What is ventilation? respiration?

Ventilation is the process of moving air in and out of the lungs. Respiration is the process during which the exchange of oxygen (O₂) and carbon dioxide (CO₂) occurs in the alveoli of the lungs. The alveoli are small air sacs at the end of the bronchial tree in the lungs, and it is through the walls of these air sacs that O₂ diffuses into the blood and CO₂ diffuses out of the blood. Ventilation is a constant process of maintaining the proper balance between the two.

What is a ventilator?

A ventilator, also known as a respirator, is the equipment used to mechanically assist breathing by delivering air to the lungs. Many people may be familiar with ventilators in the hospital setting, such as the ICU, where large complex acute care ventilators are used. The ventilators used in the home are small, lightweight and portable; they can be mounted on wheelchairs or carts or put on a bedside stand. Most of these operate on household electric current—some have internal batteries—and can be operated with external batteries. It is advisable to have a backup battery or even a generator readily available in case of power outages or emergencies.

How does mechanical ventilation work?

The diaphragm is the primary muscle for inspiration, along with the intercostal muscles between the ribs. Other muscles of the chest, neck and shoulders play smaller roles. When these breathing muscles are weakened or paralyzed, breathing becomes difficult or impossible. A mechanical ventilator can take over the act of breathing completely or make breathing easier by assisting weakened respiratory muscles.

The muscles of the abdomen are important for breathing out and for an effective cough. Weak expiratory muscles result in impaired cough and inability to clear secretions that can lead to respiratory infections and pneumonias. In certain neuromuscular diseases, the bulbar muscles—those responsible for swallowing, speech and coughing—can become progressively impaired. Cough can be assisted by the use of manual techniques such as lung volume recruitment and breath-stacking and/or mechanical devices such as the CoughAssist®.

How did mechanical ventilation develop?

The iron lung or “tank” was the first effective form of mechanical ventilation, and one of the earliest iron lungs, often used to resuscitate drowning victims, dates from 1838. A century later, in the 1930s, improvements in the iron lung made widespread use of mechanical ventilation possible, particularly during the polio epidemics.

Positive pressure ventilators developed as a more effective breathing option to the larger, bulkier negative pressure devices. Since the 1980s, computer technology has enabled manufacturers to produce even smaller, lightweight ventilators that are easier to transport and operate, and are better suited for people living at home.
What is negative pressure ventilation?

When the pressure around the chest is negative—lower than atmospheric pressure—the chest expands to allow air to enter the nose and mouth. Iron lungs enclose the whole body, except for the head, and create pressure changes between the chest and the encasing shell of the unit.

Other forms of negative pressure ventilation, also known as body ventilators, include the chest shell or cuirass, Nu-Mo suit and Pulmo-wrap. The Porta-Lung™ is a smaller and more mobile version of the iron lung that is still used by a small number of people.

A technologically advanced form of negative pressure ventilation called biphasic cuirass ventilation (BCV) controls both the inspiratory and expiratory phases of breathing. Higher frequencies and tidal volumes allow for higher minute ventilation.

The following equipment specifications are for negative pressure ventilators currently on the markets. There is no “standard” form for specifications. American and European manufacturers differ in the technical information that they provide about their products. Alarms must be a certain volume. Minimum and maximum alarm volume is regulated.

**Hayek RTX (Biphasic cuirass ventilation)**
United Hayek Medical, www.unitedhayek.com

- Pediatric use > 5 kg
- Also used as cough assistant
- Modes: Continuous negative; mandatory control; respiratory synchronized
- Rate: 6-1200 cycles per minute
- Maximum inspiratory pressure: -50 cm H2O
- Maximum expiratory pressure: +50 cm H2O
- I:E ratio: 1:6 - 6:1
- AC voltage: 110-230, 50-60 Hz
- External battery: 12 VDC
- Dimensions: 370 mm W x 260 mm D x 180 mm H
- Weight: 9 kg

**Hayek RTX**
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- Modes: Continuous negative; mandatory control; respiratory synchronized
- Rate: 6-1200 cycles per minute
- Maximum inspiratory pressure: -50 cm H2O
- Maximum expiratory pressure: +50 cm H2O
- I:E ratio: 1:6 - 6:1
- AC voltage: 110-230, 50-60 Hz
- External battery: 12 VDC
- Dimensions: 370 mm W x 260 mm D x 180 mm H
- Weight: 9 kg

**Pegaso V**
Dima Italia S.r.l., www.dimaitalia.com

- Rate: 5-50 CPM
- Negative pressure: Variable from -5 to -99 cm H2O
- Positive/negative pressure E: Variable from +99 to -25 cm H2O
- AC voltage: 115V/230V, 50-50 Hz, 400 VA
- Dimensions: 30 cm H x 32 cm W x 25 cm D
- Weight: 17 lbs.
- Alarms: High/low respiratory pressure, power failure, mechanical failure

**Porta-Lung™**
Porta-Lung, Inc., www.portalung.com

(Discontinued; still in use; repairs available)

- Breathing rate: 4-60 BPM
- Pressure: -60 to +20 cm H2O
- Sizes: X-small, small, medium and large
- AC voltage: 120 VAC
- External battery: 12 VDC
- Weight: 72 lbs-138 lbs
- Alarms: Low pressure
**What is a pneumobelt?**

The pneumobelt, also known as an exsufflation belt, consists of an air bag or bladder inside a cloth corset that is worn around the abdomen and lower chest. The pneumobelt is connected by tubing to a positive pressure ventilator that alternately inflates and deflates the bladder.

As the belt inflates, the abdominal contents are compressed and the abdomen rises, forcing air out of the lungs. When the belt deflates, the diaphragm is lowered and inhalation occurs passively. Because the pneumobelt works with gravity, it is most effective in the sitting and standing positions and should not be used at night in the supine position. The pneumobelt is powered by a volume or combination/multi-mode ventilator. It is available as needed from Philips Respironics. Contact the area representative.

An exsufflation belt is also made in Italy by Dima Italia S.r.l. The LunaBelt (a device) applies IAPV (Intermittent Abdominal Pressure Ventilation) through the use of a defined corset “exsufflation belt” which is available in four sizes.

**What is positive pressure ventilation?**

Positive pressure—higher than atmospheric pressure—pushes air into the lungs. It can be administered either noninvasively via a wide variety of interfaces (nasal, facial and oral masks, nasal pillows, or mouthpieces), with tubing attaching the interface to the ventilator or invasively via tracheostomy.

Examples of equipment that deliver positive pressure ventilation are bilevel positive airway pressure ventilators, pressure support ventilators and volume ventilators, and combination/multi-mode ventilators.

The high flow of air from positive pressure may cause dryness in the nasal passages and upper airway, and humidifiers may help relieve symptoms of nasal stuffiness, dry mouth and thick nasal secretions. An integrated humidifier is a feature of some ventilators.

**What is CPAP?**

CPAP (continuous positive airway pressure) provides a continuous flow of air at a constant pressure for both inhalation and exhalation to keep the airway open during sleep. It is the standard of treatment for obstructive sleep apnea, during which the muscles of the throat collapse and block the airway. Auto-titrating CPAP units or APAPs deliver varying pressures based on the detection of sleep-disordered breathing events; the pressure can change breath-by-breath. A nasal or facial mask, connected by tubing to the CPAP unit, is worn during the night.

**What is a bilevel positive airway pressure ventilator?**

Bilevel ventilators were developed by modifying CPAP so that both inspiratory positive airway pressure (IPAP) and expiratory positive airway pressure (EPAP) could be delivered. The IPAP/EPAP settings can be adjusted separately.

People with neuromuscular disorders and weak diaphragmatic muscles may have difficulty breathing in and may need IPAP set higher than EPAP, e.g. IPAP of 14, EPAP of 3. The difference between IPAP and EPAP is called the span, and in these cases, should be at least 10.

Bilevel ventilators are made by several manufacturers. BiPAP® was the name patented and registered by Respironics, Inc., and many bilevels have been incorrectly referred to as BiPAPs.

Bilevels are used primarily during the night with a noninvasive facial, nasal or oral mask, or nasal pillows. Some people use their bilevels continuously, but in the USA, the FDA has not approved them for 24-hour use in the home. They are also not approved for use by people who have tracheostomies.
What is a bilevel positive airway pressure ventilator? (continued)

Some physicians prescribe them for infants and children, particularly in developing countries because the bilevel ventilators are more affordable and available than volume, pressure, or combination/multi-mode ventilators.

The bilevel modes are:

- “S” for spontaneous breathing patterns that the unit senses and then switches between prescribed pressures.
- “T” for timed breaths that are delivered at a preset rate.
- “S/T” for spontaneous/timed. The unit switches to a timed mode (also known as a backup rate) when breaths are not spontaneously initiated by the individual. People with neuromuscular disorders should use a bilevel ventilator with a backup rate so that breaths are initiated for them.

The advantages of bilevel ventilators are: small size, light weight and portability, lower cost, and compensation for leaks from masks. Disadvantages include lack of internal batteries, no or few alarms, inadequate pressures for some people, higher electricity operating costs, and discomfort from EPAP. Many of the combination/multi-mode ventilators can provide bilevel ventilation.

The following equipment specifications are for bilevel ventilators currently on the markets. There is no “standard” form for specifications. American and European manufacturers differ in the technical information that they provide about their products. Alarms must be a certain volume. Minimum and maximum alarm volume is regulated.

<table>
<thead>
<tr>
<th>Bilevel Positive Airway Pressure Ventilators</th>
<th>Mode</th>
<th>IPAP</th>
<th>EPAP/CPAP</th>
<th>Breath Rate</th>
<th>Trigger/Tidal Volume</th>
<th>AC Voltage</th>
<th>Battery</th>
<th>Dimensions</th>
<th>Weight</th>
<th>Noise</th>
<th>Alarms</th>
</tr>
</thead>
<tbody>
<tr>
<td>BiLevel ST 22 Löwenstein Medical</td>
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</tr>
<tr>
<td><a href="https://loewensteinmedical.de/en/produkt-katagorie-ventilation">https://loewensteinmedical.de/en/produkt-katagorie-ventilation</a></td>
<td>CPAP, spontaneous, timed, spontaneous/timed</td>
<td>6-22 hPa</td>
<td>4-20 hPa</td>
<td>6-45 BPM</td>
<td>6</td>
<td>115-230 V, 50/60 Hz</td>
<td>No internal</td>
<td>External: Ventipower</td>
<td>230 mm W x 120 mm H x 280 mm D</td>
<td>3.7 kg</td>
<td>&lt;26 dB</td>
</tr>
<tr>
<td>Available only outside USA</td>
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<td>H - VentiO2</td>
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<tr>
<td>BiPAP A30 Philips Respironics</td>
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<tr>
<td><a href="http://healthcare.philips.com/main/homehealth/respiratory_care/bipapa30">http://healthcare.philips.com/main/homehealth/respiratory_care/bipapa30</a></td>
<td>CPAP, spontaneous, timed, spontaneous/timed, pressure control</td>
<td>4-30 cm H2O</td>
<td>4-25 cm H2O</td>
<td>0-40 BPM (4-40 BPM in T mode)</td>
<td>200-1500 ml</td>
<td>100-240 V, 50/60 Hz</td>
<td>12-24 VDC</td>
<td>21.6 cm W x 19 cm L x 11.5 cm H</td>
<td>2.1 kg (with power supply)</td>
<td>&lt;30 dB</td>
<td>Apnea, circuit disconnect, high respiratory rate, low minute ventilation, low tidal volume</td>
</tr>
<tr>
<td>Available only outside USA</td>
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<td></td>
<td>H - integrated</td>
</tr>
</tbody>
</table>

