL resolution
Rate:	2-100 B/min	1 B/min increment
Inspiratory Flow:	10-100 liters per minute	Resulting I:E Ratio: 1:0.5 minimum, 0.5 resolution
Inspiratory Pressure Limit:	20-100 cm H ₂ O	1 cm H ₂ O increment
Inspiratory Pause:	25% T _I — 25 percent of inspiratory time	
Sigh Function:	150% of set V _T (up to 1500 mL) every 64 th breath	

Monitoring

Oxygen monitoring:

Display:	Range:	0 to 110 % oxygen
	Resolution:	1 % of full scale
Sensor:	Sensor type:	Galvanic fuel cell
	Response time:	90 % of total change in oxygen concentration in less than 20 seconds at 25°C (77°F)
	Drift:	±1 % over 8 hour period
	Monitor linearity:	±3 % of full scale
	Life:	12 months typical (assuming average O ₂ equal to 50% concentration at 25°C (77°F)
	Low Oxygen Alarm Limit:	18 to 99%, 1% increment
	High Oxygen Alarm Limit:	19 to 99%, 1% increment (disabled when set to zero)

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Volume monitoring

Display range:	Tidal volume:	0 to 9999 mL, 1 mL resolution
	Minute volume:	0.0 to 99.9 liters, 0.1 liter resolution
	Breath rate:	0 to 99 Breaths per minute, 1 B/min resolution
Accuracy:	Tidal volume:	300 mL to 1.5 liter range: $\pm 8\%$ or ± 40 mL (whichever is greater)
		50 milliliters to 299 milliliters range: $\pm 20\%$ or ± 20 mL (whichever is greater)
Sensor:	Type:	Expendable turbine vane flow cartridge with clip-on, heated, optical coupler
	Turbine Resistance:	Approximately 1 cm H ₂ O at 60 liters per minute
	Flow Range:	3 to 600 liters per minute
	Repeatability, same cartridge:	At a constant flow rate, $\pm 5\%$ of original reading
	Repeatability, different cartridges:	± 35 mL over a range of 0.1 to 3.0 liter
	Dead air space:	6 to 10 mL depending upon breathing circuit adapters
Minimum breath:	Volume:	18 mL
	Flow:	≥ 6.6 liters per minute when tidal volume knob set to 300 mL or more.
		≥ 2.0 liters per minute when tidal volume knob set to less than 299 mL
Breathing circuit connections:	Inlet:	22-mm male tapered or 15-mm female tapered with tracheal tube adapter
	Outlet:	22-mm female tapered
	Low Minute Volume Alarm Limit:	0-9.9 liters per minute, 0.1 liter increment ((disabled when set to 0.0)

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Airway pressure monitoring

Pressure Transducer Range:	-20 to +120 cm H ₂ O, ±3 cm H ₂ O
Response Time:	10 milliseconds
Accuracy:	±3 cm H ₂ O over the range of -20 to 120 cm H ₂ O
High Pressure Alarm Limit:	20-100 cm H ₂ O, 1 cm H ₂ O increment
Sustained Pressure Alarm Limit:	10 to 30 cm H ₂ O, 1 cm H ₂ O increment

Performance characteristics

Supply Gas Requirements:	240 to 620 kPa (35 to 90 psig) at 100 liters per minute continuous flow at inlet to ventilator; 350 kPa (50 psig) nominal at pipeline.	
Ventilator Compliance:	Adult Bellows:	Approximately 3 mL per cm H ₂ O
	Pediatric Bellows:	Approximately 1.5 mL per cm H ₂ O
Note:	Compliance for connecting hoses — not included in these compliance specifications.	
Ambient Operating Temperature Range:	10 to 40°C (50 to 104°F)	
Ambient Operating Humidity Range:	0 to 100 % Relative Humidity (non-condensing)	
Ambient Operating Pressure:	500 to 800-mm Hg	
Altitude Compensation:	Sea level to 3000 meters —1 meter = 3.28 feet	
Backup battery:	Internal, rechargeable battery. Twenty minute minimum operation (set tidal volume 650 mL set rate 100 BPM, set flow 100 liters per minute) from full charge. After a full discharge, requires 24 hours of plug-in time to recharge fully.	

