Achieva

Ventilator with Flow Acceleration Limit

CONTENTS

Contents

Contents

Contents

Safety Information

1.1   Definitions

This manual uses three indicators to highlight information of particular importance. They are:

Warning

Indicates a condition that can endanger the patient or the ventilator operator.

Caution

Indicates a condition that can damage the equipment.

NOTE:

Indicates points of particular emphasis that make operation of the ventilator more efficient or convenient.

1.2   Warnings and Cautions

Please take the time to familiarize yourself with the following caveats as they cover safety considerations, special handling requirements, and regulations that govern the use of the Achieva ventilators.

Warning

- For a thorough understanding of ventilator operations, be sure to thoroughly read this manual before attempting to use the ventilator.
- Anything that damages the ventilator may cause danger to the patient.
- The ventilator is a prescription device. It should only be used for the patient for whom prescribed.
- Federal Law (U.S.) restricts the sale of this device to, or by the order of, a licensed physician.
- To avoid a fire hazard, keep matches, lighted cigarettes, and all other sources of ignition (e.g., flammable anesthetics and/or heaters) away from the Achieva ventilator system and oxygen hoses.
- Do not use hoses that are worn, frayed, or contaminated by combustible materials such as grease or oils.
- In case of a burning smell, immediately disconnect the ventilator from the oxygen supply, AC power, and backup power source.
- Check the ventilator periodically as outlined in this manual; do not use if defective. Immediately replace parts that are broken, missing, obviously worn, distorted, or contaminated.

Warning

- To ensure patient safety, an appropriately trained caregiver must monitor ventilation. If the patient's condition warrants the use of an independent secondary alarm or external monitoring device, the physician must prescribe it. The physician must also determine to what level the patient may require an alternate means of ventilation in the event of ventilator failure.
- When handling any part of the Achieva ventilator, always follow your hospital infection control guidelines for handling infectious material.
  Nellcor Puritan Bennett recognizes that cleaning, sterilization, sanitation and disinfection practices vary widely among health care institutions. It is not possible for Nellcor Puritan Bennett to specify or require specific practices that will meet all needs, or to be responsible for the effectiveness of cleaning, sterilization, and other practices carried out in the patient care setting.
- Always verify the ventilator's breath delivery settings before using with a patient. When adjusting settings, special care should be taken to make sure that the new settings are set accurately. Using incorrect settings during ventilation can cause danger to the patient.
- To reduce the risk of electrical shock, do not operate the ventilator without the covers and panels in place.
- Use only Nellcor Puritan Bennett-approved accessories with the Achieva ventilator. Use of other accessories may be hazardous to the patient.

Caution

- To ensure proper servicing and avoid the possibility of physical injury, only qualified personnel should attempt to service the ventilator.
- Do not use or store this ventilator in the presence of strong electromagnetic fields such as an MRI environment.

1.3 Contraindications

The Achieva ventilator is not to be used with anesthetic gases.

The ventilator should not be used or stored in the presence of strong electromagnetic fields, such as an MRI environment.

1.4 Electromagnetic Interference

The Achieva ventilator is an electronic device. Any electronic device may create and is subject to electrical interference.

1.5 Symbols

The symbols identified in Table 2-2 are the symbols used on all Achieva ventilator models and the corresponding product labeling.

Table 1-1: Achieva Symbols and Definitions

⚠	Attention, consult accompanying manual.
∼	Alternating current
⎓	Direct current
V	Volts
A	Amperes
⏻	Standby
🧍	Type BF equipment, degree of protection against electrical shock
🔊	Alarm
CE 0123	CE mark: This device complies with the requirements of Medical Device Directive 93/42/EEC.
IPX1	Drip proof
⊟	External Battery power connector

Keep dry.

UL mark, classified by Underwriters Laboratories Inc. with respect to electric shock, fire and mechanical hazards only in accordance with UL2601-1.

CSA mark, certified by Canadian Standards Association to meet CAN/CSA-C22.2 No.601.1-M90

Fragile

Fuse type and rating

T3.15A,250V

Storage temperature

1.6   What the patient and caregiver must know

The following checklist presents a summary of the topics that patients and caregivers must understand in order to use ventilators successfully. Some topics do not apply to some patients; some patients may require additional information. It is the responsibility of the clinician or clinical educator to ensure that the patient and caregiver understand the appropriate topics fully.

For a detailed list of learning objectives for patients and caregivers, see *Learning Objectives for Positive Pressure Ventilation in the Home* (National Center for Home Mechanical Ventilation, Denver, CO, July 1993). This publication is available from Puritan Bennett Corporation.

The patient and caregiver must understand…	
☐	The need for ventilation.
☐	The schedule for ventilation.
☐	The supplies required for ventilation, and the sources of each.
☐	Whom to contact for medical emergencies, equipment emergencies, or power emergencies.
☐	How to contact other resources for assistance (health aides, attendants, therapists, etc.).
☐	The principles of operation for the ventilator.
☐	Power sources for the ventilator, and how to connect each.
☐	The settings for the ventilator parameters, and the importance of each.
☐	How to perform a user self test of the ventilator, and how to respond if the self test fails.
☐	The preventive maintenance schedule for the ventilator.
☐	The ventilator alarm settings, with the purpose and function of each.
☐	How to respond to ventilator alarms.
☐	What to do if the ventilator alarms inappropriately.
☐	The parts and purpose of the patient circuit.
☐	How and how often to clean and replace the patient circuit.
☐	How to recognize and respond to problems with the patient circuit.
☐	The parts and purpose of the tracheostomy and the tracheostomy tube.
☐	Care of the tracheostomy and tracheostomy tube.
☐	How to recognize and respond to problems with the tracheostomy and tracheostomy tube.
☐	The parts and purpose of the nasal mask.
☐	Care of the nasal mask.
☐	How to recognize and respond to problems with the nasal mask.
☐	The parts and purpose of the mouth piece.
☐	Care of the mouth piece.
☐	How to recognize and respond to problems with the mouth piece.
☐	The purpose of the humidifier or HME.
☐	How to connect the humidifier or HME to the ventilator and the patient circuit.
☐	How to clean and change the humidifier or HME.
☐	How to recognize and respond to problems with the humidifier or HME.
☐	The oxygen setting, and why it is required.
☐	How to connect the oxygen source to the ventilator.
☐	How to determine the amount of oxygen available, and how to acquire more.
☐	Safety rules for the use of oxygen.

The patient and caregiver must understand...
☐ Why a back up ventilation system is necessary, and how to use it.
☐ How the back up ventilation system differs from the main system.
☐ How to recognize and respond to problems with the back-up ventilation system.
☐ How to use additional equipment, such as external monitors and alarms.
☐ How and why to monitor the patient's condition.
☐ How to check the patient's vital signs.
☐ The significance of the patient's ease of breathing.
☐ What to note about the patient's skin, mucous membranes, and secretions, with their significance.
☐ How to recognize the signs of infection and how to respond.
☐ The importance of routine medical appointments and medical testing.
☐ The need and processes used to clear airway secretions.
☐ The use of manually assisted coughing.
☐ When, why, and how to use tracheal suctioning.
☐ How to recognize and respond to problems with suctioning.
☐ Equipment and phone numbers to have available in cases of emergency.
☐ When and how to use a manual resuscitator.
☐ How to respond to dyspnea.
☐ How to recognize and respond to problems with the ventilator.
☐ How to recognize and respond to problems with the oxygen supply.
☐ How to perform cardiopulmonary resuscitation.
☐ Techniques to prevent aspiration of vomit.
☐ Why and how to use a delee catheter.
☐ The importance of coordinating care for the patient.
☐ Resources for respite care.
☐ Choices about future care.
☐ The purpose of advanced directives.

Purpose of the Device

2.1   Intended Use

This device is intended to provide ventilatory support for pediatric and adult patients who require positive pressure mechanical ventilation. Patients should weight no less than 11 lbs (5 kg).This device is for use in home, institutional, and portable settings.

This device is contraindicated for use with anesthetic gases. This device is intended to be used on the order, and under the supervision, of a physician.

2.2   Modes of Ventilation

The following is a general description of the various modes of ventilation available with the Achieva ventilator.

Assist/Control (A/C) Mode

In Assist/Control mode, machine-initiated breaths are delivered at a clinician-set volume or pressure, inspiratory time, and rate. If the patient triggers a spontaneous breath between machine breaths, the ventilator will deliver a breath based on the volume or pressure settings. Whether initiated by the patient or the ventilator, all breaths are delivered at the same pre-set volume or pressure.

SIMV Mode

In SIMV (Synchronized Intermittent Mandatory Ventilation) Mode, machine-initiated breaths are delivered at a clinician-set volume, inspiratory time and rate. These mandatory breaths are synchronized with patient effort. If the patient triggers a spontaneous breath between machine breaths, the ventilator will deliver a spontaneous breath, which can be pressure-supported. Spontaneous breaths in SIMV do not have a pre-set volume or pressure.

Spontaneous (SPON) Mode

In Spontaneous mode, breaths are delivered with a volume, pressure and rate that are determined by the patient. Spontaneous mode is most frequently used with either CPAP (Continuous Positive Airway Pressure) or a combination of PS (Pressure Support)+CPAP.

CPAP

In CPAP, the ventilator maintains a constant level of pressure in the patient's airway. This can help to improve oxygenation, or the level of oxygen in the patient's blood. If your clinician has prescribed CPAP, you should talk to him or her for a further explanation of how CPAP works.

PS+CPAP

Like CPAP, PS+CPAP maintains a constant level of pressure in the patient's airway. In addition, the ventilator applies a clinician-set pressure to each of the patient's breaths. This has the same benefits as CPAP, with the additional benefit of assisting the patient in moving air into the lungs.

Description

3.1   Your Achieva Model Number

Your Achieva model number is printed on the front door panel. There are certain features described in this manual that pertain only to certain models.

3.2   Front Panel

Figure 3-1. **Front Panel**
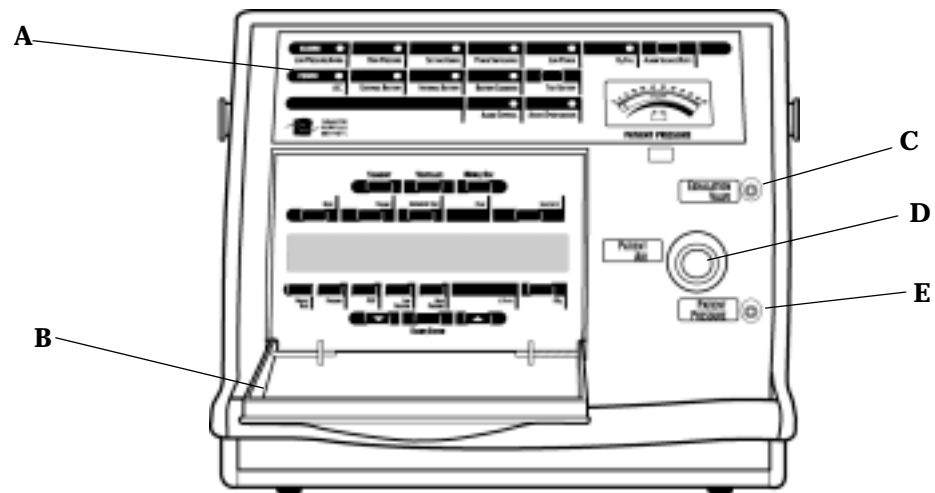
a. Top Panel

b. Door Panel (Display and Controls)

c. Exhalation Valve Port

d. Patient Air Port

e. Patient Pressure Port

Top Panel

Figure 3-2. Top Panel.
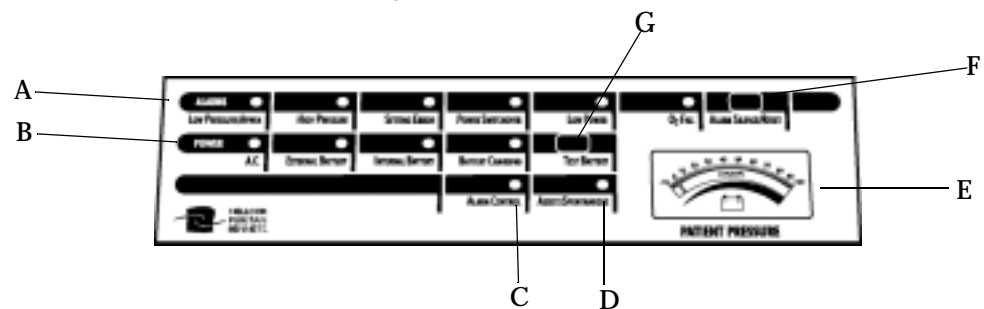
a. ALARMS INDICATOR Lights

The ventilator's ALARMS INDICATOR lights will flash when an alarm condition is detected. The lights are turned off only when the condition is corrected, and the ALARM SILENCE/RESET key is pressed. The ALARMS INDICATOR has lights for the following alarm conditions:

• Low Pressure/Apnea

• High Pressure

• Setting Error

• Power Switch-over

• Low Power

• O_2 Fail (Achieva PSO$_2$ only)

• Alarm Silence Reset

These alarm conditions will be explained later in this manual. For now, be sure to familiarize yourself with the location of the ALARMS INDICATOR lights.

NOTE:

For the Achieva and Achieva PS models, which do not have the oxygen-enrichment function, the O_2 Fail alarm-light position is present, but it has no light or label.

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b. POWER INDICATOR Lights

The ventilator's POWER INDICATOR lights indicate which electrical source the ventilator is currently using and if the internal battery is being charged. The POWER INDICATOR has lights for the following power conditions:

• AC

• External Battery

• Internal Battery

• Battery Charging

These power conditions will be explained later in this manual. For now, be sure to familiarize yourself with the location of the POWER INDICATOR Lights.

c. ALARM CONTROL Light

The ALARM CONTROL light flashes when the audible alarm has been pre silenced. The ALARM CONTROL light will continuously light when the non latching alarm feature is active.

d. ASSIST/SPONTANEOUS Light

This indicator lights when the patient's inspiratory effort is stronger than the ventilator's sensitivity setting.

e. PATIENT PRESSURE Meter

The PATIENT PRESSURE meter shows the level of pressure that is currently in the patient circuit.

f.   ALARM SILENCE/RESET

The ALARM SILENCE./RESET key silences the audible alarm during an alarm condition. The ALARM SILENCE/RESET key can be used to pre-silence the audible alarm for a period of 60 seconds. If an alarm condition occurs while the 60-second pre-silence period is in effect or while ALARM SILENCE/RESET is active, the LCD will display the alarm condition, but the alarm will not sound. This key can also be used to reset an alarm after the alarm condition has been corrected.

g.   TEST BATTERY

With the ventilator running on its internal battery, press and hold the TEST BATTERY key. The PATIENT PRESSURE meter shows the charge level of the battery currently in use. The test battery key is also used to activate the ventilator's printer output. See printing reports directly from the ventilator in the Appendix.

Door Panel (Display and Controls)

Figure 3-3. Door Panel (Display and Controls)
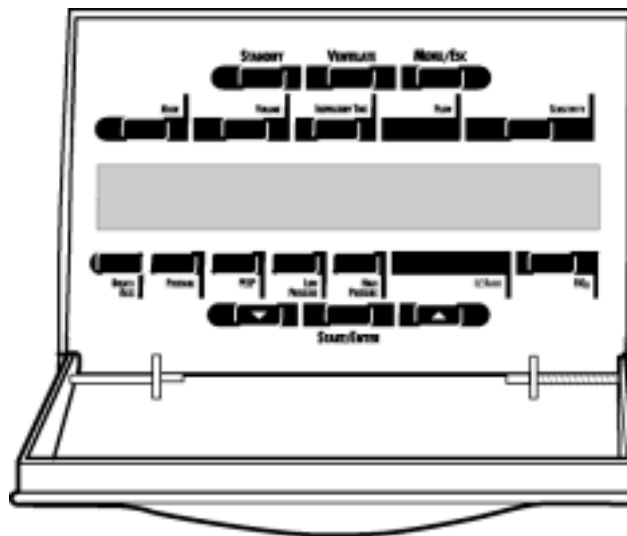
The display and control panel is located behind the ventilator's front door panel. This front door panel is magnetically latched to prevent tampering with and accidental ventilator settings.

The following is a brief explanation of what each of the controls do. Further information regarding how and when you should use the controls are provided later in this manual.

General Controls

a.   Standby

When pressed and held for three (3) seconds, the STANDBY key places the ventilator in a state where air is not being delivered.

b.   Ventilate

Pressing the VENTILATE key causes the ventilator to begin delivering air.

c.   Menu/Esc

Pressing the MENU/ESC key activates the menu options on the ventilator's display.

d. Up and Down Arrow Keys

The up and down arrow keys are typically used to move between values displayed in the ventilator's LCD window. While a ventilator setting is flashing, pressing the up and down arrow keys will increase or decrease the flashing setting's value. While the ventilator's menu options are active, pressing the up and down arrow keys allows you to move between menu levels. If none of the ventilator's settings are flashing, and the menu options are not active, pressing the up or down arrow keys will cause the last alarm message to be displayed in the LCD window.

e. Start/Enter

If the ventilator is in Standby, pressing START/ENTER will activate the display in the LCD window. START/ENTER is also used to accept a flashing setting value.

Setting Controls

You can select a setting by pressing the corresponding setting control key. Selecting a setting will cause the current setting value to flash in the display screen, allowing the setting value to be adjusted.

Setting values are displayed in the LCD window. Each setting value displayed in the window corresponds with the control nearest it (above or below.) Values displayed in the top row correspond to the row of controls located directly above the LCD window. Values in the bottom row correspond to the controls directly below the window.

Figure 3-4. Setting Display and Control Correlation
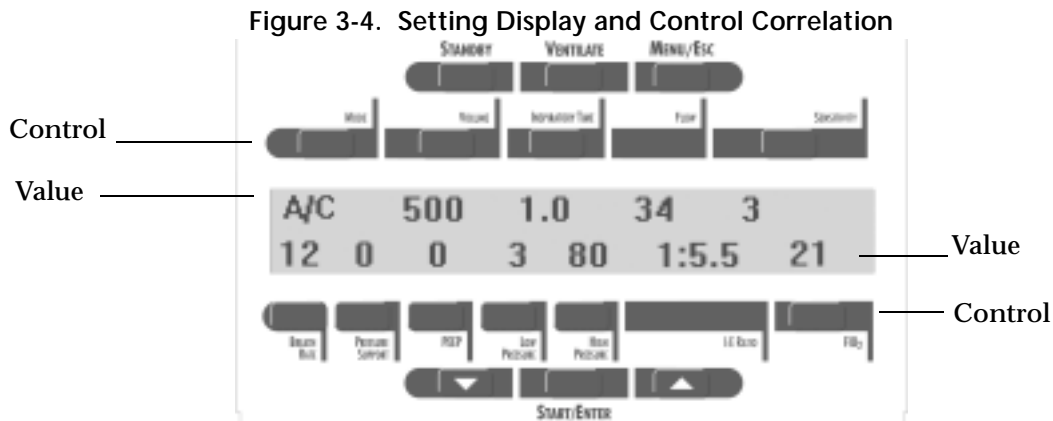
NOTE:

The I:E Ratio and Flow settings do not have keys. These controls are labeled for display purposes only.

f. Mode

The Mode section of the display screen shows the current ventilation mode setting. Pressing the Mode key causes the current mode on the display to flash and allows the ventilation mode to be changed.

g. Volume

The Volume section of the display screen shows the volume of air that is set to be delivered to the patient's lungs during volume breaths. Pressing the Volume key causes the current volume setting to flash and allows it to be changed.

h. Inspiratory Time

The Inspiratory Time section of the display screen shows the length of time it takes the ventilator to deliver the volume breaths and pressure controlled breaths to the patient. Pressing the Inspiratory Time key causes the current inspiratory time setting to flash and allows it to be changed.

i. Flow (Display only)

The Flow section of the display shows the average air flow delivered to the patient for volume delivery only. This calculated value is given in liters/minute.

j. Sensitivity

The Sensitivity section of the display screen shows the amount of flow generated by the patient that will trigger an assisted breath. Pressing the Sensitivity key causes the current sensitivity setting to flash and allows it to be changed.

NOTE: When using PEEP, use the pressure trigger along with sensitivity (Flow Trigger). The pressure trigger setting can be accessed and changed as a menu option.

k. Breath Rate

The Breath Rate section of the display screen shows the rate at which volume and pressure control breaths are delivered. Pressing the Breath Rate key causes the current breath rate setting to flash and allows it to be changed.

l. Pressure

The Pressure section of the display shows the pressure level maintained during a pressure supported breath and the maximum pressure allowed during a pressure controlled breath. Pressing the Pressure key causes the current pressure support setting to flash and allows it to be changed.

m. PEEP

The PEEP (Positive End Expiratory Pressure) section of the display screen shows the pressure maintained at the end of a delivered breath. Pressing the PEEP key causes the current PEEP setting to flash and allows it to be changed. Set the pressure trigger when using PEEP. This allows the patient to initiate either an assisted or supported breath. When using PEEP, use the pressure trigger along with sensitivity (Flow Trigger). The pressure trigger functions relative to the PEEP setting baseline. The pressure trigger setting can be accessed and changed as a menu option.

n. Low Pressure

The Low Pressure limit section of the display shows the minimal pressure limit that must be exceeded to prevent a Low Pressure alarm. The Low Pressure alarm sounds after two consecutive cycles below the low pressure limit. The Low Pressure alarm sound for a valley alarm after two consecutive breath cycles that *do not* fall below the low pressure limit. Pressing the Low Pressure key causes the current low pressure limit setting to flash and allows it to be changed.

Warning

Some circuit components will prevent a Low Pressure alarm by keeping the pressure in the circuit above the alarm limit. Examples of these components include hydrated heat and moisture exchangers (HMEs) and tracheostomy tubes If the patient circuit is disconnected from the patient, but still connected to these components, a Low Pressure alarm may not sound. Always use the digitally displayed pressure, not the analog manometer pressure, when setting the low pressure limit.

o. High Pressure

The High Pressure section of the display shows the highest pressure the ventilator allows without sounding the High Pressure alarm. Pressing the High Pressure key causes the current high pressure limit setting to flash and allows it to be changed. Always use the digitally displayed pressure, not the analog manometer pressure, when setting the high pressure limit.

p. I:E Ratio (Display only)

The I:E Ratio display shows the ratio of inspiratory to expiratory time. The Achieva ventilators permit a range of inspiratory times from 0.2 seconds to 5.0 seconds. The I:E Ratio is calculated according to the formula:

I:E Ratio = (1/(*Breath Rate*) - (*Inspiratory Time*)) / (*Inspiratory Time*)

q. F_IO_2 (Achieva PSO$_2$ only)

The F_IO_2 display shows the set enriched oxygen level. Pressing the F_IO_2 key causes the current F_IO_2 level setting to flash and allows it to be changed. A setting of over 21 activates the internal oxygen blender.

NOTE: For the Achieva model that does not have the oxygen function, the F_IO_2 key is present, but has no label and is inoperative.

NOTE: Flow and pressure measurements are not displayed on the front panel of the ventilator. To obtain these values, use the Achieva Report Generator. Flow is measured at the output port of the ventilator. These measurements must be corrected for altitude (using Altitude setting) and have an accuracy of ±2 LPM at nominal barometric pressures. Pressure measurements are taken at the patient end of the breathing circuit. Pressure measurements are relative to the current atmospheric pressure and have an accuracy of ±2.5 cm H_2O.

