HALLOWELL EMC

Hallowell EMC Model 2002^{PRO} & Model 2002IE^{PRO}

Veterinary Anesthesia Ventilators

OPERATING & SET-UP MANUAL

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USER/OWNER RESPONSIBILITY

PLEASE READ THIS MANUAL BEFORE OPERATING THE VENTILATOR.

This **Model 2002^{PRO} /2002IE^{PRO}** equipment is designed to function, as specified in this manual, when operated and maintained in accordance with supplied instructions. This equipment must be periodically checked, calibrated, maintained and components repaired and replaced when necessary for equipment to operate reliably. Parts that have failed, in whole or in part, exhibit excessive wear, are contaminated, or are otherwise at the end of their useful life, should not be used and should be replaced immediately with parts supplied and approved by **Hallowell EMC**. Equipment that is not functioning correctly should not be used. This equipment and any of its accessories or component parts should not be modified.

The user/owner of this equipment shall have the sole responsibility and liability for any damage or injury to patients or property (including the equipment itself) resulting from operation not in accordance with the authorized maintenance instructions, unauthorized repair or modification of the equipment or accessories, or from the use of components or accessories that have either been damaged or not authorized for use with this equipment by **Hallowell EMC**.

WARNINGS AND CAUTIONS

Personnel operating the ventilator must become thoroughly familiar with the instruction manual prior to using the **Model 2002^{PRO} /2002IE^{PRO} Anesthesia Ventilator** with patients.

- **ELECTRIC SHOCK HAZARD - DO NOT** remove any of the ventilator covers or panels. Refer all servicing to an authorized service technician.
- **DANGER** - Possible explosion hazard if the unit is used in the presence of flammable anesthetics.
- Before using the ventilator, check that all connections are correct, and verify that there is no leak, per instructions on side plate of the controller.
- Any problems arising from an improperly functioning scavenging system is solely the user's responsibility.
- **OPENING THE CONTROL UNIT BY UNAUTHORIZED PERSONNEL AUTOMATICALLY VOIDS ALL WARRANTIES AND SPECIFICATIONS. THE PREVENTION OF TAMPERING WITH THE CONTROL UNIT IS EXCLUSIVELY THE USER'S RESPONSIBILITY: THE MANUFACTURER ASSUMES NO LIABILITY FOR ANY MALFUNCTION OR FAILURE OF THE VENTILATOR IF THE CONTROL UNIT'S SEAL IS BROKEN.**
- Compressed Supply Gas must be clean and dry to prevent ventilator malfunction.

WARRANTY

The **Model 2002^{PRO} /2002IE^{PRO} Veterinary Anesthesia Ventilator** is covered under the warranty expressed on the warranty card attached to the unit at the time of sale to the end user, which reads as follows:

LIMITED WARRANTY STATEMENT

WHAT THIS WARRANTY COVERS:
HEMC offers you a limited warranty that the enclosed subscriber unit and its enclosed accessories will be free from defects in material and workmanship, according to the following terms and conditions:
1. The limited warranty for the product extends for TWENTY-FOUR (24) MONTHS beginning on the date of purchase of the product with valid proof of purchase.
2. The limited warranty extends only to the original purchaser of the product and is not assignable or transferable to any subsequent purchaser. Only through a HEMC authorized Dealer the warranty can be transferred to the original end user.
3. The housing, bellows and cosmetic parts shall be free of defects at the time of shipment and, therefore, shall not be covered under these limited warranty terms.
4. Upon request from HEMC, the consumer must provide information to reasonably prove the date of purchase.
5. The customer shall bear the cost of shipping the product to the Customer Service Department of HEMC. HEMC shall bear the cost of shipping the product back to the consumer after the completion of service under this limited warranty.

WHAT THIS WARRANTY DOES NOT COVER:
1. Defects or damages resulting from use of the product in other than its normal and customary manner.
2. Defects or damages from abnormal use, abnormal conditions, improper storage, exposure to moisture or dampness, unauthorized modifications, unauthorized connections, unauthorized repair, misuse, neglect, abuse, accident, alteration, improper installation, or other acts which are not the fault of HEMC, including damage caused by shipping, blown fuses, spills of food or liquid.
3. Alleged defect or malfunction of the product during the applicable limited warranty period not reported by the end user to HEMC prior to the expiration of the warranty period as defined.
4. Products which have had the serial number removed or made illegible.
5. Damage resulting from use of non-HEMC approved accessories.
6. All plastic surfaces and all other externally exposed parts that are scratched or damaged due to normal customer use.
7. Products operated outside published maximum ratings.
8. Products used or obtained in a rental program.
9. Consumables (such as fuses).
10. This limited warranty is in lieu of all other warranties, expressed or implied either in fact or by operations of law, statutory or otherwise, including, but not limited to any implied warranty of marketability or fitness for a particular use.

WHAT HEMC WILL DO?
HEMC will, at its sole discretion, either repair, replace or refund the purchase price of any unit that does not conform to this limited warranty. HEMC may choose at its discretion to use functionally equivalent reconditioned, refurbished or new units or parts.

STATE LAW RIGHTS:
THE DURATION OF ANY IMPLIED WARRANTIES, INCLUDING THE IMPLIED WARRANTY OF MARKETABILITY, IS LIMITED TO THE DURATION OF THE WARRANTY EXPRESSED HEREIN. HEMC SHALL NOT BE LIABLE FOR THE LOSS OF THE USE OF THE PRODUCT, INCONVENIENCE, LOSS OR ANY OTHER DAMAGES, DIRECT OR CONSEQUENTIAL, ARISING OUT OF THE USE OF, OR INABILITY TO USE, THIS PRODUCT OR FOR ANY BREACH OF ANY EXPRESS OR IMPLIED WARRANTY, INCLUDING THE IMPLIED WARRANTY OF MARKETABILITY APPLICABLE TO THIS PRODUCT.

