BRAINTREE SCIENTIFIC, INC.
LAB RESEARCH PRODUCTS

R415 VentStar Small Animal Ventilator

User Manual V1.2

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Contents

1. Equipment general description

The R415 small animal ventilator, which designed for scientific research and teaching, suitable for the basic experimental use in small laboratory animals, aim in the field of cardiovascular modeling, pulmonary diseases, and cerebral ischemia, our users include: universities, research institutes, CRO agencies, hospitals, affiliated hospitals, pharmaceutical companies, FDA, CDC and so on.

The R415 small animal ventilator developed multiple functions: mode switching (Volume/Pressure), touchscreen display and control, digital detect and control of IPPV, VT, respiratory rate adjustment, the inhale/exhale ratio (I: E), peak inspiratory pressure (PIP) protection, sigh breathing, sleep apnea and so on.

Designed for scientific research, such as rat/mouse cardiopulmonary or respiratory experiments, maintain or improve pulmonary ventilation experiments. Assisting breath while enabling option access to anesthetic gases, also provide monitoring information on respiratory rate, tidal volume, I: E ratio and PIP. R415 can effectively improve the maintenance of animal respiratory ventilation, which meets the ventilation requirements during laboratory surgery, cardiopulmonary respiratory drug test and respiratory anesthesia in rats and mice.

Animals size range: 10g-1kg (from mice, rats to guinea pigs.)

Detailed features:

- Simple and elegant exterior, compact layout, small size, easy-to-use touchscreen;
- Utilizes intermittent positive pressure ventilation (IPPV), Two-modes switch between volume and pressure ventilation modes;
- Meets the respiratory requirements of laboratory animals weighing from 10g to 1kg, automatically set breathing parameters after manually weight input;
- Introduces multiple breathing parameters storage up to 10 groups, one-touch switch among them;
- 7-inch LCD RGB resistive touch screen, wide-angle visible;

- Adaptive to breathing frequency from 10bpm to 300bpm, tidal volume from 0.05ml to 5ml, PIP from 1cmH_2O to 50cmH_2O, Enable combined parameters setting among PIP/PEEP/Sign/INSP.Hold/EXP.Hold and so on;
- Full-screen real-time display of pressure-time curve in both volume control and pressure control ventilation mode;
- Vocal alarm, text message prompt and error code query, which enhance user experience and reduce errors during operate;
- Utilizes DC power supply to maintain safety integrity.

2. Safety instructions

⚠ Please read the safety instructions carefully and ensure that the power supply is properly connected before starting the small animal ventilator.

For safety reasons, be sure to note the following issues:

Overview

- Please read this manual carefully.
- This manual is an integral part of the equipment, put it beside the equipment to ensure easy access.
- R415 can be categorized to external power supplied desktop equipment.
- Only for the intended use (see "2.1 Precautions").

⚠ **Caution：**

- **Use proper power supply**
  The unit is supplied with a certified power supply and line cord. To maintain the safety integrity of the device, please ensure the input power range is 100 ~ 240V, 50/60Hz, 1.0A, and the adapter output is 24V DC, 1.67A.
- **Use proper line cord**
  Use only the specified line cord for this product. The operating voltage range for the R415 is 24VDC. The universal power supply operating voltage range is 100-240VAC, 50/60 Hz.
- **Ground the equipment**
  This equipment is grounded through the grounding conductor of the line cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making any connections to the input/output terminals of the product, ensure that the product is properly grounded.
- **Make Proper Connections**

Make sure all line cords are properly and securely connected to equipment.
Caution: Any signal wire connections to the unit must be no longer than 3 meters!

- **Observe All Terminal Ratings**
  Review the operating manual to learn the ratings on all connections.
- **Avoid All Exposed Circuitry**
  Do not touch any electronic circuitry inside of the product!
- **Do Not Operate with Suspected Failures**
  If the product damage is suspected or cannot be regularly operated. Contact qualified service personnel to perform inspection.
- **Properly Orient the Equipment**
  Orient the equipment properly to avoid difficult to operate or device disconnection situation.
- **Place Product in Proper Operating/Storage Environment**
  Review the operating manual for guidelines for proper operating and storage environments.

Software

- Highly developed software with a great deal of quality assurance measures, minimized the risk due to software defects.

Accessories

- Prevent the silicone parts from being exposed to UV light or prolonged direct sunlight to avoid embrittlement of these parts.

2.1 Precautions

- Before starting use this device to operate on animals, make sure the users have carefully read this manual and fully understood the contents.

⚠ **Electric Shock:** Paraprofessionals are not allowed to disassemble the rear cover or panel of the equipment.

⚠ **Danger:** Prohibit the use of inflammable or explosive gas as a gas source of the equipment.

- Before using the equipment, please carefully check all the gas pipeline interfaces to ensure no leakage.
- Any equipment failure caused by improper cleaning, maintenance or operation to the equipment, the users will take the corresponding responsibility.
- Equipment disassembly without authorization from RWD, RWD will no longer provide any warranty and technical maintenance service on this equipment. Please contact our authorized personnel or RWD for technical support when you need.

2.2 Safety instruction

This equipment only for use by skilled personnel with anesthesia knowledge. Choose a locality where away from water, with good ventilation, constant air pressure, temperature, and humidity to place the equipment. Avoid direct sunlight and avoid corrosive, inflammable and explosive gases and chemicals contact. Avoid the equipment in a tilt, vibration, extrusion and other dangerous states! Notice the voltage and current value of the power supply and its frequency. Make sure the ground terminal is firmly grounded. Do not overload operating!

⚠ Warning!!!

R415 small animal ventilator must complete self-check before boot up, failed self-check indicating that the equipment may have circuit fault or internal gas pipeline leakage. At this time, please power off the equipment, then confirm the pipeline connection is correct. If still cannot pass the self-check process, please contact your supplier or our customer service department immediately.

2.3 Warranty

The warranty period is two years, from the date of manufacture, please refer to the following instructions:

- The warranty of this equipment starts from the date of manufacture. During the warranty period, RWD will undertake the after-sale service such as repair or replace the unit if it is found to be defective as to workmanship or materials.
- This warranty does not extend to damage resulting from misuse, neglect or abuse, normal wear and tear, or accident. If repair or unit replacement is still required, the expenses incurred shall be borne by the user.
- This warranty does not extend to unauthorized equipment disassembly.
- This warranty (including its limitations) is the exclusive release of RWD, cover all the other warranty terms.

2.4 Technical Specifications

Suggested Weight Range	10g～1kg
Species	Mouse/Rat～Guinea Pig
Tidal Volume Range (TV)	0.05ml～5ml Resolution: 0.001ml
Peak Inspiratory Pressure (PIP)	1～50cmH_2O Resolution: 1 cmH_2O Accuracy: ±0.7 cmH_2O
PEEP	0～10 cmH_2O Resolution: 1 cmH_2O
Breath Rate (bpm)	10～300 bpm
I:E Ratio	20～80%
Sigh Breath	Frequency: Every 10～999 or Manual Volume: 0～20% of tidal volume (in volume mode) or PIP (in pressure volume)
Display	7'' LCD touchscreen, resistive
Remote Communication	RS-485
Power Supply	100～240VAC, 50/60Hz
Input Power	24V DC, adaptor: 40W Max
Safety Alarms	Over-/Under-pressure, occlusion, high PEEP
Dimensions	320*210*180mm
Weight	5.1kg
Operating Temperature	4℃～40℃ (40°F～104°F)
Operating Humidity	20～80%, non-condensing
Storage Temperature & Humidity	-10℃～70℃ (14°F～158°F), 20%～80% RH, non-condensing

3. Unpacking

1. Check the shipping boxes before unpacking, make a damage claim to the carrier and contact RWD if unexpected damage appears on delivery.
2. Carefully open each box and take out each individual component. Preserve all boxes and packing materials for future shipments.
3. Check the packing list (as follows) to ensure all ordered components are included. In case there is any doubt or need any help, contact RWD or local supplier immediately.

