

Puritan Bennett™

700 Series Ventilator System



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The ventilator should be operated and serviced only by trained professionals. Covidien's sole responsibility with respect to the ventilator, and its use, is as stated in the limited warranty provided.

Nothing in this manual shall limit or restrict in any way Covidien's right to revise or otherwise change or modify the equipment (including its software) described herein, without notice. In the absence of an express, written agreement to the contrary, Covidien has no obligation to furnish any such revisions, changes, or modifications to the owner or user of the equipment (including its software) described herein.

Definitions

This manual uses these special indicators to convey information of a specific nature:

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.

Warnings, cautions, and notes

Please take the time to familiarize yourself with the following safety considerations, special handling requirements, and regulations that govern the use of the 700 Series Ventilator System.

Warning

To avoid an electrical shock hazard while servicing the ventilator, be sure to remove all power to the ventilator by disconnecting the power source and turning off all ventilator power switches.

Warning

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 ventilator and oxygen hoses.

Do not use oxygen hoses that are worn, frayed, or contaminated by combustible materials such as grease or oils. (Textiles, oils, and other combustibles are easily ignited and burn with great intensity in air enriched with oxygen.)

In case of fire or a burning smell, immediately disconnect the ventilator from the oxygen supply and electrical power source.

Warning

Patients on life-support equipment should be appropriately monitored by competent medical personnel and suitable monitoring devices.

The 700 Series Ventilator is not intended to be a comprehensive monitoring device and does not activate alarms for all types of dangerous conditions for patients on life-support equipment.

Warning

Check the ventilator periodically as outlined in the service manual; do not use if defective. Immediately replace parts that are broken, missing, obviously worn, distorted, or contaminated.

Warning

An alternative source of ventilation should always be available when using the 700 Series Ventilator System.

Warning

To ensure proper servicing and avoid the possibility of physical injury, only qualified personnel should attempt to service or make authorized modifications to the ventilator.

The user of this product shall have sole responsibility for any ventilator malfunction due to operation or maintenance performed by anyone not trained by Covidien staff.

Warning

For a thorough understanding of ventilator operations, be sure to read the *700 Series Ventilator System Operator's Manual* in its entirety before attempting to use the system.

Warning

Before activating any part of the ventilator, be sure to check the equipment for proper operation and, if appropriate, run the self-diagnostic *short self test (SST)* program described in this manual.

Caution

U.S. Federal law restricts this device to sale by or on the order of a physician.

Warranty

The 700 Series Ventilator System is warranted against defects in material and workmanship in accordance with Covidien Medical Equipment Warranty for a period of one year from the time of sale. To ensure the validity of the warranty, be sure to keep a maintenance record.

Year of manufacture

The 700 Series Ventilator System's year of manufacture is indicated by the fifth and sixth digits of the serial number which is located at the lower edge of the ventilator front panel.

Manufacturer

Manufacturer:
Covidien llc
15 Hampshire Street
Mansfield, MA 02048
USA

Authorized Representative:
Covidien Ireland Limited
IDA Business & Technology Park
Tullamore

Electromagnetic susceptibility

The 700 Series Ventilator System complies with the requirements of IEC 60601-1-2 (EMC Collateral Standard), which includes E-field susceptibility and ESD requirements. However, even though the device is compliant at the levels of immunity specified in the standard, certain transmitting devices (cellular phones, walkie-talkies, cordless phones, paging transmitters, etc.) emit radio frequencies that could interrupt ventilator operation if located in a range too close to the ventilator. It is difficult to determine when the field strength of these devices becomes excessive. Practitioners should be aware that radio frequency emissions are additive, and that the ventilator must be located a sufficient distance from transmitting devices to avoid interruption. Do not operate the ventilator in a magnetic resonance imaging (MRI) environment. The *Alarm handling* section of this manual describes possible ventilator alarms and what to do if they occur. Consult with your institution's biomedical engineering department in case of interrupted ventilator operation, and before relocating any life support equipment.

Customer assistance

For further assistance contact your local Covidien representative.

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Introduction

The 700 Series Ventilator System (including the 740 and 760 Ventilators) provides respiratory support for a wide range of pediatric to adult patients for a wide variety of clinical conditions. The ventilator's mixing technique allows it to ventilate critically ill patients at adjustable oxygen concentrations without the need for a blender, compressor, or hospital-grade wall air.

The 700 Series Ventilator System can be mains- or battery-powered. Each ventilator includes two microcontrollers: one for breath delivery (which controls ventilation), and one for the user interface (which monitors ventilator and patient data). Each microcontroller verifies that the other is functioning properly. Using two independent microcontrollers in this fashion prevents a single fault from causing a simultaneous failure of controlling and monitoring functions.

The 700 Series Ventilator System supplies mandatory or spontaneous breaths with a piston-based pneumatic system. Table 1-1 summarizes the modes and breath types offered by the 740 and 760 Ventilators. Mandatory breaths can be *volume control ventilation* (VCV, available on 740 and 760 Ventilators) or *pressure control ventilation* (PCV, available on the 760 Ventilator only). VCV delivers breaths to the patient at a preset tidal volume, peak flow, waveform, and oxygen concentration at a minimum respiratory rate. PCV delivers breaths to

the patient at a preset inspiratory pressure, I:E ratio or inspiratory time, rise time factor (how quickly inspiratory pressure rises to achieve the set inspiratory pressure), and oxygen concentration at a minimum respiratory rate. A spontaneous breath allows the patient inspiratory flows of up to 300 L/min, with or without *pressure support ventilation* (PSV). On the 760 Ventilator, you can set the rise time factor and exhalation flow sensitivity (that is, the point at which the ventilator cycles from inspiration to exhalation) in PSV.

The ventilator begins *apnea ventilation* if no breath (patient-, ventilator-, or operator-initiated) is delivered within the selected apnea interval. Apnea ventilation is active during all modes. On the 740 Ventilator, only VCV breaths are available in apnea ventilation. On the 760 Ventilator, VCV or PCV breaths are available in apnea ventilation.

The 760 Ventilator also offers the ability to perform respiratory mechanics calculations and maneuvers as a standard feature using the EXP PAUSE (to calculate auto-PEEP) and INSP PAUSE (to calculate patient resistance and compliance) keys.

Table 1-1: Mode/breath type availability on 740/760 Ventilators

Mode/breath type	740 Ventilator	760 Ventilator
VCV breath type	•	•
PCV breath type		•
PSV breath type (support pressure setting)	•	•
PSV (rise time factor and exhalation sensitivity settings)		•
SIMV mode	•	•
Apnea ventilation (VCV breath type)	•	•
Apnea ventilation (choice of VCV or PCV breath type)		•
Respiratory mechanics (EXP PAUSE and INSP PAUSE)		•

This manual tells you how to operate and perform simple maintenance for the 700 Series Ventilator. Covidien recommends that you become familiar with this manual and accompanying labels before attempting to operate or maintain the ventilator. If you need additional copies of this manual, contact your Covidien representative.

To ensure optimum performance of the 700 Series Ventilator System, Covidien recommends that a qualified service technician perform periodic maintenance on the ventilator. For more information, contact your Covidien representative.

1.1 Functional description

By pressing keys and turning the knob on the ventilator keyboard, the operator gives initial instructions and data to the ventilator (Figure 1-1). The user interface microcontroller processes this information and stores it in the ventilator's memory. The breath delivery microcontroller uses this stored information to control and monitor the flow of gas to and from the patient.

The 700 Series Ventilator uses a flow trigger to recognize patient effort. The trigger monitors flow from the piston during exhalation. When the patient inhales, patient circuit pressure drops very slightly below end-expiratory pressure. At the same time, the piston moves forward to deliver flow to the ventilator breathing circuit and maintain the preset PEEP/CPAP level. The level of flow depends on the patient's effort. If this flow exceeds the user-set level, the ventilator triggers. By design, the ventilator attempts to maintain PEEP in the presence of a circuit leak. Since a leak drives the piston to deliver flow to make up for pressure losses, a circuit leak can require an increase in the flow trigger level to avoid autocycling.

During exhalation, the ventilator's piston retracts and draws air and oxygen into the cylinder. The ventilator uses room air, which means the ventilator can operate without a compressor or wall air source. Room air enters the ventilator through a protected user-replaceable air intake filter just inside the ventilator cabinet. This filter captures airborne particles.

Oxygen from a cylinder or wall supply enters the ventilator through a hose and oxygen fitting (the fitting is available in several versions). Once inside the ventilator, the oxygen is regulated to a pressure the ventilator can use, then mixed with air, according to the selected % O₂.

The flow-triggered *piston/cylinder system* and *motor controller circuit* control the flow of gas to the patient. On the 760 Ventilator in PCV or PSV, the rate of flow is also determined by the preset rise time factor. This system is designed with a minute gap (about the size of a thin sheet of paper) between the piston and the cylinder wall. This design eliminates the friction between the piston and cylinder, allowing it to respond more rapidly than a "sealed" system.

A small amount of gas leaks through the gap between the piston and cylinder. Ventilator software and a continuous forward motion of the piston compensate for this leak.

The piston delivers the mixed air and oxygen through the *inspiratory manifold system*, and out to the patient. The oxygen concentration and temperature of the delivered gas are monitored here, using a galvanic oxygen sensor and a thermistor. The galvanic sensor generates a voltage proportional to the partial pressure of oxygen, from which the oxygen concentration is calculated. The ventilator alarms if the monitored oxygen concentration is more than ten percentage points above or below the % O₂ setting. The inspiratory manifold system also includes a safety valve to relieve patient pressure if necessary (for example, if the ventilator breathing circuit is kinked or occluded).

The *patient system* includes the components external to the ventilator that route gas between the ventilator and the patient. These components include the *inspiratory filter* (which protects against contamination between the ventilator and patient), a humidification device, *ventilator breathing circuit* (the tubing through which the gas travels), *collector vial* (which protects the exhalation system from moisture in the exhaled gas, and can be emptied without losing circuit PEEP), and an *expiratory filter* (which limits the bacteria in the patient's exhaled gas from escaping to room air or contaminating the ventilator).

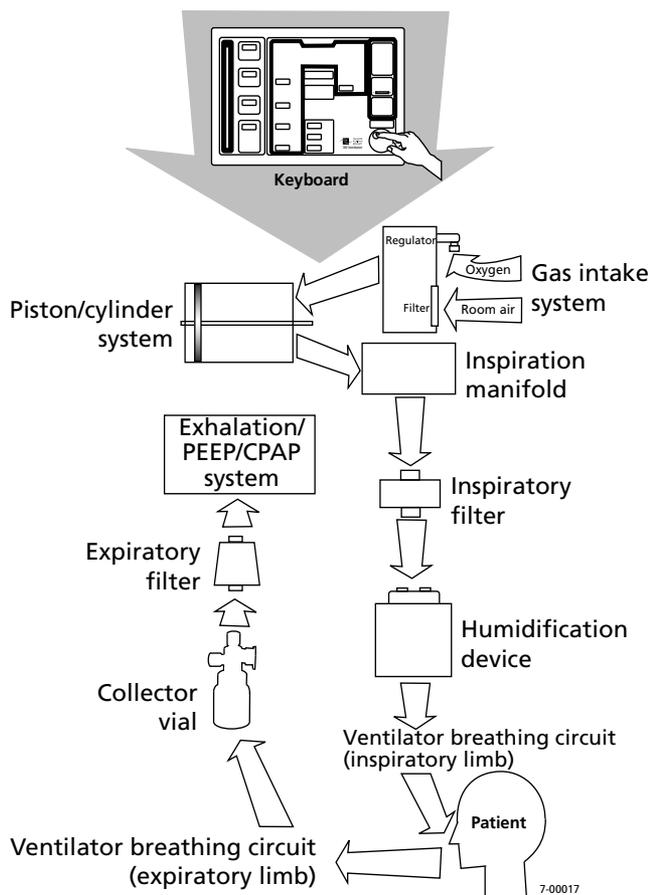


Figure 1-1 . Block diagram: 700 Series Ventilator function

The heated *exhalation system* monitors the flow of the patient's exhaled gas using a differential pressure transducer. The patient exhales through the *exhalation valve*. During exhalation, the *PEEP/CPAP system* maintains user-selected pressure in the ventilator breathing circuit.

Throughout the respiratory cycle, pressure transducers monitor inspiratory, expiratory, and atmospheric pressures. The temperatures of the pneumatic compartment and inspiratory gas are also monitored. Information from these transducers is continuously used to update the calculations that control ventilation. (Appendix F provides a diagram of the ventilator's pneumatic system and ventilator breathing circuit.)

Power to operate the ventilator comes from ac mains (wall) or battery power. The power supply is designed to protect against excessive voltages, temperatures, or current draws. A power cord retainer prevents the cord from accidental disconnection.

The ventilator includes an internal battery, and accommodates an optional external battery. Depending on the ventilator settings, battery backup power can be supplied for up to 2½ hours using the internal battery, and up to 7 hours using the external battery. Both batteries are recharged during operation from ac power. If both are installed, the external battery is used first when ac power is not present. If the external battery is depleted or not installed, the internal battery supplies power to the ventilator when ac power is not available. The keyboard indicates the source of power and battery charge level of the internal battery at all times.

Emergency modes: The ventilator declares a *ventilator inoperative (VENT INOP) condition* if a hardware failure or critical software error that could compromise safe ventilation occurs. In case of a ventilator inoperative condition, the VENT INOP indicator lights and the ventilator enters the *safety valve open (SVO) state*. To correct a ventilator inoperative condition, the ventilator must be turned off, then powered on again; at power-on, the operator must run extended self-test (EST). The ventilator must pass EST before normal ventilation can resume.

The safety valve allows the patient to breathe room air unassisted when the ventilator is in the SVO state. The ventilator remains in the SVO state until power-on self-test (POST) verifies that power levels to the ventilator are acceptable and that the motor controller and microcontrollers are functioning correctly, and until the user has confirmed ventilator settings.

If the ventilator enters the SVO state and POST is not running, the SAFETY VALVE OPEN indicator lights and a high-priority alarm sounds. The ventilator enters the SVO state if it detects a hardware or software failure that could compromise safe ventilation. In case of a malfunction that prevents software from opening the safety valve, there is also an analog circuit that opens the safety valve when system pressure exceeds 115 cmH₂O (113 hPa).

If the ventilator detects an occlusion or a continuous high inspiratory pressure condition, it opens the safety and exhalation valves to vent excess pressure, then shuts them and begins *occlusion cycling mode*. In occlusion cycling mode the ventilator uses current settings except for those summarized in Table 1-2. If the ventilator again detects an occlusion or continuous high pressure condition, it again opens the safety and exhalation valves then resumes occlusion cycling mode. If the operator presses the alarm reset key or the ventilator does not detect an occlusion or continuous high pressure condition, it reverts to normal ventilation using the most recently accepted settings.

Table 1-2: Changes to current settings in occlusion cycling mode

Setting	Change to setting
HIGH PRESSURE alarm (VCV breath type)	Set to 30 cmH ₂ O
PEEP (all modes)	Set to 0 cmH ₂ O
% O ₂ (all modes)	Set to 100%
SPONT mode (PSV breath type)	Breaths are delivered at a rate of 12/min with an inspiratory time of 2 seconds.
SUPPORT PRESSURE (PSV breath type)	If less than 15 cmH ₂ O: set to 15 cmH ₂ O. If 15 cmH ₂ O or above: the current setting is used (no change).
SUPPORT PRESSURE (PCV breath type)	If less than 15 cmH ₂ O: set to 15 cmH ₂ O. If 15 cmH ₂ O or above: the current setting is used (no change).
RISE TIME FACTOR (PCV breath type)	Set to 70%

1.2 Symbols and labels

These symbols and labels appear on the 700 Series Ventilator System:



Power switch positions per IEC 601-1. "I" represents ON position; "O" represents OFF position.



7-00421



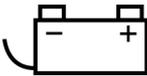
Refer to manual per IEC 601-1. When this symbol appears on product, it means "Refer to documentation for information."

7-00418



Potential equalization point, per IEC 601-1

7-00416



External battery connection

7-00426



Circuit breaker

7-00414



Serial number



ac current

7-00427



Type B equipment, per IEC 601-1

7-00415



Indicates the degree of protection provided by enclosure (drip-proof).

IPX1

7-00403



Signifies compliance with the Medical Device Directive, 93/42/EEC

0123



CSA and NRTL (Nationally Recognized Testing Laboratory) certification, granted by CSA



The TUV Rheinland logo signifies TUV Rheinland Type Test approval to Annex III of the Medical Device Directive

Exhaust port connector



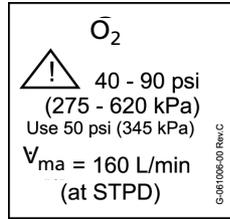
Inspiratory limb connector



Expiratory limb connector

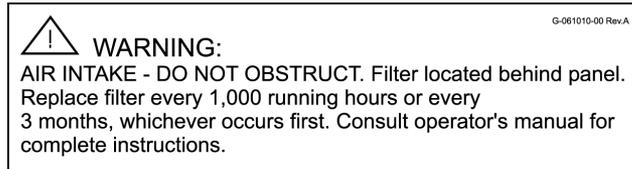


Oxygen inlet port label



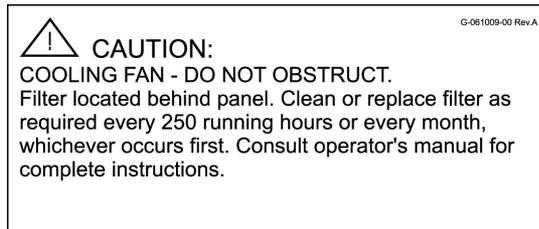
61006

Air intake label



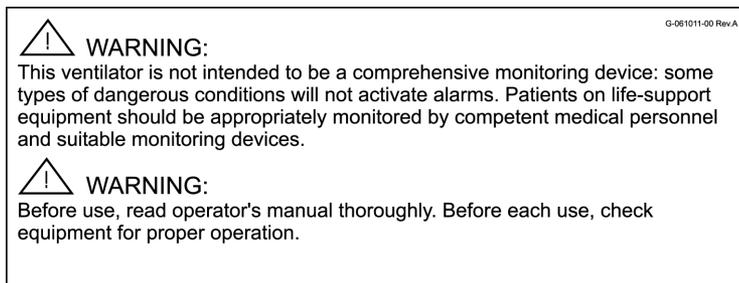
61010

Cooling fan label



61009

General life support equipment warning label



61011

740 Ventilator back panel label

 0123	 NRTL/C	
<p> WARNING: FIRE HAZARD. Keep matches, lighted cigarettes, and all other sources of ignition, including flammable anesthetics and/or heaters, away from the 740 Ventilator System and oxygen hoses. Textiles, oils and other combustibles are easily ignited and burn with great intensity in air enriched with oxygen. In case of fire or a burning smell, immediately disconnect the ventilator from the oxygen supply and electrical power source. Do not use oxygen hoses that are worn, frayed, or contaminated by greases or oils.</p>		
<p> WARNING: ELECTRICAL SHOCK HAZARD. Disconnect and switch off the ventilator before opening it for servicing.</p>		
<p> WARNING: If used in the U.S., connect the ventilator to an AC receptacle marked "Hospital Only" or "Hospital Grade" to ensure grounding reliability.</p>		
<p> CAUTION: U.S. federal law restricts this device to sale by or on the order of a physician.</p>		
<p>100 - 120 V~, 50/60 Hz, 2.9 A (290 VA) 220 - 240 V~, 50/60 Hz, 1.3 A (290 VA) External Battery: 24 Vdc, 12 A</p>		 IPX1
700 Series, 740 Ventilator System		Patent Nos. 5,524,615, 5,540,222, 5,596,984, 5,632,270, 5,664,560 & 5,673,689
<p> Covidien llc, 15 Hampshire Street, Mansfield, MA 02048 USA.  Covidien Ireland Limited, IDA Business & Technology Park, Tullamore.</p>		

760 Ventilator back panel label

 0123	 NRTL/C	 TUV Rheinland Product Safety	 CapriLife Medizinprodukte Approved medical device
 WARNING: FIRE HAZARD. Keep matches, lighted cigarettes, and all other sources of ignition, including flammable anesthetics and/or heaters, away from the 760 Ventilator System and oxygen hoses. Textiles, oils and other combustibles are easily ignited and burn with great intensity in air enriched with oxygen. In case of fire or a burning smell, immediately disconnect the ventilator from the oxygen supply and electrical power source. Do not use oxygen hoses that are worn, frayed, or contaminated by greases or oils.			
 WARNING: ELECTRICAL SHOCK HAZARD. Disconnect and switch off the ventilator before opening it for servicing.			
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 CAUTION: U.S. federal law restricts this device to sale by or on the order of a physician.			
100 - 120 V~, 50/60 Hz, 2.9 A (290 VA) 220 - 240 V~, 50/60 Hz, 1.3 A (290 VA) External Battery: 24 Vdc, 12 A			 IPX1
700 Series, 760 Ventilator System		Patent Nos. 5,524,615, 5,540,222, 5,596,984, 5,632,270, 5,664,560 & 5,673,689	
 Covidien llc, 15 Hampshire Street, Mansfield, MA 02048 USA.  Covidien Ireland Limited, IDA Business & Technology Park, Tullamore.			

1.3 Keyboard

Caution

To avoid damaging the keyboard, do not press on it with sharp objects.

The keyboard (Figure 1-2 shows the 740 keyboard and Figure 1-3 shows the 760 keyboard) is grouped into three sections:

- **VENTILATOR SETTINGS:** Where you set breath delivery variables.
- **PATIENT DATA:** Where you set alarm limits and view the monitored pressures, breath timing, and volumes.
- **VENTILATOR STATUS:** Where you see the alarm status and operating condition of the ventilator.

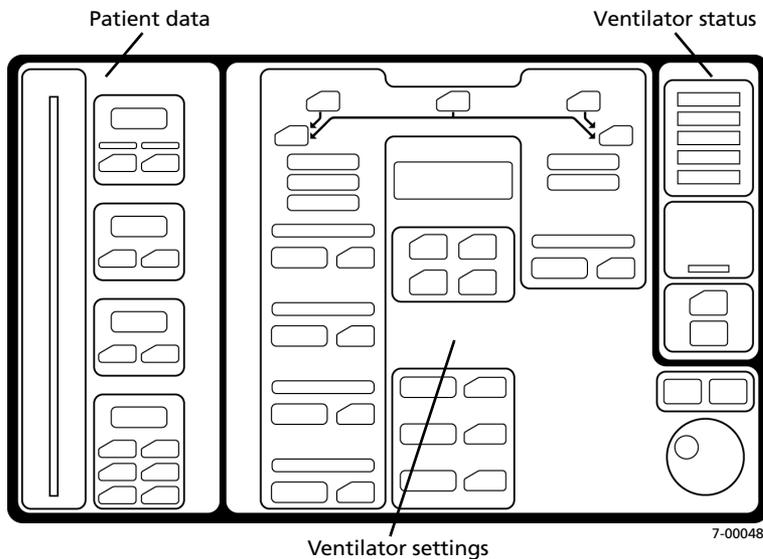


Figure 1-2. 740 Ventilator System keyboard

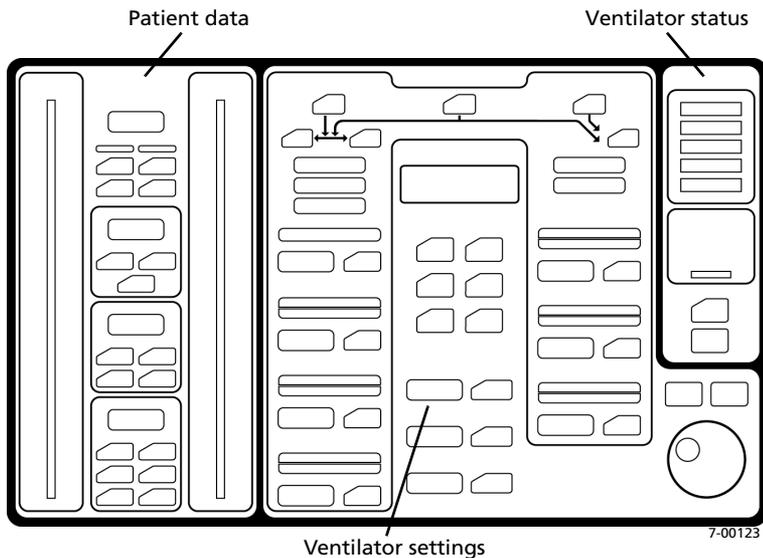


Figure 1-3. 760 Ventilator System keyboard

1.3.1 VENTILATOR SETTINGS

The VENTILATOR SETTINGS section of the keyboard allows you to select the ventilation mode, breath type, and settings. For more detail on ventilation modes and breath delivery, see Appendix D.

To change the mode and settings, select the mode, then the breath type, and then the ventilator settings. The keys flash during setup and mode changes to ensure that you review all pertinent settings. The keyboard is designed to minimize accidental or unintentional changes.

Table 1-3 summarizes the functions of the keys, knob, and indicators in the VENTILATOR SETTINGS section of the keyboard. Ventilator settings are also limited by these breath delivery boundaries:

- I:E ratio \leq 4:1 for PCV (760 Ventilator only), \leq 3:1 for all other breath types
- Inspiratory time = 0.2 to 8 seconds (excluding plateau)
- Expiratory time \geq 0.2 seconds

- PEEP/CPAP + SUPPORT PRESSURE or INSPIRATORY PRESSURE ≤ 80 cmH₂O (80 hPa)

NOTE:

Maximum SUPPORT PRESSURE is 70 cmH₂O, maximum INSPIRATORY PRESSURE is 80 cmH₂O.

- SUPPORT PRESSURE or INSPIRATORY PRESSURE + PEEP/CPAP < HIGH PRESSURE - 2 cmH₂O (2 hPa)
- HIGH PRESSURE (in A/C and SIMV modes) > PEEP/CPAP + 7 cmH₂O (7 hPa)
- HIGH PRESSURE (in SPONT mode) > PEEP/CPAP + SUPPORT PRESSURE + 2 cmH₂O (2 hPa)
- HIGH PRESSURE > LOW INSP PRESSURE
- Minute volume ≤ 50 L/min at an I:E ratio of 2:1

Table 1-3: 700 Series Ventilator keyboards: VENTILATOR SETTINGS

Key/indicator	Specifies...	Range
Mode/breath type settings		
A/C	Assist/control mode	VCV (volume control ventilation) and PCV (pressure control ventilation) breath types. (PCV available on 760 Ventilator only.)
SIMV	Synchronous intermittent mandatory ventilation mode	VCV, PCV (760 only), and PSV (pressure support ventilation) breath types.
SPONT	Spontaneous mode	PSV breath type
VCV	VCV breath type	VCV available on 740 and 760 Ventilators in A/C or SIMV modes.

Table 1-3: 700 Series Ventilator keyboards: VENTILATOR SETTINGS

Key/indicator	Specifies...	Range
Mode/breath type settings (continued)		
PCV	PCV breath type	PCV available on 760 Ventilator only in A/C or SIMV modes.
PSV	PSV breath type	PSV available in SIMV or SPONT modes.
Mandatory (VCV) settings		
RESPIRATORY RATE	The minimum number of mandatory breaths the patient receives per minute. During apnea ventilation the minimum RESPIRATORY RATE setting is 6 /minute.	1 to 70 /minute Accuracy: $\pm (0.1 + 1\%)$ /minute
TIDAL VOLUME	Volume delivered to the patient during a mandatory breath, compliance-compensated and corrected to body temperature and pressure, saturated (BTPS).	40 to 2000 ml Accuracy: $\pm (10 \text{ ml} + 10\% \text{ of setting})$
PEAK FLOW	Maximum flow of gas delivered during a mandatory breath (BTPS). (Combined with tidal volume, peak flow defines the active portion of inspiratory time.)	3 to 150 L/min Accuracy: $\pm (5 + 10\% \text{ of setting})$ L/min
PLATEAU (s)	Length of inspiratory pause after a mandatory breath has been delivered, during which no gas is delivered.	0.0 to 2.0 second Accuracy: ± 0.05 second
Mandatory (PCV) settings (760 Ventilator only)		
RESPIRATORY RATE	The minimum number of mandatory breaths the patient receives per minute. During apnea ventilation the minimum RESPIRATORY RATE setting is 6 /minute.	1 to 70 /minute Accuracy: $\pm (0.1 + 1\%)$ /minute

Table 1-3: 700 Series Ventilator keyboards: VENTILATOR SETTINGS

Key/indicator	Specifies...	Range
Mandatory (PCV) settings (760 Ventilator only) (continued)		
INSPIRATORY PRESSURE (760 only)	Pressure above PEEP during the inspiratory phase of a PCV breath.	5 to 80 cmH ₂ O (5 to 80 hPa) Accuracy: ± (3 + 2.5% of setting) cmH ₂ O
T _I /I:E RATIO (760 only)	You can use the MENU key to select inspiratory time (T _I) or I:E ratio as the breath timing setting for a PCV breath. You can change the selected breath timing setting (T _I or I:E ratio), but the setting remains constant when you change the respiratory rate in PCV. Selecting I:E ratio makes the set ratio of inspiratory time to expiratory time for a PCV breath.	Inspiratory time (T _I): 0.2 to 8 seconds Accuracy: ± 0.05 second I:E ratio: ≤ 4:1 Accuracy: ± (0.1 + 2%)
RISE TIME FACTOR (760 only)	The time for inspiratory pressure to rise from 0 to 95% of the target pressure level during a PCV breath. A setting of 100 = a 100-ms rise time, and a setting of 5 = 80% of the inspiratory time or 2500 ms, whichever is less. When you adjust this setting, the message window shows the actual time (in seconds) to reach 95% of target pressure.	5 to 100
<p>NOTE: To help determine the correct setting for inspiratory time, during PCV the message window displays peak inspiratory flow, end inspiratory flow, and end exhalation flow in L/min.</p>		

Table 1-3: 700 Series Ventilator keyboards: VENTILATOR SETTINGS

Key/indicator	Specifies...	Range
Spontaneous (PSV) settings		
SUPPORT PRESSURE	Pressure above PEEP maintained during spontaneous inspiration. Support pressure is terminated when inspiratory flow falls to 25% of peak inspiratory flow, or to the exhalation sensitivity setting (760 only), or 10 L/min or 25% of peak flow, whichever is lower (740 only). Maximum inspiratory time is 3.5 seconds for adults, and 2.5 seconds for pediatric patients.	0 to 70 cmH ₂ O (0 to 70 hPa) Accuracy: ± (3 + 2.5% of setting) cmH ₂ O
RISE TIME FACTOR (760 only)	The time for inspiratory pressure to rise from 0 to 95% of the target pressure level during a PSV breath. A setting of 100 = a 100-ms rise time, and a setting of 5 = 80% of the inspiratory time or 1500 ms (when adult ventilator breathing circuit is selected) or 600 ms (when pediatric circuit is selected), whichever is less. When you adjust this setting, the message window shows the actual time (in seconds) to reach 95% of target pressure.	5 to 100

Table 1-3: 700 Series Ventilator keyboards: VENTILATOR SETTINGS

Key/indicator	Specifies...	Range
Spontaneous (PSV) settings (continued)		
EXH SENSITIVITY (760 only)	The percent of peak expiratory flow at which the ventilator cycles from inspiration to exhalation for spontaneous breaths. The flow at which the ventilator cycles from inspiration to exhalation for PSV breaths. Exhalation begins when the inspiratory flow is less than the set value. To help set EXH SENSITIVITY appropriately, the peak inspiratory flow and end inspiratory flow are displayed in the message window in PSV. (To ensure accurate estimates of these flows, it is important to run SST so that tubing compliance calculations are correct.)	1 to 80%
Common settings		
PEEP/CPAP	Positive end expiratory pressure/continuous positive airway pressure. Minimum pressure maintained during inspiratory and expiratory phases.	0 to 35 cmH ₂ O (0 to 35 hPa) Accuracy: ± (2 cmH ₂ O + 4% of setting)
TRIGGER SENSITIVITY (L/min)	Inspiratory flow required to trigger the ventilator to deliver a breath.	1 to 20 L/min
% O ₂	Percentage of inspired oxygen of the gas delivered to the patient.	21 to 100% Accuracy: ± 3% full scale
	NOTE: It may take several minutes for the oxygen percentage to stabilize.	

