LTV® 1200 / 1150 Ventilator

Service Manual

CardinalHealth

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User/Owner Responsibility

This manual is intended for use only by service personnel who have been trained and authorized by Pulmonetic Systems to service the LTV® 1200/1150 ventilator. Pulmonetic Systems does not condone or approve of service activity on its products by untrained and unauthorized personnel. **Pulmonetic Systems is not responsible for any unauthorized repairs or any repairs made by unauthorized procedures.**

Use of an incorrect part or failure to exercise due care in the installation, removal, servicing, checkout or calibration of parts and equipment may result in damage or malfunction of the equipment. This may also result in damage to property and injury including death.

The purchaser and installer of these parts shall bear full responsibility and liability for the above. All maintenance performed within the applicable warranty period must be authorized in advance by a Pulmonetic Systems' Service representative in order to retain the warranty status of the subject unit.

Warranty

Pulmonetic Systems warrants that the LTV® 1200/1150 ventilator is free from defects in material and workmanship for a period of one (1) year from the date of shipment, or 8,800 hours as measured on the usage meter, whichever comes first, with the following limitations:

- The battery is warranted for ninety (90) days from date of shipment.

Pulmonetic Systems will, at its option, either repair, replace, or issue credit for products that prove to be defective during the warranty period.

For warranty service or repair, the product must be returned to Pulmonetic Systems or a service facility designated by Pulmonetic Systems, shipping prepaid by the Buyer.

LIMITATION OF WARRANTY

Ordinary maintenance, as specified in the LTV® 1200/1150 Ventilator Operator's and Service Manuals, is not covered under the foregoing warranty

The foregoing warranty does not apply to defects resulting from:

1) Improper or inadequate maintenance of the unit;
2) Improper use or misuse of the unit;
3) Unauthorized modifications or repair to the unit;
4) Use of the unit with unauthorized accessories, e.g. external battery or AC adapter.
5) Operation of the unit outside the specified environment.

NO IMPLIED WARRANTIES

This warranty is exclusive. There are no other warranties expressed or implied.

LIMITATION OF LIABILITY

Pulmonetic Systems shall not be liable for loss of profits, loss of use consequential damages, or any other claim based on breach of warranty. Pulmonetic Systems' liability for damages of any kind shall be limited to the purchase price of the defective unit.

Notices

The LTV® 1200/1150 ventilator complies with limitations as specified in IEC 601-1-2 for Medical Products. It does however, use and radiate radio frequency energy.

The function of this machine may be adversely affected by the operation of other nearby equipment, such as high frequency surgical diathermy equipment, short-wave therapy equipment, defibrillators or MRI equipment.

CE 0086

European Regulatory Requirements per 93/42/EEC Medical Device Directives

Pulmonetic Systems European Representative for vigilance reporting within the European Community is:

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Any product malfunctioning issues that fall under Medical Device Directives Essential Requirements should be directed to MediMark.

Notice to Users

Unsafe Operation - Servicing the LTV® 1200/1150 ventilator without a complete and thorough understanding of its attributes may result in unsafe operating conditions. It is important that this manual be read and understood in its entirety before servicing the ventilator.

Warnings and Cautions Section - Read the section on **Warnings** and **Cautions** carefully before attempting to service or operate the LTV® 1200/1150 ventilator. General warnings and cautions which apply any time you use the ventilator are listed in the front of this manual. General and specific warnings and cautions also appear throughout the text where they are most meaningful.

Use and Maintenance - Any questions regarding installing, setting up, operating, or maintaining the LTV® 1200/1150 ventilator, should be directed to a service technician who has been trained and certified by Pulmonetic Systems to service the LTV® 1200/1150 ventilator or Pulmonetic Systems using the contact information at the front of this manual.

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Chapter 1 - INTRODUCTION

This manual describes how to perform routine maintenance, troubleshooting, and repairs on the LTV® 1200/1150 ventilator. It is designed for use by service personnel who have been trained and authorized by Pulmonetic Systems. **Do not perform any of the procedures in this manual unless you are trained and authorized for service on LTV® 1200/1150 ventilators.**

This manual contains what you need to know to:

1) Perform preventative maintenance.
2) Calibrate the ventilator.
3) Perform routine troubleshooting.
4) Remove and replace major components of the ventilator.

See the LTV® 1200 Ventilator Operator's Manual (P/N 18247-001) or the LTV® 1150 Ventilator Operator's Manual (P/N 19159-001) for information on setting up and operating the ventilator.

Getting Assistance

If a problem occurs while maintaining the LTV® 1200/1150 ventilator or if you require additional information, contact a service technician who has been trained and certified by Pulmonetic Systems to service the LTV® 1200/1150 ventilator or Pulmonetic Systems at:

Cardinal Health

Pulmonetic Systems

17400 Medina Rd., Suite 100

Minneapolis, Minnesota 55447-1341

Phone:	(763) 398-8500
Office Fax:	(763) 398-8400
Customer Care Center Phone:	(800) 754-1914, ext. 2
Customer Care Center Fax:	(763) 398-8403
Sales/Marketing E-mail:	info@pulmonetic.com
Customer Care Center E-mail:	service@pulmonetic.com
Pulmonetic Systems Website:	http://www.pulmonetic.com

Operator’s Safety Information

All Operators must read and understand the following information about Warning, Caution and Note statements before operating the LTV® 1200/1150 ventilator.

General warnings and cautions which apply any time you use the ventilator are listed here. General and specific warnings and cautions also appear throughout this manual where they are most meaningful.

WARNING

“**Warning**” statements contain information about circumstances or practices that may cause serious and undesirable results, or expose the patient or operator to danger.

CAUTION

“**Caution**” statements contain information about circumstances or practices that may result in equipment damage.

NOTE

“**Note**” statements contain additional information to assist in the proper operation of the ventilator.

WARNING

Ventilator Service and Repair - Only service technicians who have been trained and certified by Pulmonetic Systems to service the LTV® 1200/1150 ventilator are authorized to perform repairs or maintenance on the LTV® 1200/1150. Do not attempt to repair or replace any part of the ventilator unless you are trained and certified to do so by Pulmonetic Systems. Personal injury could result.

Fire or Explosion - Operation of the ventilator in the presence of flammable gases could cause a fire or explosion. Under no circumstances is the ventilator to be operated when explosive gases are present. The presence of nitrous oxide or flammable anesthetics presents a danger to the patient and operator.

Untrained Personnel – Only properly trained personnel should operate the ventilator. The LTV® 1200/1150 ventilator is a restricted medical device designed for use by Respiratory Therapists or other properly trained and qualified personnel under the direction of a physician and in accordance with applicable state laws and regulations.

Unauthorized Parts or Accessories – Serious harm to the patient may result from the use of unauthorized parts or accessories. Only items expressly approved by Pulmonetic Systems may be used in conjunction with the LTV® 1200/1150 ventilator.

Ventilator Checkout Tests – Be aware that gas is not delivered to the patient during these tests. Disconnect the patient from the ventilator and ventilate using an alternative method before running the Ventilator Checkout tests.

Ventilator Checkout and Maintenance Modes - The LTV® 1200/1150 ventilator does not deliver gas during the Ventilator Checkout mode (**VENT CHECK**) or Ventilator Maintenance mode (**VENT MTNCE**) and should not be used to ventilate a patient during these tests.

Mounting Screw Use – Internal damage to the ventilator may result if wrong length mounting screws are used to secure parts or accessories. Refer to the information contained in Replacement Screws Kit, P/N 11149, to determine the appropriate accessories mounting screws or accessories replacement screws to use when removing or exchanging external accessories on an LTV® 1200/1150 ventilator.

CAUTION

Electrical Grounding –Loss of protective ground could result in electrical shock. Only use the unmodified power supplies and cords supplied for the LTV® 1200/1150 ventilator, maintained in good condition and connected to a properly wired and grounded electrical power outlet.

Fuse Fire Hazard – Replacement of existing fuses with fuses of different voltage or electrical current ratings may cause a fire.

Storage Temperature - Storing the LTV® 1200/1150 ventilator at temperatures above 60°C (140°F) for long periods can damage the LTV® battery and cause battery duration to degrade.

Patient Assist Call Connector – Do not apply more than 25V rms or 32VDC to the Patient Assist Call connector.

CLEAR Function Cautions - The **CLEAR** function should be used with great care as once a section of the memory is cleared, all data in that section of memory is lost and it cannot be automatically restored.

Electronic and Mechanical Parts - The LTV® 1200/1150 ventilator contains delicate electronic and mechanical parts that must be handled properly to avoid damage. Follow the instructions given in this manual carefully and make sure to observe all instructions.

Opening the ventilator - Always turn the ventilator **OFF** and remove the external power before opening the ventilator case or attempting to service the ventilator.

Anti-static Precautions - Always wear a grounded anti-static wrist strap when handling the ventilator with the case open. Electrostatic discharge can damage the internal electronics.

Verification of Operation - After opening the ventilator and performing any maintenance, verify proper operation of the ventilator by performing the checks and calibrations recommended in *Chapter 9 - Final Checkout Test.*

Ventilator Sterilization – To avoid irreparable damage to the LTV® 1200/1150 ventilator, do not attempt to sterilize it.

Cleaning Agents – To avoid damaging the ventilator's plastic components and Front Panel, do not use cleaning agents containing ammonium chloride, other chloride compounds, more than 2% glutaraldehyde, phenols, or abrasive cleaners.

Ventilator Immersion - Do not immerse the ventilator in liquids.

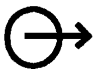
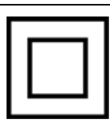
High pressure air nozzle – Only a low-pressure air nozzle with flow less than 10 liters per minute should be used around the ventilator. High pressure can damage the ventilator, in particular the differential pressure ports.

Front Panel – Do not pour or spray liquids onto the Front Panel.

Care of Bacterial Filters – If bacterial filters are used in conjunction with the LTV® 1200/1150 ventilator, comply with all recommended care procedures as specified by the filter manufacturer.

Wet or Damp Filters - Do not install any wet or damp filters into the LTV® 1200/1150 ventilator. This could damage the ventilator.

Software Version – Never install a version of software lower than that *originally installed* in the ventilator. Erroneous operation may result from use of incompatible software. LTV® ventilator software is generally designed to be backwards-compatible.

Symbol	Compliance[1]	Title	Application
	ISO 3864 (Prev. IEC 348) Symbol No. B.3.1	Caution (refer to accompanying documents)	Direct the user to the instruction manual where it is necessary to follow certain specified instructions where safety is involved.
	IEC 417 Symbol No. 417-IEC-5016	Fuse	Indicates the location of fuses.
	IEC 417 Symbol No. 417-IEC-5035	Output	Identifies an output terminal when it is necessary to distinguish between inputs and outputs.
	IEC 417 Symbol No. 417-IEC-5019	Protective earth (ground)	To identify any terminal which is intended for connection to an external protective conductor for protection against electric shock in case of a fault or the terminal of a protective earth (ground) electrode.
	IEC 417 Symbol No. 417-IEC-5333	Type BF equipment.	To mark type BF equipment complying with IEC Publication 601.
	IEC 417 Symbol No. 417-IEC-5031	Direct Current	Indicates on the rating plate that the equipment is suitable for direct current only; to identify relevant terminals.
	IEC 417 Symbol No. 417-IEC-5032	Alternating current	Indicates on the rating plate that the equipment is suitable for alternating current only; identifies relevant terminals.
	IEC 417 Symbol No. 417-IEC-5172	Class II equipment	To identify equipment meeting safety requirements specified for Class II equipment.
	IEC 60417 Symbol No. 5182	Sound; audio	Identifies controls or terminals related to audio signals.
	Directive 2002/96/EC	Waste Container	To identify Waste Electrical and Electronic Equipment (WEEE) that is not to be disposed of as unsorted municipal waste and is to be collected separately.

[1] Reference IEC Medical Electrical Equipment, 2nd. Edition 1988

Chapter 2 - VENTILATOR CHECKOUT TESTS

This chapter details test procedures that are initiated through the Vent Check menu and used to verify the proper operation of the LTV® 1200/1150 ventilator. These checkout tests are to be performed before using the ventilator on a patient and in accordance with recommended periodic maintenance and testing of the ventilator. See *Chapter 5 - Preventative Maintenance.*

The checkout test procedures are:

Test	**Test used to:**
Alarm Test	Verify that the audible alarm is working correctly.
Display Test	Verify that the ventilator displays are working correctly.
Control Test	Verify that the ventilator buttons and the **Set Value** knob are working correctly.
Leak Test	Test the patient circuit for leaks.
Vent Inop Alarm Test	Verify that the Vent Inop alarm is working correctly.

The Vent Check Menu is set up as follows:

VENT CHECK
- **ALARM**
- **DISPLAY**
- **CONTROL**
- **LEAK**
- **EXIT**

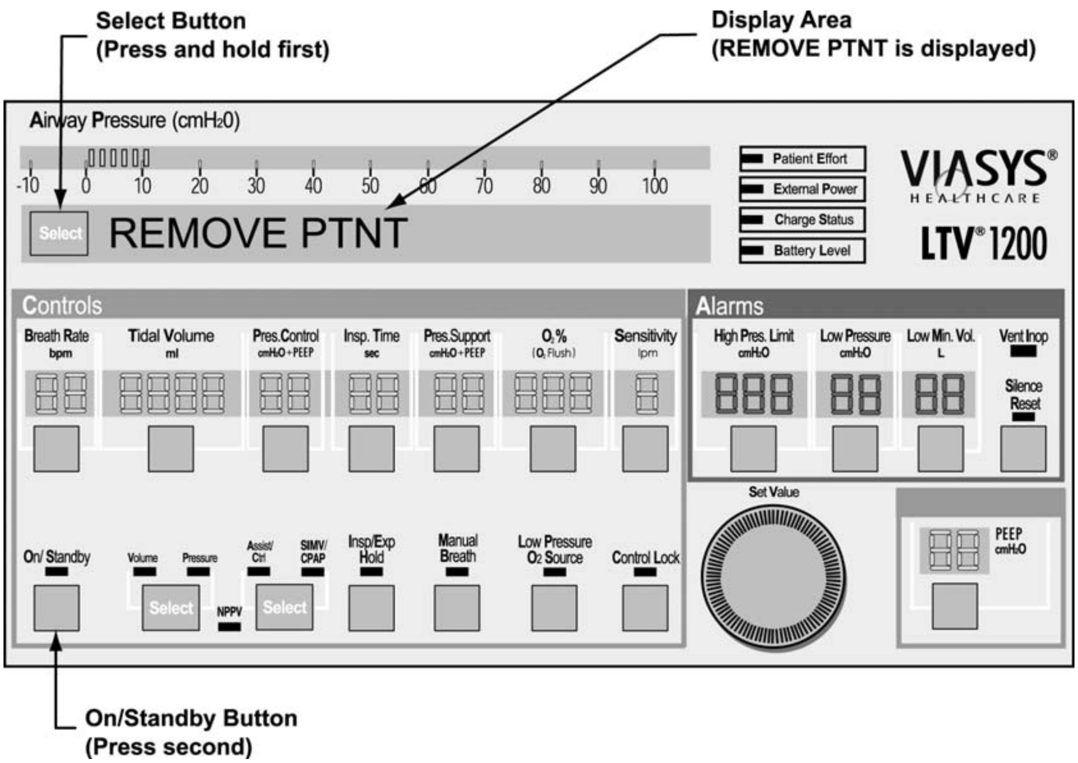
WARNING

Ventilator Checkout and Maintenance Modes - The LTV® 1200/1150 ventilator does not deliver gas during the Ventilator Checkout mode (**VENT CHECK**) or Ventilator Maintenance mode (**VENT MTNCE**) and should not be used to ventilate a patient during these tests.

To enable the ventilator checkout menu:

To enter the ventilator checkout (**VENT CHECK**) menu, a special power on sequence is required.

1) Disconnect the patient from the ventilator and ventilate using an alternative method.
2) With the ventilator off, connect the AC adapter to the ventilator and plug it in to a valid AC power source. Verify that the **External Power** and **Charge Status** LEDs are illuminated or flashing.
3) Press and hold down **Select**. While holding **Select**, press **On/Standby** to turn the ventilator on.



- **REMOVE PTNT** is displayed; if it does not display, repeat steps 2 through 4.
- An audible alarm (alternating on/off tone) sounds while **REMOVE PTNT** is displayed.

4) Clear the alarm by pressing the **Silence Reset** button.
   - The audible alarm silences, and the display changes from **REMOVE PTNT** to **VENT CHECK**.

To enter the Ventilator Checkout menu:

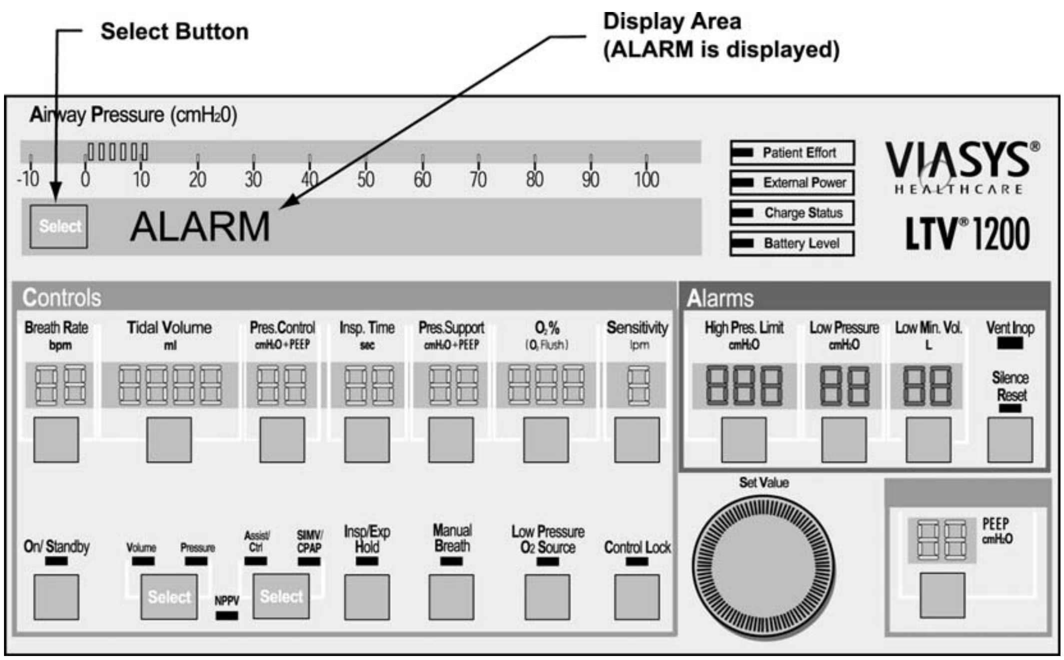
1) Press **Select.**
2) The first Ventilator Checkout Test, **ALARM** is displayed.

Alarm Test

The alarm test verifies that the audible alarm is working correctly.

To run the alarm test:

1) Press **Select** while **ALARM** is displayed.
2) Verify that the audible alarm sounds. When the alarm has sounded for at least 2 seconds, press **Select** again.
   - The audible alarm is silenced and the next menu item is displayed.



3) Verify a confirming audible chirp sounds after the alarm is silenced.

If the ventilator fails the alarm test, see *Chapter 7 - Troubleshooting* for more information.

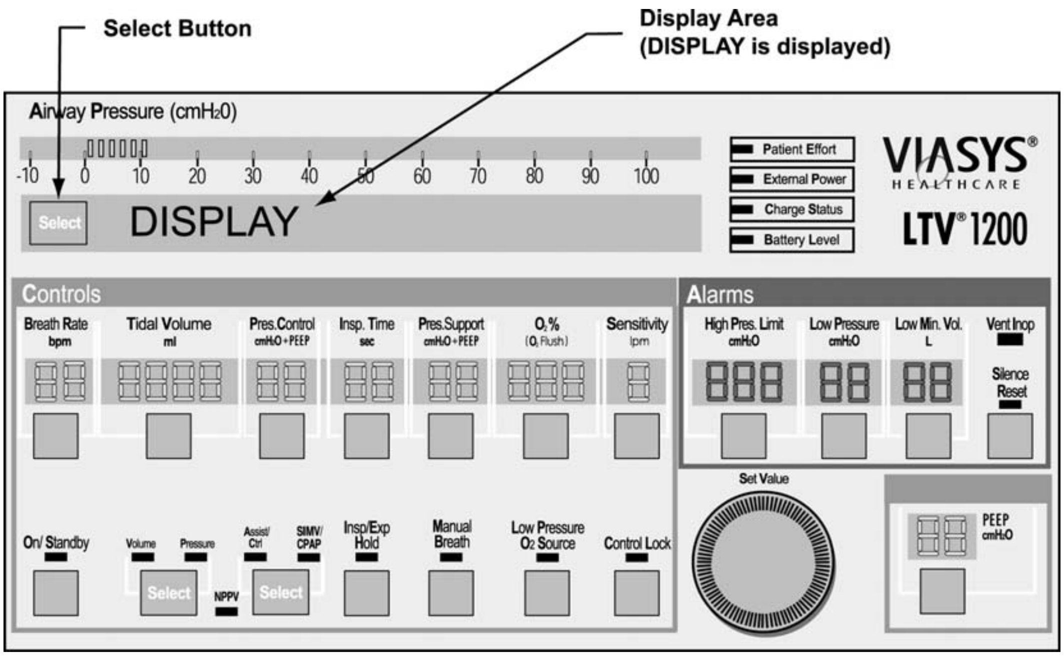
> **NOTE**
>
> Although the LTV® 1200 Front Panel is shown, the test is applicable to the LTV® 1150 Ventilator.

Display Test

At the end of the alarm test, **DISPLAY** shows in the LED display window. The display test verifies that the ventilator displays are working correctly.

To run the display test:

1) Press **Select** while **DISPLAY** is showing.
2) All segments of the 7-segment control displays; all dots of the dot-matrix window displays and all LEDs are illuminated.
3) To end the display test, press **Select** again and the next menu item is displayed.



NOTE

The displays for the **External Power**, **Vent Inop**, and **Charge Status** LEDs are not tested by the display test.

- The **External Power** and **Charge Status** LEDs are tested when the AC adapter is connected to the ventilator (see *page 2-2*).
- The **Vent Inop** LED is tested during the Vent Inop alarm test (see *page 2-10*).
- Although the LTV® 1200 Front Panel is shown, the test is applicable to the LTV® 1150 Ventilator.

Displays illuminate in the following colors:

Display	Color	Display	Color
Airway Pressure Display	Green	Assist/Control Mode LED	Green
Display Window	Red	SIMV/CPAP Mode LED	Green
Breath Rate	Green	NPPV Mode LED	Green
Tidal Volume	Green	Inspiratory / Expiratory Hold LED	Green
Pressure Control	Green	Manual Breath LED	Green
Inspiratory Time	Green	Low Pressure O_2 Source LED[2]	Green
Pressure Support	Green	Control Lock LED	Green
O_2 % (O_2 Flush)[2]	Green	PEEP	Green
Sensitivity	Green	Patient Effort LED	Green
High Pressure Limit alarm	Red	External Power LED	Not tested
Low Pressure alarm	Red	Charge Status LED	Not tested
Low Minute Volume alarm	Red	Battery Level LED	Amber
On/Standby LED	Green	Vent Inop LED	Not tested
Volume Mode LED	Green	Silence Reset LED	Red
Pressure Mode LED	Green		

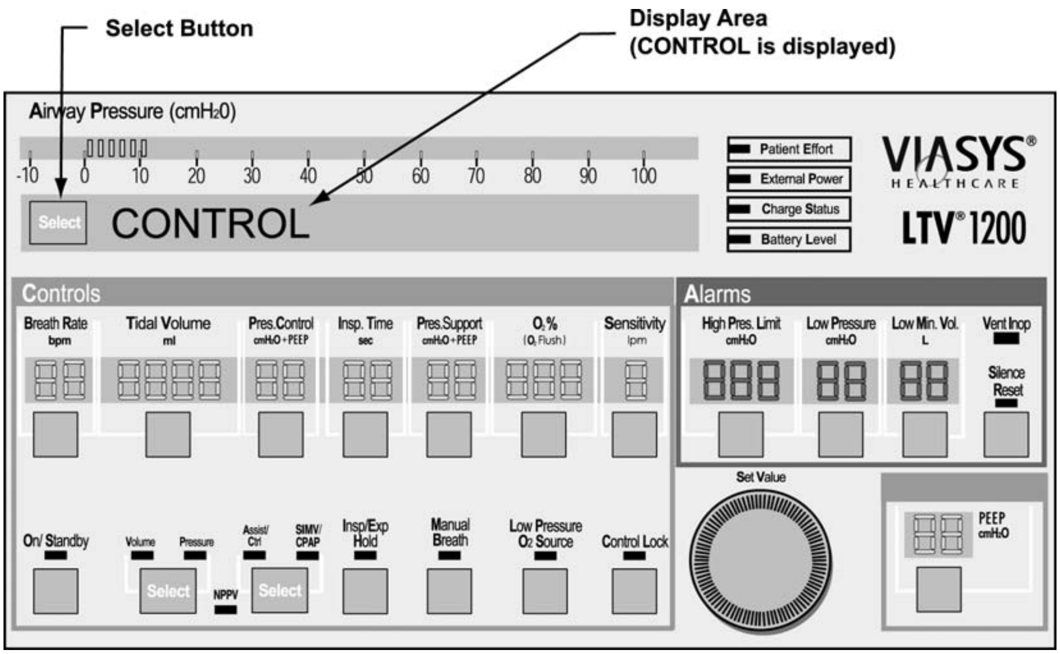
If the ventilator fails the display test, see *Chapter 7 - Troubleshooting* for more information.

[2] Available on the LTV® 1200 Only.