Some states do not allow the exclusive of limitation of incidental or consequential damages or limitations on how long an implied warranty lasts; these limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from state to state.

HOW TO GET WARRANTY SERVICE:
To obtain warranty service, you may contact us by telephone, fax or email at:
Tel. 1-413-445-4263, Fax. 1-413-496-9254 or info@hallowell.com.
Visit www.hallowell.com

Correspondence may also be mailed to:
Hallowell EMC
35 Downing Industrial Park
Pittsfield, MA 01201

Prices, terms, and product specifications are subject to change without notice.

INTRODUCTION

The **Model 2002^{PRO}/2002IE^{PRO} Veterinary Anesthesia Ventilator** are designed specifically for veterinary anesthesia use. It is volume cycled with a choice of three bellows sizes, providing consistent IPPV for patients from rabbits to foals.

The **Model 2002^{PRO}/2002IE^{PRO}** from **Hallowell EMC** incorporates experience resulting from over twenty years of ventilator design and manufacture. The device is small, portable, and quiet in operation. It has been designed to be economical in its consumption of supply gas.

The ventilator consists of two main assemblies: the controller assembly, comprising all electronics, regulatory and control electronics and pneumatics; and the bellows assembly, comprising the bellows base with pop-off valve, the bellows and the bellows housing. The bellows assembly is easily removed to facilitate cleaning and sterilization. Equally as easily, the different size bellows and bellows housings may be interchanged on the same bellows base to minimize the ventilator's contribution to the compliance of the breathing system, and to provide increased resolution on the tidal volume scale in the 0-300 ml tidal volume range.

The bellows base is of injection molded ULTEM®, a product of General Electric Plastics. ULTEM® is a high temperature, high-impact resistant material that is unaffected by water or the presence of all state-of-the-art anesthetics. In addition, the high temperature properties of ULTEM® make it fully compatible with standard steam sterilization techniques.

The **Model 2002^{PRO}/2002IE^{PRO}** is shipped as a free-standing unit with the bellows assembly mounted on top of the controller. For custom installations such as for use in conjunction with MRI units, the bellows assembly may be separated from the controller and mounted in a location closer to the patient. As supplied, the ventilator may be located on the anesthesia machine shelf or cart, or on a table top. The rubber feet can be removed for installation on an optional heavy-duty stand with casters. The stand increases the mobility of the unit permitting convenient use in multiple operating rooms. Optionally, **Hallowell EMC** provides mounting hardware for the Matrx VMC and Spartan, VMS and VML anesthesia machines. Mounting hardware is also available for anesthesia machines manufactured by A.M. Bickford, Anesco, Delmarva Labs, Dispo-Med, SDI, and VetEquip (formally Omni Medical).

Important

Before attempting to use this ventilator, it is important that you first thoroughly familiarize yourself with this manual. After your review, you should complete the receiving and setup procedures, then perform the verification check with a test lung, as described herein. Become familiar with the ventilator's controls during the verification check and observe the effect of control adjustments on the breathing system.

RECEIVING PROCEDURES

1. Remove all components from the shipping carton. Retain and store both original shipping cartons for use in the event that the unit has to be shipped. (See "Returning for Service").

2. Inspect the ventilator and accessories for any signs of damage that may have occurred during shipping. If damage has occurred, immediately file a damage claim with the carrier.

Packed by _____ Date ____/____/____ Controller SN_____

Received by _____ Date ____/____/____ Serial Number verified _____

3. Check the items against the packing slip and report discrepancies immediately.

All ventilator models include and are shipped with the following:

- **Model 2002^{PRO}/2002IE^{PRO}** Controller
- Bellows Base Assembly (PN 000A0510)
- Tube, Driving Gas (7½" black rubber) (PN 000A0495)
- Airway Pressure Sampling Tee (PN 000A2420B)
- 36" x 22 mm Breathing System Tube (PN 201A1615)
- Power Cord (not included for export) (PN 110A1118)
- Warranty Card (DOCB0015)
- Operating Manual (DOCA3667C)
- Pro Series Vent. Accessory Kit (000A6557):
  - O_2, DISS Inline Pressure Gauge.
  - O_2 DISS HT Fem Inlet WYE w/ DISS Demand Outlets.
  - O_2, DISS Male Coupler
  - O_2, DISS 4' Green Supply Hose (F x F)

The standard Model - our 300 - 1600 ml version - PN 000A5766 (IE Model PN 000A5770)
Includes one each of:

- Bellows, 300 - 1600 ml (PN 000A0488A)
- Bellows Housing, 300 - 1600 ml (PN 200A2289)

The 0 - 300 ml version - PN 000A5765 (IE Model PN 000A5769)
Includes one each of:

- Bellows, 0 - 300 ml (PN 000A0487A)
- Adapter, Bellows, 0 - 300 ml (PN 000A0486)
- Bellows Housing, 0 - 300 ml (PN 200A2288)

The 1600 - 3000 ml version - PN 000A5767 (IE Model PN 000A5771)
Includes one each of:

- Bellows, 1600 - 3000 ml (PN 000A1866)
- Bellows Housing, 1600 - 3000 ml (PN 200A1867)

Numerous other optional parts may have been shipped with your order also. Please refer to the packing slip for details.

4. Complete and return the enclosed Warranty Registration card.

SET-UP PROCEDURE

1. **Inspect the control unit for debris from shipping.** Inspect all three ports, the 50 psi SUPPLY GAS, EXHAUST, and DRIVING GAS ports on the back of the ventilator and remove any obstructions that may have become lodged inside during shipping and unpacking.

2. **Inspect the bellows assembly for debris from shipping.** Tilt the top of the bellows housing toward you and lift it off. Remove the accessories from within the bellows housing.