Table 1-3: 700 Series Ventilator keyboards: VENTILATOR SETTINGS

Key/indicator	Specifies...	Range
Other keys, knobs, and indicators		
APNEA PARAMS key	Allows you to select VCV or PCV (760 Ventilator only) apnea ventilation, and the apnea ventilation settings. The apnea interval is adjustable from 10 to 60 seconds. Apnea ventilation is available in all modes. For apnea parameter ranges, see mandatory VCV settings and mandatory PCV (760 Ventilator only) settings.	
MENU	Allows you to view active and reset alarms, run SST and EST, adjust certain settings (including alarm volume, PCV timing, volume bar graph display, endotracheal tube size, and date and time), access oxygen sensor functions (calibrate, enable or disable % O ₂ alarm limits, and enable or disable display of oxygen sensor reading), enter standby mode, view battery information, display software revision, display service information, and enter <i>EasyNeb</i> nebulizer functions. (Chapter 6 tells you how to use the menu function.)	
100% O ₂	Switches the % O ₂ to 100% for 2 minutes, then returns to the current % O ₂ setting. The 2-minute interval restarts every time you press 100% O ₂ . Once the 100% O ₂ has started, you can press CLEAR to stop the maneuver (unless you have entered a MENU key function or selected a setting).	
MANUAL INSP	Delivers one mandatory breath to the patient according to the current mandatory settings (in A/C or SIMV) or the current apnea parameters (in SPONT). You can deliver a MANUAL INSP at any time during the exhalation phase of a breath as long as the exhaled flow is less than 30% of the peak exhaled flow, except during apnea ventilation.	

Table 1-3: 700 Series Ventilator keyboards: VENTILATOR SETTINGS

Key/indicator	Specifies...	Range
Other keys, knobs, and indicators (continued)		
EXP PAUSE (760 only)	<p>Allows you to measure the patient's auto-PEEP. An EXP PAUSE maneuver causes the ventilator to close the exhalation valve at the end of the expiratory phase, and not deliver the next mandatory breath. At the end of the maneuver, the message window shows the calculated value for auto-PEEP (expiratory pressure at the beginning of the maneuver minus expiratory pressure at the end of the maneuver) and total PEEP for 30 seconds.</p> <p>The message window shows the end expiratory flow in L/min at the beginning of each breath. If there is expiratory flow when the ventilator delivers the next breath, auto-PEEP is present.</p> <p>The EXP PAUSE continues as long as you hold down the key, and should last only until expiratory pressure stabilizes. An EXP PAUSE maneuver ends when you release the key, the patient initiates a breath, an alarm occurs, the expiratory phase (including the maneuver) lasts more than 20 seconds, or the ventilator detects a leak.</p> <p>Auto-PEEP: Range: 1 to 35 cmH₂O. Accuracy: ± (1 cmH₂O + 3% of reading).</p> <p>The EXP PAUSE maneuver is unavailable when the RESPIRATORY RATE setting is less than 3 /minute.</p>	

Table 1-3: 700 Series Ventilator keyboards: VENTILATOR SETTINGS

Key/indicator	Specifies...	Range
Other keys, knobs, and indicators (continued)		
INSP PAUSE (760 only)	<p>Allows you to measure the patient's compliance and resistance. An extended inspiratory pause also allows you to expand the patient's lungs for up to 10 seconds.</p> <p>Pressing INSP PAUSE momentarily causes the ventilator to wait until the end of the inspiratory phase of the current or next mandatory breath (in SPONT mode, the ventilator delivers a mandatory breath using the MANUAL INSP key according to the apnea settings), stop breath delivery, and keep the exhalation valve closed. The INSP PAUSE continues until the ventilator detects a stable plateau pressure or 2 seconds have elapsed. An INSP PAUSE maneuver ends when a stable plateau is reached or an alarm occurs.</p> <p>Pressing INSP PAUSE for 2 or more seconds after the pause begins causes the ventilator to deliver an inspiratory pause for as long as you hold down the key. An extended INSP PAUSE maneuver ends when you release the key or 10 seconds have elapsed.</p> <p>You can press CLEAR or release the INSP PAUSE key at any time to cancel an INSP PAUSE maneuver, and alarms cancel the maneuver.</p> <p>At the end of the breath, the message window shows the calculated value for compliance and resistance (if the mandatory breath was a VCV breath) or compliance (if the mandatory breath was a PCV breath) for 30 seconds.</p> <p>Compliance: Range: 1 to 150 mL/H₂O. Accuracy: ± (1 mL/cmH₂O + 20% of reading).</p> <p>Resistance: Range: 0 to 150 cmH₂O/L/second. Accuracy: ± (3 cmH₂O/L/second + 20% of reading).</p>	
CLEAR	<p>Pressing CLEAR before accepting a setting cancels the proposed setting. Pressing CLEAR does not cancel accepted settings.</p> <p>Pressing CLEAR twice returns the ventilator to its previous state (unless you have entered a MENU key function that requires you to press CLEAR more times).</p> <p>Pressing CLEAR during a 100% O₂ maneuver cancels the maneuver.</p>	

Table 1-3: 700 Series Ventilator keyboards: VENTILATOR SETTINGS

Key/indicator	Specifies...	Range
Other keys, knobs, and indicators (continued)		
ACCEPT	Makes changes to settings effective. If you don't press ACCEPT within 30 seconds of proposing a new setting, the user interface returns to its previous state.	
Knob	Adjusts the value of a setting or selects a menu option. A setting value that flashes means that the knob is linked to that setting. Turning the knob clockwise increases the value, and turning the knob counterclockwise decreases the value.	
CURRENT	Lights when the ventilator is operating according to the displayed settings, or during apnea ventilation. (There is one indicator for mandatory breaths, and one for spontaneous breaths.)	
PROPOSED	Lights when you propose a mode or breath type, or you are setting apnea parameters. Once a proposed setting is accepted, it becomes effective at the next breath.	
APNEA PARAMS indicator	Lights when apnea ventilation is active. Lights with PROPOSED indicator when you are setting apnea parameters, and both indicators turn off once apnea parameters are accepted.	
Message window	Shows up to four lines of information (20 characters per line). <i>First line:</i> Reserved for the highest-priority active or autoreset alarm. On the 760 Ventilator only, if no alarm is active and the display of the oxygen sensor reading is enabled, the % O ₂ is displayed here. Otherwise, if VCV is the current or proposed breath type and there are no active or autoreset alarms, shows the selected VCV flow pattern (ramp or square). <i>Second line:</i> Information about the menu function or settings, alarm silence time remaining, or current date and time. During normal ventilation, shows "Flow (L/min)." <i>Third and fourth lines:</i> Reserved for other messages. For every breath type, peak and end inspiratory flows are displayed on the third line, and end expiratory flow is displayed on the fourth line (except that inspiratory flow is not displayed during VCV breaths or VCV apnea ventilation).	

1.3.2 PATIENT DATA

The PATIENT DATA section of the keyboard allows you to view the pressure, breath timing, and volume of the patient's breath. You can also view the alarm settings. A lighted key indicates that a measurement is selected, and its value appears in the display window. Values are continuously displayed and updated during ventilation.

Table 1-4 summarizes the functions of the keys and indicators in the PATIENT DATA section of the keyboard.

Table 1-4: 700 Series Ventilator keyboards: PATIENT DATA

Key/ indicator	Function	Range
Pressure		
MEAN PRESSURE	Shows the calculated value of ventilator breathing circuit pressure over an entire respiratory cycle. Updated at the beginning of each breath.	0 to 99 cmH ₂ O (0 to 99 hPa) Accuracy: ± (3 + 4% of reading) cmH ₂ O
PEAK PRESSURE	Shows the maximum pressure measured during inspiration. Updated at the beginning of each expiratory phase. (Default pressure display.)	0 to 140 cmH ₂ O (0 to 140 hPa) Accuracy: ± (3 + 4% of reading) cmH ₂ O
PLATEAU PRESSURE (760 only)	Shows the pressure measured at the end of the plateau period of a mandatory inspiration (whether the inspiration is in a regular VCV breath or is part of an inspiratory pause maneuver). Updated at the beginning of each expiratory phase. The PRESSURE display shows a blank if the ventilator does not detect a stable plateau pressure.	0 to 140 cmH ₂ O (0 to 140 hPa) Accuracy: ± (3 + 4% of reading) cmH ₂ O
PEEP/CPAP (760 only)	Shows the pressure measured at the expiratory limb before any inspiratory effort. Updated at the beginning of each inspiratory phase.	0 to 140 cmH ₂ O (0 to 140 hPa) Accuracy: ± (3 + 4% of reading) cmH ₂ O

Table 1-4: 700 Series Ventilator keyboards: PATIENT DATA

Key/ indicator	Function	Range
Breath timing		
RATE (/min)	Shows the calculated value of the total respiratory rate, based on the previous 60 seconds or 8 breaths (whichever interval is shorter). Updated at the beginning of each breath. (Default breath timing display.) The calculation is reset (and display is blank) when ventilation starts, when apnea ventilation starts or autoresets, when you change the mode, breath type, or RESPIRATORY RATE setting, and when you press the alarm reset key.	1 to 199 /minute Accuracy: $\pm (0.1 + 1\% \text{ of reading})/\text{minute}$
I:E RATIO	Shows the ratio of measured inspiratory time to measured expiratory time. Updated at the beginning of each breath.	1:99.9 to 9.9:1 Accuracy: $\pm (0.1 + 2\%)$
INSP TIME(s) (760 only)	The measured inspiratory time, including breaths that are truncated due to a HIGH PRESSURE alarm. Updated at the beginning of each expiratory phase.	0.1 to 9.90 seconds Accuracy: $\pm 0.05 \text{ seconds}$

Table 1-4: 700 Series Ventilator keyboards: PATIENT DATA

Key/ indicator	Function	Range
Volume		
EXHALED VOLUME (ml)	Shows the patient's measured expiratory tidal volume averaged over the last 5 breaths (for A/C VCV breaths, ventilator-initiated PCV breaths, and PCV apnea breaths) or for the just-completed breath (for all other breaths). Corrected to BTPS and compliance-compensated. Updated at the beginning of each inspiration. (Default volume display.) The calculation is reset when ventilation starts, when apnea ventilation starts or autoresets, when you change the mode or breath type, and when you press the alarm reset key.	0 to 9 L Accuracy: ± (10 ml + 10% of reading)
TOTAL MINUTE VOLUME (L)	Shows the patient's measured expiratory minute volume, based on the previous 60 seconds or 8 breaths (whichever interval is shorter). Updated at the beginning of each breath. The calculation is reset when ventilation starts, when apnea ventilation starts or autoresets, when you change the mode or breath type, and when you press the alarm reset key.	0 to 99 L Accuracy: ± (10 ml + 10% of reading)
DELIVERED VOLUME (ml) (760 only)	Shows the measured inspiratory tidal volume for the just-completed PCV or PSV breath. Corrected to BTPS and compliance-compensated. Updated at the beginning of each inspiration for PCV and PSV breath types.	0 to 3000 ml Accuracy: ± (10 ml + 10% of reading)

Table 1-4: 700 Series Ventilator keyboards: PATIENT DATA

Key/ indicator	Function	Range
Volume (continued)		
SPONT MINUTE VOLUME (L) (760 only)	Shows the patient's measured expiratory minute volume for all spontaneous breaths, based on the previous 60 seconds or 8 breaths (whichever interval is shorter). Updated at the beginning of each breath. The calculation is reset when ventilation starts, when apnea ventilation starts or autoresets, when you change the mode or breath type, and when you press the alarm reset key.	0 to 99 L Accuracy: $\pm (10 \text{ ml} + 10\% \text{ of reading})$
Alarm settings		
HIGH RATE	An active alarm indicates that measured respiratory rate is higher than the alarm setting.	3 to 100 /minute Accuracy: $\pm (0.1 + 1\% \text{ of setting})/\text{minute}$
HIGH TIDAL VOLUME	An active alarm indicates that exhaled volume for three out of four consecutive breaths was above the alarm setting.	20 to 6000 ml Accuracy: $\pm (10 \text{ ml} + 10\% \text{ of setting})$
LOW INSP PRESSURE	An active alarm indicates that monitored circuit pressure is below the alarm setting at the end of inspiration. Inactive in for any spontaneous breath.	3 to 60 cmH ₂ O (3 to 60 hPa) Accuracy: $\pm (1 + 3\% \text{ of setting})$
LOW TIDAL VOLUME	An active alarm indicates that delivered volume for three out of four consecutive breaths were below the alarm setting. (If this alarm is set to 0 ml and breath type is PCV, an active alarm indicates that delivered volume is less than 3 ml for three out of four consecutive breaths.)	0 to 2000 ml Accuracy: $\pm (10 \text{ ml} + 10\% \text{ of setting})$

Table 1-4: 700 Series Ventilator keyboards: PATIENT DATA

Key/ indicator	Function	Range
Alarm settings (continued)		
HIGH PRESSURE	An active alarm indicates that two consecutive breaths were truncated because circuit pressure reached the alarm setting.	10 to 90 cmH ₂ O (10 to 90 hPa) Accuracy: ± (1 + 3% of setting)
LOW MINUTE VOLUME	An active alarm indicates that monitored minute volume is less than the alarm setting, based on an eight-breath running average or the previous minute, whichever is less.	0 to 50 L Accuracy: ± (10 ml + 10% of setting)
Other indicators		
Pressure bar graph	Shows real-time pressures in centimeters of water (cmH ₂ O) or hectopascals (hPa). LEDs show the current HIGH PRESSURE alarm setting and the peak pressure of the last breath during exhalation.	-10 to 90 cmH ₂ O (-10 to 90 hPa) Resolution: 1 cmH ₂ O (1 hPa)
Volume bar graph (760 only)	Shows real-time exhaled volume in milliliters (ml). Volumes are compliance-compensated and corrected to BTPS. The active scale is determined by the HIGH TIDAL VOLUME alarm setting. LEDs show the current HIGH TIDAL VOLUME and LOW TIDAL VOLUME alarm settings. You can use the MENU key to enable or disable the volume bar graph. During exhalation, LEDs show the maximum exhaled volume of the last breath.	If HIGH TIDAL VOLUME setting < 500 ml: 0 to 500 ml Resolution: 5 ml If HIGH TIDAL VOLUME setting ≥ 500 ml: 0 to 2000 ml Resolution: 20 ml
MAND	Lights at the start of each breath to indicate a ventilator- or operator-initiated (time or manually triggered) mandatory breath is being delivered.	Not applicable

Table 1-4: 700 Series Ventilator keyboards: PATIENT DATA

Key/ indicator	Function	Range
Other indicators (continued)		
ASSIST	Lights at the start of each breath to indicate a patient-initiated mandatory (flow triggered) breath is being delivered.	Not applicable
SPONT	Lights at the start of each breath to indicate a patient-initiated spontaneous (flow triggered) breath is being delivered.	Not applicable

1.3.3 VENTILATOR STATUS

The VENTILATOR STATUS section of the keyboard shows the operating condition of the ventilator, and is continuously updated during operation. Table 1-5 summarizes the functions of the keys and indicators in the VENTILATOR STATUS section of the keyboard.

Table 1-5: 700 Series Ventilator keyboards: VENTILATOR STATUS

Key/ indicator	Color	Function
ALARM	Red (high priority)	Flashes when a high-priority alarm is active. A repeating sequence of three, then two beeps sounds. Lights steadily when a high-priority alarm has been autoreset.
CAUTION	Yellow (medium priority)	Flashes when a medium-priority alarm is active. A repeating sequence of three beeps sounds. Lights steadily when a medium-priority alarm has been autoreset.
NORMAL	Green	Lights when no alarm condition is present.

Table 1-5: 700 Series Ventilator keyboards: VENTILATOR STATUS

Key/ indicator	Color	Function
VENT INOP	Red (high priority)	Lights to indicate that the ventilator is inoperative, and the ventilator safety valve is open. A qualified service technician must run and pass the extended self-test (EST) before normal ventilation can resume. If the condition that caused the safety valve to open no longer exists, and the VENT INOP indicator is off, press the alarm reset key to resume ventilation.
SAFETY VALVE OPEN	Red (high priority)	Lights when the ventilator's safety valve and exhalation valve open and only room air is available to the patient. Can indicate that the ventilator is inoperative, or there is an occlusion in the ventilator breathing circuit. If possible, the message window shows the alarm that triggered the safety valve open condition and how much time has elapsed since the last breath was triggered.
ON AC/ BATTERY CHARGING	Green	Lights when the ventilator is running on ac power and the battery is charging.
ON INTERNAL BATTERY	Yellow	Flashes when the ventilator is running on the internal battery.
ON EXTERNAL BATTERY	Yellow	Flashes when the ventilator is running on the external battery.
INTERNAL BATTERY LEVEL	Green	Shows the relative charge level of the internal battery.
 2 min 7-00423	Yellow	Alarm silence: Silences the alarm sound for 2 minutes from the most recent key press.

Table 1-5: 700 Series Ventilator keyboards: VENTILATOR STATUS

Key/ indicator	Color	Function
 RESET 7-00424	Not applicable	Alarm reset: Reestablishes all alarm indicators, cancels the alarm silence period, and resets the patient data displays. If the condition that caused the alarm still exists, the alarm reactivates. Cancels apnea ventilation, if active. Reestablishes previous settings and ventilation resumes, unless the ventilator is inoperative.

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Setting up the ventilator

This section tells you how to set up the ventilator, including:

- Connecting and using the internal and external batteries
- Connecting the electrical supply
- Connecting the oxygen supply
- Connecting the ventilator breathing circuit
- Installing the collector vial
- Installing the flex arm
- Installing the humidifier
- Using the ventilator cart

Warning

- To avoid tipping or damaging the ventilator, do not stack other equipment on the ventilator. 700 Series Ventilators are designed to be mounted on either a cart or a shelf by a qualified service technician. When lifting the ventilator, lift from the base, and use assistance and appropriate safety precautions. Figure 2-1 shows proper lifting technique.

- To avoid the possibility of injury to the patient and to ensure proper ventilator operation, *do not* attach any device to the port labeled “EXHAUST” unless the device is specifically authorized by Covidien.
 - To minimize the increased risk of fire due to an oxygen-enriched environment, do not use the ventilator in a hyperbaric chamber.
 - To avoid raising the oxygen concentration of room air, use the ventilator in an adequately ventilated room.
-

Caution

Do not obstruct the cooling fan.

Use two people to lift

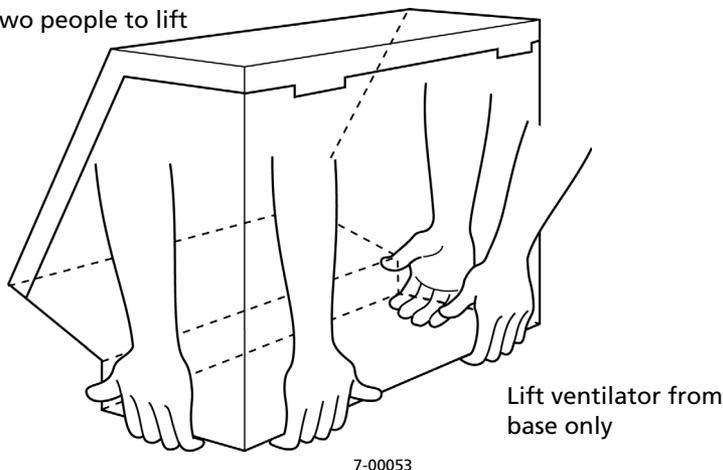


Figure 2-1. Lifting the ventilator

2.1 Connecting and using internal and external batteries

Warning

A Covidien battery must always be installed in the ventilator. Without a battery, the ventilator is not protected against low or lost ac power. Do not use the ventilator unless a battery with at least minimal charge is installed.

NOTE:

If the ventilator has been stored for an extended period, allow it to acclimate to its environment before turning it on. This helps ensure that the ventilator powers up correctly.

Every 700 Series Ventilator System includes an internal battery as a backup power supply that comes standard with the ventilator. The internal battery can provide up to 2½ hours of backup power, depending on ventilator settings and battery charge level. The ventilator operates on backup power when ac power is lost or drops below minimum. The internal battery's charge level is continuously indicated on the keyboard (see Figure 2-2). The ventilator alarms when it determines that only 5 minutes of power remain using the current settings.

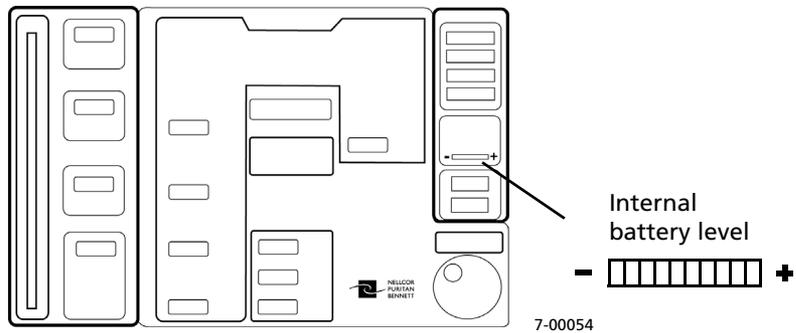


Figure 2-2. Internal battery charge indicator

The optional external battery supplies up to 7 additional hours of backup power in case ac power is lost or falls below minimum. (See Appendix B for external battery ordering information.) If installed, the external battery is the first source of backup power. The ventilator uses the internal battery if the external battery is depleted or is not connected.

NOTE:

When the ventilator switches off because battery charge is inadequate, turn off the power switch to prevent the battery from being fully depleted. Connect the ventilator to ac power as soon as possible.

The ventilator charges the internal and external batteries during ac power operation, or in standby mode when attached to ac power. (See Appendix C for battery specifications.) When the ventilator is operating on battery, you can use the MENU key to check the estimated operational time remaining until recharge is required for the internal and external batteries. (Chapter 6 tells you how to use the MENU key.) The ventilator must operate for 2 minutes before it can estimate battery time remaining.

You can disconnect and connect the external battery during normal operation. When operating the ventilator on battery power, you can install the external battery on the cart for easy transport. Follow these steps to connect the external battery:

1. Mount the external battery on the base of the cart (or other suitable location).
2. Plug the external battery's cable into the connector (Figure 2-3).
3. Figure 2-4 shows you how to disconnect the external battery.

To ensure that the batteries retain their charge, store the ventilator in standby mode, with its power switch on, and connected to ac power. If the ventilator is not stored in this manner, check battery charge levels before using the ventilator.

Caution

If you plan to store the ventilator for more than 6 months, remove batteries before storage. Replace the internal battery before using the ventilator again. A qualified service technician must replace the battery according to the instructions in the *700 Series Ventilator System Service Manual*.

If you turn on the ventilator after it has been unplugged for an extended period, the LOW EXT BATTERY and LOW INT BATTERY alarms may become active. If so, recharge the internal battery by leaving the ventilator plugged in and turned on in standby mode (with no patient connected) for up to 8 hours.

If the LOW EXT BATTERY, LOW INT BATTERY, or BAT NOT CHARGING alarm is still active after 8 hours, replace the batteries. If you turn off the ventilator when the battery is absent or inadequately charged, a LOSS OF POWER alarm sounds for at least 2 minutes.

NOTE:

The ON BATTERY indicator flashes when the ventilator is operating on battery power.

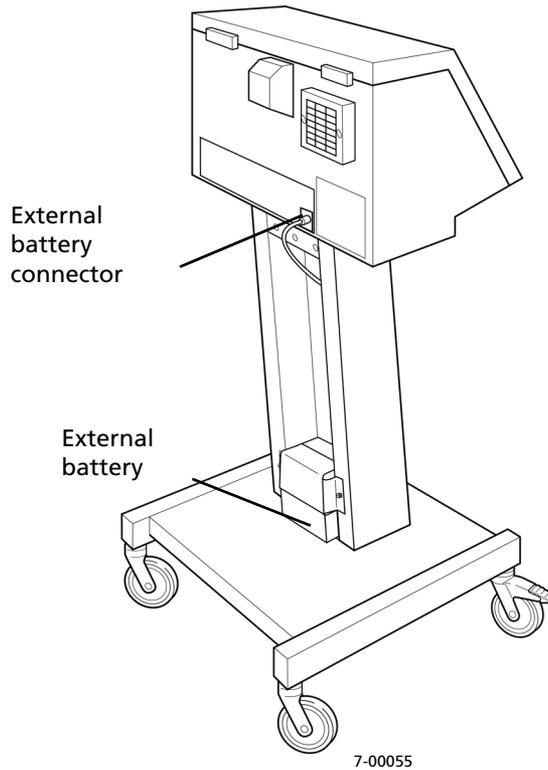


Figure 2-3. Plugging the external battery into the ventilator

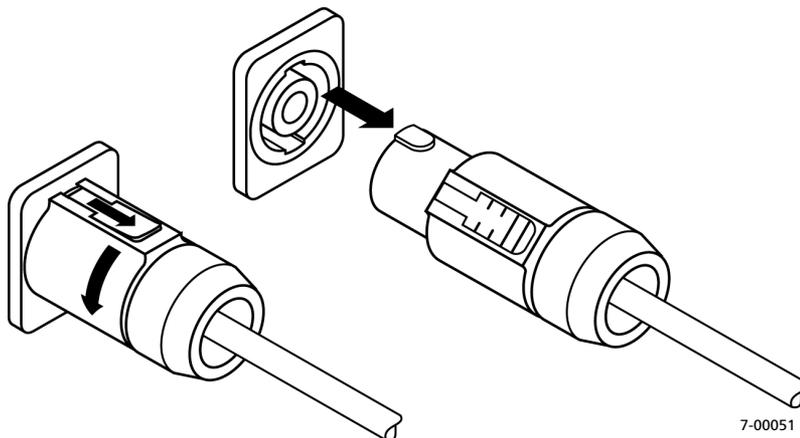


Figure 2-4. Disconnecting the external battery

2.2 Connecting the electrical supply

Warning

- To avoid electrical shock hazard, connect the ventilator power cord into a grounded ac power outlet. If the integrity of the ac ground is in question, operate the ventilator from the internal or external battery.
 - If used in the U.S., connect the ventilator to an ac receptacle marked "Hospital Only" or "Hospital Grade" to ensure grounding reliability.
-

Every 700 Series Ventilator System is supplied with a power cord. A power cord retainer covers the connector and socket to protect against liquid spills or accidental disconnection.

When the ventilator is ready for operation on ac power, connect the power cord to ac power (see Figure 2-5).

NOTE:

During operation on ac power, the power cord retainer must always be in place.

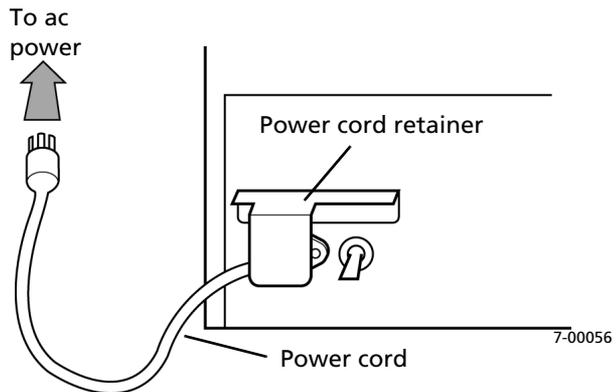


Figure 2-5. Connecting the ventilator power cord

When the power cord is not in use, you can wrap the power cord around the brackets on the back of the ventilator for convenient storage (see Figure 2-6).

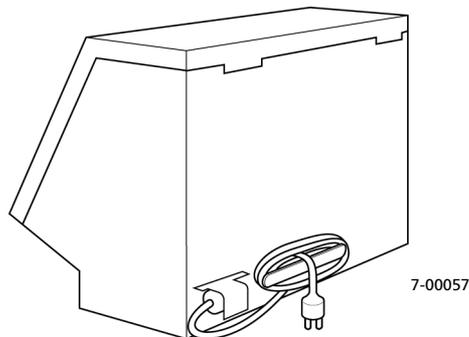


Figure 2-6. Storing the power cord on the ventilator

2.3 Connecting the oxygen supply

Warning

- To ensure proper oxygen concentration, do not obstruct the ventilator's air intake.
 - To ensure adequate oxygen delivery to the patient, use Covidien-supplied oxygen hoses only. Use of other oxygen hoses could result in inadequate or inappropriate oxygen pressures or leaks at the oxygen inlet.
 - When using a cylinder oxygen supply, point the cylinder's pressure relief device away from the ventilator air intake. This helps avoid creating an oxygen-rich environment within the ventilator in the event that the cylinder oxygen regulator malfunctions.
-

The 700 Series Ventilator System can use oxygen from a cylinder or wall supply. Follow these steps to connect the oxygen supply:

1. Ensure that the oxygen supply pressure is between 40 and 90 psi (275 and 620 kPa) (50 psi (345 kPa) recommended).

Warning

Due to excessive restriction of certain hose assemblies (listed in Table B-1), reduced FiO_2 levels may result when oxygen inlet pressures < 50 psi (345 kPa) are used. To maintain correct FiO_2 levels, make sure that oxygen inlet pressure is ≥ 50 psi (345 kPa) when using these hose assemblies.

2. Connect the oxygen supply to the oxygen inlet connector on the side of the ventilator (see Figure 2-7). Make sure ventilator is configured with adapter(s) as required.

Caution

To prevent damage to the ventilator, ensure that the connection to the oxygen supply is clean and unlubricated.

NOTE:

Whenever a pressurized oxygen source is connected to the ventilator, the oxygen regulator has a maximum bleed rate of 3 L/min, even when the ventilator is not in use. Always take this bleed rate into account when calculating oxygen cylinder volume and duration. This is especially important when using the ventilator and cart while transporting patients who are being ventilated at above-ambient FiO_2 levels.