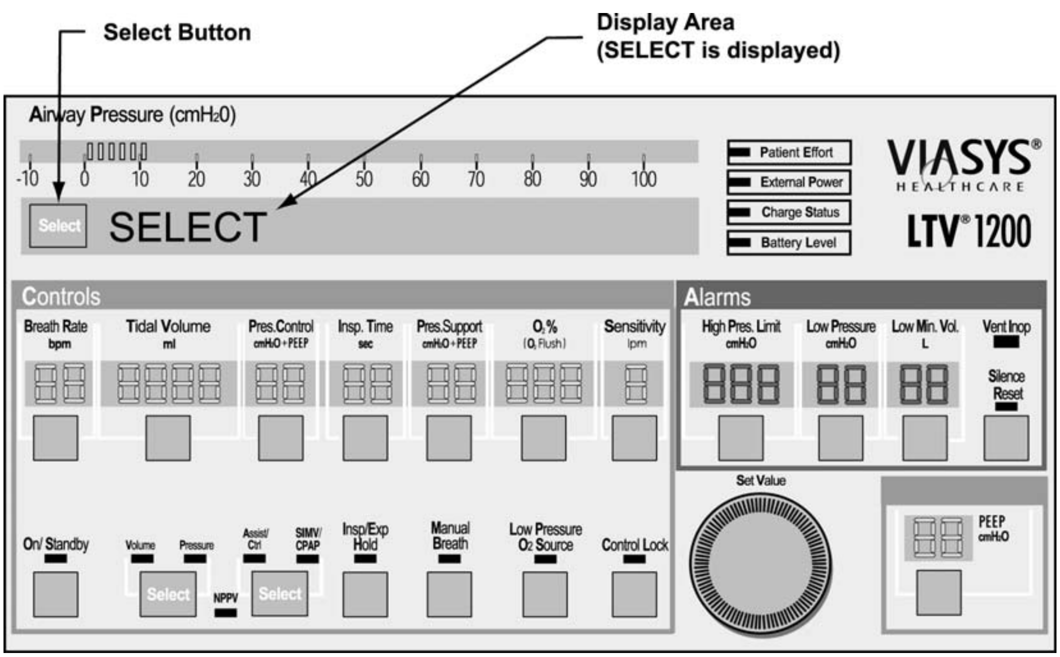
At the end of the display test, **CONTROL** shows in the LED display window. The control test is used to verify that the ventilator buttons and the **Set Value** knob are working correctly.

To run the control test:

1) Press **Select** while **CONTROL** is displayed.



2) **SELECT** is displayed in the display window.



NOTE

Although the LTV® 1200 Front Panel is shown, the test is applicable to the LTV® 1150 Ventilator.

3) Test each control by pressing every button, one at a time. When each one is pressed, verify that the name of the button is displayed in the display window.

   Control names are as shown below:

Control	Display
Display Select	**SELECT**
Breath Rate	**BREATH RATE**
Tidal Volume	**TIDAL VOLUME**
Pressure Control	**PRES CONTROL**
Inspiratory Time	**INSP TIME**
Pressure Support	**PRES SUPPORT**
O_2 % (O_2 Flush)[3]	**O2%**
Sensitivity	**SENSITIVITY**
High Pressure Alarm	**HIGH PRES**
Low Peak Pressure	**LOW PRES**
Low Minute Volume	**LOW MIN VOL**
Silence Reset	**SILENCE**
On/Standby	**ON / STNDBY**
Volume & Pressure	**MODE VOL/PRS**
Assist/Control & SIMV/CPAP	**MODE A/C S/C**
Inspiratory / Expiratory Hold	**IE HOLD**
Manual Breath	**MANUAL BRTH**
Low Pressure O_2 Source[3]	**LOW PRES O2**
Control Lock	**CONTROL LOCK**
Set Value Knob rotate Left	**ROTATE LEFT**
Set Value Knob rotate Right	**ROTATE RIGHT**
PEEP	**PEEP**

4) Test the **Set Value** knob by turning it clockwise and counterclockwise. Verify that the direction of rotation is displayed in the display window.

5) To exit the control test, press **Select** and the next menu item is displayed.

If the ventilator fails the control test, see *Chapter 7 - Troubleshooting* for more information.

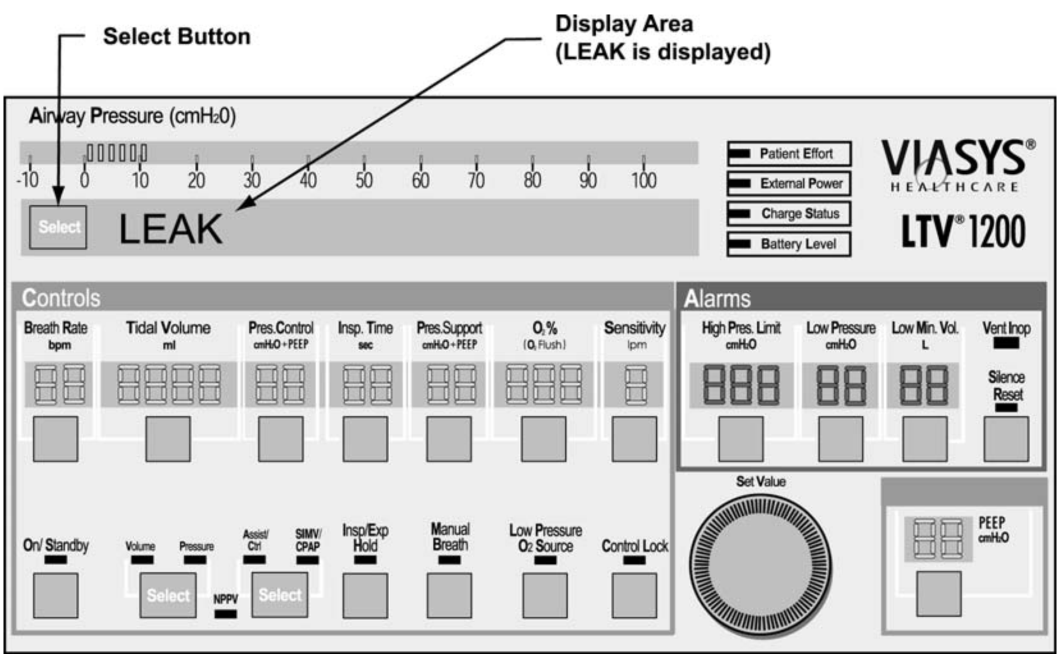
[3] Available on the LTV® 1200 Only.

Leak Test

The leak test is used to test the patient circuit for leaks.

To run the leak test:

1) At the end of the control test, **LEAK** shows in the LED display window.
2) Attach a patient circuit with all accessories (such as water traps, heated circuits and humidifiers to the patient circuit).
3) Connect the patient circuit to the ventilator.
4) With a clean, gloved hand or 4”X4” gauze pad, occlude the proximal end of the patient circuit.
5) Press **Select** while **LEAK** is displayed.



> **NOTE**
>
> - The leak test cannot be run until the ventilator has been running for 60 seconds. If you attempt to run the leak test before the warm-up period has completed, a **WARMUP xx** message will be displayed. When the warm-up period is complete, the leak test menu is redisplayed.
> - Although the LTV® 1200 Front Panel is shown, the test is applicable to the LTV® 1150 Ventilator.

6) To perform the leak test, the ventilator does the following:

   a) Closes the exhalation valve and sets the flow valve to a near-closed state. The display briefly shows **HOMING VALVE**.

   b) Elevates the turbine motor speed. The display shows **SET TURBINE**.

   c) Elevates the circuit pressure. The display shows **PRES xx.x cmH$_2$O** where **xx.x** is the real-time airway pressure.

   d) Sets the flow valve to a near closed position. The display shows **FLOW xx.x Lpm** where **xx.x** is the flow through the flow valve.

   e) After several seconds, the display shows **LEAK xx.xx PASS** or **LEAK xx.xx FAIL** indicating the leak test results.

7) The leak test will fail if the flow through the flow valve is $\geq$1.0 Lpm.

NOTE

The leak test may be performed without occluding the patient circuit to confirm a failing response.

8) To exit the leak test, press **Select** again. The next menu item is displayed.

If the ventilator fails the leak test, see *Chapter 7 - Troubleshooting* for more information.

Vent Inop Alarm Test

The Vent Inop alarm test is used to verify that the Vent Inop alarm is working correctly.

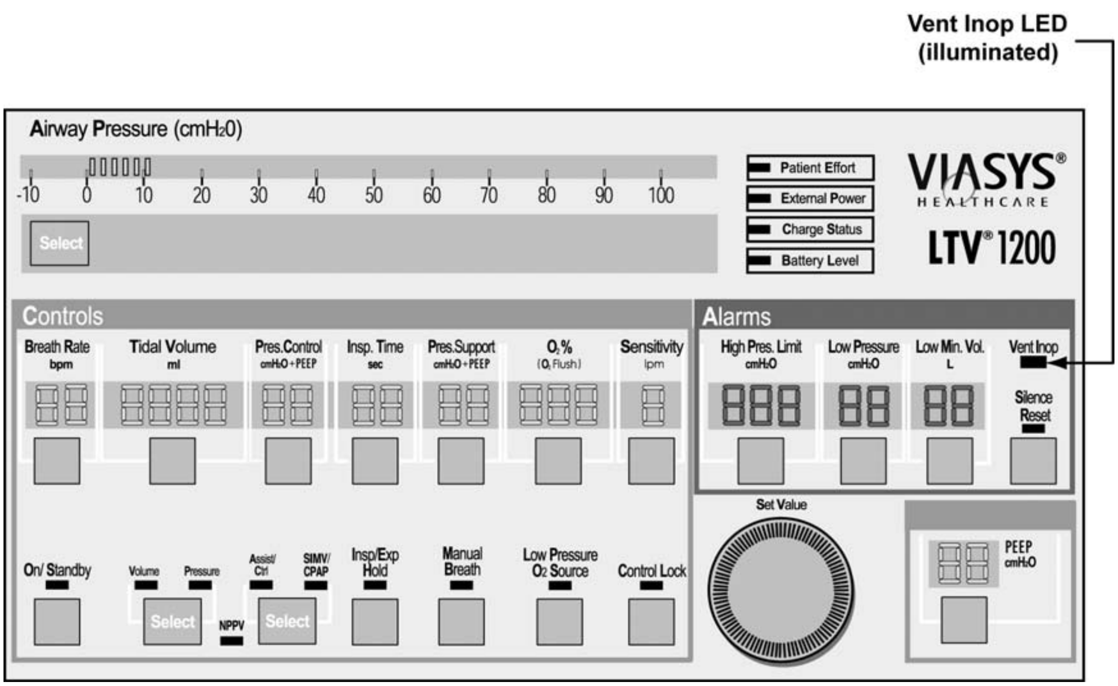
To run the Vent Inop alarm test:

1) To run the Vent Inop alarm test, the ventilator must be on (running) for at least 60 seconds.

2) Turn the ventilator off by pressing and holding **On/Standby** for a minimum of 3 seconds. <u>**DO**</u> <u>**NOT**</u> press **Silence Reset**.

3) Observe the ventilator for 15 seconds and verify that <u>**both**</u> of the following occur;

   - The alarm tone sounds continuously for a full 15 seconds.
   - The **Vent Inop** LED illuminates continuously for a full 15 seconds.



4) When the test is complete, silence the alarm by pressing **Silence Reset**.

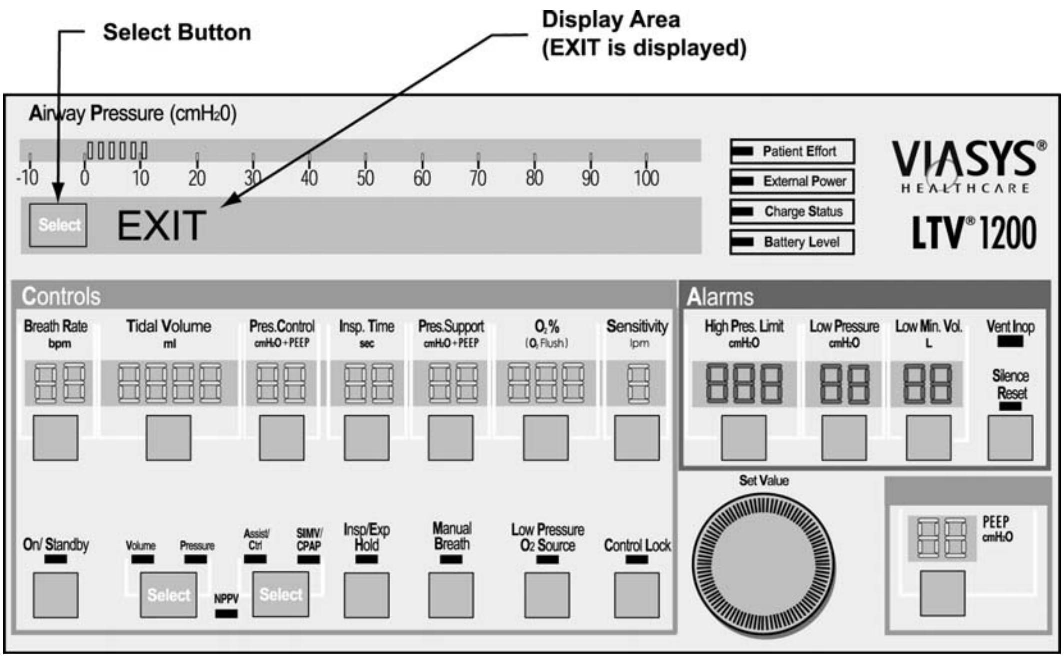
5) Verify a confirming audible chirp sounds after the alarm is silenced.

If the ventilator fails the Vent Inop alarm test, see *Chapter 7 - Troubleshooting* for more information.

> **NOTE**
>
> Although the LTV® 1200 Front Panel is shown, the test is applicable to the LTV® 1150 Ventilator.

To exit VENT CHECK and enter normal ventilation mode:

1) Turn the **Set Value** knob to scroll through the main menu entries (**VENT OP, ALARM OP, VENT CHECK**, etc.) until **EXIT** is displayed.
2) Press **Select** while **EXIT** is displayed. Alternatively, press **Control Lock** repeatedly until normal ventilation mode is restored. After performing POST, the ventilator begins ventilation using the previously stored settings.



Chapter 3 - Real-Time Transducer Data

The real-time transducer data allows you to view the real-time activity in the ventilator. The menu is set up as follows:

RT XDCR DATA

AP	**xx.xx**	**$^{c}{}_{m}H_{2}0$**
FDb	**xx.xx**	**$^{c}{}_{m}H_{2}0$**
FDw	**xx.xx**	**$^{c}{}_{m}H_{2}0$**
FDn	**xx.xx**	**$^{c}{}_{m}H_{2}0$**
FTw or **FTn**	**xx.xx**	**Lpm**
FTb	**x.xx**	**Lpm**
LEAK	**xx.xx**	**Lpm**
FVd	**xx.xx**	**$^{c}{}_{m}H_{2}0$**
FV	**xx.xx**	**Lpm**
STEP	**xxxx**	
FVt	**xxx.x**	**°F**
TS	**xxxx**	**rpm**
O2[4]	**xx.xx**	**PSIG**
BV	**xx.xx**	**VOLTS**
EV	**xx.xx**	**VOLTS**
PPP	**xx.xx**	**$^{c}{}_{m}H_{2}0$**
RT EXIT		

Each item displays real-time activity in the displayed units. For some items, transducer counts can also be displayed. Pressing **Select** while a specific transducer is displayed shows additional data for that transducer.

Display	Real-time Data
AP xx.xx $^{c}{}_{m}H_{2}0$	Airway pressure as measured at the patient wye using the high side proximal sense line.
FDb xx.xx $^{c}{}_{m}H_{2}0$	Flow differential pressure as measured at the patient wye using the bi-directional transducer. Differential pressure is measured between the high and low side proximal sense lines.
FDw xx.xx $^{c}{}_{m}H_{2}0$	Flow differential pressure as measured at the patient wye using the wide scale transducer. Differential pressure is measured between the high and low side proximal sense lines.

[4] Available on the LTV® 1200 Only.

Display	Real-time Data
FDn xx.xx $^{c}{}_{m}H_20$	Flow differential pressure as measured at the patient wye using the narrow scale transducer. Differential pressure is measured between the high and low side proximal sense lines. The narrow scale transducer is only used for differential pressures between -0.35 cmH_2O and 0.35 cmH_2O (approximately -15 Lpm to 15 Lpm).
FTw xx.xx Lpm or **FTn xx.xx Lpm**	Flow in Lpm calculated from the differential pressure measured at the patient wye. When the value is calculated using the wide scale differential pressure, **FTw** is displayed. When the value is calculated using the narrow scale differential pressure, **FTn** is displayed. When Leak Compensation is on, **FTw xx.xx** and **FTn xx.xx** Lpm values are offset by the value of **LEAK xx.xx** Lpm. Transducer count display is not available for this item.
FTb x.xx Lpm	Flow in Lpm calculated from the differential pressure measured at the patient wye using the bi-directional transducer. Transducer count display is not available for this item.
LEAK xx.xx Lpm	Leak flow calculated from the differential pressure transducer, measured at the patient wye during exhalation.
FVd xx.xx $^{c}{}_{m}H_20$	Differential pressure as measured across the flow valve.
FV xx.xx Lpm	Flow valve flow in Lpm calculated from the differential pressure measured across the flow valve. Transducer count display is not available for this item.
FVt xxx.x °F	Flow valve temperature.
STEP xxxx	Commanded flow valve motor step position. Transducer count display is not available for this item.
TS xxxx rpm	Monitored turbine speed in rpms.
O2 xx.xx PSIG	Oxygen inlet pressure in PSIG as measured at the inlet pressure transducer (LTV® 1200 only).
BV xx.xx VOLTS	Internal battery voltage.
EV xx.xx VOLTS	External power voltage.
PPP xx.xx $^{c}{}_{m}H_2O$	Pressure in the PEEP accumulator (PEEP Pilot Pressure)

Chapter 4 - Cleaning, Disinfecting and Sterilizing

Cleaning the Ventilator

All ventilator external surfaces should be cleaned before and after each patient use, and as otherwise necessary.

To clean the ventilator:

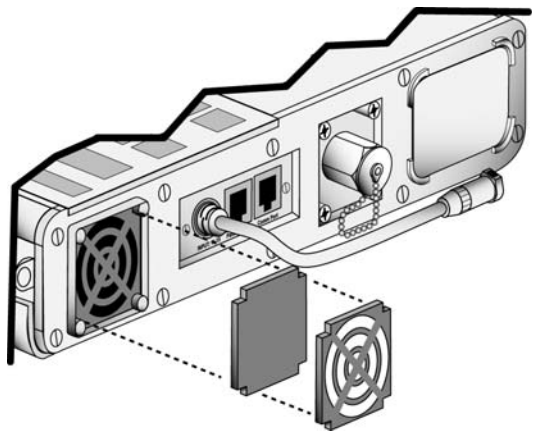
1) Wipe the exterior surfaces of the ventilator with a clean, damp cloth. The use of an anti-bacterial cleaning solution is recommended. Be sure to wipe away any residual cleaner.

> **CAUTION**
>
> **Ventilator Sterilization** – To avoid irreparable damage to the LTV® 1200/1150 ventilator, do not attempt to sterilize it.
>
> **Cleaning Agents** – To avoid damaging the ventilator's plastic components and front panel, do not use cleaning agents containing ammonium chloride, other chloride compounds, more than 2% glutaraldehyde, phenols, or abrasive cleaners.
>
> **Ventilator Immersion** - Do not immerse the ventilator in liquids.
>
> **Exhalation Valve Cleaning -** Do not pour or spray liquid cleaners into the exhalation valve.
>
> **Front Panel Cleaning** – Do not pour or spray liquid cleaners onto the front panel.

Cleaning or replacing the Fan Filter

To clean the fan filter:

1) Using a small screwdriver, detach the fan filter grill from its housing.
2) Remove the fan filter by squeezing the foam filter gently with your fingers and pulling it out.



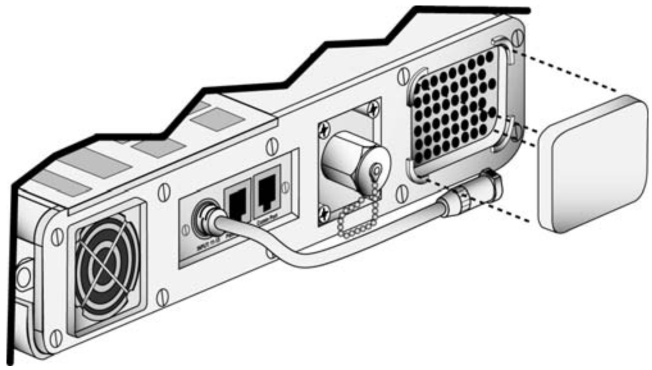
> **NOTE**
> **Hardware Fault -**If you touch the fan blades while removing the fan filter grill or filter, a **HW FAULT** may occur. This is normal. Clear the **HW FAULT** alarm by using the **Silence Reset** button.

3) Gently bathe the filter in a solution of mild detergent and warm water.
4) Rinse thoroughly in warm water.
5) Examine the filter for excessive wear or damage. Discard and replace with a new filter if necessary.
6) Allow the filter to thoroughly air dry before reinstallation.
7) Reinstall the filter.
8) Reposition the filter grill over the filter and apply light pressure until it fully seats (“clicks”) into the filter housing.

> **CAUTION**
> **Wet or Damp Filters -** Do not install a wet or damp filter into the LTV® 1200/1150 ventilator. This could damage the ventilator.

To clean the Inlet Filter:

1) Remove the inlet filter by squeezing the foam filter gently with your fingers and pulling it out.



2) Gently bathe the filter in a solution of mild detergent and warm water.
3) Rinse thoroughly in warm water.
4) Examine the filter for excessive wear or damage. Discard and replace with a new filter if necessary.
5) Allow the filter to thoroughly air dry before reinstallation.
6) Reinstall the filter.

CAUTION

Wet or Damp Filters - Do not install a wet or damp filter into the LTV® 1200/1150 ventilator. This could damage the ventilator.

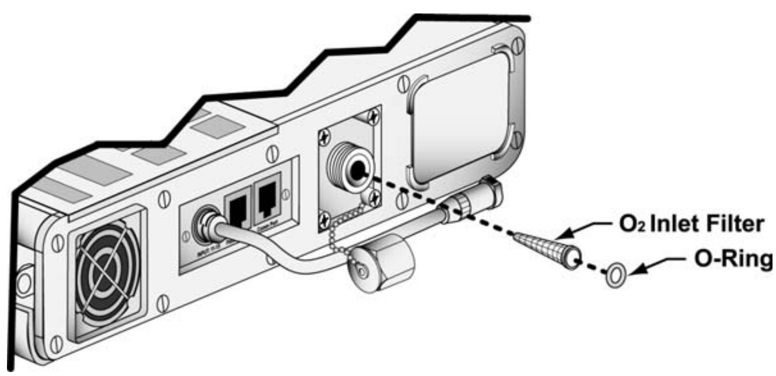
Cleaning or Replacing the O_2 Inlet Filter (LTV® 1200 Only)

The O_2 inlet filter should be cleaned or replaced when it becomes soiled. Failure to do this can affect ventilator performance.

> **CAUTION**
>
> **Oxygen Supply Contamination -** The accuracy of the oxygen delivery capabilities of LTV® 1200/1150 ventilator can be compromised by foreign debris contamination in the oxygen supply system. To reduce the risk of airborne contaminants entering the ventilator, ensure that any oxygen supply connected to the ventilator is clean, properly filtered[5] and that the ventilator's O_2 inlet port cap is securely installed on the O_2 Inlet Port whenever the ventilator is not connected to an external oxygen supply.

To clean or replace the O_2 Inlet Filter:

1) Disconnect the high pressure O_2 hose from the oxygen block on the left side of the ventilator.
2) Using a pick, gently remove the rubber O-Ring from inside the O_2 inlet port. Use caution: Do not damage the O-Ring while removing it. Tip the ventilator to allow the O_2 Inlet Filter to slide out.



3) Clean the filter using a mild cleanser, warm water and a soft brush. Rinse the filter thoroughly to remove all traces of the cleanser. Allow the filter to dry completely before replacing it in the ventilator.

[5] In addition to the existing internal O_2 Inlet filter, P/N 14313, an External, In-Line Oxygen Filter (P/N 14470) is available from Pulmonetic Systems, Inc.

4) Inspect the filter for damage. If the filter is not intact, shows signs of damage or cannot be completely cleaned, replace it with a new O_2 Inlet Filter (P/N 14313) and O-Ring (P/N 10609), available from Pulmonetic Systems.

5) Replace the filter by sliding it back into the O_2 inlet port. Replace the O-Ring, making sure it is completely tucked under the retaining lip on the inside of the O_2 inlet port.

6) Reconnect the high pressure O_2 line.

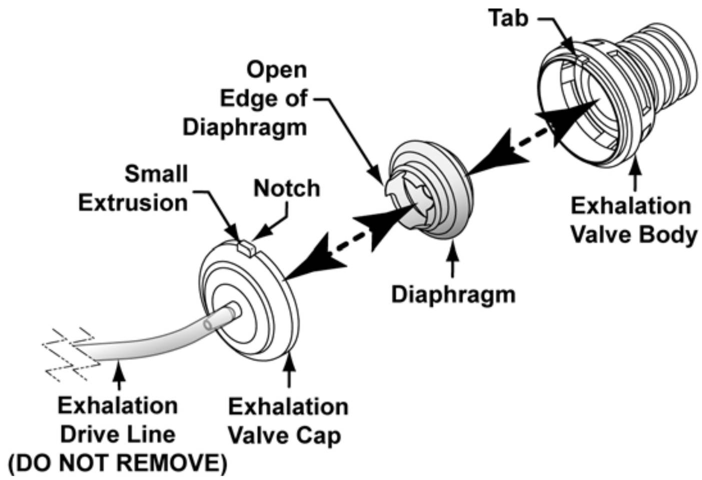
CAUTION

Wet or Damp Filters - Do not install a wet or damp filter into the LTV® 1200 ventilator. This could damage the ventilator.

WARNING

Patient Circuits – Pulmonetic Systems' Patient Circuits, Exhalation Valve Assemblies and Water Traps are shipped clean, not sterile.

Refer to your LTV® 1200 or LTV® 1150 Ventilator Operator's Manual or the Instructions for Use enclosed with your patient circuits and patient circuit components for assembly, disassembly, care and cleaning recomendations. The illustration here is provided for reference.



Exhalation Valve Assembly

Always leak test the patient breathing circuit after assembly or cleaning.