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Physical characteristics

	Bellows Assembly	Control Module (Ohmeda Excel or stand-alone configuration)
	Weight: 1.8 kg (4.0 lb.)	10.8 kg (23.7 lb.)
	Depth: 20.3 cm (8.0 in.)	38.3 cm (15.1 in.)
	Width: 19.0 cm (7.5 in.)	22.2 cm (8.8 in.)
	Height: 22.9 cm (9.0 in.)	39.5 cm (15.6 in.)
Tidal Volume Scale (marked tidal values are approximate):	Adult Bellows Housing:	1600 mL maximum
	Pediatric Bellows Housing:	300 mL maximum
Storage Requirements:	Temperature:	-20 to +70°C (-4 to +158°F)
	Humidity:	0 to 100 % relative humidity (non-condensing)
	Long Term Ventilator Storage:	It is not necessary to disconnect the rechargeable batteries before long term storage. If the ventilator is to be stored for an extended period of time, the batteries will eventually discharge. This is not destructive to the ventilator or the batteries, however, the ventilator must be plugged into a wall outlet for at least 24 hours prior to use to fully recharge the batteries.

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9.1 Accessories

Ventilator mounting kits

Mounting to Ohmeda Excel Anesthesia System

Stock number	Description
1001-8953-000	Remote bellows mounting kit, dovetail mount
1001-8951-000	Excel (ISO) ventilator mounting bracket kit (to mount control module from right side of top shelf)

Mounting bellows assembly to anesthesia system dovetail

Stock number	Description
1001-8953-000	Remote bellows mounting kit, dovetail mount
1500-8042-000	Remote bellows drive gas kit (required for dovetail mounted bellows assembly kit)

Bellows assemblies (non-autoclavable)

See section 8 for detailed illustrated parts list on Autoclavable Bellows Assembly

Stock number	Description
1500-3225-000	Adult bellows housing
0229-1013-700	Adult bellows
1500-7052-000	Adult bellows assembly, international
1500-3215-000	Pediatric bellows housing
0229-1018-700	Pediatric bellows
0229-1023-700	Pediatric bellows mtg. ring and retainer
1500-8154-000	Pediatric bellows assembly, international

Optional monitoring accessories

Stock number	Description
6050-0000-400	Extra long volume-sensor clip assembly 4,8 m (16 ft)
0237-2041-880	Volume sensor extension cord kit 1,8 m (6 ft)
0237-2040-880	Oxygen sensor extension cord kit 1,8 m (6 ft)

Optional Test Plug, 15-mm and 22-mm

Stock number	Description
2900-0001-000	Red double ended test plug with flange to ensure visibility in the system

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9.2 Replaceable parts

Monitoring

Stock number	Description
0237-2226-700	Volume sensor clip assembly, 2,4 m (8 ft), English label
6050-0001-005	Volume sensor clip assembly, 2,4 m (8 ft), French label
0237-2228-870	Volume sensor cartridges (10), English label
6050-0001-009	Volume sensor cartridges (10), French label
6026-0000-014	Pressure sensing tube, 2,4 m (8 ft)
6050-0000-456	Pressure-sensing tee (patient-circuit adapter)
0237-2034-700	Oxygen cartridge, English label
6050-0000-624	Oxygen cartridge, French label
0237-2030-700	Oxygen sensor (without cartridge), 1,8 m (6 ft), English label
6050-0000-468	Oxygen sensor (without cartridge), 1,8 m (6 ft), French label
0210-0503-300	Oxygen sensor O-ring (Outside)
0210-0499-300	Oxygen sensor O-ring (Inside)

Drive gas tubes

Stock number	Description
0211-0118-300	23 cm (9 inch) corrugated drive tube, short
0211-0809-800	100 cm (40 inch) corrugated drive tube, medium
0211-0842-300	195 cm (77 inch) 5/8" I.D. flex wire reinforced drive tube, long

Supply gas filter, ventilators set up for air

Stock number	Description
1500-3319-000	Complete filter assembly.
1500-3320-000	Service kit, 5 micron filter, O-ring and gasket only.

Adapters

Stock number	Description
0212-0763-100	O ₂ sensor adapter 22-mm manifold tee
1500-3337-000	30/25-mm AGSS Adapter
1500-3338-000	19/25-mm AGSS Adapter
1500-3376-000	19/30-mm Adapter

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9.3 Ventilator communications protocol

For remote recording, a 25-pin female "D" type connector on the ventilator's rear panel provides access to an RS232C serial port, which conforms to the Ohmeda standard communications protocol.