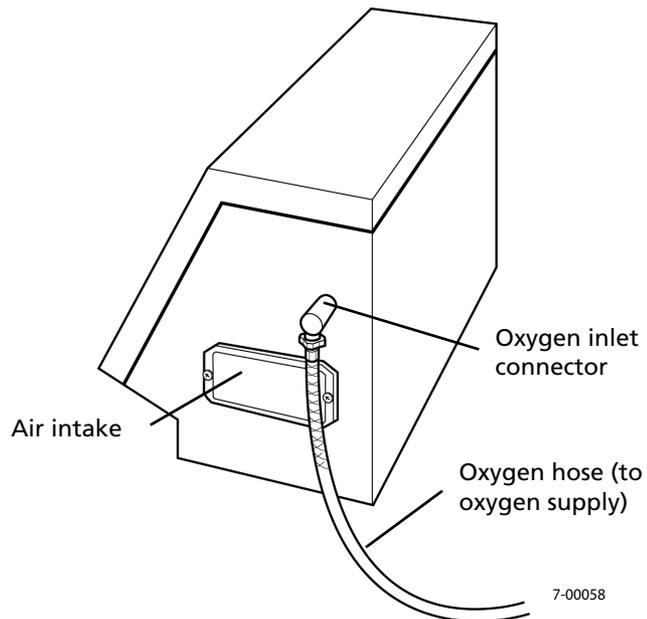


Figure 2-7. Connecting the oxygen supply

2.4 Connecting the ventilator breathing circuit

Warning

- To minimize the risk of bacterial contamination or component damage, inspiratory and expiratory filters must always be handled with care and connected to the ventilator during use.
 - Use of an external pneumatically powered nebulizer with a 700 Series Ventilator results in added flow to the ventilator breathing circuit. This additional flow can affect delivered tidal volumes, spirometry and spirometry alarms, delivered FiO_2 , and patient triggering. (However, the Covidien EasyNeb Nebulizer is designed to deliver aerosol medications to the patient without affecting ventilator performance or patient data.)
 - To minimize the risk of patient injury, use only ventilator breathing circuits qualified for use in oxygen-enriched environments with 700 Series Ventilators. Do not use antistatic or electrically conductive tubing. To ensure a leak-tight connection, only use connectors and tubes with ISO-standard cone and socket fittings (or use adapters to connect barbed cuff fittings to ISO-standard fittings).
 - Use ventilator breathing circuits identified by Covidien for use with 700 Series Ventilators or circuits that ensure that the maximum resistance values specified in Table C-5 are not exceeded. Using a circuit with a higher resistance does not prevent the ventilator from ventilating as long as the ventilator passes SST.
-

Caution

Adding accessories to the ventilator can increase system resistance. Ensure that any changes to the recommended ventilator circuit configurations do not exceed the values for resistance provided in Appendix C.

NOTE:

- Covidien recommends that you run SST every 15 days, between patients, and when you change the ventilator breathing circuit. Covidien recognizes that the protocol for running SST varies widely among healthcare institutions. It is not possible for Covidien to specify or require specific practices that will meet all needs, or to be responsible for the effectiveness of those practices.
 - The ventilator uses an oxygen sensor to trigger an alarm if the delivered % O₂ is 10 percentage points above or below the % O₂ setting. You can view the ventilator's % O₂ measurement by using the *User settings* function of the MENU key.
 - Check the inspiratory and expiratory limbs of the ventilator breathing circuit and the collector vial and in-line water traps regularly for water buildup. Under certain conditions, they can fill quickly. In case of a partial occlusion alarm, check for water in the ventilator breathing circuit. In very severe cases, such a water occlusion can potentially cause the ventilator to enter occlusion cycling mode. Empty and clean the collector vial and in-line water traps as necessary.
 - Covidien recommends using pediatric circuits when ventilating patients with 5-mm or smaller internal-diameter artificial airways.
-

Figure 2-8 shows how to connect the ventilator breathing circuit, including the inspiratory filter, humidifier (if used), inspiratory limb, patient wye, expiratory limb, collector vial, and expiratory filter.

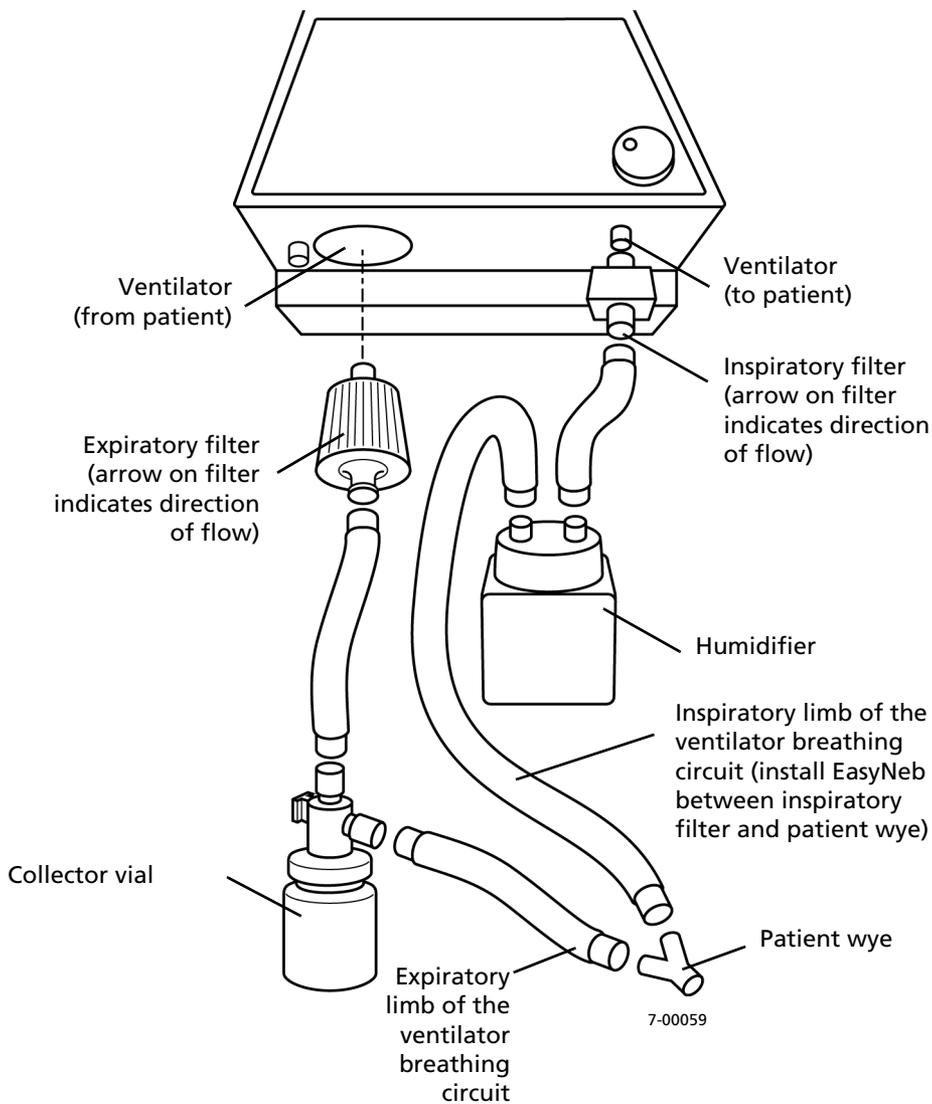
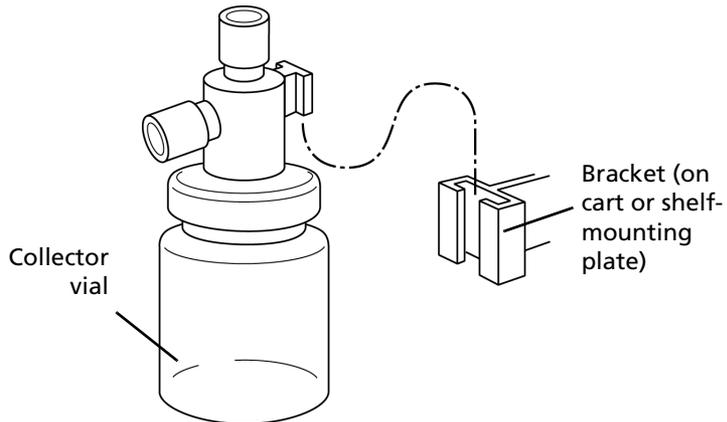


Figure 2-8 . Connecting the ventilator breathing circuit

2.5 Installing the collector vial

Figure 2-9 shows you how to slide the collector vial into the bracket on the cart or shelf mounting plate.



7-00060

Figure 2-9. Installing the collector vial

2.6 Installing the flex arm

Figure 2-10 shows you how to install the flex arm onto the threaded socket on the ventilator.

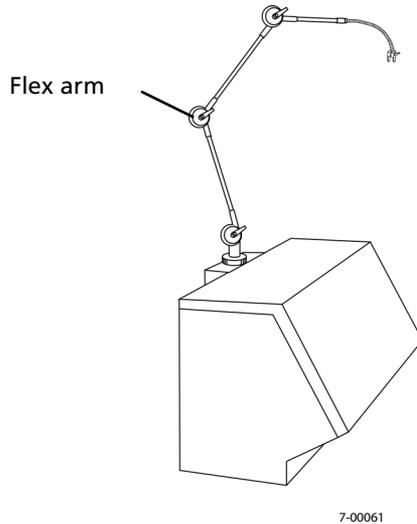


Figure 2-10. Installing the flex arm

NOTE:

If the flex arm is too large to fit into a tight space, you can shorten the arm by removing the middle segment (Figure 2-11).

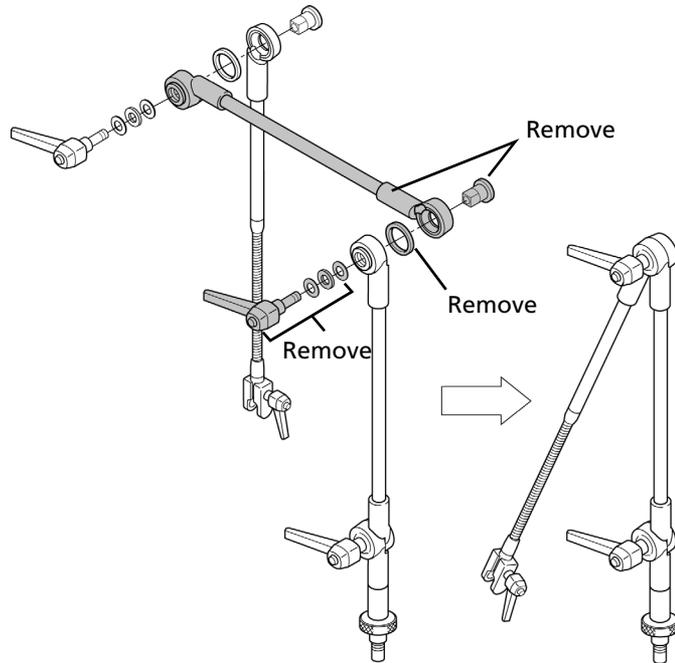


Figure 2-11. Shortening the flex arm

2.7 Installing the humidifier

Figure 2-12 shows you how to slide the humidifier into the bracket on the cart or shelf mounting plate.

NOTE:

The humidifier must be powered independently of the ventilator (regardless of whether the ventilator is running on ac or battery power).

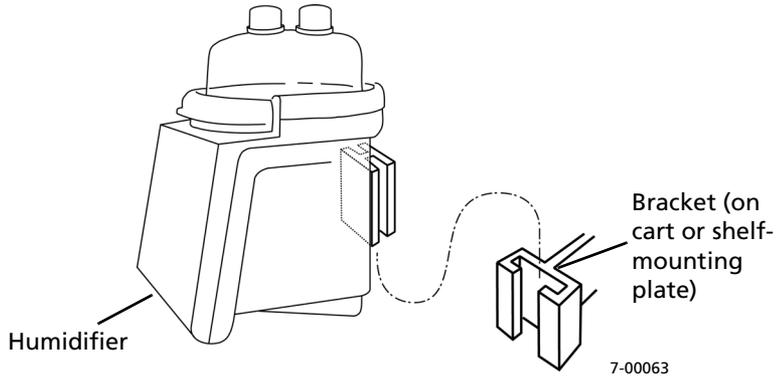


Figure 2-12. Installing the humidifier

2.8 Using the ventilator cart

The ventilator cart is equipped with a storage area for the external battery. You can lock and unlock the cart's front wheels with your foot, as shown in Figure 2-13.

Caution

To prevent equipment damage, pull, rather than push, the ventilator over high thresholds when using the cart to transport the ventilator. Ensure that the flex arm is positioned at the front of the ventilator.

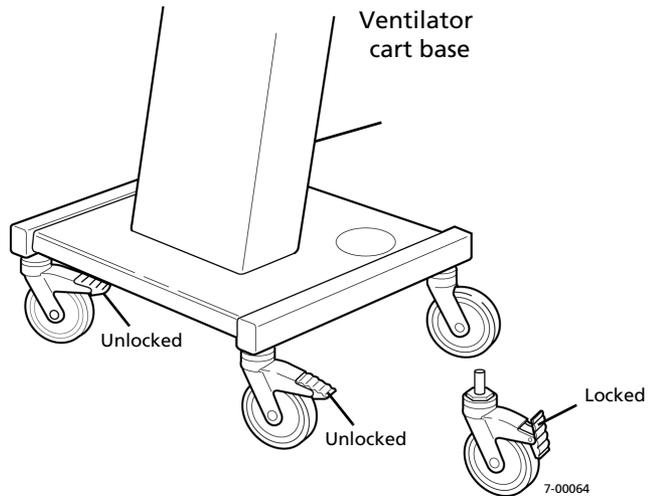


Figure 2-13. Locking and unlocking the cart's front wheels

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Getting started

This section tells you how to:

- Power up the ventilator
- Select ventilator settings
- View and change alarm limits
- Enter and exit standby mode

NOTE:

Covidien recommends that before using the ventilator for the first time, you wipe the ventilator exterior clean and sterilize its components according to the instructions in Appendix A. Follow your institution's protocol for cleaning and sterilizing the ventilator and its components.

3.1 Powering up the ventilator

NOTE:

To ensure battery charge(s), store the ventilator in standby mode with the power cord plugged into the mains and the power switch in the on (I) position whenever possible. The power switch controls ac mains and battery power to the ventilator.

1. Turn the power switch on (see Figure 3-1). The ventilator displays this message:

**POST running...
NPB 7x0 S/W Rev x
PM due xxxxx hrs**

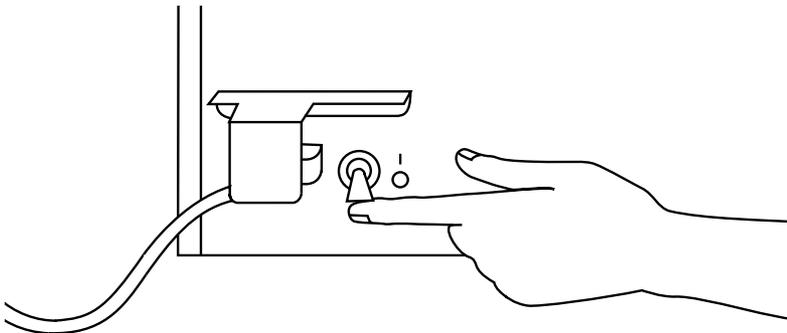
“PM due” refers to the number of hours until a routine preventive maintenance procedure is due, based on the ventilator’s operational hours.

Warning

If a single beep is not audible during POST, the main audible alarm may be malfunctioning. Remove the ventilator from use and contact service.

NOTE:

- If the ventilator is running on ac but the battery is low, upon power up it may begin ventilating using the last valid settings and an ABNORMAL RESTART alarm may occur.
 - Do not switch off ventilator power during POST.
-



7-00065

Figure 3-1. Turning the power switch on (the “I” position)

2. Once the power-on self-test (POST) is complete (several seconds), the ventilator displays the message:

**Accept settings
to start ventilation**

The last valid settings are proposed, and the appropriate indicator lights to show the ventilator's source of power.

Warning

Always let the ventilator run for 10 minutes before placing it on a patient to allow heaters to warm up. Failure to warm up the ventilator could result in failure of the SST flow sensor test, and higher measured exhaled tidal volumes.

Caution

Covidien recommends running short self-test (SST) and testing alarms to check proper operation of the ventilator before ventilation begins or according to your institution's protocol. Chapter 4 tells you how to run SST. Appendix E tells you how to test alarms.

NOTE:

If the ventilator detects low oxygen pressure, a low battery level, or an occluded or missing air intake filter during POST, POST continues uninterrupted. These alarms become active when POST is complete, and you can override them by pressing the alarm reset key.

3.2 Selecting ventilator settings

NOTE:

Each keypress should result in a “blip” sound; otherwise, the main alarm speaker may be faulty. If a keypress does not result in this sound, turn the ventilator off then on to run POST and verify the proper functioning of the speaker.

1. *Select the mode:* To select a mode, press A/C, SIMV, or SPONT. (Appendix D gives a detailed explanation of these ventilation modes.)



In assist/control (A/C) mode, you can only select volume control ventilation (VCV) or pressure control ventilation (PCV) settings (PCV is only available on the 760 Ventilator).



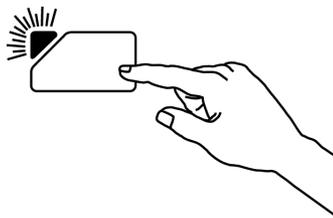
In synchronous intermittent mandatory ventilation (SIMV) mode, you can select both VCV or PCV (760 only) and pressure support ventilation (PSV) settings.



In spontaneous (SPONT) mode, you can only select PSV settings.

2. *Confirm or change settings:* For every flashing key light, you must touch the key (and adjust the setting if necessary) before you can apply the settings. You can confirm or change settings in any order.

Once you press a key, the proposed setting flashes to indicate that the knob is linked to the selected setting. The setting's LCD window shows the setting and the message window displays the current setting, range, units, name of the setting, and associated parameter. Turn the knob to change the setting or press another key to leave the setting as is. (The setting then stops flashing.)



Press each flashing key and turn the knob to adjust.

7-00066

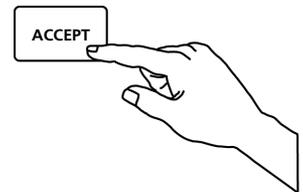
3. Press CLEAR to cancel the most recently changed setting and return to the last valid setting. (This only works if you haven't pressed ACCEPT yet.) Pressing CLEAR after you've pressed 100% O₂ stops the 100% O₂ maneuver. The ventilator will beep if you attempt to change a setting to a value above or below the setting range.
4. *PEEP/CPAP, TRIGGER SENSITIVITY, and % O₂*: You can change these settings in any mode. These keys don't flash when you select a new mode, and you are not required to confirm these settings.



NOTE:

The O₂ % alarm is delayed for 30 seconds and 12 L of tidal volume following a change in setting so that the oxygen concentration can stabilize.

5. *Apply the settings:* Press ACCEPT.



7-00067

NOTE:

If apnea ventilation is possible, the ventilator displays this message when normal ventilation begins:

Review Ta = xx s

where *Ta* is the apnea interval and *xx* is the current setting in seconds (from 10 to 60 s). Chapter 5 tells you how to adjust apnea ventilation parameters. You are not required to review apnea parameters before normal ventilation begins.

Ventilation begins according to the displayed settings and the existing alarm limits. You should review all alarm limits and change them if necessary. (Section 3.3 tells you how.) You can change alarm limits or ventilator settings at any time during normal ventilation.

Warning

In PSV it is impossible to set support pressure + PEEP to deliberately cause a HIGH PRESSURE alarm. Although Covidien does not recommend doing so, it is possible in VCV to set a tidal volume that causes breath truncation and a HIGH PRESSURE alarm. To avoid activating a HIGH PRESSURE alarm, select the appropriate TIDAL VOLUME and HIGH PRESSURE alarm settings.

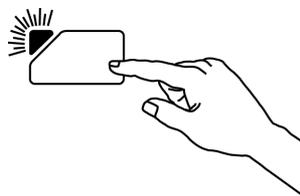
3.3 Viewing and changing alarm settings

You can view alarm settings at any time without affecting ventilation by pressing the appropriate key. The ALARM SETTINGS window displays the value of the alarm being viewed or changed. The alarm setting flashes for up to 30 seconds, and you can change an alarm setting any time its setting is flashing in the window.

All alarm settings are in effect during ventilation (except for LOW INSP PRESSURE, which is not active in SPONT mode). You can change alarm settings at any time during ventilation. You can only change one alarm setting at a time.

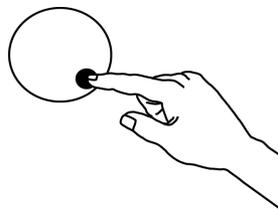
To change a setting: *touch, turn, ACCEPT.*

1. *Touch the key:* The key light turns on, and the current alarm setting flashes in the window for 30 seconds. The message window shows the current setting, range, and units of the alarm.



7-00066

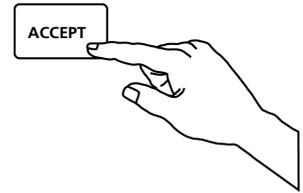
2. *Turn the knob* to adjust the alarm setting (this only works when the alarm setting is flashing in the window). The ventilator will beep if you attempt to select a setting above or below the setting range.



7-00068

3. Press *ACCEPT* to apply the new alarm setting. The new alarm setting stops flashing and the message window displays this message:

Setting(s) accepted



7-00067

Warning

- Inadvertent extubation in which the endotracheal tube remains connected to the breathing circuit could result in pressurization above the LOW INSP PRESSURE alarm setting. The LOW INSP PRESSURE and low volume alarms should be set appropriately.
- To ensure patient safety, always set the LOW TIDAL VOLUME and HIGH RATE alarms.

NOTE:

The O₂ % alarm limits are based on the set % O₂. The high O₂ % alarm limit is 10 percentage points above the set % O₂, and the low O₂ % alarm limit is 10 percentage points below the set % O₂. The measured % O₂ is shown in the message window if its display is enabled (using the *Oxygen sensor* menu function, described in Chapter 6).

3.4 Entering and exiting standby mode

Standby mode is a waiting state in which there is no ventilation, but the ventilator maintains its settings and battery charge(s).

Warning

- To avoid raising the oxygen concentration of room air, ensure that the ventilator is in an adequately ventilated room if connected to an oxygen supply while in standby mode. Disconnect the oxygen supply if you do not intend to use the ventilator immediately.
 - To avoid patient injury due to lack of ventilatory support, do not enter standby mode with a patient attached to the ventilator. You must confirm that no patient is attached before entering standby mode.
-

NOTE:

To maintain battery charge(s), the ventilator must be plugged into ac power with the power switch on while in standby mode.

Follow these steps to enter standby mode:

1. Turn on the ventilator. If ventilation has already begun, you must turn off the ventilator, then turn it back on without starting ventilation. This allows you access to the *Standby mode* menu function.
2. Press MENU.
3. Turn the knob to select standby mode.
4. Press ACCEPT. The ventilator displays this message:
**Is pt disconnected?
ACCEPT to proceed**
5. Confirm that no patient is attached by pressing ACCEPT. (If you don't press ACCEPT while this message is displayed, the ventilator will not enter standby mode.)

6. This message tells you that the ventilator is in standby mode:

In standby mode

Clear to exit

The ON AC/BATTERY CHARGING, INTERNAL BATTERY LEVEL, and SAFETY VALVE OPEN indicators turn on. All other key lights and displays are off during standby mode. The only alarms that can become active during standby mode are FAN FAILED ALERT, BAT NOT CHARGING, LOSS AC POWER, and LOSS OF POWER.

Follow these steps to exit from standby mode and resume ventilation:

1. Press CLEAR.
2. The ventilator displays this message:

POST running...
3. After a few seconds, POST is complete and the ventilator begins ventilation using the last valid settings.

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Self tests (SST and EST)

All 700 Series Ventilators include these built-in self tests:

- Short self test (SST) is a short (about 2 to 3 minutes) and simple sequence of tests that verifies proper ventilator operation, checks the ventilator breathing circuit for leaks, and measures the circuit compliance. Power on self test (POST) is part of SST.
- Extended self test (EST) is a thorough test of the operational integrity of the ventilator, both the electronics and the pneumatics. POST and SST are part of EST.

Warning

- Before running SST or EST, you must disconnect the ventilator from the patient. Running SST or EST while the ventilator is connected to the patient can injure the patient.
 - A fault identified in SST or EST indicates that the ventilator or an associated component is defective. A defective ventilator or associated component should be repaired before the ventilator is returned to service, unless it can be determined with certainty that the defect cannot create a hazard for the patient, or add to the risks which may arise from other hazards.
-

Caution

To ensure accurate SST and EST operation, run SST and EST in room air (% O₂ is 21%) after the ventilator has been powered on for at least 10 minutes. (EST also requires an oxygen supply.)

Table 4-1 describes SST and EST.

Table 4-1: 700 Series Ventilator self tests

Test name	Purpose	When test is run
Short self test (SST)	An abbreviated version of EST to be run primarily by the operator. Makes detailed checks of the pneumatics and electronics. It also characterizes system leaks and system/tubing compliance to compensate during breath delivery. POST is run as part of SST.	Before patient is connected to the ventilator or after ventilator breathing circuit or humidifier is changed.
Extended self test (EST)	Thoroughly tests the operational integrity of the ventilator, both the electronics and pneumatics. POST and SST are part of EST.	<ul style="list-style-type: none"> • When the ventilator is serviced. • As part of the ventilator performance verification. • Following a ventilator inoperative. <hr/> <p>NOTE: The performance verification, described in the <i>700 Series Ventilator System Service Manual</i>, is a more thorough test of the ventilator to verify specifications are met. The technician runs a partial or full performance verification after servicing the ventilator and at regular intervals.</p>

4.1 Short self test (SST)

Table 4-2 summarizes the functions of SST.

NOTE:

- Covidien recommends that you run SST every 15 days, between patients, and when you change the ventilator breathing circuit. Covidien recognizes that the protocol for running SST varies widely among healthcare institutions. It is not possible for Covidien to specify or require specific practices that will meet all needs, or to be responsible for the effectiveness of those practices.
 - When SST asks you to do something (for example, press ACCEPT or block the patient wye), the ventilator will wait indefinitely for your response.
-

Follow these steps to run SST:

1. Turn on the ventilator. If ventilation has already begun, you must turn off the ventilator, then turn it back on without starting ventilation. This allows you access to the *Self test* menu function.

If you select the *Self test* function during ventilation the window displays this message:

N/A in ventilation

2. Press MENU, turn the knob to select *Self test*, then press ACCEPT. The usual 30-second timeout for your input is disabled during the entry to the *Self test* function.
3. The window displays this message:

Short self test

Turn knob to view

4. Turn the knob to select *Short self test* (you can also select *Extended self test*). The window displays this message:

Short self test

Vent warming 09:59

CLEAR to bypass

If the ventilator has already been running for more than 10 minutes before you select *Short self test*, this message is bypassed (see step 5). If the ventilator was recently running and is already warmed up, you can press CLEAR to override the *Vent warming* message and begin SST. Covidien cannot guarantee the accuracy of test results in this case, however.

5. The window displays this message:

**Is pt disconnected?
ACCEPT to proceed**

6. Press ACCEPT to confirm that no patient is connected to the ventilator. (Or press CLEAR to back up through the menu.)
The window displays this message:

Block wye

7. Block the patient wye and then press ACCEPT.

8. The ventilator runs power-on self-test (POST) and displays this message for a few seconds:

POST running...

Warning

If a single beep is not audible during POST, the main audible alarm may be malfunctioning. Remove the ventilator from use and contact service.

NOTE:

- If the ventilator is running on ac but the battery is low, upon power up it may begin ventilating using the last valid settings and an ABNORMAL RESTART alarm may occur.
 - During POST it is recommended that you not switch off ventilator power.
-

9. The message window then displays this message:

humidification device type
Choose humidifier

where the *humidification device type* is the most recently selected type, as follows:

- *HME*: Heat moisture exchanger (“artificial nose”)
- *Dual heated wire*: Humidifier with heated wire on expiratory limb, or on both inspiratory and expiratory limbs
- *No heated wire*: Conventional humidifier without heated wire circuit on the expiratory limb

Turn the knob to select the humidifier type attached, then press ACCEPT.

Warning

Incorrectly specifying the humidifier type during SST can affect the accuracy of spirometry calculations.

10. The message window then displays this message:

tubing type
Choose tubing type

where the *tubing type* is the most recently selected ventilator breathing circuit type.

Turn the knob to select the ventilator breathing circuit type (adult or pediatric tubing) attached to the ventilator, then press ACCEPT.

Warning

Incorrectly specifying the ventilator breathing circuit type during SST can cause an inappropriate sensitivity for the leak test and occlusion alarm. Covidien recommends using pediatric circuits when ventilating patients with 5-mm or smaller internal-diameter artificial airways.

NOTE:

To ensure that compliance compensation functions correctly, you must run SST with the circuit configured as intended for use on the patient.

11. The message window then displays this message:

ET size: x.x mm

Choose ET size

Turn the knob to select the appropriate ET (endotracheal tube) size, then press ACCEPT.

Warning

Specifying an ET tube size that is too large can cause premature termination of breaths on very small pediatric patients. During normal ventilation, you can use the MENU key's *User settings* function to change the ET tube size (see Chapter 6).

12. The ventilator automatically starts the test sequence. A message indicates which test is being performed. Once started, a test cannot be interrupted. In most cases you don't need to do anything unless a test result is *fault* or *fail*, or your action is required. When a test passes, SST automatically starts the next test.

NOTE:

The PRESSURE bar graph and the PRESSURE display window show the real-time expiratory pressure throughout SST.

These keys are valid during SST:



To confirm that a requested action is complete.



To repeat a test, return to the prompt at the start of a test, or indicate an inaudible alarm (during the Main alarm speaker test and Backup alarm test only).



To override an *Incomplete* or *Fault* test result.



To restart from the beginning of SST.



To stop testing and skip to the end of SST.

7-00424
7-00423
7-00072

NOTE:

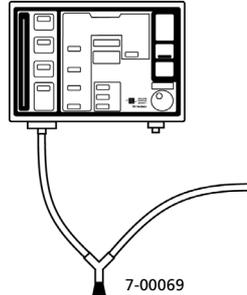
If the tubing or humidifier type or ET tube size that you've selected has changed from the previous time SST was run, this key is temporarily disabled until the Circuit comp test is complete.

13. The I/E filter test prompts you to complete these actions (press ACCEPT when each action is complete):

Display:

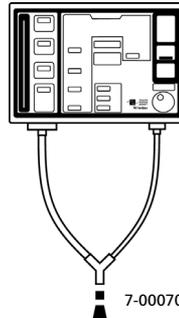
**Disconnect I tubing
Reconnect I tubing**

(Do not disconnect inspiratory filter.)



Display:

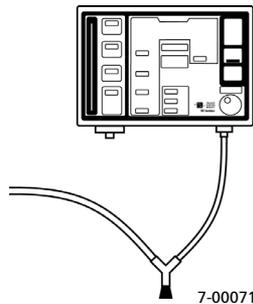
**Unblock wye
Block wye**



Display:

**Disconnect E tubing
Reconnect E tubing**

(Do not disconnect expiratory filter.)



14. When the final test in the sequence is complete, this message is displayed along with the overall SST result:

SST finished testing

Table 4-3 summarizes overall SST results and how to proceed in each case.

15. Unblock the patient wye, then press ACCEPT. The ventilator reruns POST.

Table 4-2: SST sequence of tests

Test	Function	Comments
Is pt disconnected?	Asks for confirmation that a patient is not connected to the ventilator.	SST cannot proceed until you confirm that a patient is not connected.
Leak test	Checks the ventilator breathing circuit for leaks. Displays expiratory pressure on pressure bar graph.	<i>Fault</i> if not passed. Overriding a fault could cause improper compliance compensation, inaccurate tidal volume delivery, or autocyling.
P _e P _{cyl} compare	Verifies proper function of pressure transducers in internal pneumatics and ventilator breathing circuit. Displays expiratory pressure on pressure bar graph.	<i>Fault</i> if not passed. Overriding a fault could cause improper compliance compensation, or autocyling.
Auto-zero sol test	Verifies the proper function (ability to open and close) of the P _e (expiratory) and P _{cyl} (cylinder) solenoids.	<i>Failure</i> if not passed.
Circuit comp test	Determines the compliance of the ventilator breathing circuit. Displays expiratory pressure on pressure bar graph.	<i>Fault</i> if not passed. Overriding a fault could cause improper compliance compensation or inaccurate tidal volume delivery.