（**Figure 1**）

Inhalation anesthesia kit (optional)

Packing list：

- Ventilator ----------1
- Trachea cannula for mouse-20G----------5
- Trachea cannula for rat-14G----------5
- Male Luer taper (PP-1/8") ----------1
- Y-shape triplet (PP-1/8"） ----------2
- Medical silicone tube (ID: 3.0mm) ----------1
- Reducing coupling (1/8"-1/4") ----------1
- Diaphragm check valve ----------1
- Medical silicone tube (ID: 6.0mm) ----------1
- Inhalation anesthesia kit (optional)----------1
- Screwdriver ----------1
- cleaning cloth ----------1
- Power supply ----------1
- Power cable ----------1
- Certificate----------1
- User manual----------1

Caution： If your order include other accessories, they may ship together in the same batch of boxes, please check your packing list.

4. Operating instructions

Before using this equipment, make sure the users have carefully read this manual.
This equipment must be periodically maintained to ensure its stabilization.
When any following situation happen: partial or total damage, excessive wear, equipment life ending caused by contamination or other reasons. It should be replaced by RWD Company or by the authorized accessories.
Immediately stop the equipment that do not work properly and unauthorized users are not allowed to make any modifications to the equipment.
Improper operation to the equipment, unauthorized equipment disassembly and using unauthorized accessories, the unexpected outcome and its responsibility borne to the user.

5. Features introduction

5.1 Operational principle

The R415 was designed to fulfill animal research applications in many fields and is intended for use on subjects ranging in size from mice to guinea pigs (weighing 1g - 1kg). The design goal of this ventilator was to maintain versatility and ease of use while retaining safe and physiologically accurate mechanical ventilation conditions.
The R415 utilizes advanced technologies to precisely control respiration profiles.
The R415 has two operating modes (Volume Control/Pressure Control), which allows users to easily switch between these two modes via the settings button on the large touchscreen.

1. The Volume Control mode delivers the desired tidal volume to the subject by precisely controlling the stroke of the piston. Since the actual stroke length, and therefore tidal volume, may be modified for a given stroke, sigh breaths are supported. Similarly, since stroke speed is precisely controllable during inspiration and expiration, variable inspiration-to-expiration (I: E) ratios are also supported. A pressure sensor continuously monitors the airway pressure to alert the user of over- and under-pressure conditions.
2. The Pressure Control mode of the R415 allows the user to set the peak inspiratory pressure (PIP) value. Flow rates are automatically adjusted by changing the tidal volume while keeping the respiration rate constant. The stroke is adjusted in a manner in which the PIP is reached near the end of the piston stroke. This ensures that the subject, which has a higher airway resistance than the airway path within the ventilator, receives the majority of the expected tidal volume and that the unit does not prematurely terminate

the piston stroke. Manual adjustment of the inspiratory flow rate is not required.

The R415 offers built-in Positive End Expiratory Pressure (PEEP) capability, allowing a PEEP setting via the touch screen user interface of up to 10 cmH_2O. Another feature is the ability to perform Inspiratory or Expiratory Hold. The user can enter the desired hold time and initiate inspiratory or expiratory hold by pressing the Insp. Hold/Exp. Hold button on the user interface.

5.2 Features

Volume Control Mode	R415 small animal ventilator delivers a controlled volume of gas to the subject on each inspiration stroke. In this mode, respiration frequency (bpm) and I:E ratio determine the time span for inspiration and expiration phases.
Pressure Control Mode	R415 small animal ventilator continuously delivers gas to the subject until the user defined pressure limit is reached in the pipeline (PIP). Stroke volume is automatically adjusted by the unit so that the pressure limit is reached near the end of the stroke. Respiration frequency and I:E Ratio determine the time span for inspiration and expiration phases.
Tidal Volume (VT)	Adjustable from 0.05ml to 5ml (set value depends on the animals).
Respiratory Rate (bpm)	Adjustable from 10 to 300 bpm.
Inhalation: Exhalation Ratio (I:E Ratio)	This function allows user to select the ratio of inhalation to exhalation times when respiratory control is needed. The default I:E ratio is 50% and is user adjustable from 20 to 80%, depending on respiration rate.
Sigh Breath	Long-term continuous ventilation will cause the lungs collapse to the animals. Introducing a large tidal volume to over-inflates the animal's lungs results in collapsed alveoli expansion, replicating a natural sigh breath. Sigh breaths are supported in both Volume Control and Pressure Control modes. In the Volume Control mode, a sigh tidal volume is delivered. In the Pressure Control mode, a sigh pressure limit is delivered. The frequency and volume of the sigh breath are user selectable via the Sigh button on the user interface. Sigh frequency can be programmed 10-999 cycle/time, Sigh volume can be programmed from 0-20% of tidal volume.
Positive End Expiratory Pressure (PEEP)	The user can adjust Positive End Expiratory Pressure (PEEP) 0-10 cmH2O based on peak inspiratory pressure (PIP).
Inspiratory/Expiratory Hold	User selectable option for switch between inspiratory or expiratory hold, for user defined time to maintain peak (inspiratory) or minimal (expiratory) tidal volume/pressure in the subject's lungs
Safety Alarms	R415 small animal ventilator offers visual info besides audible alarms for over pressure, under pressure, occlusion, and high PEEP. As well as error code query.

6. Installation

（**Figure 2**）

6.1 Initial setup

1. Takeout ventilator from the box, pay attention to use the handle at the top of the ventilator.
2. Remove foam-packing inserts to both ends of the ventilator, then gently lay it on a level bench.
3. Carefully find and remove the power supply and line cord from the shipping package.
4. Check the ventilator for any damage that might have occurred in the shipping process.
5. Carefully read the manual to get familiar with all features and functions of the R415 ventilator.

6.2 Operating Environment Requirements

- Need a stable, clean, level, nonflammable and dry bench or table;
- Reserve a minimum of 2.5 cm clearance interspace around the ventilator;
- Use proper power supply;
- Operating at room temperature 4° to 40°C (40° to 104°F);
- Operating at relative humidity of 20 to 80%;
- Keep the room ventilated.

⚠ Warning !

Do not use in the presence of inflammable or explosive gases!

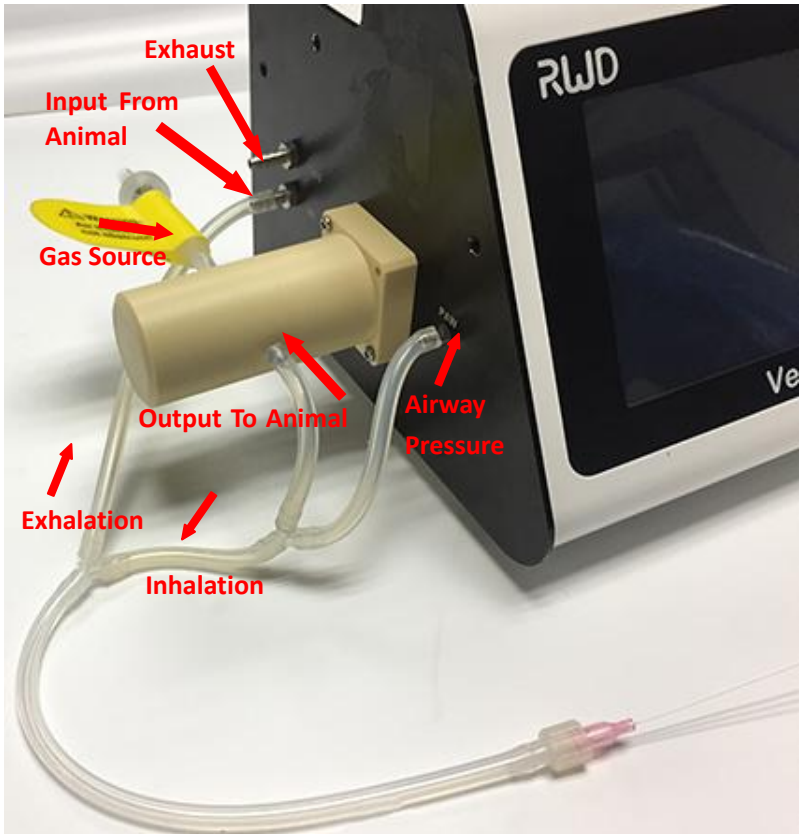
Do not use in a high oxygen concentration environment!