3.3   Rear and Side Panels
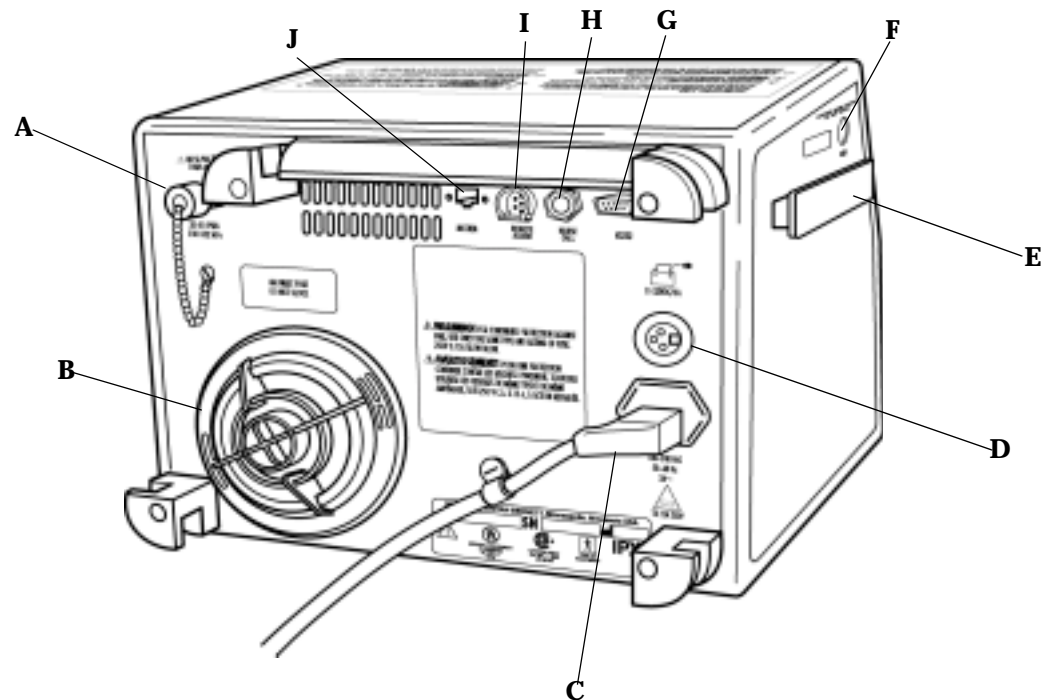
a. Oxygen Input Connection (Achieva PSO_2 only)

Connect the optional internal O2 blender to an oxygen source with a standard oxygen connection hose. Screw the hose fitting tightly onto the oxygen input connection. The hose fitting must be compatible with a 9/16-18, DISS 1240 male connector. For the Achieva model there is a label but no connector. NIST adapter kits are available.

b. Inlet Filter — Filters air as it enters the ventilator.

c. Power Cord Connector

d. External Battery Connector — Used for connecting an external battery.

e. Side Rail — Used for mounting ventilator accessories.

f. Audible Alarm Port (on side of ventilator) — DO NOT BLOCK

g. Communications Connector — Used to connect a printer, external modem, or computer (with Achieva Report Generator software) directly to the ventilator. Follow the accessory manufacturer's connection instructions for the appropriate connection procedure.

h. Nurse Call Output — Used to connect the ventilator to nurse call stations.

i. Remote Alarm Connector

The remote alarm cable plugs into the remote alarm cable jack on the back of the ventilator. Ensure that it is firmly in place. The cable slips on only if you have the button on the end of the connector facing down. To remove the cable from the ventilator, press the button and pull the connector straight out.

j. Modem Connector (Achieva PS and PSO_2 only)

A telephone cord is plugged into the ventilator's modem connector. Insert the cord with the tab facing down until it clicks into place. Plug the other end of the cord into a standard phone outlet.

3.4 Power Supply

Any one of the following power sources can be used to power the ventilator:

- AC Power
- External 12 or 24 Volt DC Battery
- Internal Battery

All three power sources can be connected to the ventilator at the same time; if AC power is available, the ventilator will automatically select it as the operating power source. If AC power fails, the ventilator will automatically switch to the next best power source.

AC Power

NOTE:
- Whenever possible, the ventilator should be plugged in to an AC power outlet. This allows the ventilator to maintain its internal battery charge.

The ventilator has a hospital grade, three-pronged power connector. The connector's hospital grading depends upon its use in a hospital grade outlet. If you encounter a two-pronged outlet, have a qualified electrician replace it with a properly grounded, three-prong outlet.

When the ventilator is plugged in to a functioning wall outlet, it automatically selects the AC power source. It will operate indefinitely on AC power. While the ventilator is operating from AC power, the AC power light (on the top panel) will be lit.

While connected to AC power, the ventilator automatically charges its internal battery.

External Battery (Accessory)

An external battery should be used as a backup power source, in case of AC power failure (i.e. a power outage.) An external battery may also be required when AC power is unavailable (i.e. while the patient is in a wheelchair, car or other vehicle.) While the ventilator is operating from the external battery, the EXTERNAL BATTERY power light (on the top panel) will be lit.

The external battery can only be charged by a battery charger. Connecting the ventilator to AC power will not charge the external battery.

When connected to an external battery, the ventilator automatically charges its internal battery. As the internal battery charges, the charge remaining in the external battery will decrease.

3.5 Internal Battery

NOTE:
The internal battery will automatically charge while the ventilator is connected to an AC power source and is operating in any mode, including Standby.

The ventilator has an internal battery that is capable of powering the ventilator for a limited time. The internal battery should only be used if an AC power source or an external battery is not available. The internal battery should not be the sole backup power source for the ventilator.

The ventilator will automatically switch to its internal battery when other power sources fail or drop below adequate levels. The Power Switch-over alarm signals whenever the ventilator switches from AC or an external battery to its internal battery.

While the ventilator is operating from its internal battery, the INTERNAL BATTERY light (on the top panel) will be lit. As the battery nears depletion, the ventilator will sound one of the following audible alarms to signal that you should provide another power source.

- Low Internal Battery Alarm: When approximately 45 minutes of power remains, the ventilator's alarm will sound a single beep every five minutes.

- Extremely Low Internal Battery Alarm: When approximately 10 minutes of power remains, the LOW POWER light flashes and the alarm sounds 3 pulses. The ventilator continues to sound the alarm until an external power source is connected. You can silence the alarm for five minute intervals by pressing the ALARM SILENCE/RESET key.

- Battery Charge Depleted (ventilator continues to operate): When the internal battery is nearly depleted, the LOW POWER light continues to flash and the alarm sounds 5 pulses. The ventilator will continue to alarm until an external power source is connected. You cannot silence a Battery Charge Depleted alarm until you connect an alternate power source.

3.6   Supplemental Oxygen

NOTE:

Determine if your patient needs supplemental oxygen and provide specific instructions as necessary.

If you are operating an Achieva model PSO_2 ventilator, the ventilator has an optional internal oxygen blender. This means an external oxygen source can be connected to the oxygen input connector on the back of the ventilator.

Figure 3-5. Connecting Oxygen Supply
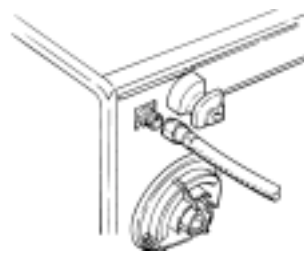
Two other methods of delivering supplemental oxygen are available:

- Oxygen Enrichment Kit
- 90° Elbow with Oxygen Fitting

Oxygen Enrichment Kit

The Oxygen Enrichment Kit (OEK) can be connected to the air inlet port on the back of the ventilator. The OEK comes with complete instructions for set up and use.

90° Elbow with Oxygen Fitting

Warning

If you are using the 90° elbow to deliver supplemental oxygen, care should be taken to securely attach the oxygen line to the elbow's oxygen fitting. If the oxygen tube becomes disconnected from the 90° elbow, the drop in pressure may not be significant enough to sound the ventilator's Low Pressure Alarm. This means that the patient may not receive the prescribed levels of oxygen and the tidal volume may be decreased, but you may not be alerted by the ventilator's audible alarm system. To prevent this, you should push the oxygen line tubing as far down on the elbow's oxygen fitting as possible, to reduce the possibility of inadvertent disconnection.

The 90° elbow releases controlled amounts of oxygen directly into the patient circuit. The elbow should be connected between the bacteria filter and the patient circuit. A low-pressure oxygen line can then be connected to the fitting on the elbow.

3.7   Humidification Devices

Air can be humidified by passing it through an HME (heat and moisture exchanger), an "artificial nose" device (used for short term humidification), or a humidifier. Follow the device manufacturer's instructions for connecting any of these devices to the patient circuit.

Follow these safety guidelines for using a humidification device with your ventilator:

Warning

- Always position a humidification device so that it is lower than the patient.

- Do not place a humidifier on top of, or above the ventilator.

- Using an HME or an "artificial nose" may affect the ventilator's low pressure alarm setting. See "Setting the Low Pressure Alarm" on page 17.

- If a heated humidifier is used, you should always monitor the temperature of delivered air. Air that becomes too hot may burn the patient's airway.

Figure 3-6. Achieva Ventilator Connected to a Humidifier
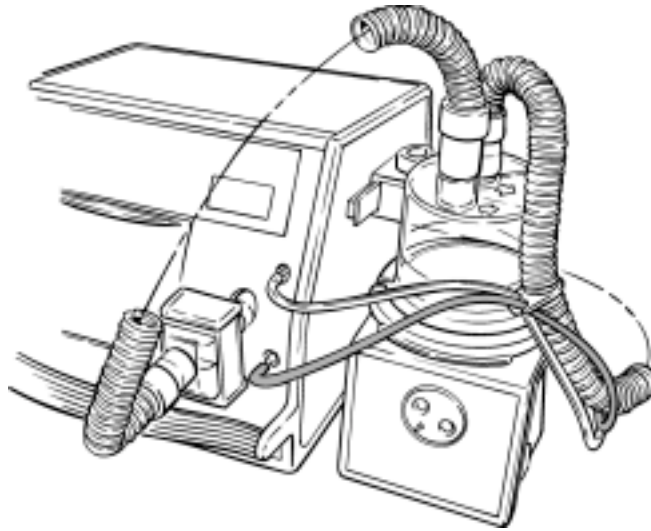
When a humidification device is used, condensation may form in the patient circuit over time. Regularly check the patient circuit for signs of condensation. If you notice moisture in the patient circuit, disconnect and drain the circuit, or replace it with a dry circuit.

Refer to the humidification device's instruction manual for operating, cleaning, and sterilization instructions.

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Set Up

NOTE:

Alarm conditions frequently occur during setup of the ventilator. Because the audible alarm sound can be annoying, they can be pre silenced. See *Pre-Silencing Audible Alarms* in Section 7.

4.1   Unpacking the Ventilator

Follow these instructions to unpack your ventilator.

NOTE:

- These instructions are also printed on your ventilator's packaging.

- You should save all packaging material, in case you need to return the ventilator to Nellcor Puritan Bennett. If your packaging is damaged or discarded, contact Nellcor Puritan Bennett for replacement packaging.

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1. Remove the manuals and other material from the top of the carton.

2. Pull the ventilator out of the box using the handles on the cardboard insert.

3. Remove the ventilator from the cardboard insert.

4. Remove the ventilator from the plastic bag.

4.2   Preparing the Ventilator

1. After unpacking your ventilator, inspect the device. Make sure that:

    – The power cord does not have any kinks, breaks or damaged insulation.

    – The connectors, rubber feet, filter housings, etc. are not loose or broken.

    – The outer casing does not have any dents or scratches which may indicate dropping or other damage.

    – All of the labels and markings on the ventilator are clear and legible.

Caution

If the ventilator does not pass visual inspection, contact your equipment supplier or Puritan Bennett Corporation for assistance; 1-800-255-6774. Do not use a ventilator that appears to be damaged.

NOTE:

Visual inspection should be performed each time the ventilator is used after storage as well as periodically during normal use.

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2. Clean the ventilator with a mild soap solution, if necessary.

3. Check to see if a clean air inlet filter is installed. If the filter is dirty, or if there is no filter in place, install a new one. See *Replacing the Air Filter* in Section **8** of this manual.

4.3   Where to Place the Ventilator

Choose a place in your home to set up the ventilator according to the following safety guidelines:

Warning

- Make sure you can hear the ventilator's alarm from all rooms in the house, and when you are using appliances such as a vacuum cleaner, dishwasher, clothes dryer, television or radio. Do not leave the patient unattended if you cannot hear the ventilator's alarm.

- Do not place the ventilator in a position where a child could reach it and change the controls.

- Do not place the ventilator in any position that might cause it to fall on the patient.

- Place the ventilator where the patient circuit can easily reach the patient. Make sure the tubing hangs loose, without strain, so that the patient can move freely.

- Maintain at least four inches between the air inlet filter (on the back of the ventilator) and the wall. Make sure the rear panel is not close to draperies or other items that could block the air flow into the air inlet filter.

- Do not place anything in front of the ventilator's alarm port (on the side of the ventilator) that could block or decrease the sound of the alarm.

- Do not place anything in front of the ventilator's patient air port (on the front of the ventilator) that could block or decrease the amount of air flowing from the ventilator to the patient.

Caution

- Do not place the ventilator on or near electrical equipment such as a cellular or cordless phone, television, radio, microwave oven, or an electric heater. These may affect the ventilator and cause it to work improperly.

- Do not expose the ventilator to extreme moisture, such as direct exposure to rain. Extreme moisture can cause the ventilator to fail or work improperly.

- Do not place a humidifier above the ventilator. Moisture from the humidifier may condense in the patient circuit and may drain into the ventilator.

- Do not place a container of liquid on or near the ventilator. Liquids spilled on the ventilator may cause it to work improperly.

Follow these instructions to check your ability to hear the ventilator's alarm in the home.

1. Before connecting to the patient, place the ventilator on a flat, sturdy surface in the location where it will be used most frequently.

2. Plug the ventilator into a grounded AC power outlet.

3. Press the START/ENTER button to turn on the ventilator.

4. Press VENTILATE to start breath delivery. Because the ventilator is not connected to a patient, an alarm condition will sound.

5. Go to various parts of the home to make sure that you can hear the alarm. You should also turn on any device that produces sounds (e.g. radio, television, tools, and household appliances) to make sure that you can still hear the ventilator alarm over the device. If you find that there are certain areas of the home or noisy activities over which you cannot hear the alarm, do not leave the patient alone while you are in those areas or engaging in those activities.

4.4   Power

Any one of three power sources can power the ventilator:

• External AC

• Internal 24 VDC battery

• External 24 or 12 VDC battery (Use 24 VDC for optimum performance.)

When plugged into a functioning wall outlet the ventilator automatically selects AC power. It will operate indefinitely on AC. All three sources may be connected to the ventilator at the same time. If the AC power fails, the ventilator automatically switches to the next best power source.

4.5   AC power

The ventilator has a hospital grade, three-pronged AC power connector. If you encounter a two-pronged outlet, have an electrician replace it with a properly grounded three-pronged outlet. If the integrity of the external three-pronged outlet is in doubt, run the ventilator on its internal electrical power source.

Warning

This equipment must be protectively grounded.

The plug may not fit wall outlets in other countries. Either replace the ventilator's plug with one designed for local outlets or use an adaptor. If you have doubts about the ground connection, have a qualified electrician examine the outlets. If necessary, have them properly grounded.

Caution

If you have questions about the power line, contact a qualified electrician or Puritan Bennett Technical Support.

If you have questions about how the ventilator will operate, contact Puritan Bennett Technical Support.

When operating on AC power, the ventilator will recharge the internal battery in any ventilation mode, including Standby. The internal battery will charge from the external battery only when the ventilator is operating (not in Standby); but charging from the external battery will reduce the power remaining in the external battery. AC power does not recharge the external battery when connected to the ventilator. The external battery can be charged only by a battery charger.

4.6   External battery 24 volt DC

Whenever AC power is unavailable, the ventilator can operate from an external 24 VDC battery. Use a special cable from Puritan Bennett to connect the ventilator to the battery. Use only Puritan Bennett approved batteries. A power Switchover alarm signals a change from AC to external battery or from external to internal battery.

Puritan Bennett recommends use of a 24 VDC external battery for optimal performance. Although a 12 V battery can power the ventilator, a Setting Error alarm is more likely to occur with the use of a 12 V battery under extremely heavy load. Refer to the section *Specifications* for definitions of normal and heavy load conditions. If you are using a 12 V battery, run the ventilator at the intended settings before connecting it to the patient to make sure the ventilator is able to function fully at the selected settings. As the battery discharges, a setting alarm is more likely to occur.

Carefully connect the 24 VDC battery to the ventilator. Follow the battery manufacturer's instructions.

NOTE:
- Use only Puritan Bennett cables.
- Check to see if the ventilator's EXTERNAL BATTERY light is lit. This light signals that your ventilator is properly connected and is using the external battery.
- Do not reverse the positive and negative cables when connecting a battery to your ventilator. If you accidentally reverse the connections, a protective fuse may open in the battery box or in the ventilator. With the resulting open circuit, the cable will not provide power to the ventilator. You must first correct the connections and install a correct replacement fuse in the system. Only then will the external battery power the ventilator.
- Always keep a spare fuse with your battery and cable. Contact your equipment supplier or Puritan Bennett.
- Batteries and connecting cables are available from Puritan Bennett. These accessories come with instructions for connection and use. The battery and case provided by Puritan Bennett has a cable with a three pin connector. When properly used, this cable and connector prevent reversed connections between the battery and ventilator. Use of other cables may damage the ventilator or make it inoperable if the cable connections are accidentally reversed.

4.7   External Battery 12 Volt DC

The ventilator can also operate from an external 12 VDC battery. However, a Setting Error alarm is more likely to occur with the use of a 12 VDC battery, as the ventilator may not be able to deliver gases at the selected parameters. Use of a 24 VDC battery is recommended if at all possible.

4.8   Battery performance

The internal battery will charge from the external battery only when the ventilator is operating (not in Standby); but charging from the external battery will reduce the power remaining in the external battery.

As they age, batteries lose their capacity to retain an electrical charge. For best performance, follow the manufacturer's instructions.

The following affect the life of the battery:
- Ambient temperature
- Charge level
- Storage conditions
- Age of battery
- The number of times, and the extent to which, the battery is discharged and recharged
- Type (12 V or 24 V)

To ensure maximum running time of the ventilator on any external battery, keep the battery fully charged. Some batteries need to be discharged and recharged monthly. Refer to the battery manufacturer's instructions. Recharge any external battery immediately after use. Use a Puritan Bennett-approved battery charger. The time required to recharge a battery varies. With a Puritan Bennett charger, a fully depleted external battery will be fully charged in twelve hours.

Every four to six weeks, run the ventilator on the external battery until the ventilator switches to the internal battery. Immediately disconnect the external battery, switch to AC power and recharge the external battery until it is fully charged.

> **Caution**
>
> - Recharge an external battery immediately after use. You should use a Puritan Bennett-approved battery charger to recharge external batteries.
> - There is a possibility of reduced performance when the ventilator is powered by a 12 VDC battery. In this case, you will get a Setting Error alarm (Volume Error, Rate Error, or Inspiratory Error alarm).
> - When recharging the external battery, first connect the battery to the charger, then connect the charger to AC power.
> - Never connect a battery charger to an external battery while the battery is connected to the ventilator. This may cause permanent damage to the ventilator.

With a 24 or 12 volt DC battery, the ventilator can operate for at least 19 hours with NORMAL LOAD operating parameters. There is a possibility of reduced performance with a 12 volt battery.

4.9   Testing the batteries

Make sure the battery to be tested is powering the ventilator before performing the battery test; failure to do so will result in an erroneous reading of the battery condition. To run the test, press and hold the TEST BATTERY switch. The needle on the PATIENT PRESSURE meter registers the battery charge. A fully charged battery, in good condition, will register approximately 100% on the scale.

The battery test meter is only a relative indicator of the remaining battery charge. An older battery may register a high charge level, but discharge more rapidly. Carefully monitor battery power sources. Always have a back-up power source available.

The amount of power available is directly related to the battery's age, as well as the number and depth of cycles the battery has delivered. As a battery ages, its ability to power the ventilator decreases. The extent to which a battery is discharged each time it is used also affects its longevity. A battery that is nearly or completely discharged each time it is used will age more quickly than one that is only partially discharged. Take both the age of the battery and its history of use into account in all applications, but especially in portable applications where another power source may not be readily available. The power required by the ventilator varies with the ventilation parameters.

The ventilator will switch to the internal battery and signal an alarm when the external battery's voltage drops below a preset limit. The alarm indicates the ventilator can no longer operate reliably on the external battery.

4.10   External battery precautions

Place the battery as far away as possible from the ventilator's Inlet Filter (located on the rear panel).

When using a tray to hold both the battery and the ventilator, put a partition between the battery and ventilator.

Batteries need to be discharged and recharged monthly. Refer to the battery instructions.

> **Warning**
>
> Never place the battery above or on top of the ventilator.

> **Caution**
>
> Always use separate batteries to power a motorized wheelchair and the ventilator.

4.11   Internal battery 24 Volt DC

Before use, run the ventilator on AC Power for twelve hours to make sure the internal battery is charged. The internal battery can maintain its charge for at most three months when the system is turned off .

The Internal 24 VDC battery is intended only for backup use. It requires no special connections. The ventilator switches to the internal battery when other power sources fail or drop below adequate levels. The Power Switchover alarm signals whenever the ventilator switches from AC or an external DC battery, to its internal battery. Charging the internal battery from the external battery will reduce the power remaining in the external battery.

> **Warning**
>
> If health or safety would be jeopardized by a long-term power failure, a reliable backup power source is mandatory. Do not regard the internal battery as a long-term backup power source.

When powered by the internal battery, the INTERNAL BATTERY light is continuously lit. As the battery nears depletion the ventilator will give the following alarm indications (times based on Normal Load conditions as defined in *Specifications* section):

• **Low Internal Battery Alarm**: When approximately 45 minutes of power remains, the audible alarm sounds a single beep every five minutes. Switch to an external power source.

• **Extremely Low Internal Battery Alarm**: When approximately 10 minutes of power remains, the low power light flashes and the alarm sounds three pulses (repeating) which can be silenced for five minutes at a time by pressing the ALARM SILENCE/RESET switch. Switch immediately to another power source.

• **Battery Charge Depleted**: When the internal battery is nearly depleted, the LOW POWER light continues to flash and the alarm sounds five pulses (repeating) that cannot be reset or silenced. You must respond immediately and provide another source of ventilation. Switch to an external power source and reset the ventilator. For instructions on how to recover from this condition, see Response to Low Internal Battery Power or Extremely Low Internal Battery Power alarms on page 6-14.

> NOTE:
>
> During Low Battery and Extremely Low Battery alarms, other alarms (such as Setting Error) can occur when the ventilator is no longer able to deliver gases at the selected parameters.

Test the charge level of the internal battery by pushing the TEST BATTERY switch. Read the charge level on the Battery Condition scale of the PATIENT PRESSURE meter. A fully charged battery, in good condition, will register approximately 100% on the scale.

NOTE:

The ventilator must be operating on internal battery power to obtain a reading of the internal battery's charge level.

Caution

To retain electrical charge, recharge the internal battery by plugging the unit into an AC power outlet after each use. A fully depleted internal battery will be fully charged in twelve hours. Always charge the internal battery before disconnecting AC power from the ventilator.

Keep the internal battery fully charged at all times. The ventilator charges the internal battery when it is connected to an AC power source and is in any operating mode including Standby.

Every four to six weeks, run the ventilator on its internal battery until the low power alarm sounds. Immediately switch to AC power and recharge the internal battery for at least twelve hours.

Warning

Batteries contain toxic chemicals and no attempt to remove or replace the batteries should be made by anyone other than the equipment supplier or a trained service center.

4.12   Attaching the patient circuit

The patient circuit has a long flexible hose and several other parts shown in the diagram. It attaches to the ventilator. Inspect it every day to:

• Make sure there are no cracks in the hose.

• Be certain all the connections are secure and free of leaks.

Clean the exhalation manifold according to the manufacturer's instructions.

Each time the Patient Circuit is reassembled, perform a user self test to make sure the circuit is functioning properly. See Section 6, *Operating the Ventilator.*
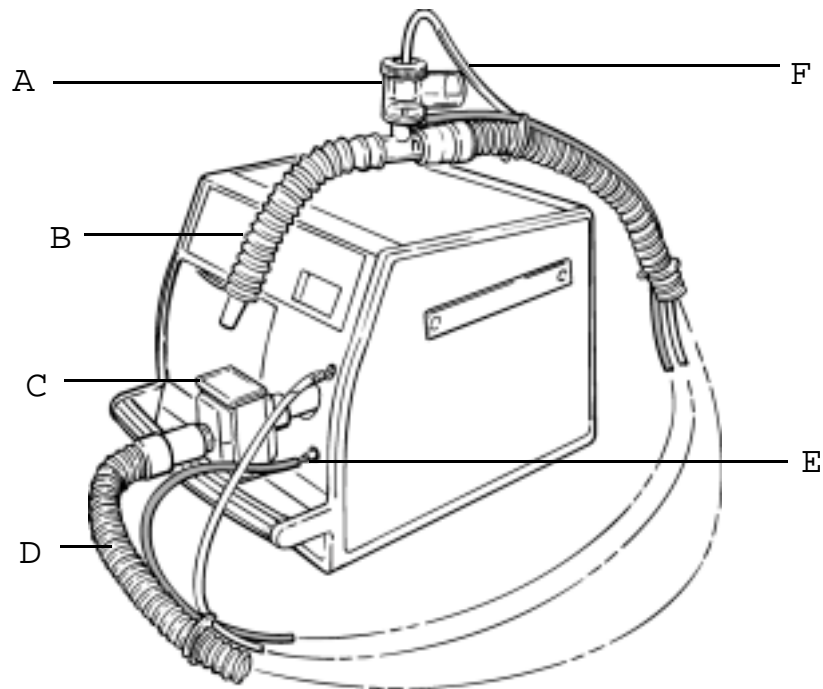
The following instructions are for a reusable patient circuit, as illustrated. Disposable patient circuits are also available from Puritan Bennett, and include instructions.

a. EXHALATION MANIFOLD

The exhalation manifold directs the flow of gases to and from the patient. The exhalation manifold is also used to control PEEP and regulate pressure during Pressure Control. This assembly consists of a manifold body, a mushroom valve, and a cap. Refer to the manufacturer's instructions, before using it with the patient. Secure all connections and ensure that the mushroom valve is seated properly.