WARNING

Leak Testing Patient Circuits – Leak test the patient circuit with all accessories connected before connection to the patient. Failing to do this can result in ineffective ventilation and possible harm to the patient. Refer to *Leak Test* in Chapter 2 – Ventilator Checkout Tests for detailed instructions.

Chapter 5 - PREVENTATIVE MAINTENANCE

The following preventative maintenance is required for proper operation of the LTV® 1200/1150 ventilator.

Recommended Maintenance Schedule

The LTV® 1200/1150 ventilator is designed to operate for extended periods of time with minimum maintenance. The following maintenance is recommended:

Hours of Service[6]	Maintenance Required
Prior to initial use	• Charge the internal battery by plugging the ventilator into an AC power source for 24 hours. • Setup the ventilator/accessories. • Check the ventilator for proper operation per *Chapter 2 - Ventilator Checkout Tests*
While in storage, every two months	• Recharge the internal battery by plugging the ventilator into an AC power source for 24 hours[7].
Daily	• Check the Inlet filter, clean if necessary. • Check the fan filter, clean if necessary.
If in use, a minimum of once a month	• Check the ventilator per *Chapter 2 - Ventilator Checkout Tests.* While the ventilator is off-patient, perform the power (external) disconnect test* • Verify Vte or VE monitor * • Verify airway pressure or PIP monitor * • Verify delivered O_2 concentration (LTV® 1200 only) if not using an oxygen analyzer continuously. * (See *Ventilator Specifications* for accuracy tolerances). **Use existing patient settings or examples shown in Installation and Checkout*
Every 10,000 hours or two years[8], whichever comes first	• Replace the internal battery[9] with Pulmonetic Systems battery P/N 18608-001[10] • Calibrate the transducers. • Replace the Motor Board. • Clean or replace the Interior Air Inlet filter. • Clean or replace the O_2 Inlet filter (LTV® 1200 only).
Every 30,000 hours or six years, whichever comes first[8]	• Replace the Turbine Manifold assembly. • Replace the Solenoid Manifold. • Replace the Flow Valve. • Replace the Rotary Switch assembly. • Replace the O_2 Blender (LTV® 1200 only). • Replace the Solenoid Mount assembly • Replace the PEEP Accumulator • Replace the Fan assembly. • Replace all Silicone Tubing. • Check the Thermo Pads for compression and replace if necessary.

This is the recommended schedule for typical clinical or home settings. Some environmental conditions may require you to perform the maintenance procedures more frequently.

---

6 For the number of hours the ventilator has been in service, see Extended Features in the LTV Series Operator's Manual.

7 If the battery is deeply discharged, it may take several charge and discharge cycles before it is at full capacity.

8 10,000 hour, two year and/or 30,000 hour, six year extended maintenance and ventilator repair must be performed by a service technician who has been trained and certified by Pulmonetic Systems, Inc.

9 Replacement at 10,000 hours or 2 years is based on normal use of up to 200 charge cycles. The battery may need to be replaced more frequently if it is being charged more often. The battery should also be replaced any time it fails to reach a full charge, or if the ventilator runs for less than 40 minutes on a fully charged battery.

10 The LTV® 1200/1150 Internal Battery is available in battery replacement kit, P/N 18634-001.

Before Initial Use

Plug the ventilator into an AC power source for 24 hours to fully charge the internal battery. While charging in the standby mode, the **Charge Status** Indicator LED displays as flashing amber, solid amber or solid green. If the **Charge Status** Indicator displays red, the internal battery cannot be charged and should be replaced. If the **Charge Status** Indicator does not display green at the end of 24 hours of charging, the internal battery should be replaced.

Storage Maintenance

To prevent damage to the LTV® 1200/1150 ventilator internal battery while in storage, connect the ventilator to an AC power source for 24 hours every 2 months to recharge.

While recharging in the standby mode, the **Charge Status** Indicator LED displays as flashing amber, solid amber or solid green. If the **Charge Status** Indicator displays red, the internal battery cannot be charged and should be replaced. If the **Charge Status** Indicator does not display green at the end of 24 hours of charging, the internal battery should be replaced.

Daily Maintenance

Each day of operation, do the following:

- Check the external air filter, clean or replace if necessary. In dusty or high humidity environments, the filter may need to be cleaned often.
- Check the fan filter, clean or replace if necessary. In dusty or high humidity environments, the filter may need to be cleaned often.

Monthly Maintenance

After each month of operation, do the following:

- Run the Ventilator Checkout Alarm test
- Run the Ventilator Checkout Display test
- Run the Ventilator Checkout Control test
- Run the Ventilator Checkout Leak test
- Run the Ventilator Checkout Vent Inop Alarm test.
- While the ventilator is off patient, perform the External Power Disconnect test
- Verify the Vte or VE monitor*
- Verify airway pressure or PIP monitor*
- Verify O_2 delivery* (See *Ventilator Specifications* for accuracies)

To clean the air inlet filter, see *Cleaning or replacing the Inlet Filter* in Chapter 4.

To clean the fan filter, see *Cleaning or replacing the Fan Filter* in Chapter 4.

To run the Ventilator Checkout Tests, see *Chapter 2 - Ventilator Checkout Tests.*

** Use existing patient settings or the settings given under General Checkout in Chapter 9*

WARNING

Qualified technicians – Only service technicians who have been trained and certified by Pulmonetic Systems to service the LTV® 1200/1150 ventilator are qualified to perform the 10,000 and 30,000 hour maintenance on LTV® 1200/1150. Do not attempt to service the ventilator unless you have been properly trained to do so, personal injury could result. Refer all servicing and repair to Pulmonetic Systems or an authorized service center.

10,000 Hour / 2 Year Maintenance

After every 10,000 hours or 2 years of operation, whichever comes first, do the following:

- Perform all items on the Monthly maintenance list
- Calibrate the transducers
- Replace the internal Battery Pack[11]
- Replace the Motor Board
- Clean or replace the interior Air Inlet filter
- Clean or replace the O_2 inlet filter

To calibrate the transducers, see *Chapter 6 - Maintenance & Calibration*.

To replace the internal battery pack, the motor board, the internal air inlet filter or the Oxygen Blender Inlet filter, see *Chapter 8 - Component Removal and Replacement.*

30,000 Hour Maintenance / 6 Year Maintenance

After every 30,000 hours of operation, or 6 years, whichever comes first, perform a complete ventilator maintenance. To perform a 30,000-hour maintenance, do the following:

- Perform all items on the Monthly and 10,000-hour maintenance lists
- Replace the Turbine Manifold assembly
- Replace the Solenoid Manifold
- Replace the Flow Valve
- Replace the Rotary Switch assembly
- Replace the O_2 Blender
- Replace the Solenoid Mount assembly
- Replace the PEEP Accumulator
- Replace the Fan assembly
- Replace all Silicone Tubing
- Check the Thermal Pads for compression and replace if necessary

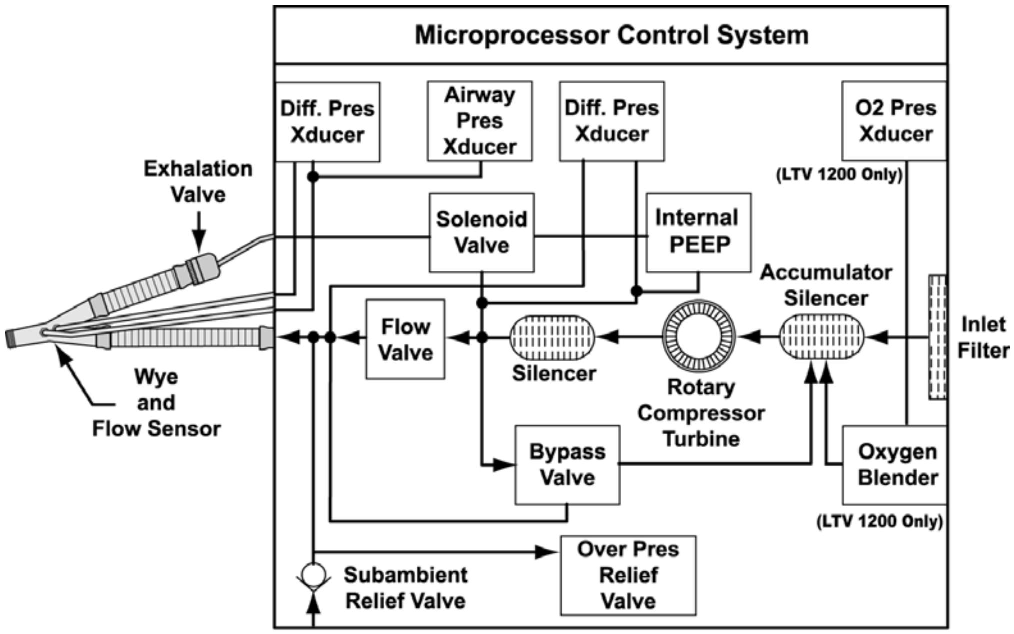
For instructions, see *Chapter 8 - Component Removal and Replacement.*

[11] Replacement at 10,000 hours or 2 years is based on normal use of up to 200 full charge cycles or 400 partial charge cycles. The battery may need to be replaced more frequently if it is being charged more often. The battery should also be replaced any time it fails to reach a full charge, or if the ventilator runs for less than 40 minutes on a fully charged battery.

Chapter 6 - MAINTENANCE & CALIBRATION

Operating Theory

The LTV® 1200/1150 ventilator utilizes an electromechanical pneumatic system under the control of a microprocessor to deliver patient ventilation. The following diagram and descriptions illustrate the major components of the ventilator and their respective functions.



Room air enters the ventilator through a flexible foam **Inlet filter**. After exiting the filter, the air enters an **Accumulator/Silencer** where it mixes with oxygen delivered from the **Oxygen Blender (LTV® 1200 only)**. In addition, this chamber provides acoustic silencing to reduce the **Rotary Compressor** input noise. Mixed gas then enters the **Rotary Compressor Turbine,** where energy is added to the gas stream as required to meet the pressure and flow delivery requirements of the current ventilation settings.

Gas exiting the **Rotary Compressor Turbine** output port enters another **Silencer**. This chamber dampens acoustic noise from the **Rotary Compressor Turbine**. Upon exiting the silencing chamber, the gas flow splits in two paths. Gas flow for ventilation diverts to the **Flow Valve**, while excess flow is recirculated through the **Bypass Valve** to the inlet **Accumulator/Silencer**. The **Bypass Valve** maintains **Flow Valve** inlet pressure high enough above **Flow Valve** outlet pressure to ensure a positive differential pressure across the valve, yet low enough to ensure that excess energy is not wasted when operating from batteries.

Ventilation flow enters the **Flow Valve,** which controls all inspiratory gas flow to the patient. The valve is driven by a rotary actuator, and translates circular motion to a poppet position, which in turn meters flow to the patient. The valve is characterized such that gas flow is a known function of differential pressure across the valve and actuator position. A **Differential Pressure transducer** is provided to measure the differential flow valve pressure.

Ventilation gas exiting the **Flow Valve** is connected to the **Wye and Exhalation Valve** by a patient circuit.

The **Flow Sensor** at the **Wye** measures the exhaled flow using a fixed orifice type transducer. Transducer sensor ports are located between the patient and ventilator connection ports. The **Exhalation Valve** provides the following functions:

1) Closes the exhalation port during inspiration to divert gas to the patient.
2) Opens the exhalation port during exhalation to allow patient gases to be exhausted to the atmosphere.
3) Measures the exhaled flow using a fixed orifice type transducer. Transducer sensor ports are located between the patient and ventilator connection ports.

The **Solenoids (Pilot-in and Pilot-out)** are used to control the pressure in the pressure accumulator that is used to control the exhalation valve on the patient circuit. The activation of the exhalation circuit controls the PEEP (positive end expiratory pressure) at the patient wye during the expiratory phase.

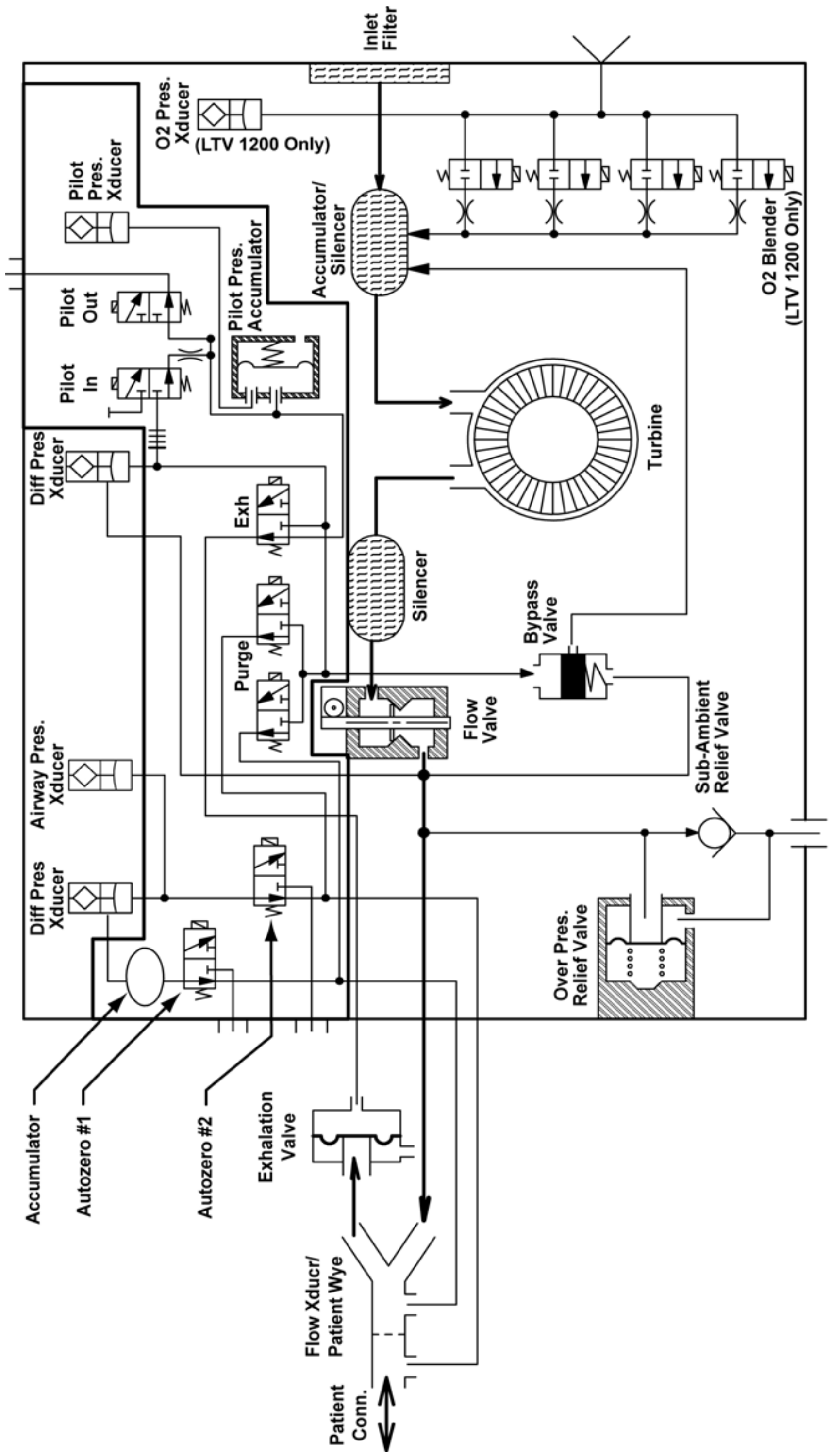
A **PEEP** transducer is used to monitor the pilot pressure in the accumulator. This pilot pressure is used in conjunction with the airway pressure transducer by the LTV® software to control delivered PEEP.

A **Differential Pressure transducer** is provided to measure the delta pressure developed across the flow transducer. The transducer is auto zeroed to ambient pressure and the sense lines are purged to prevent moisture migration into the transducer.

The **Oxygen Blender (LTV® 1200 only)** accepts pressurized oxygen from an external source and, as directed by the control system, meters the oxygen flow to meet the requirements of the current O_2% setting and ventilation flow demand. The **O_2 Pressure transducer** measures inlet pressure and is used by the Blender control system to compensate the oxygen delivery for variations in oxygen inlet pressure.

The **Sub-Ambient Relief Valve** allows the patient to inspire spontaneously from room air in the event of a failure of the main ventilator system. The **Over Pressure Relief Valve** provides an independent mechanical means to limit the maximum inspiratory pressure. Both of these functions are physically included in the Flow Valve Body.

The **Airway Pressure transducer** measures pressure at the patient airway and is used for a feedback signal during the delivery of pressure breaths. The transducer is auto zeroed to ambient pressure and the sense lines are purged to prevent moisture migration into the transducer.



LTV 1200 / LTV 1150
Pneumatic Schematic Detail

Vent Maintenance

The ventilator maintenance tests are used to verify the ventilator is working correctly, troubleshoot problems with performance, and perform maintenance procedures such as calibration.

The maintenance menu is set up as follows:

VENT MTNCE

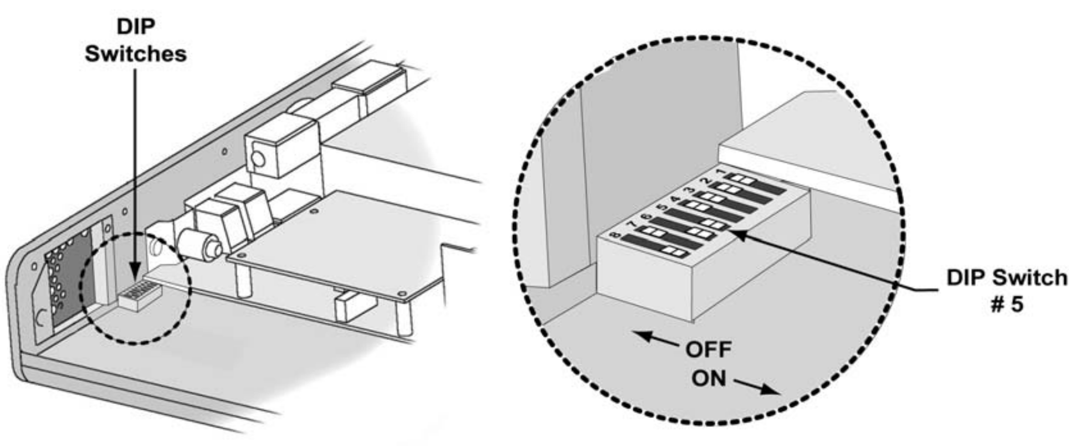
- **CALIBRATION**
- **SERVO**
- **SOLENOID**
- **STEP TEST**
- **WDOG TEST**
- **CONFIG**
- **CLEAR**
- **EXIT**

WARNING

Ventilator Checkout and Maintenance Modes - The LTV® 1200/1150 ventilator does not deliver gas during the ventilator Checkout mode (**VENT CHECK**) or ventilator Maintenance mode (**VENT MTNCE**) and should not be used to ventilate a patient during these tests.

The Ventilator Maintenance menu is not enabled when the ventilator is powered up normally. **To enable the Ventilator Maintenance menu:**

1) Turn the ventilator off.
2) Place the ventilator in an ESD-safe environment, and use ESD controls.
3) Remove the back panel of the ventilator. For instructions see *Chapter 8 - Component Removal and Replacement*.
4) Locate DIP switch #5 and set it to ON (see illustration)



5) Turn the ventilator on.

Vent Maintenance Entry Alarm

When you power the ventilator on in Vent Maintenance mode, **REMOVE PTNT** is displayed and the audible alarm sounds to remind you to remove the patient from the ventilator and use an alternate method of ventilation.

To clear the REMOVE PTNT alarm:

1) Press the **Silence Reset** button.
2) The first Ventilator Maintenance menu, **VENT MTNCE**, is displayed.

Calibration

The Calibration menu is used to calibrate the pressure transducers and flow valve motor speed for the ventilator. A Calibration Worksheet for recording calibration results is provided at the end of this section.

To Enter the Calibration Menus

1) Rotate the **Set Value** knob until **VENT OP** is displayed. Press **Select**.
2) Rotate the **Set Value** knob until **COM SETTING** is displayed, then press **Select**.
3) Rotate the **Set Value** knob until **DATA** is displayed, then press **Select**.[12]
4) Press **Control Lock**, then turn the **Set Value** knob until **VENT MTNCE** displays**.**
5) Press **Select** then select **CALIBRATION**.

The calibration menu is set up as follows:

CALIBRATION

- **AIRWAY**
- **FLOW DIFF**
- **VALVE DIFF**
- **PPP**
- **O2 INLET (LTV® 1200 only)**
- **MOTOR DRIVE**
- **CAL EXIT**

An asterisk (*) displayed in front of a menu item, for example: * **FLOW DIFF** indicates that item has not been calibrated.

> **NOTE**
> When calibrating a transducer always continue uninterrupted to the completion of that transducer. If several minutes of inactivity occur during a calibration, repeat the calibration of that transducer as the transducer may drift over time.
> For best results, run the ventilator for at least 20 minutes to warm it up prior to calibration.

If **CAL FAIL** appears at any time during a calibration, press **Select** to exit, then reenter the calibration menu and perform the complete process again. Calibrations may fail because the calibration pressure is unstable or outside the expected range.

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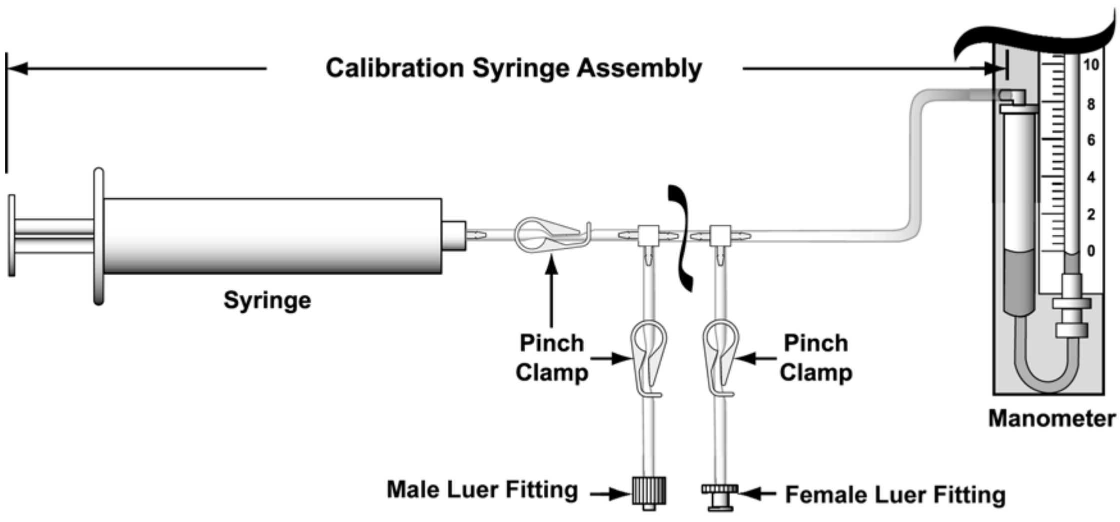
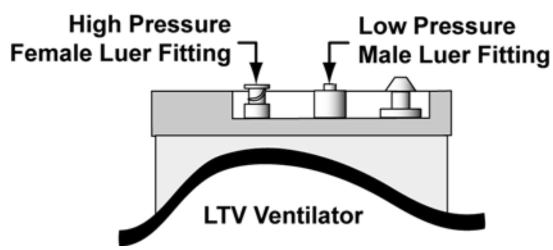
[12] The ventilator should be calibrated in DATA mode, to leverage the unique code and timers that make test results more consistent.

To perform the airway pressure calibration, you will need the following equipment:

- Calibration Syringe assembly[13], P/N 11471, with a T-connection to a pressure manometer (0-90 cmH_2O).





Leak Test the Hi & Low Flow Transducer Ports

1) Connect the tubes from the calibration syringe assembly test fixture to the High and Low Flow transducer ports on the right side of the ventilator as shown above.
2) Using the test fixture manometer as the pressure measurement instrument, apply 50 – 55 cm H2O pressure to the ventilator with the syringe.
3) Pinch off the pressure supply tube near the syringe to seal the supply of pressure. Observe any downward change in pressure on the manometer.

   Requirement: The change in pressure in 1 minute shall be ≤ 1.0 cmH2O

4) Record the data on the Calibration Worksheet
5) Disconnect the tubes from the ventilator ports. Open the pinch clamp on the pressure supply tube to the syringe.

[13] The Calibration Syringe is available separately, or as part of the Maintenance Calibration Kit, P/N 11566.

6) If leakage exceeds the values noted above, perform the following tests:

High Flow Transducer Test:

- Connect appropriate tube from the test fixture to the High Flow transducer port on the right side of the ventilator and pinch off other unused tubes.
- Using the test fixture manometer as the pressure measurement instrument, apply 50 – 55 cm H2O pressure to the ventilator with the syringe.
- Pinch off the pressure supply tube near the syringe to seal the supply of pressure. Observe any downward change in pressure on the manometer.

  Requirement: The change in pressure in 1 minute shall be ≤ 1.0 cmH_2O

- Record the data on the Calibration Worksheet
- Disconnect the tube from the ventilator port. Open the pinch clamp on the pressure supply tube.

Low Flow Transducer Test:

- Connect the tube from the test fixture to the Low Flow transducer port on the right side of the ventilator and pinch off other tubes.
- Using the test fixture manometer as the pressure measurement instrument, apply 50 – 55 cm H2O pressure to the ventilator with the syringe.
- Pinch off the pressure supply tube near the syringe to seal the supply of pressure. Observe any downward change in pressure on the manometer.

  Requirement: The change in pressure in 1 minute shall be ≤ 1.0 cmH_2O

- Record the data on the Calibration Worksheet
- Disconnect the tube from the ventilator port. Open the pinch clamps on the pressure supply tube.

7) If leakage in excess of the required values is observed, troubleshoot leaks (see *Chapter 7 - Troubleshooting*). If the leak persists, contact the technical support department at Pulmonetic Systems using the information at the front of this manual.

NOTE

For best calibration results, allow the ventilator to warm up by running it for at least 20 minutes prior to beginning the calibration procedures.