3. **Ensure that all passages, ports, and chambers are free, clear and unobstructed.** Note that even a hair across the pop-off valve seat will produce an unacceptable leak in the breathing system.

Caution:

If removal of the pop-off valve becomes necessary, remove the bellows by gently lifting it off to the side. Unscrew the three red thumb screws. Gently lift the pop-off valve off the bellows base assembly to reveal the pop-off valve seat and red silicone o-ring. Do not damage the valve seat. Do not touch the seat with any type of hard object--even a fingernail scratch--could permanently damage the seat. Be sure the red o-ring remains in its gland in the bellows base.

4. **Reassemble the bellow assembly.** If removed, first install the pop-off valve with the three red thumbscrews. Next install the bellows with its first convolution over the bellows-mounting ring. Carefully hold the outer edge of the bellows disk (top of bellows): lift and lower it quickly several times to puff out and remove any folds in the convolutions. Place the bellows housing over the bellows, positioning the housing so that the tabs are to the immediate right of the bayonet locks. Gently press the housing down, twisting the housing clockwise at the same time until the tabs engage with the bayonet locks. The bellows assembly is now reassembled.

5. **Connect the drive gas tube.** Locate the 7½" long corrugated black rubber drive gas tube, with 15 mm diameter cuffed ends. Connect the tube between the bellows assembly DRIVING GAS port and the DRIVING GAS port of the control unit. If the bellows assembly is being mounted remotely from the control unit, a longer 15 mm tube will be needed. (A ½" garden hose works well for the long runs to MRI units, but the shorter this tube can be, the better.)

6. **Position the ventilator.** Place the ventilator in an accessible location, close to the area where it will be used, both for convenience, and in an effort to keep the breathing system tubing as short as possible.

7. **Connect the ventilator to the breathing system.** Remove the breathing bag from the bag connector of the Anesthesia machine. Connect the 22 mm x 36” corrugated tube (PN 201A1615) to the BREATHING SYSTEM port of the bellows assembly and to the bag connector. Use of the clear breathing circuit tubing is recommended so the user can see an excessive accumulation of condensation that may interfere with gas flows within the breathing system

SET-UP PROCEDURE (Continued)

8. **Insert the Airway Pressure Sampling Tee into the breathing system.** Disconnect the patient breathing hose from the INHALE VALVE of the anesthesia machine. Connect the Airway Pressure Sampling Tee (PN 000A2420B) to the INHALE VALVE and reconnect the patient breathing hose to the Airway Pressure Sampling Tee. Route the sampling tube as desired to the ventilator Pressure Transducer port on the rear panel. Trim sampling tube to length leaving enough slack for movement. Install Luer Lock fitting such that the hose barb is fully set into the tube. Attach fitting to ventilator Pressure Transducer port.

9. **Connect the ventilator to the scavenger.** Use a 19-mm corrugated tube (not provided) to connect the EXHAUST port of the bellows assembly to a properly functioning scavenger system.

Warning:
Applying any negative or positive pressure to the EXHAUST port of the bellows base assembly will result in a more positive pressure in the patient breathing system and improper operation of the ventilator.

10. **Connect the supply gas** Connect the O_2, DISS Inline Pressure Gauge (Accessory Kit) to the 50 psi SUPPLY GAS INLET of the control unit and to the DISS 4' Green Supply Hose of the oxygen gas supply. The unit is provided with a DISS 1240 male oxygen bulkhead fitting. Gas consumption of the ventilator is very economical, therefore, the use of oxygen as a drive gas is recommended. Oxygen use reduces the risk of unit malfunction due to contamination of the pneumatics. Compressed air may be used, but it must be CLEAN and DRY.