6.3 Applicable Features

The R415 ventilator is suitable for small laboratory animals with a body weight ranging from 10g to 1kg. It offers respiration rates from 10 to 300 breaths per minute (bpm) and offers tidal volumes supply from 50µl to 5ml. The R415 is ideal for the use in a laboratory, operating room, or any other well-ventilated, explosive gas free environment. The R415 can be used to deliver many types of nonexplosive gas mixtures including, but not limited to, anesthetic gases and high concentration oxygen.

6.4 Airway Tubing Connections

1. Tubing connection ports of the R415 small animal ventilator localized on both sides of the cylinder, animal expander tubing connections are on the valve outlet. These connections are shown in the picture below.



（**Figure 3**）Tubing Connections of R415

Gas Source： Tubing port of the R415 ventilator which connects to the source of medical oxygen or room air or leave disconnected to use room air. The gas flow enters the cylinder through this port during its aspirating stroke.

Caution: Keep the gas source port unobstructed. Keep the piston running normally when connects to external gas source!

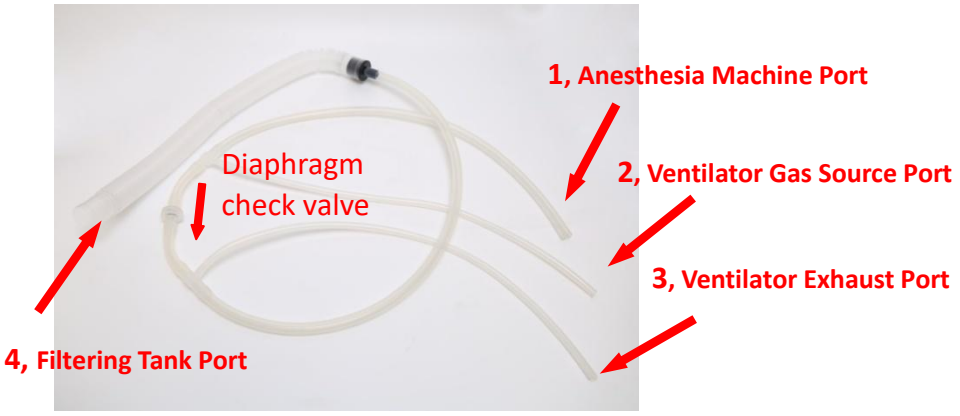
Output To Animal: Output port of gas flow from ventilator to the animal.

Input from Animal: Input port of expired gas from animal to ventilator.
Exhaust: Port to release the expired air from the ventilator. Expired gas may be vented to the room or filtered in the waste gas scavenging apparatus (filtering tank).

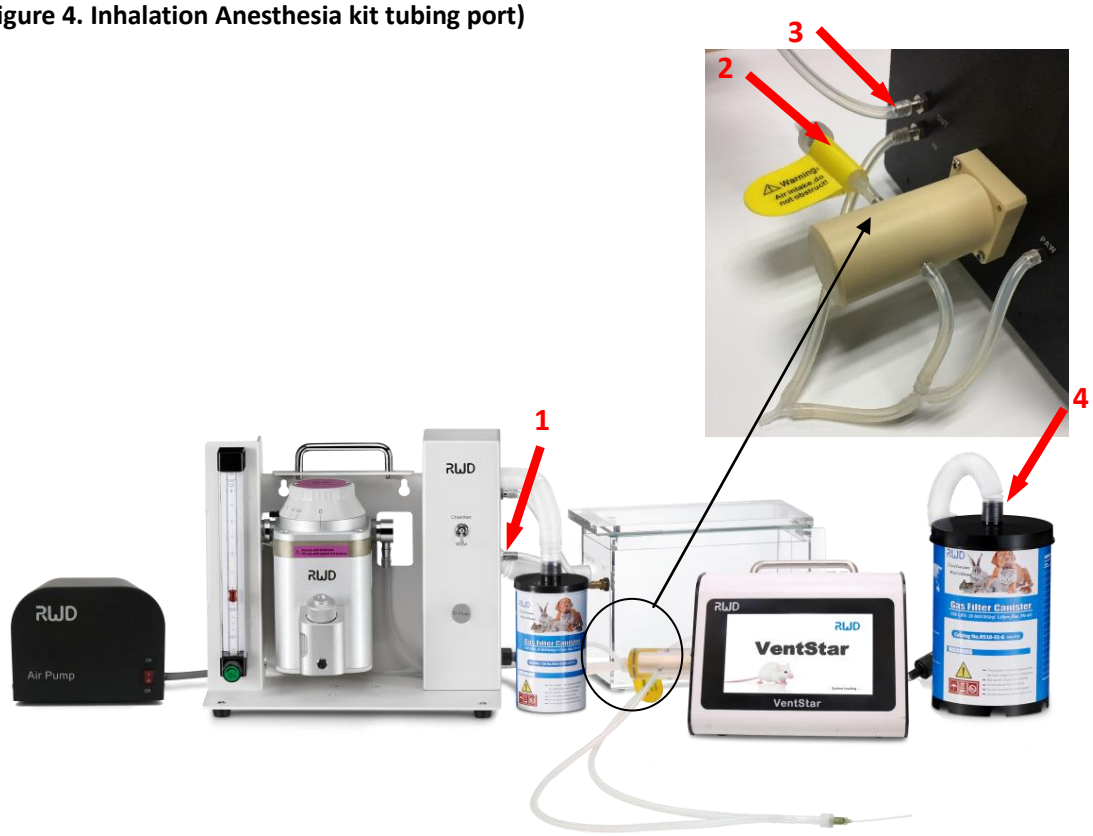
⚠ **Caution:** When anesthesia gas is used with the R415 ventilator, vent expired anesthesia gas to filtering tank to ensure environmental security.

Airway pressure: port to measure the airway pressure.

2. When the user purchases optional R415-AP inhalation anesthesia kit, it will enable the user to combine the anesthesia machine and R415 ventilator, which use inhalation anesthesia gas as a source during ventilation. See the connection as follows (Figure 4 & Figure 5)

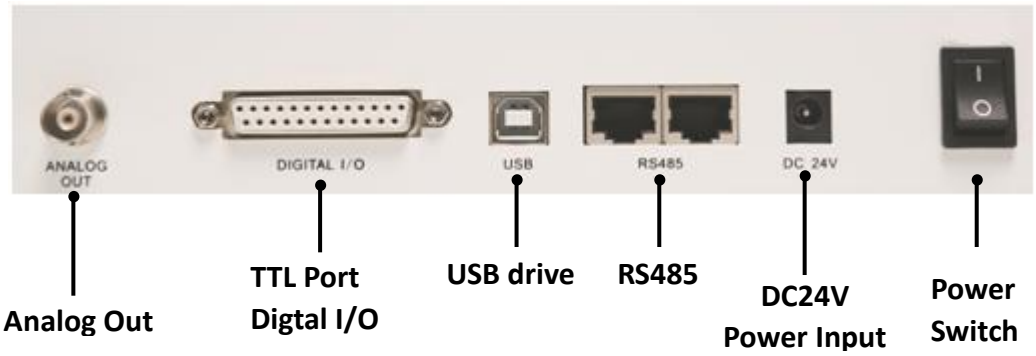


(Figure 4. Inhalation Anesthesia kit tubing port)



(Figure 5. Tubing connections to the anesthesia machine and ventilator)

6.5 Rear Panel details



7. User Interface

7.1 System booting interface

Figure 7.1

Connect the R415 ventilator to 24V DC power supply, turn on the main power switch on the rare panel, The equipment enters the booting interface, the system will automatically initialize and reset the motor, then enters the main user interface after the self-check phase successfully passed.