Table 4-2: SST sequence of tests (continued)

Test	Function	Comments
Safety valve test	Verifies that safety valve relieves excess circuit pressure. Displays expiratory pressure on pressure bar graph.	<i>Failure</i> if not passed.
PEEP system test	Verifies that the PEEP system can generate and maintain preset PEEP levels. Displays expiratory pressure on pressure bar graph.	<i>Failure</i> if not passed.
Flow/O ₂ sensor test	Checks the accuracy of the exhalation flow sensor and the oxygen sensor.	<p><i>Failure</i> if flow sensor test does not pass.</p> <p><i>Fault</i> if oxygen sensor test does not pass. Use the MENU key's Oxygen sensor function to recalibrate the oxygen sensor (see Chapter 6).</p> <p>Overriding a fault (oxygen sensor test only) could result in inaccurate % O₂ measurement.</p>
I/E filter test	Checks the pressure drop across the inspiratory and expiratory limbs of the entire patient system. Checks the pressure drop across the filters.	<p><i>Fault</i> if not passed. This test is optional: pressing CLEAR at the initial prompt skips this test.</p> <p>Skipping this test or overriding a fault could result in inadequate bacteria protection or excessive resistance to inspiration or exhalation.</p>

Table 4-2: SST sequence of tests (continued)

Test	Function	Comments
Heaters test	Verifies correct operation of the heaters in the exhalation subsystem.	<i>Fault</i> if not passed. Overriding a fault could cause inaccurate monitoring of exhaled volume or lead to damage to the ventilator's flow sensor or exhalation valve.
Main alarm test	Sounds alarm at three volumes and verifies that user reports hearing it.	<i>Failure</i> if not passed. If alarm is audible press ACCEPT. If not, press CLEAR.
Backup alarm test	Checks the operation of the backup alarm circuit.	<i>Fault</i> if not passed. If alarm is audible press ACCEPT. If not, press CLEAR. Overriding a fault could cause no backup audible alarm in case the main audible alarm fails.
<p>NOTE: <i>Faults</i> detected during SST may require removing the ventilator from clinical use immediately and servicing it. A trained operator, however, must evaluate the situation and determine whether the ventilator can be used. <i>Failures</i> detected during SST require rerunning SST (using the alarm reset key). It is not possible to exit SST if SST fails. If SST continues to fail, the ventilator must be removed from service.</p>		

Table 4-3: Overall SST results

If the SST result is:	It means:	Do this:
SST passed	All tests passed.	Press ACCEPT to exit SST or press the alarm reset key to restart SST from the beginning.
SST incomplete	All tests performed were passed, but some were skipped. The skipped tests were passed on a previous run.	Press the alarm reset key to restart SST from the beginning or press MANUAL INSP to override this result and exit SST.*
SST fault	One or more tests did not pass. These tests might not compromise the ventilator's ability to ventilate safely, based on the operator's evaluation of the situation.	Press the alarm reset key to restart SST from the beginning or press MANUAL INSP to override this result and exit SST.*
SST failed	One or more critical problems were detected.	Press the alarm reset key to rerun SST. It is not possible to exit SST if SST fails. If SST continues to fail, remove the ventilator from use and contact service.

* If you press MANUAL INSP to exit SST, you will be prompted to confirm that you wish to override the fault or incomplete test. Confirm by pressing MANUAL INSP again.

4.2 Extended self test (EST)

To run EST, you must have the hardware listed in Table 4-4.

Table 4-4: EST hardware requirements

Hardware description	Manufacturer/model or Covidien part number
Ventilator breathing circuit	<p>To use as test circuit: G-061208-00 or equivalent (adult, reusable, without heated wire)</p> <hr/> <p>NOTE: To ensure that compliance compensation functions correctly, the user must run EST or SST with the circuit configured as intended for use on the patient.</p> <hr/>
Stopper, wye (no. 2)	G-061574-00 or local supplier
Stopper, inspiration port (no. 3)	G-061575-00 or local supplier
Oxygen source, 40 to 90 psi (275 to 620 kPa)	Local supplier
<p>Warning</p> <p>Due to excessive restriction of Air Liquide™*, Australian, and Dräger™* hose assemblies, reduced FiO₂ levels can result if you use oxygen inlet pressures < 50 psi (345 kPa). Make sure oxygen inlet pressure is ≥ 50 psi (345 kPa) when using these hose assemblies, to maintain correct FiO₂ levels.</p>	

NOTE:

Covidien recommends that you always run the full EST before placing the ventilator into operation following service and as part of the ventilator’s routine performance verification. For more information on performance verification, see the *700 Series Ventilator System Service Manual*.

Follow these steps to run EST:

1. Set up the ventilator as for normal operation, complete with humidifier, if applicable, and leak-tight ventilator breathing circuit.
2. Turn on the ventilator. If ventilation has already begun, you must turn off the ventilator, then turn it back on without starting ventilation. This allows you access to the *Self test* menu function.
3. Press MENU, turn the knob to select *Self test*, then press ACCEPT.
4. Turn the knob to select *Extended self test*. The window displays the messages shown in Table 4-5.

Table 4-5: EST setup messages

Message	Description
Extended self test Vent warming xx:xx CLEAR to bypass	This message is displayed (followed by a countdown) if you just turned on the ventilator. The ventilator must be on for 10 minutes before running EST so that component temperatures can stabilize. If the ventilator was recently running and is already warmed up, you can press CLEAR to override the <i>Vent warming</i> message and begin SST. Covidien cannot guarantee the accuracy of test results in this case, however.
Is pt disconnected?	Confirm that patient is disconnected by pressing ACCEPT; or press CLEAR to return to service menu.
Block wye	Install no. 2 stopper and then press ACCEPT.

Table 4-5: EST setup messages (continued)

Message	Description
POST running...	<p data-bbox="527 250 1023 277">Wait a few seconds until POST is completed.</p> <hr/> <p data-bbox="565 331 645 358">NOTE:</p> <ul data-bbox="565 363 1079 509" style="list-style-type: none"> <li data-bbox="565 363 1079 444">• If a single beep is not audible during POST, the main audible alarm may be malfunctioning. Contact service. <li data-bbox="565 456 1079 509">• During POST do not switch off ventilator power. <hr/>
<p data-bbox="305 563 473 675"><i>humidification device type</i> Choose humidifier</p>	<p data-bbox="527 563 1138 735">Turn knob to select desired humidification device, then press ACCEPT. Device types include: HME (heat-moisture exchanger or “artificial nose”), Dual heated wire (humidifier with heated wires on both inspiratory and expiratory limbs), or No heated wire (humidifier without a heated wire on expiratory limb).</p> <hr/> <p data-bbox="527 773 724 800">Warning</p> <p data-bbox="565 816 1103 898">Incorrectly specifying the humidifier type during EST can affect the accuracy of spirometry calculations.</p> <hr/>

Table 4-5: EST setup messages (continued)

Message	Description
<p><i>tubing type</i> Choose tubing type</p>	<p>Turn knob to select either Adult tubing or Pediatric tubing and then press ACCEPT.</p> <hr/> <p>Warning</p> <p>Incorrectly specifying the ventilator breathing circuit type during EST can cause an inappropriate sensitivity for the leak test and occlusion alarm. Covidien recommends using pediatric circuits when ventilating patients with 5-mm or smaller internal-diameter artificial airways.</p> <hr/> <p>NOTE:</p> <p>To ensure that compliance compensation functions correctly, run EST with the circuit configured as intended for use on the patient.</p>
<p>ET size: x.x mm Choose ET size</p>	<p>Turn knob to select appropriate ET (endotracheal tube) size, and then press ACCEPT.</p> <hr/> <p>Warning</p> <p>Specifying an ET tube size that is too large can cause premature termination of breaths on very small pediatric patients. During normal ventilation, you can use the MENU key's <i>User settings</i> function to change the ET tube size (see Chapter 6).</p>

5. The ventilator automatically starts the test sequence (Table 4-6). Unless a test requires your intervention (and waits indefinitely for your response), you don't need to do anything until a test result is fault or failed, or EST is complete. Use the keys listed in Table 4-7 as needed.

Table 4-6: EST test sequence

Test number and name	Function	Comments
1. DAC-ADC loop test	A loopback test to check digital-to-analog (D/A) and analog-to-digital (A/D) converters' operation.	Failure if not passed. Not in SST.
2. Safety valve test	Verifies that safety valve relieves excess circuit pressure.	Failure if not passed. Also in SST.
3. Motor sensor test	Checks operation of rotary encoder.	Failure if not passed. Not in SST.
4. Zeroing of P _o	Zeroes oxygen regulator pressure transducer. Disconnect and reconnect oxygen supply, as directed. Press ACCEPT to signify you have performed each requested action.	Fault if not passed. Not in SST. <hr/> NOTE: Overriding this fault could result in inaccurate oxygen percentage delivery. <hr/>
5. O ₂ solenoids test	Checks oxygen solenoids and oxygen sensor.	Fault if not passed. Not in SST. <hr/> NOTE: Overriding this fault could result in inaccurate oxygen percentage delivery. <hr/>
6. Flow sensor test	Checks accuracy of exhalation flow sensor.	Failure if not passed. Also in SST.

Table 4-6: EST test sequence (continued)

Test number and name	Function	Comments
7. Leak test	Checks ventilator breathing circuit for leaks.	Fault if not passed. Also in SST. <hr/> NOTE: Overriding this fault could cause improper compliance compensation, inaccurate tidal volume delivery, or autocycling.
7. P_e P_{cyl} compare (also part of test 7)	Verifies proper functioning of pressure transducers and ventilator breathing circuit.	Fault if not passed. Also in SST. <hr/> NOTE: Overriding this fault could cause improper compliance compensation, inaccurate tidal volume delivery, or autocycling.
7. Auto-zero sol test (also part of test 7)	Verifies the proper function of the P_e and P_{cyl} solenoids.	Failure if not passed. Also in SST. <hr/> NOTE: Overriding this fault could cause improper compliance compensation, inaccurate tidal volume delivery, or autocycling.
8. Circuit comp test	Determines ventilator breathing circuit compliance.	Fault if not passed. Also in SST.

Table 4-6: EST test sequence (continued)

Test number and name	Function	Comments
9. I/E filter test	<p>Checks pressure drop across inspiratory and expiratory limbs of entire patient system. Checks pressure drop across filters.</p> <p>Disconnect and reconnect inspiration (I) tube from/to inspiratory filter outlet, and exhalation (E) tube from/to expiratory filter inlet, as directed. Block and unblock wye with a no. 2 stopper, as directed. Press ACCEPT to signify you have performed each requested action.</p>	<p>Fault if not passed. Also in SST. Mandatory in EST, but optional in SST.</p> <hr/> <p>NOTE: Overriding this fault could result in inadequate bacteria protection or excessive resistance to inspiration or exhalation.</p> <hr/>
10. PEEP system test	<p>Verifies that PEEP system can generate and maintain preset PEEP levels within either of two sets of limits. If results are within the inner set of limits, test passes the first time. If the results are outside of the outer set of limits, test fails the first time. If the results are outside the inner limits but within the outer limits, the ventilator adjusts its calibration table in nonvolatile RAM (NVRAM) and repeats the test to verify the calibration. The test fails if the calibration cannot be verified after five attempts.</p>	<p>Failure if not passed. Also in SST, but not identical.</p>
11. Check valve test	<p>Checks check valves on inlet and outlet ports of cylinder and on exhalation limb of ventilator breathing circuit.</p>	<p>Failure if not passed. Not in SST.</p>

Table 4-6: EST test sequence (continued)

Test number and name	Function	Comments
12. Piston leak test	Checks piston leak against a table of leak values stored in NVRAM. First remove inspiratory filter; then block and unblock inspiratory filter port as directed, using no. 3 stopper. Press ACCEPT to signify you have performed each requested action. Replace inspiratory tubing at end of test.	Failure if not passed. Not in SST.
13. Lights-displays test	Verifies that lights and displays function. Observe each named display, and press ACCEPT to verify that it is lit. Press CLEAR if a display is not lit.	Failure if not passed. Not in SST.
14. Keys test	Verifies that every row and column of key matrix can be correctly read. Press each named key (each key's LED will also be lit). Press CLEAR if a key's LED is not lit.	Failure if not passed. Not in SST.
15. Main alarm test	Checks whether various alarm sounds are audible (at maximum volume). Listen for each named sound, then press ACCEPT to verify that it is audible. Press CLEAR if a sound is not audible.	Failure if not passed. Also in SST.

Table 4-6: EST test sequence (continued)

Test number and name	Function	Comments
16. Backup alarm test	Checks operation of backup alarm circuit. Press ACCEPT if alarm is audible or press CLEAR if alarm is not audible.	Fault if not passed. Also in SST. NOTE: Overriding this fault could result in no audible alarm if the main speaker fails.
17. Fan test	Verifies that main fan is operating correctly by reading fan status bits.	Failure if not passed. Not in SST.
18. Heaters test	Verifies correct operation of heaters in exhalation system.	Fault if not passed. Also in SST. NOTE: Overriding this fault could result in inaccurate monitoring of exhaled volume or damage to the ventilator's flow sensor or exhalation valve.

At the end of each test, the test name and pass/fail/fault status are displayed. When a test passes, EST automatically starts the next test. You do not need to do anything unless a test result is *Fault* or *Fail*, or your action is required. If a test does not pass, you can still continue EST, although the overall EST result is not *passed* until the error condition is corrected. Since information on multiple errors can help troubleshooting, it can be useful to complete EST even with errors.

Table 4-7: Key functions during EST

Key	Function
	To confirm that a requested action is complete.
	Repeat a test or return to prompt at start of a test.
	To override an <i>Incomplete</i> or <i>Fault</i> test result.
 7-00424	To restart from the beginning of SST.
 7-00423 7-00072	To stop testing and skip to the end of SST. NOTE: If the tubing or humidifier type or ET tube size that you've selected has changed from the previous time SST was run, this key is temporarily disabled until the Circuit comp test is complete.

- Some tests display additional prompts, some of which require your response. These are listed in Table 4-8.

Table 4-8: Prompts during EST

Prompt	Your response
Disconnect O ₂ supply	Disconnect ventilator from oxygen supply. Press ACCEPT.
Reconnect O ₂ supply	Reconnect ventilator to oxygen supply. Press ACCEPT.

Table 4-8: Prompts during EST (continued)

Prompt	Your response
Disconnect I tubing	Disconnect tubing from inspiratory filter outlet. Leave inspiratory filter in place. Press ACCEPT.
I drop = x x.x at 100 or I drop = x x.x at 40 Reconnect I tubing	This is the inspiratory filter pressure drop in cmH ₂ O at a flow of 100 L/min (adult tubing) or 40 L/min (pediatric tubing). Reconnect tubing to inspiratory filter outlet. Press ACCEPT.
Unblock wye	Remove stopper from patient wye. Press ACCEPT.
Block wye	Insert a stopper into patient wye. Press ACCEPT.
Disconnect E tubing	Reconnect tubing to inspiratory filter outlet, and disconnect tubing from expiratory filter inlet. Leave expiratory filter in place. Press ACCEPT.
E drop = x.x at 100 or E drop = x x.x at 40 Reconnect E tubing	This is the expiratory filter pressure drop in cmH ₂ O at a flow of 100 L/min (adult tubing) or 40 L/min (pediatric tubing). Press ACCEPT. Reconnect tubing to expiratory filter outlet.
Block insp filt port	Remove inspiratory filter. Insert no. 3 stopper into inspiratory filter outlet. Press ACCEPT.
Reconnect I tubing	Remove stopper from inspiratory filter outlet. Reinstall inspiratory filter. Press ACCEPT.
<i>Name of a section of display</i>	Press ACCEPT to confirm that all LEDs/LCDs in named section are on.
Upper MDW = blocks?	Press ACCEPT to confirm that all pixels are turned on in upper half.
Lower MDW = blocks?	Press ACCEPT to confirm that all pixels are turned on in lower half.
<i>Name of a key</i>	Press named key.
High alarm sound	Confirm that you hear alarm by pressing ACCEPT.
Medium alarm sound	Confirm that you hear alarm by pressing ACCEPT.

Table 4-8: Prompts during EST (continued)

Prompt	Your response
No sound	Confirm that you <i>do not</i> hear alarm by pressing ACCEPT.
Is backup alarm ON?	Confirm that you hear alarm by pressing ACCEPT.

7. When the last test in the sequence is complete, the EST completion status is displayed (Table 4-9). Respond as indicated.
- If certain tests do not pass, safe ventilation may be compromised, and the ventilator is rendered inoperative until it is repaired. This is called a ventilator *failure*. If certain other tests do not pass, but ventilation might not be compromised (subject to a trained operator’s evaluation), this is called a ventilator *fault*.

NOTE:

Faults detected during EST may not require the ventilator to be serviced or removed from use immediately. A trained operator, however, must evaluate the situation and determine whether the ventilator can be used. *Failures* detected during EST require immediate servicing and removal of the ventilator from clinical use.

Table 4-9: EST completion status

If the EST result is:	It means:	Do this:
EST passed	All tests were performed and all passed.	To retest from start of test sequence, press alarm reset key. To exit EST and resume ventilation, press ACCEPT. Unblock the wye as directed, then press ACCEPT. POST now runs, and ventilation resumes at last valid settings.
EST incomplete	All tests passed, but some tests were skipped. The skipped tests were passed on a previous run.	To retest from the start of the test sequence, press the alarm reset key. To exit EST and resume ventilation, press MANUAL INSP. You are then asked whether you want to use the override feature. Press MANUAL INSP again to complete the override. Unblock the wye as directed, then press ACCEPT. POST now runs, and ventilation resumes at last valid settings.

Table 4-9: EST completion status (continued)

If the EST result is:	It means:	Do this:
EST fault	<p>One or more tests did not pass. These tests might not compromise the ventilator's ability to ventilate safely, based on the operator's evaluation of the situation.</p>	<p>To retest from the start of the test sequence, press the alarm reset key.</p> <p>To exit EST and resume ventilation, press MANUAL INSP. You are asked whether you want to use the override feature. Press MANUAL INSP again to complete the override. Unblock the wye as directed, then press ACCEPT. POST now runs, and ventilation resumes at last valid settings.</p>
<p style="text-align: center;">Warning</p> <p style="text-align: center;">Do not use a ventilator that has completed EST with a fault status without verifying its operational integrity by means other than EST and determining that the patient will not be placed at risk.</p>		
EST failed	<p>One or more tests failed that might compromise the ventilator's ability to ventilate safely.</p> <p>A VENT INOP condition is declared when you cycle power to the ventilator.</p>	<p>Contact service.</p> <p>To retest from the start of the test sequence, press the alarm reset key.</p>

Once ventilation begins

This section tells you:

- How to change settings (a quick review)
- How to view and change alarm limits (a quick review)
- How to adjust apnea parameters
- How to view patient data
- About the 100% O₂ and MANUAL INSP keys
- About the EXP PAUSE and INSP PAUSE keys

5.1 Changing settings: a quick review

This section describes changing settings, switching between volume control ventilation (VCV), pressure control ventilation (PCV, available on the 760 Ventilator only) and pressure support ventilation (PSV), and changing modes.

5.1.1 Changing settings

You can only change a setting that is part of the current or proposed mode and breath type, or is one of the three common settings (PEEP/CPAP, TRIGGER SENSITIVITY, and % O₂). For example, in SPONT mode, you cannot change TIDAL VOLUME. You can change several settings at once, or one at a time.

To change a setting: *touch, turn, ACCEPT.*

1. *Touch the key:* The key lights, the selected setting flashes, and the message window shows the current setting, range, units, and name of the setting. (If applicable, associated parameter information is also displayed.)
2. *Turn the knob* to adjust the setting.
3. Repeat steps 1 and 2 for every setting you want to change. Press CLEAR to cancel the most recent setting.
4. *Press ACCEPT* to apply the new settings. The key lights turn off, new settings are displayed, and the message window displays this message:

Setting(s) accepted

5.1.2 Switching between VCV, PCV, and PSV

To switch between breath types, you must first select a mode that allows it. Follow the steps in Section 5.1.3 to change the mode.

If you try to select a breath type that is not allowed in the current mode, the ventilator displays this message:

**Choose mode before
choosing type**

Table 5-1 summarizes which breath types are available on the 740 and 760 Ventilators, and when those breath types are selectable.

Table 5-1: Breath type availability

Ventilator	Breath types	Comments
740 Ventilator	<ul style="list-style-type: none"> • Volume control ventilation (VCV) • Pressure support ventilation (PSV) 	<ul style="list-style-type: none"> • VCV not available in SPONT mode • PSV not available in A/C mode • All breath types available in SIMV mode.
760 Ventilator	<ul style="list-style-type: none"> • VCV • PSV • Pressure control ventilation (PCV) 	<ul style="list-style-type: none"> • VCV and PCV not available in SPONT mode • PSV not available in A/C mode • All breath types available in SIMV mode.

5.1.3 Changing the mode

During ventilation, the current mode key is lit and settings are displayed. To change the mode:

1. *Select the mode:* Press A/C, SIMV, or SPONT. The key lights for the applicable settings flash.
2. *Select the breath type:* If you selected A/C or SIMV modes, select VCV or PCV (760 only). If you selected SIMV or SPONT modes, select PSV.
3. *Select the settings:* For every flashing key light, you must touch the key (and adjust the setting if necessary) before the new mode can be applied.
4. You can change PEEP/CPAP, TRIGGER SENSITIVITY, and % O₂ at any time, but you are not required to acknowledge or change these settings when you change the mode.
5. *Apply the settings:* Press ACCEPT.

NOTE:

See Appendix D for a detailed explanation of mode and breath types.

5.2 Viewing and changing alarm settings: a quick review

You can view alarm settings at any time without affecting ventilation: just touch the appropriate key.

You can change alarm settings at any time during ventilation. You can only change one alarm setting at a time. To change a setting: *touch, turn, ACCEPT.*

1. *Touch the key:* The key lights steadily and the alarm setting flashes in its window for up to 30 seconds.
2. *Turn the knob* to adjust the alarm setting. (You can adjust the setting as long as the setting flashes.)
3. *Press ACCEPT* to apply the new alarm setting. The new alarm setting stops flashing, and the message window displays this message:

Setting(s) accepted

You cannot change alarm settings until ventilator settings have been accepted.

5.3 Adjusting apnea parameters

Warning

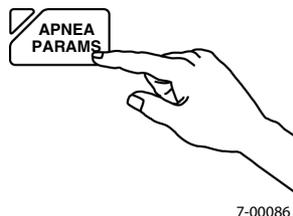
To ensure that the patient is ventilated appropriately in case of apnea, you must review apnea parameters, and adjust them if necessary.

NOTE:

During an APNEA alarm, you can change APNEA PARAMS but not other settings.

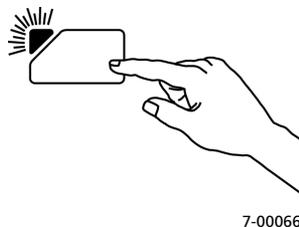
You can view or change apnea parameters only when apnea ventilation is possible (in SPONT mode, or in A/C or SIMV when RESPIRATORY RATE is less than 6 /minute).

1. Press *APNEA PARAMS* to view apnea parameter settings. When apnea ventilation is possible, the ventilator shows this message when you have accepted settings and normal ventilation has started:



Review $T_a = xx$ s

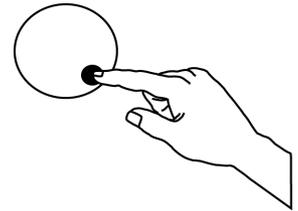
where T_a is the apnea interval, and xx is the current apnea interval setting in seconds.



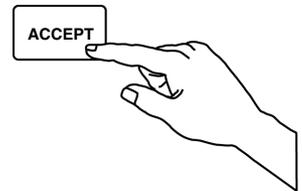
For every flashing key light, touch the key (and adjust the setting if necessary), then apply the settings.

- On the 740 Ventilator, only VCV apnea ventilation settings (RESPIRATORY RATE, TIDAL VOLUME, and PEAK FLOW) are available.
- On the 760 Ventilator, you can select VCV apnea settings or PCV apnea settings (RESPIRATORY RATE, INSPIRATORY PRESSURE, and I:E RATIO or T_i ; RISE TIME FACTOR is fixed at 50%).

2. *To change apnea parameters:* Touch each flashing key. Its key light stops flashing, the current setting flashes, and the message window shows the current setting, range, units, and name of the setting.
3. *Turn the knob* to change the setting.
4. *Repeat* for each flashing key light.
5. *Press ACCEPT* to apply the new apnea ventilation settings. APNEA PARAMS turns off and this message is displayed:



7-00068



7-00067

Setting(s) accepted

If you press CLEAR before settings have been accepted, apnea parameters will not be updated. The APNEA PARAMS key flashes, and the ventilator displays this message:

**All setup canceled
Update apnea**

5.3.1 Adjusting the apnea interval

To adjust the apnea interval, select MENU option 4 (*User settings*) and follow these steps:

1. Once you've selected the *User settings* menu function, press ACCEPT. Turn the knob to display:

Apnea interval (Ta)

Press ACCEPT.

2. The ventilator displays this message:

**xx (10 - 60) s
Apnea interval**

where xx is the apnea interval in seconds. Turn the knob to adjust the apnea interval from 10 to 60 seconds. Press CLEAR to cancel any changes, or press ACCEPT to select the new apnea interval and return to the list of user settings.

5.4 Viewing patient data

You can view patient data (pressure, breath timing, and volume values) on the 740 and 760 Ventilators at any time without affecting ventilation by pressing the appropriate key (see Figure 5-1). The key lights and the value is displayed in its window. Patient data values are continuously updated during ventilation.

- During ventilation on the 740 and 760 Ventilators, if no alarm is active or autoreset, the first line of the message window displays % O₂ (unless display of the oxygen sensor reading is disabled). % O₂ information is overwritten by maneuver information (auto-PEEP, and compliance and resistance calculations), which is displayed for 30 seconds after a maneuver is complete. % O₂ information is also displayed during an oxygen sensor calibration. If no maneuver information is being displayed, the first line is blanked when you select a setting or use the MENU key.
- On the 740 and 760 Ventilators, peak inspiratory flow, end inspiratory flow, and end expiratory flow are displayed on the second, third, and fourth lines of the message window for every breath type (except that inspiratory flow is not displayed during VCV breaths and VCV apnea ventilation). You can use these values to adjust the settings for T_I/I:E RATIO (for PCV breaths) and EXH SENSITIVITY (for PSV breaths). These flows are updated at the beginning of every inspiration or exhalation, and are displayed as follows:

Flow (L/min)

I: Peak: xx End xx

E: End xx

Pressing ALARM RESET blanks the third and fourth lines. Status messages may overwrite this information for up to 30 seconds.

- If patient data is measured to be outside of the specified range, the minimum or maximum value flashes in its window.
- The 760 keyboard also includes a volume bar graph (see Figure 5-2), which you can enable using the MENU key.

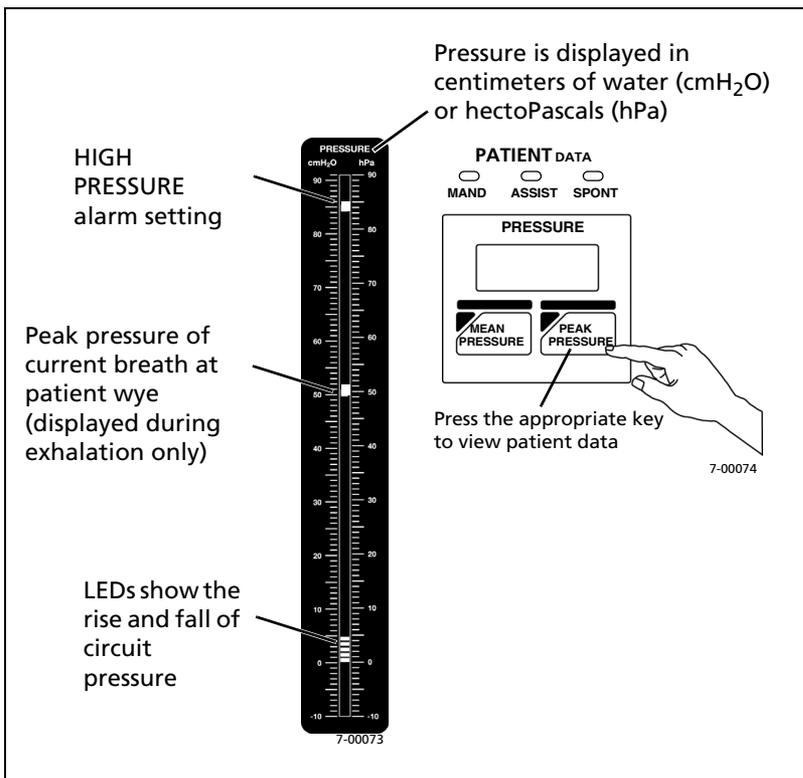


Figure 5-1. Viewing patient data

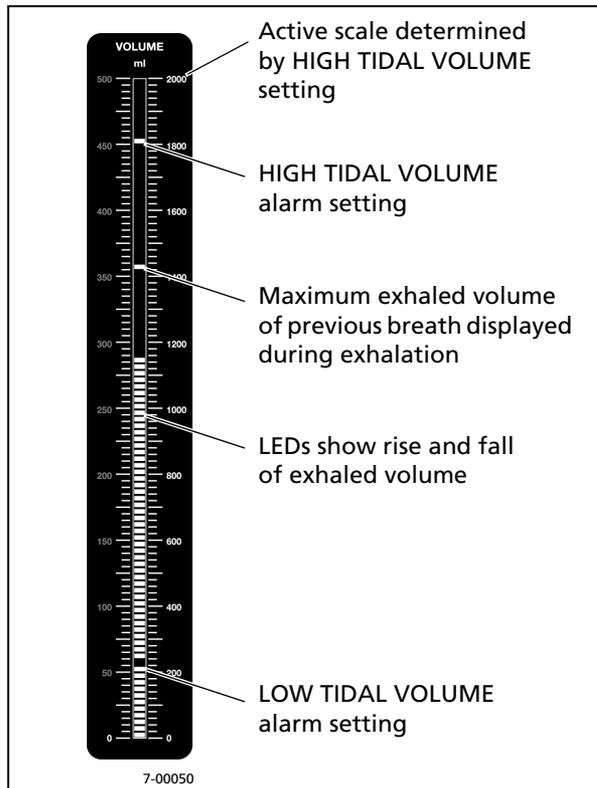
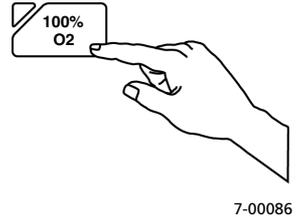


Figure 5-2. Volume bar graph (760 Ventilator only)

5.5 The 100% O₂ and MANUAL INSP keys

The 100% O₂ key delivers 100% oxygen to the patient for 2 minutes at any time except during apnea ventilation. Pressing CLEAR at any time after the 100% O₂ maneuver begins cancels the maneuver and the oxygen concentration returns to the set % O₂.