WARNING: When specific DIP switches are set, writing to the ventilator's RS232 port can alter the operation of the ventilator's software, which may result in unpredictable performance. Do not alter the ventilator's hardware or software.



CAUTION: Interconnect cables must be unplugged and removed from the RS232 port when peripheral equipment is disconnected. DO NOT leave unattached cables hanging from the ventilator's RS232 port.

The connector's assigned pin outs conform to DTE (Data Terminal Equipment) specifications and is listed below.

25 pin female D connector
pin 2 - transmit data (transmitted from ventilator)
pin 3 - receive data (received by ventilator)
pin 7 - signal ground

The RS232 data format for this protocol is summarized as follows:

Signal Levels:	±5 volts minimum
Baud rate:	1200 baud
Character Code:	7-bit ASCII
Data bit format:	(1) start bit, logic 0 (7) data bits (1) odd parity bit (1) stop bit, logic 1

When the ventilator is first turned ON, the default transmission mode is set to "AUTO," the data format mode is set to "PRINTER," and the checksum mode is "disabled."

Two standard forms of the device commands are shown below and detailed in the following sections.

<ESC>VTxc<CR>

where:

<ESC>VT	=	header
x	=	command
c	=	checksum
<CR>	=	terminator

<ESC>VTxaac<CR>

where:

<ESC>VT	=	header
x	=	command
aa	=	parameter
c	=	checksum
<CR>	=	terminator

The header consists of the ascii escape character (27 decimal) followed by the device designator for the 7810 Ventilator, "VT." The command

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terminator for all commands is an ascii carriage return (13 decimal). If the checksum is enabled, a 7-bit checksum (twos complement of the sum of the transmitted bytes) is included before the command terminator at the end of the device command. If not, an ascii space character is included.

Device Commands—sent to ventilator

Data Transmit Mode Select Commands

<ESC>VTXc<CR>

Auto mode command causes the ventilator to output data at each breath or every 10 seconds.

<ESC>VTSc<CR>

Slave mode command causes the ventilator to output data when requested by communications device using a "send all data command."

Data Format Mode Select Commands

<ESC>VTPc<CR>

Printer mode command (default at turn ON) Ventilator outputs data in a printer format, an 80 byte frame.

<ESC>VTQc<CR>

Compressed mode command Ventilator outputs data in a compressed measured-and-status data format, 30 and 37 bytes respectively.

Data Request Command

<ESC>VT?c<CR>

Send all data command. This command is active in slave mode only, and requests a data and status frame from the ventilator (in the compressed format).

Front Panel Control Commands

<ESC>VTCS<CR>

Silence all alarms command. The ventilator responds just as if the front panel alarm silence switch had been pressed.

Checksum Control Commands

<ESC>VTEc<CR>

Enable checksum command. This command invokes checksum mode.

<ESC>VTDc<CR>

Disable checksum command. The checksum byte will be ignored in this mode (but must be accounted for in the command string). This is the default mode at power ON. (Checksum byte cannot be a <CR> character)

Device Responses—sent back by ventilator

:VTYc<CR>

Acknowledge Only Response: For valid commands, other than send data or reset all alarms commands, the ventilator will respond by transmitting a positive acknowledge response.

:VTNc<CR>

Negative Acknowledge Response: For unrecognized or invalid commands, or when a valid command is not allowed, the monitor will respond by transmitting a negative acknowledge response.

:VTRc<CR>

Alarm Silence Switch Pressed Response: For valid reset all alarms commands and when the front panel alarm silence switch is pressed, the ventilator will respond with an alarm silence switch pressed response if no alarms are active or if all alarms are silenced.

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Format for data in compressed mode

Measured Data Response

:VTDaaaabbbbddddeeefffggghhic<cr>

aaaa	measured tidal volume	mL, ?, -
bbbb	measured minute volume	L*100, ?, -
ddd	measured respiratory rate	B/min, ?, -
eee	measured oxygen level	% O ₂ (0-255)
fff	measured max + pressure	cm H ₂ O, ?
ggg	measured inspiratory plateau pressure	cm H ₂ O, ?, -
hhh	measured minimum pressure	cm H ₂ O, ?
i	measured data status	01xxxxxx (Fifth "x" from left = 0 = normal breath, 1 = sigh breath. Sixth "x" = 0=10 sec data, 1=new breath data.)
c	checksum	