**KEY:** 1 = available only in USA  
2 = available only outside USA  
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What is a bilevel positive airway pressure ventilator? (continued)

<table>
<thead>
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<th>Bilevel Positive Airway Pressure Ventilators</th>
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<th>EPAP/CPAP</th>
<th>Breath Rate</th>
<th>Trigger/Tidal Volume</th>
<th>AC Voltage</th>
<th>Battery</th>
<th>Dimensions</th>
<th>Weight</th>
<th>Noise</th>
<th>Alarms</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BiPAP A40</strong> Philips Respironics [2]</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>CPAP, spontaneous, timed, spontaneous/timed, pressure control, AVAPS-AE</td>
<td>4-40 cm H2O</td>
<td>4-25 cm H2O</td>
<td>0-40 BPM (4-40 BPM in T mode)</td>
<td>200-1500 ml, flow trigger, auto-trak</td>
<td>100-240 V, 50/60 Hz</td>
<td>12 VDC detachable external up to 5 hrs; 24 VDC power supply</td>
<td>21.6 cm W x 19 cm L x 11.5 cm H</td>
<td>2.1 kg (with power supply)</td>
<td>&lt;30 dB</td>
</tr>
<tr>
<td><strong>BiPAP AVAPS</strong> (Average Volume-Assured Pressure Support) Philips Respironics [3] [2]</td>
<td></td>
<td>CPAP, spontaneous, timed, spontaneous/timed, pressure control, average volume-assured ventilator pressure support</td>
<td>4-25 cm H2O</td>
<td>4-25 cm H2O</td>
<td>0-30 BPM</td>
<td>200-1500 ml</td>
<td>110-240 V, 50/60 Hz</td>
<td>No internal External: 12 V</td>
<td>7&quot; L x 5.5&quot; W x 4&quot; H: 18 cm x 14 cm x 10</td>
<td>3 lbs, 1.36 kg</td>
<td>&lt;30 dB</td>
</tr>
<tr>
<td><strong>BiPAP Harmony</strong> Philips Respironics [2]</td>
<td>Spontaneous, spontaneous/timed, CPAP</td>
<td>4-30 cm H2O</td>
<td>4-25 cm H2O</td>
<td>0-30 BPM</td>
<td>100-240 V</td>
<td>No internal External: 12-24 V with inverter</td>
<td>24 L x 17 W x 11 H cm</td>
<td>2.6 kg</td>
<td>&lt;30 dB</td>
<td>Disconnect, apnea, device failure, low external battery</td>
<td></td>
</tr>
<tr>
<td><strong>BiPAP S/T</strong> Philips Respironics [2]</td>
<td>Spontaneous, spontaneous/timed, CPAP</td>
<td>4-25 cm H2O</td>
<td>4-25 cm H2O</td>
<td>0-30 BPM</td>
<td>100-240 V</td>
<td>No internal External: 12 V with inverter</td>
<td>7&quot; L x 5.5&quot; W x 4&quot; H: 18 cm x 14 cm x 10</td>
<td>3 lbs, 1.36 kg</td>
<td>&lt;30 dB</td>
<td>Mask disconnect, apnea, low minute ventilation, unit malfunction, low/empty internal battery, power failure</td>
<td></td>
</tr>
<tr>
<td><strong>BiPAP Synchrony</strong> Philips Respironics [2]</td>
<td>Spontaneous, timed, spontaneous/timed, CPAP, pressure control</td>
<td>4-30 cm H2O</td>
<td>4-25 cm H2O</td>
<td>0-30 BPM (S/T); 4-30 BPM (T)</td>
<td>200-1500 ml</td>
<td>100-240 V, 50/60 Hz</td>
<td>No internal External: 12 V with inverter</td>
<td>4.4&quot; H x 6.625&quot; W x 9.75&quot; H</td>
<td>4.2 lbs</td>
<td>&lt;30 dB</td>
<td>Low Vte, mask disconnect, apnea, low minute ventilation, low external battery, power failure</td>
</tr>
</tbody>
</table>

**KEY:** [1] = available only in USA  [2] = available only outside USA  [3] = available worldwide

**Humidifier =** H  
**Oxygen =** O
### What is a bilevel positive airway pressure ventilator? (continued)

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<tr>
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<th>Breath Rate</th>
<th>Trigger/ Tidal Volume</th>
<th>AC Voltage</th>
<th>Battery</th>
<th>Dimensions</th>
<th>Weight</th>
<th>Noise</th>
<th>Alarms</th>
<th>Humidifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>DreamStation BiPAP AVAPS (Average Volume-Assured Pressure Support) Philips Respironics <a href="http://www.usa.philips.com/healthcare/solutions/sleep-and-respiratory-care/ventilation">www.usa.philips.com/healthcare/solutions/sleep-and-respiratory-care/ventilation</a></td>
<td>CPAP, Spontaneous, spontaneous/ timed, Timed, Pressure assist control</td>
<td>6-30 cm H2O</td>
<td>4-30 cm H2O Max 20 cm H2O</td>
<td>1-30 BPM</td>
<td>200-1500 ml per breath (increment is 10 ml)</td>
<td>100-240 V, 50/60 Hz</td>
<td>No Internal</td>
<td>15.7 x 19.3 x 8.4 cm 29.7 x 19.3 x 8.4 m with humidifier</td>
<td>1.33 kg, 2.94 lbs 1.98 kg, 4.37 lbs with humidifier</td>
<td>n/a</td>
<td>Low/high pressure; low/high rate/ low/high inspired tidal volume; apnea; malfunction; low internal battery; power failure</td>
<td>H optional</td>
</tr>
<tr>
<td>Falco 51 Siare Engineering International Group, S.r.l. <a href="http://www.siare.it">www.siare.it</a></td>
<td>Spontaneous, spontaneous/ timed, CPAP</td>
<td>6-40 cm H2O</td>
<td>0-20 cm H2O</td>
<td>5-50 BPM</td>
<td>50-2500 ml; 1-9 L/min inspiratory trigger; 5-90% expiratory</td>
<td>100-240 V, 50/60 Hz</td>
<td>Internal: NiMH up to 5 hrs</td>
<td>240 L x 330 D x 210 H mm</td>
<td>3.9 lb</td>
<td>n/a</td>
<td>Low/high pressure; low/high rate/ low/high inspired tidal volume; apnea; malfunction; low internal battery; power failure</td>
<td>n/a</td>
</tr>
<tr>
<td>iSleep™ 25 BREAS Medical AB <a href="http://www.breas.com">www.breas.com</a></td>
<td>Spontaneous, CPAP, spontaneous/ timed, pressure assist control</td>
<td>4-25 cm H2O</td>
<td>4-20 cm H2O</td>
<td>4-30 BPM</td>
<td>1-9 inspiratory 1-9 expiratory</td>
<td>100-240 V</td>
<td>No internal External: 24 V DC, 12V adapter</td>
<td>173 mm W x 172 mm H x 201 mm D</td>
<td>1.9 kg</td>
<td>&lt;28 dB</td>
<td>Device failure, malfunction, high pressure leak, power failure</td>
<td>H, integrated</td>
</tr>
<tr>
<td>Monnal T30 Air Liquide Medical Systems, Inc. <a href="http://www.device.airliquidehealthcare.com">www.device.airliquidehealthcare.com</a></td>
<td>CPAP, S, ST, T, Pressure assist control</td>
<td>4-30 hPa</td>
<td>EPAP: 2- 25 hPa CPAP: 4- 20 hPa</td>
<td>0, and 4-40 BPM</td>
<td>4 inspiratory; 3 expiratory</td>
<td>110-230 VAC, 50/60 Hz</td>
<td>No internal External: 12 V</td>
<td>175 H x 338 L x 196 mm W</td>
<td>3.8 kg</td>
<td>30 dB</td>
<td>Leak, patient disconnect, power failure</td>
<td>H</td>
</tr>
</tbody>
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<th>Battery</th>
<th>Dimensions</th>
<th>Weight</th>
<th>Noise</th>
<th>Alarms</th>
<th>Humidifier</th>
<th>Oxygen</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Multilevel ST-30</strong>&lt;br&gt;Multilevel ST-30V&lt;br&gt;Multilevel ST-40V**&lt;br&gt;Dima Italia S.r.l.&lt;br&gt;www.dimaitalia.com</td>
<td>CPAP, Spontaneous, spontaneous/timed, Timed, SP</td>
<td>3-30 cm H2O (3-40 cm H2O for ST-40V)</td>
<td>0-25 cm H2O</td>
<td>5-60 BPM</td>
<td>1-9 autotrack Target volume (ST-30V and ST-40V only): 100-1500 cc/cycle</td>
<td>100-240 V, 50/60 Hz</td>
<td>No Internal External: 50 V</td>
<td>18 cm W x 14 cm D x 19 cm H</td>
<td>1.5 kg</td>
<td>&lt;25 dBA</td>
<td>Apnea, leak/mask disconnect, high respiratory rate, high/low inspiratory pressure, high expiratory rate, low tidal volume, empty battery, malfunction, power failure</td>
<td>H</td>
<td>O</td>
</tr>
<tr>
<td><strong>Nippy™ S+</strong>&lt;br&gt;B&amp;D Electromedical (now part of BREAS)&lt;br&gt;www.nippyventilator.com</td>
<td>Pressure support</td>
<td>3-38 cm H2O</td>
<td>3-20 cm H2O</td>
<td>Fixed Backup 12 BPM</td>
<td>.7-3.0 sec 1-10 inspiratory 1-10 expiratory</td>
<td>100-240 VAC</td>
<td>Internal 4-12 hrs External: 4-12 hrs</td>
<td>297 mm x 223 mm x 132 mm</td>
<td>3.6 kg</td>
<td>4.5 kg with ext. battery</td>
<td>Mask off, power failure</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Nippy™ ST+</strong>&lt;br&gt;B&amp;D Electromedical (now part of BREAS)&lt;br&gt;www.nippyventilator.com</td>
<td>CPAP, pressure support</td>
<td>3-38 cm H2O</td>
<td>3-20 cm H2O</td>
<td>6-43 BPM</td>
<td>Flow, 200 L/min</td>
<td>100-240 V, 47-63 Hz</td>
<td>Opt. internal 4-12 hrs External: 24 V, 4-12 hrs</td>
<td>30 L x 22 W x 13 H cm</td>
<td>3.6 kg</td>
<td>4.5 kg with battery</td>
<td>Mask off, apnea, power failure, low battery, low/high pressure, device malfunction</td>
<td></td>
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</tr>
<tr>
<td><strong>Puritan Bennett™ Smartair ST</strong>&lt;br&gt;Medtronic&lt;br&gt;www.medtronic.com/covidien</td>
<td>Spontaneous, spontaneous/timed, CPAP pressure control</td>
<td>5-30 mbar</td>
<td>4-20 mbar CPAP: 5-25 mbar</td>
<td>4-40 BPM</td>
<td>5 inspiratory, 200 L/min</td>
<td>115-230 V, 50/60 Hz</td>
<td>No internal</td>
<td>200 x 125 x 290 mm</td>
<td>2.7 kg</td>
<td>&lt;30 dB</td>
<td>Optional low pressure, mask leak</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SOMNOvent ST</strong>&lt;br&gt;Löwenstein Medical&lt;br&gt;<a href="https://loewensteinmedical.de/en/produkt-kategorie-ventilation">https://loewensteinmedical.de/en/produkt-kategorie-ventilation</a></td>
<td>Spontaneous, timed, spontaneous/timed, CPAP</td>
<td>4-20 mbar</td>
<td>4-18 mbar</td>
<td>5-45 BPM</td>
<td>5 inspiratory 5 expiratory</td>
<td>115-230 V, 50/60 Hz</td>
<td>No internal</td>
<td>18 W x 9 H x 32 D cm</td>
<td>4 kg</td>
<td>26 dB</td>
<td>Mask leak, disconnect, apnea, low external battery, power failure</td>
<td>H, O</td>
<td></td>
</tr>
<tr>
<td><strong>VENTImotion 2</strong>&lt;br&gt;Löwenstein Medical&lt;br&gt;<a href="https://loewensteinmedical.de/en/produkt-kategorie-ventilation">https://loewensteinmedical.de/en/produkt-kategorie-ventilation</a></td>
<td>Timed, timed/spontaneous, timed adaptive, CPAP</td>
<td>6-40 hPa</td>
<td>4-20 hPa</td>
<td>6-45 L/m</td>
<td>6 inspiratory 6 expiratory</td>
<td>115-230 V, 50/60 Hz</td>
<td>No Internal External: VENTIPower, 7 hrs</td>
<td>230 W x 120 H x 280 D mm</td>
<td>3.7 kg</td>
<td>26 dB</td>
<td>Low minute ventilation, low/high pressure, apnea, disconnect, device malfunction, overheating, low/empty external battery, power failure</td>
<td>H, O</td>
<td></td>
</tr>
</tbody>
</table>
What is a bilevel positive airway pressure ventilator? (continued)