During inhalation, the "mushroom" inflates and allows air to enter the lungs. During exhalation, the "mushroom" deflates and allows air to be expelled from the lungs.

b. FLEX TUBE

This tube connects the patient circuit to the tracheostomy tube. The tube's flexibility makes the circuit more comfortable.

Caution

The flex tube may contain natural rubber latex which may cause allergic reactions.

c. BACTERIA FILTER

This filter cleans the incoming air before the patient inhales it.

d. PATIENT AIR TUBE

This is the large tube between the bacteria filter and the exhalation manifold.

Warning

Anti-static or conductive hoses or tubing should not be used.

e. PATIENT PRESSURE TUBE

This small tube connects the patient pressure port on the ventilator to the proximal pressure port on the exhalation manifold.

f. EXHALATION TUBE

This small tube connects the exhalation valve port to the mushroom valve in the patient circuit.

Warning

- Ensure the proper connection and operation of the patient circuit at least daily. The patient could be at risk if the manifold does not function as intended. Connecting patient pressure and exhalation tubes to the incorrect port prevents proper patient ventilation. Be aware that adding attachments or other components to the breathing system may increase inspiratory and expiratory resistances.

- A ventilator patient is highly susceptible to respiratory infections. Dirty or contaminated equipment may be a source of infection. Clean equipment and proper use of bacteria filters are essential to reduce the chance of infection.

- When patients are in respiratory failure on pressure-controlled or pressure-supported modes, the physician must determine at what level the patient may require an alternative means of monitoring effective ventilation.

4.13 Attaching oxygen

Connect an external oxygen source to the oxygen input connector on the back of the ventilator (available only on Achieva PSO$_2$). The connector is a DISS 1240 fitting. Input pressure range is 20–80 PSIG.
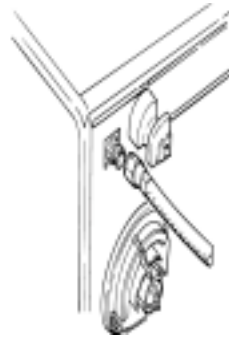
To start the oxygen blender, the F_IO_2 setting must be above 21%. The F_IO_2 level should be set according to the prescription. The oxygen fail alarm will sound if the ventilator does not detect an oxygen source.

Supply pressures of less than 45 PSIG during the expiratory phase of the breath may result in reduced oxygen performance at some settings. Optimum performance is achieved at 65 PSIG oxygen supply pressure. It may take several minutes for the oxygen concentration to stabilize. An oxygen supply capable of delivering a minimum of 80 SLPM (Standard Liters per Minute) is required to realize the full capacity of the blender.

The capacity of the oxygen blender is a function of tidal volume and inspiratory time, which in combination influence peak flow. As peak flows increase (i.e. large tidal volumes combined with short inspiratory times), the limit of the oxygen flow capacity is approached. The set oxygen concentration cannot be delivered if the flow capacity of the oxygen blender has been exceeded.

> **Warning**
>
> - This device does not include an oxygen analyzer. Always measure the delivered gases with a calibrated analyzer having high and low concentration alarms in order to ensure that the prescribed oxygen concentrations are delivered to the patient.
> - In compliance with ASTM F1100, measure the oxygen with a calibrated analyzer in order to ensure that the prescribed oxygen concentrations are delivered to the patient.

> **Caution**
>
> Altitude changes and oxygen source pressure can affect the ventilator's oxygen blender. To ensure correct oxygen blending, verify that the correct altitude has been entered into the ventilator's parameters.

> **Warning**
>
> Two other methods of supplemental oxygen delivery are available:
>
> - the 90° elbow with oxygen fitting
> - the oxygen enrichment kit

Oxygen enrichment kit — You can achieve high oxygen concentrations at the proximal airway by delivering source oxygen directly into the Air Inlet port on the back of the ventilator. Use the optional Oxygen Enrichment Kit. This kit contains complete instructions.

90° Elbow with oxygen fitting — Use the elbow to bleed oxygen directly into the patient circuit. This method can achieve concentrations up to 40%. Connect the elbow between the bacteria filter and the patient circuit. Connect a low-pressure oxygen line to the fitting on the elbow. Use the formula below to calculate the volume of pure oxygen to be bled into the patient circuit to achieve the desired oxygen concentration:

$$\text{LPM} = \frac{\text{BPM} \times \text{V}_t \times (\text{C} - 0.21)}{0.79}$$

Where:

LPM=100% oxygen flow in liters per minute
BPM=breath rate in breaths per minute
V_t=tidal volume in liters
C=desired patient oxygen concentration (i.e., 30% = 0.3)

NOTE: Oxygen bled into the circuit is additional volume. Adjust for this volume when setting the ventilator volume.

4.14   Short term humidification

When using humidification for a short time, or during transport, you can use a heat and moisture exchanger (HME, or artificial nose) with the ventilator. Connect this regenerative humidifier to the patient circuit between the trach connector and the flex tube, or follow the manufacturer's instructions.

Warning

The use of an HME or humidifier may affect the ventilator's low pressure alarm. See *Setting the Low Pressure Alarm* in this manual section.

4.15   Extended use

The patient's doctor will usually prescribe humidification of the delivered gases. Mallinckrodt offers special humidifier mounting brackets. The brackets include instructions for use.
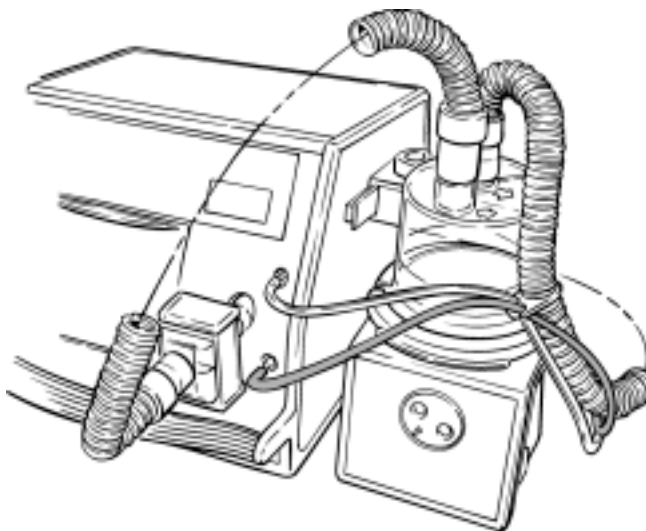
For complete instructions on the operation, cleaning, and sterilization of the humidifier, refer to the appropriate sections of the humidifier manufacturer's instruction manual.

Warning

- Always position the humidifier at a level lower than the patient and at the same, or lower, level than the ventilator. This will help prevent excessive moisture from entering the system.

- Some active humidifiers do not have temperature monitoring or alarm capabilities. Failure to monitor air temperature may allow inspired air to become too hot. Thermal injury to the patient's airway may result. Always follow the recommendations of the humidifier manufacturer.

- Do NOT use compressed gas to clear moisture from the pressure line when connected to the patient. First disconnect the ventilator and circuit.

- Always drain the tubing away from the patient connection.

<div style="border:1px solid black; padding: 8px;">

Caution

- Condensation forms in the patient circuit over time. Periodically check for moisture in the patient circuit. When present, remove the moisture. Before attempting to dry the circuit, disconnect it from the ventilator.

- Always disconnect the tubing from the ventilator before drying with pressurized air. Failure to do so may damage the ventilator.

</div>

4.16   Connecting to a nurse call system

The nurse call output on the back of the Achieva ventilators is connected to the contacts of a normally-open relay. During low pressure alarms, the contacts open and close (1.67Hz, 50% duty cycle). During all other alarms, the contacts remain closed. The contacts are also closed while the ventilator is in Standby (non-ventilate) mode.

Pressing the A̲L̲A̲R̲M̲ S̲I̲L̲E̲N̲C̲E̲/R̲E̲S̲E̲T̲ button resets the contacts in the open position.

Use a ¼″ phone plug (available from Puritan Bennett) to connect this output to a nurse call station. The relay is rated at 30V, 0.5A.
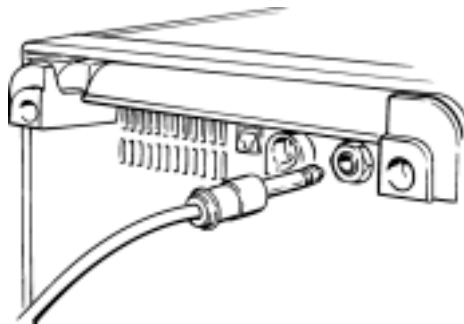
If your application requires a normally-closed (open on alarm) connection, you can change the setting by following these instructions:

1. Make sure the ventilator is unplugged and fully powered down (no power source LED lit).

2. Use a 1/8" hex driver to remove the two screws securing the left side rail and the left side cover (the side with the alarm). Remove the left side rail.

3. Remove the plastic left side cover.

4. There is a label on the left side panel that looks like the sample shown below:
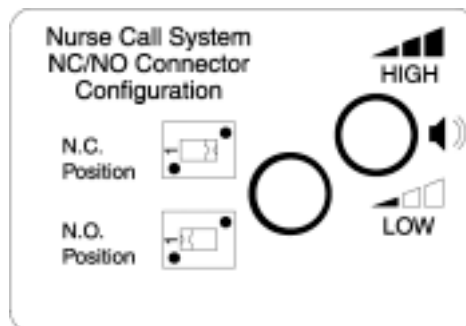
5. Insert a small, non conductive screw driver through the left adjustment hole in the side panel and slide the switch to the right until it clicks into position. (The right adjustment hole is for changing the alarm volume level.)

6. Insert the tabs on the bottom of the plastic left side cover into the groove at the bottom of the left side panel. Reposition the left side cover into place.

7. Secure the left side rail and the left side cover using a 1/8" hex driver and the two screws removed in step two.

8. Connect the nurse call system that will be used to the nurse call jack on the back of the ventilator and test for proper operation. The nurse call system should be alerted during an alarm condition, or when the ventilator is set to Standby.

Remote Alarm Accessory

If required, a remote alarm accessory is available. The remote alarm can help you to hear the ventilator's alarm from a remote location. Contact your clinician or a Nellcor Puritan Bennett representative for more information on purchasing and using a remote alarm.

If you are using a remote alarm, follow the procedure above to find the best location for it.

Electrical Interference

The Achieva ventilator may be subject to electrical interference. Electrical interference can come from television sets, cordless or cellular telephones, microwave ovens, air conditioners, food processors, and other appliances. Follow these guidelines to reduce the risk of interference:

- Do not place your ventilator near an appliance.
- Do not plug your ventilator into the electrical outlet or electrical outlet circuit that is used by an appliance.
- Do not place the ventilator cables near an appliance.

If your ventilator causes interference to other devices, follow the guidelines below:

- Turn the antenna on the affected device (e.g., radio, television, cordless phone.)
- Move the device away from the ventilator.
- Connect the ventilator to an outlet which is on a different electrical circuit than the affected device.
- Consult the dealer or an experienced radio/TV technician for help.

4.17   Mounting the Ventilator on a Wheelchair

When using the ventilator on a wheelchair, follow these safety guidelines:

Warning

Position the external battery as far away from the ventilator's air inlet port as possible. This will help prevent battery gases from drifting toward the ventilator's air inlet.

Caution

- Always provide an external battery as the power source. Do not rely solely on the ventilator's internal battery to sustain ventilation.
- Do not use the same battery to power both the ventilator and an electric wheelchair.
- Protect the ventilator from extreme moisture, such as direct exposure to rain.
- Check the air inlet filter frequently while the ventilator is mounted on a wheelchair as environmental conditions may cause the air filter to become dirty more rapidly.

Mounting instructions may vary depending on the wheelchair model and manufacturer. Consult the wheelchair supplier or manufacturer for standard wheelchair adaptations. Figure 4-1 illustrates the recommended placement of the ventilator and the external battery.

Figure 4-1. Ventilator and Battery Placement on Wheelchair

External Battery

Achieva Ventilator
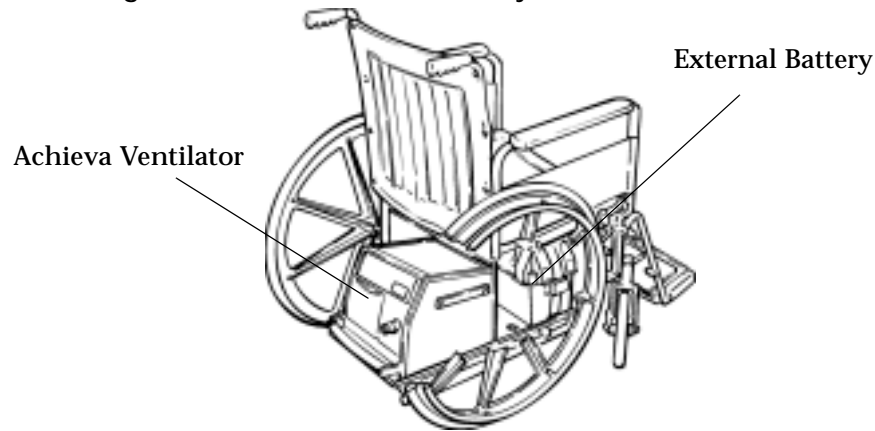
Place a partition between the ventilator and the external battery. This will help to protect the ventilator from battery fluid, in the event of a battery leak. This partition should be at least four inches away from the ventilator's air inlet filter, so that it does not impede the flow of air into the ventilator.

If the ventilator and the battery are in the same tray, holes should be cut into the tray to allow any leaking battery fluid to drain away from the ventilator. Placing the battery in a plastic container may also help to protect the ventilator from leaking battery fluid.

4.18   Connecting the Ventilator to an AC power outlet

The ventilator may be operated on AC power or it can operate on its internal battery for a limited time. The ventilator may also be operated on an external battery. If you are using an external battery, See *Using an External Battery* in this manual section.

Warning

- This equipment must be protectively earthed.

- The AC outlet must be properly grounded. If you intend to use AC power and have doubts about the ground connection of your outlets, contact a qualified electrician. If necessary, have the outlets properly grounded before connecting your ventilator.

- Never connect your ventilator to an electrical outlet controlled by a wall switch because the power may be inadvertently turned off.

1. Plug the socket end of the power cord into the power cord connector on the back of the ventilator

Figure 4-2. Connecting the Power Cord.
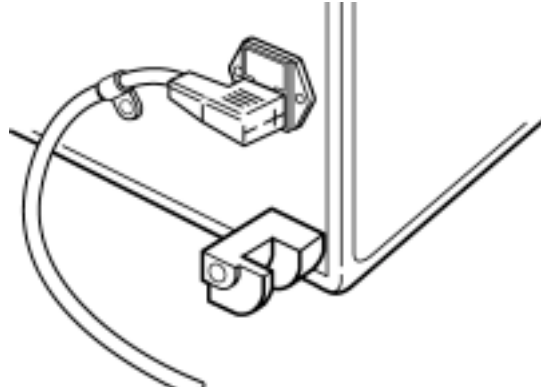
2. Plug the other end of the cord (the end with three prongs) into a grounded, functioning AC power outlet.
   When you plug in the ventilator, the BATTERY CHARGING and AC POWER lights will light at the same time.

Warning

If the BATTERY CHARGING or AC light does not light up, do not use the ventilator. Contact your equipment supplier or Nellcor Puritan Bennett for assistance.

NOTE:

The power plug may not be compatible with outlets in some countries. If you encounter an outlet that is not compatible, you can either replace the ventilator's plug with one that is compatible, or use an outlet adaptor.

4.19   Using an External Battery

When AC power is unavailable, the ventilator can operate from an external 12 or 24 Volt DC battery.

NOTE:

For optimal performance, a 24 Volt battery is recommended. Although a 12 Volt battery can be used, a Setting Error alarm is more likely to occur as the 12 Volt battery discharges.

Follow these safety guidelines when using an external battery:

Warning

• Position the external battery as far away from the ventilator's air inlet port as possible. This will help prevent battery gases from drifting toward the ventilator's air inlet.

• If the EXTERNAL BATTERY indicator does not light once the battery is connected, do not use the external battery. Connect your ventilator to AC power and contact your clinician.

Caution

• Do not place a battery above or on top of the ventilator.

• Use only Nellcor Puritan Bennett approved cables and batteries.

Follow the instructions included with your battery to connect it to your ventilator. Once the battery is connected, check to make sure that the ventilator's EXTERNAL BATTERY indicator light is lit. This light signals that your ventilator is properly connected and is using the external battery.

4.20   Connecting the Patient Circuit

Connect the patient circuit according to the circuit manufacturer's instructions. Make sure that all connectors fit snugly. If a connector does not fit properly, contact your clinician for guidance. Do not use the ventilator if any of the connections do not fit properly.

Figure 4-3. Achieva Ventilator with Patient Circuit
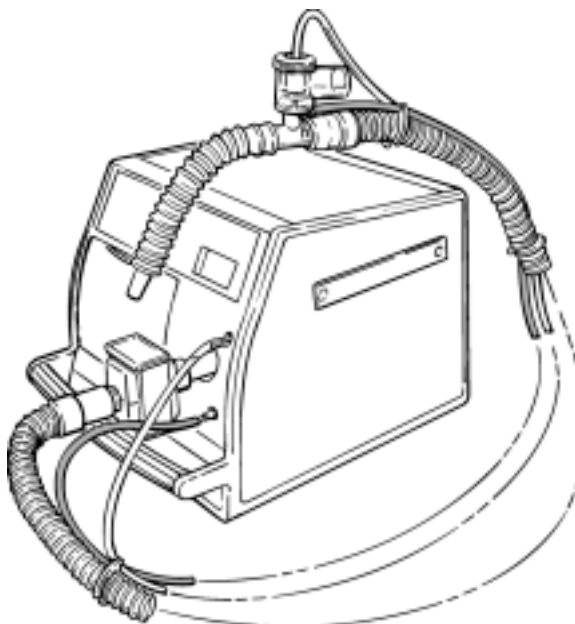
4.21   Setting the Low Pressure Alarm

The low pressure alarm will notify you if the air pressure in the patient circuit drops below a prescribed limit. Follow these safety guidelines when setting the low pressure alarm.

Warning

- Do not set the low pressure alarm while the ventilator is connected to the patient. Provide an alternate means of ventilation.

- Under certain conditions, the patient's breathing effort may cause continuous low pressure alarms, even when the Low Pressure Alarm is carefully set. If this occurs, contact your clinician immediately for guidance.

- Repeat the low pressure alarm setting procedure whenever you change, replace, remove or reconnect components of the patient circuit, or when you change the ventilator's parameters.

- If you are using an HME with your ventilator, you must periodically re-adjust the low pressure alarm setting. Contact your clinician to determine the appropriate interval.

- Some patient circuit components may prevent low pressure alarms when the low pressure limit is not carefully set.

Follow these instructions for setting the low pressure alarm:

1. Check to make sure that the patient circuit is assembled exactly as it will be used by the patient. Attach all accessories, including the HME and inner cannula of the tracheostomy tube.

2. Verify that all of the ventilator's parameters are set to the prescribed values. Adjust them if necessary. See *Adjusting Setting Parameters* in Section 6.

3. Press VENTILATE to start breath delivery.

4. Press START/ENTER to display current settings.

5. Press LOW PRESSURE to select the low pressure parameter.

6. Adjust the LOW PRESSURE setting by pressing the up or down arrow on the control panel.

7. After each adjustment, allow the ventilator to complete two breath cycles. It takes two breath cycles for the alarm to sound.
    If you do not hear the low pressure alarm (5 audible pulses), repeat steps 6-7.

8. Stop adjusting the LOW PRESSURE setting when you hear the low pressure alarm. The low pressure alarm is set.

4.22   Configuring for Assist/Control Ventilation

- **Risk of change from Assist/Control Volume Ventilation to Assist/Control Pressure ventilation:** If the ventilator is operating in Assist/Control Volume ventilation and the MODE button is pressed, the setting display will show "Assist/Control Pressure" using whatever the last pressure support value setting was (such as the Pressure Support value set for SIMV or SPONT.) If the START/ENTER button is pressed while this Assist/Control Pressure display is present, the ventilator will switch to operating in Assist/Control Pressure. Therefore, **do not** press START/ENTER unless you intend to change to A/C Pressure ventilation and you have verified that the ventilator is set to the correct pressure.

- To eliminate the possibility of an accidental change in ventilator parameters by an inadvertent START/ENTER entry, you should set the Pressure Support values to zero ("0") before placing the ventilator into the Assist/Control Volume ventilation mode. Follow the instructions below.

1. Press the MODE button.

2. Press the SPONT button. (10 BPM back-up rate will be displayed.) Press START/ENTER.

3. If Pressure Support is present, use the arrow buttons to set it to zero ("0"). Press START/ENTER to accept the setting.

4. Press MODE.

5. Press the SIMV button to select SIMV mode. Press START/ENTER.

6. If Pressure Support is present, use the arrow buttons to set it to zero ("0"). Press START/ENTER to accept the setting.

7. Press MODE.

8. Press the A/C button to select A/C mode. Press START/ENTER.

9. If a pressure value is present, use the arrow buttons to set the pressure to zero ("0"), then press START/ENTER.

Check - Out

5.1   Completing the User Self Test

Before connecting the patient, it is important to test the ventilator to make sure that it's pneumatic system is working properly. It is recommended that the User Self Test be conducted:

- Before initial use

- Once per month

- Each time you remove or replace the patient circuit

Warning

- Do not conduct this test while the patient is connected to the ventilator. Switch the patient to an alternate means of ventilation before conducting this test.

- To reduce the risk of infection, be sure to wash your hands thoroughly before and after handling the ventilator or its accessories.

NOTE:

Nellcor Puritan Bennett recommends that you run the User Self Test before initial use, once per month while the ventilator is in use, and each time you remove or replace the patient circuit. Nellcor Puritan Bennett recognizes that the protocol for running the User Self Test varies widely among health care providers. It is not possible for Nellcor Puritan Bennett to specify or require specific practices that will meet all needs, or to be responsible for the effectiveness of those practices.
---

1. Press and hold the STANDBY button for three (3) seconds to put the ventilator in Standby mode.

2. Press the MENU/ESC button. The following text will appear in the display:

   Press ENTER to begin User Self Test.

3. Press the START/ENTER button. The following text will appear in the display:

   Occlude patient end of breathing circuit.

4. Block the part of the exhalation manifold that connects to the patient, as illustrated in Figure 5-1. Make sure that you have a tight seal and do not let any air escape. The following message will be displayed:

   Press ENTER when ready to begin test.

Figure 5-1. Blocking the Exhalation Manifold

5. Keep your seal on the exhalation manifold and press the START/ENTER button. The ventilator will push air into the circuit as it runs the test.

Once the test is completed, you will see one of four messages in the display window. Refer to Table 5-2 for a listing of the display messages and appropriate responses.

Table 5-2: User Self Test Results

If the ventilator displays...	It Means...	Do this...
TEST PASSED. ENTER: repeat ESC: exit	The ventilator passed the User Self Test.	• Press START/ENTER if you wish to repeat the test. • Press MENU/ESC to end the test. The ventilator will remain in Standby mode.
Test ERROR. Refer to MANUAL.	The test was not conducted properly.	• Press ALARM SILENCE/RESET to cancel the test. The display will indicate that the test failed. • Check all connections in the patient circuit. Press START/ENTER to repeat the test.
Leak Test FAILED. Refer to MANUAL	There is a leak in the patient circuit between the patient air port and the exhalation manifold.	• Press ALARM SILENCE/RESET to cancel the test. The display will indicate that the test failed. • Press START/ENTER to repeat the test. • If the ventilator fails the test again, connect a new patient circuit and retry. • If the ventilator fails after connecting a new patient circuit, contact your equipment supplier or Nellcor Puritan Bennett.
Relief Valve Test FAILED. Refer to MANUAL	The ventilator's relief valve did not function properly.	• Press ALARM SILENCE/RESET to cancel the test. The display will indicate that the test failed. • Press START/ENTER to repeat the test. • If the ventilator fails the test again, contact your equipment supplier or Nellcor Puritan Bennett.

If the ventilator fails the User Self Test, do not use it. Contact your equipment supplier or Nellcor Puritan Bennett.

5.2   Testing the Ventilator's Alarms

Before connecting to the patient, conduct the following tests to make sure the ventilator's alarm functions are working properly.

- Do not attempt to conduct ventilator alarm tests while the patient is connected to the ventilator. Provide an alternate means of ventilation during testing.

- If the ventilator fails the alarm test or if you cannot complete the test, refer to the Troubleshooting section of this manual or call your equipment supplier or Nellcor Puritan Bennett.

While the ventilator is in Standby, press START/ENTER to check the ventilator's settings. The initial settings for these tests are:

Breath Rate: 12 BPM (breaths per minute)

High Pressure: 80 cm H_2O

Low Pressure: 3 cm H_2O

Volume: 500 ml

Inspiratory Time: 1.0 seconds

FIO_2: 21 percent

Ventilation Mode: Assist/Control

Make sure your ventilator is set to these settings before proceeding with the alarm tests.