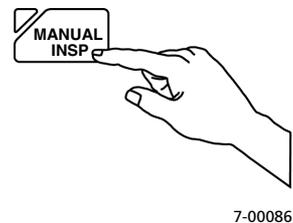
1. Press 100% O₂: The key lights and delivered oxygen concentration increases to 100%.
2. Once the oxygen concentration reaches 100%, a 2-minute timer starts and the ventilator delivers 100% O₂ to the patient. Pressing the 100% O₂ key again restarts the 2-minute timer.
3. When the 2-minute interval has elapsed, the 100% O₂ key light turns off and the oxygen concentration returns to the set % O₂.



NOTE:

The displayed EXHALED VOLUME for the first breath after you press the 100% O₂ key may be higher than the actual volume exhaled from the patient. The high displayed volume is a result of an initial flush of the ventilator with 100% O₂ and does not reflect actual volume delivered to the patient.

The MANUAL INSP key delivers one mandatory breath to the patient according to the current settings (in A/C or SIMV mode) or the current apnea settings (in SPONT mode). You can deliver a MANUAL INSP at any time during the exhalation phase of a breath. (To deliver a MANUAL INSP, 200 ms of the exhalation phase must have elapsed, and expiratory flow must have decreased to 50% of peak inspiratory flow. If you press INSP PAUSE during SPONT mode, a manual inspiration is delivered when 200 ms of the exhalation phase have elapsed, and expiratory flow is less than 2 L/min for 50 ms) MANUAL INSP is not functional during apnea ventilation.



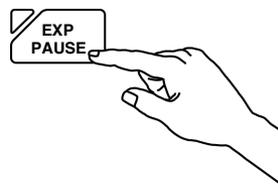
4. Press MANUAL INSP; you do not have to hold the key down. The key lights and the ventilator displays this message:

Man insp in progress

5. When the manual inspiration is complete, the MANUAL INSP key light turns off and breath delivery continues according to existing settings.

5.6 The EXP PAUSE and INSP PAUSE keys (760 only)

You can use the EXP PAUSE key to calculate the patient's auto-PEEP (an estimate of the pressure that remains in the patient's lungs at the end of exhalation, also known as *intrinsic PEEP* or *occult PEEP*). The presence of end expiratory flow (displayed as *E: End xx* in the message window) indicates the presence of auto-PEEP.



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1. Press the EXP PAUSE key during inspiration or exhalation: The key lights, and the ventilator closes the exhalation valve at the end of the expiratory phase without delivering a breath.

Until the maneuver begins, the ventilator displays this message:

Exp pause requested

During the maneuver the ventilator displays this message:

Exp pause active

2. The EXP PAUSE maneuver ends when you release the key: hold the key down only until expiratory pressure stabilizes (watch the pressure bar graph or the message window).
3. Once you release the EXP PAUSE key, the message window continues to display the patient's calculated auto-PEEP for 30 seconds:

PEEP: i=xxx t=xxx

where *i* is intrinsic PEEP and *t* is the total PEEP (total PEEP = measured PEEP + intrinsic PEEP).

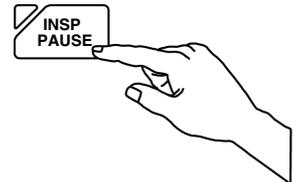
Once the maneuver is complete, the ventilator immediately delivers the mandatory breath that was suspended for the maneuver.

An EXP PAUSE maneuver also ends if the patient initiates a breath, an alarm occurs, the expiratory phase (including the pause) lasts longer than 20 seconds, or the ventilator detects a leak. If the EXP PAUSE maneuver is canceled for any reason, the ventilator displays this message:

Exp pause canceled

You can use the INSP PAUSE key to:

- Calculate the patient's compliance (an estimate of the elasticity of the patient's lungs) and resistance (an estimate of how restrictive the patient's airway is, based on the pressure drop at a given flow) by pressing, then immediately releasing, the INSP PAUSE key to generate a momentary inspiratory pause of two seconds or less.
- Expand the patient's lungs for purposes such as x-rays or lung mechanics by holding down the INSP PAUSE key for more than two seconds after the start of the pause to generate an extended inspiratory pause. The pause continues as long as you hold down the key (up to a maximum of ten seconds). Compliance and resistance are also displayed at the end of an extended INSP PAUSE maneuver.



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The INSP PAUSE maneuver is performed during a mandatory breath, and if SPONT mode is selected, the ventilator delivers a mandatory breath according to current apnea settings when the exhaled flow for the last breath drops below 2 L/min. Compliance can be calculated for VCV or PCV breaths, and resistance can be calculated only for VCV breaths.

If you request a momentary pause, you can press CLEAR before or during the pause to cancel the maneuver. An INSP PAUSE maneuver (momentary or extended) is also canceled if an alarm occurs or if circuit pressure reaches the HIGH PRESSURE setting.

If the INSP PAUSE maneuver is canceled for any reason, the ventilator displays this message:

Insp pause canceled

1. Press the INSP PAUSE key during inspiration or exhalation: the key lights, and the ventilator adds a plateau (keeps the exhalation valve closed) at the end of the inspiratory phase of the current or next mandatory breath.
 - For a momentary pause, press and release the INSP PAUSE key, or
 - For an extended pause, hold down the INSP PAUSE key for more than two seconds after the pause starts.

Until the maneuver begins, the ventilator displays this message:

Insp pause requested

During the maneuver the ventilator displays this message:

Insp pause active

2. The INSP PAUSE maneuver ends when:
 - the ventilator detects a stable plateau pressure or two seconds have elapsed (for a momentary pause), or
 - you release the key or ten seconds have elapsed (for an extended pause).
3. Once the maneuver is complete, the message window displays the patient's calculated compliance and resistance for 30 seconds:

$$C = (xxx)? R = (xxx)?$$

where:

- xxx is the calculated value of compliance or resistance.
- Values from 0.0 to 9.9 are displayed as x.x, values from 10 to 99 are displayed as _xx, and values from 100 and above are displayed as xxx.
- C (compliance) is measured in units of mL/cmH₂O, and R (resistance) is measured in units of cmH₂O/L/second.
- Parentheses () indicate potentially inaccurate values, and appear around both values when the inspiratory time is short and the compliance or resistance is large. (Check for patient airway occlusion or adjust settings to increase the inspiratory time.)

- A question mark ? indicates potentially inaccurate values, and appears after both values if the pressure was unstable at the end of the plateau. (Possible causes for this may be an excessive leak, excessive tube movement, or the patient fighting the ventilator.) A question mark ? appears after the resistance value if the inspiratory pressure rise was too fast or too slow. (A possible cause may be a peak flow or tidal volume that is inappropriate for a given respiratory rate.)
- Three dashes (- - -) appear after *R* when the ventilator is in PCV, since resistance can't be measured in PCV.

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The MENU key

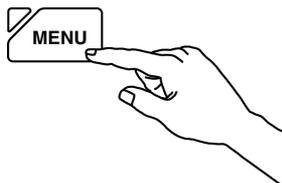
You can use the MENU key at any time to:

- View all active alarms.
- View all autoreset alarms.
- Run SST and EST (Chapter 4 tells you how to run these self tests.)
- Select user settings, including endotracheal (ET) tube size, humidifier type, ventilator date and time, apnea interval, VCV flow pattern, speaking valve setup, alarm volume, PCV timing variable (760 Ventilator only), and volume LED bar enable/disable (760 Ventilator only).
- Use oxygen sensor functions, including calibration, O₂ % alarm limit enable/disable, and O₂ sensor display enable/disable.
- Enter standby mode (Chapter 3 tells you how to enter and exit standby mode).
- View battery information.
- View the software revision.
- View the service summary.
- Use the *EasyNeb* Nebulizer functions, including, start nebulization, stop nebulization, and view nebulization state.

Menu information is displayed on the second line of the message window. (The first line is reserved for displaying the highest-priority active or autoreset alarm, if any, and any relevant breath or maneuver information.)

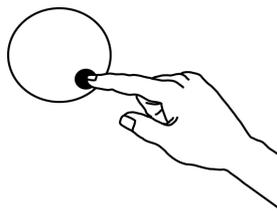
To access the menu function, remember: *touch, turn, ACCEPT*.

1. *Touch* MENU. The MENU key lights and the first menu function is displayed in the message window.



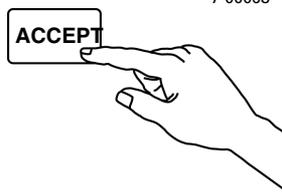
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2. *Turn* the knob to select a menu function.



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3. *Press ACCEPT* to enter the menu function. Table 6-1 summarizes the menu functions.



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- Turning the knob scrolls through the menu items or changes a menu setting.
- Press ACCEPT to select a function or setting.
- Press CLEAR to cancel the current function or the displayed setting, or to exit from the menu function.
- You can view any patient data, or press the alarm reset or alarm silence key, without affecting the menu function.
- Pressing any ventilator settings or alarm settings key exits the menu function and cancels any changes in progress.

Table 6-1: Menu function summary

MENU option	Function
1. More active alarms	Lists other active alarms in order of priority. (The highest-priority active alarm is always displayed on the first line of the message window.) Turning the knob displays other active alarms. The alarm reset key clears (erases) this list.
2. Autoreset alarms	Lists alarms that have autoreset since alarm reset key was last pressed. Turning the knob lists other autoreset alarms. The alarm reset key clears (erases) this list.
3. Self tests	Begins short self test (SST) or extended self test (EST). See Chapter 4 for detailed instructions on running SST and EST.

Table 6-1: Menu function summary (continued)

MENU option	Function
4. User settings	<p>Selects the following:</p> <ul style="list-style-type: none"> • <i>Endotracheal tube</i>: selects the patient’s ET tube size. This allows the ventilator to adjust breath delivery in PCV (760 Ventilator only) and PSV accordingly. • <i>Humidifier type</i>: selects the humidifier type (HME, dual heated wire, or no heated wire). This option helps correct spirometry calculations without re-running SST. • <i>Date and time set</i>: sets ventilator date and time. CLEAR returns to user settings. • <i>Apnea interval (Ta)</i>: sets the apnea interval from 10 to 60 seconds. • <i>VCV flow pattern</i>: selects a square or ramp flow waveform for VCV mandatory breaths, including apnea breaths. • <i>Speaking valve setup</i>: selects settings for use with one-way valves that allow patients to speak. • <i>Alarm volume</i>: selects the loudness of the audible alarm from 1 to 5 (5 is the loudest), then return to user settings. You can adjust the alarm volume even when the alarm silence is active. • <i>PCV timing setting (760 Ventilator only)</i>: selects the I:E ratio or inspiratory time setting to remain constant when the respiratory rate setting changes. • <i>Volume LED bar (760 Ventilator only)</i>: enables or disables the volume bar graph.

Table 6-1: Menu function summary (continued)

MENU option	Function
5. Oxygen sensor	<p>Selects these oxygen sensor functions:</p> <ul style="list-style-type: none"> • <i>Calibrate O₂ sensor</i>: allows you to perform a two-point calibration of the oxygen sensor. Only available before normal ventilation begins (patient must not be connected). <hr/> <p>NOTE: Covidien recommends calibrating the oxygen sensor once a week or with each new patient.</p> <hr/> <ul style="list-style-type: none"> • <i>O₂ alarm info</i>: allows you to enable or disable the oxygen sensor. • <i>O₂ sensor display</i>: allows you to enable or disable displaying the oxygen sensor reading (unless an alarm is active) in the message window, which is updated several times per second.
6. Standby mode	Places the ventilator in a non-ventilating waiting state. See Chapter 3 for detailed instructions on entering and exiting standby mode.
7. Battery info	Displays the estimated operational time remaining on the internal and external batteries until they need recharging. (Available only when ventilator has been operating on battery power for at least two minutes.)
8. Software revision	Displays the version of software installed in the ventilator.
9. Service summary	Allows you to view estimates of oxygen sensor life remaining, internal battery operational time remaining, and time until the next preventive maintenance is due.
10. Nebulizer	Allows you to start, stop, or view the current state of an EasyNeb Nebulizer attached to the ventilator.

6.1 More active alarms

1. Once you've selected the *More active alarms* menu function, press ACCEPT.

The message window displays the list of currently active alarms, except the highest-priority active alarm, which is always flashing on the first line of the message window.

2. Turn the knob to scroll through the list of active alarms, which are listed in order of priority (see Figure 6-1). Each alarm is listed only once, even if the alarm occurred several times.
3. Press CLEAR to return to the list of menu functions.

Pressing the alarm reset key clears the *More active alarms* list.

If a new alarm becomes active, or a currently active alarm becomes autoreset, the ventilator exits the active alarm list and returns to the list of menu functions.

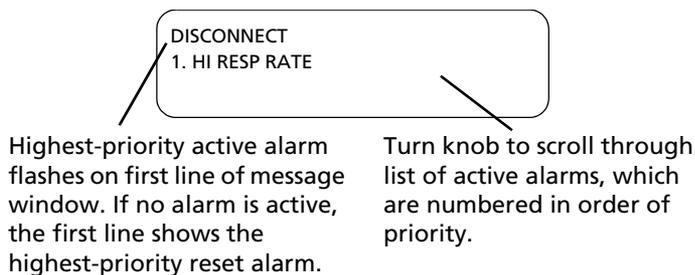


Figure 6-1. Using the *More active alarms* menu function to view active alarms

6.2 Autoreset alarms

1. Once you've selected the *Autoreset alarms* menu function, press ACCEPT.

The message window displays a list of alarms that have been autoreset since the last time the alarm reset key was pressed. The highest-priority active alarm is always flashing on the first line of the message window. If no alarm is active, the first line shows the highest-priority autoreset alarm.

2. Turn the knob to scroll through the list of autoreset alarms, which are listed in order of priority (see Figure 6-2). Each autoreset alarm is listed only once, even if the alarm was autoreset several times.
3. Press CLEAR to return to the list of menu functions.

Pressing the alarm reset key clears the *Autoreset alarms* list.

If a new alarm becomes active, or a currently active alarm becomes autoreset, the ventilator exits the autoreset alarm list and returns to the list of menu functions.

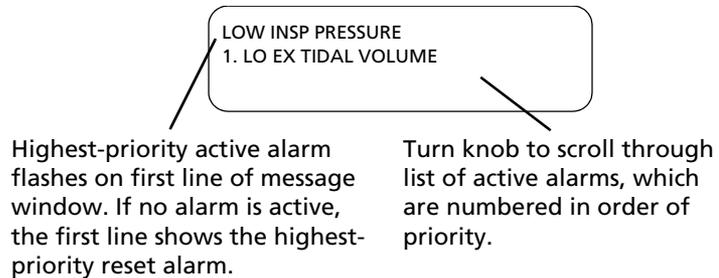


Figure 6-2. Using the *Autoreset alarms* menu function to view autoreset alarms

6.3 Self tests

The Self tests menu option allows you to run short self-test (SST) or extended self test (EST). SST checks for leaks, determines the compliance of the ventilator breathing circuit, and verifies the proper operation of the ventilator. EST is a thorough test of the operational integrity of the ventilator's electronics and pneumatics, and should be run following service. Chapter 4 tells you how to run SST and EST.

6.4 User settings

1. Once you've selected the *User settings* menu function, press ACCEPT. Turn the knob to display one of these messages:

Endotracheal tube
Humidifier type
Date and time set
Apnea interval (Ta)
VCV flow pattern
Speaking valve setup
Alarm volume
PCV timing setting
Volume LED bar

2. Press ACCEPT to select the option.

6.4.1 Endotracheal tube

If you select *Endotracheal tube*, the ventilator displays the current ET size setting.

1. Turn the knob to select the appropriate size for the patient.
2. Press ACCEPT to apply and return to the list of user settings. Press CLEAR to exit without making any changes.

6.4.2 Humidifier type

1. If you select *Humidifier type*, the ventilator displays the currently-selected type:
 - *HME*: Heat-moisture exchanger ("artificial nose")
 - *Dual heated wire*: humidifier with heated wire on expiratory limb, or on both inspiratory and expiratory limbs
 - *No heated wire*: conventional humidifier, no heated wire on expiratory limb
2. Turn the knob to select the humidifier type attached, then press ACCEPT. Press CLEAR to exit without making any changes.

6.4.3 Date and time set

1. If you select *Date and time set*, turn the knob to display one of these messages, then press ACCEPT:

Time set

Date set

2. If you are setting the time, the message window displays one of these messages:

12hr: *hh:mm am*

12hr: *hh:mm pm*

24hr: *hh:mm*

The time (*hh* = hours; *mm* = minutes) is displayed in 12- or 24-hour format. This format can be changed by a qualified service technician.

3. If you are setting the date, the message window displays one of these messages:

EUR: *dd/mm/yy*

US: *mm/dd/yy*

Whether the date is displayed in European (day/month/year) or American (month/day/year) format can be changed by a qualified field service technician.

4. Turn the knob to adjust the value of each time or date field, then press ACCEPT. The next field is then selected. Even if you make no change, press ACCEPT for each field. You must confirm or change all fields of the time or date message before the new time or date can be applied.
5. Once you have selected the new time or date, the message window returns to the *Time set* or *Date set* messages. You can turn the knob to select time or date, or press CLEAR to return to the list of user settings.

6.4.4 Apnea interval (Ta)

1. If you select *Apnea interval (Ta)*, the ventilator displays this message:

xx (10 - 60) s
Apnea interval

where *xx* is the apnea interval in seconds.

2. Turn the knob to select an apnea interval from 10 to 60 seconds.
3. Press CLEAR to cancel any changes, or press ACCEPT to apply the new interval and return to the list of user settings.

6.4.5 VCV flow pattern

1. If you select *VCV flow pattern*, the ventilator displays this message:

VCV Flow: xxxxxx
Ti = y.yy s

where *xxxxxx* is the currently selected flow pattern and *y.yy* is the current inspiratory time (the value of *y.yy* depends on the selected flow pattern).

2. Turn the knob to select *RAMP* (descending ramp flow pattern) or *SQUARE* (square flow pattern).

If the flow pattern change would result in a violation of breath delivery boundaries, the ventilator displays one of these messages:

Change not permitted
Adjust VCV first

or

Change not permitted
Adjust Ap. VCV first

3. Press CLEAR to cancel any changes, or press ACCEPT to select the new flow pattern and return to the list of user settings.

NOTE:

When VCV is the current or proposed breath type and there are no active or autoreset alarms, the ventilator displays one of the following messages on the first line of the message window:

VCV RAMP FLOW

VCV SQUARE FLOW

6.4.6 Speaking valve setup

700 Series Ventilators now offer a speaking valve option for use with one-way valves that allow patients to speak. Because exhaling through a speaking valve affects the accuracy of any exhaled volume measurements, the ventilator monitors delivered (instead of exhaled) volume to detect the LOW TIDAL VOLUME and HIGH TIDAL VOLUME alarms, and turns off the LOW MINUTE VOLUME and DISCONNECT alarms. Once the speaking valve option is enabled, it remains in effect until you disable the option, the ventilator is turned off, the ventilator exits standby mode, a ventilator inoperative condition occurs, or any other reset condition occurs.

Warning

Enabling the speaking valve option requires that competent medical practitioners closely monitor the patient and ventilator. Because the speaking valve option decreases the ventilator's ability to detect some conditions, ensure that all ventilator settings and alarm limits are set appropriately. In the case of these specific conditions, consider the following:

- Low pressure delivered to the patient: check for appropriate LOW INSP PRESSURE alarm and the apnea interval settings, check the ventilator breathing circuit regularly for water buildup.
- Possible breath stacking (that is, delivering a breath before the previous breath is complete): check for appropriate TRIGGER SENSITIVITY and other mandatory settings.
- Low respiratory rate delivered to the patient: check for appropriate RESPIRATORY RATE setting.
- Low flows delivered to the patient: monitor patient's condition and check for appropriate LOW TIDAL VOLUME alarm and ventilator settings.
- High flows delivered to the patient: monitor the patient's condition and check for appropriate HIGH TIDAL VOLUME and HIGH PRESSURE alarm settings.
- Exhaling through a speaking valve affects the accuracy of the INSP PAUSE and EXP PAUSE maneuvers (760 Ventilator only).

Read the manufacturer's instructions in their entirety before attempting to use the speaking valve.

To select the speaking valve option, select MENU option 4 (*User settings*). See the *MENU key* section of the *700 Series Ventilator System Operator's Manual* for complete information on using MENU functions. Follow these steps to select the speaking valve option:

1. Once you've selected the User settings menu function, press ACCEPT. Turn the knob to display:

Speaking valve setup

Press ACCEPT.

-
2. The message window shows this message:

Speaking valve XXX

where XXX is the current option status (ON or OFF). Turn the knob to select ON (option enabled) or OFF (option disabled). Press CLEAR to cancel any changes, or press ACCEPT to select the displayed status.

3. At each of these prompts, press ACCEPT to proceed with the speaking valve setup or CLEAR to return to user settings without enabling the speaking valve option:

**Volume alarms based
on delivered volume**

**Alarm DISABLED
Low minute volume**

**Alarm DISABLED
Disconnect alarm**

NOTE:

Because the ventilator monitors delivered (instead of exhaled) volume to detect the LOW TIDAL VOLUME and HIGH TIDAL VOLUME alarms when the speaking valve option is enabled, their alarm messages change as follows:

- HIGH TIDAL VOLUME (instead of HI EX TIDAL VOLUME)
- LOW TIDAL VOLUME (instead of LO EX TIDAL VOLUME)

The recommended alarm handling (described in Chapter 7 of this manual) for these conditions is unchanged.

4. The ventilator then prompts you to set PEEP. The default and recommended PEEP setting is 0.0 H₂O (to minimize the probability of autocycling), but you can choose a different setting:

**Recommend 0.0 cmH₂O
PEEP/CPAP**

If you adjust the setting, the ventilator displays:

**xx (0-35) cmH₂O
PEEP/CPAP**

Once you have selected the setting, press ACCEPT to proceed with the speaking valve setup or CLEAR to return to user settings without enabling the speaking valve option.

5. The ventilator then prompts you to review the apnea interval. The default and recommended apnea interval setting is 10 seconds, but you can choose a different setting:

**Recommend 10 s
Apnea interval**

If you adjust the setting, the ventilator displays:

**xx (10 - 60) s
Apnea interval**

Once you have selected the setting, press ACCEPT to enable the option, or press CLEAR to return to user settings without enabling the option.

6. The ventilator then prompts you to review the LOW INSP PRESSURE alarm limit. If A/C or SIMV mode is active, the ventilator displays:

**Review xx cmH₂O
Low insp pressure**

If you adjust the setting, the ventilator displays:

**xx (3 - 60) cmH₂O
Low insp pressure**

In SPONT mode the LOW INSP PRESSURE alarm is not normally available, but is active when the speaking valve option is enabled. This helps the ventilator to detect a disconnected patient circuit. The default and recommended LOW INSP PRESSURE alarm limit in SPONT mode is based on the target pressure, but you can choose a different setting:

**Recommend xx cmH₂O
Low insp pressure**

If you adjust the setting, the ventilator displays:

**xx (3 - 60) cmH₂O
Low insp pressure**

Once you have selected the setting, press ACCEPT to enable the speaking valve option or CLEAR to return to user settings without enabling the speaking valve option.

NOTE:

When the speaking valve option is enabled and there are no active or autoreset alarms, the ventilator displays these messages on the first line of the message window:

DISCONNECT DISABLED
SPEAKING VALVE ON
DELIVERED VOLUME xxxxml (740 Ventilator only)

To help you select the HIGH TIDAL VOLUME and LOW TIDAL VOLUME alarm settings when the speaking valve option is enabled, the ventilator displays delivered volume:

- In the message window (740 Ventilator).
- In the DELIVERED VOLUME (mL) display (760 Ventilator).

760 Ventilator only: turning the speaking valve option on disables the volume bar graph.

7. To disable the speaking valve option, select the *User settings* menu function, then turn the knob to select the *Speaking valve* setup option. Turn the knob to display:

Speaking valve OFF

then press ACCEPT to disable the option or CLEAR to exit and leave the option enabled.

8. If you choose to disable the speaking valve option, the ventilator displays the following messages to tell you that it is resuming exhaled volume monitoring to detect the LOW TIDAL VOLUME and HIGH TIDAL VOLUME alarms, and restoring the previous settings for PEEP/CPAP, LOW MINUTE VOLUME alarm, DISCONNECT alarm, LOW INSP PRESSURE alarm, and the apnea interval:

**Volume alarms based
on exhaled volume**

**Restore to x.xL
Low minute volume**

**Alarm RESTORED
Disconnect alarm**

**Restore to x.xcmH₂O
PEEP/CPAP**

**Restore to xx s
Apnea interval**

When A/C or SIMV mode is active:

**Restore to xx cmH₂O
Low insp pressure**

When SPONT mode is active:

No LIP alarm in SPONT

NOTE:

If a setting changed when the speaking valve option was enabled that makes any of these previous settings invalid, the ventilator displays the maximum valid value for that setting in its *Restore* message.

On the 760 Ventilator, if the volume bar graph was disabled by turning the speaking valve option on, it is re-enabled when the option is off.

Press ACCEPT at each prompt to disable the option and return to user settings. Press CLEAR to exit and leave the option enabled.

6.4.7 Alarm volume

1. If you select *Alarm volume*, the ventilator displays this message:

Volume level: x

An audible tone sounds that corresponds to *x*, the alarm volume for a high-priority alarm.

2. Turn the knob to adjust the alarm volume from 1 to 5 (where 5 is the loudest).
3. Press CLEAR to cancel any changes, or press ACCEPT to select the new alarm volume and return to the list of user settings.

6.4.8 PCV timing setting

1. If you select *PCV timing setting* (760 Ventilator only), the ventilator displays the currently-selected variable (one of these messages):

Timing variable = Ti

Timing variable = I:E

This allows you to change which timing variable remains constant when the respiratory rate setting changes in PCV (the currently-selected variable is lit on the keyboard).

2. Turn the knob to select T_i (inspiratory time) or *I:E* (I:E ratio).
3. Press CLEAR to cancel any changes, or press ACCEPT to change the timing variable and return to the list of user settings.

6.4.9 Volume LED bar

1. If you select *Volume LED bar* (760 Ventilator only), the ventilator displays one of these messages:

Enable LED bar

Disable LED bar

2. Turn the knob to enable or disable the volume LED bar.
3. Press ACCEPT to select *Enable* or *Disable* and return to the list of user settings. Press CLEAR to exit without making any change.

6.5 Oxygen sensor

1. Once you've selected the Oxygen sensor menu function, press ACCEPT. Turn the knob to display one of these messages:

Calibrate O₂ sensor
O₂ alarm info
O₂ sensor display

2. Press ACCEPT.
3. If you selected *Calibrate O₂ sensor*, turn the knob to display one of these messages:

Start O₂ calibration
Exit O₂ calibration

Once normal ventilation has begun, you cannot perform an oxygen sensor calibration until you turn off the ventilator and restart without entering ventilation. (The ventilator must be connected to a 50-psi oxygen source to perform a calibration.)

4. Turn the knob to display *Start O₂ calibration*, then press ACCEPT. While the calibration is in progress, the message window shows this message:

Start O₂ calibration
Please wait...

Once the calibration has begun, you can only restart the calibration or exit. Oxygen sensor calibration takes approximately 5 minutes.

5. When the calibration is complete press ACCEPT, turn the knob to display *Exit O₂ calibration*, then press ACCEPT. The ventilator restarts.

NOTE:

If the calibration is not successful, contact service. To continue ventilating (if indicated by your institution's protocol), disable the oxygen sensor (select *O₂ alarm info* from the *Oxygen sensor* menu function). Covidien recommends using an external oxygen monitor whenever the ventilator's oxygen sensor is disabled.

-
6. If you selected *O₂ alarm info*, turn the knob to display one of these messages:

Enable O₂ alarm +/-10%

Disabled O₂ alarm

Press ACCEPT to select *Enable* or *Disabled* and return to the *Oxygen sensor* function. Press CLEAR to exit without making a change.

The *O₂ alarm info* function allows you to enable or disable the O₂% alarm limits by suspending all oxygen sensing capability from the inspiratory limb of the ventilator. Disabling the O₂% alarm does not disable the LOW O₂ SUPPLY alarm.

NOTE:

The O₂ % alarm limits are based on the set % O₂, and are not operator-adjustable. The high O₂% alarm limit is ten percentage points above the set % O₂, and the low O₂% alarm limit is ten percentage points below the set % O₂.

Warning

Covidien recommends that the O₂ % alarm limits be enabled at all times, unless the oxygen sensor is depleted. Replace a defective or depleted oxygen sensor as soon as possible.

NOTE:

When the O₂% alarm is disabled, the message window displays this message throughout normal ventilation:

% O₂ ALARMS DISABLED

Whenever the ventilator is powered on or exits standby mode, the oxygen sensor is enabled and continuously measures the delivered oxygen concentration. The measured value of % O₂ is displayed, and triggers an alarm if the delivered value is 10 percentage points higher or lower than the set % O₂.

7. If you selected *O₂ sensor display*, the window shows one of these messages (the option that is currently selected is displayed):

Enable O₂ display
Disable O₂ display

Press ACCEPT to select *Start* or *Stop* and return to the *Oxygen sensor* function. Press CLEAR to exit without making a change. If the display is enabled, the first line of the message window shows % O₂ reading if no alarm is active.

6.6 Standby mode

Standby mode is a waiting state used for maintaining ventilator settings and battery charging, in which there is no ventilation. Chapter 3 tells you how to enter and exit standby mode.

Warning

To avoid patient injury due to lack of ventilatory support, do not enter standby mode with a patient attached to the ventilator. You must confirm that no patient is attached before entering standby mode.

6.7 Battery info

1. Once you've selected the *Battery info*, press ACCEPT. Turn the knob to display either one of these messages when the ventilator is operating on battery power:

Int battery *hh:mm*
Ext battery *hh:mm*

These are estimates of the hours (*hh*) and minutes (*mm*) of operational time remaining (based on battery charge levels and current draw) until the batteries need recharging.

If the ventilator is operating on ac power or has been operating on battery power for less than two minutes, *Battery info* displays one of these messages:

Int battery N/A
Ext battery N/A

where "N/A" indicates that the information is not available.

2. Press CLEAR to return to the list of menu functions.

6.8 Software revision

Selecting the *Software revision* function displays the revision of the software installed in the ventilator. Press CLEAR to return to the *Software revision* menu item.

6.9 Service summary

The *Service summary* function allows you to view the following information:

- An estimate of the hours of operational time remaining for the internal battery (based on its battery charge level and current draw) until the internal battery needs recharging (available only if the ventilator is operating on internal battery power).
 - When routine service is due (expressed in hours remaining) based on the ventilator's operational hours.
1. Select the *Service summary* function, then press ACCEPT.
 2. Turn the knob to scroll through the list of service summary messages.
 3. Press CLEAR to return to the list of menu functions.

6.10 Nebulizer

The *Nebulizer* function allows you to stop, start, or view the state of an EasyNeb Nebulizer attached to the ventilator.

NOTE:

- The *EasyNeb Operator's Manual* and *700 Series Ventilator Operator's Manual* describe both continuous and phasic nebulization (nebulization synchronized with the inspiratory or expiratory breath cycle). Please note that only continuous nebulization is available for *EasyNeb* nebulizers sold in the United States.
 - When using an *EasyNeb* with the ventilator, please refer to the *EasyNeb Operator's Manual* (see Appendix B for part numbers).
-

1. Select the *Nebulizer* function and press ACCEPT.

If you attempt to select the nebulizer function before ventilation begins or on a ventilator that does not have the Communications option installed, the message window displays this message:

Neb not available

2. Once you've selected ventilator settings and the *Nebulizer* function, turn the knob to view one of these messages:

Start nebulizer

Stop nebulizer

View nebulizer state

3. If you select *Start nebulizer* and the nebulizer is on, the message window displays this message:

Nebulizer already on

If the nebulizer is off, the message window displays this message:

Neb time = xx mins

Turn knob to adjust

where *xx* is the previously-selected nebulization time. Turn the knob if you want to change the time (you can select from 1 to 60 minutes), then press ACCEPT to proceed.