<table>
<thead>
<tr>
<th>Bilevel Positive Airway Pressure Ventilators (continued)</th>
<th>Mode</th>
<th>IPAP</th>
<th>EPAP/CPAP</th>
<th>Breath Rate</th>
<th>Trigger/Tidal Volume</th>
<th>AC Voltage</th>
<th>Battery</th>
<th>Dimensions</th>
<th>Weight</th>
<th>Noise</th>
<th>Alarms</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VPAP™ COPD</strong> ResMed <a href="http://www.resmed.com">www.resmed.com</a> ³</td>
<td>Spontaneous, CPAP</td>
<td>4-30 cm H₂O</td>
<td>3-25 cm H₂O</td>
<td>5 trigger settings</td>
<td>100-240 V, 50/60 Hz</td>
<td>No internal</td>
<td>External: 24 VDC</td>
<td>153 mm L x 172 mm W x 86 mm H</td>
<td>1.04 kg</td>
<td>Low SpO₂, low minute ventilation, apnea, high leak, non-vented mask, circuit occlusion/disconnection, malfunction, power failure</td>
<td>H, O</td>
</tr>
<tr>
<td><strong>VPAP™ ST (S7)</strong> ResMed <a href="http://www.resmed.com">www.resmed.com</a> ³</td>
<td>Spontaneous, timed, spontaneous/timed, CPAP</td>
<td>4-25 cm H₂O</td>
<td>3-25 cm H₂O</td>
<td>5-30 BPM</td>
<td>Flow 5 inspiratory 5 expiratory</td>
<td>100-240 V, 50/60 Hz</td>
<td>No internal</td>
<td>External: 24 VDC</td>
<td>112 L x 145 H x 164 W mm</td>
<td>1.3 kg</td>
<td>&lt;26 dB</td>
</tr>
<tr>
<td><strong>VPAP™ ST-A with iVAPS (S9)</strong> (intelligent Average Volume Assured Pressure Support) ResMed <a href="http://www.resmed.com">www.resmed.com</a> ³</td>
<td>Spontaneous, spontaneous/timed, CPAP</td>
<td>3-30 cm H₂O</td>
<td>3-25 cm H₂O</td>
<td>5 trigger settings</td>
<td>100-240 V, 50/60 Hz</td>
<td>No internal</td>
<td>External: 24 VDC</td>
<td>153 mm L x 172 mm W x 86 mm H; 6&quot; L x 6.8&quot; W x 3.4&quot; H</td>
<td>2.3 lbs, 1.045 kg</td>
<td>Power failure, block tube, tube disconnection, high leak, non-vented mask, low minute volume, apnea, low SpO₂</td>
<td>H</td>
</tr>
<tr>
<td><strong>VPAP™ III ST-A (S7)</strong> ResMed <a href="http://www.resmed.com">www.resmed.com</a> ³</td>
<td>Spontaneous, timed, spontaneous/timed, CPAP</td>
<td>3-30 cm H₂O</td>
<td>3-25 cm H₂O</td>
<td>5-30 BPM</td>
<td>Flow 3 inspiratory 3 expiratory</td>
<td>100-240 V, 50/60 Hz</td>
<td>No internal</td>
<td>External: 24 VDC</td>
<td>270 L x 230 W x 141 mm H</td>
<td>2.3 kg</td>
<td>&lt;30 dB</td>
</tr>
<tr>
<td><strong>VPAP™ III ST-A with QuickNav (S7)</strong> ResMed <a href="http://www.resmed.com">www.resmed.com</a> ²</td>
<td>Spontaneous, timed, spontaneous/timed, CPAP</td>
<td>2-30 cm H₂O</td>
<td>2-25 cm H₂O</td>
<td>3 sensitivity triggers; 50-3,000 mL</td>
<td>100-240 V, 50/60 Hz</td>
<td>ResMed Power Station up to 12 hrs</td>
<td>270 mm L x 230 mm W x 141 mm H</td>
<td>2.3 kg</td>
<td>Power failure, IPAP lower pressure, check tube, leak, non-vented, low minute ventilation, high pressure, low pressure</td>
<td>H</td>
<td></td>
</tr>
<tr>
<td><strong>VPAP™ IV ST</strong> ResMed <a href="http://www.resmed.com">www.resmed.com</a> ²</td>
<td>Spontaneous, timed, spontaneous/timed, CPAP</td>
<td>4-25 cm H₂O</td>
<td>2-25 cm H₂O</td>
<td>5 levels. 170 L/min max. flow</td>
<td>100-240 V, 50/60 Hz</td>
<td>No internal</td>
<td>External: 24 VDC</td>
<td>112 mm L x 164 mm W x 145 mm H</td>
<td>1.3 kg</td>
<td>&lt;28 dB</td>
<td>None</td>
</tr>
</tbody>
</table>

**KEY:** ¹ = available only in USA ² = available only outside USA ³ = available worldwide
**What is a volume-cycled ventilator?**

Volume-cycled ventilators deliver a preset volume of air in a constant flow during inspiration. Volume ventilators can deliver higher volumes and pressures than bilevel units; the volume remains constant despite interface leaks. The pressure limit can be adjusted by increasing the volume and lowering the high-pressure alarm. Volume-cycled ventilators can be used for breath stacking (adding one breath to another without exhaling) to enable deeper breaths for improved cough. They also have alarms and internal batteries, but they are larger, heavier and more expensive than bilevel units, although some use less electricity to operate. If an individual needs 24-hour ventilation, a volume ventilator is recommended because it is approved by the FDA for this purpose and has the necessary safety features.

**Mode Definitions**

*Control:* Delivers only controlled breaths at specified tidal volume and prescribed respiratory rate. Ventilator is triggered by pre-set machine rate, and the individual cannot take any spontaneous breaths.

*Assist/Control:* Allows individual to initiate/trigger a machine-assisted breath and to take additional breaths at prescribed tidal volume.

*SIMV (Synchronized Intermittent Mandatory Ventilation):* Prescribed tidal volume and respiratory rate but individual can breathe spontaneously in between delivered breaths.

*PEEP (Positive End Expiratory Pressure):* Airway pressure is maintained at the end of the ventilator breaths to increase volume of air remaining in the lungs at the end of expiration.

*IPPB (Intermittent Positive Pressure Breathing):* Intermittent delivery of deep insufflations.

*Sigh:* Provides an increased amount of volume at intervals to simulate a normal sigh breath.

The following equipment specifications are for volume-cycled ventilators currently on the markets. There is no “standard” form for specifications. American and European manufacturers differ in the technical information that they provide about their products. Alarms must be a certain volume. Minimum and maximum alarm volume is regulated.

<table>
<thead>
<tr>
<th>Volume-cycled Ventilators</th>
<th>Mode</th>
<th>Tidal Volume</th>
<th>Inspiratory Flow Rate</th>
<th>Breath Rate</th>
<th>PEEP</th>
<th>Trigger</th>
<th>AC Voltage</th>
<th>Battery</th>
<th>Dimensions</th>
<th>Weight</th>
<th>Alarms</th>
</tr>
</thead>
<tbody>
<tr>
<td>LTV®800 CareFusion</td>
<td>Spontaneous, control, assist/control, SIMV</td>
<td>50-2000 ml</td>
<td>10-100 LPM</td>
<td>0-80 BPM</td>
<td>0-20 cm H2O</td>
<td>Pressure</td>
<td>90-250 V, 47/63 Hz</td>
<td>Internal, 1 hr External: 3 hrs, 4 hrs, 9 hrs Automobile cigarette lighter adapter</td>
<td>3” H x 10” W x 12” D</td>
<td>12.85 lbs</td>
<td>Low/high pressure, empty/low battery, low minute ventilation, apnea, power failure, malfunction, disconnect</td>
</tr>
</tbody>
</table>

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### Volume-cycled Ventilators