NOTE:

Unless otherwise stated, you should put the ventilator in Standby mode before beginning each of these tests.

Most of these tests require that an approved patient circuit be connected to the ventilator. Make sure your patient circuit is properly connected prior to conducting these tests.

5.2.1   Low Pressure Test

1. Adjust the Volume setting to 500 ml, Inspiratory Time to 0.4 seconds, and the Low Pressure Alarm to 5 cm H_2O.

2. Keeping the patient end of the breathing circuit open, allow the ventilator to deliver three (3) consecutive breaths. At the beginning of the inspiration of the third breath, verify that:

    - the LED for the low pressure alarm lights up,

    - the LCD display indicates that a Low Pressure Alarm has occurred,

    - the audible alarm sounds.

3. Press and hold the START/ENTER button for three (3) seconds. The ventilator will switch to Standby mode.

4. Press ALARM/RESET to reset the alarm.

5.2.2   Apnea Test

1. Adjust the Volume setting to 500 ml, Inspiratory Time to 0.5 seconds, and the Breath Rate to 5 BPM.

2. Press and hold the VENTILATE button for one (1) second to begin ventilation. The ventilator will deliver a mandatory breath.

3. Before the second mandatory breath is delivered, verify that:

    •   the LED for the low pressure alarm lights up,

    •   the LCD display indicates that an Apnea Alarm has occurred,

    •   the audible alarm sounds.

4. Press and hold the START/ENTER button for three (3) seconds. The ventilator will switch to Standby mode.

5. Press ALARM/RESET to reset the alarm.

5.2.3   Power Failure Test

NOTE:
>   If the ventilator is operating on either the external or internal battery, you must plug it in to an AC power source before beginning this test.

1. Press and hold the VENTILATE button to begin ventilation.

2. Unplug the ventilator. Verify that:

    •   the Power Switchover LED lights up,

    •   the LCD display indicates that the AC power source is not powering the ventilator,

    •   the LED power-source indicator also indicates that the ventilator is not receiving AC power,

    •   the audible alarm sounds.

3. Press and hold the START/ENTER button for three (3) seconds. The ventilator will switch to Standby mode.

4. Press ALARM/RESET to reset the alarm.

5.2.4 Continuing Pressure (Valley) Test

1. Adjust the Volume setting to 200 ml and Inspiratory Time to 0.5 seconds.

2. Connect the patient-end of the patient circuit to a 1-liter elastic bag. (Verify that the pressure tube of the patient circuit is properly connected to the appropriate fitting on both the ventilator and the proximal pressure port.)

3. Block the exhalation port of the breathing circuit's exhalation valve. See Figure 5-1.

4. Press and hold the VENTILATE button for one (1) second to begin ventilation.

5. Allow the ventilator to deliver four (4) consecutive breaths. At the beginning of the fourth breath, verify that:

   • the LED for the Low Pressure Alarm lights up,

   • the LCD display indicates that a Valley Alarm has occurred,

   • the audible alarm sounds.

6. Unblock the exhalation port.

7. Press and hold the START/ENTER button for three (3) seconds to switch the ventilator to Standby mode.

8. Press ALARM/RESET to reset the alarm.

5.2.5 High Pressure Test

1. Adjust the Volume setting to 500 ml, Inspiratory Time to 0.4 seconds, and the High Pressure Alarm to 50 cm H_2O.

2. Press and hold the VENTILATE button for one (1) second to begin ventilation.

3. Keeping the patient end of the breathing circuit open, allow the ventilator to deliver one (1) breath.

4. During the inspiratory phase of the next breath, block the patient end of the breathing circuit. Verify that:

   • the LED for the high pressure alarm lights up,

   • the LCD display indicates that a High Pressure Alarm has occurred,

   • the audible alarm sounds.

5. Unblock the exhalation port.

6. Press and hold the START/ENTER button for three (3) seconds to switch the ventilator to Standby mode.

7. Press ALARM/RESET to reset the alarm.

This concludes the monthly safety check.

5.3   Testing the Battery

The ventilator is capable of testing the power of the battery it is currently using. You can determine which power source the ventilator is using by checking the power indicator, located on the top panel. The indicator light will be lit to indicate which power source is currently being used.

NOTE:
    The TEST BATTERY button does not operate when the ventilator is powered by AC.

To test the battery, press and hold the TEST BATTERY button. The needle on the PATIENT PRESSURE meter will indicate the battery charge status for the battery it is currently using.

A fully charged battery, in good condition, will register approximately 100% on the patient pressure meter's scale.

5.4   Monthly Safety Check

The following safety check should be performed prior to using the ventilator with a patient, and monthly while the ventilator is in use, to make sure the ventilator is operating properly. This safety check takes approximately ten minutes to complete.

Warning

- Do not conduct this test while the patient is connected to the ventilator. You should use an alternate means of ventilation while you are conducting this test.

- If the ventilator fails the monthly safety check or if you cannot complete this check, refer to the Troubleshooting section of this manual or call the equipment supplier, or Nellcor Puritan Bennett.

- To reduce the risk of infection, be sure to wash your hands thoroughly before and after handling the ventilator or its accessories.

NOTE:

Nellcor Puritan Bennett recommends that you run the Monthly Safety Check once per month while the ventilator is in use. Nellcor Puritan Bennett recognizes that the protocol for running the Monthly Safety Check varies widely among health care providers. It is not possible for Nellcor Puritan Bennett to specify or require specific practices that will meet all needs, or to be responsible for the effectiveness of those practices.

1. **Visual Inspection**

   Inspect the device. Make sure that:

   – The power cord does not have any kinks, breaks or damaged insulation.

   – The connectors, rubber feet, filter housings, etc. are not loose or broken.

   – The outer casing does not have any dents or scratches which may indicate dropping or other damage.

   – All of the labels and markings on the ventilator are clear and legible.

2. **User Self Test**

    See "Completing the User Self Test" on page 1.

3. **General Alarm Test**

   Press and hold the ALARM SILENCE/RESET button for five (5) seconds. You should see all of the alarm indicators light up and hear an alarm tone. If not, the ventilator is in need of repair. Do not use the ventilator until the problem has been corrected.

4. **High/Low Pressure Alarm Test**

While the ventilator is connected to AC power, and with a complete patient circuit attached, follow these steps to test the high and low pressure alarms:

   a. Set the ventilator mode to ASSIST/CONTROL (A/C). Press VENTILATE.

   b. Block the patient end of the patient circuit. It is important that you make a tight seal and do not let any air escape. This will force the air pressure to build up in the patient circuit, causing a high pressure alarm.
   At the next breath, the ventilator should sound a high pressure alarm. You will hear three (3) pulses of the alarm tone and will see the HIGH PRESSURE indicator light flash.

   c. Unblock the end of the patient circuit. Press ALARM SILENCE/RESET to reset the high pressure alarm.

d. Allow the ventilator to complete two to three (2 - 3) breath cycles. A low pressure alarm should occur. You will hear five (5) pulses of the alarm tone and will see the LOW PRESSURE indicator light flash.
Press ALARM SILENCE/RESET to reset the low pressure/apnea alarm.

e. Press and hold STANDBY for three (3) seconds to put the ventilator in Standby mode. This concludes the monthly safety check.

Operating the Ventilator

6.1 Turning on the Ventilator

Open the front door panel. Press the START/ENTER button. The current parameters will be displayed in the LCD screen. The ventilator will be in Standby Mode.

Check the parameters to make sure they agree with the prescribed settings. If the parameters are incorrectly set, adjust them at this time. See *Adjusting Setting Parameters* below.

6.2 Displaying Settings

While the ventilator is in Standby Mode - that is, while it is not ventilating - display settings by pressing START/ENTER.

While the ventilator is ventilating, the LCD window displays the actual values of the breaths being delivered. To check the settings during ventilation, press START/ENTER. The setting values will be displayed in the LCD window for approximately four to five (4 - 5) breath cycles. After this interval, the LCD will revert to displaying actual patient values.

NOTE:

Certain settings, such as low pressure and high pressure alarm settings, do not have an actual value and dashes (---) are displayed instead.

6.3 Adjusting Setting Parameters

Warning

• Never press the START/ENTER button without verifying that the settings are adjusted appropriately. Using incorrect settings during ventilation can cause danger to the patient.

---

1. Open the front door panel. Press the START/ENTER button to display the current settings.

2. Press the parameter button for the setting you wish to change. The current setting for that parameter will begin to flash in the LCD screen.

3. Use the up or down arrow button to adjust the setting's value.

4. When the setting's value matches the physician's prescribed value, press START/ENTER to accept the setting.

6.4 Starting Ventilation

> **Warning**
>
> • You must start the ventilator and allow it to complete one full breath cycle prior to connecting the patient. Do not connect the patient before this cycle completes.
>
> • Always verify that all settings are set appropriately before starting ventilation.

NOTE:

If you are powering the ventilator with the external battery or the ventilator's internal battery, the ventilator will require a warm-up period (approximately seven (7) seconds) before starting ventilation. You must wait until the ventilator's LCD displays the settings; this indicates the ventilator is ready. Pressing VENTILATE prior to the completion of this warm-up period will cause the ventilator to power down.

Press VENTILATE to start ventilation. You will hear the piston inside of the ventilator begin to move.

As ventilation begins, check the following:

• The lights on the ventilator's display become lit and the alarm sounds. If this does not occur, the ventilator needs repair. Do not use the ventilator; contact the equipment supplier or Nellcor Puritan Bennett for assistance.

• The pressure trigger and altitude settings agree with the physician's prescribed settings.

Allow the ventilator to complete one full breath cycle before connecting the patient. This breath cycle allows the ventilator's microprocessor to establish its reference point; that is, the operating mode and settings to use. This prevents delivery of incorrect volumes that could result in excessive pressure build-up. Each time you hear the ventilator's piston begin to move, it is the beginning of a breath cycle. When the piston becomes silent, it the end of a breath cycle.

6.5 Stopping Ventilation (Standby mode)

Disconnect the ventilator from the patient. Press and hold the STANDBY button for at least three (3) seconds. You will hear a beep and ventilation will stop. The following text will appear in the display:

STANDBY: Press ENTER to view parameters

In Standby mode, the ventilator does not deliver air to the patient.

NOTE:

The ventilator can be kept in Standby mode indefinitely while connected to AC power. While on Standby, the ventilator charges the internal battery, and the power indicators (AC and Battery Charging) are lit. When powered from a battery, the ventilator will remain in Standby for 30 seconds and then switch automatically to a low power mode, in which the display will be blank. Press the START/ENTER button to bring the ventilator out of low power mode.

6.6   Sensitivity and adjustment

By default, Achieva ventilator uses flow to trigger patient-initiated breaths. The ventilator can also be set to trigger on both flow and pressure. Flow triggering is always active. (Pressure triggering may result in quicker response to low-flow patient demand.) If the ventilator is set to trigger on both flow and pressure, it will respond to the threshold that is reached first. When using PEEP, set the Pressure Trigger, along with the sensitivity setting (Flow Trigger). See "Pressure trigger" on page 3.

6.7   Changing modes

When beginning ventilation in any particular mode, the settings in effect the last time that mode was used are saved. Before starting ventilation again or when switching to a different mode of ventilation, check the values for all parameters.

6.8   Flow trigger

Use the SENSITIVITY parameter to set the amount of flow the patient must generate before the ventilator will deliver a patient-triggered breath. The SENSITIVITY parameter range is 3 to 25 LPM (liters per minute) in increments of 1 LPM. The breath will be delivered to the patient when flow is within ±0.5 LPM of the SENSITIVITY setting.

To set flow sensitivity:

1. If the settings are not displayed, press START/ENTER. The settings will appear on the display.

2. Press the SENSITIVITY switch. The displayed setting will begin to flash.

3. Use the up and down arrow keys to select the flow, in liters per minute.

4. When the prescribed value is displayed, press the START/ENTER switch to accept the setting.

6.9   Pressure trigger

The pressure trigger can be set to OFF, or 1 to 15 cmH$_2$O (in increments of 1 cmH$_2$O) below the baseline pressure. When using PEEP, use Pressure trigger, along with the sensitivity setting (Flow Trigger). See "Flow trigger" on page 3.

To set the pressure trigger level:

1. Press the MENU/ESC switch. The display shows the first menu item.

2. Use the up and down arrows to scroll to the message:

    Press ENTER to change
    pressure trigger

3. Press the START/ENTER switch.

    The display shows the message:

    Trigger Level: XXX
    UP/DN: change ENTER: keep

4. Use the up and down arrow keys to select the prescribed pressure trigger level.

5. Press START/ENTER to accept the setting.

6.10   Altitude setting

Changes in barometric pressure can affect the operation of the Achieva PSO$_2$ ventilator's oxygen blender. Each ventilator must be set for the altitude of the location where it will be used. The altitude can be set from 0 feet (0 meters) to 14,760 feet (4500 meters), in increments of 100 meters (328 feet).

To set or change the altitude setting:

1. Press the MENU/ESC switch.

   The display shows the first menu item.

2. Use the up and down arrows to scroll to the message:

   Press ENTER to change operating altitude

3. Press the START/ENTER switch.

   The display shows the message:

   Altitude: XXXX m   XXXXX ft

   UP/DN: change ENTER: keep

4. Use the up and down arrow keys to select the prescribed altitude setting.

5. Press START/ENTER to accept the setting.

6.11 Limiting inspiratory flow (Flow acceleration)

For using pressure-based breaths in pressure-supported and pressure-control, you can set the ventilator to limit the inspiratory flow rate. The flow acceleration can be turned on or off. When flow acceleration is off, the ventilator delivers maximum flow with relatively little pressure integration. When Flow Acceleration is on, the flow is limited to 180 lpm maximum.

Warning

The clinician must be aware that limiting flow below the patient's inspiratory demand will limit airway pressure and may prevent adequate ventilation. Close monitoring of patient parameters is essential to ensure that the patient is adequately ventilated.

To set inspiratory flow limitation:

1. Press the MENU/ESC key.

2. Press the up or down arrow keys until the display shows the message: Press ENTER to change flow acceleration

3. Press the START/ENTER key. The display shows the current setting: Flow acceleration: OFF UP/ DN: change ENTER: keep

4. Use the up and down arrow keys to enable ("ON") or disable ("OFF") flow acceleration.

5. Press START/ENTER to accept the setting.

6.12 Expiratory sensitivity

The expiratory sensitivity level is a percentage of peak flow at which a pressure-supported breath will be terminated. The expiratory sensitivity level has settings of 15% to 55% in 10% increments. To set the expiratory sensitivity:

1. Press the MENU/ESC key.

2. Press the up or down arrow keys until the display shows the message: Press ENTER to set Expiratory Sensitivity

3. Press the ENTER key.

4. Use the up or down arrow keys to change the expiratory sensitivity level in 10% increments.

5. Press ENTER to accept the setting.

6.13 Assist/Control mode, volume breaths

To operate the ventilator in Assist/Control mode, delivering breaths of a selected volume:

1. Press MENU/ESC to enter the ventilator's menu system.

2. Set pressure trigger level (see Pressure trigger on page 6-3); flow acceleration (see Flow acceleration on page 5-7); operating altitude (see Altitude setting on page 6-3); and/or alarm latching (see Latching and non-latching on page 6-4) from the menu, as needed.

3. From standby, press START/ENTER to display the parameters.

4. Set MODE to A/C.

5. Set PRESSURE to 0.

6. Set the prescribed VOLUME.

7. Set the prescribed INSPIRATORY TIME.

8. Set the inspiratory SENSITIVITY to an appropriate level.

9. Set the BREATH RATE.

10. Set PEEP as required.

11. Set the LOW PRESSURE and HIGH PRESSURE alarm levels. See "Setting the low pressure alarm" on page 29.

12. If required, set F_IO_2 (available only on Achieva PSO$_2$).

13. Press VENTILATE to begin breath delivery.

6.14 Assist/Control mode, pressure controlled

Warning

For patients with respiratory failure conditions ventilated in the pressure-controlled or pressure-supported modes, the physician must determine at what level the patient may require an alternate means of monitoring effective ventilation.

To operate the ventilator in Assist/Control mode, pressure controlled:

1. Press MENU/ESC to enter the ventilator's menu system.

2. Set pressure trigger level (see Pressure trigger on page 6-3); flow acceleration (see Flow acceleration on page 5-7); operating altitude (see Altitude setting on page 6-3); and/or alarm latching (see Latching and non-latching on page 6-4) from the menu, as needed.

3. From standby, press START/ENTER to display the parameters.

4. Set MODE to A/C.

5. Set VOLUME to 0.

6. Set PRESSURE to the level prescribed (greater than 0). Volume will not be displayed.

7. Set the inspiratory SENSITIVITY to an appropriate level.

8. Set the BREATH RATE.

9. Set INSPIRATORY TIME for the period the ventilator must maintain the pressure.

10. Set PEEP as required.

11. Set the LOW PRESSURE and HIGH PRESSURE alarm levels. See "Setting the low pressure alarm" on page 29.

12. If required, set F$_1$O$_2$ (available only on Achieva PSO$_2$).

13. Press VENTILATE to begin breath delivery.

6.15   SIMV mode with pressure support

> **Warning**
>
> For patients with respiratory failure conditions ventilated in the pressure-controlled or pressure-supported modes, the physician must determine at what level the patient may require an alternate means of monitoring effective ventilation.

To operate the ventilator in SIMV mode with pressure support (Achieva PS and PSO$_2$ only):

1. Press MENU/ESC to enter the ventilator's menu system.

2. Set pressure trigger level; flow acceleration; Expiratory sensitivity; operating altitude; and/ or alarm latching from the menu, as needed.

3. From standby, press START/ENTER to display the parameters.

4. Set MODE to SIMV.

5. Set the prescribed VOLUME.

6. Set the prescribed INSPIRATORY TIME.

7. Set the inspiratory SENSITIVITY to an appropriate level.

8. Set the BREATH RATE for the prescribed number of volume breaths per minute. All other breaths delivered will be pressure-supported breaths.

9. Set both PRESSURE and PEEP to the prescribed level of pressure support.

10. Set the LOW PRESSURE and HIGH PRESSURE alarm levels. See "Setting the low pressure alarm" on page 29.

11. If required, set F$_1$O$_2$ (available only on Achieva PSO$_2$).

12. Press VENTILATE to begin breath delivery.

NOTE: If in SMIV mode with Pressure Support and PEEP while using the Passy-Muir Valve, you may get a setting error with Volume Error displayed. To avoid this error, turn off Pressure Support and PEEP when using the Passy-Muir Valve.

6.16   SIMV mode with CPAP

To operate the ventilator in SIMV mode with CPAP:

1. Press MENU/ESC to enter the ventilator's menu system.

2. Set pressure trigger level; flow acceleration; Expiratory sensitivity; operating altitude; and/ or alarm latching from the menu, as needed.

3. From standby, press START/ENTER to display the parameters.

4. Set MODE to SIMV.

5. Set the prescribed VOLUME.

6. Set the prescribed INSPIRATORY TIME.

7. Set SENSITIVITY to an appropriate level.

8. Set the BREATH RATE to the prescribed number of volume breaths per minute. All other breaths delivered will be CPAP supported breaths.

9. Set PRESSURE support to 0.

10. Set PEEP to the prescribed level of CPAP.

11. Set the LOW PRESSURE and HIGH PRESSURE alarm levels.   See "Setting the low pressure alarm" on page 29.

12. If required, set F_IO_2 (available only on Achieva PSO$_2$).

13. Press VENTILATE to begin breath delivery.

6.17   Spontaneous mode with pressure support

To operate the ventilator in spontaneous mode with pressure support (Achieva PS and Achieva PSO$_2$):

1. Press MENU/ESC to enter the ventilator's menu system.

2. Set pressure trigger level; flow acceleration; Expiratory sensitivity; operating altitude; and/ or alarm latching from the menu, as needed.

3. From standby, press START/ENTER to display the parameters.

4. Set MODE to SPON.

5. Set the inspiratory sensitivity to an appropriate level.

6. Set pressure support to the prescribed level (greater than 0).

7. Set PEEP as required.

8. Set the low pressure and high pressure alarm levels. see Setting the low pressure alarm on page 4-29.

9. If required, set F_IO_2 (available only on Achieva PSO$_2$).

10. Press VENTILATE to begin breath delivery.

NOTE: If in Spontaneous mode with Pressure Support and PEEP, and with Oxygen bleed-in and using in-line Nebulizer, the Achieva may go into Apnea back-up mode due to the amount of flow going through the circuit, which meets demand of patient. But the ventilator may not detect patient effort. If this occurs, turn off Apnea back-up when giving Nebulizer treatment.

6.18   Spontaneous mode with CPAP

To operate the ventilator in Spontaneous mode with CPAP (Achieva PS and Achieva PSO$_2$ only):

1. Press MENU/ESC to enter the ventilator's menu system.

2. Set pressure trigger level; flow acceleration; Expiratory sensitivity; operating altitude; and/ or alarm latching from the menu, as needed.

3. From standby, press START/ENTER to display the parameters.

4. Set MODE to SPON.

5. Set the inspiratory SENSITIVITY to an appropriate level.

6. Set PRESSURE to 0.

7. Set PEEP to the level of CPAP required.

8. Set the LOW PRESSURE and HIGH PRESSURE alarm levels. See "Setting the low pressure alarm" on page 29.

9. If required, set F_IO_2 (available only on Achieva PSO$_2$).

10. Press V<small>ENTILATE</small> to begin breath delivery.

6.19 Ventilation modes and apnea

In Assist/Control mode with B<small>REATH</small> R<small>ATE</small> settings of less than 6 BPM, the ventilator will sound an apnea alarm if no patient effort occurs for 10 ±1 second. During an apnea alarm, the ventilator delivers controlled breaths at a rate of 10 BPM. If the patient initiates a spontaneous breath, the ventilator will stop the controlled breaths and return to the previous operating parameters.

In SIMV mode with B<small>REATH</small> R<small>ATE</small> settings of less than 6 BPM, the ventilator will sound an apnea alarm if no patient effort occurs for 20 ±1 second. During an apnea alarm, the ventilator delivers controlled breaths at a rate of 10 BPM. If the patient initiates a spontaneous breath, the ventilator will stop the controlled breaths and return to the previous operating parameters.

In Spontaneous mode (Achieva PS and Achieva PSO$_2$ only), the user may choose to activate an optional apnea back-up rate, so that the ventilator will automatically begin to deliver breaths at 10 BPM if no patient effort occurs for 20 ±1 seconds. Upon choosing Spontaneous mode the alphanumeric display will show the option to enter back-up rate. Use the up and down arrows to select "Y" or "N". The pressure setting during the spontaneous back-up mode is equal to the Pressure Support setting before the apnea condition began, and the I:E ratio is 1:2. If the patient initiates a spontaneous breath while the back-up rate option is in effect, the ventilator will return to the previous operating parameters.

If the back-up rate option is not chosen, the ventilator will sound an apnea alarm if no breath is triggered by the patient in 20 seconds.

6.20 Monthly safety check

Perform this check at least monthly while the ventilator is in use.

> **Warning**
>
> Throughout this check, the ventilator must be disconnected from the patient. Provide another means of ventilation.

1. Perform a visual inspection of the device. Make sure that:

   - The power cord does not have any kinks, breaks or damaged insulation.

   - The connectors, rubber feet, filter housings, etc. are not loose or broken.

   - The outer casing has no dents or scratches which may indicate dropping or other abuse.

   - All the labels and markings on the ventilator are clear and legible.

   - This visual inspection should be performed each time the ventilator is used after storage as well as periodically during normal use. If the ventilator does not pass the inspection, provide an alternate means of ventilation and contact your equipment supplier or Puritan Bennett Technical Support at (800) 497-3787.

2. Perform a user self test. See *User Self-test* in this manual section.

3. Test the audible alarm and the indicator lights. Press and hold the A<small>LARM</small> S<small>ILENCE</small>/R<small>ESET</small> switch (while an alarm condition does not exist) for at least five seconds. The audible alarm must sound and all the ventilator's indicator lights must light.

4. Connect a patient circuit to the ventilator. Connect the ventilator to AC power.

5. Set the ventilator mode to Assist/Control (A/C). Press V<small>ENTILATE</small>.

6. Block the end of the patient circuit. It is important that you make a tight seal and do not let any air escape.

> **Warning**
>
> A ventilator patient is highly susceptible to respiratory infections. Dirty or infected equipment may be a source of infection. Clean equipment is essential for successful ventilation. Be sure to wash your hands thoroughly before and after contact with the patient circuit.

At the next attempt to deliver a breath, a HIGH PRESSURE alarm must occur.

7. Unblock the end of the patient circuit. Press ALARM SILENCE/RESET to reset the High Pressure alarm.

8. A LOW PRESSURE/APNEA alarm must occur after two or three breath cycles.

9. Press and hold (for at least three seconds) the STANDBY switch to put the ventilator in Standby mode. Press the ALARM SILENCE/RESET switch to reset the Low Pressure/Apnea alarm.