:VTQaaaabbbbddddeeefffgghhiiijqqqqqqc<cr>

aaaa	set tidal volume	mL
bbb	set respiratory rate	B/min
ddd	set inspiratory flow	L/min
eeee	set I:E ratio	1:eee.e (not rounded)
fff	set peak pressure limit	cm H ₂ O
gg	set sustained pressure alarm limit	cm H ₂ O
hh	low minute volume alarm limit	liters*10
ii	low oxygen alarm limit	% O ₂
jj	high oxygen alarm limit	% O ₂
qqqqqq	status	
c	checksum	

Each entry is zero filled, right justified (i.e. aaaa = 0095). (1) Status bytes (bit set = condition active): Status bits are latched in the in auto mode to record transient alarms.

Status Bit	Byte 1
D0	high O ₂ alarm
D1	low O ₂ alarm
D2	apnea alarm
D3	low patient V _E alarm
D4	high pressure alarm
D5	low pressure alarm
D6	1

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Status Bit	Byte 2
D0	sustained pressure alarm
D1	sub-atmospheric pressure alarm
D2	AC fail (primary supply voltage low)
D3	low battery alarm
D4	O ₂ Limit set error
D5	vent setting range error
D6	1

Status Bit	Byte 3
D0	O ₂ sensor failure alarm
D1	volume sensor failure
D2	maximum pressure > 60 cm H ₂ O
D3	reverse flow
D4	low gas supply pressure alarm
D5	apnea alarm off
D6	1

Status Bit	Byte 4	
D0	A/D conversion failure	VENT FAIL 0
D1	CPU failure	VENT FAIL 1
D2	ROM checksum failure	VENT FAIL 2
D3	RAM write/read failure	VENT FAIL 3
D4	gas supply > 30 psig	VENT FAIL 4
D5	power loss	VENT FAIL 5
D6	1	_____

Status Bit	Byte 5	
D0	flow output incorrect or continuously ON	VENT FAIL 6
D1	Exh. valve not ON/OFF in insp/exp	DRIVE CKT. OPEN
D2	gas supply control solenoid not ON	VENT FAIL 8
D3	D/A write/read failure	VENT FAIL 9
D4	pressure transducer board failure	VENT FAIL 10
D5	Positive analog supply voltage out of range	VENT FAIL 11
D6	1	_____

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Status Bit	Byte 6
D0	flow table values 0,FF or non-increasing
D1	inspiratory pause on
D2	volume monitor standby
D3	ventilation switch ON
D4	volume sensor cartridge coasting (end of breath not detected)
D5	alarms are silenced
D6	1

VENT FAIL 12

Figure 9-1
Printed sample of serial output

```

572 11.31 20 21 21 --- 3    650 20 50 1: 2.8 58 0.0 18 0 1 0
569 11.36 20 21 21 --- 3    650 20 50 1: 2.8 58 0.0 18 0 1 0
565 11.36 20 21 21 --- 3    650 20 50 1: 2.8 58 0.0 18 0 1 0
572 11.38 20 21 21 --- 3    650 20 50 1: 2.8 58 0.0 18 0 1 0

```

MEAS	VT	VE	RR	O2	MAX	PT	MIN	SET	VT	RR	IF	I:E	PL	LVE	LO	HO	MV	IP
	565	11.38	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	565	11.37	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	562	11.40	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	565	11.33	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
S	855	11.77	19	21	27	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	569	11.34	18	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	569	11.35	18	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	569	11.36	18	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	565	11.37	18	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	569	11.38	18	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	565	10.94	19	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	565	11.41	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	569	11.35	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	565	11.34	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	569	11.35	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	565	11.34	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	569	11.35	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	565	11.34	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	565	11.34	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	556	11.30	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	569	11.31	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	565	11.30	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	565	11.30	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	572	11.32	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	565	11.35	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	569	11.35	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	565	11.35	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	569	11.36	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	569	11.37	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	572	11.37	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	565	11.44	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	562	11.35	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	565	11.41	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	572	11.36	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	572	11.37	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	569	11.36	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	565	11.30	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	572	11.39	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	572	11.35	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	572	11.42	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	565	11.39	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	572	11.40	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	572	11.43	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0
	565	11.40	20	21	21	---	3		650	20	50 1:	2.8	58	0.0	18	0	1	0

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Format for data in printer mode