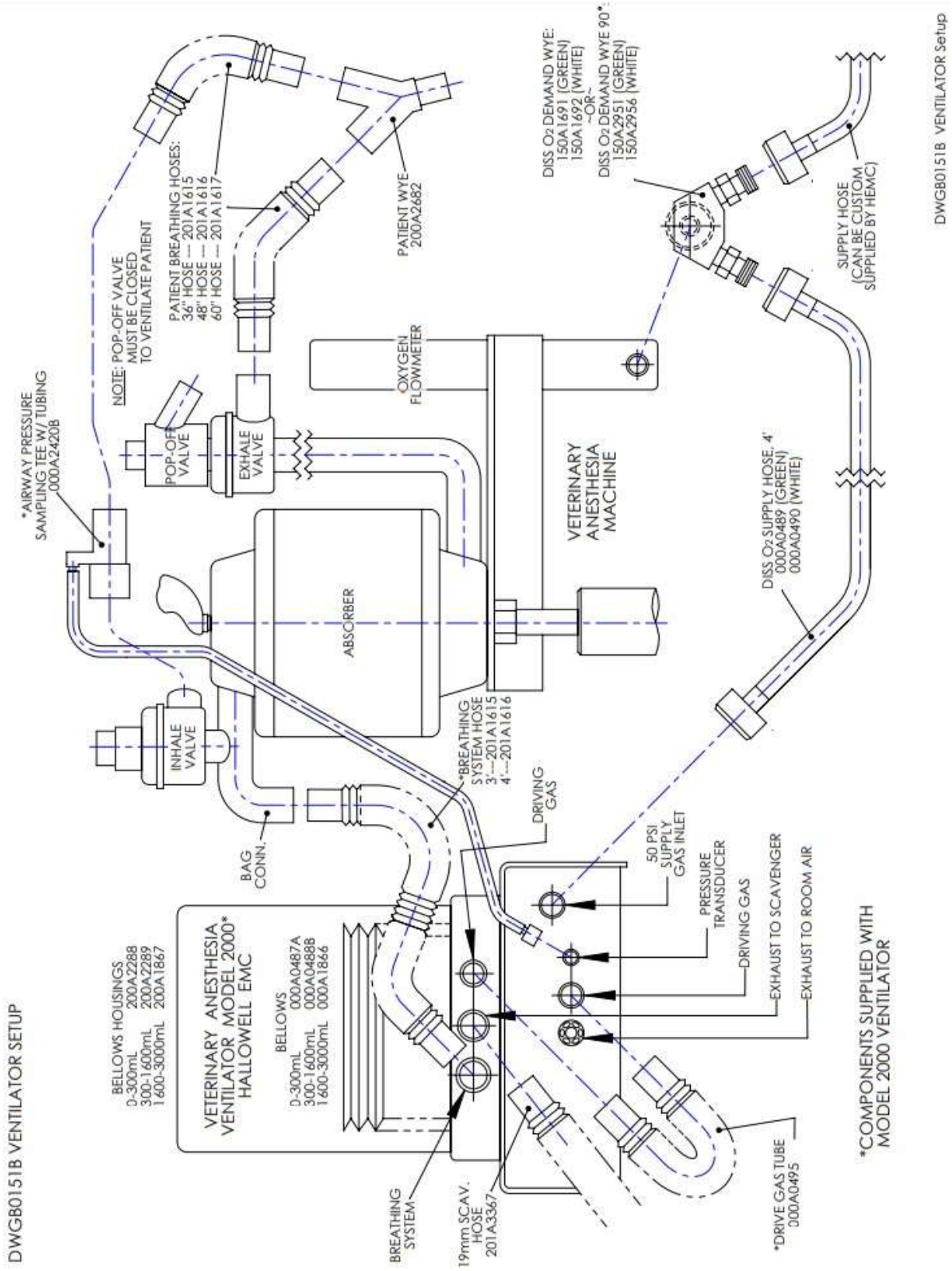
    The 50-psi source for the ventilator may be provided from a separate tank, wall, or ceiling drop, or from a PTO (Power-Take Off) on the anesthesia machine. Should none of the above be available, a common practice, for machines with DISS 1240 male O_2 inlets, is to remove the O_2 supply line to the anesthesia machine from the anesthesia machine, connect a demand wye (HEMC PN 150A1691 (GRN) from Accessory Kit to the inlet of the anesthesia machine and then reconnect the O_2 supply line to the anesthesia machine via one of the two remaining connections to the wye. This leaves one leg of the wye available to source the ventilator with O_2, connect HEMC PN 000A0489 (GRN) from Accessory Kit between the demand wye and the ventilator 50-psi inlet.

11. **Connect the electrical power.** PRIOR to connecting the electrical power, confirm that the power inlet module voltage selector switch is set appropriately for your location.

Export Customers Beware
Warning:
Turning the ventilator on with the Power Inlet Module Voltage Selector switch set for 110 volts while the unit is plugged into a 208 - 240-volt source WILL damage the unit and void the warranty.

Special order 100Vac Japanese versions require no voltage selector setting and will work ONLY on 100Vac.

Plug the ventilator into a properly grounded power source.


DWG80151B VENTILATOR SETUP
VETERINARY ANESTHESIA VENTILATOR MODEL 2000* HALLOWELL EMC
BELLOWS HOUSINGS
0-300mL 200A2288
300-1600mL 200A2289
1600-3000mL 200A1867
BELLOWS
0-300mL 000A0487A
300-1600mL 000A0488
1600-3000mL 000A1866
BREATHING SYSTEM
19mm SCAV. HOSE 201A3367
*DRIVE GAS TUBE 000A0495
BAG CONN.
INHALE VALVE
*AIRWAY PRESSURE SAMPLING TEE W/ TUBING 000A2420B
NOTE: POP-OFF VALVE MUST BE CLOSED TO VENTILATE PATIENT
POP-OFF VALVE
EXHALE VALVE
PATIENT BREATHING HOSES:
36" HOSE — 201A1615
48" HOSE — 201A1616
60" HOSE — 201A1617
PATIENT WYE 200A2682
OXYGEN FLOWMETER
ABSORBER
VETERINARY ANESTHESIA MACHINE
*BREATHING SYSTEM HOSE
3'— 201A1615
4'— 201A1616
DRIVING GAS
50 PSI SUPPLY GAS INLET
PRESSURE TRANSDUCER
DRIVING GAS
EXHAUST TO SCAVENGER
EXHAUST TO ROOM AIR
DISS O2 DEMAND WYE:
150A1691 (GREEN)
150A1692 (WHITE)
-OR-
DISS O2 DEMAND WYE 90°:
150A2951 (GREEN)
150A2956 (WHITE)
SUPPLY HOSE (CAN BE CUSTOM SUPPLIED BY HEMC)
DISS O2 SUPPLY HOSE, 4'
000A0489 (GREEN)
000A0490 (WHITE)
*COMPONENTS SUPPLIED WITH MODEL 2000 VENTILATOR
DWG80151B VENTILATOR Setup

CONTROLS

Two controls, the RATE and VOLUME on the **Model 2002^{PRO} /2002IE^{PRO}** are used to directly set the amount of ventilation.

VOLUME Control - A needle valve regulating inspiratory flow. Use to adjust the minute ventilation of the patient. Since the I:E ratio is held constant at 1:2, this is the only control that will affect minute ventilation.

RATE Control - A potentiometer. Use to set the respiratory rate in breaths per minute. (BPM).

The **MWPL** is used to set a safety limit and the **INSP HOLD** is used to pause cycling. All models with the exception of special order 100v ventilators for use in Japan have one additional control located on back panel. Each control is described in detail below.

I/O Power Switch - a toggle switch used to turn the ventilator on. The green LED indicates the power is on when illuminated.

INSPiratory HOLD Control – A momentary pushbutton. Use to pause the breathing cycle at the end of the current or next inspiration for as long as the button is held unless the set MWPL is exceeded.