This concludes the Monthly Safety Check.

> **Warning**
>
> If the ventilator fails the monthly safety check or you cannot complete this check, refer to the Troubleshooting Chapter of this manual, or call your equipment supplier or Puritan Bennett.

6.21   Menu selections

The following items are set from the menu. To access the menu, press the MENU/ESC switch.

Menu Function	Description
User Self-Test	Tests the ventilator systems.
Pressure Trigger	The Pressure Trigger menu allows the clinician to enable or disable pressure triggering.
Flow acceleration	Limits the inspiratory flow rate.
Expiratory Sensitivity	Settings of 15 to 55% in 10% increments.
Operating Altitude	Sets the operating altitude in meters and feet.
Alarm Latching Status	A latching alarm requires the caregiver to press Alarm Silence/Reset to reset the audible alarm. A non latching alarm will be silenced when the alarm condition is corrected.
Ventilating Hours Since Last Maintenance	The ventilator hours menu displays the number of operating hours on the ventilator since the last preventive maintenance.
Date and Time	Sets date and time.
Local Data Transfer	Direct connection from ventilator to computer for direct download of information.
Remote Data Transfer	Modem connection from ventilator to computer via an internal (see Achieva PS and Achieva PSO$_2$) or external modem.

Menu Function	Description
Software Version	Displays the version of software in the ventilator.

6.22   User self-test

Before connecting the patient, it is important to test the ventilator to make sure that it's pneumatic system is working properly. It is recommended that the User Self Test be conducted:

- Before initial use

- Once per month

- Each time you remove or replace the patient circuit

Warning

- Do not conduct this test while the patient is connected to the ventilator. Switch the patient to an alternate means of ventilation before conducting this test.

- To reduce the risk of infection, be sure to wash your hands thoroughly before and after handling the ventilator or its accessories.

NOTE:

Nellcor Puritan Bennett recommends that you run the User Self Test before initial use, once per month while the ventilator is in use, and each time you remove or replace the patient circuit. Nellcor Puritan Bennett recognizes that the protocol for running the User Self Test varies widely among health care providers. It is not possible for Nellcor Puritan Bennett to specify or require specific practices that will meet all needs, or to be responsible for the effectiveness of those practices.

1. Press and hold the STANDBY button for three (3) seconds to put the ventilator in Standby mode.

2. Press the MENU/ESC button. The following text will appear in the display:

    Press ENTER to begin User Self Test.

3. Press the START/ENTER button. The following text will appear in the display:

    Occlude patient end of breathing circuit.

4. Block the part of the exhalation manifold that connects to the patient, as illustrated in Figure 6-1. Make sure that you have a tight seal and do not let any air escape. The following message will be displayed:

    Press ENTER when ready to begin test.

Figure 6-1. Blocking the Exhalation Manifold

5. Keep your seal on the exhalation manifold and press the START/ENTER button. The ventilator will push air into the circuit as it runs the test.

   Once the test is completed, you will see one of four messages in the display window. Refer to Table 6-2 for a listing of the display messages and appropriate responses.

Table 6-2: User Self Test Results

If the ventilator displays...	It Means...	Do this...
TEST PASSED. ENTER: repeat ESC: exit	The ventilator passed the User Self Test.	• Press START/ENTER if you wish to repeat the test. • Press MENU/ESC to end the test. The ventilator will remain in Standby mode.
Test ERROR. Refer to MANUAL.	The test was not conducted properly.	• Press ALARM SILENCE/RESET to cancel the test. The display will indicate that the test failed. • Check all connections in the patient circuit. Press START/ENTER to repeat the test.
Leak Test FAILED. Refer to MANUAL	There is a leak in the patient circuit between the patient air port and the exhalation manifold.	• Press ALARM SILENCE/RESET to cancel the test. The display will indicate that the test failed. • Press START/ENTER to repeat the test. • If the ventilator fails the test again, connect a new patient circuit and retry. • If the ventilator fails after connecting a new patient circuit, contact your equipment supplier or Nellcor Puritan Bennett.
Relief Valve Test FAILED. Refer to MANUAL	The ventilator's relief valve did not function properly.	• Press ALARM SILENCE/RESET to cancel the test. The display will indicate that the test failed. • Press START/ENTER to repeat the test. • If the ventilator fails the test again, contact your equipment supplier or Nellcor Puritan Bennett.

> **Warning**
>
> If the ventilator fails the User Self Test, do not use it. Contact your equipment supplier or Nellcor Puritan Bennett.

6.23   Testing the Ventilator's Alarms

Before connecting to the patient, conduct the following tests to make sure the ventilator's alarm functions are working properly.

> **Warning**
>
> • Do not attempt to conduct ventilator alarm tests while the patient is connected to the ventilator. Provide an alternate means of ventilation during testing.
>
> • If the ventilator fails the alarm test or if you cannot complete the test, refer to the Troubleshooting section of this manual or call your equipment supplier or Nellcor Puritan Bennett.

While the ventilator is in Standby, press START/ENTER to check the ventilator's settings. The initial settings for these tests are:

Breath Rate: 12 BPM (breaths per minute)

High Pressure: 80 cm H_2O

Low Pressure: 3 cm H_2O

Volume: 500 ml

Inspiratory Time: 1.0 seconds

FIO_2: 21 percent

Ventilation Mode: Assist/Control

Make sure your ventilator is set to these settings before proceeding with the alarm tests.

> **NOTE:**
>
> Unless otherwise stated, you should put the ventilator in Standby mode before beginning each of these tests.
>
> Most of these tests require that an approved patient circuit be connected to the ventilator. Make sure your patient circuit is properly connected prior to conducting these tests.

6.23.1   Low Pressure Test

1. Adjust the Volume setting to 500 ml, Inspiratory Time to 0.4 seconds, and the Low Pressure Alarm to 5 cm H_2O.

2. Keeping the patient end of the breathing circuit open, allow the ventilator to deliver three (3) consecutive breaths. At the beginning of the inspiration of the third breath, verify that:

    • the LED for the low pressure alarm lights up,

    • the LCD display indicates that a Low Pressure Alarm has occurred,

    • the audible alarm sounds.

3. Press and hold the START/ENTER button for three (3) seconds. The ventilator will switch to Standby mode.

4. Press ALARM/RESET to reset the alarm.

6.23.2   Apnea Test

1. Adjust the Volume setting to 500 ml, Inspiratory Time to 0.5 seconds, and the Breath Rate to 5 BPM.

2. Press and hold the VENTILATE button for one (1) second to begin ventilation. The ventilator will deliver a mandatory breath.

3. Before the second mandatory breath is delivered, verify that:

   • the LED for the low pressure alarm lights up,

   • the LCD display indicates that an Apnea Alarm has occurred,

   • the audible alarm sounds.

4. Press and hold the START/ENTER button for three (3) seconds. The ventilator will switch to Standby mode.

5. Press ALARM/RESET to reset the alarm.

6.23.3   Power Failure Test

NOTE:
   If the ventilator is operating on either the external or internal battery, you must plug it in to an AC power source before beginning this test.

1. Press and hold the VENTILATE button to begin ventilation.

2. Unplug the ventilator. Verify that:

   • the Power Switchover LED lights up,

   • the LCD display indicates that the AC power source is not powering the ventilator,

   • the LED power-source indicator also indicates that the ventilator is not receiving AC power,

   • the audible alarm sounds.

3. Press and hold the START/ENTER button for three (3) seconds. The ventilator will switch to Standby mode.

4. Press ALARM/RESET to reset the alarm.

6.23.4 Continuing Pressure (Valley) Test

1. Adjust the Volume setting to 200 ml and Inspiratory Time to 0.5 seconds.

2. Connect the patient-end of the patient circuit to a 1-liter elastic bag. (Verify that the pressure tube of the patient circuit is properly connected to the appropriate fitting on both the ventilator and the proximal pressure port.)

3. Block the exhalation port of the breathing circuit's exhalation valve (see Figure 6).

4. Press and hold the VENTILATE button for one (1) second to begin ventilation.

5. Allow the ventilator to deliver four (4) consecutive breaths. At the beginning of the fourth breath, verify that:

    •   the LED for the Low Pressure Alarm lights up,

    •   the LCD display indicates that a Valley Alarm has occurred,

    •   the audible alarm sounds.

6. Unblock the exhalation port.

7. Press and hold the START/ENTER button for three (3) seconds to switch the ventilator to Standby mode.

8. Press ALARM/RESET to reset the alarm.

6.23.5 High Pressure Test

1. Adjust the Volume setting to 500 ml, Inspiratory Time to 0.4 seconds, and the Low Pressure Alarm to 50 cm H_2O.

2. Press and hold the VENTILATE button for one (1) second to begin ventilation.

3. Keeping the patient end of the breathing circuit open, allow the ventilator to deliver one (1) breath.

4. During the inspiratory phase of the next breath, block the patient end of the breathing circuit. Verify that:

    •   the LED for the high pressure alarm lights up,

    •   the LCD display indicates that a High Pressure Alarm has occurred,

    •   the audible alarm sounds.

5. Unblock the exhalation port.

6. Press and hold the START/ENTER button for three (3) seconds to switch the ventilator to Standby mode.

7. Press ALARM/RESET to reset the alarm.

This concludes the monthly safety check.

6.24 Testing the Battery

The ventilator is capable of testing the power of the battery it is currently using. You can determine which power source the ventilator is using by checking the power indicator, located on the top panel. The indicator light will be lit to indicate which power source is currently being used.

NOTE:

The TEST BATTERY button does not operate when the ventilator is powered by AC.

To test the battery, press and hold the TEST BATTERY button. The needle on the PATIENT PRESSURE meter will indicate the battery charge status for the battery it is currently using.

A fully charged battery, in good condition, will register approximately 100% on the patient pressure meter's scale.

6.25 Monthly Safety Check

The following safety check should be performed prior to using the ventilator with a patient, and monthly while the ventilator is in use, to make sure the ventilator is operating properly. This safety check takes approximately ten minutes to complete.

Warning

- Do not conduct this test while the patient is connected to the ventilator. You should use an alternate means of ventilation while you are conducting this test.
- If the ventilator fails the monthly safety check or if you cannot complete this check, refer to the Troubleshooting section of this manual or call the equipment supplier, or Nellcor Puritan Bennett.
- To reduce the risk of infection, be sure to wash your hands thoroughly before and after handling the ventilator or its accessories.

NOTE:

Nellcor Puritan Bennett recommends that you run the Monthly Safety Check once per month while the ventilator is in use. Nellcor Puritan Bennett recognizes that the protocol for running the Monthly Safety Check varies widely among health care providers. It is not possible for Nellcor Puritan Bennett to specify or require specific practices that will meet all needs, or to be responsible for the effectiveness of those practices.

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1. **Visual Inspection**

   Inspect the device. Make sure that:

   – The power cord does not have any kinks, breaks or damaged insulation.

   – The connectors, rubber feet, filter housings, etc. are not loose or broken.

   – The outer casing does not have any dents or scratches which may indicate dropping or other damage.

   – All of the labels and markings on the ventilator are clear and legible.

2. **User Self Test**

   See *Competing the User Self-test* in Section 5.

3. **General Alarm Test**

Press and hold the ALARM SILENCE/RESET button for five (5) seconds. You should see all of the alarm indicators light up and hear an alarm tone. If not, the ventilator is in need of repair. Do not use the ventilator until the problem has been corrected.

4. **High/Low Pressure Alarm Test**

While the ventilator is connected to AC power, and with a complete patient circuit attached, follow these steps to test the high and low pressure alarms:

a. Set the ventilator mode to ASSIST/CONTROL (A/C). Press VENTILATE.

b. Block the patient end of the patient circuit. It is important that you make a tight seal and do not let any air escape. This will force the air pressure to build up in the patient circuit, causing a high pressure alarm.
At the next breath, the ventilator should sound a high pressure alarm. You will hear three (3) pulses of the alarm tone and will see the HIGH PRESSURE indicator light flash.

c. Unblock the end of the patient circuit. Press ALARM SILENCE/RESET to reset the high pressure alarm.

d. Allow the ventilator to complete two to three (2 - 3) breath cycles. A low pressure alarm should occur. You will hear five (5) pulses of the alarm tone and will see the LOW PRESSURE indicator light flash.
Press ALARM SILENCE/RESET to reset the low pressure/apnea alarm.

e. Press and hold STANDBY for three (3) seconds to put the ventilator in Standby mode. This concludes the monthly safety check.

6.26   Alarm latching

Some of the ventilator's alarms (those that cause the Low Pressure LED to flash) have the option of operating in either a latching or non-latching mode:

- In the non-latching mode, the audible alarm will be silenced as soon as the condition that caused the alarm is corrected. (Some alarm conditions can be corrected without the intervention of the caregiver.)

- In the latching mode, the audible alarm will not be silenced until the Alarm Silence/Reset switch is pressed. See *Alarm Conditions* in Section 7.

To set the latching status of the alarms:

1. Press the Menu/Esc key.

2. Press the up or down arrow key until the display screen says:

   Press ENTER to change

   Alarm Latching Status

3. Press the Start/Enter key.

   The display will indicate the alarm's current latching status, and will give directions to change the status.

4. If you change the latching status of the alarms the ventilator will indicate the new status and ask for the change to be saved.

   Alarms NONLATCHING.
   ENTER: save ESC: exit

   Press Start/Enter to save the new setting or Menu/Esc to exit without saving.

NOTE:

If you exit without saving, the alarm latching status will not change.

6.27   Ventilating hours

The ventilator hours menu selection allows you to see the number of operating hours on the ventilator since the last preventive maintenance. To keep the ventilator operating within specifications, preventive maintenance must be performed every 6000 operating hours, or recertification every twelve (12) months (whichever occurs first).

To display the ventilator operating hours:

1. Press the MENU/ESC key.

2. Press the up or down arrow key until the display screen says:

    Ventilating hours since

    last maintenance: XXXXX

6.28   Pressure trigger

The pressure trigger menu selection allows the clinician to enable or disable pressure triggering of breath delivery, in addition to flow triggering. When using PEEP, consider using Pressure Trigger, along with the sensitivity setting (Flow Trigger).

6.29   Date and time

The date and time menu selection allows you to set the date and time in the ventilator's internal memory. This information will appear in the printed reports and the data transferred to the Report Generator software. For information on the printed reports, see *Printing reports from the ventilator* in Appendix A. For information on the Report Generator software, see the *Achieva Report Generator User's Guide.*

To set the date and time:

1. Press the MENU/ESC key.

2. Press the up or down arrow key until the display screen says:

    Press ENTER to modify

    Date and Time

3. Press START/ENTER.

    The display screen will show the date and time.

    05/18/96   01:23:30

    UP/DN: change ENTER: accept

4. The first variable in the date and time will flash. This indicates that this value can be changed. Press the up or down arrow key to change the value.

5. When the correct setting is displayed on the screen press START/ENTER to accept the setting and move to the next date or time variable.

6. When all six variables have been accepted, press START/ENTER, then press MENU/ESC

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Alarms and Alerts

Alarms are used to let you know when a condition exists that is dangerous for the patient. Alarms are accompanied by an audible tone.

Alerts lets you know when a condition exists that are not a direct risk for the patient, but that you should be aware of. The ventilator does not sound an audible tone during an alert condition.

This section of the manual describes what you will see and hear, as well as the steps you should take during an alarm or alert condition. It also describes how you can you use the ventilator's alarm-related controls to:

- Adjust the alarm limits for your patient.

- Adjust the latching mode of the ventilator's alarms.

Warning

- If an alarm occurs, attend to the patient first. Switch to an alternate means of ventilation if necessary.

- This manual tells you how to respond to the ventilator when it alarms. It does NOT tell you how to respond to the patient when the ventilator alarms.

- Any device is subject to unpredictable failures. To ensure patient safety, an appropriately trained caregiver should monitor ventilation.

- If the patient's condition warrants the use of an independent secondary alarm or other external monitoring device, the clinician should prescribe it. The clinician should also determine to what level the patient may require an alternate means of ventilation in the event of ventilator failure.

7.1   Alarm/Alert Conditions

Table 7-1 lists the alarm or alert conditions that may occur, describes what you will see and hear, and provides you with general instructions for addressing these alarms. For detailed technical information about the different alarms and alerts, see "Alarm Conditions" on page 6.

Table 7-1: Alarm and Alert Conditions

If you Hear...	And See...	It means...	Do This:
Repeating burst of 5 alarm pulses	Flashing LOW PRESSURE/ APNEA indicator	The pressure in the patient circuit has dropped below the Low Pressure setting.	1. **Attend to the patient first**. If the patient is not in danger, continue to step 2. 2. Check the patient circuit for kinks or loose connections. Fix or replace the patient circuit if necessary. 3. Inspect for and remove water from small tubing. 4. Check the ventilator's settings. Verify that the ventilator settings are set according to the prescription. 5. If the alarm condition persists, discontinue use of the ventilator and contact your clinician for guidance.
	Flashing SETTING ERROR indicator	The ventilator has detected an equipment failure.	1. **Attend to the patient first**. 2. Switch to an alternate means of ventilation. 3. Press the STANDBY button. If this corrects the error, resume normal ventilation. If not, proceed to step 4. 4. Unplug the ventilator from AC power and wait 30 seconds. Plug the ventilator into AC power and resume ventilation. If the alarm has not cleared, proceed to step 5. 5. Unplug the ventilator from AC power, press and hold STANDBY for 3 or more seconds. Plug the ventilator into AC power and resume ventilation. If the alarm has not cleared, contact your clinician.

	Flashing LOW POWER indicator	The internal battery charge is depleted	1. Disconnect the ventilator from the patient
			2. Press and hold the STANDBY button for 3 seconds
			3. Connect the ventilator to an external power supply.
			  • If using AC, it will automatically begin to charge the internal battery. Press VENTILATE to resume ventilation.
			  • If using a charged external battery, you must press START/ENTER to restart. Wait 7 seconds, then press VENTILATE to begin charging the battery and resume ventilation.
			4. Operate ventilator on AC power for at least 4 hours to recharge the internal battery.

Table 7-1: Alarm and Alert Conditions

If you Hear...	And See...	It means...	Do This:
Repeating burst of 3 pulses	Flashing LOW POWER indicator	The internal battery charge is extremely low (approximately 10 minutes of power remaining.)	1. Immediately connect the ventilator to adequate power supply. 2. Operate ventilator on AC power for at least 12 hours to recharge the internal battery.
	Flashing HIGH PRESSURE indicator	The pressure in the patient circuit is higher than the High Pressure setting.	1. **Attend to the patient first**. 2. Check the patient circuit for kinks or obstructions. Fix or replace the patient circuit if necessary. 3. Check the ventilator's settings. Verify that the ventilator settings are set according to the prescription. 4. If the alarm condition persists, discontinue use of the ventilator and contact your clinician for guidance.
			5.
	Flashing O_2 FAIL indicator	The O_2 source or the ventilator's oxygen blender has failed. (Achieva PSO$_2$ only)	1. **Attend to the patient first**. 2. Supply another oxygen source. Monitor the delivered oxygen. 3. If the alarm condition persists, discontinue use of the ventilator and contact your clinician for guidance.
Single beep, repeated every 5 minutes	Flashing SETTING ERROR indicator	There is a conflict with one or more of the setting values.	1. **Attend to the patient first**. 2. Check the ventilator's settings. Verify that the ventilator settings are set according to the prescription. 3. If the alarm condition persists, discontinue use of the ventilator and contact your clinician for guidance.
	Flashing LOW POWER indicator	The internal battery charge is low (approximately 45 minutes of power remaining.)	1. Immediately connect the ventilator to adequate power supply. 2. Operate ventilator on AC power for at least 4 hours to recharge the internal battery.
Single beep, repeated every 30 minutes	Flashing SETTING ERROR indicator	The ventilator has detected an equipment failure (minor fault condition.)	1. **Attend to the patient first**. 2. Check the patient circuit and accessory equipment. Make sure that all equipment is in good condition and properly connected. Replace if necessary. 3. If the ventilator will not start ventilation, continues alarming at the current rate, or the rate of the alarm's beeping increases, discontinue use of the ventilator and contact your clinician for guidance.
Single beep, repeated every 15 minutes	Flashing SETTING ERROR indicator	The ventilator has detected an equipment failure (serious fault condition) during ventilation.	
Single three second tone	Flashing SETTING ERROR indicator	The ventilator has detected a serious fault condition while in Standby mode. The ventilator is not ventilating.	
Steady alarm tone		The ventilator has detected a microprocessor error.	1. **Attend to the patient first**. 2. Contact your clinician. Do not use the ventilator. Provide a backup means of ventilation.

Table 7-1: Alarm and Alert Conditions

If you Hear...	And See...	It means...	Do This:
Repeated single beep	Flashing POWER Switch-over indicator	The ventilator has switched to another power source.	1. Acknowledge the power Switch-over by pressing ALARM SILENCE/RESET. 2. If the ventilator has switched to its internal battery, monitor ventilation or provide an alternate power source as soon as possible.
None	Flashing SETTING ERROR indicator	The ventilator has detected an error with either the volume or inspiratory settings. (Alert status.)	1. **Attend to the patient first**. 2. Check the ventilator's settings. Verify that the ventilator settings are set according to the prescription. 3. If the alert condition persists, discontinue use of the ventilator and contact your clinician for guidance.

7.2   Resetting Alarms

After you have corrected the alarm condition, press ALARM SILENCE/RESET to reset the alarms and deactivate the indicator lights on the Alarms panel.

7.3   Alarm Latching

Some of the ventilator's low pressure alarms can operate in either a latching or non-latching mode.

- A non-latching alarm does not require you to press ALARM SILENCE/RESET to stop the audible alarm when the condition has been corrected. It will automatically turn off the audible alarm, but the visual indicator on the Alarms panel will still light. This lets you know that an alarm event occurred and was corrected.

- A latching alarm will not stop the audible alarm unless the condition has been corrected AND the ALARM SILENCE/RESET button has been pressed. Pressing the ALARM SILENCE/ RESET button lets the ventilator know that you have responded to the alarm.

To set the latching mode of the alarms:

1. Press MENU/ESC.

2. Press the UP or DOWN arrows until the display screen reads: Press ENTER to change Alarm Latching Status.

3. Press START/ENTER. The display will indicate the alarm's latching mode and will provide further instructions.

4. Follow the displayed instructions to change the alarm's latching mode.

5. After making your change, press START/ENTER to save or ESC to exit without saving.

NOTE:

If you exit without saving, changes to the alarm latching mode will not be saved.

7.4   Pre-Silencing Audible Alarms

There may be situations in which you wish to silence an anticipated alarm for a brief period. The ventilator allows you to "pre-silence" the audible alarms for up to sixty seconds.

To pre-silence the audible alarm, press ALARM SILENCE/RESET. This will silence any audible alarms for up to sixty seconds. During this period, the lights on the alarm display panel will still light to indicate an alarm condition, but the alarm will not sound.

To stop pre-silencing of audible alarms, press ALARM SILENCE/RESET.

NOTE:

If an alarm condition occurs and has been corrected during the pre-silence period, pressing ALARM SILENCE/RESET will reset the alarms and deactivate the indicator lights.

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Cleaning and Maintenance

This section contains instructions for cleaning and maintaining the Achieva ventilator. Refer to accessory manufacturer's instructions for specific instructions for cleaning the ventilator's accessories.

Warning

To reduce the risk of infection, be sure to wash your hands thoroughly before and after cleaning or handling the ventilator or its accessories.

8.1   Cleaning the Achieva Ventilator

Warning

Do not spray, pour or spill any liquid on the ventilator, its accessories, connectors, switches, or openings in the casing. Contact with excessive moisture will damage the ventilator's internal components.

Caution

- Do not use chemical agents (i.e. alcohol, MEK, trichloroethelyne, or ethylene oxide) or steam to clean the ventilator. Use of chemical agents or steam may cause damage to the ventilator.
- Keep the front panel door closed while cleaning the ventilator.

The ventilator's surface should be cleaned as often as required. Follow these instructions for cleaning the surface of the ventilator:

1. Dip a clean, soft cloth into a mixture of mild soap and water.

2. Squeeze the cloth thoroughly to remove excess liquid.

3. Wipe the ventilator's external casing, taking care not to allow excess moisture to enter openings on the ventilator's surface.

4. Dry the ventilator's surface with a clean, soft cloth.

8.2   Cleaning your Accessories

Follow the accessory manufacturer's instructions for cleaning the ventilator's accessories.

8.3   Recharging the Internal Battery

> **Caution**
>
> You should recharge the ventilator's internal battery after each use, to retain electrical charge.

While connected to AC power, the ventilator will automatically recharge the internal battery in any mode, including Standby.

If you are using the external battery to power the ventilator, the internal battery will only be charged while the ventilator is ventilating. The battery will not be charged while the ventilator is in Standby.

> NOTE:
>
> Charging the ventilator's internal battery from the external battery will reduce the amount of charge left in the external battery.