Output format

Heading frame (including 6 blank lines):

```
<LF><CR><LF><CR><LF><CR><LF><CR><LF><CR><LF><CR><LF><CR>
```

```
MEASspVTspVEspRRspO2spMAXspPTspMINspSETspVTspRRsp
IFsp
```

```
I:EspPLspLVEspLOspHOspMVspIP
```

Data frame:

```
.dspdddspddspdddspdddspdddspdddspdddspdddspdddsp1:ddd.dsp
dddspd.dspdddspdspdddspd<LF><CR>
```

(^{sp} = ascii space character (32 decimal))

Measured Parameters

Heading	Format	Description	Units
S	d	sigh breath status	none
VT	ddd	tidal volume	mL, ?, -
VE	dd.dd	minute volume	L, ?, -
RR	ddd	respiratory rate	B/min, ?, -
O ₂	ddd	oxygen concentration	% O ₂
MAX	ddd	maximum pressure	cm H ₂ O, ?
PT	ddd	inspiratory plateau pressure	cm H ₂ O, ?, -
MIN	ddd	minimum pressure	cm H ₂ O, ?

Parameter Settings

Heading	Format	Description	Units
VT	ddd	tidal volume	mL
RR	ddd	respiratory rate	B/min
IF	ddd	inspiratory flow	L/min
I:E	1:ddd.d	inspiratory time: expiratory time ratio	—
PL	ddd	inspiratory pressure limit	cm H ₂ O
LVE	d.d	low minute volume alarm limit	L
LO	dd	low oxygen alarm limit	% O ₂
HO	dd	high oxygen alarm limit	% O ₂
MV	d	mechanical ventilation status	1=On, 0=Off
IP	d	inspiratory pause status	1=On, 0=Off

Heading will be printed once every 59 outputs.

If the measured Breath Rate exceeds 60 breaths/minute, data will be output every other breath in order to prevent partial loss of data.

Leading zeros are suppressed except for ones digit.

If in auto mode, output printed at end of each breath or every 10 seconds.

If in slave mode, output printed in response to each send all data command.

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9.4 Analog outputs

Included on the ventilator serial interface connector are analog outputs for pressure and oxygen readings.

	Signal	Analog ground	Shield	Range (0 to 1 v =)
Oxygen	pin 25	pin 24	pin 23	0 to 100% O ₂
Pressure	pin 18	pin 19	pin 20	-20 to 120 cm H ₂ O

9.5 Using a Bain circuit

When you connect a Bain circuit to the Ohmeda 7800 Ventilator, you must place the volume sensor assembly in the proximal position, between the end of the Bain circuit and the patient connector to the ET tube or mask. The volume sensor must be located in the proximal position and the arrows of the volume monitor clip must point toward the absorber to correctly measure the patient's exhaled volume in systems that include a Bain circuit.

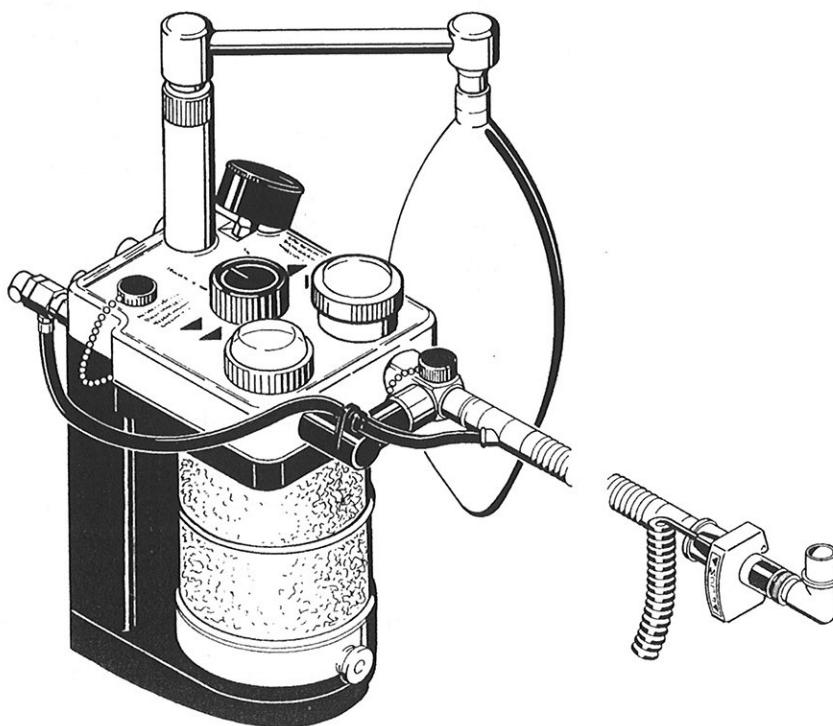
With a Bain circuit, fresh gas from the gas machine flows through the breathing circuit for the entire respiratory cycle. If the volume sensor is located distally, the ventilator will measure both the patient's exhaled volume and the fresh gas flow the Bain circuit adds to the exhaled volume. To avoid measuring this fresh gas flow, the volume sensor must be placed proximally. When the volume sensor is in the proximal position, between the end of the Bain circuit and the patient connector to the ET tube or mask, the ventilator will measure and display the patient's exhaled volume.