7.2 Main Menu

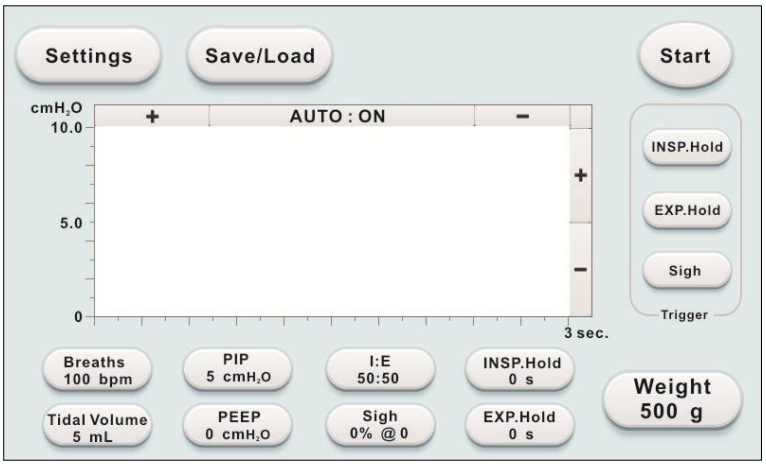


Figure 7.2

Enter "Main Menu", wait for the piston, cylinder and other internal components return to the home position, then the user can prepare system settings and the airway tubing connections.

7.3 Settings Menu

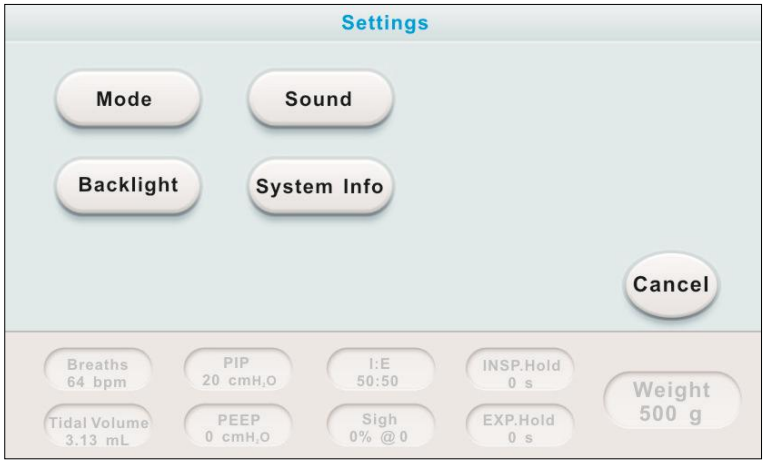


Figure 7.3

Press the **Setting** button on the top left of the main menu (see Figure 7.2), enter the **Settings** submenu where the user can set or view the **Mode**, **Sound**, **Backlight**, and **System Info**.

7.3.1 Volume Mode

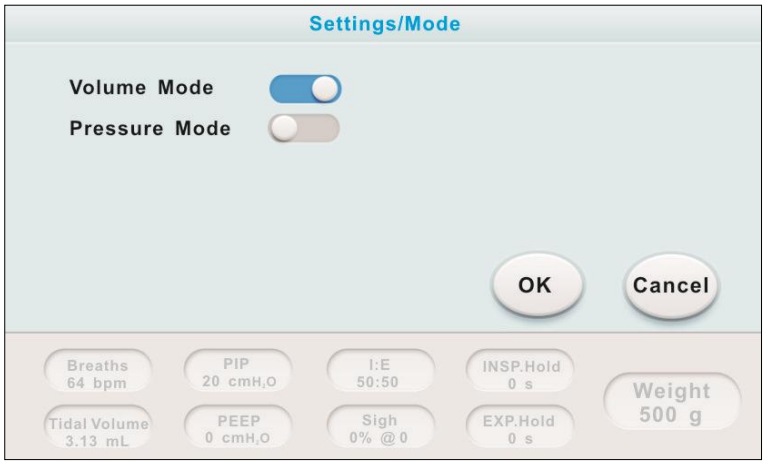


Figure 7.4

- Enter mode selection submenu by press **Mode** button in the Settings Menu (see Figure 7.3), the user can switch ventilation mode between **Volume Mode** and **Pressure Mode**.
- Activate the confirmation slider besides the corresponding mode to choose it.
- In **Volume Mode**, the ventilator will execute constant volume output according to the tidal volume set by the user. In **Pressure Mode**, the ventilator will automatically adjust the output volume according to the user's set value of the airway pressure.

7.3.2 Sound Settings

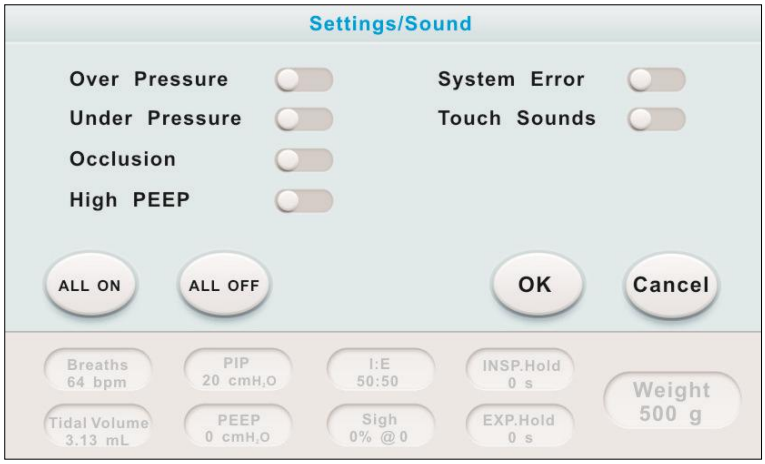


Figure 7.5

- Enter sound control submenu by press **Sound** button in the Settings Menu (see Figure 7.3), the user can choose to activate audible alarms on **Over Pressure** (high airway pressure)/ **Under Pressure** (low airway pressure) / **Occlusion** (pipeline blocked) / **High PEEP** (high expiratory pressure) / **System Error** (system error alarm) / **Touch Sounds** (touch button tone).
- The user can articulate all alarms by pressing **ALL ON** button while mute all alarms by pressing **ALL OFF** button.

7.3.3 Backlight

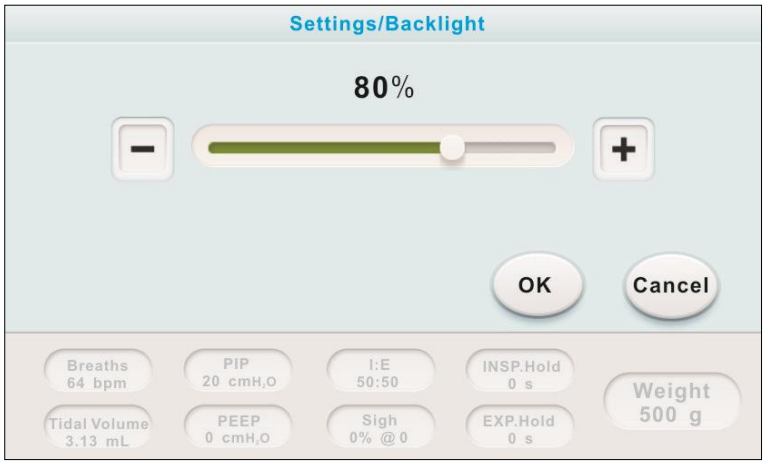


Figure 7.6

Enter backlight control submenu by press **Backlight** button in the Settings Menu (see Figure 7.3), the user can select a desired backlight brightness from 20% to 100% in the slider.