8.4   Cycling Internal and External Batteries

Every four to six weeks, the ventilator's batteries need to be fully discharged and recharged to optimize battery performance. Follow these instructions to discharge and recharge your battery.

8.4.1   External Battery

Use the external battery to power the ventilator until it switches to the internal battery (which signals that the external battery's charge is depleted.) Immediately disconnect the external battery and connect the ventilator to an AC power source. Follow the battery manufacturer's instructions for recharging the external battery.

8.4.2   Internal Battery

Use the internal battery to power the ventilator until the low power alarm sounds. Immediately connect the ventilator to AC power to begin recharging the battery. Keep the ventilator connected to AC power and allow the internal battery to charge, at least, twelve (12) hours.

8.5   Replacing the Air Inlet Filter

The ventilator uses the model Y-1609 Inlet Filter (Flatpak) to filter the air that is delivered to the patient. The filter should be inspected regularly for signs of discoloration, as discoloration indicates that it is time to replace.

> **Caution**
>
> • Failing to change a dirty filter, or operating the ventilator without a filter in place, can cause serious damage to the ventilator.
>
> • The air inlet filter is not reusable; do not attempt to wash, clean, or reuse it.
>
> • A blocked air inlet filter may cause a setting error alarm.

If the ventilator is used indoors, the air inlet filter should be checked monthly. If the ventilator is used outdoors, in transport, or in a dusty atmosphere, the filter may need to be changed more frequently. If using the ventilator in these conditions, the filter should be checked weekly and replaced as necessary.

If the filter is discolored, follow these instructions to replace it.

1. Twist off the retainer ring from the back panel of the ventilator.

2. Replace the old air inlet filter cartridge with the new cartridge. Discard the old cartridge.

3. Re-assemble the O-ring, filter and retainer ring as shown in Figure 8.1.

4. Twist the retainer ring to secure it, taking care not to overtighten.

Figure 8-1. Air Inlet Filter Assembly
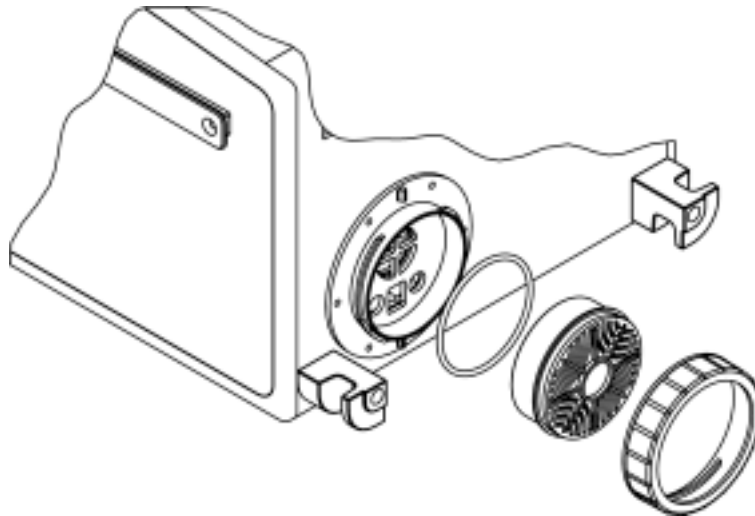
8.6 Changing the Ventilator's Fuse

If the ventilator is plugged in to an AC outlet but the battery charging LCD is not lit, a fuse may need to be replaced. The fuses for the ventilator are rated at 250 V, 3.15A, 5 x 20 mm, slow blow.

Warning

To reduce the risk of electrical shock. disconnect the ventilator from AC power before attempting to change the fuse.

Caution

To prevent fire hazard, replace only with identically rated fuses.

Follow these steps to replace the ventilator's fuse.

1. Unplug the ventilator.

Figure 8-2. Removing the fuse holder
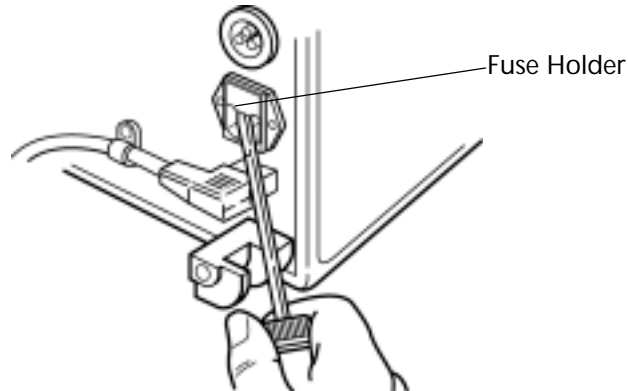
Fuse Holder

2. Insert a small screwdriver under the tab on the bottom of the fuse holder.

3. Pull the screwdriver upward and outward until the fuse holder pops out slightly.

4. Pull the fuse holder out.

5. Remove the old fuses from the fuse holder.

Figure 8-3. Fuse assembly
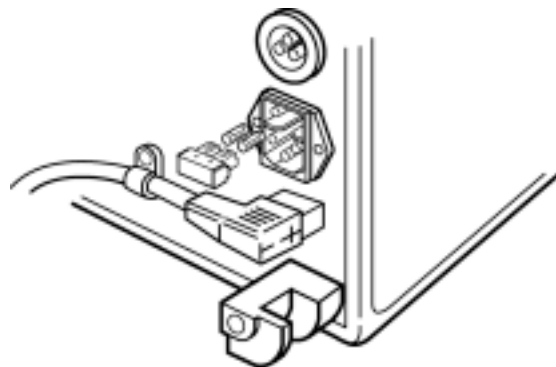
6. Place the new fuses into the fuse holder.

7. Return the fuse holder to its original position and press it into place. You should hear a click, which indicates it is securely positioned.

8. Reconnect the ventilator's power cord.

8.7   Preventive Maintenance

Preventive Maintenance must be performed by qualified personnel every 6000 operating hours, or recertification every twelve (12) months, whichever occurs first. The ventilator is intended to function within its specified parameters if the service schedule is followed.

Warning

Do not try to repair or otherwise service the ventilator yourself. Doing so might endanger the patient, cause damage to the ventilator, and/or void your warranty.

Follow these instructions to view the ventilator's operating hours since maintenance was last performed:

1. Press the MENU/ESC button.

2. Press the up or down arrow key until the display screen says:

    "Ventilating hours since last maintenance: XXXXX."

    (Where XXXXX is the total number of operating hours.)

When this number nears 6000, contact a trained service representative to schedule service for the ventilator.

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Troubleshooting

- If you suspect a problem with the ventilator or accessories, attend to the patient first. If necessary, provide an alternate means of ventilation before attempting to troubleshoot the problem.

- If you cannot determine the cause of the problem, contact your equipment supplier or Nellcor Puritan Bennett. Do not use the ventilator until the problem has been corrected.

What you see and hear...	Why this might happen...	What you should do...
All lights turn on and audible alarm sounds	The ventilator automatically self-tests the alarms each time it is turned on.	You do not need to do anything. The alarms should stop within two seconds.
	The ventilator is responding to a manual alarm test you are conducting.	You do not need to do anything. The alarms should stop within two seconds.
	Microprocessor error	1. Unplug the ventilator from external power. 2. Press and hold STANDBY for 3 seconds or more. 3. Reconnect external power. If the unit is connected to AC, it will automatically exit low power standby mode and begin to charge the internal battery. Press VENTILATE to resume ventilation. If the unit is connected to a charged external battery, press the START/ENTER switch to restart. The internal battery will not begin to recharge until the ventilator is put into the ventilate mode. Press START/ENTER and check parameter settings for accuracy. Press VENTILATE. If alarm persists, unplug the ventilator and provide another means of ventilation.

What you see and hear...	Why this might happen...	What you should do...
Low Pressure/Apnea Alarm	The patient is not breathing.	Check the patient for breathing effort and stimulate if necessary.
	There is water in the small-bore tubing.	Disconnect the small-bore tubing and remove the water per the manufacturer's instructions.
	Patient speech or other activities lower patient circuit pressure.	Low pressure alarm sounds whenever low pressure limit is not reached for two consecutive breaths. Review the section on alarms.
	There is a kink in the small-bore tubing.	Unkink and straighten the small-bore tubing.
	PEEP pressure is set higher than the Low Alarm control setting.	Set Low Alarm control setting higher than the PEEP pressure.
	There is a leak or loose connection in the large bore tubing of the patient circuit.	Check connection of the patient circuit to the ventilator; check all connections for leaks and tightness, especially at the humidifier, tracheal tube, and exhalation valve.
	The patient's breathing effort is less than the Sensitivity control setting.	Set the sensitivity so the patient's breathing effort turns on the Assist/Spontaneous light and call your clinician.
	The ventilator's Volume setting is set below patient's tidal volume.	Reset the Volume to the prescribed value. If values are correct, call your clinician.
	Incorrect control settings	Reset all controls to the prescribed values. If values are correct, call physician.
	Obstructions in the patient pressure tube	Check for leaks or kinks in the patient tubing.
	Other causes.	Notify your physician and your equipment supplier.
Low Power alarm	Failure to recharge the internal battery.	Plug ventilator into AC power.
		Plug ventilator into a charged external battery.
High Pressure Alarm	Water in the tubing.	Remove water from tubing.
	Crimped tubing	Uncrimp tubing.
	Coughing or other high-flow expiratory efforts	Treat patient's cough. The alarm is appropriate for these conditions.
	Patient inspiratory resistance or compliance changes	Have physician determine new ventilator settings.
	Airway obstruction	Check for tracheal obstruction or for a condition in which the patient requires suctioning.
	Malfunction in the exhalation manifold	Replace the exhalation manifold.

What you see and hear...	Why this might happen...	What you should do...
Setting Error Alarm	Inappropriate setting or settings beyond the capabilities of the machine	Readjust settings to the clinician's prescription. If the settings are correct and the alarm persists, consult your clinician.
	Low battery power	Connect external power supply.
	See the Alarm Section of this manual for more details.	
Green AC Power light does not glow	AC power cord is not connected.	Plug in the cord.
	The ventilator has blown a fuse.	Replace the fuse.
	No power to the wall outlet	Switch to an active outlet.
Unit will not operate on external battery power	Connection problem	Check all connections.
	Fuse(s) in battery system blown.	Replace blown fuse(s).
	Fuse inside vent is blown.	Return ventilator for service.
O_2 Fail Alarm	Low O_2 source pressure O_2 source disconnected O_2 source empty	Increase O_2 source pressure. Connect an O_2 source. Replace O_2 source.

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Specifications

This section provides complete specifications for the Achieva ventilators. It also includes information pertinent to the connection of the Achieva PS and PSO_2 ventilator modems to the telephone lines.

Power	
Power Line	100 to 240 VAC, 50 to 60 Hz, 2 Amps
External DC Power	11.6 to 32.0 VDC (24 VDC optimal)
	Operating time: At least 19 hours under normal load, and 5 hours 30 minutes under heavy load* 24 V DC (or 12 V DC, 32 Ah)
Internal Battery	24 VDC (nominal)
	Operating time: At least 4 hours under normal load, and 1 hour under heavy load*
	Gel cell, sealed Lead Acid, backup power
	Lithium Battery, Memory power
Standard Power Converters	90 to 200 VAC
Fuses	250 V, 3.15A, 5X20 mm, slow blow
Power Usage	
Maximum	Absolute maximum is 75W
Minimum	10 W
Type	Positive Pressure Volume ventilator
Motor	3-Phase Brushless Motor
Pump	Piston, 50ml to 2200ml tidal volume capability
Protection against electrical shock	Type of protection: Class I Degree of protection: Type BF
*Normal Load: Mode = Assist/Control, Volume = 1000 ml, Breath Rate = 10 BPM, Inspiratory Time = 1.5 sec., FIO2 = 21%, Sensitivity = 5 LPM, PEEP = 0 cmH2O/hPa, Vent pres.=30 cmH2O/hPa Heavy Load: Mode = Assist/Control, Volume = 1500 ml, Breath Rate = 20 BPM, Inspiratory Time = 1.0 sec., FIO2 = 100%, Sensitivity = 5 LPM, PEEP = 20 cmH2O/hPa, Vent pres.=60 cmH2O/hPa	

Indicators

Normal Events	
Patient Pressure Meter	Displays patient pressure, -10 to + 100 cmH$_2$O/hPa; also displays battery charge when TEST BATTERY button is pressed.
Alphanumeric Display	Shows current operating parameters and ventilator information.
Power	Green LEDs indicate operating power source: AC, External Battery, Internal Battery.
Battery Charging	Green LED indicates the unit is charging the internal battery.
Assist/Spontaneous	Green LED indicates that the patient's effort exceeds the sensitivity setting.
Alarm Control	Red LED flashes at 1 second intervals during a pre silence condition and continuously when the non-latching alarm feature is active.
Alarms	Flashing red LEDs: Low Pressure/Apnea, Low Power, High Pressure, Setting Error, Power Switchover, O$_2$ Fail (O$_2$ Fail available only on Achieva PSO$_2$).
Audible Alarms	
One Second Beep	Relief Valve Test Failure, User Self Test Error, Leak Test Failure
Repeated Single Beep	Power Switchover.
Repeated Three Pulses	Extremely Low Internal Battery, High Pressure, Invalid I:E Ratio, High Pres<Low Pres, Volume Error, Rate Error, Inspiratory Error, Oxygen Alarm, Pressure Differential Error
Repeated Five Pulses	Low Pressure, Valley, Exhale Fail, Apnea, Battery Charge Depleted, Vent Inop
Continuous Tone	Microprocessor failure
Single Beep Every Five Minutes	Low internal battery.
One Second Beep Every Thirty Minutes	Minor Fault.
One Beep Every Fifteen Minutes	Ventilator is ventilating and serious fault is detected.
Three Second Tone	Ventilator is in standby mode and a serious fault is detected.
Alarm Volume	85 db or 70 db at a distance of 1 meter

Controls

Alarm Silence/Reset	1. Silences audible alarms during an alarm condition. 2. Silences an alarm before a known alarm condition occurs. 3. Used to reset an alarm after the alarm condition has been corrected.
Test Battery	1. When the test battery switch is pressed, the Patient Pressure Meter shows the charge level of the battery currently in use. 2. Starts printer output activation.
Standby	Used to place the ventilator in the Non-ventilate State, disabling the delivery of air.
Ventilate	Enables the ventilator to deliver air to the patient.
Mode	Causes the current ventilatory mode on the display to flash and allows the mode to be changed.
Setting Switches	Volume, Inspiratory Time, Sensitivity, Breath Rate, Pressure, PEEP, Low Pressure, High Pressure, FIO_2 (Achieva PSO_2 only).
Menu/Esc	Activates and deactivates the menu on the ventilator's display.
START/ENTER	Used to accept the currently flashing parameter as the new setting. Activates display.
Up and Down Arrow Keys	Increases or decreases the parameter settings or menu levels. Pressing when the sub menu is not active and a parameter has not been selected will cause the last alarm message to be displayed.

Settings

Volume	50ml to 2200ml in 10 ml steps. For SIMV 50ml to 1750 ml in 10 ml steps. Accurate to ± 10 ml for 50-100 ml and ± 10 % (max 75 ml) for 100-2200 ml.
Inspiratory Time	0.2 to 5.0 seconds in increments of 0.1 seconds. Accurate to ±10%.
Sensitivity	Flow: 3 to 25 LPM in 1 LPM increments. Accurate to ±2.0 LPM. Pressure: Off, 1 to 15 cmH_2O/hPa in 1 cmH_2O/hPa increments. Accurate to ±2.5 cmH_2O/hPa.
Breath Rate	1 BPM to 80 BPM in steps of 1BPM. Accurate to ±10% or 1 BPM which ever is greater.
Pressure	0 to 50 cmH_2O/hPa in 1 cmH_2O/hPa increments. Accurate to ±2.5 cmH_2O/hPa of the setting once the pressure reaches the setting. Pressure support settings below 3 cmH_2O/hPa default to 3 cmH_2O/hPa.
PEEP	0 and 3 to 20 cmH_2O/hPa in 1 cmH_2O/hPa increments. Accurate to ±2.5 cmH_2O/hPa.
Flow Acceleration	OFF or ON (Inspiratory flow $\leq$ 180 lpm)
Expiratory Trigger	15% to 55% in 10% increments. Accurate to ±15% at 15%, ±5% from 25% - 55%.
Low Pressure	1 to 59 cmH_2O/hPa in increments of 1 cmH_2O/hPa. Activates within ±2.5 cmH_2O/hPa.
High Pressure	2 to 80 cmH_2O/hPa in increments of 1 cmH_2O/hPa. Activates within ±2.5 cmH_2O/hPa.

O₂ Level (Achieva PSO₂ Only)	21% to 100% for tidal volumes greater than or equal to 100 ml, 21% to 70% for tidal volumes less than 100 ml in 1% increments. Accuracy: 50 to 90 ml, 02 settings < = 70% ± 10% 02; 100 to 2200 ml, O2 settings <50%, ± 5% O2, all other O2 settings, ± 10% of settings. Supply pressures of less than 45 PSIG may result in reduced O2 performance at some settings. Optimum performance is achieved at 65 PSIG O2 supply pressure. It may take several minutes for the oxygen concentration to stabilize. The capacity of the O2 blender is a function of tidal volume and inspiratory time, which in combination influence peak flow. As peak flows increases (i.e. large tidal volumes combined with short inspiratory times), the limit of the O2 flow capacity is approached. The set O2 concentration cannot be delivered if the flow capacity of the O2 blender has been exceeded. To ensure the prescribed oxygen concentration is delivered to the patient, measure the delivered gases with a calibrated oxygen analyzer at all times.
Altitude	0 to 4500 meters in increments of 100 meters (or 0 to 14,760 feet in increments of 328 feet).

Connectors

Modem Jack (Acheiva PS or Achieva PSO₂)	RJ 11 phone connector to connect the optional internal modem to telephone lines.
Communications Port	RS-232 connector for Achieva Report generator computer, printer or external modem.
O₂ Inlet (Achieva PSO₂)	9/16 - 18, DISS 1240 THD
External Battery Connector	3 pin male receptacle for 24 Volt DC input.
Power Entry Module	EIA dual fuse power entry module.
	Provides connections for hot, neutral and grounded conductors.
	The receptacle incorporates fuses in the hot and neutral lines.
Inlet Filter	Intake for patient air. Screw off cap for filter change. 98% efficient at 0.3 microns.
Patient Pressure Port	Port for connection to the proximal pressure line of the patient circuit. For 3/16″ I.D. tube.
Remote Alarm Connector	Connector for remote alarm.
Nurse Call Connector	Connector for Nurse Call Station.
Patient Air	22mm O.D./15 mm I.D. ISO Fitting
Exhalation Valve Port	Port for connection to the exhalation valve of the patient circuit. For 1/8″ I.D. tube.

Sensors

Primary Pressure

Purpose	Measures the proximal pressure for use in pressure control and pressure monitoring.
Location	Proximal
Type	Gauge pressure sensor
Range	-20 hPa to 120 hPa (compensated) Temperature Range: -18°C to +63°C
Accuracy	±2.5 hPa

Secondary Pressure

Purpose	Provides backup pressure measurement for safety reasons.
Location	Distal
Type	Gauge pressure sensor
Range	1 psi (compensated) Temperature Range: 0°C to +55°C
Accuracy	±8 hPa

Oxygen Flow

Purpose	Measures the amount of oxygen entering the piston chamber during piston retraction.
Location	Inlet to piston chamber
Type	Mass flow sensor
Range	0 LPM to 80 LPM
Temperature Range	-25°C to +85°C
Accuracy	±3.5% of reading over +5°C to +60°C
Condition	Nominal barometric pressure. (Changes in gas density due to changes in altitude are compensated for via the Altitude setting.)

Primary Flow

Purpose	Measures the amount of gas discharged from the ventilator's output port.
Location	Patient output port
Type	Mass flow sensor
Range	0 LPM to 180 LPM
Temperature Range	-25°C to +85°C
Accuracy	±3.5% of reading over +5°C to +60°C
Condition	Nominal barometric pressure. (Changes in gas density due to changes in altitude are compensated for via the Altitude setting.)

Relative Motor Position

Purpose	Senses the relative motion of the piston drive motor.
Location	Stator of motor

Type	Hall sensor
Range	Digital
Accuracy	NA
Environment	
Operating	5°C to 40°C (41°F to 104°F), 10% to 90% RH.
Storage	-20°C to 50°C (-4°F to 140°F), 10% to 90% RH.
	When moving the ventilator from a non-operating to an operating environment, allow a minimum of one hour temperature stabilization before use.
	When storing the ventilator, the battery must be recharged every thirty days. Storage above or below specified operating temperatures may affect battery life.
Miscellaneous	
Maintenance	Preventative maintenance must be performed by qualified personnel every 6000 operating hours or recertification every twelve (12) months, whichever occurs first.
Dimensions	10.75″ X 13.30″ X 15.60″ (27.3 X 33.8 X 39.6 cm)
Weight	Less than 32lbs.
Resistance Factor	Maximum of 4.5 cmH$_2$O/hPa @60 LPM
Compliance Factor	1.25 mL/hPa for A/C breaths 2.50 mL/hPa for Pressure Support breaths
Emergency Pressure Relief	90 ± 10 cm H$_2$O
Response time	75 milliseconds (under the following conditions): Resistance = 5 cmH$_2$O/hPa/L/sec.; Compliance = 50 ml/cmH$_2$O/hPa; Breath Rate = 20 BPM; Volume = 1500 ml; Pressure Support = 10 cmH$_2$O/hPa; PEEP = 5 cmH$_2$O/hPa. Response time varies inversely with the displayed flow rate, and directly with the selected trigger level.
Flow (average)	2.0 LPM to 180 LPM

The ventilator is intended to operate within its specifications if it is properly maintained and the service schedule is followed.

The ventilator is protected against electrostatic contact discharge of up to eight kilovolts (8 kV). Electrostatic discharge greater than eight kilovolts may damage the ventilator.

10.1   Standard compliance

The ventilator complies with the following international agency standards:

- *IEC 601-1 Medical Electrical Equipment, 1988 Part 1: General Requirements for Safety

- IEC 601-1-2 Medical Electrical Equipment, Part 1: General Requirements for Safety, Part 2: Collateral Standard - Electromagnetic Compatibility Requirements and Tests

- *CAN/CSA-C22.2 No.601.1-M90 Medical Electrical Equipment Part 1: General Requirements for Safety

- *UL2601-1 Medical Electrical Equipment, Part I: General Requirements for Safety (1994)

*Classified as Class I and internally powered; Type BF; drip proof, not suitable for use in the presence of flammable anesthetics, continuous operation.

10.2   FCC Part 68 information

This information applies to Achieva ventilators that are equipped with an internal modem. These units have a MODEM label near the modem connector on the back panel.

Use the ringer equivalence number (REN) to determine the number of devices you can connect to the telephone line. Excessive RENs on the telephone line may result in devices not ringing in response to an incoming call. In most, but not all areas, the sum of the RENs should not exceed five (5). Contact the telephone company to determine the maximum REN for the calling area.

The required USOC jack for the Achieva ventilator is USOC RJ11C.

An FCC compliant telephone cord and modular plug is provided with this equipment. This equipment is designed to be connected to the telephone network or premises wiring using a compatible modular jack which is Part 68 compliant.

If the Achieva ventilator causes harm to the telephone network, the telephone company will notify you in advance. If advance notice is not practical, the telephone company will notify the customer as soon as possible. Also, you will be advised of your right to file a complaint with the FCC if you believe it is necessary.

The telephone company may make changes in its facilities, equipment, operations, or procedures that could affect the operation of the Achieva ventilator. If this happens, the telephone company will provide advance notice in order for you to make the necessary modifications to maintain uninterrupted service.

If you experience trouble with the Achieva ventilator, please contact Nellcor Puritan Bennett, Minneapolis, MN, phone number 800.497.3787 for repair and/or warranty information. If the trouble is causing harm to the telephone network, the telephone company may request that you remove the Achieva ventilator from the network until the problem is resolved.

Do not make repairs. Doing so voids the user's warranty.

Do not install the Achieva ventilator on public coin service telephone. Connection to party line service is subject to state tariffs. (Contact your state public utilities commission for information.)

Nellcor Puritan Bennett recommends that the customer install an AC surge arrestor in the AC outlet to which this device is connected. This is to avoid damaging the equipment caused by local lightning strikes and other electrical surges.

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Service and Warranty Information

Service information

Achieva ventilators are warranted against defects in workmanship and materials. The full text of the warranty provides the details. Do not make any service repairs on this equipment during the stated warranty period. Any unauthorized work immediately voids the warranty. If you need information or assistance, or if the information in this manual is insufficient, contact Nellcor Puritan Bennett at: 1.800.255.6774

Nellcor Puritan Bennett, Inc. does not recognize the owner of a ventilator as an authorized trained service representative. Nellcor Puritan Bennett will not be liable for any repairs attempted by the owner. Any such attempted repairs other than specified non-warranty repairs void the warranty. Parts and labor costs incurred by the owner will not be reimbursed by Nellcor Puritan Bennett. Nellcor Puritan Bennett will make available on request: diagrams, component parts lists, descriptions, calibration procedures and instructions to assist in the repair of parts classified by Nellcor Puritan Bennett as repairable.