If you are using a Bain circuit

1. Locate the volume sensor assembly in the proximal position, between the end of the Bain circuit and the patient connector to the ET tube or mask.
2. Disable the ventilator's reverse flow alarm (see "Using the setup page" in "5/Operating the Ventilator").

Figure 9-2

Correct placement of the volume sensor when used with a Bain Circuit. The oxygen sensor must be placed in the Bain Circuit O₂ sensor port.



AA.15.024

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9.6 Non-autoclavable bellows assembly, cleaning and sterilizing

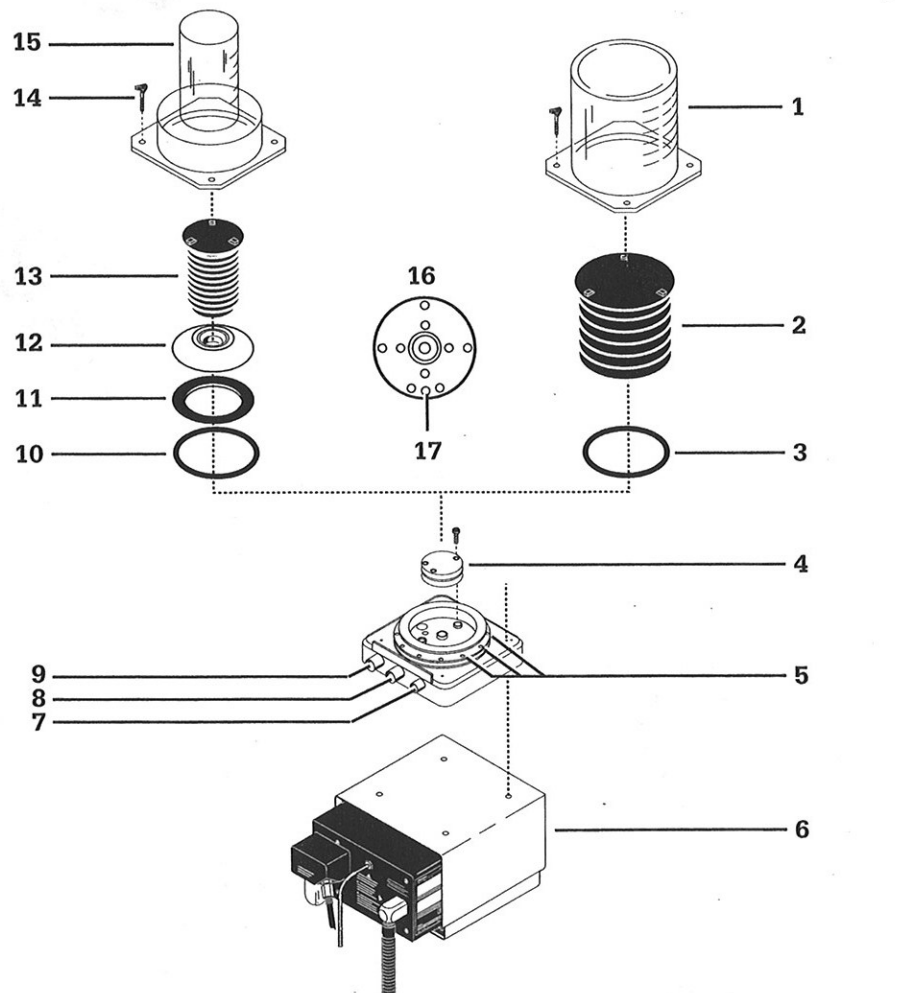


WARNING: Use a sterilization schedule that complies with your institution's infection-control and risk-management policies. Use Ohmeda-approved sterilization methods.