<table>
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<tr>
<th>Model</th>
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<th>Breath Rate</th>
<th>PEEP</th>
<th>Trigger</th>
<th>AC Voltage</th>
<th>Battery</th>
<th>Dimensions</th>
<th>Weight</th>
<th>Alarms</th>
<th>Humidifier</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LTV®1100</strong></td>
<td>Volume; controlled, assist/controlled, SIMV; Pressure support: S, T, ST, CPAP</td>
<td>50-2000 ml</td>
<td>10-100 LPM</td>
<td>0-80 BPM</td>
<td>0-20 cm H2O; Internal</td>
<td>Flow-Off; 1-9 lpm</td>
<td>100-250 V, 50/60 Hz</td>
<td>Internal, up to 1 hr External: 11-15 VDC; SpringPack up to 6 hrs Automobile cigarette lighter adapter</td>
<td>10.5” W x 13.5” D x 3.25” H; 27 cm W x 38 cm D x 8.4 cm H</td>
<td>14.5 lbs, 6.5 kg</td>
<td>High pressure limit, high breath rate, low peak pressure, low minute volume, high/low PEEP, high/low O inlet pressure, apnea, disconnect, low/empty internal battery, malfunction, power failure</td>
<td>O</td>
</tr>
<tr>
<td><strong>PLV®-100</strong></td>
<td>Control, assist/control, SIMV</td>
<td>0.05-3.00 L ± 10%</td>
<td>10-120 LPM</td>
<td>2-35 BPM + 5; 36-40 ± 2</td>
<td>120 V, 50/60 Hz, 220-240 V, 50/60 Hz</td>
<td>Internal, 1 hr External: 12 V</td>
<td>9” H x 12.25” W x 12.25” D</td>
<td>28.2 lbs</td>
<td>Low/high pressure, apnea, low battery, power failure, malfunction</td>
<td>H</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PLV®-102</strong></td>
<td>Control, control + sigh, assist/control, SIMV</td>
<td>0.05-0.20 L ± 10%</td>
<td>10-120 LPM</td>
<td>2-35 BPM + 0.5; 36-40 ± 2</td>
<td>120 V, 50/60 Hz, 220-240 V, 50/60 Hz</td>
<td>Internal, 1 hr External: 12 V</td>
<td>9” H x 12.25” W x 12.25” D</td>
<td>28.9 lbs</td>
<td>Low/high pressure, apnea, low battery, power failure, malfunction</td>
<td>H, O</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PLV®-102b</strong></td>
<td>Control, control + sigh, assist/control, SIMV</td>
<td>0.05-0.20 L ± 10%</td>
<td>10-120 LPM</td>
<td>2-35 BPM + 0.5; 36-40 ± 2</td>
<td>120 V, 50/60 Hz, 220-240 V, 50/60 Hz</td>
<td>Internal, 1 hr External: 12 V</td>
<td>9” H x 12.25” W x 12.25” D</td>
<td>28.9 lbs</td>
<td>Low/high pressure, apnea, low battery, power failure, malfunction</td>
<td>H</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>UniVent™ Eagle™ 754</strong></td>
<td>Assist/control, SIMV, CPAP</td>
<td>0-3000 ml</td>
<td>1-150 BPM</td>
<td>1-20 cm H2O</td>
<td>Flow</td>
<td>90-265 V, 47/440 Hz</td>
<td>Internal, 3 hrs max External: 11-15 V</td>
<td>8.87” x 11.5” x 4.5” D</td>
<td>13 lbs</td>
<td>Low/high pressure, low battery, malfunction, disconnect, power failure, tidal volume</td>
<td>O</td>
<td></td>
</tr>
</tbody>
</table>

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**PLV®-100 Philips Respironics**
www.usa.philips.com/healthcare/solutions/sleep-and-respiratory-care/ventilation
Discontinued; serviced through 2014

**PLV®-102 Philips Respironics**
www.usa.philips.com/healthcare/solutions/sleep-and-respiratory-care/ventilation
Discontinued; serviced through 2014

**UniVent™ Eagle™ 754 ZOLL Medical Corporation**
www.zoll.com
Discontinued (2014); service as long as parts available

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**What is a volume-cycled ventilator? (continued)**
What is a pressure support ventilator? What is pressure control?

Pressure support ventilators supplement the inspiratory effort of individuals who can breathe spontaneously by providing a preset amount of positive airway pressure throughout the complete inspiration. The tidal volume can vary from breath to breath. Pressure control means that the ventilator, rather than the individual, controls the breathing rate. Pressure control maintains a preset inspiratory pressure.

The following equipment specifications are for pressure support ventilators currently on the markets. There is no “standard” form for specifications. American and European manufacturers differ in the technical information that they provide about their products. Alarms must be a certain volume. Minimum and maximum alarm volume is regulated.

<table>
<thead>
<tr>
<th>Pressure Support Ventilators</th>
<th>Mode</th>
<th>Tidal Volume</th>
<th>Pressure Range</th>
<th>Breath Rate</th>
<th>IPAP, EPAP, PIP, PEEP</th>
<th>Trigger</th>
<th>AC Voltage</th>
<th>Battery</th>
<th>Dimensions</th>
<th>Weight</th>
<th>Alarms</th>
<th>Humidifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Falco 101</td>
<td>CPAP, bilevel-S, bilevel-ST, pressure support (PSV), pressure assist/control (PCV, APCV), pressure support ventilation with guaranteed tidal volume (PSTv), Volumetric option available</td>
<td>50-2500 ml</td>
<td>6-40 cm H2O</td>
<td>5-50 BPM</td>
<td>EPAP/PEEP: 0-20 cm H2O</td>
<td>1-9 l/min inspiratory; 20-50% expiratory</td>
<td>100-240 V, 50/60 Hz</td>
<td>Internal: up to 4 hrs External: up to 10 hrs, 12 V</td>
<td>210 mm H x 240 mm W x 330 mm D</td>
<td>3.9 kg</td>
<td>High/low pressure, high/low rate, high/low inspiratory tidal volume, overheating, malfunction, apnea, power failure, low battery, battery disconnect</td>
<td>H, O</td>
</tr>
<tr>
<td>Pediatric use &gt;5 kg</td>
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<tr>
<td>iVent™ 101 Performance</td>
<td>CPAP, PSV pressure support, Adaptive Bi-Level™, A/C assist/control in VCV volume-controlled or PCV pressure-controlled</td>
<td>40-2500 ml</td>
<td>3-60 cm H2O</td>
<td>1-80 BPM</td>
<td>PEEP: 0-45 cm H2O Flow and pressure 9 levels</td>
<td>100-240 VAC, 50/60 Hz</td>
<td>Internal: up to 4 or 6 hrs External: 24-28 VDC up to 10 hrs</td>
<td>7.5” H x 10” W x 10” D; 19 cm H x 25.5 cm W x 25.3 cm D</td>
<td>13.4 lbs; 6.1 kg</td>
<td>Low/high respiratory rate; apnea; low/high minute volume; low/high FiO2; low/high pressure; leak/occlusion; set pressure or VT not delivered; low O2 pressure; disconnect; overheat; low/empty battery; battery charge; AC disconnect; battery failure; remote; power failure</td>
<td>O</td>
<td></td>
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<tr>
<td>GE Healthcare</td>
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<tr>
<td><a href="http://www.gerespiratorycarecentral.com/home_care.php">www.gerespiratorycarecentral.com/home_care.php</a></td>
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<td></td>
</tr>
<tr>
<td>Multilevel VP</td>
<td>Control, Assist/control, pressure control, pressure support, SIMV</td>
<td>10 cc - 2500 cc</td>
<td>5-99 BPM</td>
<td>IPAP: 3-80 cm H2O EPAP: 0-15 cm H2O PEEP</td>
<td>Inspiratory; expiratory</td>
<td>110-240 V, 50/60 Hz 80 VA</td>
<td>Internal: 12 V, 1-1/2 hrs External</td>
<td>16 x 30 x 22 cm</td>
<td>3.5 kg</td>
<td>Low/high inspiratory pressure, high inspiratory pressure, apnea, low battery, power failure</td>
<td>H, O</td>
<td></td>
</tr>
</tbody>
</table>

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What is a pressure support ventilator? (continued)

<table>
<thead>
<tr>
<th>Pressure Support Ventilators</th>
<th>Mode</th>
<th>Tidal Volume</th>
<th>Pressure Range</th>
<th>Breath Rate</th>
<th>IPAP, EPAP, PIP, PEEP</th>
<th>Trigger</th>
<th>AC Voltage</th>
<th>Battery</th>
<th>Dimensions</th>
<th>Weight</th>
<th>Alarms</th>
<th>Humidifier</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nippy 3+</strong>&lt;br&gt;B&amp;D Electromedical (now part of BREAS)&lt;br&gt;www.nippyventilator.com &lt;sup&gt;v&lt;/sup&gt;</td>
<td>Pressure control, pressure support, IPPV, CPAP</td>
<td>0-30 cm H2O</td>
<td>6-60 BPM</td>
<td>IPAP: 3-30 cm H2O EPAP: 3-20 cm H2O</td>
<td>Inspiratory: 1-10 Expiratory (PS only): 1-10</td>
<td>100-240 VAC, 50/60 Hz</td>
<td>No internal External: 24 V, 2- &amp; 8-hr portable, 4- &amp; 8-hr backup</td>
<td>297 L x 223 W x 132 H mm</td>
<td>3.5 kg</td>
<td>Low/high pressure, flat low battery, disconnect, power failure</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Nippy Junior+</strong>&lt;br&gt;B&amp;D Electromedical (now part of BREAS)&lt;br&gt;www.nippyventilator.com &lt;sup&gt;v&lt;/sup&gt;</td>
<td>CPAP, Pressure Support (PS), Pressure Control (PC), IPPV</td>
<td>6-60 BPM</td>
<td>IPAP: 3-30 cm H2O EPAP: 3-20 cm H2O</td>
<td>Inspiratory: 1-10 Expiratory (PS only): 1-10</td>
<td>100-240 VAC</td>
<td>Internal: 4-12 hours autonomy dependent on settings and leak, 18.75 Vdc: 116 Whr External: 4-12 hours autonomy dependent on settings and leak, 18.75 Vdc: 116 Whr</td>
<td>297 L x 223 W x 132 H mm</td>
<td>4.5 kg</td>
<td>Mask off, power failure, low flow, high flow</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Puritan Bennett™ Smartair Plus</strong>&lt;br&gt;Medtronic&lt;br&gt;www.medtronic.com/covidien/support/product-manuals &lt;sup&gt;v&lt;/sup&gt;</td>
<td>Pressure control, pressure support, volume control, spontaneous, spontaneous/timed, CPAP</td>
<td>100-1250 ml</td>
<td>4-40 BPM in ST; 5-60 BPM in PC and AC</td>
<td>IPAP: 5-30 mbar EPAP: 0-20 mbar</td>
<td>Inspiratory: 1-5 Expiratory: -5 to -75%</td>
<td>115-230 V, 50/60 Hz</td>
<td>Internal, 2-5 hrs External: 24 V</td>
<td>200 x 125 x 290 mm</td>
<td>3.2 kg</td>
<td>Low/high pressure, low/high tidal volume, maximum rate, apnea, disconnect</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Puritan Bennett™ 520</strong>&lt;br&gt;Medtronic&lt;br&gt;www.medtronic.com/covidien/support/product-manuals &lt;sup&gt;v&lt;/sup&gt;</td>
<td>CPAP, pressure support, pressure assist/control</td>
<td>50-2000 ml</td>
<td>5-55 mbar</td>
<td>PIP &amp; PEEP: 0-99 mbar</td>
<td>Inspiratory: 1-5 Expiratory: 5-95%</td>
<td>100-240 V, 50/60 Hz</td>
<td>Internal, &lt;5 hrs External: 12-30 VDC Car adapter</td>
<td>23.5 cm W x 31.5 cm D x 15.4 cm H</td>
<td>4.5 kg</td>
<td>Apnea, high/low inspiratory tidal volume, high/low pressure, high breath rate, high/low battery temperature, leak/occlusion/patient disconnect, low empty battery, unit overheating/malfunction, remote overheating/malfunction, power failure</td>
<td></td>
<td></td>
</tr>
</tbody>
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What is a pressure support ventilator?  