4. The message window displays this message:

Neb phase = INSP

Turn knob to adjust

where *INSP* is the previously-selected nebulization breath phase. Turn the knob to select *INSP* (nebulization synchronized with the inspiratory phase), *EXH* (nebulization synchronized with the expiratory phase), or *BOTH* (continuous nebulization). Press **ACCEPT** to begin nebulization or **CLEAR** to cancel. Once nebulization begins, the display returns to *View nebulizer state*.

5. If you select *Stop nebulizer* and the nebulizer is off, the message window displays this message:

Nebulizer not active

If the nebulizer is on, the message window displays this message:

Time left = xx mins
Halt nebulization?
CLEAR(N) ACCEPT(Y)

Press **CLEAR** to leave nebulization unchanged and display *View nebulizer state*. Press **ACCEPT** to display *Stop nebulizer*.

6. If you select *View nebulizer state* and the nebulizer is on, the message window displays this message:

Time left = xx mins
Neb phase = INSP
Press CLEAR to exit

Press **CLEAR** to return to *Nebulizer* menu option.

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Alarm handling

This section describes possible ventilator alarms and what to do if they occur. 700 Series Ventilator System alarms are classified as high- or medium-priority:

- *High-priority alarms* require immediate attention to ensure patient safety. During a high-priority alarm, the red ALARM indicator flashes, the high-priority audible alarm (a repeating sequence of three, then two beeps) sounds, and the message window shows an alarm message.
- *Medium-priority alarms* require prompt attention. During a medium-priority alarm, the yellow CAUTION indicator flashes, the medium-priority audible alarm (a repeating sequence of three beeps) sounds, and the message window shows an alarm message.

If the active alarm is one of the operator-adjustable alarms, its key light also flashes, and the ALARM SETTINGS window is blank. The key light for any active alarm continues to flash if you press the alarm silence key. (The operator-adjustable alarms are HIGH RATE, LOW INSP PRESSURE, HIGH PRESSURE, HIGH TIDAL VOLUME, LOW TIDAL VOLUME, and LOW MINUTE VOLUME.)

NOTE:

You can always change an alarm setting even when alarms are active. You do not need to press the alarm reset key or wait for the alarm to autoreset.

The highest-priority active alarm always flashes on the first line of the message window. If no alarm is active, the first line displays the highest-priority autoreset alarm. You can use the menu function to view all remaining active and autoreset alarms. (Chapter 6 of this manual tells you how to use the menu function.) Figure 7-1 summarizes how to view active alarms.

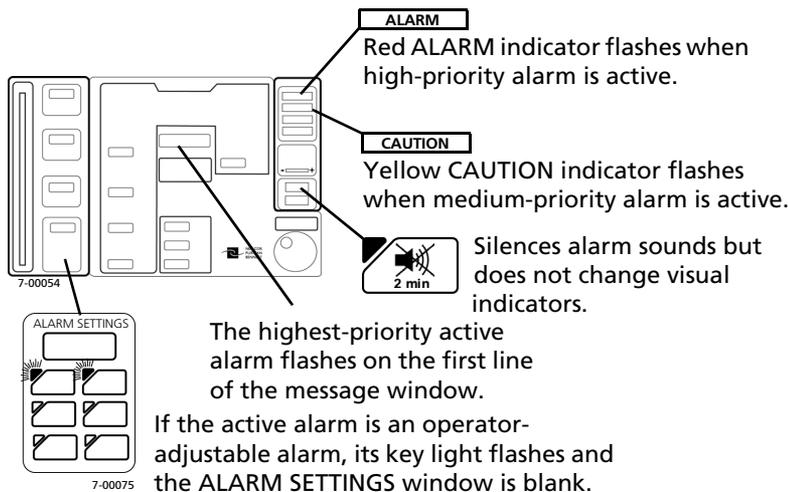


Figure 7-1. Viewing active alarms

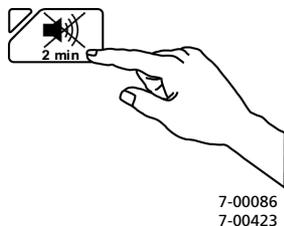
7.1 Autoreset alarms

When an alarm is autoreset (that is, reset because the condition corrected itself), it is added to the *Autoreset alarms* list. You can view the *Autoreset alarms* list using the MENU key. (Chapter 6 tells you how to use the MENU key.)

When an alarm autoresets, the CAUTION or ALARM indicator lights steadily (instead of flashing). Any alarm key lights that were flashing when the alarm was active return to their previous states (off or steadily lit).

Pressing alarm reset immediately clears all autoreset alarms. For accurate alarm condition evaluation, press alarm silence and view autoreset alarms (using the *Autoreset alarms* function, as described in Chapter 6).

7.2 Alarm silence



Silences the alarm sound for 2 minutes from the most recent key press. (The visual alarm indicators do not change.) If a new alarm occurs during the alarm silence period, the alarm sound resumes. If the condition that caused the initial alarm still exists after 2 minutes, the alarm sound resumes.

NOTE:

If the condition that caused a HIGH PRESSURE alarm persists, it cannot be silenced.

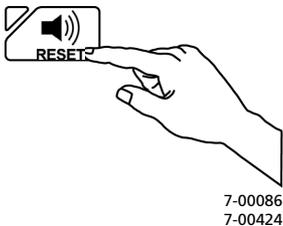
During certain bedside procedures, you may want to silence new alarms. Pressing the alarm silence key **when the ventilator is in a normal state** prevents a new alarm from sounding for 2 minutes. If a new alarm occurs, the ALARM or CAUTION indicator flashes and its alarm message is displayed in the message window. New alarms that do not sound if an alarm silence is in effect are:

- APNEA
- DISCONNECT
- HI EX TIDAL VOLUME
- HI RESP RATE
- HIGH PRESSURE (if circuit pressure is less than 90 cmH₂O (90 hPa))
- LO EX TIDAL VOLUME
- LOW EX MINUTE VOLUME
- LOW INSP PRESSURE
- LOW RATE

Warning

For all bedside procedures, such as breathing circuit disconnection, Covidien recommends that you use the alarm silence key only when you plan to perform the procedure immediately.

7.3 Alarm reset



Clears all alarm indicators and cancels the alarm silence period. If the condition that caused the alarm still exists, the alarm reactivates.

7.4 Clinical and technical alarms

Clinical alarms are triggered by a ventilator setting or patient condition and can occur in the usual course of patient care. *Technical* alarms are triggered by the ventilator's ongoing tests, and rarely if ever occur during routine ventilator operation. Table 7-1 lists clinical alarms, and Table 7-2 lists technical alarms.

Table 7-1: Clinical alarms

When you see this message...	It means...	Do this...
APNEA	<p>High-priority alarm.</p> <p>Patient has not triggered a breath within the selected apnea interval.</p> <p>Autoreset when patient triggers 2 consecutive breaths.</p>	<p>Check patient.</p> <p>Consider switching from SPONT mode.</p>
CONTINUOUS HI PRES	<p>High-priority alarm.</p> <p>HIGH PRESSURE alarm is active but circuit pressure has not dropped below HIGH PRESSURE setting.</p> <p>Alarm does not autoreset. The ventilator enters occlusion cycling mode.</p>	<p>Check patient; provide alternate ventilation.</p> <p>Check for blockage at EXHAUST port.</p> <p>Remove ventilator from use and contact service.</p>
DISCONNECT	<p>High-priority alarm.</p> <p>Measured exhaled tidal volume is 15% or less of delivered tidal volume for 4 consecutive breaths.</p> <p>Autoreset when exhaled tidal volume is greater than 15% of the delivered tidal volume for one breath.</p> <p>The DISCONNECT alarm is turned off when the speaking valve option is active (see Chapter 6 for more information).</p>	<p>Check patient.</p> <p>Check ventilator breathing circuit connections.</p> <p>Press the alarm reset key.</p>

Table 7-1: Clinical alarms (continued)

When you see this message...	It means...	Do this...
<p>HI EX TIDAL VOLUME</p>	<p>Medium-priority alarm. Exhaled volume for 3 of 4 consecutive breaths was above HIGH TIDAL VOLUME setting. Autoreset when 3 of 4 consecutive breaths are within alarm setting.</p>	<p>Check patient. Consider appropriate HIGH TIDAL VOLUME, TIDAL VOLUME, and SUPPORT PRESSURE settings.</p>
<p>HI RESP RATE</p>	<p>Medium-priority alarm. Monitored respiratory rate higher than HIGH RATE setting. Autoreset when monitored respiratory rate is less than or equal to alarm setting.</p> <hr/> <p>NOTE: The annunciation and autoreset of the HI RESP RATE alarm is deferred for 30 seconds following any breath setting change to allow an adequate number of breaths to occur for accurate determination of respiratory rate.</p> <hr/>	<p>Check patient. Check for ventilator breathing circuit leak that could cause autocycling. Consider appropriate HI RATE, RESPIRATORY RATE, and TRIGGER SENSITIVITY settings. Consider adequacy of ventilatory support and patient comfort.</p>

Table 7-1: Clinical alarms (continued)

When you see this message...	It means...	Do this...
HIGH PRESSURE	<p>High-priority alarm.</p> <p>Two consecutive breaths were truncated because circuit pressure reached the HIGH PRESSURE setting. (Inspiration phase ends and exhalation valve opens to prevent excessive pressure.)</p> <p>Autoreset when circuit pressure is less than alarm setting for 5 breaths. Cannot be silenced if alarm condition persists.</p>	<p>Check patient.</p> <p>Check for water in the inspiratory limb or kinked tubing.</p> <p>Consider appropriate HIGH PRESSURE and ventilator settings.</p>
LO EX TIDAL VOLUME	<p>Medium-priority alarm.</p> <p>Delivered tidal volume less than LOW TIDAL VOLUME setting for 3 out of 4 consecutive breaths. If LOW TIDAL VOLUME ALARM setting = 0 and breath type is PCV, this alarm indicates that delivered tidal volume is less than 3 ml for 3 out of 4 consecutive breaths.</p> <p>Autoreset when delivered value is at least equal to alarm setting for 3 out of 4 consecutive breaths.</p>	<p>Check patient. Check for blocked or kinked ET tube (PCV and PSV breath types when LOW TIDAL VOLUME setting = 0).</p> <p>Consider appropriate INSPIRATORY PRESSURE, PEAK FLOW, LOW TIDAL VOLUME, TIDAL VOLUME, EXH SENSITIVITY, RISE TIME FACTOR, and SUPPORT PRESSURE settings.</p>

Table 7-1: Clinical alarms (continued)

When you see this message...	It means...	Do this...
<p>LOW EX MINUTE VOLUME</p>	<p>Medium-priority alarm. Monitored minute volume less than LOW MINUTE VOLUME setting. Autoreset when monitored value is at least equal to alarm setting. The LOW MINUTE VOLUME alarm is turned off when the speaking valve option is active (see Chapter 6 for more information).</p> <hr/> <p>NOTE: The annunciation of the LO EX MINUTE VOLUME alarm is disabled for up to 10 breaths following a 100% O₂ maneuver, PEEP setting change, or the termination of the SVO state. It is deferred for 30 seconds to allow an adequate number of breaths to occur for accurate determination of minute volume following a setting change.</p>	<p>Check patient. Consider appropriate LOW MINUTE VOLUME and ventilator settings.</p>

Table 7-1: Clinical alarms (continued)

When you see this message...	It means...	Do this...
LOW INSP PRESSURE	<p>High-priority alarm. Monitored circuit pressure never rises above the LOW INSP PRESSURE setting during inspiration (this alarm is only active during A/C and SIMV modes). Autoreset when circuit pressure is at least equal to alarm setting during inspiration.</p> <hr/> <p>NOTE: A patient outdrawing the ventilator's set flow rate can trigger the LOW INSP PRESSURE alarm. Make sure the PEAK FLOW setting is adequate to meet the patient's demand.</p> <hr/>	<p>Check patient. Check for ventilator breathing circuit disconnect. Consider appropriate LOW INSP PRESSURE and ventilator settings.</p>

Table 7-1: Clinical alarms (continued)

When you see this message...	It means...	Do this...
<p>LOW RATE (760 Ventilator only)</p>	<p>Medium-priority alarm. The ventilator cannot deliver the current RESPIRATORY RATE setting (insufficient time for piston to retract and deliver next breath). Monitored respiratory rate lower than RESPIRATORY RATE setting by one breath per minute + 10% of the setting. Autoreset after 30 seconds. Pressing alarm reset key immediately disables the alarm and clears the autoreset, and the alarm is not reannunciated unless the condition persists after you change settings.</p> <hr/> <p>NOTE: The annunciation of the LOW RATE alarm is disabled for 30 seconds following a setting change to allow enough breaths to occur for accurate determination of respiratory rate following a setting change.</p>	<p>Check patient. Check for ventilator breathing circuit disconnect or occlusion. Consider appropriate RESPIRATORY RATE and other mandatory settings. Consider adequacy of ventilatory support and patient comfort.</p>

Table 7-1: Clinical alarms (continued)

When you see this message...	It means...	Do this...
<p>% O₂ HIGH</p>	<p>High-priority alarm. Measured % O₂ more than 10 percentage points above setting for at least 30 seconds. Autoreset when measured % O₂ is within 10 percentage points of setting.</p> <hr/> <p>Warning</p> <p>Covidien recommends that the O₂ alarm limits be enabled at all times, unless the oxygen sensor is faulty or missing. Replace a faulty or missing oxygen sensor as soon as possible.</p> <hr/>	<p>Check air intake filter for occlusions and replace if necessary. (Appendix A tells you how.)</p> <p>View the oxygen sensor measurement and consider recalibrating the sensor (using the <i>Oxygen sensor</i> menu function, as described in Chapter 6).</p> <p>If indicated by your institution's protocol, disable the O₂% alarm limits (using the <i>Oxygen sensor</i> menu function).</p> <hr/> <p>Check patient; check oxygen supply; provide alternate ventilation. Remove ventilator from use and contact service (consider replacing oxygen sensor).</p>

Table 7-1: Clinical alarms (continued)

When you see this message...	It means...	Do this...
<p>% O₂ LOW</p>	<p>High-priority alarm. Measured % O₂ more than 10 percentage points below setting for at least 30 seconds. Autoreset when measured % O₂ is within 10 percentage points of setting.</p> <hr/> <p>Warning</p> <p>Covidien recommends that the O₂ alarm limits be enabled at all times, unless the oxygen sensor is faulty or missing. Replace a faulty or missing oxygen sensor as soon as possible.</p> <hr/>	<p>View the oxygen sensor measurement and consider recalibrating the sensor (using the <i>Oxygen sensor</i> menu function, as described in Chapter 6). If indicated by your institution's protocol, disable the O₂% alarm limits (using the <i>Oxygen sensor</i> menu function).</p> <hr/> <p>Check patient; check oxygen supply; provide alternate ventilation. Remove ventilator from use and contact service (consider replacing oxygen sensor).</p>

Table 7-1: Clinical alarms (continued)

When you see this message...	It means...	Do this...
OCCLUSION	<p>High-priority alarm.</p> <p>Ventilator breathing circuit or inspiratory or expiratory filters occluded. Ventilator detects above-normal difference between inspiratory and expiratory pressure transducers. The ventilator enters occlusion cycling mode.</p> <p>Autoreset when the ventilator no longer detects an occlusion.</p>	<p>Check patient.</p> <p>Check ventilator breathing circuit and inspiratory and expiratory filters for occlusions or kinks.</p> <p>Empty excess water from tubes.</p> <p>Press the alarm reset key.</p> <p>If this does not resolve the problem, provide alternate ventilation and contact service.</p>
PARTIAL OCCLUSION	<p>High-priority alarm.</p> <p>Ventilator breathing circuit or inspiratory or expiratory filters partially occluded. Ventilator detects above-normal difference between inspiratory and expiratory pressure transducers. The ventilator continues normal ventilation.</p> <p>Autoreset when partial occlusion no longer exists for two consecutive breaths.</p>	<p>Check the patient.</p> <p>Check the ventilator breathing circuit for water, kinks, or other blockages.</p> <p>If this does not resolve the problem, provide alternate ventilation and contact service.</p>
SETUP TIME ELAPSED	<p>High-priority alarm.</p> <p>At least 30 seconds have elapsed since you pressed a key or turned the knob (occurs at power-on only).</p> <p>Autoreset when you accept proposed settings.</p>	<p>Check the patient. Be sure to complete ventilator setup before connecting the ventilator breathing circuit to the patient.</p> <p>Select appropriate ventilator settings.</p>

Table 7-2: Technical alarms

When you see this message...	It means...	Do this...
Any alarm message not listed in this table.	The ventilator’s ongoing checks have detected an alarm condition.	Check patient; provide alternate ventilation. Remove ventilator from use and contact service.
AIR INTAKE ABSENT	High-priority alarm. Air intake filter sensor has detected a missing filter. Alarm does not autoreset; you must press the alarm reset key.	Verify that air intake filter is installed and seated securely. Replace air intake filter. Remove ventilator from use and contact service.
AIR INTAKE BLOCKED	High-priority alarm. Ventilator has detected above-normal resistance at the air intake filter. Alarm does not autoreset: you must press the alarm reset key.	Check patient. Check for visible occlusions (for example, a curtain, clothing, or furniture blocking the air intake). Press the alarm reset key. Replace air intake filter. (Appendix A tells you how.)
BAT NOT CHARGING	High-priority alarm. Battery voltage has not increased during past hour. Alarm does not autoreset; you must press the alarm reset key.	Check connections and charge of external battery. Replace battery, if applicable. Contact service.
CONTACT SERVICE	High-priority alarm. Ventilator requires servicing.	Remove ventilator from use and contact service.
DELIV GAS HI TEMP	High-priority alarm. Inspiration temperature too high. Autoreset when temperature is within acceptable limit.	Make sure room temperature is not too high. Remove ventilator from use and contact service.

Table 7-2: Technical alarms (continued)

When you see this message...	It means...	Do this...
DELIV GAS LOW TEMP	High-priority alarm. Inspiration temperature too low. Autoreset when temperature is within acceptable limit.	Make sure room temperature is not too low. Remove ventilator from use and contact service.
EXH CCT HI TEMP	High-priority alarm. Temperature of the exhalation heater is above acceptable limit. The ventilator continues to annunciate the alarm while the condition persists. Autoreset when temperature is within acceptable limit.	If problem persists, remove ventilator from use and contact service. Be aware that spirometry may be affected (monitored values may be higher than actual).
EXH CCT LO TEMP	High-priority alarm. Temperature of the exhalation heater is below acceptable limit. The ventilator continues to annunciate the alarm while the condition persists. Autoreset when temperature is within acceptable limit.	If problem persists, remove ventilator from use and contact service. Be aware that spirometry may be affected (monitored values may be lower than actual).
FAN FAILED ALERT	High-priority alarm. Fan filter occluded or fan not operational. Alarm does not autoreset; you must press the alarm reset key.	Make sure ventilator has warmed up sufficiently. Check fan filter for occlusions and clean if necessary. (Appendix A tells you how to check and clean the fan filter.) Press the alarm reset key. If this does not resolve the problem, contact service.

Table 7-2: Technical alarms (continued)

When you see this message...	It means...	Do this...
HI BBU TEMP ALERT	High-priority alarm. Internal power supply temperature above acceptable limit. Autoreset when temperature is below acceptable limit.	If problem persists, remove ventilator from use and contact service.
HI SYS TEMP ALERT	High-priority alarm. Temperature inside ventilator enclosure above acceptable limit. Autoreset when temperature is below acceptable limit.	Check fan and fan filter. Press the alarm silence or alarm reset key. If problem persists, remove ventilator from use and contact service.
LOSS AC POWER	Medium-priority alarm. Loss of ac power, although battery backup available. Autoreset after 2 minutes or when ac power restored.	Check integrity of connection to ac power. If ac power is present and verified: ON AC/BATTERY CHARGING lights within 5 seconds. Press the alarm reset key to return to normal operation. If battery operation continues, remove the ventilator from use and contact service.

Table 7-2: Technical alarms (continued)

When you see this message...	It means...	Do this...
LOSS OF POWER	<p>High-priority alarm.</p> <p>The ac supply was lost and the batteries are so low that all power may be lost. The unit will shut down in 5 minutes.</p> <p>Autoreset when ac or battery power is restored. Alarm sounds until autoreset, and for at least 2 minutes following loss of both battery and ac power.</p>	<p>Check integrity of ac power and battery connections. Disconnect the ventilator power cord for a few seconds, then reconnect it to wall power.</p> <p>If ac power is present, the VENTILATOR STATUS indicator displays the ON AC/BATTERY CHARGING message within 5 seconds.</p> <p>Press the alarm reset button to return the ventilator to normal operation.</p> <p>Replace batteries (internal and external, if installed) if necessary.</p> <p>If ac power is present and battery operation continues, obtain alternative ventilation.</p>
<p>NOTE:</p> <p>Actual battery backup time remaining depends on battery condition and ventilator settings.</p>		

Table 7-2: Technical alarms (continued)

When you see this message...	It means...	Do this...
<p>LOW EXT BATTERY</p>	<p>High-priority alarm. Low external battery voltage detected during POST, although ac power is sufficient. This alarm occurs only when the internal battery is also low or missing. Autoreset after 2 minutes, or when external battery is replaced. Once reset, alarm is not reannunciated.</p>	<p>Verify reliable ac power source. Check battery connections. Replace external battery if necessary.</p>
<p>LOW INT BATTERY</p>	<p>High-priority alarm. Low internal battery voltage detected during POST, although ac power is sufficient. Autoreset after 2 minutes. Once reset, alarm is not reannunciated.</p>	<p>Verify reliable ac power source. Contact service to check internal battery connections and replace internal battery if necessary.</p>
<p>LOW O₂ SUPPLY</p>	<p>High-priority alarm. Low oxygen supply pressure. Ventilation continues with reduced % O₂. (Alarm is not activated when % O₂ setting is 21%.) Autoreset when sufficient oxygen supply pressure is detected.</p>	<p>Check patient. Check integrity of oxygen supply and connections. Increase oxygen supply pressure if necessary.</p>

Table 7-2: Technical alarms (continued)

When you see this message...	It means...	Do this...
REPLACE O ₂ SENSOR	<p>High-priority alarm. Oxygen sensor missing or reading out of range. Alarm does not autoreset; you must press the alarm reset key.</p> <hr/> <p>NOTE: This alarm is not annunciated if O₂ alarms were disabled.</p> <hr/>	Remove ventilator from use and contact service.
SPEAKER FAILED	<p>High-priority alarm. Main alarm speaker failed and backup speaker sounds. The ventilator continues to annunciate this alarm while the condition persists. Does not autoreset.</p>	Remove ventilator from use and contact service.
SWITCH INT BATTERY	<p>Medium-priority alarm. Ventilator power source has switched to internal battery, due to loss of external battery. Autoreset after 2 minutes, when ac power is restored, or when external battery is replaced.</p>	<p>Check external battery connections. Replace external battery if necessary. Verify reliable ac power source.</p>

7.5 Power alarm

This section describes what happens in case of a LOSS AC POWER or LOSS OF POWER alarm.

7.5.1 Loss of AC Power

When the 700 Series ventilator detects a loss of ac power:

- A medium-priority audio alarm sounds for 2 minutes.
- The message **LOSS AC POWER** flashes in the display window for 2 minutes.
- The **CAUTION** indicator bar flashes for 2 minutes.
- The **ON INTERNAL BATTERY** or **ON EXTERNAL BATTERY** indicator flashes, depending on which battery is providing power, once battery operation begins.

If there is no user intervention within 2 minutes, the following occurs:

- The audio alarm stops.
- **LOSS AC POWER** stops flashing and lights steadily.
- The **CAUTION** indicator stops flashing and lights steadily on the VENTILATOR STATUS bar.
- The **ON INTERNAL BATTERY** or **ON EXTERNAL BATTERY** message flashes, depending on which battery is providing power, once battery operation begins.

7.5.2 Loss of Power

If a ventilator continues to operate on battery power and 5 minutes (or less) of battery power remains:

Warning

If the 700 Series ventilator is allowed to operate on a depleted battery, ventilation support ends. The ventilator will shutdown and the backup alarm will continue to sound for a minimum of 2 minutes.

1. The following indicators occur:
 - The **INTERNAL BATTERY LEVEL** indicator turns off.
 - The high-priority main audio alarm sounds.
 - The ALARM indicator flashes on the VENTILATOR STATUS bar.
 - The LOSS OF POWER message flashes in the display window.
2. The ventilator shuts down and runs POST.
3. Following POST, the message window displays LOW INT BATTERY and CONNECT MAINS POWER.
4. The ventilator shuts down in a safe state with the safety valve open and the backup alarm sounding for a minimum of 2 minutes.
5. If ac power is reconnected, the ventilator runs POST and restarts using the previously-selected ventilation mode at the settings.

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Maintenance

To ensure proper ventilator operation, perform the following maintenance procedures at the recommended intervals. All procedures should be adapted to your institution's policies and protocol.

This section describes:

- Cleaning, disinfecting, and sterilizing
- Preventive maintenance
- Storage
- Repacking

For instructions for qualified service technicians on performing more detailed testing, troubleshooting, or other service procedures, see the *700 Series Ventilator System Service Manual* for more information, including theory of operation, calibration instructions, parts list, and circuit diagrams. (Individual electronic components are not field-repairable.)

A.1 Cleaning, disinfection, and sterilization

Table A-1 tells you how to clean, disinfect, and sterilize ventilator components.

NOTE:

Covidien recognizes that sanitation practices vary widely among healthcare institutions. It is not possible for Covidien to specify or require specific practices that will meet all needs, or to be responsible for the effectiveness of cleaning, disinfecting, sterilizing, and other practices carried out in the patient care setting. This manual can only give general guidelines for cleaning, disinfecting, and sterilizing. It is the user's responsibility to ensure the validity and effectiveness of the methods used.

Warning

- Do not attempt to remove, clean, or flush the flow sensor with liquids or pressurized air.
 - Because a patient's inspired gas contacts some parts that can absorb sterilizing agents, be sure to sterilize parts according to the techniques described in Table A-1. Exposure to sterilizing agents may reduce the useful life of some parts.
 - Handle filters with care, to minimize the risk of bacterial contamination or physical damage.
-

Table A-1: Cleaning, disinfection, and sterilization

Part	Procedure	Comments
Ventilator exterior (including keyboard and flex arm)	Wipe clean with a damp cloth and mild detergent. Clean keyboard with keyboard cleaning spray (P/N G-061576-00).	Do not allow liquid to penetrate the ventilator.
Ventilator breathing circuit tubing	<p>Reusable: Disassemble and clean, then autoclave, pasteurize or chemically disinfect.</p> <p>Disposable: Disinfect or sterilize, then discard.</p>	<p>If submersed in liquid, use pressurized air to blow moisture from inside the tubing before use. Inspect for nicks and cuts, and replace if damaged. Run SST to check for leaks when a new breathing circuit is installed. Follow circuit instructions for installation and cleaning.</p>
<p style="text-align: center;">Caution</p> <p style="text-align: center;">Autoclaving reusable ventilator breathing circuits can decrease circuit life span, decrease flexibility, and cause discoloration (yellowing) of the tubing.</p>		
In-line water traps	Disassemble and clean, then autoclave, pasteurize, or chemically disinfect.	Inspect for cracks, and replace if damaged. Follow circuit instructions for installation and cleaning.
Couplings and connectors	Autoclave, pasteurize, or chemically disinfect.	If submersed in liquid, use pressurized air to blow moisture from inside the part before use. Inspect for nicks and cuts, and replace if damaged. Follow circuit instructions for installation and cleaning.
Collector vial	Disassemble and clean, then autoclave, pasteurize, or chemically disinfect.	Inspect for cracks, and replace if damaged.

Table A-1: Cleaning, disinfection, and sterilization (continued)

Part	Procedure	Comments
Expiratory and inspiratory bacteria filters	Reusable: Autoclave. Disposable: Disinfect or sterilize, then discard.	Do not chemically disinfect or expose to ethylene oxide (ETO) gas. Check filter resistance before reuse. Follow manufacturer's recommendations for reusability.
Cooling fan filter	Every 250 hours (or 1 month of use) or as necessary: clean or replace.	Replace when filter element appears worn or occluded or a FAN FAILED ALERT alarm occurs.
Air intake filter	Replace every 1000 hours (or 3 months of use) of operation, or as necessary.	Replace when an AIR INTAKE BLOCKED alarm occurs. Do not attempt to clean or reuse the air intake filter.
Other accessories	Follow manufacturer's instructions.	

A.1.1 Cleaning: general guidelines

Do not clean or reuse single-patient use or disposable products. When cleaning parts, do not use hard brushes or other instruments that could damage surfaces.

1. Wash parts in warm water and detergent.
2. Rinse parts thoroughly in clean, warm water (tap water is fine) and air dry.
3. Covidien recommends that you inspect all parts at every cleaning. Replace any damaged parts.
4. Whenever you use new parts on the ventilator, run short self-test (SST).

Caution

Follow the detergent manufacturer's instructions. Using detergent solution stronger than necessary can shorten the useful life of the products. Detergent residue can cause blemishes or fine cracks, especially on parts exposed to elevated temperatures during sterilization.

A.1.2 Disinfection and sterilization

Do not disinfect, sterilize, or reuse single-patient use or disposable products. When sterilizing tubing, coil tubing in a large loop, avoiding kinks, or crossing tubing. The tubing lumen should be free of any visible droplets prior to wrapping.

Follow these steps (the order depends on what method of disinfection/sterilization you use):

Autoclave sterilization	Chemical disinfection or pasteurization
1. Disassemble	1. Disassemble
2. Clean	2. Clean
3. Inspect	3. Inspect
4. Reassemble	4. Disinfect
5. Sterilize	5. Reassemble
6. Run SST	6. Run SST

Caution

Formaldehyde and phenol-based disinfectants are not recommended because they can cause plastic parts to crack and craze. Exposing parts to disinfectant concentration stronger than required for excessive time may shorten product life. To prevent spotting and blemishing when exposed to elevated temperatures, thoroughly rinse and dry parts.

A.2 Preventive maintenance

Table A-2 summarizes preventive maintenance intervals and procedures. The estimated hours of use until preventive maintenance is due appears in the message window during power-on self-test (POST).

NOTE:

The internal battery must be replaced approximately every 2 years (under typical usage). You can use the MENU key to view the service summary, which includes an estimate of how long the ventilator can operate on the current charge of the internal battery. (Chapter 6 tells you how to use the MENU key. The *700 Series Ventilator System Service Manual* tells you how to replace components and perform preventive maintenance.)

Caution

To avoid component damage due to excessive wear, perform preventive maintenance and replace components at recommended intervals. You may find it convenient to note anticipated replacement dates for all components based on typical use rates or recommended intervals.

NOTE:

Dispose of all parts removed from the ventilator during maintenance procedures according to your institution's protocol. Sterilize before nondestructive disposal. Follow local governing ordinances and recycling plans regarding disposal or recycling of device components.

