

Hallowell EMC 2000 and 2002 Veterinary Ventilator Set-up, Use, and Troubleshooting

This is a quick reference for setting up, using, and troubleshooting the Hallowell EMC 2000 and 2002 Small Animal Ventilator. If you cannot get the ventilator set up and functioning properly, **DO NOT USE IT**, refer to the Hallowell Manual, or call the Tech Support line.

1. Set Up

Front View

1. Bellows
2. Bellows housing
3. Volume Scale
4. On/Off switch
5. Breaths-per-min setting
6. Fine (a, small silver) and coarse (b, large black) tidal volume control – Found on 2002 model, the 2000 model has coarse knob (b) only.
7. Inspiratory hold button
8. Maximum working pressure limit setting

Black: Bellows Assembly



Back View

9. Breathing System port
10. Breathing System Exhaust port
11. Driving gas port – Bellows side
12. Power supply
13. Driving gas Exhaust port
14. Driving gas port – Control side
15. Pressure transducer port
16. Oxygen Driving gas inlet



* The following items should remain set up at all times: The blue exhaust hose connected to the breathing system exhaust port (10), the clear breathing system hose connected to the breathing system port (9), clear small tubing connected to the pressure transducer port, and to the circle system pressure adaptor, the driving gas control (14) and bellows (11) ports connected by black rubber hose.

* Before each day of use, the following need to be set up or checked: Oxygen driving gas inlet (16) is connected to house oxygen and to the anesthesia machine, the proper sized bellows (1) is placed on the bellows assembly ring and covered with the bellows housing (2), the power supply (12) is connected to an outlet. Follow steps 1 – 8 below to completely set up and pressure check the ventilator, but attach a 1L bag to the y-piece of the circle system in place of a patient, and use only oxygen, not inhalant, for a pressure check (read system pressure off the circle system manometer as you do for the anesthesia machine pressure check). Set the breathing rate and volume to the minimum you expect the patient to need (see table pg. 5). Return the circle system to spontaneous breathing set up unless the ventilator will be used immediately, and be sure to pressure check the anesthesia machine itself with the ventilator disconnected.

Converting a patient from bag to ventilator (1 – 8 may be completed in set up):

1. Insert the circle system pressure adaptor between the inspiratory limb of the Y-piece and the anesthesia machine.
2. Attach the blue exhaust hose from the breathing system exhaust port (10) to the scavenge system port (on the anesthesia machine).
3. Remove the breathing bag and attach the clear breathing system hose from the bellows (9) to the anesthesia machine where the breathing bag was. Expel all anesthetic gas from the bag before removing it.
4. Turn the anesthesia machine oxygen flow meter up to 3 - 4 L/min.
5. Close the pop-off valve on the anesthesia machine. The bellows will begin to fill with anesthetic gas at this point. The patient can breathe spontaneously via the bellows. Do not fill the bellows by pressing the oxygen flush valve; turn up the oxygen flow meter instead so the breathing system is filled with anesthetic gas, not pure oxygen.
6. When the bellows is full, turn the ventilator switch On (4).
7. Adjust the breaths per minute rate control (5) up or down for your patient. You will need to change the volume control after changing the rate: a slower rate delivers a larger volume; a faster rate delivers a smaller volume (see pg. 5).
8. Slowly turn the volume control (6a,b) counterclockwise until the ventilator delivers an adequate breath for the patient and the low pressure alarm no longer sounds at each breath. Use the silver knob for coarse control (with caution), and the black knob for fine control. See page 5 for tidal volume ranges for small animal patients. Set the volume and rate controls so you are giving the proper tidal volume and inspiratory pressure (read directly off the circle system manometer) to your patient at the desired rate.

9. Watch the chest rise of the patient, the function of the ventilator, and check the patient and end tidal CO₂ monitor for changes as the volume and rate controls are set.
10. Turn down the oxygen flow meter on the anesthesia machine to the proper flow for your patient once the ventilator is functioning properly.
11. Re-check all settings and connections throughout the procedure.

Converting a patient from ventilator to bag:

1. It is preferable to wean patients off the ventilator and return them to spontaneous breathing before ending inhalant anesthesia. This is not essential. For very small patients (< 5 kg), you may need to replace the circle system with a non-rebreathing system for this conversion.
2. Three to five minutes before you convert, 'wean' the patient by turning down the breathing rate control to about half the selected operating rate. Lower the volume control to keep the same tidal volume and inspiratory pressure. Watch the patient carefully as rapid awakening may occur during this time.
3. If the patient has not tried to take a breath after 5 minutes at ½ the breathing rate, reduce the tidal volume to ½ your selected volume. This will lower the inspiratory pressure as well. Wait one to two minutes, and watch the patient carefully as rapid awakening may occur during this time. If the patient has not tried to breathe on it's own after 7 minutes of 'weaning', follow steps 3 - 7 below and ventilate by hand.
4. As soon as the patient attempts 2 – 4 breaths on it's own, turn the ventilator Off.
5. Open the pop-off valve on the anesthesia machine.
6. Replace the ventilator breathing system hose on the anesthesia machine with a breathing bag. To fill the bag, turn up the oxygen flow meter; do NOT press the flush valve.
7. Remove the blue ventilator breathing exhaust hose from the anesthesia machine scavenge system port and replace it with the regular anesthesia machine blue exhaust hose.
8. Manually breathe for your patient if needed, or allow the patient to breathe spontaneously. Watch the chest rise of the patient, and check the patient and monitors for changes as the animal breathes on it's own.