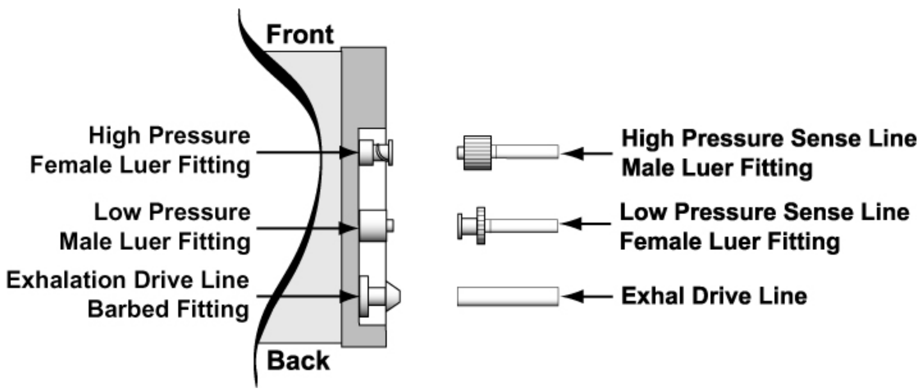
Calibrate the Airway Pressure Transducers

1) Press the **Select** button while **AIRWAY** is displayed.

   AP 50 $^{C}{}_{M}H_2O$ is displayed.

2) If necessary, disconnect the High and Low pressure sense lines from the side of the ventilator:

3) Connect the male Luer fitting from the calibration syringe assembly to the high pressure female Luer fitting on the ventilator. Pinch the clamp on the low pressure side between the calibration syringe assembly and the female Luer fitting. Increase to and maintain the pressure at 50.0 cmH_2O ± 0.2 cmH_2O pinch the clamp near the syringe to hold the pressure steady.



4) Observe the numbers displayed in the **Tidal Volume** window. When the displayed value is stable, press **Select**.

   Record that value on the Calibration Worksheet.

   AP 0 $^{C}{}_{M}H_2O$ is displayed.

5) With the high and low pressure sense lines disconnected from the side of the ventilator so that the connection(s) are open to ambient room air, observe the numbers displayed in the **Tidal Volume** setting window. When the displayed value is stable, press **Select**.

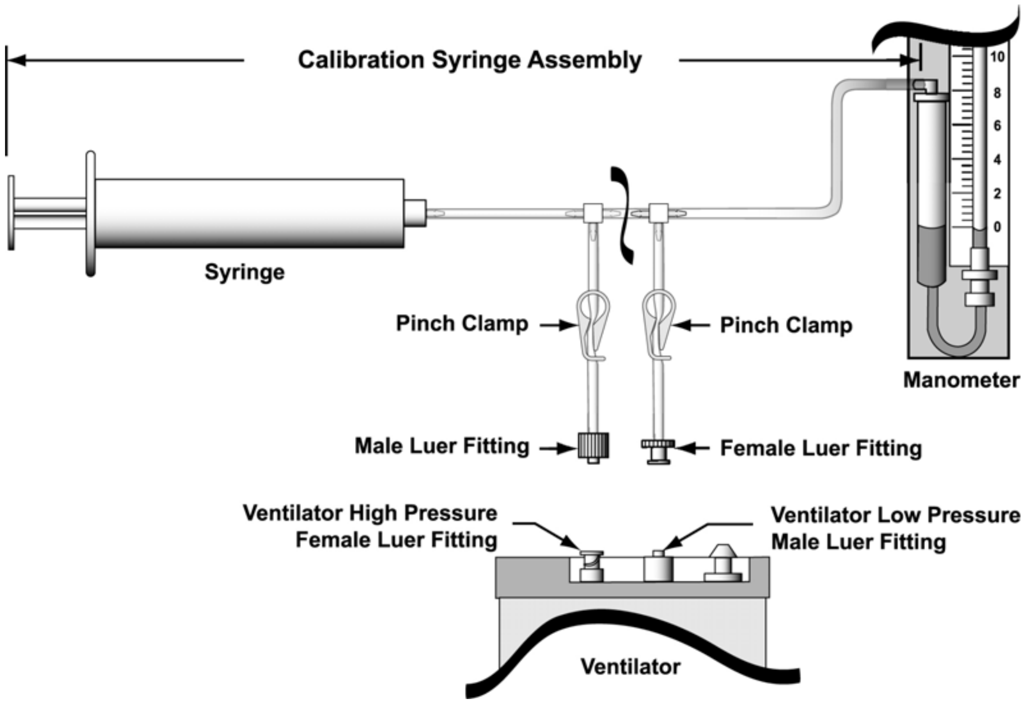
   Record that value on the calibration worksheet.

   FLOW DIFF is displayed if the calibration was successful.

6) If **CAL FAIL** appears at any time, press **Select** to exit the calibration. When **AIRWAY** is displayed, press **Select** and perform the calibration again.

To perform the flow differential calibration, you will need the following equipment:

- Calibration syringe assembly[14], P/N 11471, with a T-connection to a pressure manometer (0-90 cmH_2O). The pinch clamps should be used between each Luer fitting and the T-connection to block off the unused Luer fitting for each step in this procedure.
- Syringe with a T-connection to a test lung or other large-compliance reservoir and a male Luer fitting.



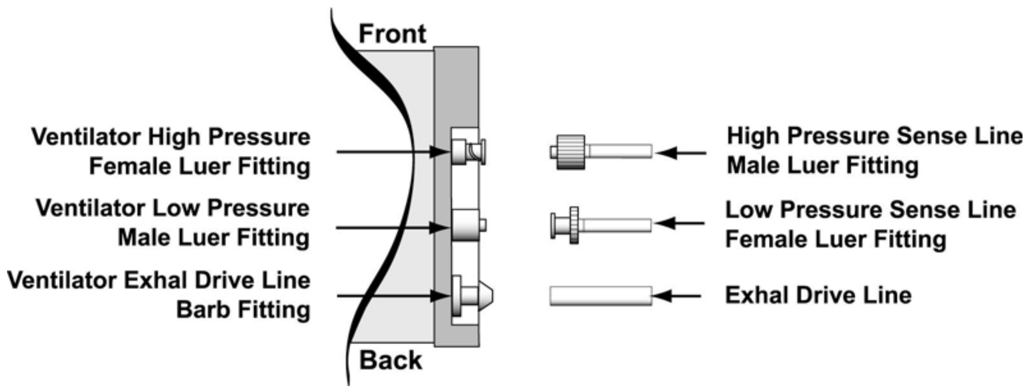
To calibrate the flow differential transducer:

1) Press the **Select** button while **FLOW DIFF** is displayed.

   FD -30 $^{C}{}_{M}H_2O$ is displayed.

[14] The Calibration Syringe is available separately, or as part of the Maintenance Calibration Kit, P/N 11566.

2) Connect the female Luer fitting from the calibration syringe assembly to the low pressure male Luer fitting. Pinch off the tubing on the calibration syringe assembly to the male Luer fitting, and increase and maintain the pressure at 30.0, ± 0.2 cmH_2O.



Observe the numbers displayed in the **Tidal Volume** setting window. When the displayed value is stable, press **Select**.

Record that value on the Calibration Worksheet.

FD 0 $^{C}{}_{M}H_2O$ is displayed.

3) Disconnect from the ventilator so the connection is open to ambient room air. Observe the numbers displayed in the **Tidal Volume** setting window. When the displayed value is stable, press **Select**.

Record that value on the Calibration Worksheet.

FD 30 $^{C}{}_{M}H_2O$ is displayed.

4) Connect the male Luer fitting from the calibration syringe assembly to the high pressure female Luer fitting. Pinch off the tubing between the calibration syringe assembly and the female Luer fitting, and increase and maintain the pressure at 30.0, ± 0.2 cmH_2O.

Observe the numbers displayed in the **Tidal Volume** setting window. When the displayed value is stable, press **Select**.

Record that value on the Calibration Worksheet.

FD 0 $^{C}{}_{M}H_2O$ is displayed.

5) Disconnect from the ventilator so the connection is open to ambient room air. Observe the numbers displayed in the **Tidal Volume** setting window. When the displayed value is stable, press **Select**.

Record that value on the Calibration Worksheet.

FD 80 ± 70 AD is displayed.

6) Connect the male Luer fitting from the calibration syringe assembly to the high pressure female Luer fitting on the side of the ventilator. Decrease and maintain the vacuum until a value in the range of 10 to 150 is displayed in the **Tidal Volume** window. Adding a large amount of compliance, such as a test lung, to the calibration syringe assembly, will significantly stabilize the readings during this step.

   During this step, any value in the range of 10 to 150 displayed in the **Tidal Volume** window is equally acceptable, but it is very important that the value displayed in the **Tidal Volume** window is stable when pressing **Select**.

   Alternatively, it is also acceptable to apply a small positive pressure to the ventilator low pressure fitting to fulfill this step.

   FD 0 $^{C}{}_{M}H_2O$ is displayed.

7) Disconnect from the ventilator so the connection is open to ambient room air. Observe the numbers displayed in the **Tidal Volume** setting window. When the displayed value is stable, press **Select**.

   Record that value on the Calibration Worksheet.

   FD 4015 ± 70 AD is displayed.

8) Connect the male Luer fitting from the Calibration Syringe assembly to the high pressure female Luer fitting. Increase and maintain the pressure until a value of 3945 to 4085 is displayed in the **Tidal Volume** window. Adding a large amount of compliance, such as a test lung to the calibration syringe assembly, will significantly stabilize the readings during this step.

   During this step, any value in the range of 3945 to 4085 displayed in the **Tidal Volume** window is equally acceptable, but it is very important that the value displayed in the **Tidal Volume** window is stable when pressing **Select**.

   FD 0 $^{C}{}_{M}H_2O$ is displayed

9) Disconnect from the ventilator so the connection is open to ambient room air. Observe the numbers displayed in the **Tidal Volume** setting window. When the displayed value is stable, press **Select**.

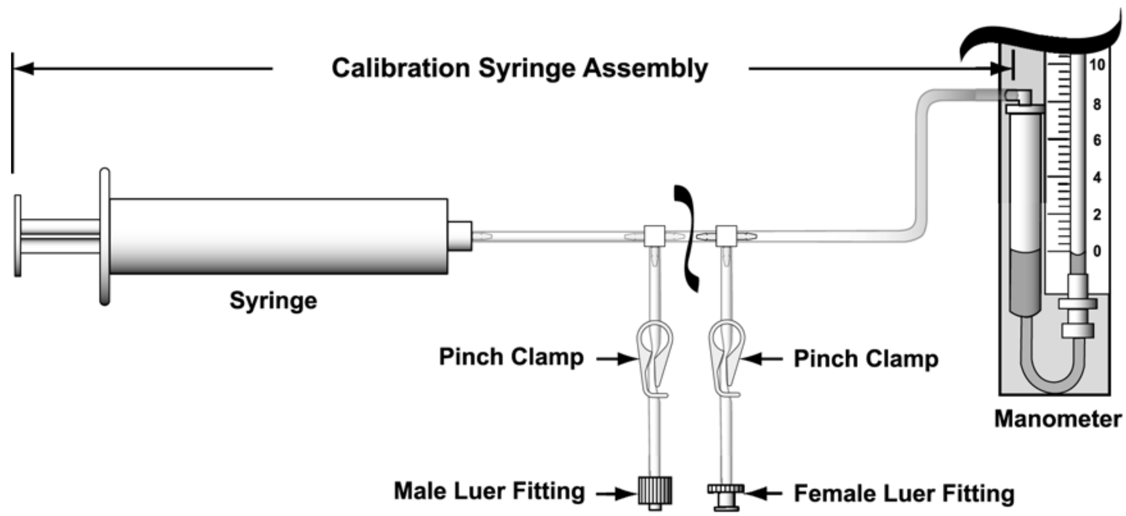
   Record that value on the Calibration Worksheet.

   VALVE DIFF is displayed if the calibration was successful.

If **CAL FAIL** appears at any time, press **Select** to exit the calibration. When **FLOW DIFF** is displayed, press **Select** and perform the calibration again.

To perform the valve differential calibration, you will need the following equipment:

- Calibration syringe assembly[15], P/N 11471, with a T-connection to a pressure manometer (0-90 cmH_2O).



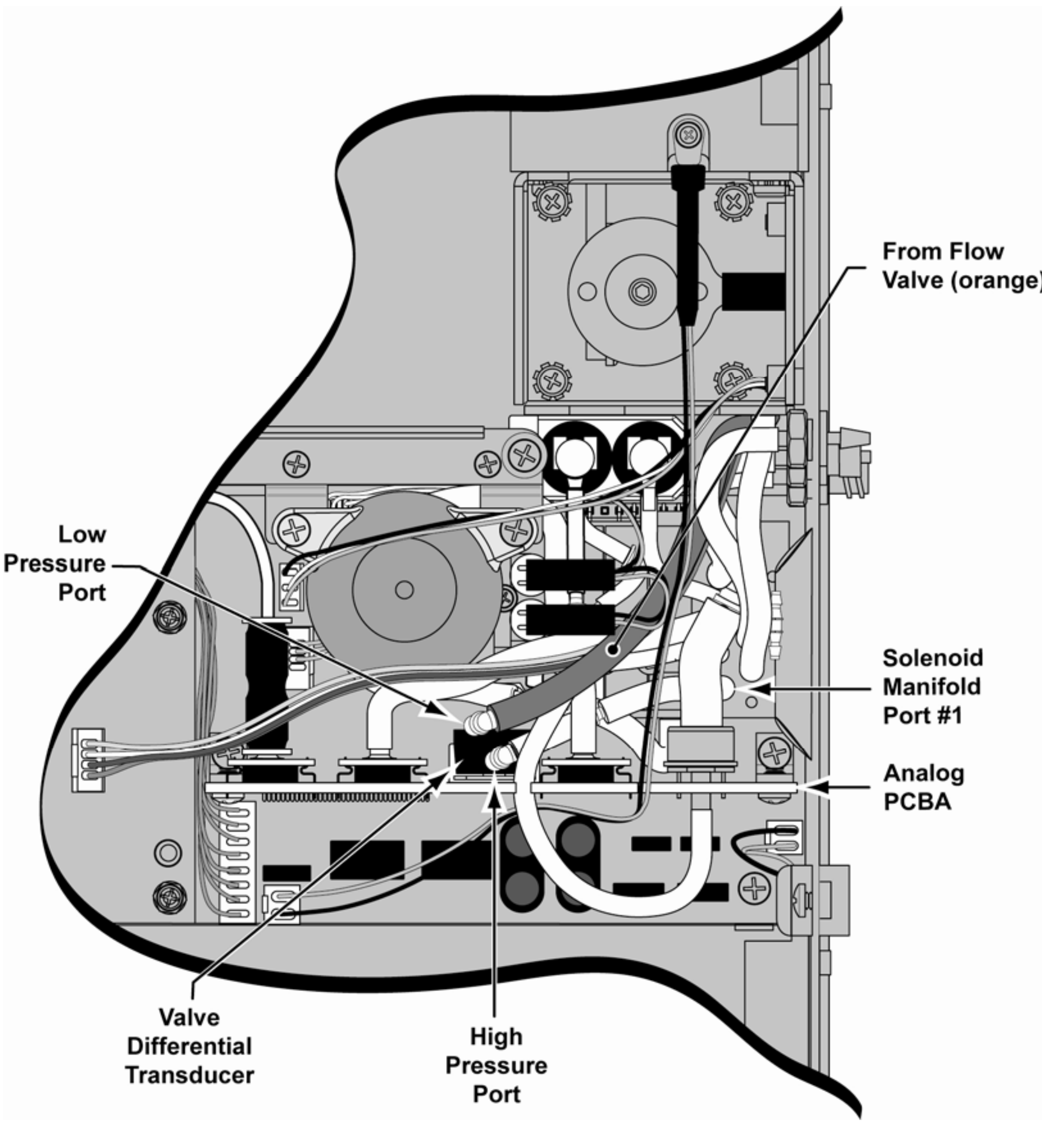
[15] The Calibration Syringe is available separately, or as part of the Maintenance Calibration Kit, P/N 11566.

To calibrate the valve differential transducer:

1) Press the **Select** button while **VALVE DIFF** is displayed.

   VD 15 $^{C}_{M}H_2O$ is displayed.

2) With the back of the ventilator open, (see *Chapter 8 - Component Removal and Replacement),* disconnect both flexible tubes from the valve differential transducer on the analog board.



> **NOTE**
>
> See instructions beginning on *page 8-33* for tube routing diagrams, tables and instructions.

3) Remove a Luer fitting from the calibration syringe assembly. Connect the tube from the syringe to the high pressure port of the valve differential transducer (the port nearest the analog board). Use the pinch clamp on the unused line from the calibration syringe assembly to hold the pressure steady. Increase to and maintain the pressure at 15.0 ± 0.2 cmH_2O.

   Observe the numbers displayed in the **Tidal Volume** setting window. When the displayed value is stable, press **Select**.

   Record that value on the Calibration Worksheet.

   VD 0 $^{C}{}_{M}H_2O$ is displayed.

4) Disconnect the tube from the syringe to the high pressure port of the valve differential transducer and observe the numbers displayed in the **Tidal Volume** setting window. When the displayed value is stable, press **Select**.

   Record that value on the Calibration Worksheet.

   PPP is displayed if the calibration was successful.

5) Reconnect the flexible tubes from the solenoid manifold and the flow valve to the valve differential transducer.

   The orange tube from the bottom of the flow valve should be reconnected to the port farthest from the analog board (low pressure), and the clear flexible tube from port #1 on the solenoid manifold should be reconnected to the port nearest the analog board (high pressure).

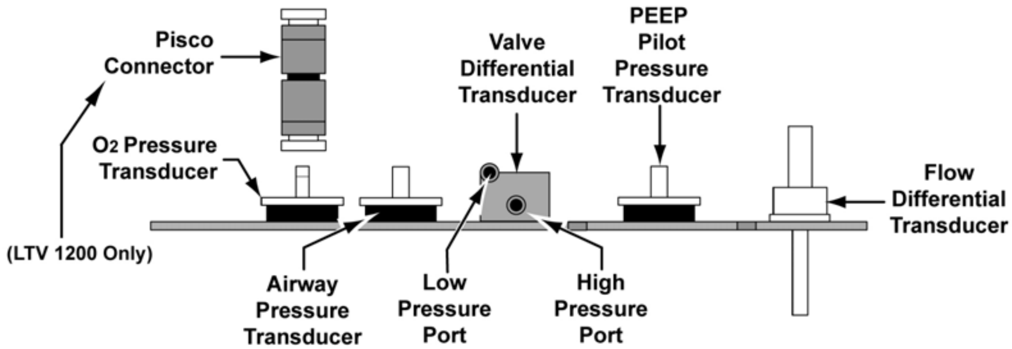
If **CAL FAIL** appears at any time, press **Select** to exit the calibration. When **VALVE DIFF** is displayed, press **Select** and perform the calibration again.

To calibrate the PEEP Pilot Transducer:

1) Press the **Select** button while **PPP** is displayed.

   PPP 30 $^{C}{}_{M}H_2O$ is displayed.

2) Remove the tube connected to the PEEP pilot pressure transducer (PT2 on the analog PCBA).



3) Connect an open tube from the syringe to PT2. Use a pinch clamp on the unused line from the calibration syringe assembly to hold the pressure steady.

   Increase and maintain the pressure at 30.0 ± 0.2 cmH_2O.

   Observe the numbers displayed in the **Tidal Volume** setting window. When the displayed value is stable, press **Select**.

   Record that value on the Calibration Worksheet.

   PPP 0 $^{C}{}_{M}H_2O$ is displayed.

4) Disconnect the tube from the syringe to the PEEP pilot pressure transducer.

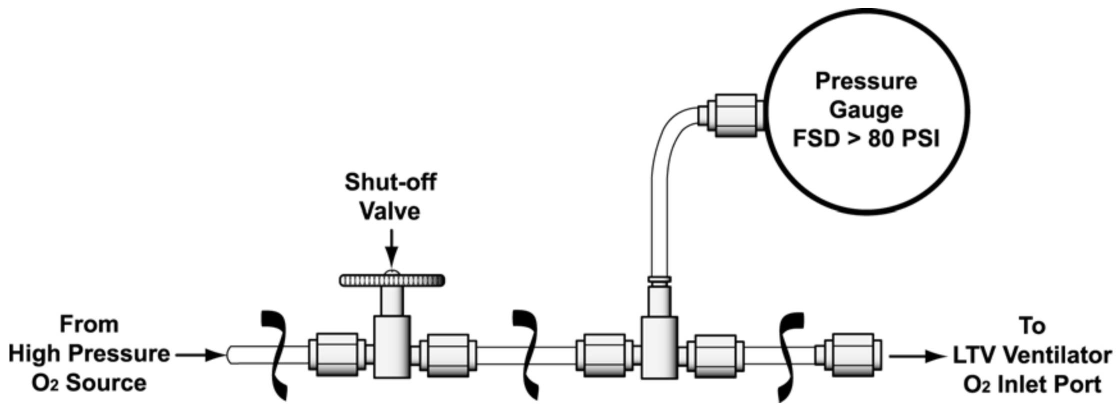
   Observe the numbers displayed in the **Tidal Volume** setting window. When the displayed value is stable, press **Select**.

   Record that value on the Calibration Worksheet.

5) Reconnect the flexible tube to the pilot pressure transducer of the analog PCBA.

To perform the O_2 inlet pressure calibration, you will need the following equipment:

- Gas source capable of 80 PSI with a T-connection to a pressure gauge and an O_2 inlet connector.



O_2 leak test

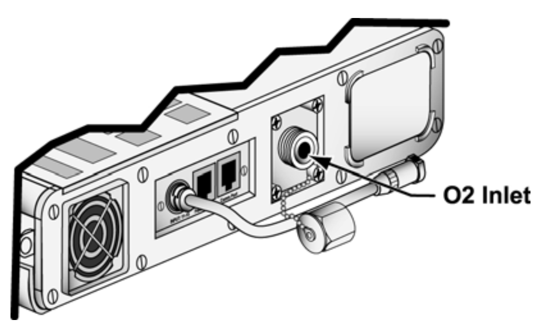
1) Remove the O_2 inlet port cap and connect the high pressure gas source to the O_2 inlet port. Set the O_2 supply to approximately 50 PSI.
2) Turn off the O_2 supply.
3) Observe the gauge and record any drop in pressure

   Requirements: The leakage rate shall be ≤ 1 PSI in one (1) minute.
4) Record the leakage value on the Calibration Worksheet.

To calibrate the O_2 inlet pressure transducer

1) Press the **Select** button while **O2 INLET** is displayed.

   O2 50 PSI is displayed.
2) Increase to and maintain the pressure at 50.0 ±0.2 PSI.



3) Check the values displayed in the **Tidal Volume** setting window. When the value stabilizes, record the number on the Calibration Worksheet at the end of this section and press **Select**.

   O2 0 PSI is displayed.

4) With the O_2 inlet port open to ambient room air, observe the values in the **Tidal Volume** window. When value stabilizes, record the number on the Calibration Worksheet. Press **Select.**

   MOTOR DRIVE is displayed if the calibration was successful.

If **CAL FAIL** appears at any time, press **Select** to exit the calibration. When **O2 INLET** is displayed, press **Select** and perform the calibration again.

Stepper Motor Calibration

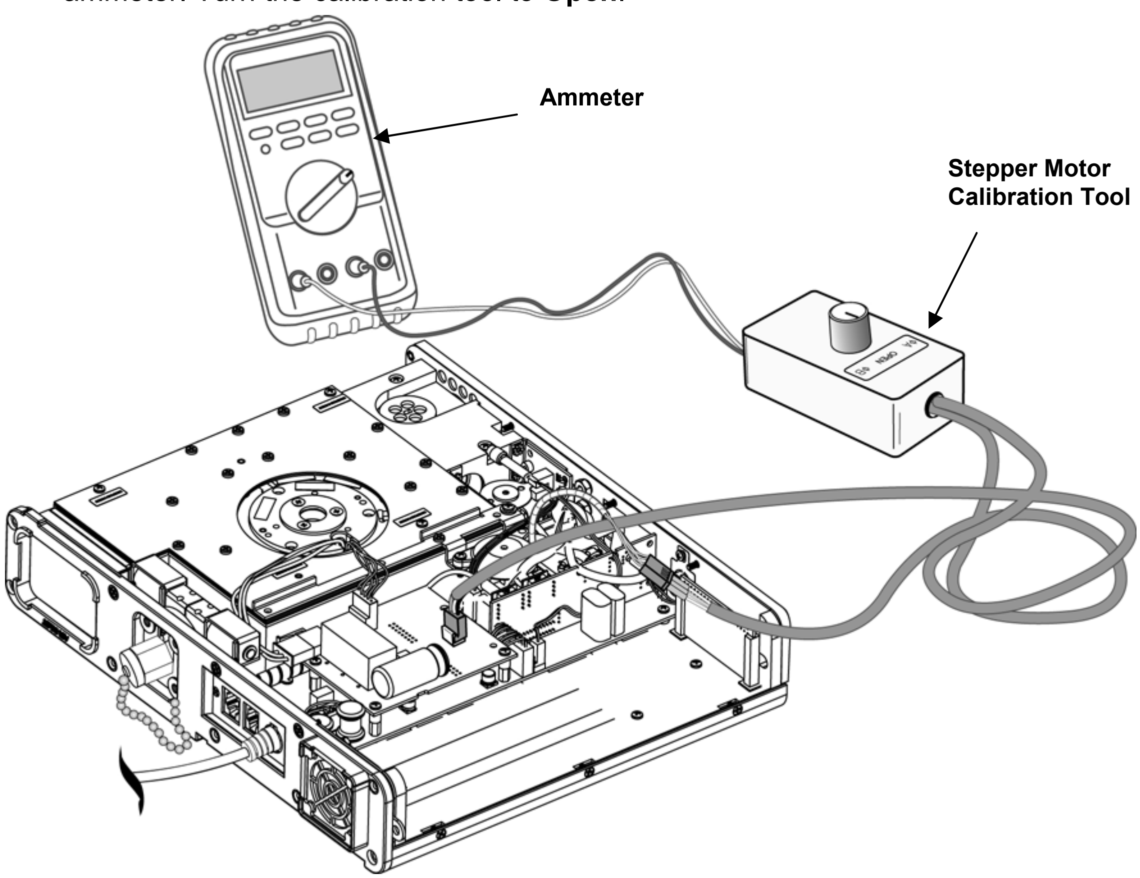
To perform the stepper motor calibration, you will need the following equipment:

- Stepper Motor Calibration Tool[16], P/N 10871
- 10 amp 60 Hz amp meter set to measure between 400 and 700 ma.