Table A-2: Preventive maintenance schedule

Frequency	Part	Maintenance
Daily or as required by your institution's policy	Ventilator breathing circuit: Inspiratory and expiratory limbs	Check for water build-up; empty and clean as necessary.
	Inspiratory and expiratory bacteria filters	Use SST to check filter resistance whenever new filter is installed, or if you suspect excess resistance.
	Collector vial and water traps	Check and empty as needed.
250 hours or 1 month of use (or more often, if required)	Cooling fan filter	Clean. Replace when filter shows signs of wear, or a FAN FAILED ALERT alarm occurs.
1000 hours or 3 months of use (or more often, if required)	Air intake filter	Replace at recommended interval or when an AIR INTAKE BLOCKED alarm occurs.
Annually or after 100 autoclave cycles	Reusable inspiratory and expiratory bacteria filters	Replace. Sterilize between patients and circuit changes, or according to your institution's policy. Sterilize before nondestructive disposal.
As necessary	Oxygen sensor	Perform a calibration by selecting <i>Calibrate O₂ sensor</i> from the MENU key's <i>Oxygen sensor</i> function.
As necessary	Internal battery, and external battery (if installed)	Replace if necessary.

Table A-2: Preventive maintenance schedule (continued)

Frequency	Part	Maintenance
Every year from ventilator's first use, or as needed	Oxygen sensor	<ul style="list-style-type: none"> Replace the oxygen sensor as needed. When replacing the sensor, follow the information contained on the replacement oxygen sensor's package for expiration or install-by dates and information provided in the oxygen sensor's instructions-for-use. Document the replacement of the oxygen sensor and the date replacement is required according to the institution's protocol. Actual sensor life depends on operating environment. Operation at higher temperature or O₂% levels will result in shorter sensor life.
Every 2 years	Entire ventilator	Perform device checks described in Section A.2.7.
Every 15,000 hours	Various parts	Use appropriate preventive maintenance kit (preventive maintenance must be performed by a qualified service technician according to instructions in the <i>700 Series Ventilator System Service Manual</i>).

A.2.1 Daily or as required: inspiratory and expiratory bacteria filters

Inspect and check the resistance across inspiratory and expiratory filters before every use, and after 15 days of continuous use in the exhalation limb. At every circuit change, autoclave reusable filters or discard disposable filters. SST checks the resistance of the inspiratory and expiratory filters.

- Filter resistance greater than 4 cmH₂O (4 hPa) at 100 L/min flow can indicate an occluded filter. For reusable filters, autoclave and check the resistance again. If filter resistance is still greater than 4 cmH₂O, discard the filter. For disposable filters, discard and replace with a new filter.
- Filter resistance less than 1 cmH₂O (1 hPa) at 100 L/min flow can indicate a ruptured filter. Discard the filter.

Replace reusable filters after a maximum of one year of service or 100 autoclave cycles, whichever comes first. When you put a reusable filter into service, write the anticipated replacement date on the filter and keep of record of the number of autoclave cycles to which the filter has been subjected. Discard disposable filters between patients.

A.2.2 Daily or as required: collector vial

At every ventilator breathing circuit change, autoclave or disinfect the collector vial. The patented design of the collector vial maintains circuit pressure (minimizes PEEP loss) and prevents condensate from spraying when you remove the collector vial from the ventilator breathing circuit.

Empty the collector vial before it fills:

1. Turn the collector vial counterclockwise to release it from the ventilator breathing circuit.
2. Empty the collector vial, referring to Figure A-1.
3. Replace the empty collector vial: turn clockwise to secure the vial into place, which reopens its access to the ventilator breathing circuit.

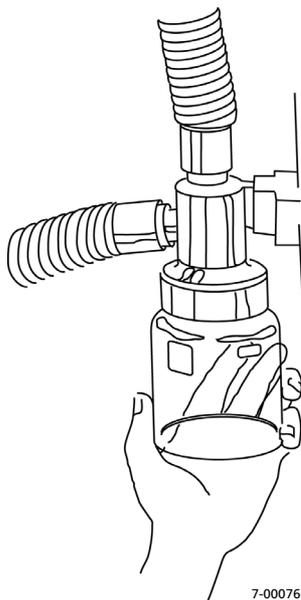


Figure A-1. Removing/replacing the collector vial

A.2.3 Daily or as required: in-line water traps

Drain as required.

A.2.4 As necessary: oxygen sensor calibration

Use the MENU key's *Oxygen sensor* function, then select *Calibrate O₂ sensor* to perform a two-point calibration of the oxygen sensor anytime you want to verify proper sensor operation. You can only calibrate the oxygen sensor immediately following powerup, before a patient is connected. (Chapter 6 tells you how to use the MENU key.)

A.2.5 Every 250 hours (or 1 month of use): cooling fan filter

1. Remove the cooling fan cover from the back of the ventilator by loosening the two screws (see Figure A-2).
2. Remove the cooling fan filter, wash in a mild detergent solution, rinse well, then dry thoroughly. Replace filter if it appears worn or occluded, or a FAN FAILED ALERT alarm occurs.
3. Replace the cooling fan filter inside the cooling fan cover.
4. Reposition the cooling fan cover and tighten the two screws (see Figure A-2).

NOTE:

Clean the filter more often than every 250 hours (or 1 month of use) if necessary, or when the ventilator displays the FAN FAILED ALERT message. (Some environments cause lint and dust to collect more quickly.)

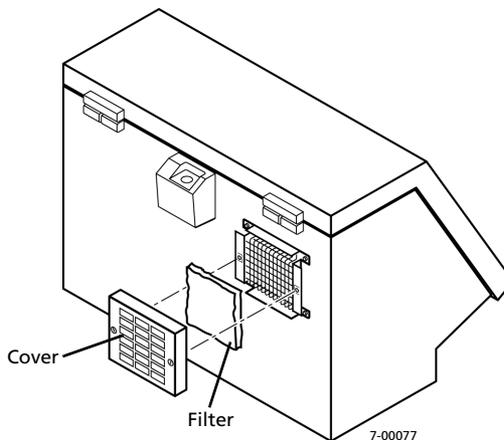


Figure A-2. Cooling fan cover

A.2.6 Every 1000 hours (or 3 months of use): air intake filter

1. Turn the two captive thumbscrews to remove the air intake cover (see Figure A-3).
2. Discard the used air intake filter.

Caution

Do not attempt to clean or reuse the air intake filter.

3. Place the new air intake filter over the air intake port inside the ventilator.
4. Reposition the air intake cover, making sure the intake slots face down. Tighten the two thumbscrews.

NOTE:

Replace the filter more often than every 1000 hours (or 3 months of use) if necessary, or when the ventilator displays the AIR INTAKE BLOCKED message. (Some environments collect lint and dust more quickly.)

NOTE:

To prevent an AIR INTAKE ABSENT alarm, ensure that the filter is seated properly.

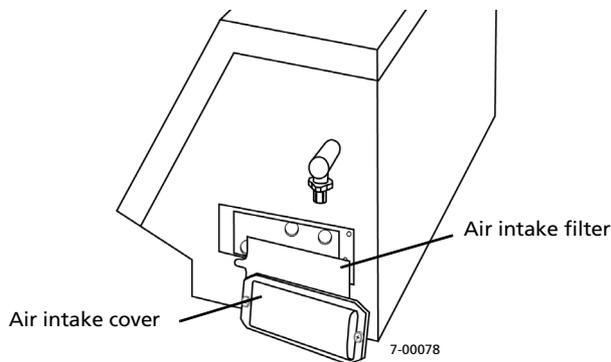


Figure A-3. Air intake filter

A.2.7 Every 2 years: device checks

Covidien recommends that you perform these checks every 2 years:

1. Inspect the ventilator exterior for mechanical damage or evidence that the device has been subjected to a mechanical shock (for example, dropped). Any apparent damage constitutes a failure of this check.
2. Run a full performance verification to verify that the ventilator functions properly, as described in the *700 Series Ventilator System Service Manual*.
3. Verify that the audible and visual alarms are functioning properly, as described in Appendix E.
4. Inspect the labels for legibility.

Record this data in an equipment log. If the ventilator fails any of checks 1 through 3, remove it from use. Have a suitably qualified person service the ventilator and perform a full performance verification, as described in the *700 Series Ventilator System Service Manual*. If the ventilator fails check 4, replace the labels, referring to the *Service Manual* for ordering information.

A.2.8 Storage

If you are storing the ventilator for 10 days or less, place the ventilator in standby mode (Chapter 3 tells you how) and disconnect the oxygen supply if you do not intend to use the ventilator immediately.

If you are storing the ventilator for 6 months or longer, Covidien recommends that a qualified service technician remove the internal battery (according to instructions in the *700 Series Ventilator System Service Manual*), and that the external battery be disconnected.

NOTE:

A LOSS OF POWER alarm will sound for at least 2 minutes after you turn off the power switch when no batteries are connected.

A.2.9 Repacking

If it is necessary to ship the ventilator for any reason, use the original packing materials if possible. If those materials are not available, order a repacking kit.

See the *700 Series Ventilator System Service Manual* for repacking instructions.

Part numbers

This appendix lists 700 Series Ventilator part numbers. Figure B-1 shows ventilator parts corresponding to the part numbers listed in Table B-1.

NOTE:

Although Covidien does not offer single-patient use ventilator breathing circuits for use with 700 Series Ventilators, the ventilator has been tested and shown to meet the specifications of Table C-5 using Baxter Healthcare Corporation single-patient use circuits. Contact your Baxter Medical representative to purchase these circuits.

Table B-1: Ventilator accessories

Item no.	Description	Part no.
1	Ventilator breathing circuit, adult, reusable. Includes: Tube, adult, 120-cm (2 included) Tube, adult, 40-cm (2 included) Tube, adult, 15-cm Wye, adult Wye, adult, with temperature port Water trap, in-circuit (2 included) Adapter, 22-mm male x 22-mm male Tube hanger Directions for use, 700/800 Series breathing circuit, adult	G-061208-00 G-061439-00 G-061440-00 G-061441-00 G-061718-00 G-061209-27 G-061213-00 G-061483-00 G-061214-00 10072487
	Ventilator breathing circuit, adult, reusable, with heated wire, for Fisher & Paykel™* humidifiers.* Includes: Tube, adult, 15-cm Tube, adult, 150-cm (2 included) Wye, adult, with temperature port Adapter, 22-mm male x 22-mm male Tube hanger Adapter, hose heater Temperature probe, dual-airway Heater wire, inspiratory limb Heater wire, expiratory limb Draw wire, 1.5-m Directions for use, 700/800 Series breathing circuit, adult, heated wire	G-061235-00 G-061441-00 G-061438-00 G-061209-00 G-061483-00 G-061214-00 G-061437-00 G-061479-00 G-061436-00 G-061435-00 G-061478-00 10070393

* Not shown

Table B-1: Ventilator accessories (continued)

Item no.	Description	Part no.
1 (cont.)	Ventilator breathing circuit, pediatric, reusable.* Includes: Tube, pediatric, 120-cm (2 included) Tube, pediatric, 40-cm (2 included) Tube, pediatric, 15-cm Wye, pediatric, straight Water trap, in-circuit (2 included) Adapter, 22-mm male/15-mm female, with temperature port Adapter, 22-mm male/15-mm female Tube hanger Adapter, 22-mm male x 15-mm female Adapter, 15-mm male x 10-mm female Directions for use, 700/800 Series breathing circuit, pediatric	G-061223-00 G-061452-00 G-061453-00 G-061454-00 G-061480-00 G-061213-00 G-061482-00 G-061481-00 G-061214-00 4-900MR5-34 4-900MR5-33 10068219
	Ventilator breathing circuit, pediatric, reusable, with heated wire, for Fisher & Paykel™* humidifiers.* Includes: Tube, pediatric, 15-cm Tube, pediatric, 150-cm (2 included) Wye, pediatric, straight Adapter, 22-mm male x 15-mm female Tube hanger Adapter, hose heater Temperature probe, dual-airway Heater wire, inspiratory limb Heater wire, expiratory limb Draw wire, 1.5-m Adapter, 22-mm male/15-mm female, with temperature port Adapter, 22-mm male/15-mm female Adapter, 15-mm male/10-mm female Directions for use, 700/800 Series breathing circuit, pediatric, heated wire	G-061237-00 G-061454-00 G-061451-00 G-061480-00 4-900MR1-34 G-061214-00 G-061437-00 G-061479-00 G-061436-00 G-061435-00 G-061478-00 G-061482-00 G-061481-00 4-900MR5-33 10070394

* Not shown

Table B-1: Ventilator accessories (continued)

Item no.	Description	Part no.
2	Flex arm	4-032006-00
3	Power cord, for North America and Japan	G-061241-00
	Power cord, for Australia	G-061242-00
	Power cord, for continental Europe	G-061243-00
	Power cord, for Denmark	G-061244-00
	Power cord, for India/South Africa (old British-style plug with round prongs)	G-061247-00
	Power cord, for Israel	G-061248-00
	Power cord, for Italy	G-061245-00
	Power cord, for Switzerland	G-061246-00
	Power cord, for United Kingdom	G-060135-00

* Not shown

Table B-1: Ventilator accessories (continued)

Item no.	Description	Part no.
4	Hose assembly, oxygen, DISS female (for USA and Japan)	4-001474-00
	Hose assembly, oxygen, DISS male (for Canada)	G-061269-00
	Hose assembly, oxygen, NIST (for United Kingdom)	G-061201-00
	Hose assembly, oxygen, Air Liquide™* (for France)	G-061190-00
<p>Warning</p> <p>Due to excessive restriction of this hose assembly, reduced FiO₂ levels may result when oxygen inlet pressures < 50 psi (345 kPa) are employed. Make sure oxygen inlet pressure is ≥ 50 psi (345 kPa) when using this hose assembly, to maintain correct FiO₂ levels.</p>		
	Hose assembly, oxygen, for Australia	G-061198-00
<p>Warning</p> <p>Due to excessive restriction of this hose assembly, reduced FiO₂ levels may result when oxygen inlet pressures < 50 psi (345 kPa) are employed. Make sure oxygen inlet pressure is ≥ 50 psi (345 kPa) when using this hose assembly, to maintain correct FiO₂ levels.</p>		
	Hose assembly, oxygen, Dräger™* (for Germany)	5-029059-00
<p>Warning</p> <p>Due to excessive restriction of this hose assembly, reduced FiO₂ levels may result when oxygen inlet pressures < 50 psi (345 kPa) are employed. Make sure oxygen inlet pressure is ≥ 50 psi (345 kPa) when using this hose assembly, to maintain correct FiO₂ levels.</p>		

* Not shown

Table B-1: Ventilator accessories (continued)

Item no.	Description	Part no.
5	External battery kit (Includes external battery and cover)	G-061140-00
6	External battery charger, for North America and Japan*	G-061260-00
	External battery charger, for Australia*	G-061261-00
	External battery charger, for continental Europe*	G-061500-00
	External battery charger, for Denmark*	G-061501-00
	External battery charger, for India/South Africa (old British-style plug with round prongs)*	G-061504-00
	External battery charger, for Israel*	G-061505-00
	External battery charger, for Italy*	G-061502-00
	External battery charger, for Switzerland*	G-061503-00
	External battery charger, for United Kingdom*	G-061499-00
7	Collector vial assembly with mounting bracket (includes items 8, 9, and 17)	G-061668-00
8	Collector vial kit	G-062501-00
9	Tube, adult, 10 cm (connects collector vial to expiratory filter)	G-062499-00
10	Inspiratory bacteria filter, 22-mm ISO connectors, disposable (<i>DiFlex</i> , carton of 12)	4-074601-00
	Inspiratory bacteria filter, 22-mm ISO connectors, reusable (<i>ReFlex</i> , one per package)	4-074600-00

* Not shown

Table B-1: Ventilator accessories (continued)

Item no.	Description	Part no.
11	Expiratory bacteria filter, reusable (<i>ReIX700</i> , one per package)*	G-060525-00
	Expiratory bacteria filter, disposable (<i>DIX7</i> , carton of 12)*	G-060526-00
12	Cooling fan filter (package of 6)*	G-061263-00
13	Air intake filter (package of 6)*	G-061262-00
14	Mounting kit, shelf, for use with Fisher & Paykel™* Humidifiers. Includes shelf plus the applicable mounting hardware.*	G-061279-00
	Mounting kit, shelf, for use with Hudson RCI™* ConchaTherm™* Humidifier. Includes shelf plus the applicable mounting hardware.*	G-061601-00
15	Mounting kit, humidifier, Fisher & Paykel™*, shelf mount only*	G-061602-00
	Bracket, humidifier, Hudson RCI™* ConchaTherm™*, shelf-mount only*	G-061603-00

* Not shown

Table B-1: Ventilator accessories (continued)

Item no.	Description	Part no.
16	Cart kit, including Fisher & Paykel™* humidifier mount	G-061581-00
	Cart kit, including Hudson RCI™* ConchaTherm™* Humidifier mount*	G-061582-00
	EasyCart Mobility System (quick-connects to standard wheelchair, order humidifier mounting kit separately)*	G-061727-00
	Mounting kit, EasyCart, Fisher & Paykel™* humidifier*	G-061227-00
	Mounting kit, EasyCart, Hudson RCI™* humidifier*	G-061228-00
	EasyCart Mobility linkage arm kit (to dock the EasyCart to a nonstandard wheelchair)*	G-061845-00
17	Mounting kit, collector vial, cart-mount	G-062502-00
18	Mounting kit, humidifier, Fisher & Paykel™*, cart	G-061227-00
	Mounting kit, humidifier, Hudson RCI™* ConchaTherm™*, cart*	G-061228-00
19	Test lung	4-000612-00
20	Humidifier kit, Fisher & Paykel™* MR730	G-061232-00
21	Operator's manual, 700 Series, English*	10066984
	Operator's manual, 700 Series, Japanese*	10069633
	Operator's manual, 700 Series, Polish*	10069631
	Operator's manual, 700 Series, Russian*	10069632
	Operator's manual, 700 Series, Spanish*	10069625
22	Service manual, English*	10070389

* Not shown

Table B-1: Ventilator accessories (continued)

Item no.	Description	Part no.
23	Oxygen sensor (To be replaced as necessary by a qualified service technician.)*	10097559
24	Internal battery (To be replaced as necessary by a qualified service technician.)*	G-061139-00
25	15,000-hour preventive maintenance kit (Preventive maintenance kits must be installed by a qualified service technician.)*	G-061166-00
26	30,000-hour preventive maintenance kit (Preventive maintenance kits must be installed by a qualified service technician.)*	G-061167-00
27	Keyboard cleaning spray*	G-061576-00
28	700 Series Ventilator Communications option kit (Communications option must be installed by a qualified service technician.)*	G-061831-00

* Not shown

Table B-1: Ventilator accessories (continued)

Item no.	Description	Part no.
29	Operator's manual, <i>EasyNeb Nebulizer</i> , Czech*	G-061781-00
	Operator's manual, <i>EasyNeb Nebulizer</i> , English*	G-061769-00
	Operator's manual, <i>EasyNeb Nebulizer</i> , French*	G-061782-00
	Operator's manual, <i>EasyNeb Nebulizer</i> , German*	G-061783-00
	Operator's manual, <i>EasyNeb Nebulizer</i> , Italian*	G-061784-00
	Operator's manual, <i>EasyNeb Nebulizer</i> , Japanese*	G-061785-00
	Operator's manual, <i>EasyNeb Nebulizer</i> , Polish*	G-061786-00
	Operator's manual, <i>EasyNeb Nebulizer</i> , Portuguese*	G-061787-00
	Operator's manual, <i>EasyNeb Nebulizer</i> , Russian*	G-061788-00
	Operator's manual, <i>EasyNeb Nebulizer</i> , Spanish*	G-061789-00
30	Basket, ventilator cart*	G-061205-00
31	Ventilator attachment kit (attaches ventilator to cart)*	G-061849-00
32	Bumpers, cart (quantity 4 cart, 2 handle)*	G-062019-00

* Not shown

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Specifications

This appendix provides specifications for the 700 Series Ventilator System, including:

- Physical
- Environmental
- Power
- Compliance and approvals
- Technical

C.1 Physical

Table C-1: Physical specifications

Weight	Ventilator only: 30 kg (66 lb) Cart only: 18 kg (40 lb) External battery: 12.75 kg (28 lb)
Dimensions	Ventilator only: 378 mm H x 515 mm W x 370 mm D (14.9 in. H x 20.3 in. W x 14.6 in. D) Ventilator and cart: 1255 mm H x 515 mm W x 370 mm D (49.4 in. H x 20.3 in. W x 14.6 in. D)
Connectors	Inspiratory limb connector: ISO 22-mm conical male Expiratory limb connector: ISO 22-mm conical female Gas exhaust port: ISO 30-mm conical Oxygen inlet: DISS, DISS female, NIST, Air Liquide™*, or Australian type (depending on country and configuration)
Ventilator heat generation	400 to 500 British thermal units (BTUs) per hour
Oxygen sensor life	The oxygen sensor's life is one year, nominal after the ventilator's first use. When replacing the sensor, follow the information contained on the replacement oxygen sensor's package for expiration or install-by dates and information provided in the oxygen sensor's instructions for use. Document the replacement of the oxygen sensor and the date replacement is required according to the institution's protocol. Actual sensor life depends on operating environment; operation at higher temperature or O ₂ % levels will result in shorter sensor life.

Table C-1: Physical specifications (continued)

Gas mixing system	<p>Range of flow delivery to the patient: Up to 300 L/min for pressure support ventilation (PSV) spontaneous breaths or pressure control ventilation (PCV) mandatory breaths; 3 to 150 L/min for mandatory or assisted volume control ventilation (VCV) breaths.</p> <p>Leakage from one gas system to another: Not applicable (no high-pressure air source).</p> <p>Design pressure: 50 psi (345 kPa) Operating pressure range: 40 to 90 psi (275 to 620 kPa) Oxygen regulator bleed: Up to 3 L/min</p>
Bacteria filter efficiency	Inspiratory and expiratory filters (disposable and reusable): 99.97% retention of 0.3 μm particles at 100 L/min.
Alarm volume	<p>Minimum (level 1): 74 dBA at 1 m</p> <p>Maximum (level 5): 88 dBA at 1 m</p>

C.2 Environmental

Table C-2: Environmental specifications

Temperature	Operating:	5 to 45 °C (41 to 113 °F) at 10 to 95% relative humidity
	Storage:	-40 to 60 °C (-40 to 140 °F) at 10 to 95% relative humidity
Atmospheric pressure	Operating:	8.7 to 16.0 psi (600 to 1100 hPa)
	Storage:	7.3 to 16.0 psi (500 to 1100 hPa)

Table C-2: Environmental specifications

Altitude	Operating: Up to 4570 m (15,000 ft) Storage: Up to 15,240 m (50,000 ft)
Oxygen inlet supply	Pressure: 40 to 90 psi (275 to 620 kPa)
	<div style="border: 1px solid black; padding: 5px;"> <p>Warning</p> <p>Due to excessive restriction of certain hose assemblies (listed in Table B-1), reduced FiO₂ levels may result when oxygen inlet pressures < 50 psi (345 kPa) are employed. Make sure oxygen inlet pressure is ≥ 50 psi (345 kPa) when using these hose assemblies, to maintain correct FiO₂ levels.</p> </div> <hr style="border: 0.5px solid black;"/> Flow: At least 160 L/min at standard temperature and pressure, dry (STPD) required

C.3 Power

Table C-3: Power specifications

Power supply	<p>Input range: 100 to 120 V ac nominal, 220 to 240 V ac nominal, 50/60 Hz, 2.9 A (100 to 120 V units) or 1.3 A (220 to 240 V units), 290 VA</p> <p>Main fuse: 10 A, 250 V, medium time lag, high (H) breaking capacity, 6 x 32 mm (meets IEC and CSA standards). (A circuit breaker opens when current draw exceeds 4 A.)</p>
Earth leakage current	<p>At 100 to 120 V ac operation: less than 300 μA</p> <p>At 220 to 240 V ac operation: less than 500 μA</p> <p>(Includes ventilator, power cord, and internal and external batteries)</p>
Enclosure leakage current	<p>Less than 50 μA in normal condition (all units)</p> <p>Less than 300 μA in single fault condition at 100-120 V AC operation</p> <p>Less than 500 μA in single fault condition at 220-240 V AC operation</p>
Internal battery	<p>24 V dc, 7 Ah</p> <p>Operating time (for a new, fully-charged battery at 20 °C and sea level):</p> <ul style="list-style-type: none"> • Approximately 2.5 hours under nominal conditions (nominal conditions: tidal volume 0.6 L, respiratory rate 15/min, PEEP/CPAP 5 cmH₂O, peak flow 60 L/min, plateau 0 s; average peak pressure 30 cmH₂O, average mean pressure 8 cmH₂O) • Approximately 2 hours under extreme conditions (extreme conditions: tidal volume 1.2 L, respiratory rate 15/min, PEEP/CPAP 15 cmH₂O, peak flow 60 L/min, plateau 0 s; average peak pressure 64 cmH₂O, average mean pressure 24 cmH₂O) <p>Recharge time: 2.5 to 3 hours in ventilator</p> <p>Charges automatically while ventilator is connected to ac power and power switch is on (including standby mode)</p> <p>Charge level indicated on keyboard</p>

Table C-3: Power specifications (continued)

<p>External battery</p>	<p>24 V dc, 17 Ah</p> <p>Operating time (for a new, fully-charged battery at 20 °C and sea level):</p> <ul style="list-style-type: none"> • Approximately 7 hours under nominal conditions (See internal battery for definition of nominal conditions.) • Approximately 5.5 hours under extreme conditions (See internal battery for definition of extreme conditions.) <p>Recharge time: 7.5 to 8 hours in ventilator, 3 to 4 hours using optional battery charger</p> <p>Charges automatically while ventilator is connected to ac power and the power switch is ON (including standby mode)</p> <p>Battery charge levels available under menu function</p>
<p>Battery shelf life when charge is not maintained</p>	<p>Ideally internal and external batteries should be stored in a cool, dry place. If the batteries are stored <i>without</i> maintaining charge, typical shelf life is as follows:</p> <p>At 0 to 20 °C (32 to 68 °F): 12 months</p> <p>At 21 to 30 °C (69 to 86 °F): 9 months</p> <p>At 31 to 40 °C (87 to 104 °F): 5 months</p> <p>At 41 to 50 °C (105 to 122 °F): 2.5 months</p> <hr/> <p>NOTE:</p> <p>Battery life specifications are approximate. To ensure maximum battery life, maintain full charge and minimize the number of complete discharges.</p> <hr/>

C.4 Compliance and approvals

Table C-4: Compliance and approvals

 0123	<p>The 700 Series Ventilator System complies with the requirements of Directive 93/42/EEC concerning medical devices. It therefore bears the CE marking.</p>
<p>IEC 601-1 classification</p>	<p>Protection class I, Type B, internally powered, drip-proof equipment, continuous operation.</p>
<p>The 700 Series Ventilator System complies with these International and European standards:</p>	<p>IEC 601-1/EN 60601-1 IEC 601-1-2/EN 60601-1-2 EN 794-1 In addition, the 700 Series Ventilator System has been approved to the type test requirements of Annex III of the Medical Device Directive, by the notified body, TUV Rheinland.</p>
<p>The 700 Series Ventilator System has been certified by these test agencies:</p>	<p>TUV Rheinland: EC Type Test Certificate to the requirements of Annex III of the Medical Device Directive CSA: CSA C22.2 No. 601-1, CSA C22.2 No. 601-2-12, NRTL certification</p>

C.5 Technical

Table C-5: Technical specifications

Maximum limited pressure	92 cmH ₂ O (92 hPa). A dedicated backup circuit opens the safety valve if system pressure exceeds 115 cmH ₂ O (113 hPa).								
Maximum ventilating pressure	89 cmH ₂ O (89 hPa) for VCV breaths or 80 cmH ₂ O (80 hPa) for PSV breaths, ensured by HIGH PRESSURE limit.								
Measuring and display devices	<table> <tr> <td>Purpose:</td> <td>Mean airway pressure</td> </tr> <tr> <td>Sensing position:</td> <td>Exhalation limb</td> </tr> <tr> <td>Range:</td> <td>0 to 99 cmH₂O (0 to 99 hPa)</td> </tr> <tr> <td>Type:</td> <td>Silicon solid state</td> </tr> </table>	Purpose:	Mean airway pressure	Sensing position:	Exhalation limb	Range:	0 to 99 cmH ₂ O (0 to 99 hPa)	Type:	Silicon solid state
	Purpose:	Mean airway pressure							
	Sensing position:	Exhalation limb							
	Range:	0 to 99 cmH ₂ O (0 to 99 hPa)							
	Type:	Silicon solid state							
	<table> <tr> <td>Purpose:</td> <td>Peak pressure</td> </tr> <tr> <td>Sensing position:</td> <td>Exhalation limb</td> </tr> <tr> <td>Range:</td> <td>0 to 140 cmH₂O (0 to 140 hPa)</td> </tr> <tr> <td>Type:</td> <td>Silicon solid state</td> </tr> </table>	Purpose:	Peak pressure	Sensing position:	Exhalation limb	Range:	0 to 140 cmH ₂ O (0 to 140 hPa)	Type:	Silicon solid state
	Purpose:	Peak pressure							
Sensing position:	Exhalation limb								
Range:	0 to 140 cmH ₂ O (0 to 140 hPa)								
Type:	Silicon solid state								
<table> <tr> <td>Purpose:</td> <td>Plateau pressure (760 Ventilator only)</td> </tr> <tr> <td>Sensing position:</td> <td>Exhalation limb</td> </tr> <tr> <td>Range:</td> <td>0 to 140 cmH₂O (0 to 99 hPa)</td> </tr> <tr> <td>Type:</td> <td>Silicon solid state</td> </tr> </table>	Purpose:	Plateau pressure (760 Ventilator only)	Sensing position:	Exhalation limb	Range:	0 to 140 cmH ₂ O (0 to 99 hPa)	Type:	Silicon solid state	
Purpose:	Plateau pressure (760 Ventilator only)								
Sensing position:	Exhalation limb								
Range:	0 to 140 cmH ₂ O (0 to 99 hPa)								
Type:	Silicon solid state								
<table> <tr> <td>Purpose:</td> <td>PEEP/CPAP pressure</td> </tr> <tr> <td>Sensing position:</td> <td>Exhalation limb</td> </tr> <tr> <td>Range:</td> <td>0 to 140 cmH₂O (0 to 140 hPa)</td> </tr> <tr> <td>Type:</td> <td>Silicon solid state</td> </tr> </table>	Purpose:	PEEP/CPAP pressure	Sensing position:	Exhalation limb	Range:	0 to 140 cmH ₂ O (0 to 140 hPa)	Type:	Silicon solid state	
Purpose:	PEEP/CPAP pressure								
Sensing position:	Exhalation limb								
Range:	0 to 140 cmH ₂ O (0 to 140 hPa)								
Type:	Silicon solid state								
<table> <tr> <td>Purpose:</td> <td>Rate</td> </tr> <tr> <td>Sensing position:</td> <td>Microprocessor</td> </tr> <tr> <td>Range:</td> <td>3 to 500/min</td> </tr> <tr> <td>Type:</td> <td>Calculated from inspiratory and expiratory time measurements</td> </tr> </table>	Purpose:	Rate	Sensing position:	Microprocessor	Range:	3 to 500/min	Type:	Calculated from inspiratory and expiratory time measurements	
Purpose:	Rate								
Sensing position:	Microprocessor								
Range:	3 to 500/min								
Type:	Calculated from inspiratory and expiratory time measurements								
<table> <tr> <td>Purpose:</td> <td>I:E ratio</td> </tr> <tr> <td>Sensing position:</td> <td>Microprocessor</td> </tr> <tr> <td>Range:</td> <td>1:99.9 to 1:9.9</td> </tr> <tr> <td>Type:</td> <td>Calculated from inspiratory and expiratory time measurements</td> </tr> </table>	Purpose:	I:E ratio	Sensing position:	Microprocessor	Range:	1:99.9 to 1:9.9	Type:	Calculated from inspiratory and expiratory time measurements	
Purpose:	I:E ratio								
Sensing position:	Microprocessor								
Range:	1:99.9 to 1:9.9								
Type:	Calculated from inspiratory and expiratory time measurements								

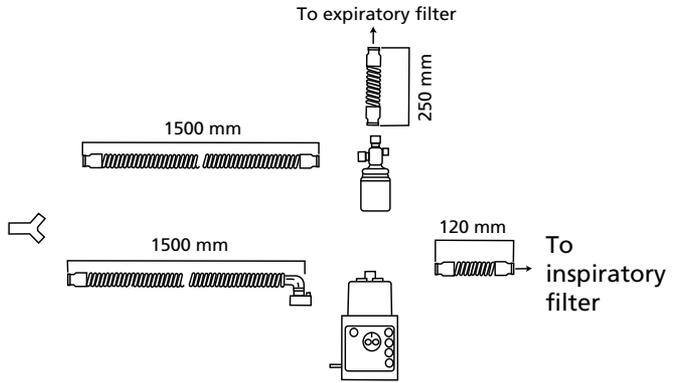
Table C-5: Technical specifications (continued)

Measuring and display devices (continued)	Purpose:	Inspiratory time (760 Ventilator only)
	Sensing position:	Microprocessor
	Range:	0.00 to 9.90 s
	Type:	Inspiratory time measurement
	Purpose:	Exhaled tidal volume
	Sensing position:	Exhalation limb
	Range:	0 to 9 L
Type:	Differential pressure pneumotach	
Purpose:	Total minute volume	
Sensing position:	Exhalation limb	
Range:	0 to 99 L	
Type:	Differential pressure pneumotach	
Purpose:	Delivered volume (760 Ventilator only)	
Sensing position:	Exhalation limb	
Range:	0 to 3000 ml	
Type:	Differential pressure pneumotach	
Purpose:	Spontaneous minute volume	
Sensing position:	Exhalation limb	
Range:	0 to 99 L	
Type:	Calculated from expiratory flow measurements	
Purpose:	FiO ₂ sensor	
Sensing position:	Inspiratory manifold	
Range:	18 to 109%	
Type:	Galvanic cell	

Table C-5: Technical specifications (continued)

<p>Results of ventilator breathing system testing (using circuits identified for use with 700 Series Ventilators)</p>	<p>NOTE: To achieve compliance with the more rigid requirements for oxygen monitoring (as set forth in ISO 7767), Covidien recommends using an external monitor that meets that standard.</p>
	<p>Internal volume: Not applicable; 700 Series Ventilators automatically adjust for volume losses due to gas compressibility (that is, automatic compliance compensation), subject to a maximum delivered volume of 2.5 L.</p>
	<p>NOTE: To ensure that compliance compensation functions correctly, the user must run SST with the circuit configured as intended for use on the patient.</p>
	<p>NOTE: Ventilator breathing circuit testing specifications are based on the recommended configurations shown in Figure C-1 (heated wire humidifier <i>without</i> water traps and non-heated wire humidifier <i>with</i> water traps).</p>

Heated wire humidifier, no water traps



No heated wire humidifier, with water traps

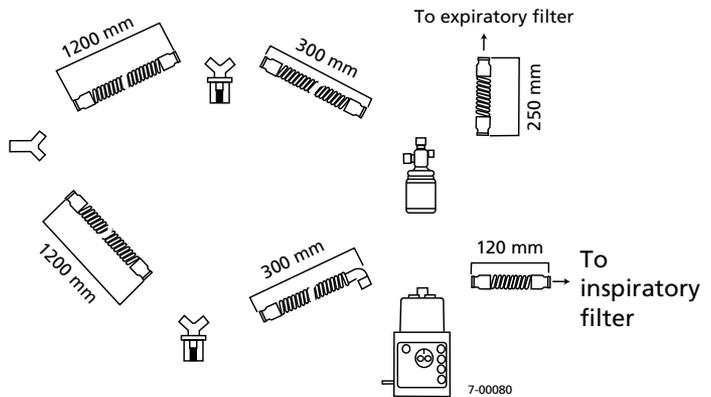


Figure C-1. Recommended ventilator breathing circuit configurations

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Breath delivery

All ventilatory modes are classified as *mandatory* or *spontaneous*, or synchronous intermittent mandatory ventilation (SIMV), which is a mix of mandatory and spontaneous breaths.