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<th>Dimensions</th>
<th>Weight</th>
<th>Alarms</th>
<th>Humidifier</th>
</tr>
</thead>
</table>
| **PV 403 PEEP**  
BREAS Medical AB  
www.breas.com  
Pediatric use  
*Discontinued; service until February 2019; spare parts are sold* | Pressure support, pressure control, volume control | 0.3-1.6 L | 6-50 mbar | Optional: 0-10 cm mbar | Inspiratory; expiratory | 100-240 V, 50/60 Hz | Internal, up to 15 hrs  
External: 12-24 V, 8-10 hrs | 35 W x 18 H x 26 D cm | 5.5 kg | Low/high pressure, leak, low battery, power failure, malfunction, low tidal volume | HO |
| **Stellar™ 100**  
ResMed  
www.resmed.com  
www.stellar100.com  
Pediatric use >13 kg, 2 years old | CPAP, S spontaneous, T timed, S/T spontaneous timed; pressure assist control | Maximum flow >200 L/min at 20 cm H2O | 5-60 BPM | IPAP: 2-40 cm H2O  
EPAP: 2-25 cm H2O  
CPAP: 4-20 cm H2O | 5 settings | 100-240 V, 50/60 Hz | Internal, up to 2 hrs  
External: 24 VDC or ResMed Power Station II up to 8 hrs | 230 mm L x 170 mm W x 120 mm H | 2.1 kg | Apnea, high/low pressure, high/low respiratory rate, low minute ventilation, high leak, occlusion, circuit disconnect, non-vented mask, high FiO2, low SpO2, empty internal battery, external battery switchover, unit overheating, malfunction, power failure | H4i™, O |
| **Stellar™ 150**  
ResMed  
www.resmed.com  
www.stellar150.com  
Pediatric use >13 kg, 2 years old | CPAP, S spontaneous, T timed, S/T spontaneous timed; pressure assist control, iVAPS (intelligent volume assured pressure support) | Maximum flow >200 L/min at 20 cm H2O | 2-4 cm H2O  
Targets minute ventilation | IPAP: 2-40 cm H2O  
EPAP: 2-25 cm H2O  
CPAP: 4-20 cm H2O | 5 settings | 100-240 V, 50/60 Hz | Internal, up to 2 hrs  
External: 24 VDC or ResMed Power Station II up to 8 hrs | 230 mm L x 170 mm W x 120 mm H | 2.1 kg | Apnea, high/low pressure, high/low respiratory rate, low minute ventilation, high leak, occlusion, circuit disconnect, non-vented mask, high FiO2, low SpO2, empty internal battery, external battery switchover, unit overheating, malfunction, power failure | H4i™, O |
### What is a pressure support ventilator?

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<th>Battery</th>
<th>Dimensions</th>
<th>Weight</th>
<th>Alarms</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vivo® 30</strong> BREAS Medical AB</td>
<td>Pressure support, pressure control, CPAP</td>
<td>4-40 BPM</td>
<td>IPAP: 4-30 cm H2O EPAP: 2-20 cm H2O</td>
<td>Inspiratory 1-9; Expiratory 1-9</td>
<td>100-240 V</td>
<td>External: 12/24 V DC</td>
<td>185 mm W x 230 mm H x 227 mm D</td>
<td>3.3 kg</td>
<td>Low/high pressure, low volume, low/high leakage, low external &amp; internal battery, low power, internal function failure</td>
<td>H</td>
<td></td>
</tr>
<tr>
<td><strong>Vivo® 40</strong> BREAS Medical AB</td>
<td>Pressure support, pressure control, CPAP, target volume</td>
<td>200-1500 ml</td>
<td>IPAP: 4-40 cm H2O EPAP: 2-20 cm H2O</td>
<td>Inspiratory 1-9; Expiratory 1-9</td>
<td>100-240 V</td>
<td>Internal: 3.8 Ah capacity External: 12.5/24 V DC</td>
<td>185 mm W x 240 mm H x 227 mm D</td>
<td>4 kg</td>
<td>Low/high pressure, low volume, low/high breath rate, low/high leakage, low external &amp; internal battery, low power, internal function failure</td>
<td>H</td>
<td></td>
</tr>
<tr>
<td><strong>VS Integra™</strong> ResMed</td>
<td>Pressure control, pressure support, spontaneous, spontaneous/timed</td>
<td>50-2500 ml</td>
<td>IPAP: 5-50 cm H2O EPAP: 4-20 cm H2O</td>
<td>Flow; pressure</td>
<td>100-230 V; 110-230 V</td>
<td>Internal, up to 4 hrs External, up to 8 hrs</td>
<td>135 x 285 x 204 mm</td>
<td>2.6 kg</td>
<td>Minimum/maximum tidal volume, power supply, low/empty battery, low/high pressure, disconnect</td>
<td>O</td>
<td></td>
</tr>
</tbody>
</table>
What is a combination or multi-mode ventilator?

The current generation of ventilators can provide many modes of ventilation: pressure support, pressure control, volume control, bilevel pressure or CPAP.

The following equipment specifications are for combination ventilators currently on the markets. There is no “standard” form for specifications. American and European manufacturers differ in the technical information that they provide about their products. Alarms must be a certain volume. Minimum and maximum alarm volume is regulated.

<table>
<thead>
<tr>
<th>Combination or Multi-Mode Ventilators</th>
<th>Mode</th>
<th>Tidal Volume</th>
<th>Pressure Range</th>
<th>Breath Rate</th>
<th>PEEP</th>
<th>Trigger/Circuits</th>
<th>AC Voltage</th>
<th>Battery</th>
<th>Dimensions</th>
<th>Weight</th>
<th>Alarms</th>
<th>Humidifier</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Astral 100</strong>&lt;br&gt;ResMed&lt;br&gt;www.resmed.com</td>
<td>Volume and pressure; Valve circuit: CPAP, ACV, PACV, P-SIMV, V-SIMV, PS&lt;br&gt;Leak circuit therapy: CPAP, ST, PAC 2 preset programs</td>
<td>100-2500 ml, adult 50-300 ml, pediatric</td>
<td>2-50 cm H2O, leak circuit 0-50 cm of H2O, valve circuit</td>
<td>Off, 2-50 BPM, adult Off, 5-80 BPM, pediatric</td>
<td>Off, 0-20 cm H2O</td>
<td>Single circuit with leak (Vsync) Single circuit with valve (NIV+) TiControl™ Adjustable trigger and cycle</td>
<td>AC 100-240V, 50-60Hz, 90 W 3.75 A continuous, 120 W / 5A peak 115V/400 Hz</td>
<td>Internal: Lithium-Ion battery, 14.4 V, 6.6 Ah, 95 Wh. 8 hr run time, rechargeable External: Two external (8 hr each) batteries, rechargeable</td>
<td>285 mm x 215 mm x 93 mm</td>
<td>3.2 kg</td>
<td>Numerous, including Low-battery, Total power failure, Low/High Pressure, Obstruction, Low/high Resp rate, High leak, Low/High SpO2, Low/High FiO2, Ventilation not started/stopped, Circuit fault, Low/High PEEP, Pressure line disconnected</td>
<td>H, O</td>
</tr>
<tr>
<td><strong>Astral 150</strong>&lt;br&gt;ResMed&lt;br&gt;www.resmed.com</td>
<td>Volume and pressure Valve circuit: CPAP, ACV, PACV, P-SIMV, V-SIMV, PS&lt;br&gt;Leak circuit therapy: CPAP, ST, PAC Manual breath Sigh breath (recruitment) 4 preset programs</td>
<td>100-2500 ml, adult 50-300 ml, pediatric</td>
<td>2-50 cm H2O, leak circuit 0-50 cm of H2O, valve circuit</td>
<td>Off, 2-50 BPM, adult Off, 5-80 BPM, pediatric</td>
<td>Off, 0-20 cm H2O</td>
<td>Single circuit with leak Single circuit with valve Double circuit</td>
<td>AC 100-240V, 50-60Hz, 90 W 3.75 A continuous, 120 W / 5A peak 115V/400 Hz</td>
<td>Internal: Lithium-Ion battery, 14.4 V, 6.6 Ah, 95 Wh. 8 hr run time, rechargeable External: Two external (8 hr each) batteries, rechargeable</td>
<td>285 mm x 215 mm x 93 mm</td>
<td>3.2 kg</td>
<td>Numerous, including Low-battery, Total power failure, Low/High Pressure, Obstruction, Low/high Resp rate, High leak, Low/High SpO2, Low/High FiO2, Ventilation not started/stopped, Circuit fault, Low/High PEEP, Pressure line disconnected</td>
<td>H, O</td>
</tr>
</tbody>
</table>

**KEY:** 1 = available only in USA 2 = available only outside USA 3 = available worldwide
## What is a combination or multi-mode ventilator? (continued)