To calibrate the motor drive:

> **CAUTION**
> **Possible ventilator damage** - To avoid damaging the ventilator, turn the ventilator off and disconnect the AC adapter before attaching the calibration tool.

1) **Turn the ventilator OFF and disconnect the AC adapter from the unit.**
2) Disconnect the 4-wire flow valve cable from **J4** on the motor board and connect it to the male 4-wire connector on the calibration tool. Connect the female 4-wire connector from the calibration tool to **J4** on the motor board. Connect the calibration tool to the ammeter. Turn the calibration tool to **Open**.



[16] The Stepper Motor Calibration tool is available separately, or as part of the Maintenance Calibration Kit, P/N 11566.

3) Set the calibration tool to **ΦA**. Reconnect the AC adapter to the ventilator. Turn the ventilator on, silence alarms and enter the **CALIBRATION** menu. Turn to **MOTOR DRIVE** and press **Select**.

    ΦA:+600ma: xxx is displayed where the xxx is a numeric value.

4) The Phase A amp meter will show a positive value. Turn the **Set Value** knob on the ventilator right or left until the amp meter reads 600ma, or as close as possible.

    Record Pass or Fail on the Calibration Worksheet and press **Select**.

    ΦA:-600ma: xxx is displayed where the xxx is a numeric value.

5) The Phase A amp meter will show a negative value. Turn the **Set Value** knob on the ventilator right or left until the amp meter reads -600ma, or as close as possible.

    Record Pass or Fail on the Calibration Worksheet and press **Select**.

    ΦB:+600ma: xxx is displayed where the xxx is a numeric value.

6) Set the calibration tool to **ΦB**. The Phase B amp meter will show a positive value. Turn the **Set Value** knob on the ventilator right or left until the amp meter reads 600ma, or as close as possible.

    Record Pass or Fail on the Calibration Worksheet and press **Select**.

    ΦB:-600ma: xxx is displayed where the xxx is a numeric value.

7) The Phase B amp meter will show a negative value. Turn the **Set Value** knob on the ventilator right or left until the amp meter reads -600ma, or as close as possible.

    Record Pass or Fail on the Calibration Worksheet and press **Select**.

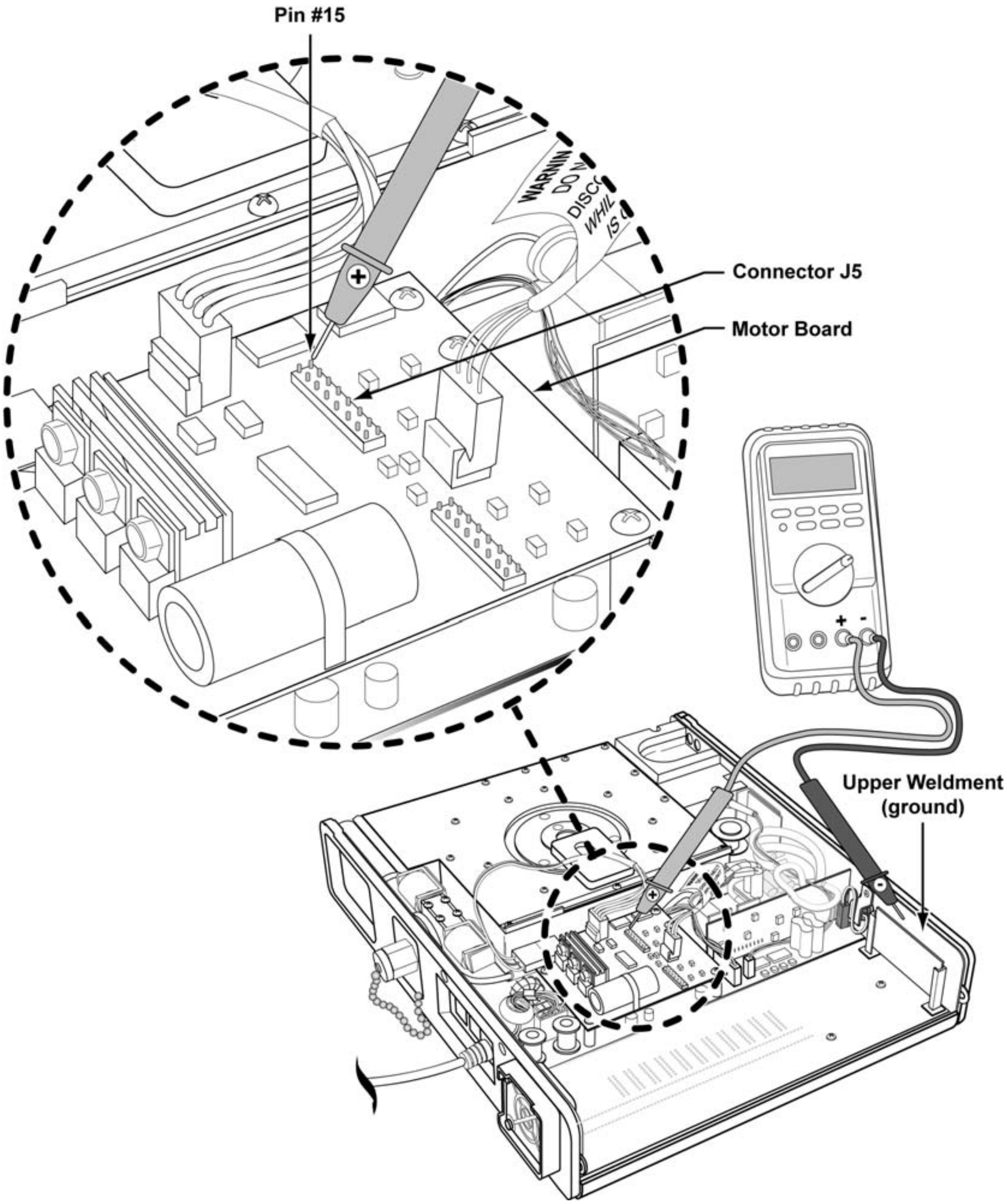
    CAL EXIT is displayed if the calibration was successful.

8) Turn the test tool to **Open**. Power the unit off and disconnect the AC from the unit. Disconnect the test tool connections from the vent and reconnect the 4-wire flow valve cable to the motor board.

If **CAL FAIL** appears at any time, press **Select** to exit the calibration. When **MOTOR DRIVE** is displayed, press **Select** and perform the calibration again.

Measure Turbine Speed (T/S)

1) Enter the **SERVO** menu. Run the ventilator in Servo mode at default settings (flow **10** and turbine speed **4000**) for approximately one minute to stabilize turbine speed.
2) Set up a multimeter to measure frequency. Connect the meter test leads as follows:
   - **black** lead to the meter **COM** connection
   - **red** lead to the meter **VΩ** connection.
3) Set the meter selector to Voltage (alternating or DC) and change to a frequency measurement (Hz).
4) Connect the black meter test lead to chassis ground on the ventilator. Touch the red meter test lead to PIN 15 of connector **J5** on the Motor PCBA as shown below.



5) Allow approximately 10-15 seconds for the value to stabilize then read the meter-displayed value for frequency.

6) Calculate the turbine speed value measured in revolutions per minute (RPM) by multiplying the frequency displayed on the meter by the number 30. Round the total to the nearest 10.

7) The measured turbine speed must be between 3400 and 4400 RPM.

8) Record the measured turbine speed (T/S) value. This value is used in the Performance Checkout patient port pressure testing.

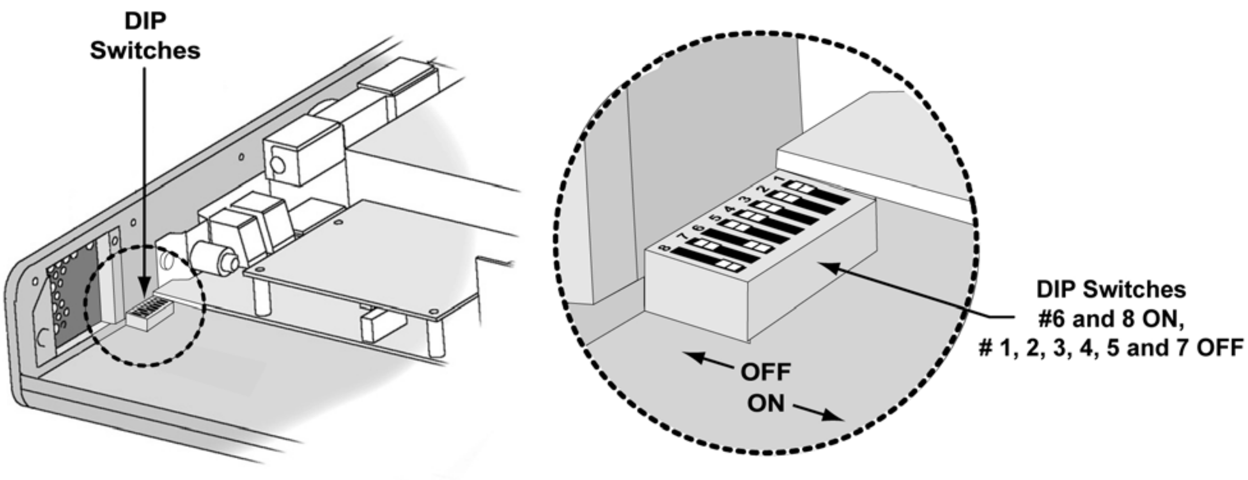
If the measured T/S value is outside of the above range, check the setup and repeat the test. For assistance, call technical support at Pulmonetic Systems using the contact information at the front of this manual.

Vent Maintenance Exit

The ventilator will not resume normal operation while the maintenance mode DIP is set.

To exit maintenance mode:

1) Turn the ventilator off.
2) Locate DIP #5 and set it to OFF (towards the outside of the ventilator). Verify that DIP switches #6 and #8 remain ON.



> **NOTE**
> An O_2 Sampling Tube[17] used for testing internal oxygen enrichment (oxygen leakage) during General Checkout testing, must be installed before replacing the ventilator's back panel. See *General Checkout* in Chapter 9 – Final Checkout Test for test requirements.

3) Install an O_2 Sampling Tube. See *Back Panel, Reinstallation* in Chapter 8 – Component Removal and Replacement for detailed instructions.

> **CAUTION**
> **Final Tubing Check -** Anytime internal flexible tubing is removed or replaced, check to ensure all tubes have been correctly routed (point to point and layering), are fully connected on the ports or fittings, and do not have any holes or tears in them. If necessary, gently reposition the tubing to eliminate possible kinks or occlusions.

4) Replace the back panel (see *Back Panel, Reinstallation* in Chapter 8). Turn the ventilator on to resume normal operation.

---

[17] O_2 Sampling Tube, P/N 10544, ~10.0" long, 0.125" O.D. X 0.079 I.D. clear polycarbonate tubing.

Calibration Worksheet

LTV® 1200/1150 SERIAL NUMBER:	____________	CONDUCTED BY:	____________
MEMORY BOARD SOFTWARE VER.:	____________	DATE:	____________

TEST DESCRIPTION	MEAS. VALUE	REQUIREMENT	ACCEPTABLE A/D COUNTS	PASS / FAIL
VENTILATOR CALIBRATION				
Airway Pressure				
Leak test: High & Low Xdcr		Leak ≤ 1.0 cmH2O in 1 min	N/A	
Leak test: High		Leak ≤ 1.0 cmH2O in 1 min	N/A	
Leak test: Low		Leak ≤ 1.0 cmH2O in 1 min	N/A	
@ 50 cmH_2O		Enter displayed value	733 - 1570	
@ Ambient		Enter displayed value	35 - 350	
Flow Differential Pressure				
FD (BiDir) @ -30 cmH_2O		Enter displayed value	64 - 3240	
FD (BiDir) @ Ambient		Enter displayed value	3180 - 4045	
FD (Wide) @ 30 cmH_2O		Enter displayed value	854 - 4030	
FD (Wide) @ Ambient		Enter displayed value	10 - 400	
FD (Narrow) @ 80 ± 70 AD		Enter value displayed under **Tidal Volume** window	10 - 150	
FD (Narrow) @ Ambient		Enter displayed value	128 - 3968	
FD (Narrow) @ 4015 ±- 70 AD		Enter value displayed under **Tidal Volume** window	3945 - 4085	
FD (Narrow) @ Ambient		Enter displayed value	128 - 3968	
Valve Differential Pressure				
VD @15 cmH_2O		Enter displayed value		
		For Software Version < 05.04	1915 - 2340	
		For Software Version ≥ 05.04	1915 - 2521	
VD @ Ambient		Enter displayed value	40 - 328	
PEEP Pilot Pressure				
PPP @ 30 cmH_2O		Enter displayed value	999 - 2493	
PPP @ Ambient		Enter displayed value	135 - 272	
Oxygen Pressure (LTV® 1200 only)				
Leak test		Leakage ≤ 1 PSI in 1 minute	N/A	
O_2 @ 50 psig		Enter displayed value	900 - 1822	
O_2 @ Ambient		Enter displayed value	122 - 246	
Stepper Motor				
Phase A / +600 ma			N/A	
Phase A / -600 ma			N/A	
Phase B / +600 ma			N/A	
Phase B / -600 ma			N/A	
Record Actual Measured Turbine Speed			N/A	
DIP Switch #5 re-set at end of Calib.		Procedure Check	N/A	

Flow Valve Calibration

The flow valve should not normally require recalibration from its factory set values. However, some circumstances, such as mechanical shock, may cause the flow valve calibration to change from its factory-set condition. This flow valve calibration procedure can be used to adjust the flow valve calibration setting to compensate for improper flows measured during the Performance Checkout procedure.

LTV® software includes an adjustable **VHOME** option to allow for field calibration of the flow valve. Specifically, the location of the flow valve **HOME** position Flag can be set relative to the position sensor.

Proper ventilator flow performance depends on several conditions, such as transducer calibration and lack of leaks in the airway passages, in addition to flow valve calibration. Flow valve recalibration should only be performed after all other factors affecting flow performance are verified to be correct. This procedure is designed so that it checks the other factors contributing to flow performance before adjusting the flow valve calibration. For this reason, it is important to follow this flow valve calibration procedure completely, and in the stated order. Enter the measurements on the flow valve Calibration Worksheet at the end of this section.

> **CAUTION**
>
> **Recalibration of the flow valve -** When recalibrating the flow valve this procedure must be followed completely, and in the listed order of events.
>
> Calibration of the valve differential (see *page 6-13*) <u>and</u> stepper motor (see *page 6-19*) <u>must</u> be performed prior to performing flow valve calibration.

1) Determine the current configuration of the flow valve.
   - Turn on the LTV® in the **VENT CHECK** mode. (Push and hold the **Select** button while the unit powers on).
   - Turn the **Set Value** knob to the **VENT OP** menu and push the **Select** button.
   - Turn the **Set Value** knob to the **VHOME XXX** display and record the value.
2) Warm the ventilator up by running it at the following settings on a test lung for approximately 1 hour; Mode: Volume, Assist/Control, Rate:12 bpm, Tidal Vol:500 ml, Insp Time:1.5 sec. Measure the flow in Vent Maintenance / Servo mode at 4000 rpm and 10 Lpm. The measured flow should be 9.5 Lpm – 10.5 Lpm. If the measured flow is within this range, then the flow is within specification, and there is no need to continue with flow valve calibration; otherwise power down the ventilator and proceed to step 3.
3) Place the ventilator in an ESD-safe environment, and use ESD controls. Remove the back panel from the ventilator. Perform a visual inspection of the flow valve:
   - Is the Motor bracket interfering with the turbine manifold?
   - Is the Motor bracket interfering with the side weldment?
   - Are any of the screws loose, including the screws for the Drive Band, Motor bracket, Sensor PCB, and Flag?

- Are there any errors in the flexible tubes routing to the flow valve? This includes the flexible tubes connecting to the bypass valve and the high and low-pressure ports connecting to the solenoid manifold and Differential Pressure transducer.

4) Run Leak Test in **VENT CHECK** mode. Block the patient outlet port and the exhalation drive port. Test should pass with values of less than 1.0 Lpm.

5) Calibrate the valve differential pressure transducer at 0 and 15 cmH_2O.

6) **Stepper Motor Calibration:** Remove power from the ventilator, and connect the step motor current calibration box with current meter. In **VENT MNTCE** go to **Calibration: Motor Drive**. Calibrate the currents for phase A and B, per the Motor Drive Calibration procedure (see *page 6-19*).

7) Warm the ventilator up by running it at the following nominal settings on a test lung for approximately 1 hour; Volume Control, 12 bpm, 500 ml, 1.5 sec. Recheck the flow in **Vent Maintenance / Servo** mode at 4000 rpm and 10 Lpm. The measured flow should be 9.5 Lpm – 10.5 Lpm. If the measured flow is within this range, then the flow is within specification, and there is no need to continue with this procedure; otherwise power down the ventilator and proceed to step 8.

8) **Recalibrate the flow valve as follows:**

   a) Using ESD safe protocol, remove the back panel. Turn on DIP switch #5.

   b) Lay the ventilator flat, facing upwards. Reconnect external power and turn the ventilator on in **VENT MTNCE** mode.

   c) Turn the **SERVO** on in the **VENT MTNCE** menu. Push the **Tidal Volume** button once and change the step position to the starting position. Use the **VHOME** position labeled on the flow valve.

   d) Connect a calibrated flow meter **BTPD** (Body Temperature Pressure Dry) to the flow valve outlet port.

   e) Determine the desired flow at 15 cmH_2O: Record the **FVt** temperature reading from the **RT XDCR DATA** menu. Use the table below to determine the appropriate delivered flow based on the recorded temperature.

FVt	Desired Flow (Lpm ± 0.02)
62.01 - 67.00	11.61
67.01 - 72.00	11.57
72.01 - 77.00	11.53
77.01 - 82.00	11.48
82.01 - 87.00	11.44
87.01 - 92.00	11.40
92.01 - 97.00	11.35
97.01 -102.00	11.31
102.01 - 107.00	11.27
107.01 - 112.00	11.23

   f) Monitor the **FVd** pressure from the **RT XDCR DATA** menu. Adjust the turbine speed until the **FVd** pressure reaches 15.00 ±.10 cmH_2O.

g) Adjust the Step position (**Tidal Volume** button) until the delivered flow matches the desired flow as shown in step e). Press the **Manual Breath** button after each adjustment.

h) From the adjusted value, record the magnitude of the adjustment from the original VHome value. For example, if the original VHome value was 220 and the adjusted step position is 215, then the magnitude of the change would be 220-215= **-**5 steps.

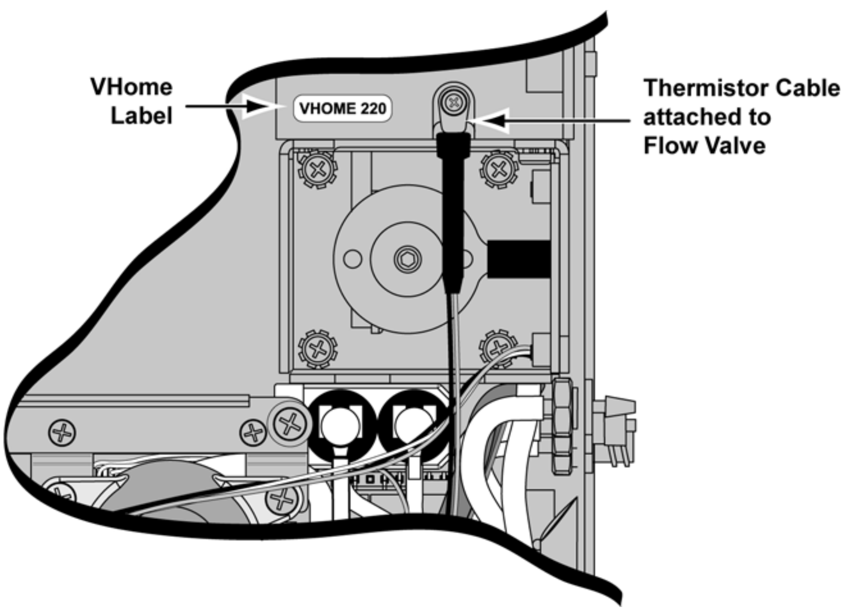
i) Turn the Servo off. From the **VENT MTNCE**, **CONFIG, FLOW VALVE** menu adjust the **VHOME** by the negative value of the value in the previous step. For example for an adjustment value of –5 from the previous step, increase the **VHOME** value by +5. Push the **Select** button before exiting this menu. Push the **Control Lock** button to exit this menu.

- The adjustable range for the flow valve is 200 – 240.
- Flow valve assembly requires replacement if adjusted value is outside of this range.

j) Continue the steps f) thru i) until the delivered flow matches the required flow with an **FVd** = 15.00 cmH_2O. Be sure to frequently check the **FVt** temperature reading to make certain the required flow value is appropriate for the monitored flow.

k) Record the ending VHome position, turbine speed, and measured flow on the flow valve Calibration Worksheet at the end of this section.

l) Install new VHome label showing the resulting VHome position.



LTV® 1200/1150 SERIAL NUMBER:	______________	**CONDUCTED BY:**	______________
MEMORY BOARD SOFTWARE VER.:	______________	**DATE:**	______________

TEST DESCRIPTION	MEAS. VALUE	REQUIREMENT	ACCEPTABLE A/D COUNTS	PASS / FAIL

FLOW VALVE CALIBRATION

Calibration Date:				

Flow Valve Calibration

1) Determine flow valve configuration		Enter VHOME value (220 ±20)	N/A	
2) Measure 10 Lpm flow		Enter measured value Pass = 10 Lpm ± 0.5 Lpm	N/A	
3) Perform visual inspection		Enter inspection result	N/A	
4) Leak test in VENT CHECK		Enter displayed value (Pass < 1.0 Lpm)	N/A	
5) Calibrate valve differential transducer				
VD @ Ambient		Enter displayed value	40 - 328	
VD @ 15 cmH_2O		Enter displayed value		
		For Software Version < 05.04	1915 - 2340	
		For Software Version ≥ 05.04	1915 - 2521	
6) Calibrate stepper motor				
Phase A / +600 ma		Enter displayed value	N/A	
Phase A / -600 ma		Enter displayed value	N/A	
Phase B / +600 ma		Enter displayed value	N/A	
Phase B / -600 ma		Enter displayed value	N/A	
7) Measure 10 Lpm flow		Enter measured value Pass = 10 Lpm ± 0.5 Lpm	N/A	
8 e) Determine desired flow at FVd = 15 cmH_2O		Enter value from table	N/A	
8 k) Flow valve calibration results				
VHOME position		Enter final VHOME position	N/A	
TS (Turbine speed)		Enter turbine speed for FVd = 15 cmH_2O	N/A	
Measure final 10 Lpm flow		Enter measured value	N/A	

Servo

The Servo feature allows you to verify certain ventilator functions. When **SERVO** is on, the ventilator continuously delivers gas according to the highlighted settings. Gas may be delivered by:

- turbine speed and flow valve step position
- turbine speed and flow in Lpm

SERVO is used to check ventilator operation or diagnose problems by setting specific conditions on the ventilator and monitoring the system either externally (e.g. with a flow meter or pressure gauge) or internally (by using the monitored values under the **RT XDCR DATA** menu). For example, delivered flow can be verified[18] by setting the flow to a specified Lpm[19] and connecting a flow meter to the patient wye. In addition, the monitored flow (**FTx**) and other data can be checked under the **RT XDCR DATA** menu. The servo menu is set up as follows:

SERVO

SERVO OFF

SERVO ON

To enable the servo functions, press **Select** while **SERVO ON** is displayed. The following displays are turned on (highlighted). Dimmed displays do not affect gas delivery.

Display	Purpose
Tidal Volume	Sets the flow valve step position
Insp Time	Sets the flow in Lpm
O_2%	Sets the delivered O_2%
High Pres Limit / Low Pres	Sets the turbine speed

To turn off the servo functions, press **Select** while **SERVO OFF** is displayed. Servo functions are automatically turned off when you enter the Calibration menu.

To modify a SERVO setting:

1) Press the associated button to select the control.
2) Turn the **Set Value** knob until the desired setting is displayed.
3) Press the button again or wait 5 seconds to accept the setting.

To select delivery by flow valve step position, press **Tidal Volume** twice. The controls for step position and turbine speed will be highlighted to indicate they are active.

To select delivery by Lpm, press **Insp. Time** twice. The controls for flow, turbine speed and O_2% will be highlighted to indicate they are active.

Oxygen blending is active only when delivery by Lpm is selected.

To Home the flow valve, press **Manual Breath**. After the home is complete, the valve will return to its previous position.

[18] For information on performance tolerances, see Appendix A - Ventilator Specifications in the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual.

[19] Turbine speed must be set to an appropriate value for flow to be delivered accurately.

Solenoid

The Solenoid menu is used to test the operation of the solenoids. The menu is set up as follows:

SOLENOID

ExhPilot OFF

Purge OFF

APres OFF

ExhDiffP OFF

PPin OFF

PPout OFF

O2 #1 OFF (LTV® 1200 only)

O2 #2 OFF (LTV® 1200 only)

O2 #3 OFF (LTV® 1200 only)

O2 #4 OFF (LTV® 1200 only)

EXIT

Use the **Set Value** knob to rotate between solenoid options. To change the state of any solenoid, press **Select** while it is displayed in the window. Pressing **Select** toggles the state of the solenoid on and off.

Solenoids are automatically set to the off state when you enter the Calibration menu.

Step Test

The flow valve stepper motor synchronization test is used to exercise the flow valve and insure LTV® software / hardware synchronization.

1) Set the ventilator to VENT MAINTENANCE mode (**VENT MTNCE),** (refer to Vent Maintenance Entry in this chapter).
2) From the **VENT MTNCE** display, press **Select** and rotate the **Set Value** knob to select the **STEP TEST** display.
3) Press **Select** to start the test.