Before returning any device to Nellcor Puritan Bennett you must get a Return Authorization Number by calling Nellcor Puritan Bennett at the number listed above.

Limited Warranty

Nellcor Puritan Bennett Inc. warrants to the owner that the Achieva ventilators, exclusive of expendable parts and other accessories, shall be free from defects in material and workmanship for twenty-four months from the original date of sale. Nellcor Puritan Bennett's sole obligation, with respect to any such defect, is limited to the repair or, at Nellcor Puritan Bennett's option, replacement of the ventilator. Purchaser pays return freight charges.

This warranty is made on the condition that prompt notification of a defect is given to Nellcor Puritan Bennett within the warranty period, and that Nellcor Puritan Bennett has the sole right to determine whether a defect exists.

This warranty is conditional on the performance of Preventive Maintenance at a minimum of once every 6000 operating hours, or recertification every twelve (12) months (whichever occurs first) by service personnel qualified by Nellcor Puritan Bennett. The warranty does not apply to ventilators that have been partially or completely disassembled; altered; subjected to misuse, negligence, or accident; or operated other than in accordance with the instructions provided by Nellcor Puritan Bennett. This includes repair by trained personnel.

This warranty represents the exclusive obligation of Nellcor Puritan Bennett and the exclusive remedy of the purchaser regarding defects in the ventilator.

THIS WARRANTY IS GIVEN IN LIEU OF ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

No person is authorized to modify, in any manner, Nellcor Puritan Bennett's obligation as described above.

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Appendix A: Ventilator data

This chapter tells how to print a report from the ventilator, and describes the information in that report. It also describes how to transfer information from the ventilator to a computer equipped with the Achieva Report Generator software.

The Achieva ventilators store data which can be used to evaluate the ventilation program. Some information is available in a report that can be printed directly from the ventilator. More complete reports can be made with the Achieva Report Generator software.

For more information on the Report Generator, see the Achieva *Report Generator User's Guide*.

Printing reports directly from the ventilator

You can use a printer to create a permanent copy of the patient information and ventilator operation. The printer must be Epson-compatible with a serial input (or a serial-to-parallel adaptor).

1. Connect a printer to the Communications port on the back of the ventilator.

2. Load the printer with paper and ink, as required.

3. Connect the printer to power. Turn it on and ensure that the printer is Selected or On Line. See the printer manufacturer's instructions for details.

4. On the ventilator, briefly press the TEST BATTERY switch.

The printout will contain the ventilator's settings and measured or calculated parameters as of the last breath (inspiration and expiration) completed before the printout was created.
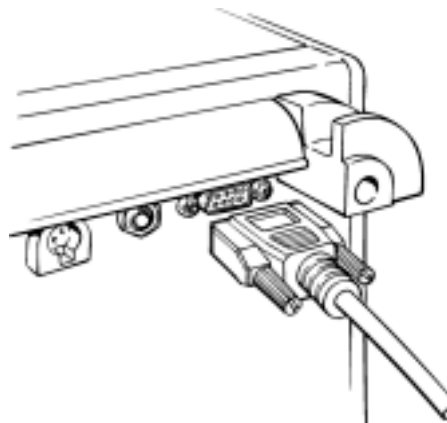
NOTE:

Reports are printed automatically:

- after any alarm

- after any parameter change

- every four hours

The header of the printout displays:

- model and serial number for the ventilator

- blanks for writing in the patient's name and room

- date and time of the printout, with machine operating hours since the last maintenance

- mode and power source at the time of the printout

- any alarm condition

- latched or non-latched Low Pressure alarms. See Latching and non-latching in *Section 7.*

The remainder of the printout displays the set and/or actual values for:

- tidal volume and breath rate (set and actual for each)

- inspiratory time and inspiratory to expiratory ratio (set and actual for each)

- average (actual and set) and maximum inspiratory flow (actual only)

- sensitivity, pressure trigger, pressure control, and PEEP settings (set for each)

- selected oxygen concentration (set) and estimated oxygen concentration

- low pressure setting (set) and minimum pressure (actual)

- high pressure setting (set) and maximum pressure (actual)

- the average expiratory and inspiratory pressures (actual for each).

Local data transfer

You can connect the ventilator directly to the computer through the ventilator's communications port (on the back panel). For more information on the Achieva Report Generator software, see the Achieva *Report Generator Software User's Guide.*

NOTE:

    You cannot start ventilation during a local data transfer, however you can continue ventilation started before the data transfer.

---

1. Connect one end of the RS-232 communications cable to the communications port on the back of the ventilator.

2. Connect the other end of the cable to the computer's COM1 or other COM port, as selected when installing the Achieva Report Generator software.
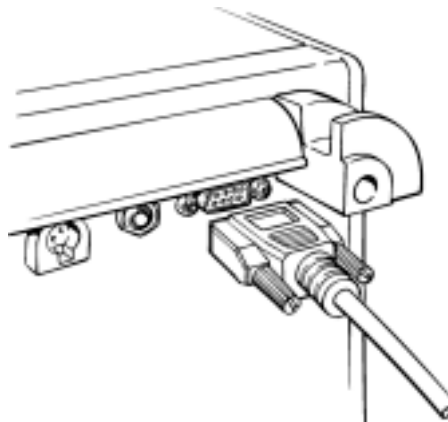

NOTE:

    Your computer may require a 9 pin-to-25 pin adaptor.

---

3. On the computer, start the Achieva Report Generator software.

4. On the main software application screen, select Connection, and Local Connection. The computer will display:

    Connected to VSN (ventilator serial number), Patient (patient name)

5. On the computer, click OK.

Download procedure

1. On the ventilator, press the START/ENTER switch.

2. Press the Menu/Esc switch.

3. Press the up or down arrow keys until its display screen reads:

<div align="center">

Press ENTER for local
data transfer

OR

Press ENTER for remote
data transfer

</div>

4. Press the START/ENTER switch.

5. While the ventilator is sending the data, the display will read:

<div align="center">

Sending Data…

</div>

6. After the "Sending Data…" is displayed and the download is complete, one of the four messages will be displayed.

<div align="center">

Transfer Successful

or

Transfer Failed

Hanging up

or

Failed to initialize modem

or

Failed to connect to remote computer

</div>

"Failed to initialize modem" indicates a problem with the modem. Check switch settings and connections for the external modem. If you are using an internal modem, contact Puritan Bennett Technical Services at 1.800.255.6774.

"Failed to connect to remote computer:" Check the connections between the Achieva Report Generator-equipped computer and the ventilator. Make sure the computer is set to use the correct COM port. Retry the transfer. See the *Achieva Report Generator User's Guide* for details.

Remote data transfer

You can connect the ventilator to a computer through the ventilator's internal modem or through an external modem.

The phone number for the location of the Achieva Report Generator computer must be entered into the ventilator via a local (RS-232 cable) connection. For more information, see the *Achieva Report Generator User's Guide.*

NOTE:

   You cannot start ventilation during a remote data transfer, however you can continue ventilation started before the data transfer.

---

1. **Internal modem:** Connect one end of a telephone cord to the Modem port on the back of the ventilator, and the other end of the cord to a telephone outlet; or
    External modem: Connect one end of the communication cable to your ventilator's communications port, and the other end to your modem. Connect the modem to the telephone line per the manufacturer's instructions.

2. Make sure the computer with the Achieva Report Generator software is connected to a modem and set to either Remote Attended or Remote Unattended, to wait for a call.

3. On the Report Generator application screen, select Connection and Remote Attended or Remote Unattended.

Follow the Download procedure.
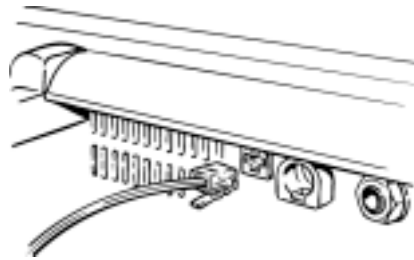
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Appendix B: Glossary

Airway pressure   P$_{aw}$. Measured by the ventilator at the point where the proximal pressure line connects to the patient circuit.

Alarm latching/non-latching   Latching alarms continue to sound until the ALARM SILENCE/RESET switch is pressed, regardless of whether the alarm condition has been corrected. Non-latching alarms will stop sounding as soon as the condition is corrected, although the alarm Light Emitting Diode (LED) will stay on until the ALARM SILENCE/RESET switch is pressed. The user has a menu option to set some alarms (those that cause the Low Pressure LED to flash) to either latching or non-latching operation.

Alert   Alerts signify a condition that occurs between the patient and the ventilator which is not an immediate danger to the patient, but of which the operator should be aware.

Apnea   During Assist/Control ventilation, an absence of breath delivery or inspiratory effort for 10±1 second. During SIMV or Spontaneous ventilation, an absence of breath delivery or inspiratory effort for 20±1 second.

Assist/Control   In Assist/Control mode, the ventilator delivers an assisted breath of a set volume or set pressure when the patient's breathing effort creates a flow or pressure drop that is greater than the SENSITIVITY setting.

When the patient's breath rate falls below the breath rate setting, the ventilator will deliver a controlled breath of the set volume or pressure. (Does not apply in Spontaneous mode.)

Assist/Spontaneous   Assist/Spontaneous Light Emitting Diode (LED) indicates inspiratory effort sufficient to trigger delivery of a breath.

Caregiver   An individual who assists a patient with the tasks of daily living. This may be a family member, a live-in assistant, or the nursing staff of a health care facility.

Caution   Directions that warn of potential damage to the ventilator or of data loss.

Continuous Positive Airway Pressure (CPAP)   Airway pressure maintained above ambient pressure. Available in SIMV mode on all Achieva ventilator models. Available in Spontaneous mode with, or using, Achieva PS and Achieva PSO$_2$ only. Achieve CPAP by setting PRESSURE SUPPORT to 0 and PEEP to the prescribed level of CPAP.

Expiratory sensitivity   The expiratory sensitivity level is a percentage of peak flow at which a pressure-supported breath will be terminated. The expiratory sensitivity level has settings of 15% to 55% in 10% increments.

Flow $\dot{V}$. The average inspiratory air flow, calculated as V_t/t_i.

Flow acceleration   The inspiratory Flow acceleration feature controls flow during pressure-supported and pressure-controlled breaths. When the flow acceleration feature is ON, the actual flow rate during the inspiratory phase of a pressure-supported or a pressure-controlled breath cannot exceed 180 LPM.

Modem (modulator/demodulator)   Device for converting binary signals into tones that can be transmitted over telephone lines.

Note   Directions that make it easier to use the ventilator.

Nurse call output   Connector on the ventilator for use with call systems in use at many health care facilities. Connected to a relay that switches during alarm conditions. See connecting to a Nurse Call System in *Section 4.*

O_2 Fail   The O_2 FAIL alarm will sound after 10 breaths if the ventilator does not detect a flow source at the oxygen inlet.

Positive End Expiratory Pressure (PEEP)   Pressure in the patient circuit at the end of expiration, above ambient.

Pre silence   Pressing the ALARM SILENCE/RESET switch while no alarm conditions exist and no alarm LEDs are lit. Prevents the audible alarm from sounding for 60 seconds. Useful for routine procedures that would otherwise cause an alarm.

Pressure Control   Augmentation of the patient's ventilation synchronously with inspiratory effort until a preset pressure is met. Pressure is maintained throughout patient inspiratory flow, and is cycled to expiration by time (controlled by the selected INSPIRATORY TIME setting). Used in Assist/Control mode by setting PRESSURE above 0.

Pressure Support   Augmentation of the patient's ventilation synchronously with inspiratory effort until a preset pressure is met. Pressure is maintained until inspiratory flow is reduced to a percentage of peak flow (between 15% and 55%) that depends on the expiratory sensitivity setting for the inspiration, when the ventilator cycles into exhalation. Available in SIMV or Spontaneous modes (Achieva PS and Achieva PSO$_2$ only).

Respiratory Failure   The inability of a patient to spontaneously ventilate at a level that maintains normal respiration for any period of time.

Respiratory Insufficiency   The inability of a patient to spontaneously ventilate at a level that maintains normal respiration for some time period (usually less than 12 hours), leading to negative effects over a prolonged period.

Sensitivity   Level at which the ventilator delivers an assisted breath. The
SENSITIVITY switch sets the flow (in liters per minute) the patient must
generate to trigger inspiration. The clinician can also set the pressure
below the baseline that will trigger inspiration. Pressure triggering may
result in greater sensitivity to patient demand in low-flow conditions.
When using PEEP, use Pressure Trigger, along with the sensitivity setting
(Flow Trigger).

Spontaneous   A ventilation mode that delivers assisted breaths only.

Warning
Spontaneous mode does not provide breaths if the patient does not make an inspiratory effort greater than the sensitivity settings and the apnea backup is off, but an apnea alarm will occur.

Standby   The operational mode of the ventilator where it is connected to
power, but is not ventilating the patient.

Synchronous Intermittent Mandatory Ventilation (SIMV)   A ventilator mode
which provides a mechanism for synchronizing the ventilator-delivered
breaths with a patient's inspiration, as detected by the ventilator.

Tidal volume V_t. Volume of gas entering or leaving the patient.

User self test   A ventilator test, performed with user assistance, that
checks for leaks in the patient circuit, and tests operation of the high
pressure relief valve.

Volume breath   Inspiration of the selected volume, delivered over the
selected inspiratory time.

Warning   Directions that warn of conditions that put the patient,
caregiver, or other individuals at risk of injury.

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Appendix C: Resources

This chapter provides a brief bibliography, and a list of organizations of interest to clinicians, caregivers, and patients.

Bibliography

ACCP Consensus Conference on Mechanical Ventilation. Respire Care 1993; 38:1389–1417

Consensus Conference on the Essentials of Mechanical Ventilators. Respire Care 1992; 37:999-1130

Murray JE. Payment Mechanisms for Pediatric Home Care. Caring Oct. 1989: 33–35

The National Center for Home Mechanical Ventilation. *Learning Objectives for Positive Pressure Ventilation in the Home.* Denver CO, 1993

Organizations

Congenital Central Hypo ventilation Syndrome (CCHS) Family Network.

Publishes the CCHS Family Network Newsletter, and supports camps for ventilator-dependent children.

Editor: 71 Maple St.
                   Oneonta NY 13820
                   607.432.8872

I.V.U.N. (International Ventilator Users Network)   Links ventilator users with each other and with home care professionals interested in home mechanical ventilation.

Publishes spring and fall issues of I.V.U.N. NEWS

Publisher: Gazette International Networking Institute (GINI)
                   4207 Lindell Blvd. #110
                   St. Louis, MO 63108-2915
                   314.534.0475

Contact: Executive Director

National Spinal Cord Association   This is a membership, consumer-based organization whose purpose is to address the needs of persons with spinal cord injury or disease (which includes many ventilator-dependent individuals). The association conducts programs in the area of research and services, includes a network of local chapters providing direct services, and compiles a resource directory. The directory provides information on services, programs, and resources available for persons with limited mobility.
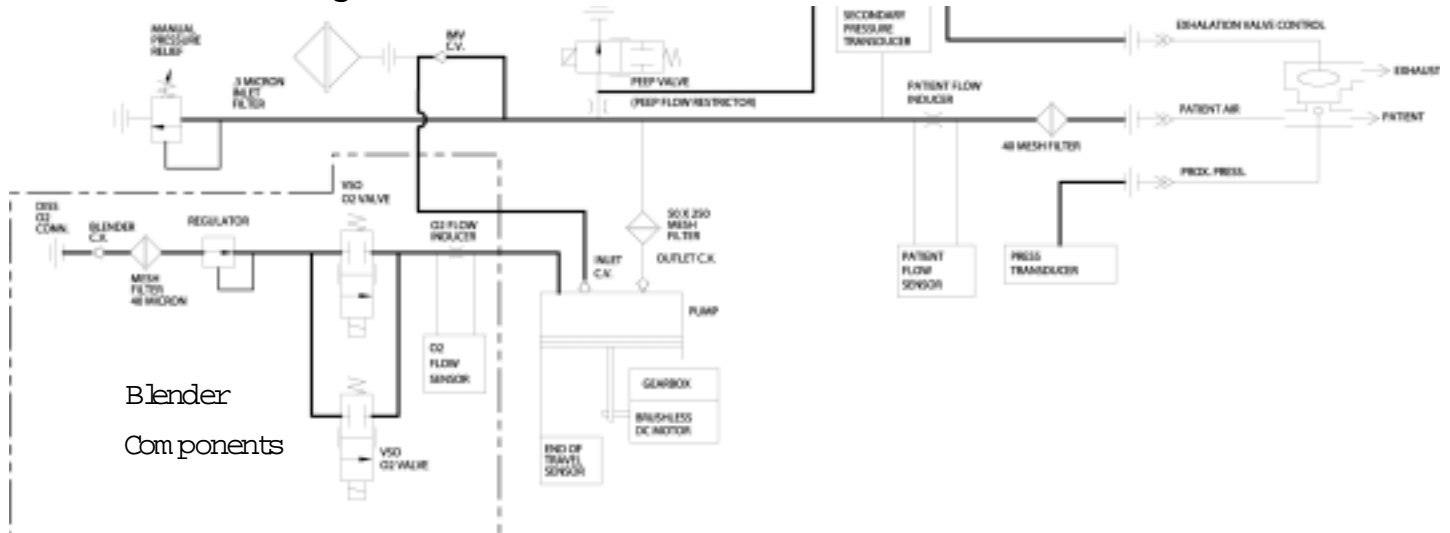
Address: 600 W Cummings Park, Suite 2000
                   Wooburn, MA 01801
                   617.935.2722

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Theory of Operation

This appendix provides an operating theory for Achieva ventilators. It includes a description of the ventilation modes and sample waveforms.

Pneumatic diagram

Blender
Components

The following is a theory of operation for the pneumatic system in Achieva ventilators. For a complete theory of operation, see the *Achieva Ventilator Technical Manual*.

Text in a `sans-serif font` refers to the labels in the illustration, see the Pneumatic diagram above.

Air enters the ventilator through a `.3 micron inlet filter`. Negative pressure for entrainment is accomplished by the withdraw stroke of the piston in the mechanical piston `pump` (7" diameter cylinder). Passing through an `inlet c.v.` (check valve), the air enters the cylinder and is mixed with oxygen from the blender. The combined gases become pressurized by the forward piston stroke. Gas exits through a pump `outlet c.v.` (check valve) and through a `50 X 250 mesh filter`. Before exiting to the patient through the `patient air` outlet tube, the gas passes through one additional `40 mesh` filter.

Ventilator by-pass is accomplished by use of a parallel path incorporated into the manifold. This path bypasses the `pump` and allows air to move directly to the `patient air` outlet tube after passing through the `.3 micron inlet filter` and the `ventilator by-pass c.v.` (check valve). This allows the patient to breathe spontaneously in the event of complete ventilator failure.

The `PEEP valve` is a voltage sensitive orifice (VSO) that controls the mushroom valve in the exhalation manifold. With the VSO open, the mushroom valve is deflated, resulting in a PEEP level of 0 cmH$_2$O. With the VSO fully closed, the mushroom valve is fully seated, and the maximum PEEP pressure in the patient circuit is 20 cmH$_2$O. As a safety measure, the VSO is normally open to deflate the mushroom valve. This allows the patient, in the event of ventilator failure, to exhale through the exhalation manifold (and inhale through the ventilator).

The `patient flow sensor` operates on the principle of heat transfer due to the airflow directed across the surface of the sensing element. The `patient flow inducer` creates a small airflow to feed the sensor by creating a pressure drop across an orifice.

The `pressure transducer` is connected to the proximal pressure line of the patient circuit. The transducer functions from -10 to +100 cmH$_2$O. The `secondary pressure transducer` is part of the ventilator check for gross failure. Pressure differences between the transducers greater than 15 cmH$_2$O (averaged over a 100 millisecond period) will result in a ventilator fault alarm.

The `high pressure relief` valve limits the pressure delivered to the patient to a maximum of 90 cmH$_2$O ±10 cmH$_2$O.

The internal oxygen blender (available only on Achieva PSO$_2$) is shown in the solid box on the pneumatic diagram. Oxygen (20-80 PSIG) enters the blender through the `DISS O`$_2$ `connector`, and passes through the `blender c.v.` (check valve) and the `mesh filter` (40 micron). The `regulator` drops the pressure to 55 PSIG before feeding the oxygen to two parallel `VSO O`$_2$ `valves`. The oxygen flow supplying the pump is controlled from 0 to 100% capacity by varying the voltage sensitive orifices (VSOs) from fully closed to fully opened. Oxygen concentrations available to the patient are reduced by low pressure supplied to the blender and high volume of total gases delivered to the patient. The `O`$_2$ `flow sensor` measures the oxygen volume delivered to the `pump`. This is compared to the total volume, to determine the percentage of oxygen concentration delivered to the patient. At low flow rates, total gas flow is calculated based on tidal volume. When the ventilator determines that the measured flow rates are insufficient for the F$_1$O$_2$ setting, the O$_2$ FAIL alarm will sound.

Breaths and ventilation modes

Breaths available from the ventilator are:
- Volume breaths in Assist/Control mode
- Pressure controlled in Assist/Control mode
- Mandatory volume breaths in SIMV mode
- Pressure supported breaths in SIMV or Spontaneous modes
- CPAP in SIMV or Spontaneous modes

Volume breaths in Assist/Control mode

In Assist/Control mode, with PRESSURE set to 0, each delivered breath will be of the selected VOLUME, delivered over the selected INSPIRATORY TIME. Inspiration is triggered by patient-generated flow or pressure drop (for assisted breaths) or by the ventilator (for controlled breaths; BREATH RATE is the controlling parameter). For both controlled and assisted breaths, the inspiration is limited by the volume, and is cycled by volume and time.

See the waveforms below.
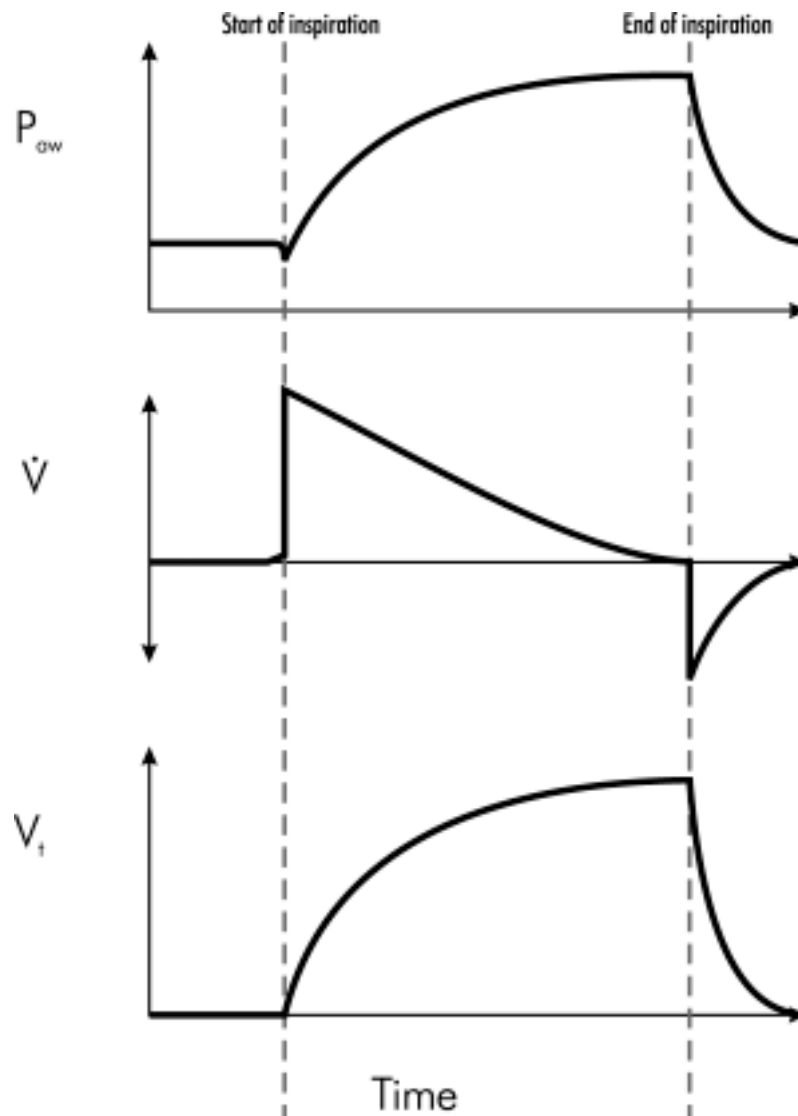
Assist/Control mode guarantees a maximum period between breaths, as determined by the Breath Rate setting. In the waveform below, the ventilator delivers a controlled (machine) breath, and calculates the time before another controlled breath must be delivered. The ventilator delivers a second controlled breath at the conclusion of that machine-calculated breath time (for simplicity, we will use the term *period* for "machine-calculated breath time"). Following the second controlled breath, but before another period can elapse, the patient's effort triggers an assisted (or patient-initiated) breath. This restarts the period. At the conclusion of the period, the ventilator delivers another controlled breath.
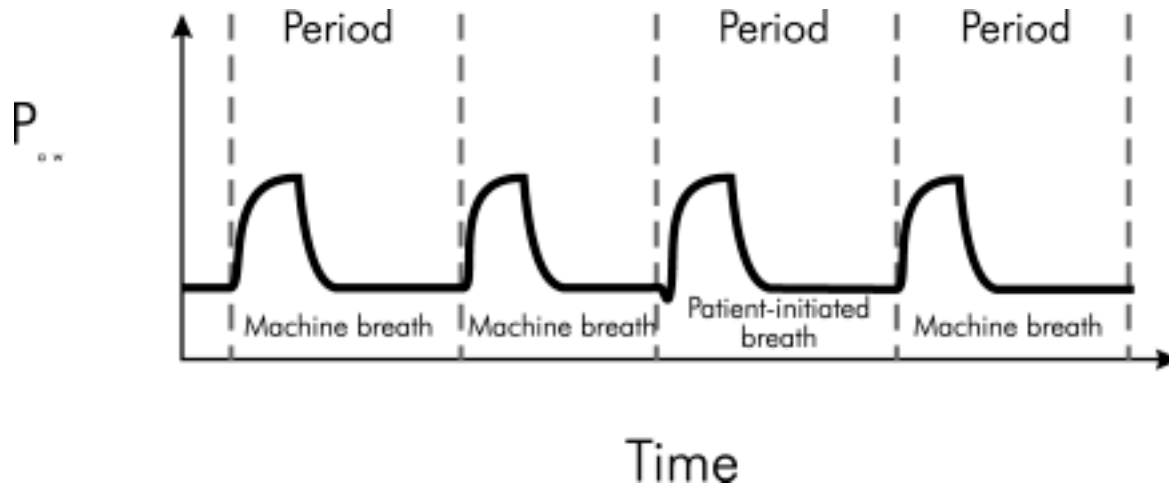
Pressure control in Assist/Control mode

In Assist/Control mode, with PRESSURE set greater than 0, each delivered breath will maintain the selected PRESSURE, maintained over the selected INSPIRATORY TIME. Inspiration is triggered by patient-generated flow or pressure drop (for assisted breaths) or by the ventilator (for controlled breaths; BREATH RATE is the controlling parameter). For both controlled and assisted breaths, the inspiratory pressure is limited to the PRESSURE setting, and is cycled by time.