Mandatory modes deliver breaths whose parameters are determined by the ventilator's settings. For volume control ventilation (VCV) breath types, settings include respiratory rate, peak inspiratory flow, tidal volume, and plateau. For pressure control ventilation (PCV) breath types, settings include respiratory rate, inspiratory pressure, I:E ratio or inspiratory time, and rise time factor (PCV is available on the 760 Ventilator only). Breaths in a mandatory mode can be initiated by the ventilator, operator, or patient. The 740 and 760 Ventilator Systems deliver mandatory mode breaths with a square (constant flow) waveform.

- Ventilator-initiated mandatory (VIM) breaths are delivered at a rate determined by the RESPIRATORY RATE setting. The MAND indicator lights when a VIM breath is delivered.
- Patient-initiated mandatory (PIM) breaths are delivered when the patient triggers a mandatory breath. The ASSIST indicator lights when a PIM breath is delivered.

- Operator-initiated mandatory (OIM) breaths are delivered when the operator presses MANUAL INSP. The ventilator does not deliver a manual inspiration until at least 200 ms of the exhalation phase have elapsed, and expiratory flow has fallen to less than 30% of peak expiratory flow. The ventilator does not deliver manual inspirations during apnea ventilation. The MAND indicator lights when a OIM breath is delivered.

Spontaneous modes deliver breaths whose parameters (including peak inspiratory flow and tidal volume) are partially determined by the patient. The breaths in a spontaneous mode are initiated by the patient. When the patient triggers a spontaneous breath, the inspiratory flow and the tidal volume are determined by the combination of patient effort and the support pressure setting (on the 740 Ventilator), or the support pressure, rise time factor, and exhalation sensitivity (on the 760 Ventilator). The SPONT indicator lights when a spontaneous breath is delivered.

The 700 Series Ventilator System offers three modes of ventilation:

- Assist/control (A/C), which consists entirely of mandatory breaths.
- Spontaneous (SPONT), which consists entirely of spontaneous breaths.
- SIMV, which can include both mandatory and spontaneous breaths.

During ventilation the message window shows flow information (Figure D-1 illustrates this information using a waveform) that can be helpful in selecting ventilator settings:

- Peak inspiratory flow and end inspiratory flow are displayed as:

I:Peak xx End xx

where *I*: refers to inspiratory flows, *Peak* is peak inspiratory flow and *End* is end inspiratory flow.

- End exhalation flow is displayed as:

E:End xx

where *E*: refers to expiratory flow and *End* is end expiratory flow.

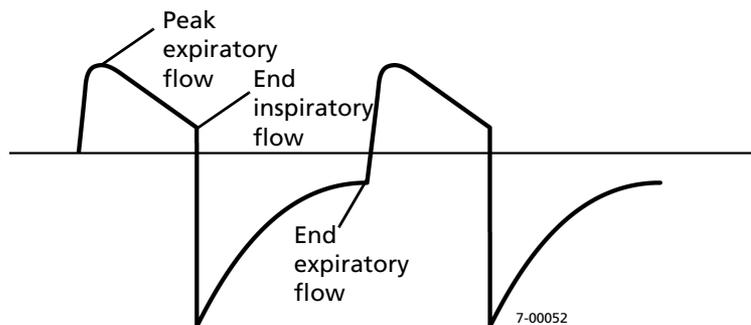


Figure D-1. Flow waveform

Apnea ventilation is declared in any mode if no breath (spontaneous, VIM, or OIM) is detected within the selected apnea interval. Apnea ventilation continues until the operator presses the alarm reset key or the patient triggers two consecutive breaths.

D.1 A/C mode

During A/C mode, the ventilator delivers mandatory breaths only, using *volume control ventilation* (VCV, available on the 740 and 760 Ventilators) or *pressure control ventilation* (PCV, available on the 760 Ventilator only).

When a VCV breath is triggered, the ventilator delivers a breath based on the set TIDAL VOLUME and PEAK FLOW settings. You can extend the inspiratory phase of a VCV breath by setting a PLATEAU time (though this reduces the expiratory time). When a PCV breath is triggered, the ventilator delivers a breath based on the set INSPIRATORY PRESSURE, I:E RATIO or inspiratory time, and RISE TIME FACTOR.

During A/C, the RESPIRATORY RATE setting determines when a VIM breath is delivered. If PIM or OIM breaths increase the respiratory rate, the set breath is delivered more often and the minute volume increases.

The ventilator normally terminates the inspiratory phase of a breath when:

- the set TIDAL VOLUME has been delivered (VCV breaths), or
- a plateau period has elapsed (VCV breaths), or

- the set I:E RATIO is reached or inspiratory time has elapsed (PCV breaths).

The ventilator delivers a VIM breath at the preset respiratory rate. The ventilator delivers a PIM breath if it detects a patient effort, as defined by the TRIGGER SENSITIVITY setting. The ventilator delivers an OIM breath if the operator presses MANUAL INSP.

D.2 SPONT mode

During SPONT mode, the ventilator delivers spontaneous breaths. *Pressure support ventilation (PSV)* is available in SPONT. In PSV the ventilator augments the patient's inspiratory effort to sustain the set level of SUPPORT PRESSURE. On the 760 Ventilator only, the RISE TIME FACTOR setting determines how quickly the target pressure is achieved, and the EXH SENSITIVITY setting determines the point at which the breath cycles to exhalation. When the inspiratory phase of a PSV breath terminates, the exhalation valve opens and pressure falls to the set level of PEEP/CPAP. The patient triggers all spontaneous breaths, and influences their inspiratory flow, inspiratory time, and tidal volume.

The ventilator normally terminates the inspiratory phase of a PSV breath when:

- inspiratory flow drops to 10 L/min or 25% of peak flow, whichever is less (740 Ventilator), or when the inspiratory flow is less than the set value of EXH SENSITIVITY (760 Ventilator), or
- patient wye pressure exceeds the set inspiratory pressure ($P_i + \text{PEEP}$) by more than 3 cmH₂O (3 hPa), or
- inspiratory time exceeds 3.5 seconds (2.5 seconds for pediatric ventilator breathing circuits).

The ventilator delivers an OIM breath during SPONT when an operator presses MANUAL INSP. OIM breaths delivered during SPONT are based on the apnea settings.

D.3 SIMV mode

During SIMV, the ventilator can deliver a combination of mandatory and spontaneous breaths. The ventilator, operator, or patient can trigger mandatory breaths. The patient can also trigger spontaneous breaths. Spontaneous breaths can be augmented by PSV.

D.3.1 Breath timing

In SIMV, a breath period (T_b) is divided into two intervals: a mandatory interval (T_m) and a spontaneous interval (T_s) (Figure D-2).

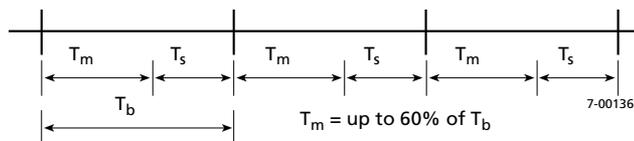


Figure D-2. SIMV breath period intervals

During T_b , the ventilator typically delivers one mandatory breath, and the patient may trigger a number of spontaneous breaths. When T_b begins, the ventilator enters T_m . If the patient triggers a breath during T_m , a PIM breath is delivered, the T_m terminates (regardless of whether the full T_m has elapsed), and the ventilator enters and remains in T_s until T_b has elapsed (Figure D-3).

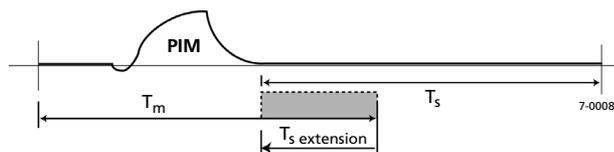


Figure D-3. Synchronizing breath intervals with patient effort

If the patient triggers a breath during T_s , the ventilator delivers a spontaneous breath based on the SUPPORT PRESSURE setting (Figure D-4). On the 760 Ventilator, a spontaneous breath is also based on the RISE TIME FACTOR and EXH SENSITIVITY settings.

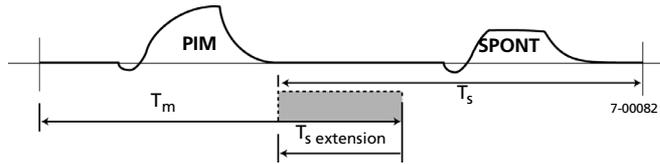


Figure D-4. Spontaneous breaths during SIMV

The ventilator remains in T_s until T_b has elapsed, then reenters T_m . If the patient does not trigger a breath during T_m , the ventilator delivers a VIM breath when T_m has elapsed (Figure D-5).

NOTE:

To prevent “breath stacking” in SIMV mode, the ventilator will not deliver the next VIM breath to maintain the breath rate until the flow drops to 50% of the peak inspiratory flow and at least 200 ms of the expiratory phase have elapsed.

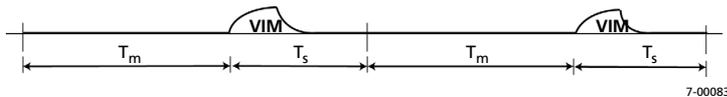


Figure D-5. Mandatory breaths during SIMV

The ventilator can deliver an OIM (manual inspiration) during T_m or T_s (Figure D-6). If the ventilator delivers an OIM during T_s , the SIMV breath timing is unaffected. If the ventilator delivers an OIM during T_m , T_m terminates and the ventilator enters T_s .

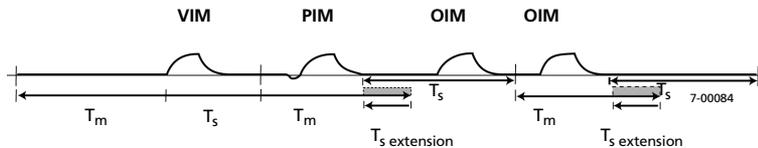


Figure D-6. Manual inspiration during SIMV

Alarm testing

This appendix tells you how to check the operation of these alarms before attaching the ventilator to a patient:

- LOW INSP PRESSURE
- LO EX TIDAL VOLUME
- DISCONNECT
- HIGH PRESSURE
- CONTINUOUS HI PRES
- LOSS AC POWER
- APNEA
- % O₂ LOW

Section 3.3 tells you how to view and change alarm limits, and Chapter 7 tells you what to do if an alarm occurs.

1. Set up the ventilator for operation (connect oxygen source, attach adult or pediatric breathing circuit). Attach a test lung (P/N 4-000612-00) to the wye.
2. Select the following settings:

Mode	A/C
RESPIRATORY RATE	5/min
TIDAL VOLUME	500 ml
PEAK FLOW	60 L/min
PLATEAU	0 s
HIGH RATE	100/min
LOW INSP PRESSURE	3 cmH ₂ O (3 hPa)

HIGH PRESSURE	50 cmH ₂ O (50 hPa)
HIGH TIDAL VOLUME	1500 ml
LOW TIDAL VOLUME	5 ml
LOW MINUTE VOLUME	0 L
PEEP/CPAP	5 cmH ₂ O (5 hPa)
TRIGGER SENSITIVITY	3 L/min

- 3. LOW INSP PRESSURE, LO EX TIDAL VOLUME, and DISCONNECT alarm tests:** Allow the ventilator to deliver at least 10 breaths. During the inspiratory phase of a breath, disconnect the test lung.
- 4.** The ventilator annunciates the LOW INSP PRESSURE alarm during the first breath after you disconnect the test lung, and the DISCONNECT and LO EX TIDAL VOLUME alarms after the fourth breath. Verify the correct audible and visual characteristics of the alarm.
- 5. HIGH PRESSURE alarm test:** Change the HIGH PRESSURE alarm setting to 11 cmH₂O (11 hPa).
- 6.** Press the alarm reset key to reset the DISCONNECT alarm. Block the wye.
- 7.** The ventilator terminates inspiration without alarming on the first breath. The ventilator annunciates a HIGH PRESSURE alarm during the second breath.
- 8. CONTINUOUS HI PRES alarm test:** Reset the HIGH PRESSURE alarm setting to 20 cmH₂O. Block the EXHAUST port. Press the alarm reset key to reset all alarms.
- 9.** Press MANUAL INSP. After one breath, the ventilator annunciates a CONTINUOUS HI PRES alarm. (If not, check the ventilator breathing circuit to ensure that it is not leaking.)
- 10.** Unblock the EXHAUST port. Unblock the wye and reconnect the test lung. Change the HIGH PRESSURE alarm setting to 50 cmH₂O. Press the alarm reset key to reset all alarms.
- 11. LOSS AC POWER alarm test:** Allow the ventilator to deliver at least 3 breaths, then disconnect the power cord from ac power.

NOTE:

Run this test only with a fully charged battery. (Determine charge of internal battery by checking INTERNAL BATTERY LEVEL display.)

12. If battery backup is available, the ventilator annunciates a LOSS AC POWER alarm. (If less than 5 minutes of battery backup are available, the ventilator annunciates a LOSS OF POWER alarm.)
13. Reconnect the power cord to ac power. The LOSS OF POWER or LOSS AC POWER alarm should autoreset.
14. **APNEA alarm test:** Press the MENU key, turn the knob to display *User Settings*, then press ACCEPT. Turn the knob to display *Apnea interval (Ta)*, then press ACCEPT. Turn the knob to select an apnea interval of 20 seconds.
15. Select the following settings:

Mode	SPONT
APNEA PARAMS:	
RESPIRATORY RATE	5/min
TIDAL VOLUME	400 L
PEAK FLOW	10 L/min
SUPPORT PRESSURE	0 cmH ₂ O (0 hPa)

The ventilator annunciates an APNEA alarm 20 seconds after the last breath triggered.

NOTE:

To avoid triggering a breath during the selected apnea interval, do not touch the test lung.

16. Squeeze the test lung twice to simulate two subsequent patient-initiated breaths. The APNEA alarm should autoreset.

17. **% O₂ LOW alarm test:** Select the following settings:

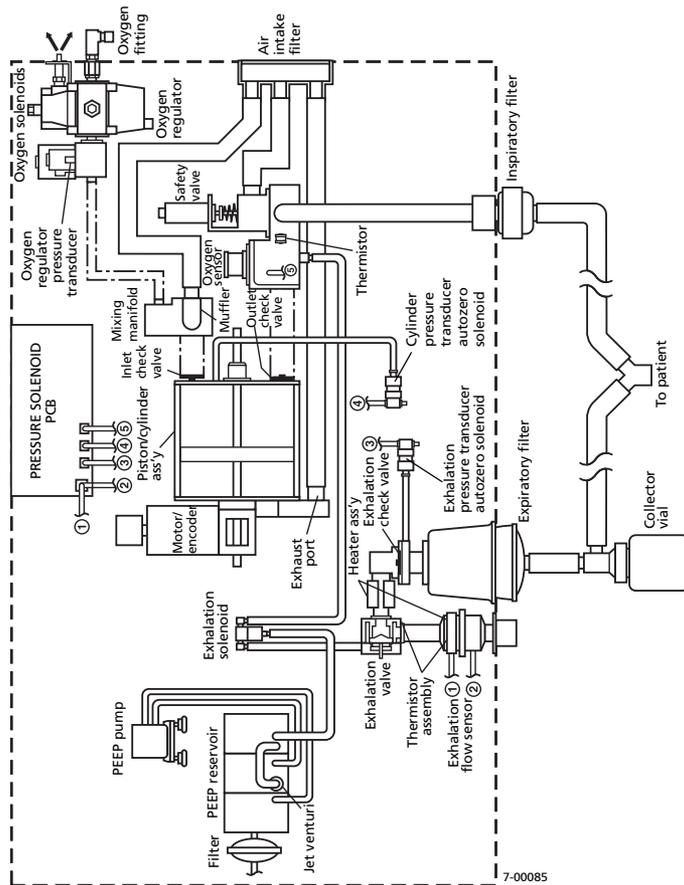
Mode	A/C
RESPIRATORY RATE	20/min
TIDAL VOLUME	1000 ml
PEAK FLOW	60 L/min
PLATEAU	0 s
HIGH PRESSURE	90 cmH ₂ O (90 hPa)
% O ₂	100 %

Allow 36 seconds for % O₂ setting to stabilize (the % O₂ setting is stable when the ventilator has delivered 12 L of volume).

18. Disconnect the oxygen inlet supply.
19. The ventilator annunciates a LOW O₂ SUPPLY alarm within 2 breaths, and a % O₂ LOW alarm within approximately 30 seconds.
20. Reconnect the oxygen inlet supply. The LOW O₂ SUPPLY and % O₂ LOW alarms should autoreset within approximately 30 seconds.

The alarm test is complete.

Pneumatic schematic



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Glossary

/min	Breaths per minute (unit of respiratory rate).
% O ₂	The percentage of oxygen in the gas delivered to the patient.
A	Amperes (unit of current).
A/C	Assist/control mode. Allows the patient, ventilator, or operator to initiate mandatory breaths.
ac	Alternating current.
alarm reset	Clears all alarm indicators and cancels the alarm silence period.
alarm silence	Silences alarm sound for two minutes from the most recent key press, but does not change visual indicators.
apnea	Cessation of breathing. 700 Series Ventilators declare apnea and begins apnea ventilation when the patient does not trigger a breath within the user-selected apnea interval.
APNEA PARAMS	Apnea parameters, the settings for apnea ventilation. The ventilator enters apnea ventilation if it does not deliver a breath to the patient within the user-selected apnea interval.
autoreset	When an alarm becomes inactive because the triggering condition has self-corrected.
BTPS	Body temperature and pressure, saturated: 37 °C, at ambient barometric pressure, at 100% relative humidity.

CE	Mark that indicates compliance with the Medical Device Directive, 93/42/EEC.
clinical alarm	An alarm triggered by a ventilator setting or patient condition, can occur in the usual course of patient care.
cm	Centimeter (unit of length).
cmH ₂ O	Centimeters of water (unit of pressure), approximately equal to 1 hPa.
CSA	Canadian Standards Association.
dc	Direct current.
DISS	Diameter index safety standard, a standard for high-pressure gas inlet fittings.
EMC	Electromagnetic compatibility.
EN	European norm.
end inspiratory flow	The flow at the patient wye at the end of the inspiratory phase. On the 760 Ventilator only, the end inspiratory flow is displayed in the message window at the end of each PCV or PSV breath, and can be used to assess the EXH SENSITIVITY setting.
END INSP PRESSURE	End inspiratory pressure, patient data displayed on the 760 Ventilator only. The pressure measured at the end of inspiration, excluding any plateau.
EST	Extended self-test, a comprehensive test of ventilator function, intended to be run by a qualified service technician.
ETO	Ethylene oxide.
EXP PAUSE	Expiratory pause, available on the 760 Ventilator only. Closes the exhalation valve at the end of the expiratory phase while the EXP PAUSE key is pressed, used to calculate patient's auto-PEEP.
EXH SENSITIVITY	Exhalation sensitivity, a ventilator setting that determines the flow (in L/min) at which the ventilator cycles from inspiration to exhalation for PSV breaths, available on the 760 Ventilator only.
FiO ₂	Fractional inspired oxygen, often expressed as % O ₂ .

ft	Feet (unit of length).
heated wire	A type of ventilator breathing circuit that includes a heated wire on the expiratory limb, or on both the inspiratory and expiratory limbs.
high-priority alarm	An alarm that requires immediate attention to ensure patient safety. When a high-priority alarm is active, the red ALARM indicator flashes and the high-priority audible alarm (a repeating sequence of three, then two beeps) sounds.
HME	Heat-moisture exchanger (“artificial nose”).
hPa	Hectopascal (unit of pressure), approximately equal to 1 cmH ₂ O.
Hz	Hertz (unit of frequency), indicating cycles per second.
I:E ratio	The ratio of inspiratory time to expiratory time. On the 760 Ventilator only, a ventilator setting that determines breath timing in PCV.
IEC	International Electrotechnical Commission.
INSP PAUSE	Inspiratory pause, available on the 760 Ventilator only. Closes the exhalation valve at the end of the inspiratory phase of a mandatory breath until a stable plateau is reached (for a momentary pause), or for as long as you hold down the key (for an extended pause). Used to calculate patient’s compliance (for VCV or PCV mandatory breaths) and resistance (for VCV mandatory breaths).
INSP PRESSURE	Inspiratory pressure, available on the 760 Ventilator only. Defines the pressure above PEEP during the inspiratory phase of a PCV breath.
INSP TIME	Inspiratory time, available on the 760 Ventilator only. As a ventilator setting (selected using the MENU key), determines the breath timing of a PCV breath. As a patient data display, shows the measured inspiratory time.
ISO	International Standards Organization.
kg	Kilogram (unit of weight).
L	Liter (unit of volume).

L/min	Liters per minute (unit of flow).
lb	Pound (unit of weight).
LOW INSP PRESSURE	An alarm that indicates that monitored circuit pressure is below the alarm setting at the end of inspiration.
m	Meter (unit of length).
maintenance	All actions necessary to keep equipment in, or restore it to, serviceable condition. Includes servicing, repair, modification, overhaul, inspection, and performance verification.
mandatory	A breath whose settings and timing are preset; can be triggered by the ventilator, patient, or operator. A mandatory breath is characterized by three of these four variables: tidal volume, flow waveform, inspiratory time, and plateau (inspiratory pause).
manual inspiration	An operator-initiated mandatory breath. Pressing the MANUAL INSP key on a 700 Series Ventilator delivers one mandatory breath to the patient.
mean pressure	A calculation of the measured average ventilator breathing circuit pressure over an entire respiratory cycle.
medium-priority alarm	An alarm that requires prompt attention. When a medium-priority alarm is active, the yellow CAUTION indicator flashes and the medium-priority audible alarm (a repeating sequence of three beeps) sounds.
min	Minute (unit of time).
minute volume	The volume delivered to a patient in 1 min ($V_T \times$ respiratory rate). The 740 Ventilator estimates total minute volume based on the previous 60 s or eight breaths, whichever interval is shorter.
ml	Milliliter (unit of volume).
MRI	Magnetic resonance imaging.
ms	Millisecond (unit of time).
NIST	Non-interchangeable screw thread, a standard for high-pressure gas fittings.

normal ventilation	The state of the ventilator when breathing is in progress and no alarms are active.
O ₂	Oxygen.
occlusion cycling mode	A ventilation mode in effect during a severe occlusion. In occlusion cycling mode, the ventilator opens the safety and exhalation valves to vent excess pressure, then attempts to deliver breaths using modified settings. If the ventilator again detects an occlusion or continuous high pressure condition, it reopens the safety and exhalation valves to vent excess pressure, then resumes occlusion cycling mode.
OIM	Operator-initiated mandatory breath, delivered when the operator presses MANUAL INSP.
PCV	Pressure control ventilation, in which the ventilator delivers a breath at a preset inspiratory pressure for a preset inspiratory time or I:E ratio. Available on the 760 Ventilator only, in A/C or SIMV mode.
peak flow	Maximum flow of gas delivered during a mandatory breath. (Combined with tidal volume and plateau, constant peak flow defines the inspiratory time.)
peak pressure	The patient wye pressure measured at the end of inspiration (excluding plateau, if any).
PEEP/CPAP	Positive end expiratory pressure/continuous positive airway pressure. The minimum level of pressure maintained in the patient circuit throughout ventilation. On the 760 Ventilator only, PEEP/CPAP can be displayed in patient data area.
PIM	Patient-initiated mandatory breath.
plateau	The amount of time the inspiration phase of a mandatory breath is extended after inspiratory flow has ceased (inspiratory hold).
POST	Power-on self-test, a self-test that the ventilator runs whenever it is powered on, or when normal ventilation resumes.

PSV	Pressure support ventilation, in which a positive pressure is delivered during the inspiratory phase of spontaneous breaths. Available in SPONT and SIMV modes.
preventive maintenance	Procedures that keep subassemblies in satisfactory operational condition by providing system inspection, detection, and prevention of failures. Procedures include fan and air intake filter replacement, lubrication, calibration, etc.
resistance	The pressure drop resulting from the restriction of flow through an airway. Measured in $\text{cmH}_2\text{O/L/s}$ or hPa/L/s .
respiratory rate	As a setting in A/C and SIMV, the minimum number of mandatory breaths the patient receives per minute. As a monitored value, the average total number of breaths delivered to the patient.
RISE TIME FACTOR	A ventilator setting that determines how quickly the ventilator achieves target inspiratory pressure, available on the 760 Ventilator only for PCV and PSV breath types.
s	Second (unit of time).
SIMV	Synchronous intermittent mandatory ventilation, a mode that allows the ventilator to deliver a combination of mandatory and spontaneous breaths.
SN	Serial number.
SPONT	Spontaneous ventilation, a mode during which the patient triggers all breaths delivered by the ventilator with no set mandatory respiratory rate (the 20-second apnea interval ensures a minimum rate of 3 breaths per minute). The patient controls the breath variables, and the breath can be augmented by support pressure.
SST	Short self-test, a test that checks circuit integrity, calculates circuit compliance and filter resistance, and checks ventilator function. SST is intended to be run by the operator, at intervals according to your institution's protocol.
standby mode	A waiting state used for maintaining ventilator settings and battery charging, in which there is no ventilation.

STPD	Standard temperature and pressure, dry. (In the United States STPD = 760 mmHg at 21.11 °C; in Europe STPD = 760 mmHg at 0 °C.)
support pressure	Pressure above PEEP maintained during spontaneous inspiration.
SVO	Safety valve open, a condition in which the ventilator is inoperative, and the safety valve opens to allow the patient to breathe room air unassisted by the ventilator.
T_b	SIMV breath period.
T_I	Inspiratory time.
T_m	SIMV mandatory breath period.
T_s	SIMV spontaneous breath period.
technical alarm	An alarm that is triggered by the ventilator's ongoing background tests, and typically does not occur in the normal course of patient care.
tidal volume	Volume delivered to the patient during a mandatory breath. The tidal volume delivered by a 700 Series Ventilator is compliance-compensated and corrected to body temperature and pressure, saturated (BTPS).
trigger sensitivity	Inspiratory flow required to trigger the ventilator to deliver a breath.
unheated wire	A type of ventilator breathing circuit that does not include a heated wire on the expiratory or inspiratory limb.
V	Volts (unit of voltage).
VA	Volt-amperes (unit of power).
VCV	Volume control ventilation, in which the ventilator delivers a preset tidal volume at a preset peak flow. Available in A/C and SIMV modes.
VENT INOP	A condition in which the ventilator is inoperative, and the safety valve opens to allow the patient to breathe room air unassisted by the ventilator. A qualified service technician must power up the ventilator and run extended self-test (EST) before normal ventilation can resume.

ventilator breathing circuit	The entire inspiratory-expiratory conduit, including tubing, humidifier, and water traps.
VIM	Ventilator-initiated mandatory breath.
V_{MAX}	Maximum flow rate demanded by the ventilator at the oxygen inlet connector.
V_T	Tidal volume.

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