   The flow valve stepper motor will begin to actuate continuously for approximately seven (7) minutes. During the test, the status monitor window display will change continuously. To the right side of the display a numeric value will appear (for example, “3”) to indicate the maximum number of step errors that have occurred during the test.

   Upon completion of the test, the status monitor window will automatically display the results of the test with one of the following messages:

   PASS X (where “X” is a number of 8 or less)

   or,

   FAIL X (where “X” is a number greater than 8)

Ventilator Settings and Procedure	Performance Requirement
Steps 1 through 3 (above).	**PASS X**

4) If ventilator fails this test, replace the flow valve assembly and re-test.

Watchdog Test

The watchdog timer is used to verify that essential parts of the software are running at the correct times. If the software does not update the watchdog timer correctly, the watchdog timer causes the ventilator to inop. This item tests that the watchdog timer is operating correctly.

To run the watchdog test:

1) Press **Select** while **WDOG TEST**is displayed in the VENT MTNCE menu.

2) The ventilator will restart, and begin the normal POST tests:
   - At the end of POST the audible alarm will sound and a **RESET** alarm message will be displayed and the ventilator will resume operation.
   - Press **Silence Reset** twice to clear the alarm.

If the Watchdog Test fails:

Problem	**Possible Cause**	**What To Do**
Vent does not reset when watchdog test is performed.	Defective main board.	Replace the main board. See *Chapter 8 - Main Board Assembly* for instructions.

Configuration

The Configuration menu is used to set the operational parameters for LTV® ventilators. The Configuration menu is set up as follows:

CONFIG

MODEL
FLOW VALVE
TEMP COMP
SERIAL NUM[20]
CONFIG EXIT

1) Use the **Set Value** knob to rotate between options.
2) To select an option, press **Select** while it is displayed in the window.
3) Pressing **Control Lock** exits to the previous menu without making any selections.

The menu selections are described further in the following pages.

> **NOTE**
> The configuration menus are used to configure many models of LTV®.

[20] The Serial Number menu option is for use by Pulmonetic Systems personnel only.

Model Selection

The model selection menu is used to select the appropriate model of LTV® ventilator. This configuration option determines which functions are available for the selected unit. The model selected should match the model number on the front of the ventilator. The menu is set up as follows:

MODEL

LTV 1200

LTV 1150

LTV 1000

LTV 900

LTV 950

LTV 800

LTV EXIT

> **CAUTION**
>
> **Configuration Errors -** Selecting an incorrect model number will not upgrade the unit and will cause features to be enabled or disabled inappropriately.

1) The model selection can be checked during normal operation in the **VENT OP** menu.

Flow Valve Home Position

The flow valve home position menu is used to select the home step position for the flow valve. The VHome value is printed on the VHome label of the flow valve. The menu is set up as follows:

FLOW VALVE

Range **VHome 200** through **240, VHome EXIT**

1) Use the **Set Value** knob to rotate between home position options.
2) To select a home position, press **Select** while it is displayed in the window.
3) Pressing **Control Lock** exits to the previous menu without making any modifications to the home position.
4) The valve home position selection can be viewed during normal operation in the **VENT OP** menu.

For information on Flow Valve Calibration procedures see *Flow Valve Calibration* in this chapter.

WARNING

Incorrect settings - Selecting an incorrect valve home position will cause the flow valve to operate incorrectly and could result in volumes and flows that are too large or too small for the patient.

Temperature Compensation

The Temperature Compensation menu is used to set the temperature compensation for the flow valve ON or OFF.

NOTE

This configuration menu is used for many models of LTV®. For the LTV® 1200/1150, which always has a Thermistor installed, the setting for Temperature Compensation is always ON.

CAUTION

Selecting **TCOMP OFF** on the LTV® 1200/1150 will cause slightly high or slightly low flows and volumes to be delivered. This phenomenon may occur at either end of the operating temperature range, when the unit is warm or when the unit is cold.

The Configuration menu is set up as follows:

TEMP COMP
- **TCOMP ON**
- **TCOMP OFF**
- **TCOMP EXIT**

If the Temperature Compensation is set to Off, set it to On as follows:

1) Press **Select** while **TCOMP** is displayed in the window.
2) Rotate the **Set Value** knob until **TCOMP ON** is displayed.
3) Press **Select**.
4) Pressing **Control Lock** exits to the previous menu without making any modifications to the temperature compensation.
5) The temperature compensation selection can be viewed in the **VENT MTNCE** menu when powered up in Vent Maintenance mode.

Configuration Menu Exit

To exit the configuration menu:

1) Press **Select** while **CONFIG EXIT** is displayed.
2) **CONFIG** is displayed. To access other Vent Maintenance menu options, turn the **Set Value** knob to the desired item and press **Select**.

CLEAR

The **CLEAR** menu is used to clear sections of the non-volatile[21] EEPROM memory.

The menu is set up as follows:

CLEAR

- **CLR EVENTS**
- **CLR CONTROLS**
- **CLR CAL**
- **CLR BAD REC**
- **CLR ALL**
- **CLR EXIT**

Use the **Set Value** knob to rotate between **CLEAR** options. To clear data from a section of the EEPROM, press **Select** while the appropriate name is displayed in the window. Pressing **Control Lock** exits the menu without clearing any data.

> **CAUTION**
>
> **Using the CLEAR Function -** The **CLEAR** function should be used with great care as once a section of the memory is cleared, all data in that section of memory is lost and it cannot be automatically restored.

The selections clear the following data from the EEPROM memory:

Option	Action
CLR EVENTS	Clears the event trace. • **All events and associated dates, times and data are removed.**
CLR CONTROLS	Clears the control settings. • **All settings will be returned to their default values.**
CLR CAL	Clears the calibration records. • **Once this is done, the unit must be recalibrated.**
CLR BAD REC	Reclaims all incorrectly recognized bad EEPROM records. Logs a **CLR BREC** event showing the number of records cleared.
CLR ALL	Clears events, control settings and calibration records. • **All events and associated dates, times and data are removed.** • **All settings will be returned to their default values.** • **All calibration records are removed, the unit must be recalibrated prior to powering down the ventilator.**

[21] Non-volatile memory is memory that is not erased when the ventilator is turned off or disconnected.

Vent Maintenance Menu Exit

To exit the vent maintenance menu:

1) Press **Select** while **EXIT** is displayed.
2) **VENT MTNCE** is displayed. To access the other main Extended Features menu options, turn the **Set Value** knob to the desired item and press **Select**.
3) To return the ventilator to normal operation, see the instructions under *Vent Maintenance Exit* at the beginning of this section.

Chapter 7 - Troubleshooting

This chapter describes troubleshooting for the LTV® 1200/1150 ventilator. Some problems can result from improper operation and can easily be corrected without any modification to the ventilator. Other problems may require that the ventilator be recalibrated or have parts replaced.

> **WARNING**
>
> **Ventilator Service and Repair** - Only service technicians who have been trained and certified by Pulmonetic Systems to service the LTV® 1200/1150 ventilator are authorized to perform repairs or maintenance on LTV® 1200/1150. Do not attempt to repair or replace any part of the ventilator unless you are trained and certified by Pulmonetic Systems. Personal injury could result.

> **NOTE**
>
> Event log entries are only one of many diagnostic tools used to troubleshoot the ventilator. Additional information is often required to accurately identify the root cause of a problem.

This chapter is organized into eight sections:

• Displays and Buttons	Includes problems with control and window displays and with setting controls.
• Ventilator Performance	Includes problems with delivered or monitored pressure, volume or PEEP, accuracy, sensitivity and triggering.
• Advanced Vte Diagnostic Procedures	Includes advanced diagnostic procedures for troubleshooting Vte problems involving transducer accuracy/drift, the pneumatic system and flow valve accuracy.
• Advanced FiO_2 Diagnostic Procedures	Includes advanced diagnostic procedures for troubleshooting O_2% concentration (FiO_2) problems involving calibration of the oxygen pressure transducer, flow valve and O_2 blender.
• Power and Battery Operation	Includes problems with turning the ventilator on, operating from external power sources, battery operation or duration, and Vent Inops.
• Alarms	Includes problems with recurring alarms.
• Checkout Test Failures	Includes problems detected while performing the VENT CHECK and VENT MTNCE tests.
• Test Lung Operation	Includes problems encountered when operating the ventilator with a test lung.

The troubleshooting tables are organized by symptoms, then by possible causes and methods of diagnosing and resolving the problem. If you do not find the symptom you are looking for under one section, you may find it listed under another. You may also be able to diagnose the problem by reading sections with related symptoms. For information on resolving problems that are not listed here, contact Pulmonetic Systems using the contact information at the front of this manual.

Displays and Buttons

Some of the symptoms listed in this section are part of the normal operation of the ventilator and do not indicate a problem with the ventilator. They are included for information only.

Symptoms	Possible Causes	What to Do
Pressure Control display flashing.	Pressure control breath terminated by flow - **PC FLOW TERM** is set to on.	Pressure control breaths are normally terminated when the set inspiratory time expires. Flow termination of pressure control breaths is allowed when **PC FLOW TERM** is set to ON (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for an explanation of this feature). When a pressure control breath is terminated by flow instead of time, the **Pres. Control** display is flashed.
Pressure Support display flashing.	Pressure support breath terminated by time - set under **TIME TERM**.	Pressure support breaths are normally terminated when the flow drops below the set percentage of the peak flow. Pressure support breaths may also terminate on time when the variable time limit is reached before the flow drops to the set level. (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for an explanation of the **FLOW TERM** and **TIME TERM** features). When a pressure support breath is terminated based on time, the **Pres. Support** display is flashed.
High Pres Limit display flashing.	**HIGH PRES** alarm occurred.	The **High Pres Limit** display is flashed and the **HIGH PRES** message is displayed when a high pressure alarm occurs. The display will continue to flash even after the condition clears. (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for an explanation of the **HIGH PRES** alarm feature.) Check high and low pressure sense lines to be sure they are correctly attached and securely seated at both the ventilator and wye ends.

Symptoms	Possible Causes	What to Do
Low Pressure display flashing.	**LOW PRES** alarm occurred.	The **Low Pressure** display is flashed and the **LOW PRES** message is displayed when a low pressure alarm occurs. The display will continue to flash even after the condition clears. (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for an explanation of the **LOW PRES** alarm feature.)
Low Min Vol display flashing.	**LOW MIN VOL** alarm occurred.	The **Low Min Vol** display is flashed and the **LOW MIN VOL** message is displayed when a low minute volume alarm occurs. The display will continue to flash even after the condition clears. (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for an explanation of the **LOW MIN VOL** alarm feature.)
O_2% (O_2 Flush) flashing.	**LOW O2 PRES** or **HIGH O2 PRES** alarm occurred.	The **O_2% (O_2 Flush)** display is flashed and the **LOW O2 PRES** or **HIGH O2 PRES** message is displayed when a low or high O_2 pressure alarm occurs. The display will continue to flash even after the condition clears. (See the LTV® 1200 Ventilator Operator's Manual for an explanation of the **LOW O2 PRES** and **HIGH O2 PRES** alarm features.)
Control display flashing when setting a control.	Control setting is limited.	A control's value can be limited by the current settings of other controls. (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for an explanation of **Control Limiting**.)
A display or LED does not illuminate.	Wrong model selected.	If an incorrect model is selected, some controls may not be lit and will not operate. Verify the model number selected in **VENT MTNCE**, **MODEL** matches the model number on the front of the ventilator. See *Chapter 6 -Maintenance & Calibration* for instructions.
	Misaligned LED.	If displays are operating but misaligned, remove the main board and realign the LEDs or displays. See *Main Board Assembly* in Chapter 8 for instructions.
	Defective LED or display. Defective main board.	If a display is not operating during the display test, replace the main board. See *Main Board Assembly* in Chapter 8 for instructions.

Symptoms	Possible Causes	What to Do
Ventilator is running but displays are turned off.	Displays are blanked while on battery power.	To conserve battery life while running from the internal battery, most of the displays are turned off when no changes are made to the control settings for 60 seconds. To turn the displays back on, touch any control or button or turn the **Set Value** knob.
	Defective main board.	Replace the main board. See *Main Board Assembly* in Chapter 8 for instructions.
A control doesn't activate. **Set Value** knob doesn't operate.	Control not active in selected mode.	If a control is dimmed, it is not active in the currently selected mode and changing its setting does not affect ventilation. (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for an explanation of **Bright, Dim and Blank Control Displays**.)
	Controls are locked.	If the controls are locked, a **LOCKED** message will be displayed when a control is selected. To unlock in **EASY** mode, press and release the **Control Lock** button. To unlock in **HARD** mode, press and hold the **Control Lock** button for 3 seconds. (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for an explanation of the **CTRL UNLOCK** feature and **Control Lock** button.)
	Control is not selected.	Before a control value can be changed, the control must be selected. To select a control, press the associated button. When a control is selected, it is displayed at normal intensity and all other controls are dimmed. (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for an explanation of how to use the controls.)
	Controls are limited.	A control's value may be limited by the current settings of other controls. To change the value of the current control, change the value of the flashing controls. (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for an explanation of **Control Limiting**.)
	Wrong model selected.	If an incorrect model is selected, some controls may not be lit and will not operate. Verify the model number selected in **VENT MTNCE**, **MODEL** matches the model number on the front of the ventilator. See *Chapter 6 -Maintenance & Calibration* for instructions.

Symptoms	Possible Causes	What to Do
Continued... *A control doesn't activate* ***Set Value** knob doesn't operate*	Front panel ribbon cable not properly connected.	Remove the power board to access the ribbon cable connection on the main board. Disconnect and reconnect the front panel ribbon cable connector. See *Main Board Assembly* in Chapter 8 for instructions. Handle the ribbon cable carefully to avoid scratching or damaging it.
	Front panel ribbon cable damaged. Defective switch.	Replace the membrane switch panel and overlay. See *Front Panel* in Chapter 8 for instructions
	Rotary switch is disconnected. Defective rotary switch.	Verify the rotary switch is properly connected. If necessary, replace the rotary switch assembly. See *Rotary Switch (Set Value Knob) Assembly* in Chapter 8 for instructions.
	Defective main board.	Replace the main board. See *Main Board Assembly* in Chapter 8 for instructions.
Can't unlock the controls	**HARD** unlock method selected under **CTRL UNLOCK**.	Two unlock methods are available on the LTV® 1200/1150 ventilator: (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for an explanation of this feature.) To unlock in **EASY** mode, press and release the **Control Lock** button. To unlock in **HARD** mode, press and hold the **Control Lock** button for 3 seconds.
LMV OFF is displayed.	Low Minute Volume alarm is turned off.	This is an informational message only (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for an explanation of this feature).
LMV LPPS OFF is displayed.	Low Minute Volume alarm is turned off and the LPP ALARM has been set to VC/PC ONLY.	This is an informational message only (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for an explanation of this feature).
LPPS OFF is displayed.	LPP ALARM has been set to VC/PC ONLY.	This is an informational message only (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for an explanation of this feature).
f PEEP OFF is displayed.	The High Breath Rate and High PEEP alarms are turned off.	This is an informational message only (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for an explanation of this feature).
HI PEEP OFF is displayed.	The High PEEP alarm is turned off.	This is an informational message only (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for an explanation of this feature).

Symptoms	Possible Causes	What to Do
High f OFF is displayed.	The High Breath Rate alarm is turned off.	This is an informational message only (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for an explanation of this feature).
HI f/Vt OFF is displayed.	The SBT High f/Vt alarm is turned off during the SBT mode of ventilation.	This is an informational message only (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for an explanation of this feature).
LO f/Vt OFF is displayed.	The SBT Low f/Vt alarm is turned off during the SBT mode of ventilation.	This is an informational message only (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for an explanation of this feature).
LO PEEP OFF is displayed.	The Low PEEP alarm is turned off.	This is an informational message only (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for an explanation of this feature).
SBT f OFF is displayed.	The SBT High Breath Rate and SBT Low Breath Rate alarms are turned off during the SBT mode of ventilation.	This is an informational message only (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for an explanation of this feature).
SBT f/Vt OFF is displayed.	The SBT High f/Vt and SBT Low f/Vt alarms are turned off during the SBT mode of ventilation.	This is an informational message only (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for an explanation of this feature).
SBT HI OFF is displayed.	The SBT High Breath Rate alarm is turned off during the SBT mode of ventilation.	This is an informational message only (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for an explanation of this feature).
SBT LO f OFF is displayed.	The SBT Low Breath Rate alarm is turned off during the SBT mode of ventilation.	This is an informational message only (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for an explanation of this feature).
SBT TIME is displayed.	The SBT mode of ventilation will end in two (2) minutes.	This is an informational message only (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for an explanation of this feature).

Symptoms	Possible Causes	What to Do
Ventilator is auto cycling, monitored volumes are very small, **and RT XDCR DATA** item **FTx** shows negative flows during exhalation and positive flows during inspiration.	Sense lines are reversed.	The sense lines are not designed to be removed from either the wye or the Luer fittings. If the sense lines have been removed and replaced incorrectly, they may not seal correctly when replaced. Replace the patient wye and sense lines with a known good assembly.
Ventilator won't allow patient to exhale.	Diaphragm installed backwards or incorrectly seated in exhalation valve.	Open the exhalation valve and remove the diaphragm. Reseat the diaphragm and snap the valve cap back in place. See *Cleaning the Reusable Exhalation Valve and Patient Circuit* in Chapter 4 for a diagram of the exhalation valve assembly.
	Sense lines occluded, pinched or reversed.	Check high and low pressure sense lines to be sure they are correctly attached and securely seated at both the ventilator and wye ends. Verify lines are not occluded or pinched.
	Internal flexible tubing occluded or pinched. Internal flexible tubing has pinhole leaks or leaking at connections.	This problem will often be accompanied by **XDCR FAULT** alarms. Open the vent and verify that none of the flexible tubes connected to the solenoid manifold or analog board are pinched or leaking. See *Internal Flexible Tubing* on *page 8-33*
	Defective exhalation drive solenoid.	Replace the solenoid manifold. See *Solenoid Manifold Assembly* in Chapter 8 for instructions.
Set pressure not reached and turbine is humming. Turbine sounds like inspiration even during exhalation.	Bypass flexible tube pinched. Pinhole leaks in bypass flexible tube.	If the bypass flexible tube is pinched, it can usually be seen pressed against the louver openings in the bottom of the ventilator case. Open the ventilator and remove the back panel. Replace the back panel being sure to fit the louvers in between the upper and lower loop of the bypass flexible tube before seating the back cover. If the bypass flexible tube is leaking, replace it.

Symptoms	Possible Causes	What to Do
Monitored volume is high. Delivered volume is high.	Very small ET tube connected directly to wye.	A very small ET tube connected directly to the wye may cause turbulence that causes the flow differential to be read incorrectly. To reduce this turbulence, add a short larger bore extension between the ET tube and wye. In this case, the monitored volume is high, but the delivered volume is accurate.
	Low side sense line or elbow at patient wye loose or leaking. High or low sense lines are occluded. High or low sense ports in the wye are occluded.	Check high and low pressure sense lines to be sure they are correctly attached and securely seated at both the ventilator and wye ends. Check the Luer fitting connections for leaks. Check the elbow connectors at the wye to be sure they have not loosened or been broken loose. Verify lines are not occluded or pinched.
	Sense lines are reversed.	The sense lines are not designed to be removed from either the wye or the Luer fittings. If the sense lines have been removed and replaced incorrectly, they may not seal correctly when replaced. Replace the patient wye and sense lines with a known good assembly.
	Failed auto zero.	Perform an auto zero under **XDCR ZERO**. See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for more information.
	VHome setting does not match flow valve.	Correct the VHome setting. See *Chapter 6 - Maintenance & Calibration.*
	Bypass flexible tube pinched. Pinhole leaks in bypass flexible tube.	If the bypass flexible tube is pinched, it can usually be seen pressed against the louver openings in the bottom of the ventilator case. Open the ventilator and remove the back panel. Replace the back panel being sure to fit the louvers in between the upper and lower loop of the bypass flexible tube before seating the back cover. If the bypass flexible tube is leaking, replace it.
	Failed calibration.	Recalibrate the vent. See *Chapter 6 - Maintenance & Calibration* for instructions. If the problem reoccurs after careful recalibration, a transducer may be drifting excessively. Perform the Advanced Vte Diagnostic Procedures, see *page 7-23.*

Symptoms	Possible Causes	What to Do
CONTINUED… *Monitored volume is high.* *Delivered volume is high.*	Defective flow valve.	Calibrate the flow valve. See *Flow Valve Calibration* in Chapter 6 for instructions. Clean the Flow Valve following the Flow Valve Cleaning Procedure, see page 8-65. Perform the Advanced Vte Diagnostic Procedures, see *page 7-23*. If testing and cleaning fails, replace the Flow Valve. *See Chapter 8 - Flow Valve Assembly and Cleaning Instructions.*
	Defective turbine. Defective bypass valve. Defective or leaking solenoid manifold.	Perform the Advanced Vte Diagnostic Procedures, see *page 7-23*. If testing fails, replace defective parts.
Monitored volume is low. Delivered volume is low.	Circuit leak.	Run a Leak Test and reseat or replace the leaking parts or connections. See*Leak Test* in Chapter 2 for instructions.
	High or low side sense line or elbow at exhalation valve loose or leaking. High or low sense lines are occluded. High or low sense ports in the wye are occluded.	Check high and low pressure sense lines to be sure they are correctly attached and securely seated at both the ventilator and wye ends. Check the Luer fitting connections for leaks. Check the elbow connectors at the wye to be sure they have not loosened or been broken loose. Verify lines are not occluded or pinched.
	Exhalation drive line leaking or loose. Exhalation valve leaking during inspiration.	Check the exhalation drive line at both the ventilator and exhalation valve ends. Verify the line is securely seated and not leaking. Verify the exhalation valve is not leaking during inspiration. If it is leaking, open the exhalation valve and remove the diaphragm. Reseat the diaphragm and snap the valve cap back in place. See *Cleaning the Reusable Exhalation Valve and Patient Circuit* in Chapter 4 for a diagram of the exhalation valve assembly. If necessary, replace the exhalation diaphragm, or exhalation valve with a new one.
	Sense lines are reversed.	The sense lines are not designed to be removed from either the wye or the Luer fittings. If the sense lines have been removed and replaced incorrectly, they may not seal correctly when replaced. Replace the patient wye and sense lines with a known good assembly.

Symptoms	Possible Causes	What to Do
CONTINUED … *Monitored volume is low.* *Delivered volume is low.*	Leak Compensation is not on.	Verify that the Leak Compensation Extended Features option is set to **On** (default setting is on). See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for more information.
	Failed auto zero.	Perform an auto zero under **XDCR ZERO**. See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for more information.
	Bypass flexible tube pinched. Pinhole leaks in bypass flexible tube.	If the bypass flexible tube is pinched, it can usually be seen pressed against the louver openings in the bottom of the ventilator case. Open the ventilator and remove the back panel. Replace the back panel being sure to fit the louvers in between the upper and lower loop of the bypass flexible tube before seating the back cover. If the bypass flexible tube is leaking, replace it.
	VHome setting does not match flow valve.	Correct the VHome setting. See *Chapter 6 - Maintenance & Calibration.*
	Failed calibration.	Recalibrate the vent. See *Chapter 6 - Maintenance & Calibration* for instructions. If the problem reoccurs after careful recalibration, a transducer may be drifting excessively. Perform the Advanced Vte Diagnostic Procedures, see *page 7-23*.
	Defective flow valve.	Calibrate the flow valve. See *Flow Valve Calibration* in Chapter 6 for instructions. Clean the Flow Valve following the Flow Valve Cleaning Procedure, see page 8-65. Perform the Advanced Vte Diagnostic Procedures, see *page 7-23*. If testing and cleaning fails, replace the Flow Valve. *See Chapter 8 - Flow Valve Assembly and Cleaning Instructions.*
	Defective turbine.	Perform the Advanced Vte Diagnostic Procedures, see *page 7-23.* If testing fails, replace the turbine. *See Chapter 8 - Turbine Manifold.*

Symptoms	Possible Causes	What to Do
Delivered pressure is low, PEEP is low, ventilator is auto cycling. Delivered pressure is low. Monitored pressure is low.	Circuit leak.	Run a Leak Test and reseat or replace the leaking parts or connections. See *Leak Test* in Chapter 6 for instructions.
	High or low side sense line or elbow at patient wye loose or leaking. High or low sense lines are occluded. High or low sense ports in the wye are occluded.	Check high and low pressure sense lines to be sure they are correctly attached and securely seated at both the ventilator and wye ends. Check the Luer fitting connections for leaks. Check the elbow connectors at the wye to be sure they have not loosened or been broken loose. Verify lines are not occluded or pinched. Check the exhalation drive line at both the ventilator and exhalation valve ends. Verify the line is securely seated and not leaking.
	Exhalation drive line leaking or loose. Exhalation valve leaking during inspiration.	Check the exhalation drive line at both the ventilator and exhalation valve ends. Verify the line is securely seated and not leaking. Verify the exhalation valve is not leaking during inspiration. If it is leaking, open the exhalation valve and remove the diaphragm. Reseat the diaphragm and snap the valve cap back in place. See *Cleaning the Reusable Exhalation Valve and Patient Circuit* in Chapter 4 for a diagram of the exhalation valve assembly. If necessary, replace the exhalation diaphragm, or exhalation valve with a new one.
	Sense lines are reversed.	The sense lines are not designed to be removed from either the wye or the Luer fittings. If the sense lines have been removed, they may not seal correctly when replaced. Replace the patient wye and sense lines with a known good assembly.
	Leak Compensation is not on.	Verify that the Leak Compensation Extended Features option is set to **On** (default setting is off). See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for more information.