Maximum Working Pressure Limit Control (MWPL) - A potentiometer. Use to adjust an upper limit above which you wish the airway pressure never to exceed.

Voltage Selector - A switch adjacent to the power inlet module on the back panel. Use to select either 105-125v or 208-240v operation.

Caution:
Be absolutely sure the voltage selector switch is set to the appropriate setting BEFORE the ventilator is turned on. Turning on a ventilator connected to at 208-240V source while the voltage selector switch is in the 110v position WILL damage the unit and VOID the warranty.

ALARMS

Maximum Working Pressure Limit (MWPL): The MWPL feature allows the operator to set an upper limit above which the airway pressure will not exceed. The ventilator will terminate the inspiratory phase of the breathing cycle and begin an expiratory phase when the pressure transducer senses a pressure above the MWPL setting. The MWPL is settable over a range from 10 to 60 cm H_2O. When the airway pressure reaches the set limit, the yellow light on the front panel blinks and a short tone is heard. If the excessive pressure is not immediately relieved, cycling is paused and the alarm sounds continuously. Note that the INSPiratory HOLD feature is designed to not function when the MWPL setting is exceeded. Therefore, a holding inspiration will be released when the MWPL setting is exceeded.

Low Breathing System Pressure Alarm (LO BSP): The LO BSP alarm is activated at the end of inspiration if there is not at least 5 cm H_2O pressure sensed by the pressure transducer. This alarm is sometimes commonly referred to as a "disconnect" alarm; however, it should be understood that a patient disconnect is not always nor the only cause of low breathing system pressure. During the alarm condition a yellow light is illuminated on the front panel and the sound of a raspy siren is heard. The alarm is automatically reset at the end of the next inspiratory phase in which there is a minimum of 5 cm H_2O pressure sensed by the pressure transducer.

Low 50 psi Supply Gas Alarm: The Low Supply Gas alarm is activated when the supply gas pressure drops below 35 psi (2.4 bar). The sensor for this alarm is located downstream of the internal 40-micron filter and may also indicate a clogged filter condition. During an Alarm condition, the yellow light on the front panel is illuminated and a steady, continuous tone is heard. This alarm automatically resets when the pressure increases above 40 psi (2.7 bar).

VERIFICATION OF PROPER FUNCTION

A Note on Test Lungs

The most readily available test lung will probably be the breathing bag you removed to connect the ventilator. A breathing bag is a very poor model of a lung. It can be used if one understands how poor a model of the lung it is and how to avoid using it in such a way that it creates problems that will not occur with a real patient.

A far better test lung is a ridged walled container such as a gas can, water fountain bottle, or beer keg. The compliance of these containers is equal to their volume in liters and will be linear as is that of a real lung over normal operating ranges. Most importantly they will maintain a functional residual capacity (FRC) that is hard to maintain in a breathing bag.

The breathing bag has an unpredictable FRC from breath to breath if bumped or squeezed beyond the point of relaxation, more gas than would normally be popped off at the end of exhalation escapes from the breathing system. The bellows then abnormally fails to remain at the top of the bellows housing at the end of exhalation. To use the bag successfully, connect it to the patient wye, hang it vertically, and do not disturb it.

Verification of proper ventilator operation requires that you first complete the system setup, as described on page 7 and connect a test lung to the patient wye piece. During verification, you will be observing the operation of the entire system configuration, checking for leaks, and monitoring the ventilator for consistent cycling.

- Install appropriate bellows assembly. Use the 0-300 ml bellows, bellows adapter, and bellows housing for tidal volume requirements below 300 ml.

- Connect a test lung to the patient wye and close the pop-off of the anesthesia machine.

- Fill the breathing system with the O_2 flush until the bellows reaches the top of the bellows housing.

- Turn the VOLUME controls fully clockwise to the minimum setting, set the rate as desired and turn the ventilator on.

- Increase the VOLUME controls until the peak pressure of each breath is approximately 30 cm H_2O.

- Depress the INSPiratory HOLD button long enough to verify that the breathing system is not leaking. The pressure should remain constant.

- Release the INSPiratory HOLD button. Observe that the ventilator is continuing to cycle, and that over time, ~ten cycles, and the bellows is not falling significantly.

- Turn the VOLUME controls fully clockwise to the minimum setting and turn the ventilator off.

Note that this verification procedure is printed on each instruction plate on the ventilator sides.

STOP HERE.

IF THE VENTILATOR IS NOT PERFORMING IN ACCORDANCE WITH THESE EXPECTED OBSERVATIONS, DO NOT USE THE VENTILATOR. REFER TO THE "TROUBLESHOOTING" SECTION.

Note that in the above procedure no fresh gas flow was used. During actual operation of the system, the anesthesia machine will be set to deliver enough fresh gas to compensate for minor leaks in the entire breathing system and variations in patient uptake. This fresh gas will keep bellows full between each Inspiratory cycle.

A TYPICAL USAGE SCENARIO

The **Model 2002^{PRO}/2002IE^{PRO}** is a time cycled volume ventilator with an adjustable pressure limit. The more you understand of the ventilator, how it works, and what it does in response to your settings, the more comfortable you will be with it. It will feel "right" to change a setting and get what you want from the ventilator.

Making the initial settings:

What are you going to do first? If this is your first ventilator, you've probably spent many an hour bagging patients that required IPPV. You are, by now, comfortable doing that. Let's setup the ventilator to "bag" a patient as you would bag one yourself. If you are convinced the ventilator is bagging the patient, as you would be, you can feel comfortable with what the machine is doing.

When you bag a patient, you're careful not to over inflate the lungs. You have a feeling as to how hard to squeeze the bag. Your feelings have grown out of experience: checking the chest wall excursion and correlating that with a reading from the airway pressure manometer on the anesthesia machine. In general, for a healthy patient, the peek inspiratory pressure (PIP) should be kept in the range of 15-20 cm H_2O. Patients with more compliant lungs may even require less pressure for adequate ventilation and vice versa.