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<th>Battery</th>
<th>Dimensions</th>
<th>Weight</th>
<th>Alarms</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATHENA Dima Italia S.r.l. <a href="http://www.dimaitalia.com">www.dimaitalia.com</a></td>
<td>Volume: controlled, assist/controlled, SIMV; Pressure: controlled, assist/control, SIMV, support - S, T, ST; CPAP</td>
<td>10 cc - 2500 cc</td>
<td>3-60 cm H2O</td>
<td>5-60 BPM</td>
<td>0-25 cm H2O</td>
<td>9 inspiratory and Auto Track; 10-90% expiratory</td>
<td>100-240 V, 50/60 Hz</td>
<td>Internal, up to 12 hrs Rechargeable</td>
<td>240 mm W x 290 mm D x 180 mm H</td>
<td>3.5 kg</td>
<td>High/low inspiratory, high expiratory pressure, high/low breath rate, minimum volume guarantee, low expiratory volume, high/low FiO2, high/low SpO2, high/low pulse rate, low battery, power failure</td>
</tr>
<tr>
<td>Elisée 150™ ResMed <a href="http://www.resmed.com">www.resmed.com</a></td>
<td>Assist/control in volume, assist pressure control, SIMV, IPPV, pressure support with backup, pressure support with tidal volume</td>
<td>50-500 ml, pediatric 300-2500 ml, adult</td>
<td>3-40 cm H2O, pediatric 5-60 cm H2O, adult</td>
<td>2-80 BPM, pediatric 2-50 BPM, adult</td>
<td>0-20 cm H2O, pediatric 0-25 cm, adult</td>
<td>Inspiratory/Flow and pressure Expiratory/Flow</td>
<td>110-230 V, 50/60 Hz</td>
<td>Internal, up to 14 hrs External: 12-28 V, 20 hrs</td>
<td>260 x 240 x 130 mm</td>
<td>4.4 kg</td>
<td>dependent on internal battery option</td>
</tr>
<tr>
<td>Falco 202 Siare Engineering International Group, S.r.l. <a href="http://www.siare.it">www.siare.it</a></td>
<td>Pressure; spontaneous, spontaneous/timed, CPAP; pressure control - assist control; pressure support with guaranteed tidal volume; volume: assist control, SIMV</td>
<td>50-2500 ml</td>
<td>6-60 cm H2O</td>
<td>5-50 BPM</td>
<td>0-20 cm H2O</td>
<td>1-9 l/min inspiratory; 5-90% expiratory</td>
<td>100-240 V, 50/60 Hz</td>
<td>Internal: NiMH up to 2.5 hrs External: NiMH up to 10 hrs</td>
<td>240 L x 330 D x 210 mm</td>
<td>3.9 kg</td>
<td>Low/high pressure; low/high rate; low/high inspired tidal volume; apnea; overheating; malfunction; low internal battery; battery disconnect; power failure</td>
</tr>
<tr>
<td>Falco 202 New Siare Engineering International Group, S.r.l. <a href="http://www.siare.it">www.siare.it</a></td>
<td>Pressure; CPAP; pressure control - assist control; pressure support with guaranteed tidal volume; volume: assist control; APCV; V-SIMV+PS; P-SIMV+PS</td>
<td>50-3000 ml</td>
<td>2-80 cm H2O</td>
<td>4-80 BPM</td>
<td>Off, 2-50 cm H2O</td>
<td>Pressure: 1-20 cm H2O, Flow: 3-152/min</td>
<td>100-240 V, 50/60 Hz</td>
<td>Integrated External optional</td>
<td>240 L x 245 D x 215 mm</td>
<td>5.5 kg</td>
<td>Low/high pressure; low/high rate; low/high inspired tidal volume; apnea; overheating; malfunction; low internal battery; battery disconnect; power failure</td>
</tr>
</tbody>
</table>

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What is a combination or multi-mode ventilator? (continued)

**KEY:** ① = available only in USA ② = available only outside USA ③ = available worldwide

<table>
<thead>
<tr>
<th>Combination or Multi-Mode Ventilators (continued)</th>
<th>Mode</th>
<th>Tidal Volume</th>
<th>Pressure Range</th>
<th>Breath Rate</th>
<th>PEEP/CPAP</th>
<th>Trigger</th>
<th>AC Voltage</th>
<th>Battery</th>
<th>Dimensions</th>
<th>Weight</th>
<th>Alarms</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flight 60®</strong> Flight Medical Innovations, Ltd. <a href="http://www.flight-medical.com">www.flight-medical.com</a> ③</td>
<td>Volume control, assist/control, SIMV, pressure control, pressure support, spontaneous, CPAP/BiPAP, target tidal volume</td>
<td>30-2,200 ml</td>
<td>0-60 cm H2O</td>
<td>1-99 BPM</td>
<td>3-30 cm H2O</td>
<td>Pressure - 9.9 to -0.1 cm H2O, Flow 1-10 LPM</td>
<td>100-240 V, 50/60 Hz</td>
<td>Internal: up to 12 hrs, rechargeable External: 12-30 VDC</td>
<td>29 cm W x 28 cm D x 25 cm H</td>
<td>6.3 kg</td>
<td>High/low pressure, high/low minute ventilation, high/low FiO2, apnea, low/empty battery, power failure, high respiratory rate, low tidal volume</td>
</tr>
<tr>
<td><strong>Flight 60® i 02</strong> Flight Medical Innovations, Ltd. <a href="http://www.flight-medical.com">www.flight-medical.com</a> ③</td>
<td>Advanced pressure, volume, PRVC, ARPV</td>
<td>30-2,200 ml</td>
<td>5-80 cm H2O</td>
<td>1-99 BPM</td>
<td>0-40 cm H2O</td>
<td>Pressure - 20.0 to -0.1 cm H2O, Flow 1-20 LPM</td>
<td>100-240 V, 50/60 Hz</td>
<td>Internal: up to 12 hrs, Hot Swappable</td>
<td>29 cm W x 28 cm D x 25 cm H</td>
<td>6.3 kg, 6.9 kg</td>
<td>High/low pressure, high/low minute ventilation, high/low FiO2, apnea, low/empty battery, power failure, high respiratory rate, low tidal volume, check circuit, O2 supply failed, check O2, target volume not reached</td>
</tr>
<tr>
<td><strong>iVent 101™ Expert</strong> GE Healthcare <a href="http://www.gerespiratorycarecentral.com/home_care.php">www.gerespiratorycarecentral.com/home_care.php</a> ③</td>
<td>CPAP, PSV pressure support, Adaptive Bi-Level™, A/C assist/control in VCV volume-controlled or PCV pressure-controlled or PRVC pressure regulated volume control; SIMV in VCV, PCV, or PRVC</td>
<td>40-2,500 ml</td>
<td>3-60 cm H2O</td>
<td>1-80 BPM</td>
<td>0-45 cm H2O</td>
<td>Flow and pressure 9 levels</td>
<td>100-240 VAC, 50/60 Hz</td>
<td>Internal, up to 4 or 6 hrs External: 24-28 VDC up to 10 hrs</td>
<td>7.5” H x 10” W x 10” D; 19 cm H x 25.5 cm W x 25.3 cm D</td>
<td>13.4 lbs; 6.1 kg</td>
<td>Low/high respiratory rate; apnea; low/high minute volume; low/ high FiO2; low/high pressure; leak/occlusion; set pressure or Vt not delivered; low O2 pressure; disconnect; overflow; low/empty battery; battery charge; AC disconnect; battery failure; remote; power failure</td>
</tr>
</tbody>
</table>
## What is a combination or multi-mode ventilator?

(continued)

### Combination or Multi-Mode Ventilators

(continued)

<table>
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<tr>
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</tr>
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<tbody>
<tr>
<td><strong>iVent 101™ Signature</strong>&lt;br&gt;GE Healthcare&lt;br&gt;www.gehealthcare.com/respiratorycare&lt;br&gt;Pediatric use</td>
<td>CPAP, PSV pressure support, Adaptive Bi-Level™, A/C assist/control in VCV volume-controlled or PCV pressure-controlled; SIMV in VCV, PCV</td>
<td>40-2,500 ml</td>
<td>3-60 cm H₂O</td>
<td>1-80 BPM</td>
<td>0-45 cm H₂O</td>
<td>Flow and pressure 9 levels</td>
<td>100-240 VAC, 50/60 Hz</td>
<td>Internal, up to 4 or 6 hrs External: 24-28 VDC up to 10 hrs</td>
<td>7.5” H x 10” W x 10” D; 19 cm H x 25.5 cm W x 25.3 cm D</td>
<td>13.4 lbs; 6.1 kg</td>
<td>Low/high respiratory rate; apnea; low/high minute volume; low/high FiO₂; low/high pressure; leak/occlusion; set pressure or Vt not delivered; low O₂ pressure; disconnect; overheat; low/empty battery; battery charge; AC disconnect; battery failure; remote; power failure</td>
<td>O</td>
</tr>
<tr>
<td><strong>LTV®900</strong>&lt;br&gt;CareFusion&lt;br&gt;www.carefusion.com/our-products/browse-brands/ltv&lt;br&gt;Pediatric use &gt; 5 kg&lt;br&gt;Discontinued; serviced through October 2016</td>
<td>Volume control, pressure support, control, assist/control, SIMV, Spontaneous, CPAP</td>
<td>50-2000 ml</td>
<td>Pressure support; 0-60 cm H₂O</td>
<td>0-80 BPM</td>
<td>0-20 cm H₂O</td>
<td>Flow</td>
<td>90-250 V, 47/63 Hz</td>
<td>Internal, 1 hr External: 11-15 V, 3 hrs, 4 hrs, 9 hrs, automobile cigarette lighter adapter</td>
<td>3” H x 10” W x 12” D</td>
<td>13.4 lbs</td>
<td>Low/high pressure, low/empty battery, power failure, malfunction, low minute ventilation, apnea, disconnect</td>
<td>H, O</td>
</tr>
<tr>
<td><strong>LTV®950</strong>&lt;br&gt;CareFusion&lt;br&gt;www.carefusion.com/our-products/browse-brands/ltv&lt;br&gt;Pediatric use &gt; 5 kg&lt;br&gt;Discontinued; serviced through December 2016</td>
<td>Volume control, pressure control, pressure support, control, assist/control, SIMV, spontaneous, CPAP</td>
<td>50-2000 ml</td>
<td>Pressure control 1-99 cm H₂O; Pressure support 0-60 cm H₂O</td>
<td>0-80 BPM</td>
<td>0-20 cm H₂O</td>
<td>Flow</td>
<td>90-250 V, 47/63 Hz</td>
<td>Internal, 1 hr External: 11-15 V, 3 hrs, 4 hrs, 9 hrs, automobile cigarette lighter adapter</td>
<td>3” H x 10” W x 12” D</td>
<td>13.4 lbs</td>
<td>Low/high pressure, low/empty battery, power failure, malfunction, low minute ventilation, apnea, disconnect</td>
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<th>Weight</th>
<th>Alarms</th>
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<tbody>
<tr>
<td><strong>LTV®1000</strong> CareFusion <a href="http://www.carefusion.com/our-products/browse-brands/ltv">www.carefusion.com/our-products/browse-brands/ltv</a></td>
<td>Volume control, pressure control, pressure support, control, assist/control, SIMV, CPAP</td>
<td>50-2000 ml</td>
<td>Pressure control 1-99 cm H2O; Pressure support 0-60 cm H2O</td>
<td>0-80 BPM</td>
<td>0-20 cm H2O; Internal, 1 hr External: 11-15 V, 3 hrs, 9 hrs, automobile cigarette lighter adapter</td>
<td>Flow</td>
<td>90-250 V, 47/63 Hz</td>
<td>Internal, 1 hr External: 11-15 V, 3 hrs, 9 hrs, automobile cigarette lighter adapter</td>
<td>3” H x 10” W x 12” D</td>
<td>13.4 lbs</td>
<td>Low/high pressure, low/empty battery, power failure, malfunction, low minute ventilation, apnea, disconnect</td>
</tr>
<tr>
<td><strong>LTV®1150</strong> CareFusion <a href="http://www.carefusion.com/our-products/browse-brands/ltv">www.carefusion.com/our-products/browse-brands/ltv</a></td>
<td>Volume control, pressure control, pressure support, control, assist/control, SIMV, CPAP, spontaneous breathing trial</td>
<td>50-2000 ml</td>
<td>Pressure control 1-99 cm H2O; Pressure support 0-60 cm H2O</td>
<td>0-80 BPM</td>
<td>0-20 cm H2O; Internal</td>
<td>Flow</td>
<td>100-250 V, 50/60 Hz</td>
<td>Internal, 1 hr External: 11-15 V, 3 hrs, 9 hrs, automobile cigarette lighter adapter</td>
<td>3” H x 10” W x 12” D</td>
<td>13.4 lbs</td>
<td>Low/high pressure, low/empty battery, power failure, malfunction, low minute ventilation, apnea, disconnect</td>
</tr>
<tr>
<td><strong>Monnal T50</strong> Air Liquide Medical Systems, Inc. <a href="http://www.device.airliquidehealthcare.com">www.device.airliquidehealthcare.com</a></td>
<td>PSV pressure support and SIMV; (A)CMV assisted controlled and SIMV; (A) PCV assisted pressure controlled and SIMV</td>
<td>Adult: 100-2000 mL; Child 50-500 mL</td>
<td>5-50 cm H2O</td>
<td>5-50 cm H2O</td>
<td>Inspiratory off, then 0.5-10 L/min; Expiratory 10-90%</td>
<td>100-240 VAC, 50/60 Hz</td>
<td>Internal: Up to 6 hrs External: Up to 18 hrs</td>
<td>33 cm x 25 cm x 18 cm</td>
<td>5.3 kg</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td><strong>Newport™ HT50</strong> Medtronic <a href="http://www.medtronic.com/covidien/products/portable-ventilation">www.medtronic.com/covidien/products/portable-ventilation</a></td>
<td>Volume control, A/CMV &amp; SIMV w/o pressure support, pressure control A/CMV &amp; SIMV w/o pressure support, Spontaneous (CPAP) w/o or w/o pressure support. Backup ventilation in all modes (responds to low-minute volume alarm)</td>
<td>100-2,200 ml (in Volume Control)</td>
<td>Pressure control; 5-60 cm H2O; Volume control; 0-100 cm H2O</td>
<td>1-99 BPM</td>
<td>0-30 cm H2O (leak compensated)</td>
<td>9.9-0 cmH2O relative to built-in PEEP/CPAP</td>
<td>110-240 V, 50/60/400 Hz</td>
<td>Internal, up to 10 hrs, charges to 85% charge in 5-7 hrs from either AC or DC (12-24 V battery). Newport Supplemental Power Pack (24 V): Adds 50% more use time to internal battery. External battery: 12-30 V with automobile cable</td>
<td>10.63” W x 7.87” D x 10.24” H</td>
<td>15 lbs</td>
<td>High/low pressure, high/low minute volume, high/low PEEP, circuit occlusion, apnea, press control level not reached, check prox line, battery low, battery empty, power switchover, device alert, shut down alert</td>
</tr>
</tbody>
</table>
## Combination or Multi-Mode Ventilators