Inspiratory Flow Acceleration Limit and Expiratory Sensitivity Inspiratory flow acceleration limit controls flow and increases pressure rise time during a pressure-supported or pressure-controlled breath. By selecting the inspiratory Flow Acceleration limit feature, the operator can control flow during pressure-supported and pressure-controlled breaths. The inspiratory flow acceleration limit feature has settings of ON or OFF. When the flow acceleration limit feature is ON, the actual flow rate during the inspiratory phase of a pressure-supported or a pressure-controlled breath cannot exceed 180 LPM.

The operator can also set the expiratory sensitivity level, which is the percentage of peak inspiratory flow at which a pressure-supported breath will be terminated. The expiratory sensitivity level has settings of 15% to 55% in 10% increments.
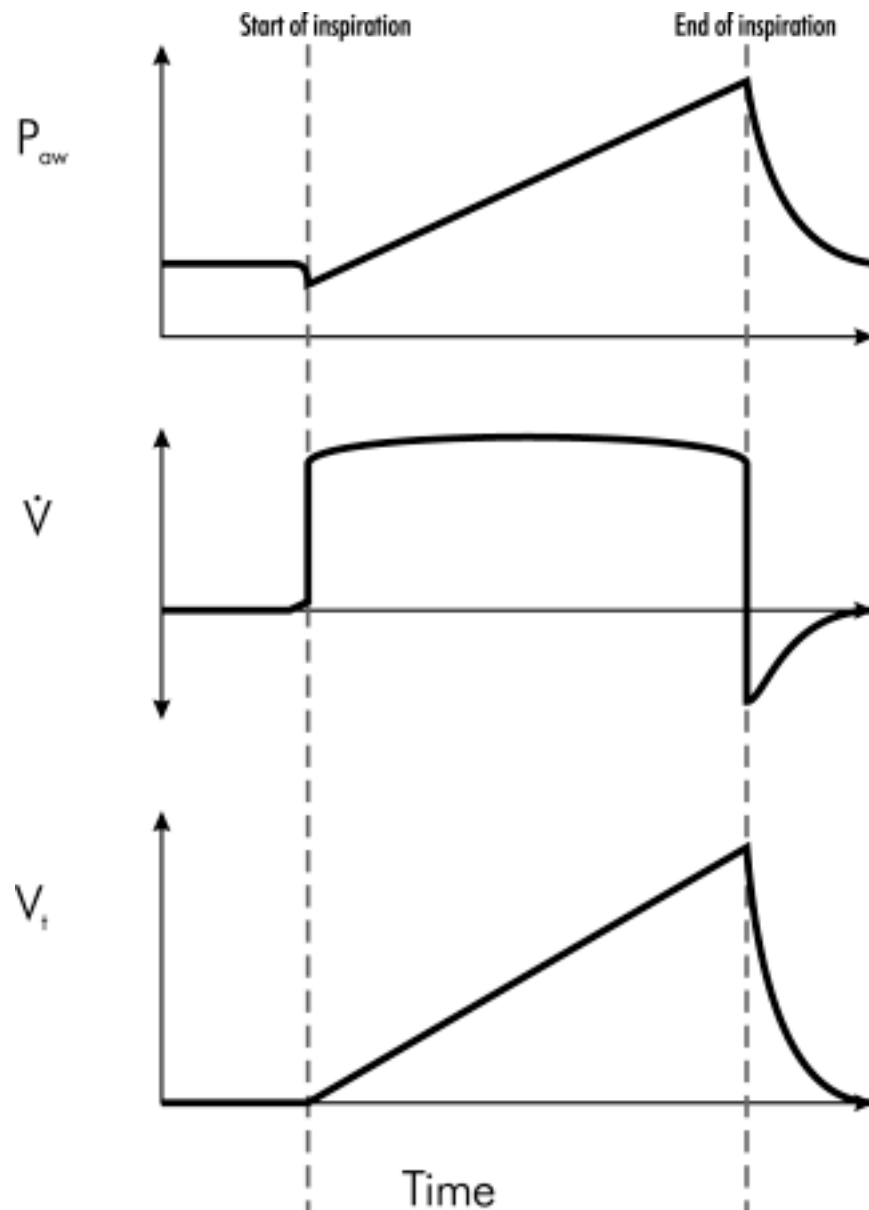
See the following waveforms.
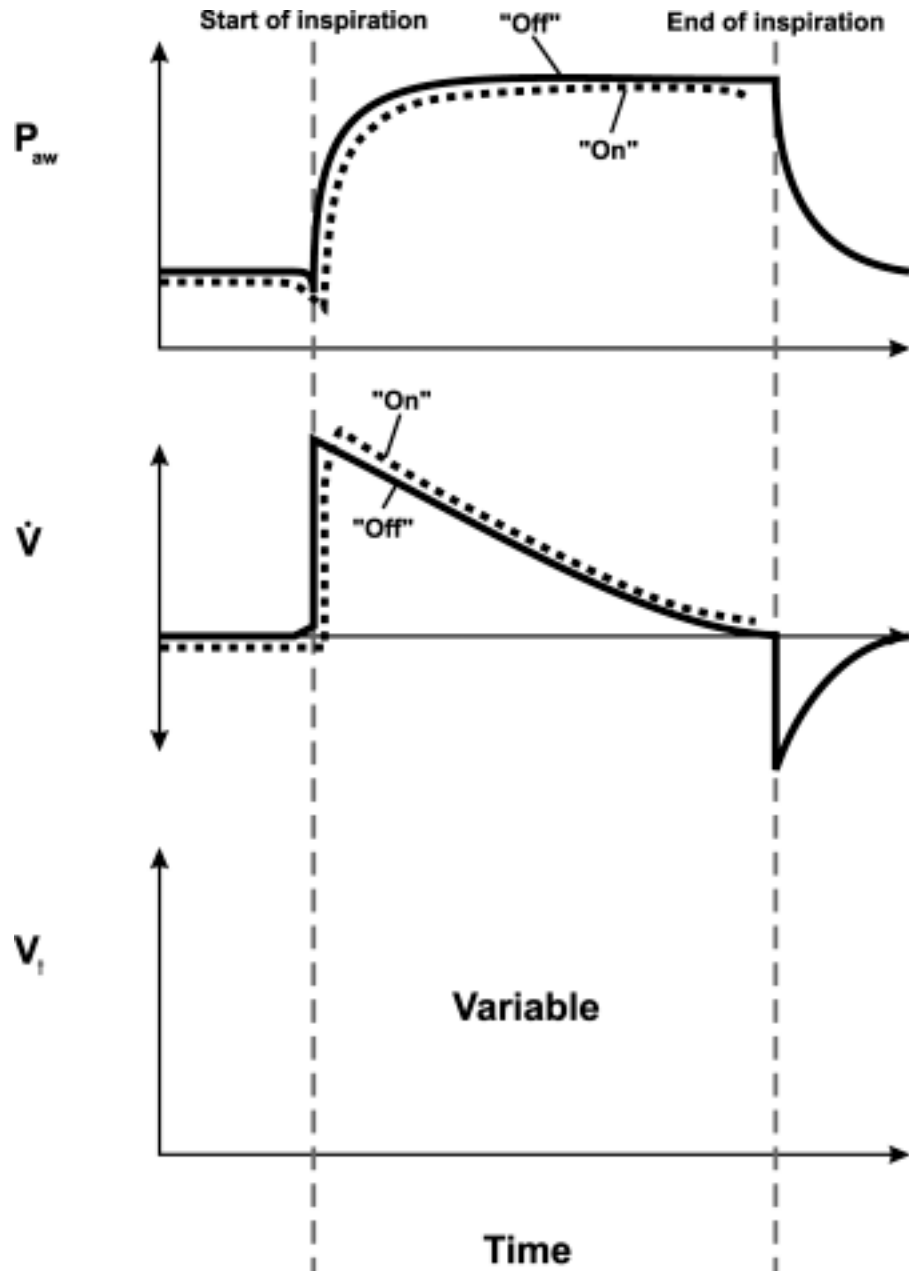
Mandatory volume breaths in SIMV mode

In Synchronized Intermittent Mandatory Ventilation (SIMV), the mandatory volume breaths deliver the selected VOLUME over the selected INSPIRATORY TIME. Inspiration is triggered by patient-generated flow or pressure drop (for assisted breaths) or by the ventilator (for controlled breaths; BREATH RATE is the controlling parameter). For both controlled and assisted breaths, the inspiration is limited by the volume, and is cycled by volume and time.

See the waveforms below.

SIMV mode will also deliver pressure-supported breaths. For a description of pressure-supported breaths, see Pressure supported breaths in *Section 6*.

In SIMV mode, the ventilator delivers volume breaths, as determined by the Breath Rate setting, with all additional breaths delivered as pressure supported breaths. See Pressure-supported breaths in *Section 6*. In the waveforms on the following page, the breath in the first machine-calculated breath time is due to a lack of patient effort in the preceding machine-calculated breath time; that is, the first breath shown is actually associated with a preceding machine-calculated breath time (for simplicity, we will use the term *period* for "machine-calculated breath time").

The second breath shown is delivered because of the absence of patient effort in the first period shown. Before the next period elapses, the patient initiates an assisted, volume breath. Although it continues into the third period, it fulfills the requirements of the second period. The second patient-initiated volume breath fulfills the requirements of the third period. Therefore, the ventilator does not deliver another breath until the fourth period has elapsed. The patient-initiated breath that starts in the fifth period fulfills the requirements for the fifth period.

The **first** patient-initiated breath in period six fulfills the requirements for period six; therefore, the **second** patient-initiated breath in period six is delivered as a pressure supported breath. Because of the patient activity in period 6, no breath is delivered in period seven; therefore, a breath is delivered at the start of period eight, to fulfill the requirements of period seven.

In SIMV mode for Achieva PS and Achieva PSO$_2$, spontaneous breaths are supported to the baseline pressure (either 0 cmH$_2$O or, if used, the selected PEEP setting).
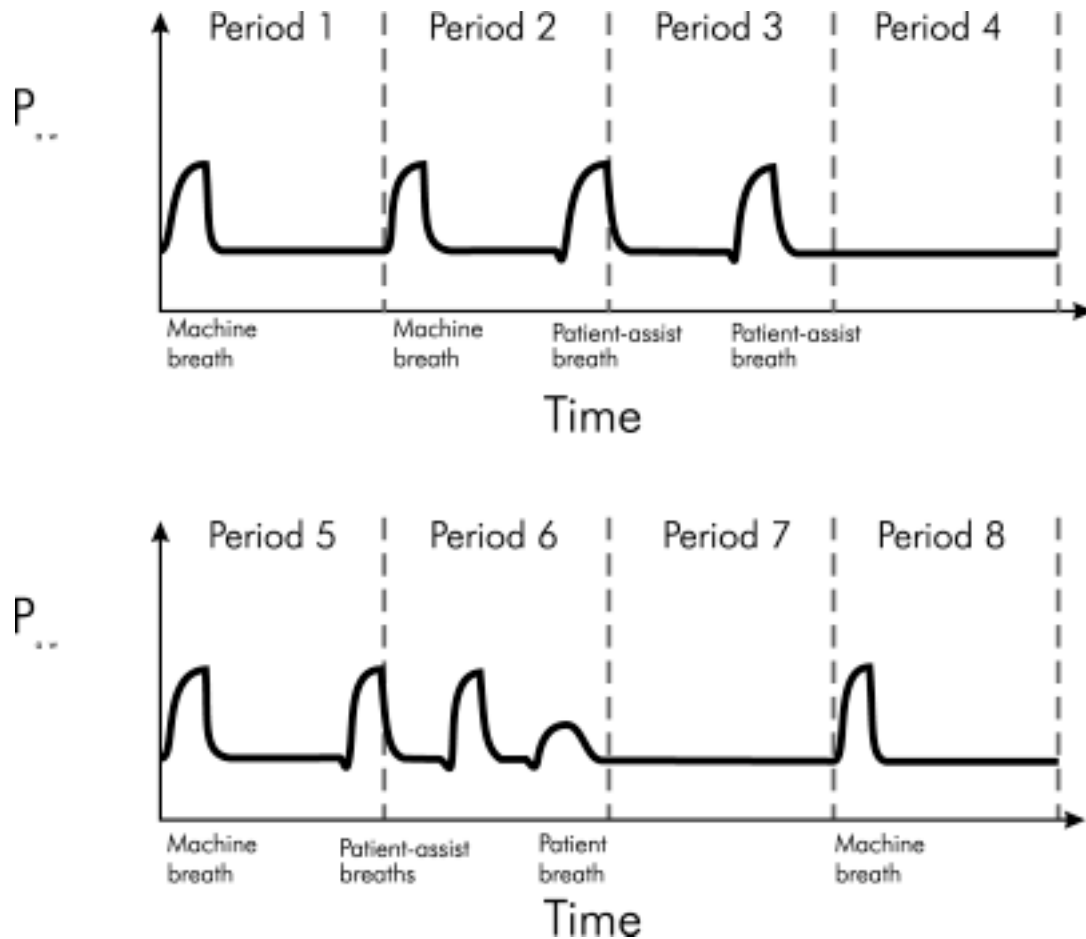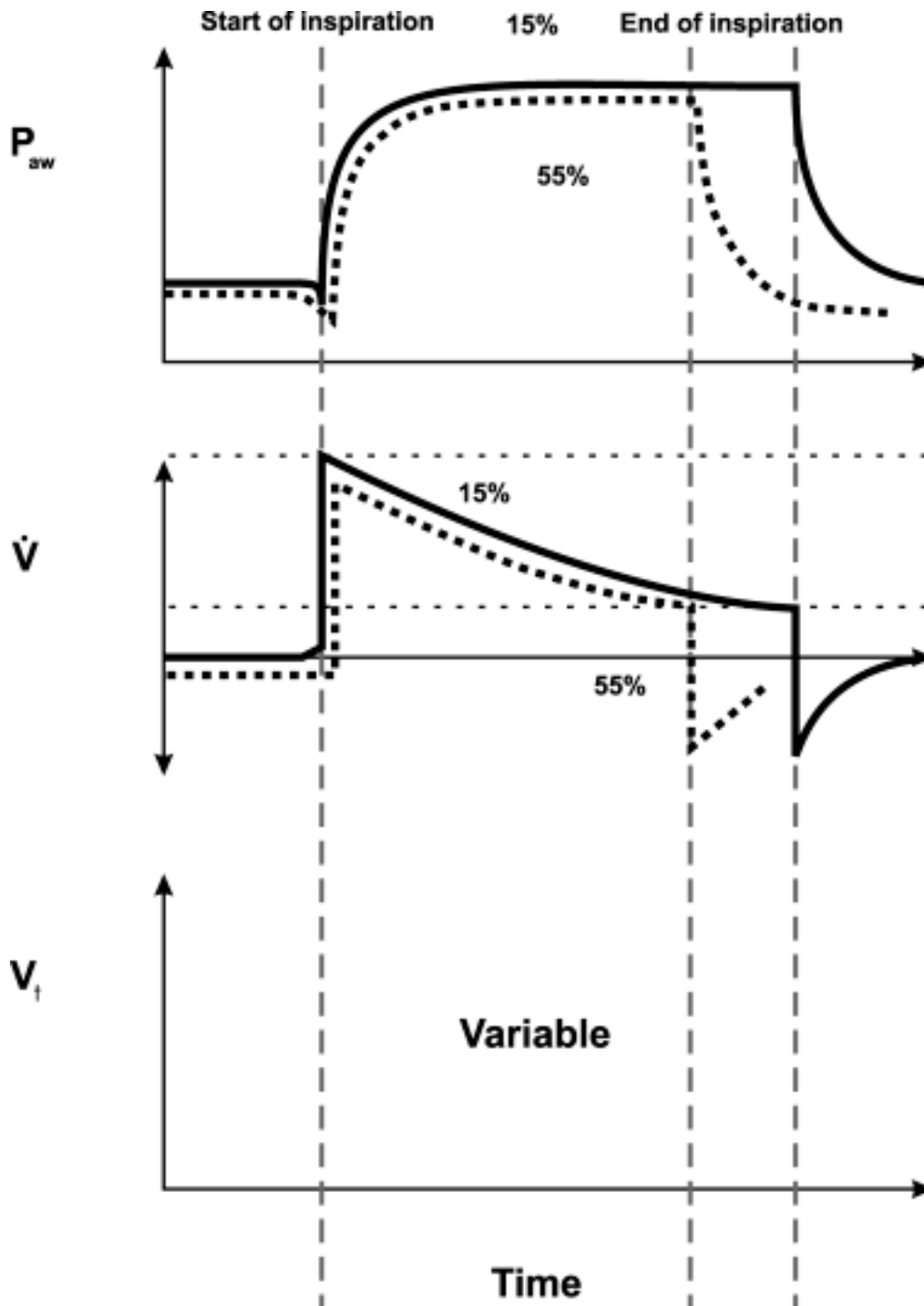
Pressure supported breaths

In SIMV or Spontaneous modes, the supported breaths maintain the selected pressure. Inspiration is triggered by patient-generated flow or pressure drop. When Flow Acceleration limit is on, maximum flow is limited to 180 lpm. When Flow Acceleration limit is off, the maximum flow is delivered and inspiration is terminated when inspiratory flow drops to the Expiratory Sensitivity setting (between 15% and 55% of peak flow).

In SIMV, additional mandatory volume breaths will be delivered, dependent on the selected Breath Rate .

Available on Achieva PS and Achieva PSO_2 only.

See the waveforms on the following page.

CPAP

Continuous Positive Airway Pressure (CPAP) is available in SIMV (all models) or Spontaneous modes (Achieva PS or PSO$_2$ only). Pressure must be set to 0. The ventilator maintains pressure at the selected PEEP over the entire breath cycle. Inspiration is triggered by patient-generated flow or pressure drop. Inspiration is limited by the pressure, and is cycled by the patient when inspiratory flow drops to the Expiratory Sensitivity setting (between 15% and 55% of peak inspiratory flow).

In SIMV, additional mandatory volume breaths will be delivered, dependent on the selected Breath Rate .See "Mandatory volume breaths in SIMV mode" on page 6.

See the waveforms on the following page.

Start of inspiration   End of inspiration

P_{aw}

$\dot{V}$

15%

55%

V_t

Variable

Time
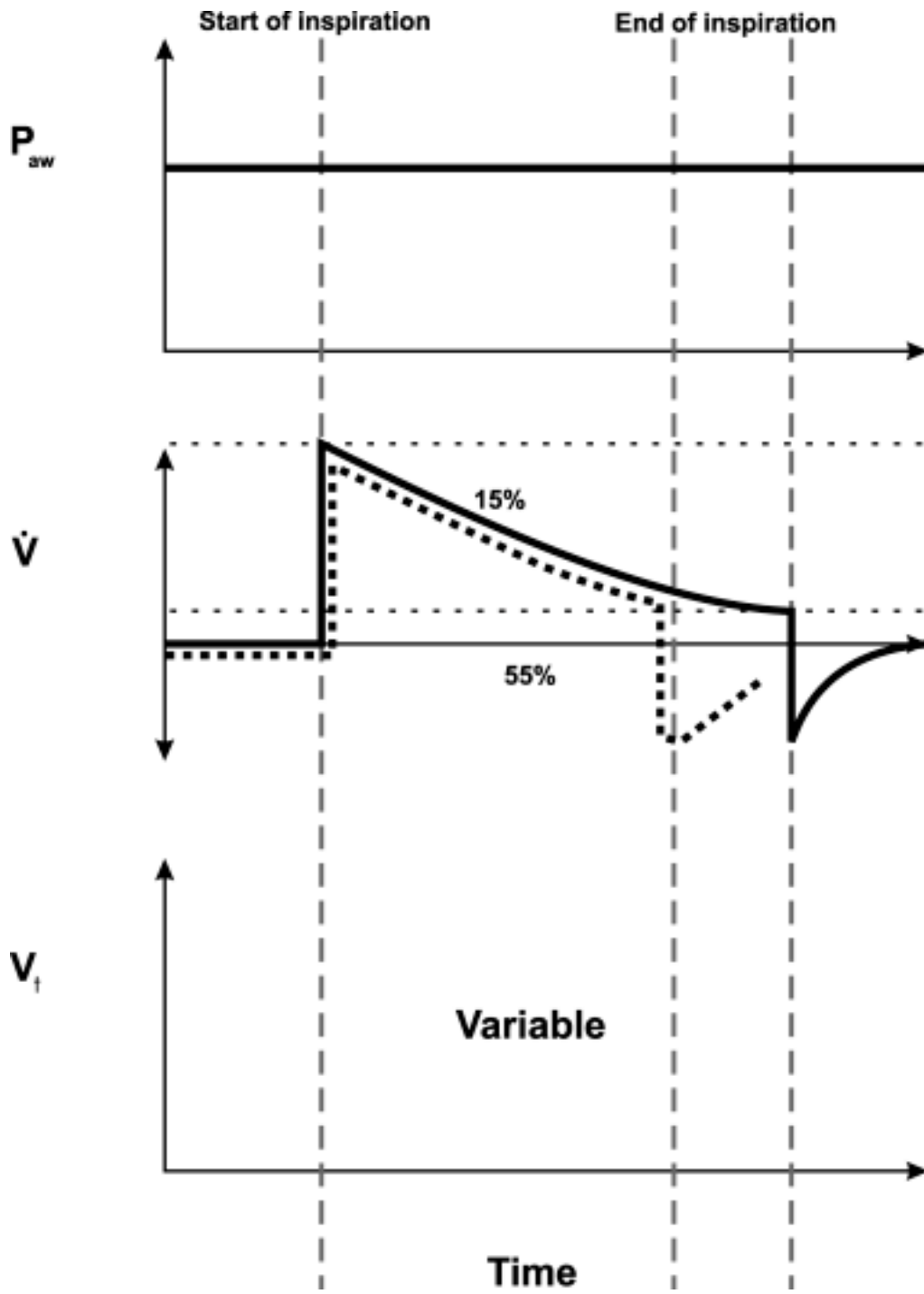
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Tyco Healthcare Group LP
Nellcor Puritan Bennett Division
4280 Hacienda Drive
Pleasanton, CA 94588
Toll Free: 1.800.NELLCOR

Authorized Representative:
Tyco Healthcare UK LTD
154 Fareham Road
Gosport PO13 0AS, U.K.

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