Symptoms	Possible Causes	What to Do
CONTINUED … *Delivered pressure is low, PEEP is low, ventilator is auto cycling.* *Delivered pressure is low.* *Monitored pressure is low.*	Failed auto zero.	Perform an auto zero under XDCR ZERO. See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for more information.
	VHome setting does not match flow valve.	Correct the VHome setting. See *Chapter 6 - Maintenance & Calibration.*
	Failed calibration.	Recalibrate the vent. See *Chapter 6 - Maintenance & Calibration* for instructions. If the problem reoccurs after careful recalibration, a transducer may be drifting excessively. Perform the Advanced Vte Diagnostic Procedures, see *page 7-23*.
	Bypass flexible tube pinched. Pinhole leaks in bypass flexible tube.	If the bypass flexible tube is pinched, it can usually be seen pressed against the louver openings in the bottom of the ventilator case. Open the ventilator and remove the back panel. Replace the back panel being sure to fit the louvers in between the upper and lower loop of the bypass flexible tube before seating the back cover. If the bypass flexible tube is leaking, replace it.
	Internal flexible tubing occluded or pinched. Internal flexible tubing has pinhole leaks or leaking at connections.	This problem will often be accompanied by **XDCR FAULT** alarms. Open the vent and verify that none of the flexible tubes connected to the solenoid manifold or analog board are pinched or leaking. See *Solenoid Manifold Assembly or Analog Board Assembly* in Chapter 8 for routing information.
	Defective flow valve.	Calibrate the flow valve. See *Flow Valve Calibration* in Chapter 6 for instructions. Clean the Flow Valve following the Flow Valve Cleaning Procedure, see page 8-65. Perform the Advanced Vte Diagnostic Procedures, see *page 7-23.* If testing and cleaning fails, replace the Flow Valve. *See Chapter 8 - Flow Valve Assembly and Cleaning Instructions.*
	Defective turbine. Defective analog board.	Perform the Advanced Vte Diagnostic Procedures, see *page 7-23.* If testing fails, replace defective parts.
	Defective power board.	Replace the power board. See *Power Board Assembly* in Chapter 8 for instructions.

Symptoms	Possible Causes	What to Do
Delivered pressure is high. Monitored pressure is high.	Diaphragm is incorrectly seated in exhalation valve.	Open the exhalation valve and remove the diaphragm. Reseat the diaphragm and snap the valve cap back in place. See *Cleaning the Reusable Exhalation Valve and Patient Circuit* in Chapter 4 for a diagram of the exhalation valve assembly.
	High or low side sense line or elbow at patient wye loose or leaking. High or low sense lines are occluded. High or low sense ports in the wye are occluded.	Check high and low pressure sense lines to be sure they are correctly attached and securely seated at both the ventilator and wye ends. Check the Luer fitting connections for leaks. Check the elbow connectors at the wye to be sure they are not loose. Verify lines are not occluded or pinched. Check the exhalation drive line at both the ventilator and exhalation valve ends. Verify the line is securely seated and not leaking.
	Failed auto zero.	Perform an auto zero under **XDCR ZERO**. See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for more information.
	VHome setting does not match flow valve.	Correct the VHome setting. See *Chapter 6 - Maintenance & Calibration.*
	Failed calibration.	Recalibrate the ventilator. See *Chapter 6 - Maintenance & Calibration* for instructions. If the problem reoccurs after careful recalibration, a transducer may be drifting excessively. Perform the Advanced Vte Diagnostic Procedures, see *page 7-23*.
	Defective flow valve.	Calibrate the flow valve. See *Flow Valve Calibration* in Chapter 6 for instructions. Clean the Flow Valve following the Flow Valve Cleaning Procedure, see page 8-65. Perform the Advanced Vte Diagnostic Procedures, see *page 7-23*. If testing and cleaning fails, replace the Flow Valve. *See Chapter 8 - Flow Valve Assembly and Cleaning Instructions.*
	Defective turbine.	Perform the Advanced Vte Diagnostic Procedures, see *page 7-23.* If testing fails, replace the turbine. *See Chapter 8 - Turbine Manifold.*

Symptoms	Possible Causes	What to Do
Delivered flow is high. Delivered flow is low.	High or low side sense line or elbow at patient wye loose or leaking. High or low sense lines are occluded. High or low sense ports in the wye are occluded.	Check high and low pressure sense lines to be sure they are correctly attached and securely seated at both the ventilator and wye ends. Check the Luer fitting connections for leaks. Check the elbow connectors at the wye to be sure they are not loose or broken. Verify lines are not occluded or pinched. Check the exhalation drive line at both the ventilator and exhalation valve ends. Verify the line is securely seated and not leaking.
	Failed auto zero.	Perform an auto zero under **XDCR ZERO**. See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for more information.
	VHome setting does not match flow valve.	Correct the VHome setting. See *Chapter 6 - Maintenance & Calibration.*
	Failed calibration.	Recalibrate the vent. See *Chapter 6 - Maintenance & Calibration* for instructions. If the problem reoccurs after careful recalibration, a transducer may be drifting excessively. Replace the analog board. See *Analog Board Assembly* in Chapter 8 for instructions.
	Internal flexible tubing occluded or pinched. Internal flexible tubing has pinhole leaks or leaking at connections.	This problem will often be accompanied by **XDCR FAULT** alarms. Open the vent and verify that none of the flexible tubes connected to the solenoid manifold or analog board are pinched or leaking. See *Solenoid Manifold Assembly or Analog Board Assembly* in Chapter 8 for a routing diagram.
	Defective flow valve.	Calibrate the flow valve. See *Flow Valve Calibration* in Chapter 6 for instructions. Clean the Flow Valve following the Flow Valve Cleaning Procedure, see page 8-65. Perform the Advanced Vte Diagnostic Procedures, see *page 7-23*. If testing and cleaning fails, replace the Flow Valve. *See Chapter 8 - Flow Valve Assembly and Cleaning Instructions.*
	Defective turbine.	Perform the Advanced Vte Diagnostic Procedures, see page 7-23. Replace the turbine manifold. See *Turbine Manifold* in Chapter 8 for instructions.

Symptoms	Possible Causes	What to Do
Sensitivity does not appear to be accurate. Ventilator is auto cycling.	Circuit leak.	Run a Leak Test and reseat or replace the leaking parts or connections. See *Leak Test* in Chapter 2 for instructions.
	Sense lines are reversed.	The sense lines are not designed to be removed from either the wye or the Luer fittings. If the sense lines have been removed, they may not seal correctly when replaced. Replace the patient wye and sense lines with a known good assembly.
	High or low side sense line or elbow at patient wye loose or leaking. High or low sense lines are occluded. High or low sense ports in the wye are occluded.	Check high and low pressure sense lines to be sure they are correctly attached and securely seated at both the ventilator and wye ends. Check the Luer fitting connections for leaks. Check the elbow connectors at the wye to be sure they have not loosened or been broken loose. Verify lines are not occluded or pinched. Check the exhalation drive line at both the ventilator and exhalation valve ends. Verify the line is securely seated and not leaking.
	Pressure Control or Pressure Support set below PEEP.	Verify the control values are appropriately set.
	Failed auto zero.	Perform an auto zero under **XDCR ZERO**. See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for more information.
	Leak Compensation is not on.	Verify that the Leak Compensation Extended Features option is set to **On** (default setting is off). See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for more information.
	Bypass flexible tube pinched. Pinhole leaks in bypass flexible tube.	If the bypass flexible tube is pinched, it can usually be seen pressed against the louver openings in the bottom of the ventilator case. Open the ventilator and remove the back panel. Replace the back panel being sure to fit the louvers in between the upper and lower loop of the bypass flexible tube before seating the back cover. If the bypass flexible tube is leaking, replace it.
	Failed calibration.	Recalibrate the ventilator. See *Chapter 6 - Maintenance & Calibration* for instructions. If the problem reoccurs after careful recalibration, a transducer may be drifting excessively. Perform the Advanced Vte Diagnostic Procedures, see *page 7-23*.

Symptoms	Possible Causes	What to Do
O_2% is high.	O_2 inlet pressure too high when Low O_2 Source selected. O_2 inlet flow too high when Low O_2 Source selected.	Verify the low pressure O_2 inlet has been correctly calculated and set using the Input O_2 Flow Chart. Pulmonetic Systems recommends the use of an O_2 monitor to verify delivered O_2%. Adjust the entrained O_2 flow so the monitored value shows the desired FIO_2. (See the LTV® 1200 Ventilator Operator's Manual for information on using the Low O_2 Source and O_2% features.)
	Low O_2 Source incorrectly selected.	Verify that the Low O_2 Source is on when using a low flow, low pressure source and off when using a high pressure source. (See the LTV® 1200 Ventilator Operator's Manual for information on using the Low O_2 Source and O_2% features.)
	Flow valve output is low.	Perform the Advanced FiO_2 Diagnostic Procedures, see *page 7-27*.
	Failed calibration.	Recalibrate the vent. See *Chapter 6 - Maintenance & Calibration* for instructions. If the problem reoccurs after careful recalibration, a transducer may be drifting excessively. Replace the analog board. See *Analog Board Assembly* in Chapter 8 for instructions.
	Internal flexible tubing occluded or pinched. Internal flexible tubing has pinhole leaks or leaking at connections.	Open the vent and verify that none of the flexible tubes connected to the solenoid manifold, analog board, oxygen blender or flow valve are pinched or leaking. See *Solenoid Manifold Assembly* or *Analog Board Assembly* in Chapter 8 for routing.
	Defective or leaking solenoid manifold. Defective solenoid.	Replace the solenoid manifold. See *Solenoid Manifold Assembly* in Chapter 8 for instructions.
	Incorrect O_2 blender solenoid output flow.	Perform the Advanced FiO_2 Diagnostic Procedures, see *page 7-27*. If testing fails, replace the O_2 blender, See *Chapter 8 - O2 Blender Assembly / O2 Block.*

Symptoms	Possible Causes	What to Do
O_2% is low.	O_2 inlet flow too low when Low O_2 Source selected.	Verify the low pressure O_2 inlet has been correctly calculated and set using the Input O_2 Flow Chart. Pulmonetic Systems recommends the use of an O_2 monitor to verify delivered O_2%. Adjust the entrained O_2 flow so the monitored value shows the desired FIO_2. (See the LTV® 1200 Ventilator Operator's Manual for information on using the Low O_2 Source and O_2% features.)
	Rolled or leaking flow valve inlet gasket.	Replace flow valve inlet gasket (see *Flow Valve Assembly* in Chapter 8).
	Flow valve output is high.	Perform the Advanced FiO_2 Diagnostic Procedures, see *page 7-27.*
	Failed calibration.	Recalibrate the vent. See *Chapter 6 - Maintenance & Calibration* for instructions. If the problem reoccurs after careful recalibration, a transducer may be drifting excessively. Replace the analog board. See *Analog Board Assembly* in Chapter 8 for instructions.
	Internal flexible tubing occluded or pinched. Internal flexible tubing has pinhole leaks or leaking at connections.	Open the vent and verify that none of the flexible tubes connected to the solenoid manifold, analog board, oxygen blender or flow valve are pinched or leaking. See *Solenoid Manifold Assembly* or *Analog Board Assembly* in Chapter 8 for a routing diagram.
	Defective or leaking solenoid manifold. Defective solenoid.	Replace the solenoid manifold. See *Solenoid Manifold Assembly* in Chapter 8 for instructions.
	Incorrect O_2 blender solenoid output flow.	Perform the Advanced FiO_2 Diagnostic Procedures, see *page 7-27.* If testing fails, replace the O_2 blender, See *Chapter 8 - O2 Blender Assembly / O2 Block.*

Symptoms	Possible Causes	What to Do
PEEP not working. PEEP low. PEEP sags during exhalation.	Circuit leak.	Run a Leak Test and reseat or replace the leaking parts or connections. See *Leak Test* in Chapter 2 for instructions.
	Diaphragm incorrectly seated in exhalation valve. Diaphragm installed backwards.	Open the exhalation valve and remove the diaphragm. Reseat the diaphragm and snap the valve cap back in place. See *Cleaning the Reusable Exhalation Valve and Patient Circuit* in Chapter 4 for a diagram of the exhalation valve assembly.
	High side sense line or elbow at patient wye loose or leaking.	Check high and low pressure sense lines to be sure they are correctly attached and securely seated at both the ventilator and wye ends. Check the Luer fitting connections for leaks. Check the elbow connectors at the wye to be sure they have not loosened or been broken loose. Verify lines are not occluded or pinched.
	Failed calibration.	The monitored PEEP can be viewed using the **RT XDCR DATA** display. (See *Real-Time Transducer Data* in Chapter 3 for instructions on using RT data.). If the monitored PEEP is significantly different from the actual PEEP, the calibration may be off or the transducers may not be working correctly. Recalibrate the vent. See *Chapter 6 - Maintenance & Calibration* for instructions. If the problem reoccurs after careful recalibration, a transducer may be drifting excessively. Perform the Advanced Vte Diagnostic Procedures, see *page 7-23*.
	Defective analog board.	Perform the Advanced Vte Diagnostic Procedures, see *page 7-23*.
		Replace the analog board. See *Analog Board Assembly* in Chapter 8 for instructions.
	Defective solenoid mount assembly.	Replace the solenoid mount assembly. See *Solenoid Mount Assembly* in Chapter 8 for instructions.
	Defective accumulator.	Replace the accumulator. See *Accumulator* in Chapter 8 for instructions.

Symptoms	Possible Causes	What to Do
CONTINUED … *PEEP not working.* *PEEP low.* *PEEP sags during exhalation (cont)*	Internal flexible tubing occluded or pinched. Internal flexible tubing has pinhole leaks or leaking at connections.	Open the vent and verify that none of the flexible tubes connected to the accumulator, solenoid mount assembly, solenoid manifold, analog board, oxygen blender or flow valve are pinched or leaking. See *Solenoid Manifold Assembly* or *Analog Board Assembly* in Chapter 8 for a routing diagram.
Delivered and monitored volumes, pressures, and sensitivity are off.	**VHome** setting does not match flow valve.	Correct the VHome setting. See *Chapter 6 - Maintenance & Calibration.*
	Failed calibration.	Recalibrate the vent. See *Chapter 6 - Maintenance & Calibration* for instructions. If the problem reoccurs after careful recalibration, a transducer may be drifting excessively. Perform the Advanced Vte Diagnostic Procedures, see *page 7-23*.
Delivered volume is high	Diaphragm is incorrectly seated in the exhalation valve.	Open the exhalation valve and remove the diaphragm. Reseat the diaphragm and snap the valve cap back in place. See *Cleaning the Reusable Exhalation Valve and Patient Circuit* in Chapter 4 for a diagram of the exhalation valve assembly.
Ventilator won't trigger at sensitivity setting of 1 Lpm.	Patient effort inadequate.	Some very small patients and patients with very weak inspiratory efforts may not be able to generate a 1 Lpm effort.
	Failed auto zero.	Perform an auto zero under **XDCR ZERO**. See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for more information.
	Leak Compensation is not on.	Verify that the Leak Compensation Extended Features option is set to **ON** (default setting is on). See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for more information.
	Failed calibration.	Recalibrate the vent. See *Chapter 6 - Maintenance & Calibration* for instructions. If the problem reoccurs after careful recalibration, a transducer may be drifting excessively. Perform the Advanced Vte Diagnostic Procedures, see *page 7-23*.

Symptoms	Possible Causes	What to Do
Ventilator is auto cycling. Sensitivity does not appear to be accurate.	Circuit leak.	Verify the sensitivity is set to an appropriate value. For a high leak environment, the sensitivity may need to be set higher to prevent auto cycling. Check for and correct airway circuit leaks. Make sure all circuit accessories are properly connected.
	High or low side sense line or elbow at patient wye loose or leaking. High or low sense lines are occluded. High or low sense ports in the wye are occluded.	Check high and low pressure sense lines to be sure they are correctly attached and securely seated at both the ventilator and wye ends. Check the Luer fitting connections for leaks. Check the elbow connectors at the wye to be sure they are not loose or broken. Verify lines are not occluded or pinched. Check the exhalation drive line at both the ventilator and exhalation valve ends. Verify the line is securely seated and not leaking.
	Pressure Control or Pressure Support set below PEEP	Verify the control values are appropriately set.
	Failed auto zero.	Perform an auto zero under **XDCR ZERO**. See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for more information.
	Bypass flexible tube pinched. Pinhole leaks in bypass flexible tube.	If the bypass flexible tube is pinched, it can usually be seen pressed against the louver openings in the bottom of the ventilator case. Open the ventilator and remove the back panel. Replace the back panel being sure to fit the louvers in between the upper and lower loop of the bypass flexible tube before seating the back cover. If the bypass flexible tube is leaking, replace it.
	Failed calibration.	Recalibrate the vent. See *Chapter 6 - Maintenance & Calibration* for instructions. If the problem reoccurs after careful recalibration, a transducer may be drifting excessively. Perform the Advanced Vte Diagnostic Procedures, see *page 7-23*.

Symptoms	Possible Causes	What to Do
Condensation in sense lines.	High or low sense lines are occluded. High or low sense ports in the wye are occluded.	Verify lines are not occluded or pinched and/or clear the lines with a low flow (less than 10 Lpm) gas source.
	Defective purge solenoids.	Replace the solenoid manifold. See *Solenoid Manifold Assembly* in Chapter 8 for instructions.
Ventilator is on, gas is not delivered and turbine is running.	Defective or disconnected flow valve. Defective turbine.	Using the Vent Maintenance mode **SERVO** test, determine if the turbine and flow valve are working correctly by changing the Turbine Speed, Flow, and Step Motor Positions. Verify all turbine and flow valve cables are connected and all flexible tubes connected to the analog board and solenoid manifold are correctly and securely connected. Perform the Advanced Vte Diagnostic Procedures, see *page 7-23*.
	Defective or disconnected solenoids.	Using the Vent Maintenance mode SOLENOID test, determine if all solenoids are working correctly. Perform the Advanced Vte Diagnostic Procedures, see *page 7-23*.
Ventilator is on, gas is not delivered and turbine is not running. **RT XDCR DATA** item **TS** shows speeds at or near 0.	Defective or disconnected turbine.	The SERVO test may be used to set the turbine speed explicitly. (See *Chapter 6 - Maintenance & Calibration* for instructions on using the servo test.) The turbine speed can be viewed using the **RT XDCR DATA** display. (See *Chapter 3 - Real-Time Transducer Data* for instructions on using RT data.) Verify all flow valve and turbine power cables are connected. Verify all flexible tubes connected to the analog board and solenoid manifold are correctly and securely connected. Replace the turbine. See *Flow Valve Assembly* or *Turbine Manifold* in Chapter 8 for instructions.
	Defective motor board.	Replace the motor board. See *Motor Board Assembly* in Chapter 8 for instructions.
	Defective power board.	Replace the power board. See *Power Board Assembly* in Chapter 8 for instructions.
Sense line connectors wobble or loose.	Fitting connectors loosened inside ventilator case.	Open the ventilator case and tighten the nuts on the sense line and drive line connectors. See *Back Panel* in Chapter 8 for instructions on opening the ventilator.

Symptoms	Possible Causes	What to Do
Ventilator makes a high pitched noise when in Standby.	Battery charge circuit running.	When the battery charge circuit is running in bulk charge (the **Charge Status** LED is amber) the ventilator may emit a high pitched sound that some people can hear. This is normal.
Ventilator gets excessively hot.	Defective or disconnected fan.	A **HW FAULT** alarm usually accompanies this problem. Fan operation can be checked by looking at it through the fan grill on the side of the vent. If the fan is not operating, open the ventilator and verify that the fan connector is securely connected to the power board. Replace the fan assembly. See *Fan Assembly* in Chapter 8 for instructions.
	Defective power board.	Replace the power board. See *Power Board Assembly* in Chapter 8 for instructions.
	Defective thermo conductive heat sink pads.	Open the ventilator and inspect the two thermo conductive heat sink pads, one attached to the back panel and one between the turbine manifold and the upper weldment.
	Patient circuit leaks. Ventilator must run harder to maintain PEEP.	Perform a Leak Test and reseat or replace the leaking parts or connections. See *Leak Test* in Chapter 2 for instructions.
Ventilator does not work with LTM Graphics Monitor.	Communications setting is not set to **MONITOR** mode.	Set communications setting to **MONITOR** mode. See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual, for detailed instructions.
	Defective connections between the LTM Graphics Monitor and the ventilator.	Check the Communications Data Cable connection between the ventilator's communications port and the LTM Graphics Monitor's Data Port. See the LTM Graphics Monitor Operator's Manual, for detailed instructions.

Advanced Vte Diagnostic Procedures

If the ventilator **Monitored Exhaled Volume (Vte)** readout, **Delivered Volume** to the lung, **Target Pressures** or **Inspired Volumes** (LTM only) appear incorrect; perform the following checkout procedures.

- When instructed to replace a subassembly/component that fails any of the following checkout procedures, verify the original problem is resolved once the subassembly/component has been replaced. If the original problem is not resolved, continue through the next Advanced Diagnostic Checkout procedure.

Transducer Null Checkout

Check the null or zero of the transducer for drift as follows:

1) Power up the unit in VENT CHECK mode and select the **XDCR ZERO** menu.
2) Record the figures for the Airway Pressure (AP) and Flow Transducer Wide Channel (**FDw**) (null figures from the time the unit was last calibrated).
3) **Perform an auto zero** by pressing **Select**. It is considered normal if the figures change slightly, however;
   - If the figures for **AP** change by more than 50, the Airway Pressure transducer may be faulty and the analog PCBA should be replaced. See *Analog Board Assembly* in Chapter 8 for instructions.
   - If the figures for **FDw** change by more than 50, the Flow Sensor transducer may be faulty and the analog PCBA should be replaced. See *Analog Board Assembly* in Chapter 8 for instructions.
   - If the figures for **AP** <u>and</u> **FDw** change by less than 20, the unit passes this test and the Pneumatic System Checkout tests are to be performed.

Pneumatic System Checkout

Check the pneumatic system as follows:

1) Apply 50 cmH_2O to the high side port, monitor the pressure with a calibrated, independent pressure meter for 1 minute and record any drop in pressure.

   Then apply 50 cmH_2O to the low side port, monitor the pressure with a calibrated, independent pressure meter for 1 minute and record any drop in pressure.

   - If a pressure drop for either the high or the low side port exceeds 1 cmH_2O, check all internal plumbing and the solenoid manifold for leaks, replace any damaged tubing or components and repeat the test.
2) Lay the unit with the front panel up, running in **Volume** mode and set the **Breath Rate** to 12, **Tidal Volume** to 500 ml and **Inspiration Time** to 1.5 seconds. Attach a test lung with a compliance of 10ml/cmH_2O and a resistance of 5 cm/L/sec and allow the unit to warm up for one hour.

3) Allow the unit to run for 1 minute and record the displayed **Vte** (average for 8 consecutive breaths).

Then stand the unit upright, allow it to run for 1 minute and record the displayed **Vte** (average for 8 consecutive breaths).

- If the difference between the two recorded averages is greater than 100 mL, the Bypass Valve may be faulty and the following should be performed:
  - Check the tubing from the flow valve to the turbine manifold for leaks and replace if damaged or leaking.
  - If the tubing is OK, replace the turbine manifold. See *Turbine Manifold* in Chapter 8 for instructions.

Transducer Accuracy Checkout

High target pressures and short inspiration times coupled with fast rise times may be beyond the capacity of the ventilator. For problems with Pressure Support or Pressure Control, first verify the ventilator is functioning properly.

Check ventilator functionality:

1) Set the ventilator up as follows:
   - Attach a test lung with a compliance of 10ml/cmH_2O and a resistance of 5 cm/L/sec
   - Set Rise time - Profile 5
   - Set Inspiration Time - 1.0 sec
   - Set Sensitivity - OFF
   - Set Pressure Control Flow Termination - OFF
2) Set Pressure Control to 50 cmH_2O and measure the Peak Inspiration Pressure (PIP) with a calibrated pressure meter.
   - If reading is between 46 to 54 cmH_2O, the unit is functioning properly.
   - If reading is less than 46 cmH_2O or more than 54 cmH_2O, proceed to the next test.

Check transducer accuracy as follows:

Select the **RT XDCR DATA** menu and verify the accuracy of the following transducers by applying the specified pressures to the applicable port or transducer.

- When/as performed, record the readout for each test and refer to the Transducer Tolerance Variance Table (see *page 7-25*) for tolerance variance actions to be taken.

AP Pressure Support or Pressure Control:

1) Verify the **RISE TIME** in **VENT OP** is set to Profile 5.
2) Apply 50 cmH_2O to the high side port and verify the **AP** readout is within ± 0.5 cmH_2O of the applied pressure.
3) Disconnect from the ventilator so the connection is open to ambient air. When the display value stabilizes, verify the **AP** readout is within ± 0.5 cmH_2O.

FVd Delivered Volume:

1) Apply 15 cmH_2O to the flow valve differential transducer at the high side port and verify the **FVd** readout is within ± 0.5 cmH_2O of the applied pressure.
2) Disconnect the tube from the syringe to the high pressure port of the valve differential transducer so the connection is open to ambient air. When the displayed value stabilizes, verify the **FVd** readout is within ± 0.5 cmH_2O.

FDw Monitored Volume:

1) Apply 30 cmH_2O to the Flow Differential transducer at the high side port and verify the **FDw** readout is within ± 0.5 cmH_2O of the applied pressure.
2) Disconnect from the ventilator so the connection is open to ambient air. When the display value stabilizes, verify the **FDw** readout is within ± 0.5 cmH_2O.

FDb Inspired Volume (LTM Only):

1) Apply 30 cmH_2O to the Flow Differential transducer at the low side port and verify the **FDb** readout is within ± 0.5 cmH_2O of the applied pressure.
2) Disconnect from the ventilator so the connection is open to ambient air. When the display value stabilizes, verify the **FDb** readout is within ± 0.5 cmH_2O.

O_2 Oxygen Inlet Pressure:

1) Apply 50 PSI to the high pressure oxygen inlet port and verify the readout is applied pressure ± 1 PSI.
2) Disconnect from the ventilator so the connection is open to ambient air. When the display value stabilizes, verify the readout is 0 ± 0.5 PSI.