**Newport™ HT70**
- Medtronic
- [Website](https://www.medtronic.com/covidien/products/portable-ventilation)
- Pediatric use > 5 kg
- Volume and pressure: AC MV; SIMV; pressure support; pressure control; spontaneous
- Tidal Volume: 50-2,200 ml
- Pressure Range: Pressure control: 5-60 cm H2O; Pressure support: 0-60 cm H2O
- Breath Rate: 1-99 BPM
- PEEP: 0-30 cm H2O
- Flow: 6-100 L/min
- Pressure trigger sensitivity: Internal, up to 10 hrs; backup battery 30 minutes
- Trigger/Circuits: External battery: 12-24 VDC
- AC Voltage: 100-240 V, 50/60/400 Hz
- Battery: Internal, up to 10 hrs; backup battery 30 minutes
- Dimensions: 9.75” W x 11” D x 10.25” H; 24.74 cm W x 27.94 cm D x 26.04 cm H
- Weight: 15.4 lbs, <7 g
- Alarms: High/low baseline and airway pressure, high/low inspiratory minute volume, high respiratory rate, apnea; high/low FiO2; device malfunction; low battery

**Newport™ HT70 Plus**
- Medtronic
- [Website](https://www.medtronic.com/covidien/products/portable-ventilation)
- Pediatric use > 5 kg
- Volume and pressure: AC MV; SIMV; pressure support; pressure control; spontaneous
- Tidal Volume: 50-2,200 ml
- Pressure Range: Pressure control: 5-60 cm H2O; Pressure support: 0-60 cm H2O
- Breath Rate: 1-99 BPM
- PEEP: 0-30 cm H2O
- Flow: 6-100 L/min
- Pressure trigger sensitivity: Internal, up to 10 hrs; backup battery 30 minutes
- Trigger/Circuits: External battery: 12-24 VDC
- AC Voltage: 100-240 V, 50/60/400 Hz
- Battery: Internal, up to 10 hrs; backup battery 30 minutes
- Dimensions: 9.75” W x 11” D x 10.25” H; 24.74 cm W x 27.94 cm D x 26.04 cm H
- Weight: 15.4 lbs, <7 g
- Alarms: High/low baseline and airway pressure, high/low inspiratory minute volume, high respiratory rate, apnea; high/low FiO2; device malfunction; low battery

**Puritan Bennett™ Achieva® Portable Ventilator**
- Medtronic
- [Website](https://www.medtronic.com/covidien/products/portable-ventilation)
- Discontinued; serviced through September 2015
- Volume control, pressure support, pressure control, control, assist/control, SIMV
- Tidal Volume: 50-2200 ml
- Pressure Range: Inspiration: 0-50 cm H2O; Expiration: 0 and 3-20 cm H2O
- Breath Rate: 1-80 BPM
- PEEP: 0 and 3-20 cm H2O
- Inspiratory/Flow and pressure: Internal, at least 4 hrs under normal load; backup use only
- Trigger/Circuits: External: 24 V, approx 20 hrs under normal load
- AC Voltage: 100-240 V, 50/60 Hz
- Battery: Internal, at least 4 hrs under normal load; backup use only
- Dimensions: 230 x 305 x 150 mm
- Weight: 31 lbs
- Alarms: Low/high pressure, low battery, power failure, malfunction, setting error, power switchover O2 failure (PSO2)

**Puritan Bennett™ Legendair**
- Medtronic
- [Website](https://www.medtronic.com/covidien/products/portable-ventilation)
- Pediatric use > 5 kg
- Discontinued; serviced through May 2015
- Pressure control, pressure support with and without tidal volume, volume control, SIMV
- Tidal Volume: 100-1400 ml
- Pressure Range: Inspiration: 5-40 mbar; Expiration: 0-20 mbar
- Breath Rate: 6-60 BPM
- PEEP: 5 inspiratory
- Trigger/Circuits: Internal, up to 10 hrs
- AC Voltage: 115-230 V, 50/60 Hz
- Battery: External: 24 V
- Dimensions: 230 x 305 x 150 mm
- Weight: 4.5 kg
- Alarms: Low/high pressure, low battery, power failure, malfunction, low minute ventilation, disconnect

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**Humidifier = H**

**Oxygen = O**
**What is a combination or multi-mode ventilator?** (continued)

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<tr>
<th><strong>Combination or Multi-Mode Ventilators</strong> (continued)</th>
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<tbody>
<tr>
<td><strong>Puritan Bennett™ 540 Ventilator</strong> &lt;br&gt; Medtronic <a href="http://www.medtronic.com/covidien/products/portable-ventilation">www.medtronic.com/covidien/products/portable-ventilation</a></td>
<td>CPAP, pressure support, pressure assist/control, volume assist/control, volume SIMV, pressure SIMV</td>
<td>50-2000 ml</td>
<td>5-55 cm H2O</td>
<td>1-60 BPM</td>
<td>0-20 cm H2O</td>
<td>5 inspiratory</td>
<td>100-240 V, 50/60 Hz</td>
<td>Internal: up to 11 hrs &lt;br&gt; External: 12-30 V</td>
<td>6” H x 9.25” W x 12.4” D</td>
<td>9.9 lb</td>
<td>Apnea, circuit occlusion, internal battery malfunction/failure, device malfunction, high/low pressure, high/low VTE, high/low minute ventilation, high device temperature, low/empty internal battery, power disconnect/failure</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td><strong>Puritan Bennett™ 560 Ventilator</strong> &lt;br&gt; Medtronic <a href="http://www.medtronic.com/covidien/products/portable-ventilation">www.medtronic.com/covidien/products/portable-ventilation</a></td>
<td>CPAP, pressure support, pressure assist/control, volume control, pressure control</td>
<td>50-2000 ml</td>
<td>5-55 cm H2O</td>
<td>1-60 BPM</td>
<td>0-20 cm H2O</td>
<td>5 inspiratory</td>
<td>100-240 V, 50/60 Hz</td>
<td>Internal: up to 11 hrs &lt;br&gt; External: 12-30 V</td>
<td>Car adapter</td>
<td>23.5 cm W x 31.5 cm D x 15.4 cm H</td>
<td>4.5 kg</td>
<td>Apnea, high/low inspiratory tidal volume, high/low expiratory tidal volume, high/low pressure, high breath rate, high/low battery temperature, high leak/occlusion/patient disconnect, valve detection error, high/low FiO2, low/empty battery, unit overheat/malfunction, remote call, power failure</td>
<td>H, O</td>
</tr>
<tr>
<td><strong>Trilogy100</strong> &lt;br&gt; Philips Respironics <a href="http://www.usa.philips.com/healthcare/solutions/sleep-and-respiratory-care/ventilation">www.usa.philips.com/healthcare/solutions/sleep-and-respiratory-care/ventilation</a></td>
<td>CPAP, bilevel S, T, T, volume assist/control, volume control, SIMV with pressure support, pressure support, pressure control SIMV, AVAPS, AVAPS-AE</td>
<td>50-2000 ml</td>
<td>IPAP: 4-50 cm H2O &lt;br&gt; EPAP: 0-25 cm H2O active circuit; 4-25 cm H2O passive circuit &lt;br&gt; CPAP: 4-20 cm H2O, Pressure differential: 0-40 cm H2O</td>
<td>0-60 BPM in AC mode; 1-60 in all other modes</td>
<td>0-25 cm H2O active circuit; 4-25 cm H2O passive circuit</td>
<td>Flow trigger sensitivity; Digital Auto-Trak; Passive circuit with exhalation port; active circuit with exhalation valve with proximal pressure, “Kiss”</td>
<td>100-240 VAC, 50/60 Hz</td>
<td>Internal: up to 3 hrs &lt;br&gt; Detachable external: up to 3 hrs &lt;br&gt; Vehicle cable adapter &lt;br&gt; External: 12 VDC</td>
<td>6.6” L x 11.2” W x 9.3” H</td>
<td>11 lb</td>
<td>Circuit disconnect, apnea, low internal battery, high/low tidal volume, high/low minute ventilation, high/low respiratory rate, remote capability, high/low inspiratory pressure, high/low expiratory pressure, power failure, device malfunction</td>
<td>H, O</td>
<td></td>
</tr>
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</table>
**What is a combination or multi-mode ventilator?** (continued)