After induction and intubations, when it is time to start IPPV, set the VOLUME controls fully clockwise to the minimum setting. These controls are needle valves regulating inspiratory flow, with no or very little flow you will deliver no or a very small tidal volume (TV). Set the maximum working pressure limit (MWPL) control to about 20 cm H_2O. The airway pressure will not exceed this setting regardless of what you do with the other controls. Connect the ventilator to the breathing system (BS) as discussed in the Set-up Procedure, fill the bellows by turning up the fresh gas flow until the bellows reaches the top of the bellows housing. Turn the ventilator on. Set the RATE control to an appropriate rate for the patient.

There will be a pause before the first inspiration. Watch the chest wall excursion and the airway manometer as you would when you bag. Since we have started with the inspiratory flow very low, the first TV delivered will be too small to generate sufficient airway pressure. Consequently, the Low Breathing System (LO BSP) alarm will sound -- don't be alarmed. Now, increase the VOLUME controls breath by breath, a little at a time, until the chest wall excursions and PIP reach levels that you would seek to achieve while bagging. At this point you can be comfortable that the ventilator "is squeezing the bag" as you would be.

Trimming the settings as the case proceeds:

At this point the ventilator is delivering an inspiratory flow, determined by your setting of the VOLUME controls, for a time as calculated from your setting of the RATE control. This flow for a time results in a volume delivered to the bellows assembly that "squeezes the bag", in this case bellows, displacing the mixed gas within to the patient.

This delivery to the patient, these TVs at the set rate, results in the overall minute ventilation (MV). It is the proper MV that must be delivered to the patient in order to maintain proper blood gas and pH levels.

This MV can be delivered in many ways from a few large TVs to a lot of small TVs. The most optimum combination is up to you to determine just as you would while bagging.

GETTING STARTED (Continued)

Our ventilator, for those of you familiar with the term, is considered a MV divider. For those unfamiliar with the term, the ventilator delivers a consistent MV to the patient and that MV is divided into different size TVs by the RATE control. You can change the RATE control all you want without changing the total ventilation delivered to the patient. Let me repeat that. You can change the RATE control all you want and it will not affect the total ventilation delivered to the patient.** In order to change the MV delivered you must change the VOLUME controls. This point will be quite important when you go to wean the patient from the ventilator.

Remember, when you change the VOLUME controls it is the inspiratory flow that you are changing directly. The rate and, therefore, the time that flow is delivered has not changed, thus the delivered TV will be either larger or smaller than before. Stop and think about it, you are now delivering a different volume of gas to the same compliance of the patient; it follows that the PIP will be different. This different PIP may be fine or it may be unnecessarily high or low. In the high extreme the MWPL alarm will sound, a short steady tone, and the PIP will be limited to the set value or in the low extreme, the LO BSP alarm will sound, a warbling tone.

Back to the change being implemented, you have changed the MV as desired now, if needed, trim the delivered TV size with the RATE control to obtain a new TV that results in a more appropriate PIP, and no alarms.

Now do it and get comfortable with it. Don't just put this document away - setup the ventilator and a test lung. Read this again trying what is discussed as you read.

Note that no discussion has been made of I-time and E-time and the need to keep them in a proper relation to each other. This relation is automatically held constant by the ventilator. The I:E ratio is a consistent 1:2, no need to think about it - there will be enough time for exhalation. For those of you that want to think about it, we offer the model 2KIE with an adjustable ratio from 1:1.5 to 1:4. Even when the I:E ratio is adjustable that ratio is still held constant over the full range of rate settings.

**This statement is somewhat of a simplification as you deviate greatly from the current RATE setting. There is a difference in MV delivered by the ventilator and the alveolar ventilation received by the patient. This difference is related to the dead space and BS compliance. With each TV delivered, a portion ventilates the dead space and BS, the more TVs per minute the greater the portion of the delivered MV that is not seen by the alveoli and, thus, is of no use to the patient. The significance of this difference is small unless the BS being used is severely mismatched with the patient or the deviation from the current setting is great. Similarly, the amount of variation is minimal with the small changes needed to trim the TV after adjusting the MV.

OPERATING INSTRUCTIONS

Output of the **Model 2002^{PRO}/2002IE^{PRO}** is adjusted by only two controls; a linearly calibrated RATE control (breaths per minute), and a metering VOLUME control.

Follow the setup and verification procedures and be certain the pop-off valve on the anesthesia machine is completely closed.

DETAILED OPERATING INSTRUCTIONS:

1. When the patient is ready, reconnect the ventilator to breathing system.

2. ALWAYS set the VOLUME controls to its minimum setting before turning on the ventilator. The VOLUME controls must be fully clockwise to be set to the minimum setting.

3. Set the maximum working pressure limit (MWPL).

4. Turn on the ventilator. Set the RATE before any adjustment is made to the VOLUME. Adjust the RATE to the desired breaths per minute setting.

NOTE: As you proceed, continually observe the anesthesia system's breathing system pressure (BSP) gauge to ensure that excessive pressures are not being attained.

5. The volume controls, as noted above, are initially set after the appropriate RATE has been selected. Turn the VOLUME controls counterclockwise to increase the tidal volume delivered, or clockwise, to decrease the tidal volume delivered. Read the approximate tidal volume by noting the displacement of the bellows in ml as indicated on the bellows housing scale. At a given RATE setting, the tidal volume can be increased or decreased in this manner.

6. Slight changes in the RATE and VOLUME controls can be made as the procedure continues but never make any gross adjustments to these controls with the patient connected.