WARNING: Perform the preoperative checkout procedure after cleaning and sterilizing the bellows assembly.

Disassembling the bellows assembly

Figure 9-3
Adult and pediatric
bellows assemblies,
exploded views



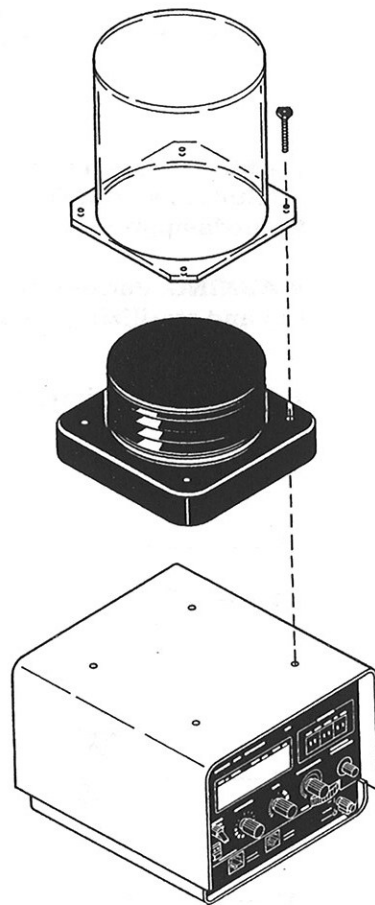
- | | |
|--|---|
| 1. Adult bellows housing | 10. Seal |
| 2. Adult bellows | 11. Adapter ring |
| 3. Seal | 12. Pediatric adapter |
| 4. Pop-Off valve (Pressure relief valve) | 13. Pediatric bellows |
| 5. Drive gas ports - 12 holes | 14. Thumbscrew |
| 6. Control module-do not wash or sterilize | 15. Pediatric bellows housing |
| 7. 17-mm gas inlet | 16. Pop-Off valve (pressure relief valve) bottom view |
| 8. 19-mm exhaust port | 17. Drive gas port |
| 9. 22-mm port to anesthesia machine | |

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Figure 9-4

Bellows assembly attached to the control module— remove the four thumbscrews that fasten the bellows assembly to the control module. Carefully lift the bellows assembly off of the control module.

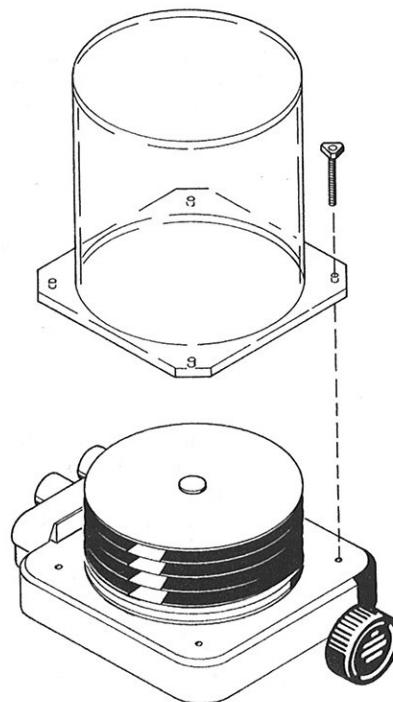


AA.10.011

Figure 9-5

To remove the bellows housing, remove the four thumbscrews that attach the bellows assembly to the base. Then lift the housing off the bellows assembly's base.

Separate the bellows from the base by removing the four screws from the bottom side of the base.



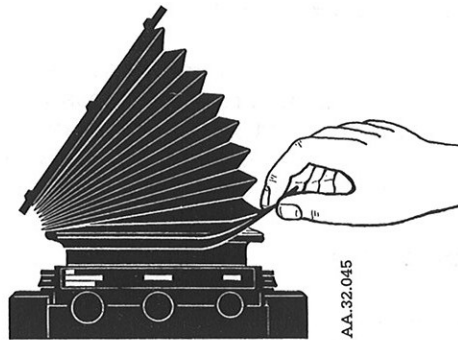
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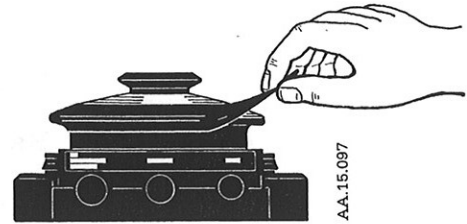
Figure 9-6

For the adult bellows, carefully grasp and lift off the bottom convolution of the bellows and lift off.