7.3.4 System Information

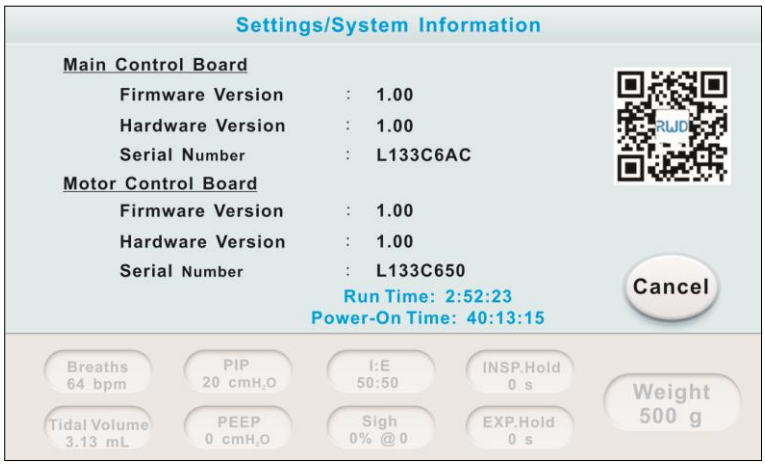


Figure 7.7

Enter system information submenu by press **System Info** button in the Settings Menu (see Figure 7.3), it allows the user to view the software version, power-on time and run time information.

7.3 Save and Load

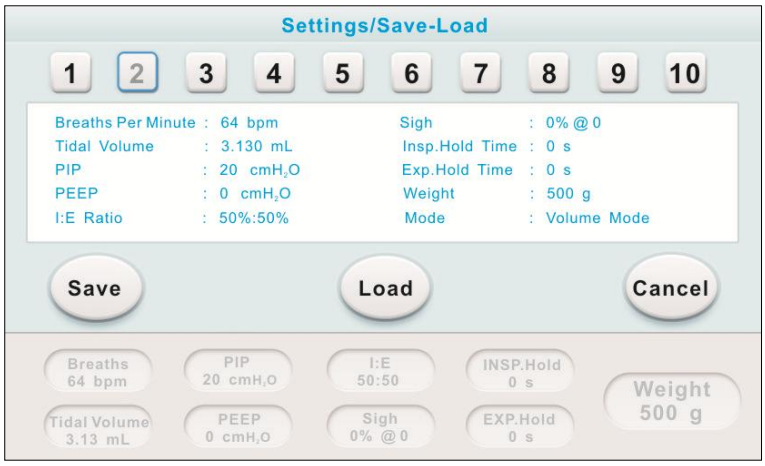


Figure 7.8

- Press the **Save-Load** button in the main menu (see Figure 7.2), enter the **Save-Load** submenu where the user can respectively save 10 groups of ventilation parameters.
- When a current ventilation parameter needs to be stored, users can press the **Save-Load** button (see Figure 7.8). Select a group number (1 to 10), then press **Save** button; when a stored ventilation parameter is needed, user can press **Save-Load** button (see Figure 7.8), Select the corresponding group number (1 to 10), then press the **Load** button.

7.4 Operation

7.4.1 Smart Parameters Setting

(body weight within 500g, needs manually setting when heavier than 500g)

Figure 7.9

The R415 ventilator **Smart Parameter Setting** function allows the user to input the weight of the animal only, the ventilator will automatically sets the ventilation

parameters **Breaths** (breathing rate)/ **Tidal Volume**. This function works in both volume and pressure mode. In volume mode, **Breaths** and **Tidal Volume** can be set automatically. In pressure mode, only **Breaths** can be automatically set.

- Press the **Weight** button in the main menu (see Figure 7.2), enter the weight submenu (see Figure 7.9) where the user can set the weight of animal in the range of 10g to 500g.
- After the weight setting, press **OK** button to accept and return to the main menu.

⚠ **CAUTION: Smart Parameters Setting** function cannot automatically set PIP, please set proper parameters other than breathing rate and tidal volume to avoid commit harm to the animals.

7.4.2 Breathing Rate setting

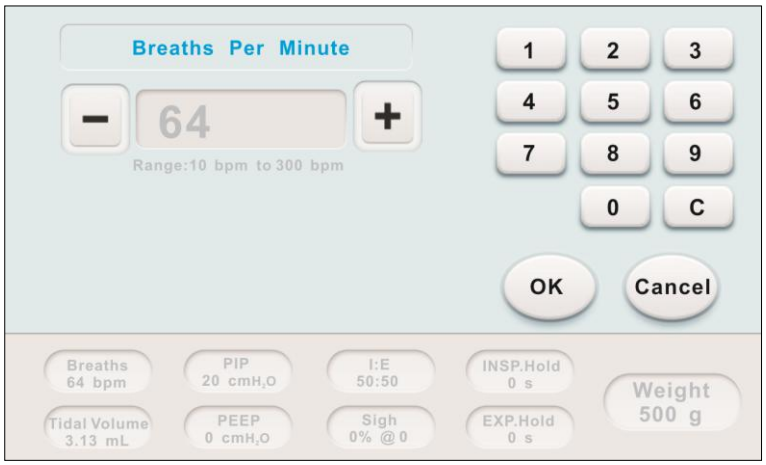


Figure 7.10

- Press the **Breaths** button in the main menu (see Figure 7.2), enter the breathing rate submenu (see Figure 7.10) where the user can set the desired breathing rate in the range of 10bpm to 300bpm.
- After the breathing rate setting, press **OK** button to accept and return to the main menu.

7.4.3 Tidal Volume Setting（Volume Mode）

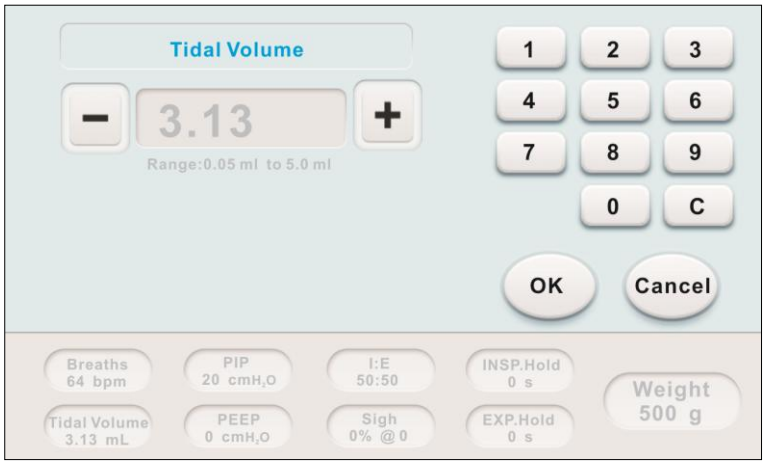


Figure 7.11

- Press the **Tidal Volume** button in the bottom right corner of main menu (see Figure 7.2), enter the tidal volume submenu (see Figure 7.11) where the user can set the desired tidal volume in the range of 0.05ml to 5ml.
- After the tidal volume setting, press **OK** button to accept and return to the main menu.

⚠ **CAUTION:** Tidal Volume is only user defined in the Volume Mode. You cannot choose the Tidal Volume in Pressure mode as it is calculated to maintain the target peak inspiratory pressure (PIP).

7.4.3 Peak Inspiratory Pressure Setting

Figure 7.12

- Press the **PIP** button in the lower right of main menu (see Figure 7.2), enter the PIP submenu (see Figure 7.12) where the user can set the desired PIP in the range of 1cmH_2O to 50cmH_2O.
- After the PIP setting, press **OK** button to accept and return to the main menu.

Note: PIP can be set in both Volume Mode and Pressure Mode. In Volume Mode the PIP serves as a desired maximum PIP not to exceed. No matter how much the user set the tidal volume, when the PIP is reached in volume mode, the audible alarm will be activated, the piston will stop moving and full set volume will not be delivered.