Warning:

Under no circumstances should the flush button on the anesthesia machine be used during the Inspiratory phase of the breathing cycle. There is the extreme danger of rupturing a lung. The flush button introduces 50 - 100 lpm, perhaps more, of oxygen flow into the breathing system. During inspiration the discharge valve in the control unit is closed so that flush flow is added to the inspiratory flow generated by the ventilator and has nowhere else to go except to the patient's lungs. It is recommended that the flush feature on the anesthesia machine NEVER be used with patient connected. The oxygen flow valve can be opened further than normal providing a more controllable high flow of oxygen.

CLEANING & STERILIZATION

A majority of the **Model 2002^{PRO}/2002IE^{PRO}** components do not come in contact with the breathing gas; consequently, they require cleaning with only a damp cloth. This includes the entire control unit as well as certain bellows assembly components. Only the bellows base interior and the inside of the bellows come in contact with the breathing system gases.

CAUTION:

NEVER use an abrasive cleaner to clean any part of the ventilator. Abrasives will scratch the transparent acrylic bellow housing and other surfaces of the ventilator. Also, DO NOT allow water from an overly-damp cloth to collect on or penetrate into the ventilator.

Cleaning the Ventilator Surfaces: The outer surface of the ventilator may be cleaned simply by using a clean, soft, slightly damp cloth. A mild detergent solution may be used to remove persistent surface dirt or grime. Be sure to use only a mild detergent, if necessary, and use care to ensure that the cloth is only slightly damp.

WARNING:

Clean bellows and bellows housing only with water and a mild detergent. Use a soft cloth. Avoid abrasives and aromatic spirits. (USE NO ALCOHOL.)

Cleaning the Bellows Housing: Remove the bellows housing for cleaning and for access to the bellows and pop-off valve. Twist the housing counterclockwise until the tabs at the base of the housing clear the bayonet locks. (This may require some degree of force because of a tight o-ring fit.) Tilt the top of the bellows housing toward you and lift it off. DO NOT attempt to steam-sterilize the bellows housing. Since it does not come in contact with the breathing gas, it needs only occasional cleaning with a clean, soft slightly damp cloth, or by immersion in a mild detergent bath, followed by rinsing. Moreover, steam sterilization may warp or deform the housing rendering it useless. USE NO ALCOHOL.

Cleaning the pop-off valve: With the bellows housing removed, it is necessary to also remove the bellows to gain access to the pop-off valve. This is easily accomplished by gently pulling the bellows to the side until it detaches from the base.

Removing the bellows exposes the pop-off valve and the three small red thumbscrews which attach it to bellows base. Loosen the three screws and remove the valve. The black, ULTEM® pop-off valve seat will now be exposed. This valve seat has a precision machined and lapped surface, which is relatively delicate: USE CONSIDERABLE CARE while cleaning the seat with a clean, soft, damp-cloth. Clean P.O.V. disk with cotton swab and alcohol.

CAUTION:

NEVER use an abrasive cleaner or hard object to clean the valve seat. Abrasives or hard objects will scratch or damage the seat, causing the pop-off valve to leak, which will result in a serious malfunction of the ventilator.

NOTE THAT EVEN A PIECE OF LINT ON THE SEAT COULD CAUSE A LEAK.

After cleaning the pop-off valve seat, replace the valve taking care to ensure that the small orange o-ring (PN 180A1429) under the pop-off valve is securely in place. If this orange o-ring is dislodged or missing, the ventilator will not be able to function properly.

Sterilizing the bellows base from the controller and bellows interior surface: The bellows and its interior surface do come in contact with the breathing gas and require periodic sterilization. Sterilization is accomplished with the bellows housing and bellows removed, as described above. The pop-off valve, and the 300-ml bellows adapter, if used may remain on the base during sterilization.

To remove the bellows base from the controller for sterilization, disconnect the hoses from the base and loosen the four black thumbscrews, located at the corners. First, clean the base using a clean, soft, slightly dampened cloth. Then wrap the whole base and steam sterilize it using the same standard hospital techniques as used for any surgical apparatus.

Finally, clean and sterilize the bellows using an appropriate hospital technique for delicate latex supplies. DO NOT steam sterilize the bellows.

After completing the above sterilization procedures, complete the reassembly of the unit by first reattaching the bellows base to the ventilator control unit, reconnect the hoses, and slip the first convolution of the bellow over the bellows mounting ring. Then and finally, reattach the bellows housing to the base. This completes the cleaning and sterilization procedures.

TROUBLESHOOTING

Leaks in the circle (breathing) system are very common. Particularly, the reuse of "single use" circle systems frequently results in leaks. This reuse practice is not recommended. Circle system leaks are not as apparent when bagging a patient or when using an older style ventilator with a falling-during-exhalation bellows system. The **Model 2002^{PRO}/2002IE^{PRO}** Ventilator with its state-of-the-art standing (ascending)-during-exhalation bellows system will, more readily reveal system leaks.

The determination as to whether a leak is in the circle system and/or anesthesia machine or in the ventilator is easily accomplished. The following procedure should be conducted:

1. Close the anesthesia machine's pop-off valve.
2. Turn off the flow of fresh gas.
3. Disconnect the 22-mm tube from the bellows base assemblies' BREATHING SYSTEM port and connect it to the patient wye piece to produce a closed loop.
4. While observing the breathing system pressure, slowly increase the fresh gas flow to the system until the pressure builds to about 50 cm H_2O.
5. Turn the flow off.
6. The pressure should hold steady without falling appreciably.

If the system passes this test, refer to the following table to locate the problem with the ventilator.

A Note on Fuse Replacement

Units with SN 2757 and higher have a dual fused Power Inlet Module. The fuse compartment is accessed by removing the power cord and sliding the fuse drawer open. Replace fuses ONLY with fuses of the same size and rating as listed on the rear panel below the Power Inlet.

The voltage selector switch with the screwdriver slot IS NOT the fuse holder.