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<th>Battery</th>
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<th>Weight</th>
<th>Alarms</th>
<th>Humidifier</th>
</tr>
</thead>
</table>
| Trilogy200 Trilogy202 | CPAP, bilevel S, S/T, T; pressure control with SIMV; volume assist/control; volume control; volume SIMV with pressure support, AVAPS, AVAPS-AE | 50-2000 ml | IPAP: 4-50 cm H₂O  
EPAP: 0-25 cm H₂O active circuit; 4-25 cm H₂O passive circuit;  
CPAP: 4-20 cm H₂O  
Pressure differential: 0-40 cm H₂O | 0-60 BPM in AC mode; 1-60 in all other modes | 0-25 cm H₂O active circuit; 4-25 cm H₂O passive circuit | Flow trigger; proximal flow trigger; Digital Auto-Trak; Passive circuit with exhalation port; active circuit with exhalation valve and proximal sensor, “Kiss” | 100-240 VAC, 50/60 Hz | Internal:  up to 3 hrs  
Detachable battery backup to 3 hrs  
External 12 VD;  
Vehical cable adapter | 6.6” x 11.2” x 23.52 cm | 11 lb, 5 kg | Circuit leak/disconnect, apnea, high/low tidal volume, high/low minute ventilation, high/low respiratory rate, high/low inspiratory pressure, high/low expiratory pressure, low internal battery, power failure, device malfunction, remote |
| VentiLogic LS | CPAP; S spontaneous; T timed; ST spontaneous/timed; TA timed adaptive; SX and SXX; PSV; PCV; aPCV; VCV | 5-3,000 ml | 4-45 hPa  
5-45 L/min | 8 levels for separate inspiratory and expiratory | 115-230 VAC, 50/60 Hz | Internal: 3 hrs  
External: VENTIpower, 7 hrs | 230 mm W x 145 mm H x 340 mm D | 6.5 kg | Low minute ventilation, high tidal volume, low/high respiratory rate, low/high control pressure, low/high oxygen; apnea, leak, mask disconnect, device malfunction, overheating, low/empty internal, external battery, power failure |
| VentiLogic plus | Leak: Spontaneous, timed, spontaneous/timed, timed adaptive, CPAP; Valve: Pressure control, assist/pressure control; pressure support, SIMV | 5-3,000 ml | 6-35 hPa leakage; 4-45 hPa valve | 5-45 L/min | 8 levels for separate inspiratory and expiratory; 300 l/min leakage, 270 l/min valve | 115-230 VAC, 50/60 Hz | Internal: 3 hrs  
External: VENTIpower, 7 hrs | 230 W x 145 H x 340 D mm | 6.5 kg | Low minute ventilation, high tidal volume, low/high respiratory rate, low/high control pressure, low/high oxygen; apnea, leak, mask disconnect, malfunction, overheating, low/empty internal or external battery, power failure |

**Pediatric use >5 kg**

Trilogy200 Trilogy202 (integrated O₂ blender)
Philips Respironics

Löwenstein Medical

**O₂ integrated blender with Trilogy202**
### What is a combination or multi-mode ventilator?  
(continued)

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</table>
| **Vivo® 50**  
BREAS Medical AB  
www.breas.com 2  
*Pediatric use* | PSV, PSV (T), PCV, PCV (T), PCV (A), PCV (A+T), VCV, VCV (A), CPAP | 100-2500 ml | 4-40 cm H2O | 5-50 BPM | 0-30 cm H2O | Off and 1-9 Inspiratory; 1-9 expiratory | 100-240 V, 50/60 Hz | Internal: up to 4 hrs  
External: 24 V up to 8 hrs | 348 W x 120 H x 264 D mm | 5.2 kg; 6.7 kg with external battery | Low/high pressure, low/high PEEP; low/high breath rate, low/high inspired tidal volume, low/high minute ventilation, low/high pulse rate, low/high FiO2, apnea; rebreathing, disconnect, low/empty internal/external battery, malfunction, power failure | O |
| **Vivo® 60**  
BREAS Medical AB  
www.breas.com 2  
*Adult and Pediatric use* | PSV, PSV (TgV), SIMV PCV, PCV, PCV (TgV), SIMV VCV, PCV (A), PCV (A+TgV), CPAP, VCV, VCV (A) | 50-2500 ml | 4-60 cm H2O | (PCV, VCV) 4-60 BPM | 0-30 cm H2O for Adult, 0-20 cm paediatric inspiratory pressure, 2 cm H2O or Min Insp Pressure - 2 H2O | 1-9 Inspiratory; 1-9 expiratory | 100-240 V AC | Internal: up to 4 hrs  
External (click-on): 24 V DC up to 8 hrs | 343 W x 125 H x 264 D mm | 5.2 kg | High pressure, low pressure, high PEEP, low PEEP, high Vte/Vli, low Vte/Vli, high MVe/Mvi, low MVe/MVI, high breath rate, low breath rate, apnea, disconnect, rebreathing, high FiO2, Low FiO2, High SpO2, Low SpO2, High EtcO2, Low EtcO2, High InSp CO2, High Pulse rate, Low pulse rate, low last power source | O |
### Combination or Multi-Mode Ventilators

(continued)

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<tr>
<td><strong>VS III™</strong>&lt;br&gt;ResMed&lt;br&gt;www.resmed.com ²&lt;br&gt;Pediatric use</td>
<td>Leak - CPAP; spontaneous; spontaneous/timed; assisted pressure controlled ventilation; Valve-assisted volume controlled ventilation; pressure support with guaranteed tidal volume; assisted pressure controlled ventilation</td>
<td>50-2500 ml</td>
<td>IPAP/PS: 5-30 cm H₂O&lt;br&gt;6-30 cm H₂O&lt;br&gt;5-50 cm H₂O&lt;br&gt;EPAP: 4-20 cm H₂O</td>
<td>5-50 BPM; 5-60 BPM pediatric in PS, VT &amp;A/CV</td>
<td>CPAP/PEEP: 4-20 cm H₂O</td>
<td>Inspiratory flow; 3-8; pressure: Auto, 1-6</td>
<td>100-240 V, 47-63 Hz</td>
<td>Internal: 2-4 hrs&lt;br&gt;External: 26 VDC</td>
<td>14.5 cm x 27.5 cm x 22.1 cm</td>
<td>2.9 kg</td>
<td>High/low pressure, low Vt, low Vte, maximum frequency, high Vt, low battery</td>
</tr>
<tr>
<td><strong>VS Ultra™</strong>&lt;br&gt;ResMed&lt;br&gt;www.resmed.com ²&lt;br&gt;Pediatric use</td>
<td>Assist/control volume, assist pressure control, pressure support with or without backup, pressure support with tidal volume, spontaneous, spontaneous/timed</td>
<td>50-2500 ml</td>
<td>5-50 hPa&lt;br&gt;5-50 adult; 5-60 pediatric</td>
<td>4-20 cm HzO</td>
<td>Inspiratory &amp; Expiratory</td>
<td>100-230 V</td>
<td>Internal: 4 hrs&lt;br&gt;External: 24 V, 8 hrs</td>
<td>135 x 285 x 204 mm</td>
<td>3.5 kg with battery</td>
<td>Low/high pressure, low/empty battery, power failure, disconnect, malfunction, remote, low/high tidal volume</td>
<td>O</td>
</tr>
</tbody>
</table>
Ventilators for infants and children

The choice of a ventilation system in infants and children involves several factors such as the child’s age; degree of respiratory impairment; need for positive end expiratory pressure (PEEP), pressure support, and higher respiratory rates; and the resources and support systems at home.

Infants who are born prematurely often need a ventilator to help them breathe while in the Neonatal Intensive Care Unit (NICU). Others may have progressive and severe muscle weakness or severe aspiration that caused lung injury. These children usually require a tracheostomy to establish an artificial airway and to protect their developing airways.

Children’s ventilatory needs can vary from full respiratory support to partial respiratory support with some ventilator-free time. In children who can initiate a breath and only require night-time support, the use of noninvasive ventilation is increasing. Popular ventilators for pediatric use include the Newport HT50® and Newport HT70®, LTV® series, Trilogy100, and Stellar™100 and 150™ with Pixi® mask system. The Nippy Junior + is the only ventilator specifically manufactured for infants and children (for use in the UK and Europe). In many developing countries, bilevel ventilators are often the only ventilators that are affordable and available to use.

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Nippy Junior +
B & D Electromedical, www.nippyventilator.com  2

Mode: Pressure control, pressure support, CPAP, IPPV (NIV and tracheostomy)
Pressure range: 0-30 cm H2O IPAP; 3-20 cm H2O EPAP
BPM: 6-60
Maximum flow rate: 200L/min
AC voltage: 100-240 V, 47-63 Hz
Internal battery: 4-12 hours depending on settings and leak
External battery: 24 VDC, 4-12 hours depending on settings and leak
Dimensions: 30 L x 22 W x 13 H cm
Weight: 4.5 kg
Alarms: Low/high pressure, low/high flow, low/empty battery, malfunction, disconnect, power failure
Humidifier: External
O: No
Which method and ventilator should be used?

The choice of ventilator can be made by an individual's primary physician, or the primary physician may make a referral to a pulmonologist (also known as a respirologist) who specializes in breathing-related disorders and lung conditions, and often sleep medicine. Some physical medicine and rehabilitation physicians, known as physiatrists, and some neurologists may also specialize in breathing disorders. In some countries only a pulmonologist can prescribe a ventilator.

After careful evaluation and pulmonary function tests to assess breathing and lung function and capacity (and sometimes a sleep study), the physician recommends a type of ventilator and appropriate interfaces. Individuals who need to use ventilation only at night have different equipment requirements than those who need to use a ventilator around the clock. Sometimes an individual may not be comfortable with a specific ventilator or interface and may need to change them in order to find the most comfortable and effective system.

Some ventilator users alternate modes and interfaces during the day and night.

What if something goes wrong with the ventilator?

Ventilator users and their caregivers must be prepared for equipment failure, disconnects, and power outages, especially if using 24-hour ventilation, in which case a backup ventilator and generator are prudent. Practicing regular safety drills helps prepare for emergencies. Keeping a manual resuscitator, such as an Ambu® bag, handy at all times is strongly advised.

Where do I find information about ventilator safety and reported incidents?

The FDA maintains a database for reports of problems with medical equipment, including ventilators, that is updated continually. www.fda.gov/MedicalDevices/safety

Home ventilator manufacturers

Air Liquide Healthcare, Inc.  
www.device.airliquidehealthcare.com

BD Worldwide (CareFusion, Pulmonetics)  

BREAS Medical AB (B&D Electromedical)  
www.nippyventilator.com; www.breas.com

Dima Italia S.r.l.  
www.dimaitalia.com

Flight Medical Innovations Ltd.  
www.flight-medical.com

GE Healthcare (VersaMed)  
www.gerespiratorycarecentral.com/home_care.php

Löwenstein Medical Technology GmbH + Co. KG (Weinmann.de)  
https://loewensteinmedical.de/en/produkt-kategorie/ventilation

Metronic (Covidien, Newport, Puritan Bennett)  
www.medtronic.com/covidien/support/product-manuals

Philips Respironics  
www.usa.philips.com/healthcare/solutions/sleep-and-respiratory-care/ventilation

Porta-Lung, Inc.  
www.portalung.com

ResMed  
www.resmed.com

Siare Engineering International Group, S.r.l.  
www.siare.it

United Hayek Medical  
www.unitedhayek.com

ZOLL Medical Corporation  
www.zoll.com/ventilator-aspirators