7.4.4 I:E Ratio Setting

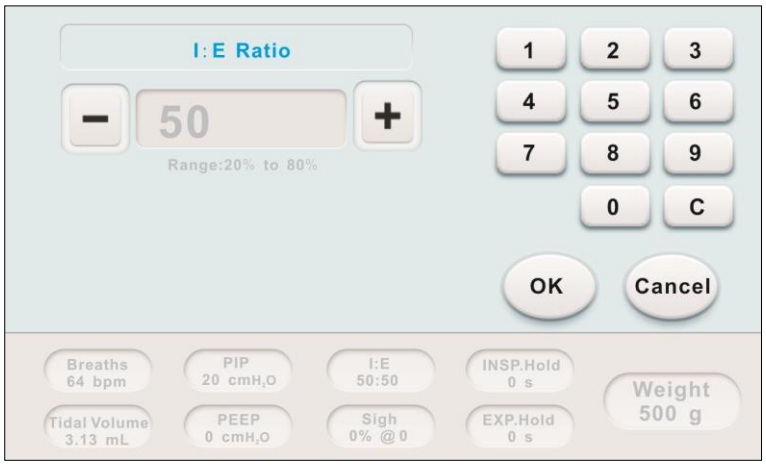


Figure 7.13

I:E ratio allows the user to control the inspiration time and expiration time in each respiratory period, default ratio is 50%:50%.

- Press the **I:E** button in the main menu (see Figure 7.2), enter the I:E ratio setting submenu (see Figure 7.13) where the user can set the desired I:E ratio in the range of 20% to 80%.
- After the I:E ratio setting, press **OK** button to accept and return to the main menu.

Note: System will limit the range of optional I:E ratio depending on the respiration rate, the user can set appropriate I:E ratio accordingly.

7.4.5 Sigh breath Setting

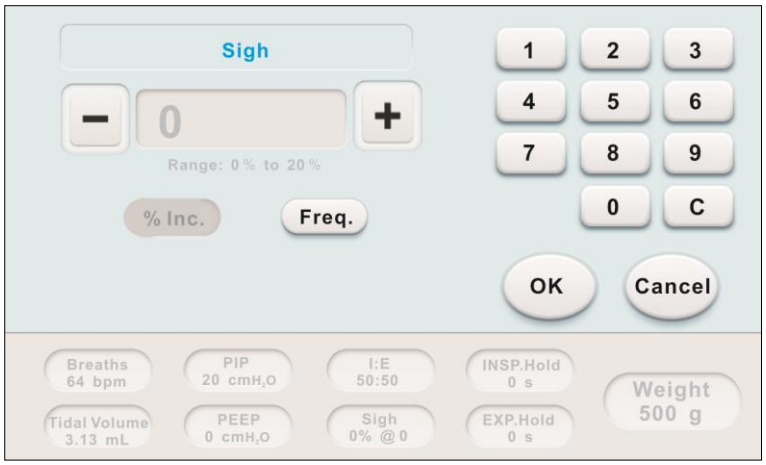


Figure 7.14

- Press the **Sigh** button in the main menu (see Figure 7.2), enter the sigh breath setting submenu (see Figure 7.14) where the user can set the desired sigh breath volume increase (% Inc.) and sigh breath frequency (Freq.).

Note: Sigh breath can be set in both Volume Mode and Pressure Mode. Sigh breath volume increase %Inc. optional range is 0% to 20%. Sigh breath frequency Freq. optional range is 10-999. Set the Freq. as 0 when manual sigh breath frequency is needed.

In Volume Mode the entered sigh is a percentage increase in the tidal volume.

In Pressure Mode the entered sigh is a percentage increase in the PIP.

- After the sigh breath volume and frequency setting, press **OK** button to accept and return to the main menu.

7.4.6 Inspiratory/Expiratory Hold Setting

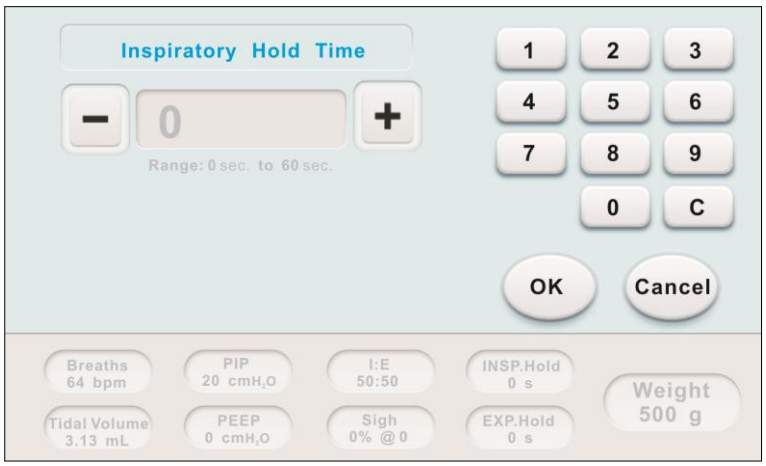


Figure 7.15

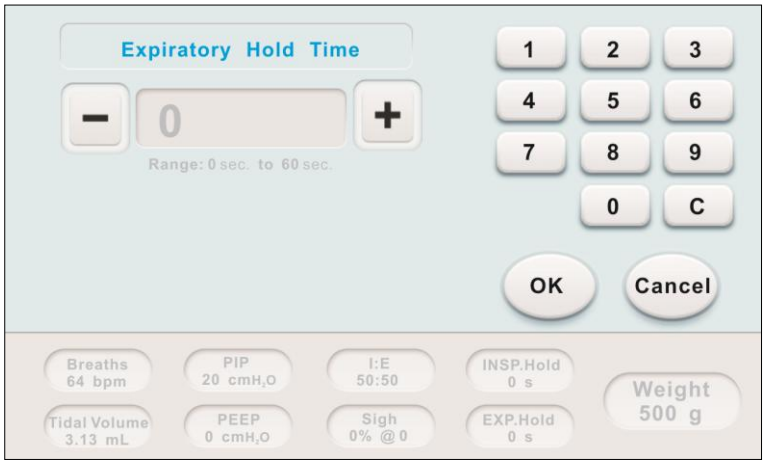


Figure 7.16

- Press the **INSP.Hold** button in the lower left of main menu (see Figure 7.2), enter the inspiratory hold setting submenu (see Figure 7.15) where the user can set the desired inspiratory hold time in the range of 0 to 60sec.
- Press the **EXP.Hold** button in the lower left of main menu (see Figure 7.2),

enter the expiratory hold setting submenu (see Figure 7.16) where the user can set the desired expiratory hold time in the range of 0 to 60sec.

- After the INSP.Hold and EXP.Hold time setting, press **OK** button to accept and return to the main menu.

Note: Inspiratory/Expiratory Hold can be set in both Volume Mode and Pressure Mode. Return to main menu after setting (see Figure 7.2). In the right field of the screen, "Trigger Zone" will show the real-time status of inspiratory/expiratory hold function, and allows one-click trigger of it. Inspiratory/expiratory hold function not available when the sigh breath function is running,

7.4.7 Positive End-Expiratory Pressure (PEEP) Setting

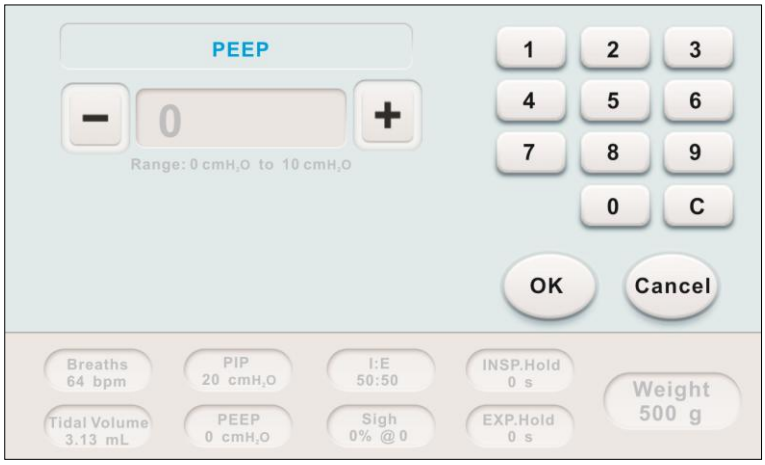


Figure 7.17

- Press the **PEEP** button in the main menu (see Figure 7.2), enter the Positive End-Expiratory Pressure (PEEP) setting submenu (see Figure 7.17) where the user can set the desired PEEP in the range of 0 to 10cmH_2O.
- After the PEEP setting, press **OK** button to accept and return to the main menu.