Changing Bellows sizes:

1. Select the size bellows required for your patient. See tidal volume chart, pg. 5. Make changes BEFORE starting the case.
2. Unscrew the thumb screws holding the bellows housing (2) to the bellows assembly; they need only be loosened, not removed.
3. Twist the bellows housing off the bellows assembly. This is difficult – two people make this much easier.
4. GENTLY remove the bellows from the bellows assembly ring. The very last ridge of the bellows should slip over the edge of the ring when the bellows are pulled gently to the side.

5. Slip the very last ridge of the new bellows over the appropriate bellows assembly ring. Do not slip more than the last complete ridge of the bellows over the ring or the bellows will leak.
6. Check that the bellows sits flat on the ring and all the ridges are compressed.
7. Replace the appropriately-sized bellows housing on the bellows assembly, twist it firmly in place, and tighten the thumb screws to secure it.
8. It is a good idea to check that the new bellows don't leak by attaching the ventilator to the anesthesia machine and run through steps 1 – 8 of the bag-to-ventilator conversion above.

Basic Troubleshooting:

1. Bellows won't fill:
 - a. Check the anesthesia machine pop-off valve (Close to ventilate) and breathing hose connection to the anesthesia machine.
 - b. Check for leaks in the anesthesia machine and circle system.
 - c. Check the anesthesia machine oxygen flow rate; it is necessary to increase oxygen flow when first converting to the ventilator from the bag.
 - d. There must be no patient using the anesthesia machine or ventilator for the diagnostics below:
 - i. Check the bellows seating on the bellows assembly ring; only the last ridge should lie over the ring. Check the bellows for an obvious tear or leak. Check that the bellows housing is on properly.
 - ii. Check the internal pop-off valve at the center of the bellows base. (Remove the three red thumb screws, gently remove the valve plate, and inspect the valve base and rim of the outflow tube for debris or hair. Wipe both surfaces with a lint-free cloth moistened with distilled water, dry, and replace the valve.) Note: if the ventilator breathing system exhaust (10) is occluded by hand and the circle system Y-piece is occluded with oxygen flow into the system of > 200 mL/min and the bellows deflates, the problem is not the ventilator pop-off valve, but more likely a bellows tear or system leak.
2. Alarms go off:
 - a. Low pressure: 'siren' sound during breath delivery, or continuous.
 - i. Check for leaks. Check that the volume control is set high enough to deliver an appropriate tidal volume for your patient. A continuous alarm means the breathing circuit has become disconnected somewhere.
 - b. High Pressure: single tone when ventilator delivers a breath.
 - i. Check for obstructions in the breathing circuit and the endotracheal tube of the patient. Check that the maximum operating pressure control (8) is set above the peak airway pressure you require to properly ventilate your patient.
3. Patient wakes up, seems deep, or ventilation is inadequate:

- i. If in doubt, disconnect the ventilator and manually ventilate your patient. Check fresh gas flow and the vaporizer on the anesthesia machine. Check the breathing circuit for leaks or kinks. Check the ventilation rate and tidal volume – both may need to be adjusted during a procedure.
4. Check the manual for more detailed troubleshooting descriptions.
 For further information: <http://www.hallowell.com/index.php?pr=zDOCA3667>

Ventilation Settings:

These are only a guide. Adjust the rate, tidal volume, and peak inspiratory pressure to the exact needs of your patient. Maintain the lowest peak inspiratory pressure which allows an adequate tidal volume at a reasonable rate. *Ventilation of patients below 2 kg using the Hallowell ventilator is not advised.

Body Wt. (kg/lb)	Bellows Size	Breathing Rate (per min)	Tidal Volume (mL)	Peak Inspiratory Pressure (cm H₂O)
*1.0/2.2	small	12 - 25	10 - 20	8 - 12
2.2/5	small	10 - 25	20 - 50	8 - 12
4.5/10	small	10 - 20	50 - 100	10 - 15
6.8/15	small	10 - 20	60 - 140	10 - 15
9.1/20	small	8 - 15	90 - 180	10 - 15
11.3/25	sm/lg	8 - 15	110 - 220	10 - 15
13.6/30	sm/lg	8 - 15	130 - 275	10 - 15
18.1/40	large	8 - 15	180 - 360	10 - 15
22.7/50	large	8 - 15	220 - 440	12 - 20
27.2/60	large	8 - 12	270 - 540	12 - 20
31.8/70	large	6 - 12	320 - 640	12 - 20
36.3/80	large	6 - 12	360 - 720	12 - 25
40.8/90	large	6 - 12	400 - 800	12 - 25
45.4/100	large	6 - 12	450 - 900	15 - 25
49.9/110	large	6 - 12	500 - 1000	15 - 25
54.4/120	large	6 - 12	540 - 1100	15 - 30

When using the Hallowell 2002 ventilator, if you change the breathing rate of the patient, you will change the tidal volume delivered:

BPM increase → tidal volume decrease

BPM decrease → tidal volume increase

When volume changes, the peak inspiratory pressure will change in the same direction as a result; monitor peak inspiratory pressure using the anesthesia machine manometer.

Select your rate first, then adjust volume to meet your patients needs. It is preferable to have a lower rate with a normal volume and pressure than to have a more rapid rate with a lower volume and pressure unless the patient's lungs cannot tolerate a normal PIP.