Units prior to SN 2757 are shipped with a Power Inlet Module with one spare fuse. The fuse compartment is accessed by removing the power cord from the controller and, using a small screwdriver, pry out the rectangular fuse carrier. Once the fuse carrier is removed, you can see the fuse. The spare fuse is located inside the rectangular part of the carrier. Slide the drawer out from one end to gain access to the spare fuse.

Symptom	Potential Causes	Possible Remedies
Ventilator sounds as though it is cycling. I can hear the valves clicking but nothing happens.	• No supply gas pressure. • VOLUME control is set at it's minimum.	• Unkink the supply gas hose. • Replace empty tank. • Increase the VOLUME setting.
Ventilator hums with each inspiration.	• Supply gas pressure at the ventilator inlet is dropping to around 25 - 30 psi with O_2 flow. • Pipeline or tank pressure is low.	• Unkink supply gas hose. • Anesthesia machine power outlet is incapable of supplying the required flow. Bypass it. Switch to new supply gas source.

Symptom	Potential Causes	Possible Remedies
Nothing happens when the ventilator is turned on. No valves are clicking, green LED not lit.	• No electrical power.	• Plug ventilator into the proper power source. • Check voltage setting. • Check the outlet. • Check the fuse
Pop-off valve in the Bellows Base chatters and the bellows shakes after it reaches the top during exhalation.	• Excessive fresh gas flow from the anesthesia machine.	• Reduce the fresh gas flow.
Inspiratory flow chugs intermittently.	• Pressure within the bellows housing is exceeding 70 cm H_2O. • Working pressure limit is shutting off the switch Inspiratory flow.	• Inflate collapsed bellows. • Unkink the drive gas tube. • Unkink breathing system hose.
The ventilator operation sounds normal but the TV delivered is incorrect and or inconsistent.	• Missing or damaged pop-off valve o-ring.	• Replace o-ring
Irregular cycling when using cautery or another electro-surgical device.	• Excessive generation of EMI and/or RFI.	• Locate and repair source of disturbance.
Bellows dislodges from mounting ring.	• Partially detached or improperly mounted bellows. • Either pressure or vacuum is occurring at the Bellows Base EXHAUST port.	• Reattach or replace the bellows. • Repair defective or poorly regulated scavenger system.
Bellows is bulging.	• P.O.V. is stuck closed. (To determine if this is the problem, temporarily disconnect scavenger to isolate problem.)	• Clean P.O.V. and seat.*
Everything seems normal, but the bellows progressively becomes less full.	• Breathing system gas is leaking from the system. (SEE THE FIRST PARAGRAPH OF THIS SECTION) • Inadequate fresh gas supply from anesthesia machine. • Missing or damaged pop-off valve o-ring • Hole in Bellows • Partially detached or improperly • installed bellows. • Damaged pop-off valve or valve seat. • Anesthesia machines pop-off valve is not completely closed.	• Remove obstruction. • Increase flow. • Replace o-ring • Replace Bellows • Reattach Bellows to the mounting ring. • Replace damaged part. • Check all tubes and tubing connections for leaks. • Clean P.O.V. and seat.* • Close, repair or replace valve.

*See “Cleaning the P.O.V.” page 17.

RETURNING FOR SERVICE – RETURN AUTHORIZATION POLICY

NO HALLOWELL EMC PRODUCTS OR ACCESSORIES CAN BE ACCEPTED FOR REPAIR OR RETURN WITHOUT A RETURN AUTHORIZATION FROM HALLOWELL.

To obtain a Return Authorization number call 413-445-4263, fax to 413-496-9254, or email your request to info@hallowell.com. Please have the following information ready and available:

1. The serial number of the item to be returned, if applicable.
2. The nature of the problem, reason for return and action requested.
3. The name, phone number and extension of the party to contact should we have future questions.
4. The billing name, address, phone number and PO number of the responsible party.
5. If the item is to be returned, such as with a repair, the name of the party to whom we should ship the item, the shipping address and receiver's PO number if needed for acceptance.
6. AND a fax number or email address to which we can send a "Return Goods Instructions Sheet." This sheet will have the RA # at the top. Clearly mark the RA # on the outside of the box that you will be returning to Hallowell EMC.

Please follow the procedures faxed to you carefully. It is based on our experience of how best to get your items back to us without damage and delay.

Deliveries will not be accepted for packages that are not expected, i.e., that do not have a valid (on file) authorization number clearly marked on them along with a complete return address.

We thank you for your understanding and cooperation.

Model 2002^{PRO} /2002IE^{PRO} by HALLOWELL EMC SPECIFICATIONS

OPERATIONAL CHARACTERISTICS	
Rate	6-40 bpm
Tidal Volume	0-3000 ml
I:E RATIO	1:2 (preset)
Gas Supply	Oxygen or **Clean Dry** Air
Pressure & Flow	35-65 psi @ 3 scfm [2.4 - 4.4 bar @ 100 lpm]
Controls	
Rate	Linear, 6-40 bpm w/Power Switch
Volume	9.5 turn Metering Valve
Maximum Working Pressure Limit	Linearly Adjustable, 10 - 60 cm H_2O
Indicators	
Power On	Front Panel-mounted green LED
Alarm, Visual	Front Panel-mounted yellow LED
Alarm, Audio	Internal audio transducer
Alarm, Audio……..	Int. Low Supply Gas Pressure Switch
PHYSICAL	
Unit Weight	Approximately 13 lb. [5.9 kg]
Dimensions:	
Controller Footprint	9"W x 10"D [228 W x 254 D mm]
Configuration Overall Height:	
PN 000A2780 - 300 ml	12 3/4"
PN 000A2781 - 1600 ml	12"
PN 000A2782 - 3000 ml	17 1/4"
Power Requirements (Switch Selectable)	105-125 or 208-240 vac, 50-60 Hz
(On special orders)	100 vac only