Note: The maximum PEEP value will lower than current PIP value; when expiratory hold function is running, the hold pressure will be PEEP value.

7.4.8 Curve Adjustment

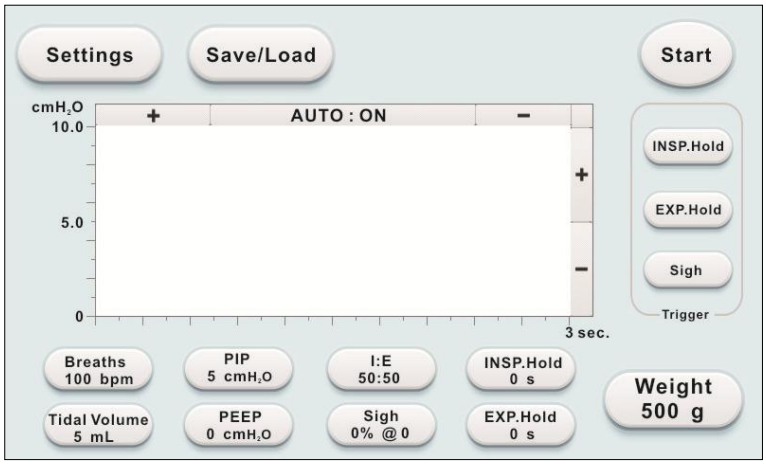


Figure 7.18

- Real-time display Pressure-Time Curve in main menu curve window (see Figure 7.18), Switch auto curve adjustment on and off by press the **AUTO** button on the upper frame of the curve window (**AUTO:ON** / **AUTO:OFF**).
- Press the "+/-" button on the upper frame of the curve window to adjust X-axis coordinate (time scale); press the "+/-" button on the right frame of the curve window to adjust Y-axis coordinate (airway pressure).

8. Experimental Operating

8.1 Pre-experimental Preparation

The R415 small laboratory animal ventilator features multiple functions such as Breathing Ratio, Tidal Volume, I:E Ratio, PIP, PEEP, INSP. / EXP.Hold and Sigh Breath. It works with a sealed piston-type cylinder which allows Volume / Pressure two ventilation modes.

It is recommended that the user read this manual carefully before using the ventilator in animal experiments and fully understand its operating protocol. Further, know when and how to use each parameter.

If you are new to the ventilator for the first time, let's get started from some basic settings and principles of the ventilator.

8.2 Initial Setting

To avoid pulmonary over-inflate of the animal during the ventilation process, use

following criterions to judge pulmonary expansion status: Observe the Pressure-Time curve on the ventilator screen as the lung expands or contracts; or observe whether there is water vapor on the inner surface of the tracheal intubation tube. After tracheal intubation succeeds, connect endotracheal tube to the ventilator to initiate intermittent positive pressure ventilation (IPPV).

⚠ **CAUTION: Before connecting the endotracheal tube into the airway of the ventilator, make sure to set appropriate breathing parameters in the ventilator! Or use the Smart Parameter Setting function (default parameters for reference only!), enter the animal's weight, set a suitable PIP value and other parameters!**
See following Table (1): Query-table for tidal volume, weight and breathing rate setting (Volume Mode).

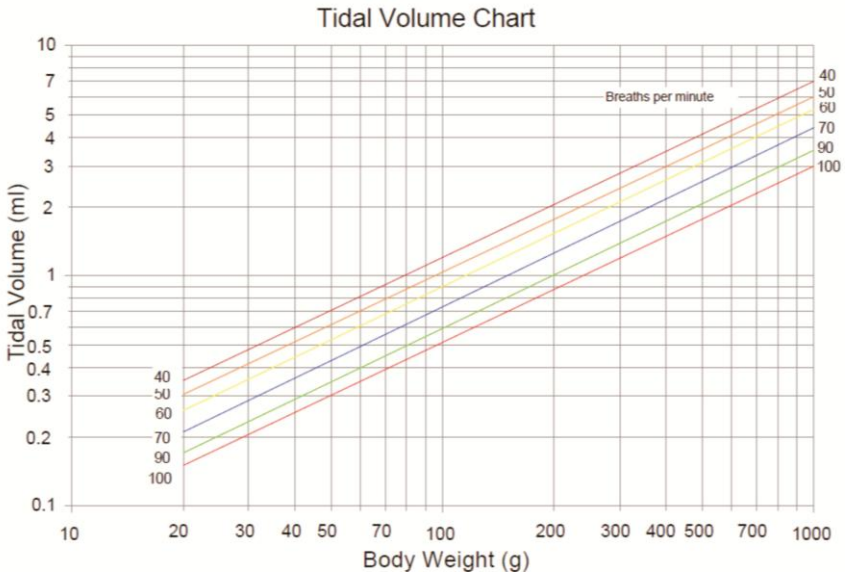


Table (1)

In Pressure mode, the R415 ventilator will deliver the starting tidal volume determined by the use offered respiration rate, see the following Table (2). The R415 will adjust the actual tidal volume from these starting points accordingly to the user offered PIP value.

Respiration Rate	Starting Tidal Volume
0～74	3 ml
75～99	2 ml
100～149	0.5 ml
150～199	0.1 ml
200～300	0.05 ml

Table (2)

Other ventilation parameters reference: recommend set system default I: E ratio as 50: 50%, the user can manually set the appropriate PEEP/Sigh/INSP. Hold and EXP. Hold value if a special experiment is needed.

8.3 Start Running

Once the desired parameters have been set, the appropriate tubing has been connected (see Figure 3), press the **Start** button in top right of the main menu (see Figure 7.18), the R415 will start intermittent positive pressure ventilation (IPPV) according to user entered parameters. Meanwhile, **Start** button will turn into **Stop** button, which allows the user to stop ventilation in the emergency.
During operation, the user can adjust the output tidal volume of the piston in real time. In Volume Mode, the user can directly adjust the "Tidal Volume" and set the appropriate respiratory rate and PIP value; In Pressure mode, the user can adjust output tidal volume by direct tune PIP value. Pay attention to the animal's respiratory status and the Pressure-Time Curve on the screen during the adjustment process and make fine-tuning of the respiratory parameters.
The R415 small animal ventilator allows tracheal intubated animal have spontaneous breath when the ventilator stop running.

WARNING!

Prohibition of setting exorbitant tidal volume or exorbitant PIP value pre or during ventilation, for this operation will cause severe expansion or even rupture of the animal's lungs!
The user may pre-set a low PIP value or a low output tidal volume, during ventilation, pay attention to real-time Pressure-Time Curve, gradually increase PIP value or increase output tidal volume if necessary!
Prohibition of prolonged apnea except special experiment requires, for this operation will cause adverse effects on animal breathing!
Prohibition of use high pressure or high flow capacity mixed gas as a source of the ventilator, for this will cause piston failures.

⚠ **CAUTION：Prohibition of use high pressure or high flow capacity mixed gas as source of the ventilator.**

8.3.1 Alarm Prompt and Coping Strategy

When there is an alarm during the ventilation, an error code and a red text prompt will appear on the LCD screen, which means the equipment encountered with an abnormal situation.