Grasp the pediatric adapter ring by its bottom edge and gently pull it up and off of the adapter. Lift the adapter off of the bellows base.



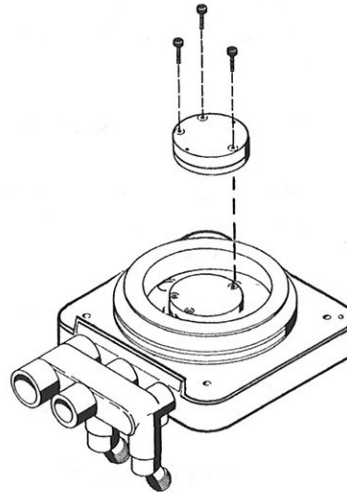
Removing the Adult Bellows



Removing the Pediatric Adapter Ring

Figure 9-7

Do not attempt to disassemble the pressure relief valve itself. Remove the three thumbscrews that hold the pressure relief valve in place. Lift the pressure relief valve off of the bellows base.



Cleaning the bellows assembly

Bellows housing

Wash in a mild soap-and-water solution. Rinse thoroughly with cold water. Dry with a soft, lint-free cloth.

Bellows, pediatric bellows adapter and ring

Wash in a mild soap-and-water solution. Rinse thoroughly with cold water. Remove excess water, hang the bellows suspended by its top disk, convolutions extended. Dry for at least twelve hours.

If not allowed to dry completely; the folds of the bellows may be tacky, causing the bellows to operate improperly.

Pressure relief valve

Do not immerse in liquid which can be trapped in the valve, impairing performance. Clean exterior surfaces with a soft cloth dampened with warm water and mild, liquid detergent. Do not let liquid enter the drive-gas port (see figure 9-3, 17). Dampen a clean, soft cloth in cold water and use the cloth to wipe clean. Let dry completely before use or sterilization.

Bellows base

Do not immerse in liquid which can be trapped in the driving gas circuit of the base, impairing performance. Clean exterior surfaces with a soft cloth dampened with warm water and mild, liquid detergent. Do not let liquid enter the drive-gas ports (see figure 9-3, 5). A bottle brush may be used to clean 22-mm port and 19-mm port. The 17-mm normally exposed to only oxygen shouldn't need cleaning. Use a clean cloth or bottle brush dampened in cold water to remove all traces of soap from the bellows base. Let the base dry completely before either use or sterilization.



WARNING: Liquids or any foreign materials trapped in the driving-gas circuit of the pressure relief valve or the bellows base can impair the valve's operation. Do not use the pressure relief valve or bellows base if you suspect that materials are trapped. Have the assembly repaired by trained service personnel.

Pressure-sensing tube

Wash with a mild soap-and-water solution. Use cold water to thoroughly rinse of all soap. Remove all soap and water from inside the tube. Dry the tube thoroughly.

Interface manifold (if your system includes one)

Wash the with a mild soap-and-water solution. Use cold water to thoroughly rinse of all soap. Dry thoroughly.

Before reassembling

Check all of the rubber parts—including the bellows—for swelling, tackiness, holes, cracking, or any other signs of damage. Rubber devices deteriorate and are expendable. Periodic replacement is good practice.

Sterilizing the bellows assembly

Adult and pediatric bellows housings, normally exposed only to driving gas, require sterilization only if the bellows has torn or leaked. If the assembly must be sterilized, wash and completely dry the bellows assembly's components as described in the previous steps. To sterilize components, use an ethylene oxide mixture at 52 to 57°C (125 to 135°F), or room temperature sterilization with 100% ethylene oxide. Follow the sterilizer manufacturer's recommendations.



CAUTION: Following ethylene oxide sterilization, quarantine the equipment in a well-ventilated area to allow dissipation of absorbed ethylene-oxide gas. In some cases, aeration periods of seven days or more may be required. Aeration time can be decreased when special aeration devices are used. Follow the sterilizer manufacturer's recommendations for aeration periods required.

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Reassembling the bellows assembly

Perform the steps in "Disassembling the bellows assembly" in reverse order. Before using the ventilator, perform the preoperative checkout procedures described in section 4.

Notes