Error type and correspond coping strategy：

Error type	Coping strategy
Ventilator will	Check for the power supply is loosen plugged. Check for power

not power on	supply and line cord are not fully connected.
Under Pressure	Check for leak in tubing. Check for leak in the intubation or tracheotomy.
Over Pressure	Check for blockage or kink in tubing. Ensure that the tubing between the ventilator and the animal is short enough.
Occlusion	Check for blockage at gas source port or between the ventilator and the animal.

Table (3)

9. Clean and Maintenance

9.1 Equipment Cleaning

There is no direct expired gas contact on the ventilator except Piston, Cylinder, Exhaust, and Output to Animal port.

To clean and maintain the equipment, use a cloth to remove the greasy filth. To clean exterior surfaces, use a clean soft cloth dampened (not soaked) with water or neutral detergent (only neutral detergent is allowed) to remove dust.

WARNING!

Only water or neutral detergent is allowed to use in cleaning piston and cylinder, use a soft cloth, and avoid use rough cloth or strong detergents. Prohibition of using alcohol (ethanol) in cleaning.

Cylinder/Piston Cleaning: Remove the cylinder fixation screws, gently pull the cylinder outward, and then separate the piston from the cylinder (keep move slow and gentle in this step). Forbid the use of alcohol (ethanol) or high-temperature sterilization to prevent the cylinder deformation or rupture. Merely wipe it with a lint-free cloth or with a neutral detergent, then wash it with clean water.

Once cleaned, be sure to allow the piston and cylinder to dry completely. Once dry, gently place the piston into the cylinder, and use original screws to fix the cylinder to the original location in ventilator. Then connect the power supply to make sure successful restart and self-check.

⚠ **CAUTION：** Prohibition of using alcohol (ethanol) in cleaning outer/inner surface of the piston and the cylinder!

9.2 Use and Maintenance of Power Supply

The R415 ventilator utilizes AC to DC power supply adaptor, input voltage 100 ~ 240VAC, 50/60Hz, 1.0A, output voltage DC24V, 1.67A, 40W MAX.

Power supply adapter has passed the security and environmental certifications.

⚠ **CAUTION：Connect the power cord firmly to the power supply adapter before get it plugged into the electric outlet. After plugged in, observe whether the indicator light of the adapter is on. Ensure that the main power switch of the equipment is turned off when the adapter DC plug is connected to the equipment!**

⚠ **CAUTION：To ensure the safe operation of the equipment, please use the standard power supply adapter!**

When using or maintaining the DC adapter, please follow the notes below:

1. Avoid intense chemicals.
   Do not clean the adapter with intense chemicals, cleaning agents or strong detergents. Use a soft cloth dampened with water to remove dust on the exterior. Once cleaned, dry it and keep it dry for storage.
2. Avoid moisture and water.
   Water percolation or prolonged expose in the humidity environment will cause its internal electronic components corrosion and oxidation.
3. Avoid drop and impact.
   Plastic shell is vulnerable to violently drop or impact.
4. Release static electricity before cleaning.
   Periodically clean the ventilator and adapter connection port, use a dampened cloth, or an anti-static cloth. Do not use dry rag!
5. Avoid extreme temperature
   Do not place the power supply adapter in overheat room. High temperature shortens the life-span of the electronics and deforms the plastic parts. Do not place it in a subcooled room, either, moisture builds up inside the adapter which will corrode the circuit board.

Poor contact may emerge on the connection port of DC adapter after repeated pulling and plugging.

Please contact your local supplier or RWD if following phenomenon emerge:

1. Indicator light does not illuminate after power cord and DC adapter connect to the current source.
2. Connection port of DC adapter loosen up, abnormal power contact, frequent auto-switch;

3. Severe heat, smoke or burnt smell within a short time after connect to current source;
4. Shell of DC adapter damaged or cracked.

9.3 Electronic Component Recycling

Dispose the DC adapter properly when it has obvious damage or need replacement. Please follow the corresponding regulations when disposing condemned adapter,

WARNING!

Do not disassemble, burn or short-circuit the DC adapter. Combustion or explosion of DC adapter may cause physical injury.

10 .Troubleshooting

10.1 Error Alarms

The R415 ventilator utilizes a menu type displayed and controlled touch screen, features a variety of respiratory parameters, with pressure sensor built-in, which provide safe and effective IPPV.

In order to secure the use of the equipment and the ventilation process of the animal, or to prompt errors during operation, the R415 ventilator utilizes sound alarms, error codes query and text prompts.

Please refer to the following <Troubleshooting Table> for inspection and resolution, if the error still cannot be fixed, please contact RWD personnel.

Table (4) Troubleshooting Table

Error	Error Code	Text	Error Type	Text color	Solution
Communication interrupted	XXXXXXXX XXXXXXX1	COMM. Error	System Error	Red	Shut down, restart, or clear the error in main menu
MOTO1 abnormal operation, BPM error	XXXXXXXX XXXXXX1X	Motor 1 stall	System Error	Red	Shut down, restart, or clear the error in main menu
MOTO1 reset failed	XXXXXXXX	Motor 1 Reset Error	System	Red	Shut down, need restart

Error	Error Code	Text	Error Type	Text color	Solution
	XXXXX1XX		Error		
MOTO2 reset failed	XXXXXXXX XXXX1XXX	Motor 2 Reset Error	System Error	Red	Shut down, need restart
MOTO2 exceed MAX	XXXXXXXX XXX1XXXX	Volume Error	System Error	Red	Reset Motor 2
MOTO2 exceed MIN	XXXXXXXX XX1XXXXX	Volume Error	System Error	Red	Reset Motor 2
Occlusion: Airway or Valve pressure > 130% PIP && ≥ 1.5 cmH_2O lasting 100ms	XXXXXXXX X1XXXXXX	Occlusion	Occlusion	Red	Release airway gas, shut down, restart, or clear the error in main menu
Pressure exceed 100% PIP; Volume Mode	XXXXXXX1 XXXXXXXX	Over Pressure	Over Pressure	Red	Release airway gas
Pressure exceed 90% PIP; Volume Mode	XXXXXX1X XXXXXXXX	Over Pressure	Over Pressure	Yellow	No
Pressure exceed 120% PIP && ≥ 1 cmH_2O: Pressure Mode, non-Sigh.	XXXXX1XX XXXXXXXX	Over Pressure	Over Pressure	Red	Release airway gas
Pressure exceed 110% PIP && ≥ 1 cmH_2O: Pressure Mode, non-Sigh.	XXXX1XXX XXXXXXXX	Over Pressure	Over Pressure	Yellow	Release airway gas
PIP 10% lower than set value after pressure balanced.	XXX1XXXX XXXXXXXX	Under Pressure	Under Pressure	Red	No
PIP 20% lower or 10% higher than set value after pressure balanced.	XX1XXXXX XXXXXXXX	Under Pressure	Under Pressure	Yellow	No
In Pressure Mode, Maximum tidal volume pressure < 90% PIP && < 0.5 cmH_2O	X1XXXXXX XXXXXXXX	Under Pressure	Maximum Volume	Red	No
PEEP > PEEP+1 cmH_2O	1XXXXXXX XXXXXXXX	High PEEP	High PEEP	Yellow	No

Error code is displayed in hexadecimal. E.g. communication interrupted or PIP 10% lower than set value in volume mode, it will display 10001001

11. Return to factory for maintenance

Prohibition of return the ventilator or related components to RWD company in unauthorized condition. Please contact RWD personnel for authorization before return.

Please prepare and provide the following information when returning an equipment back to RWD for maintenance:

a). Serial number of the equipment, instruction manual.

b). The problem description, return reason and the request for repair.

c). The contact information of the corresponding executor (phone number and detailed address).

d). Please provide contact information of the If costs involved, (telephone and address details)

⚠ **Note**: Please properly package the equipment or components before return delivery, to avoid secondary damage in transition!