Transducer Tolerance Variance Table:

Transducer	Acceptable transducer tolerance range	Recalibrate transducer if variance to tolerance is;	Replace analog board if variance to tolerance is;
AP	± 0.5 cmH_2O	>0.5 but < 2.5 cmH_2O	>2.5 cmH_2O
FVd	± 0.5 cmH_2O	>0.5 but < 0.75 cmH_2O	>0.75cmH_2O
FDw	± 0.5 cmH_2O	>0.5 but < 1.5 cmH_2O	>1.5 cmH_2O
FDb	± 0.5 cmH_2O	>0.5 but < 1.5 cmH_2O	>1.5 cmH_2O
O_2	± 1.0 PSI	>1.0 but < 2.5 PSI	>2.5 PSI

- If transducer recalibration is indicated, recalibrate that transducer (see *Chapter 6 - Maintenance & Calibration* for instructions) and repeat the test.
- If analog board replacement is indicated, replace the analog PCBA. See *Analog Board Assembly* in Chapter 8 for instructions and repeat the test.
- If the results for the transducers are within tolerance, perform the flow valve Accuracy Checkout tests to determine accuracy of the flow valve.

Flow Valve Accuracy Checkout

Check flow valve accuracy as follows:

1) At the Tidal Volume setting which is giving failing results, press the **Tidal Volume** button and **VCALC xxx Lpm** will be displayed (this is the calculated peak flow for the set volume). Record this number.

2) Turn the unit off, then on again in VENT MTNCE by holding down the **Control Lock**, **Manual Breath** and **Select** buttons (3-finger mode[22]) while turning the ventilator on. Select **VENT MTNCE** and perform a STEP TEST.
   - If the unit fails the Step Test, replace the flow valve. See *Flow Valve Assembly* in Chapter 8 for instructions.
   - If the unit passes the Step Test, proceed to the next step.

3) Select **SERVO**, **ON** and using a calibrated flow meter, measure the output flow in 10-liter increments from 10 Lpm to the peak calculated flow.
   - To adjust the set flow rate, see *Servo* in Chapter 6 for instructions.
   - If the peak flow is above 50 Lpm, increase the turbine speed to 5000 RPM.
   - If the output flow is not within ± 10% of the set flow, the flow valve may be faulty and should be replaced. See *Flow Valve Assembly* in Chapter 8 for instructions.

[22] Using the 3-finger technique enables a modified mode of VENT MTNCE in which testing may be performed, but Calibration procedures and changing Configuration settings can not.

Advanced FiO_2 Diagnostic Procedures (LTV® 1200 Only)

Delivery of the correct percentage of oxygen (FiO_2) is dependent on correct calibration of the oxygen pressure transducer, flow valve and O_2 blender. If the FiO_2 appears incorrect, perform the following diagnostic procedures.

When instructed to replace a subassembly or component that fails any of the following checks, verify the original problem is resolved once the item has been replaced. If the original problem is not resolved, continue with the Advanced Diagnostic checks in order.

Oxygen Transducer Checkout

Perform a Leak test as follows:

1) Apply a switchable 50 PSIG O_2 source to the oxygen inlet with a calibrated pressure meter in circuit.
2) Switch off the O_2 source and monitor the pressure for 1 minute.
   - If the pressure drop is greater than 1 PSI, check the Pisco connector and the thin, high-pressure tubing for damage or leaks and replace any damaged components.

Perform a Calibration Check as follows:

1) Power the unit up in VENT CHECK and select **RT XDCR DATA**, **O2**.
2) With the inlet open to ambient, verify the readout is ± 0.5 PSI.
3) With 50 PSI applied to the inlet, verify the readout is 50 ± 1.0 PSI.
4) If either step fails, recalibrate the transducer and repeat the test. If the test still fails, the oxygen transducer or associated electronics may be faulty and the analog PCBA should be replaced. See *Analog Board Assembly* in Chapter 8 for instructions.

Flow Valve Checkout

1) In VENT MTNCE, SERVO mode, check the output flow using the settings in the following table.

Flow and speed settings	Acceptable output flow range	Recalibrate flow valve if flow output variance is;	Replace flow valve if Flow Output Variance is;
10 Lpm - 4000 RPM	9.5 to 10.5 Lpm	>7.0 but < 9.5 Lpm or >10.5 but <13.0 Lpm	<7.0 or >13.0
10 Lpm - 5000 RPM	9.5 to 10.5 Lpm	>7.0 but < 9.5 Lpm or >10.5 but <13.0 Lpm	<7.0 or >13.0
50 Lpm - 4000 RPM	42.5 to 57.5 Lpm	>35.0 but < 42.5 Lpm or >57.5 but <65.0 Lpm	<35.0 or >65.0
90 Lpm - 7000 RPM	76.5 to 103.5 Lpm	>63.0 but < 76.5 Lpm or >103.5 but <117.0 Lpm	<63.0 or >117.0

2) If the flow output is out of the acceptable output flow range, perform the following, in the order shown.

- Check all flow valve flexible tubing for leaks or occlusions and replace any damaged components.
- Recalibrate the flow valve transducer (see *Valve Differential Calibration* in Chapter 6 for instructions).
- If flow valve recalibration is indicated, recalibrate the flow valve by adjusting the VHOME setting (see *Flow Valve Calibration* in Chapter 6 for instructions).
- If flow valve replacement is indicated, see *Flow Valve Assembly* in Chapter 8 for instructions.

O_2 Blender Checkout

Verify the O_2 blender Solenoid output flows, as follows:

1) Remove the O_2 blender (see *O2 Blender Assembly* in Chapter 8 for instructions).
2) Reconnect the 8-wire connector from the O_2 blender to the power board and the blender O_2 tube Pisco connector to the O_2 pressure transducer on the analog board.
3) Connect a calibrated flow meter to the blender output barb fitting and a 50 psi O_2 source to the blender O_2 inlet.
4) Set DIP switch # 5 to ON.
5) Power the ventilator On (in VENT MTNCE mode), select **SOLENOID** and set solenoids # 1 through # 4 to Off.
6) Verify each (of four) solenoid's output flow is 0.0 Lpm ± 0.5 Lpm.
   - If any are not within this range, the O_2 blender is defective and is to be replaced.
7) Select each solenoid individually, set to On and record the output flow.

Solenoid	Range
1	5.79 to 6.01 Lpm
2	17.45 to 18.15 Lpm
3	46.36 to 48.24 Lpm
4	46.36 to 48.24 Lpm

   - If the output flows of all solenoids are within the specified range, the O_2 blender is correctly calibrated.
   - If the output flow of any one of the solenoids is not within the specified range, the O_2 blender is defective and is to be replaced.
8) Set DIP switch # 5 to Off, power the ventilator Off and reinstall or replace the O_2 blender per instructions *O2 Blender Assembly* in Chapter 8.

Problem	Possible Causes	What To Do
The ventilator does not power up.	Defective AC source or adapter and depleted internal battery.	Connect the ventilator to a known good AC source using a known good AC adapter. Verify the power cord for the adapter is fully seated. Allow the internal battery to charge a minimum of 8 hours.
	Memory board **JP3** connector jumper not installed or not properly installed.	Install or reposition the Memory board **JP3** connector jumper. See *Memory Board* in Chapter 8 for instructions.
	Defective memory board.	Reseat or replace the memory board. See *Memory Board* in Chapter 8 for instructions.
	Defective power board.	Replace the power board. See *Power Board Assembly* in Chapter 8 for instructions.
	Defective main board.	Replace the main board. See *Main Board Assembly* in Chapter 8 for instructions.
Vent Inop LED is on and ventilator is not ventilating.	Vent in Standby.	After the vent has been turned off and the external power is reconnected, the **Vent Inop** LED is lit. This is normal. Press **On/Standby** button to turn ventilator on.
	Ventilator was running on internal battery and battery became depleted.	Connect ventilator to good external power source.
	Vent Inop.	Power up the vent and check the **EVENT TRACE** for events indicating the reason for Vent Inop. See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for information on reading the event trace.
	Memory board **JP3** connector jumper not installed or not properly installed.	Install or reposition the Memory board **JP3** connector jumper. See *Memory Board* in Chapter 8 for instructions.
	Defective memory board.	Reseat or replace the memory board. See *Memory Board* in Chapter 8 for instructions.
	Defective power board.	Replace the power board. See *Power Board Assembly* in Chapter 8 for instructions.
	Defective main board.	Replace the main board. See *Main Board Assembly* in Chapter 8 for instructions.

Problem	Possible Causes	What To Do
The ventilator doesn't operate from external power.	Defective AC source. AC adapter power cord loose.	Make sure the AC adapter is plugged into a good AC source and is securely connected to the ventilator. Verify the power cord for the adapter is fully seated.
	Defective AC adapter.	Replace the AC adapter.
	Defective power board.	Replace the power board. See *Power Board Assembly* in Chapter 8 for instructions.
The ventilator does not operate from internal battery. The ventilator shuts off when external power is removed.	Internal battery depleted.	If the internal battery is depleted, charge the internal battery for 24 hours by connecting the external AC adapter and plugging it into a good AC source.
	Internal battery not connected.	If the internal battery is not connected, the **Charge Status** LED will show red. Reconnect the internal battery. See *Internal Battery Pack* in Chapter 8 for instructions.
	Defective internal battery.	If the battery does not reach full capacity after several charge cycles (vent should run for more than 40 minutes on nominal settings) replace the internal battery. See *Internal Battery Pack* in Chapter 8 for instructions.
	Defective power board.	If the battery won't charge completely after replacing it, there may be a problem with the charge circuit on the power board. Replace the power board. See *Power Board Assembly* in Chapter 8 for instructions.
Battery doesn't reach full charge. Battery depletes too quickly.	Internal battery deeply discharged.	Charge the internal battery for 24 hours by connecting the external AC adapter and plugging it into a good AC source. If the battery is deeply discharged, it may take several cycles of charging and discharging for the battery to reach a maximum charge.
	Defective internal battery.	If the battery does not reach full capacity after several charge cycles (vent should run for more than 40 minutes on nominal settings) replace the internal battery. See *Internal Battery Pack* in Chapter 8 for instructions.
	Defective power board.	If the battery won't charge completely after replacing it, there may be a problem with the charge circuit on the power board. Replace the power board. See *Power Board Assembly* in Chapter 8 for instructions.

Problem	Possible Causes	What To Do
Battery **Charge Status** LED is flashing amber.	Internal battery charging.	The **Charge Status** LED flashes amber while the battery charging circuit evaluates the battery as a part of the charge cycle. If the battery is found to be OK, the **Charge Status** LED will change to solid amber while the battery is charging. The internal battery charges any time the ventilator is connected to an external power source. If the battery is deeply discharged, the **Charge Status** LED may flash amber for up to an hour.
	Defective internal battery.	If the battery does not reach full capacity after several charge cycles (vent should run for more than 40 minutes on nominal settings) replace the internal battery. See *Internal Battery Pack* in Chapter 8 for instructions.
	Defective power board.	If the battery won't charge completely after replacing it, there may be a problem with the charge circuit on the power board. Replace the power board. See *Power Board Assembly* in Chapter 8 for instructions.
Battery **Charge Status** LED is flashing red.	Defective power board.	Replace the power board. See *Power Board Assembly* in Chapter 8 for instructions.
Battery **Charge Status** LED is solid red.	Internal battery not connected.	If the internal battery is not connected, the **Charge Status** LED will show red. Reconnect the internal battery. See *Internal Battery Pack* in Chapter 8 for instructions.
	Defective internal battery.	Replace the internal battery. See *Chapter 8 - Internal Battery Pack* for instructions.
	Defective power board.	Replace the power board. See *Power Board Assembly* in Chapter 8 for instructions.

Alarms

Many alarms such as **HIGH PRES** or **LOW O2 PRES** can occur during normal operation. Information on addressing alarms is covered in the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual. Single occurrences of some alarms, such as **HW FAULT** or **RESET** may be caused by ESD. If these alarms recur, and for other alarms that do not usually occur during normal operation, follow the instructions in this section or contact Pulmonetic Systems using the contact information at the front of this manual.

Symptoms	Possible Causes	What to Do
HIGH PRES occurred but alarm did not sound.	Alarm silence was already active (**Silence Reset** LED is red).	The ventilator alarms can be silenced for 60 seconds by pressing the **Silence Reset** button. If the alarm is already silenced (**Silence Reset** LED is red), it will not sound again until the silence period expires.
	Alarm automatically silenced after 3 seconds because condition cleared.	When an alarm occurs, the audible alarms sound for a minimum of 3 seconds or for as long as the condition exists. Some alarms, such as **HIGH PRES** may clear almost immediately and the alarm will sound for only 3 seconds.
	High pressure alarm delay is on - **HP DELAY** is set to **DELAY 1 BRTH** or **DELAY 2 BRTH**.	When a high pressure condition is detected, the **HIGH PRES** message is displayed and the **High Pres Limit** control is flashed. If the **HP DELAY** option is set to **NO DELAY**, the audible alarm is sounded immediately. When the **HP DELAY** option is set to **DELAY 1 BRTH** or **DELAY 2 BRTH**, the audible is not sounded until the second or third consecutive breath with a high pressure condition. (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for an explanation of this feature.)
Alarm doesn't sound.	Ventilator did not run for more than 1 minute.	Turn the ventilator on and run for a minimum of 1 minute to charge the alarm capacitor.
	Defective or disconnected sounder.	Run an alarm test. See *Alarm Test* in Chapter 2 for instructions. If the alarm does not sound, open the ventilator and verify that the alarm sounder connector is securely connected to the power board. Replace the alarm sounder. See *page 8-55* for instructions.
	Defective power board.	Replace the power board. See *Power Board Assembly* in Chapter 8 for instructions.

Symptoms	Possible Causes	What to Do
Ventilator won't exhale, repeated **HIGH PRES** alarms, turbine stops and pressure drops, then auto cycles up to **HIGH PRES** again.	Diaphragm installed backwards or incorrectly seated in exhalation valve.	Open the exhalation valve and remove the diaphragm. Reseat the diaphragm and snap the valve cap back in place. See *Cleaning the Reusable Exhalation Valve and Patient Circuit* in Chapter 4 for a diagram of the exhalation valve assembly.
	Sense lines occluded, pinched or reversed.	Check high and low pressure sense lines to be sure they are correctly attached and securely seated at both the ventilator and wye ends. Verify lines are not occluded, pinched or reversed.
	Internal flexible tubing occluded or pinched. Internal flexible tubing has pinhole leaks or leaking at connections.	This problem will often be accompanied by **XDCR FAULT** alarms. Open the vent and verify that none of the flexible tubes connected to the solenoid manifold or analog board are pinched or leaking. See *Solenoid Manifold Assembly* or *Analog Board Assembly* in Chapter 8 for routing information.
	Defective exhalation drive solenoid.	Replace the solenoid manifold. See *Solenoid Manifold Assembly* in Chapter 8 for instructions.
Repeated **DISC/SENSE** alarms.	Circuit disconnected from patient, wye or vent. Exhalation valve disconnected from wye.	Check the circuit and exhalation valve to verify the circuit is securely connected and the valve is intact. Open the exhalation valve and remove the diaphragm. Reseat the diaphragm and snap the valve cap back in place. See *Cleaning the Reusable Exhalation Valve and Patient Circuit* in Chapter 4 for a diagram of the exhalation valve assembly.
	High or low side sense lines disconnected from vent or wye or are inappropriately attached. High or low side sense line or elbow at patient wye loose or leaking. High or low sense lines are occluded. High or low sense ports in the wye are occluded.	Check high and low pressure sense lines to be sure they are correctly attached and securely seated at both the ventilator and wye ends. Check the Luer fitting connections for leaks. Check the elbow connectors at the wye to be sure they are not loose or broken. Verify lines are not occluded, pinched or reversed Check the exhalation drive line at both the ventilator and exhalation valve ends. Verify the line is securely seated and not leaking.

Symptoms	Possible Causes	What to Do
CONTINUED … *Repeated **DISC/SENSE** alarms.*	Exhalation drive line leaking or loose. Exhalation valve leaking during inspiration.	Check the exhalation drive line at both the ventilator and exhalation valve ends. Verify the line is securely seated and not leaking. Verify the exhalation valve is not leaking during inspiration. If it is leaking, open the exhalation valve and remove the diaphragm. Reseat the diaphragm and snap the valve cap back in place. See *Cleaning the Reusable Exhalation Valve and Patient Circuit* in Chapter 4 for a diagram of the exhalation valve assembly. If necessary, replace the exhalation diaphragm, or exhalation valve with a new one.
	Pressure Control or Pressure Support set below PEEP.	Verify these control values are appropriately set.
	Internal flexible tubing occluded or pinched. Internal flexible tubing has pinhole leaks or leaking at connections.	This problem will often be accompanied by **XDCR FAULT** alarms. Open the vent and verify that none of the flexible tubes connected to the solenoid manifold or analog board are pinched or leaking. See *Internal Flexible Tubing* in Chapter 8 for routing information.
	Defective transducer on analog board.	Replace the analog board. See *Analog Board Assembly* in Chapter 8 for instructions.
	Defective auto zero solenoid.	Replace the solenoid manifold. See *Solenoid Manifold Assembly* in Chapter 8 for instructions.
Repeated **XDCR FAULT** alarms.	Internal flexible tubing occluded or pinched. Internal flexible tubing has pinhole leaks or leaking at connections.	This problem will often be accompanied by **XDCR FAULT** alarms. Open the vent and verify that none of the flexible tubes connected to the solenoid manifold or analog board are pinched or leaking. See *Internal Flexible Tubing* in Chapter 8 for routing information.
	Defective transducer on analog board.	Replace the analog board. See *Analog Board Assembly* in Chapter 8 for instructions.
	Defective auto zero solenoid.	Replace the solenoid manifold. See *Solenoid Manifold Assembly* in Chapter 8 for instructions.

Symptoms	Possible Causes	What to Do
HW FAULT alarm.	**HW FAULT** alarms: **AD MMTCH** **AD MTCH1** **EEPROM** **FAN FLT1** **HOME ER1** **INTRRPT1** **INTRRPT2** **SYNC ER1**	Check the Event Trace to determine the kind of error and follow the instructions below for the specific error type. (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for instructions on using the event trace.)
Repeated **HW FAULT** alarms, delivered pressures and volumes are off. Event Log shows **SYNC ER1** or **HOME ER1**.	Defective or disconnected flow valve.	The SERVO test may be used to set the valve step position explicitly. See *Chapter 6 - Maintenance & Calibration* for instructions on using the servo test. The step position can be viewed using the **RT XDCR DATA** display. (See *Chapter 3 - Real-Time Transducer Data* for instructions on using RT data.) If the flow valve does not respond to the SERVO controls, open the ventilator and verify that the flow valve connectors are securely connected to the motor and power boards. Replace the flow valve. See *Flow Valve Assembly* in Chapter 8 for instructions.
	Defective motor board.	Replace the motor board. See *Motor Board Assembly* in Chapter 8 for instructions.
	Defective power board.	Replace the power board. . See *Power Board Assembly* in Chapter 8 for instructions.
Repeated **HW FAULT** alarms, fan not turning, ventilator gets excessively hot. Event Log shows **FAN FLT1**.	Defective or disconnected fan. Fan housing screws over-tight.	Fan operation can be checked by looking at it through the fan grill on the side of the vent. If the fan is not operating, open the ventilator and verify that the fan connector is securely connected to the power board. Verify that the fan is mounted flush to the case and the fan wiring is not pinched between the fan and case. If the fan wiring is pinched, it may operate correctly with the ventilator case open but fail when the ventilator back panel is tightened down. Verify that the fan housing screws have not been over tightened. If the screws are too tight, the housing may be warped and the fan may not turn or may turn too slowly. If the fan wiring has been pinched, or the fan does not operate, replace the fan assembly. See *Fan Assembly* in Chapter 8 for instructions.

Symptoms	Possible Causes	What to Do
CONTINUED … *Repeated **HW FAULT** alarms, fan not turning, ventilator gets excessively hot.* *Event Log shows **FAN FLT1**.*	Defective power board.	Replace the power board. . See *Power Board Assembly* in Chapter 8 for instructions.
Repeated **HW FAULT** alarms. Event Log shows **EEPROM**.	Electro static discharge (ESD).	Clear the alarm. Reduce static causing conditions in the operating environment.
	Defective main board.	Replace the main board. See *Main Board Assembly* in Chapter 8 for instructions.
Repeated **HW FAULT** alarms. Event Log shows **INTRRPT1** or **INTRRPT2**.	Electro static discharge (ESD).	Clear the alarm. Reduce static causing conditions in the operating environment.
	Defective main board.	Replace the main board. See *Main Board Assembly* in Chapter 8 for instructions.
RESET alarm. **RESET** alarm occurs at the conclusion of POST after performing the Watchdog test, Battery Duration test, or any other test which causes the ventilator to go inoperative; other than pressing and holding the **On/Standby** button. Event Log shows **LN VENT1**	This is a normal feature.	Press the **Silence Reset** button twice to clear the alarm
RESET alarm. Repeated **RESET** alarms. Event Log shows **CRC, STACK, POST,** or **RUNAWAY**.	**RESET** alarms: **CRC** **POST** **RUNAWAY** **STACK**	Check the Event Trace to determine the kind of error. (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for instructions on using the event trace.)
	Electrostatic discharge (ESD).	Clear the alarm. Reduce static causing conditions in the operating environment.
	Defective memory board.	Replace the memory board. See *Memory Board* in Chapter 8 for instructions.
	Defective main board.	Replace the main board. See *Main Board Assembly* in Chapter 8 for instructions.
	All other causes.	Contact Pulmonetic Systems.
NO CAL DATA alarm. **NO CAL** displayed in place of monitored values. Event Log shows **NO CAL**.	Failed or missing calibration records.	Recalibrate the vent. See *Chapter 6 - Maintenance & Calibration* for instructions. If the problem reoccurs after careful recalibration, a transducer may be drifting excessively. Replace the analog board. See *Analog Board Assembly* in Chapter 8 for instructions.

Symptoms	Possible Causes	What to Do
DEFAULTS alarm. Event Log shows **DEFAULTS**.	Electro static discharge (ESD).	Some or all control settings were found to be invalid or out of range on power up and were restored to the default settings. Clear the alarm. Reduce static causing conditions in the operating environment.
	Defective main board.	Replace the main board. See *Main Board Assembly* in Chapter 8 for instructions.
	Defective memory board.	Replace the memory board. See *Memory Board* in Chapter 8 for instructions.
Repeated **HIGH f** alarms**.**	Total Breath Rate (**f**) exceeds the set **HIGH f** alarm values.	Check **HIGH f** alarm values. (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for instructions).
	Patient Circuit leak, causing auto cycling.	Run a Leak test and reseat or replace the leaking parts or connections. (See *Leak Test* in Chapter 2 for instructions).
	Internal problem with the ventilator.	If problem reoccurs, immediately contact a certified Pulmonetic Systems' service technician.
Repeated **HIGH PEEP** alarms.	Monitored PEEP exceeds the set **HIGH PEEP** alarm.	Check **HIGH PEEP** alarm value. (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual).
	Patient circuit and/or Exhalation valve occluded.	Disassemble, clean and reassemble the Patient Circuit and Exhalation Valve. See *Cleaning the Reusable Exhalation Valve and Patient Circuit* in Chapter 4 for a diagram of the exhalation valve assembly.
	Internal problem with the ventilator.	If problem reoccurs, immediately contact a certified Pulmonetic Systems' service technician.
Remote Alarm System does not work with the ventilator.	Defective or improper connections.	Check the Remote Alarm cable connection between the ventilator's Patient Assist Port and the Remote Alarm System. (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual).
	Defective Remote Alarm cable.	Replace Remote Alarm cable. (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for instructions).
	Defective Remote Alarm System.	Contact Remote Alarm System manufacturer or service personnel.
	Internal problem with the ventilator.	Immediately contact a certified Pulmonetic Systems' service technician.
Remote Alarm System (*single* tone) generates a pulsating tone and manufacturer's instructions indicate it should be a continuous tone.	PNT ASSIST option set to **PULSE**.	Set PNT ASSIST option to **NORMAL**. (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual).
	Defective Remote Alarm System.	Contact Remote Alarm System manufacturer or service personnel.
	Internal problem with the ventilator.	Immediately contact a certified Pulmonetic Systems' service technician.

Symptoms	Possible Causes	What to Do
Remote Alarm System (*dual* tone system) only generates one continuous tone.	PNT ASSIST option set to **NORMAL**.	Set PNT ASSIST option to **PULSE**. (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for instructions).
	Defective Remote Alarm System.	Contact Remote Alarm System manufacturer or service personnel.
	Internal problem with the ventilator.	Immediately contact a certified Pulmonetic Systems' service technician.
Patient Assist Call System does not work with the ventilator.	Incorrect Patient Assist cable installed (Normally Open versus Normally Closed system/cable mismatch)	Establish whether the Patient Assist Call System is a Normally Open or Normally Closed system and verify the appropriate Patient Assist Cable (Normally Open or Normally Closed) is installed. (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for instructions).
	Defective or improper connections.	Check the Patient Assist Cable connection between the ventilator's Patient Assist Port and the Patient Assist Call System. (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for instructions).
	Defective Patient Assist cable.	Replace Patient Assist Cable.
	Defective Patient Assist Call System.	Contact Patient Assist Call System manufacturer or service personnel.
	Internal problem with the ventilator.	Immediately contact a certified Pulmonetic Systems' service technician.
Patient Assist Call System generates a pulsating tone or light and manufacturers instructions indicate it should be a continuous tone or light.	PNT ASSIST option set to **PULSE**.	Set PNT ASSIST option to **NORMAL**. (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for instructions).
	Defective Patient Assist Call System.	Contact Patient Assist Call System manufacturer or service personnel.
	Internal problem with the ventilator.	Immediately contact a certified Pulmonetic Systems' service technician.
Repeated **SBT > f** alarms**.**	Total Breath Rate (**f**) exceeds the set **SBT > f** alarm value.	Check **SBT > f** alarm value. (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for instructions).
	Patient Circuit leak, causing auto cycling.	Run a Leak test and reseat or replace the leaking parts or connections. (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for instructions).
	Internal problem with the ventilator.	If problem reoccurs, immediately contact a certified Pulmonetic Systems' service technician.
Repeated **SBT < f** alarms**.**	Total Breath Rate (**f**) is less than the set **SBT < f** alarm value.	Check **SBT < f** alarm value. (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for instructions).
	Patient Circuit leak.	Run a Leak test and reseat or replace the leaking parts or connections. (See *Leak Test* in Chapter 2 for instructions).

Symptoms	Possible Causes	What to Do
CONTINUED … *Repeated* ***SBT < f*** *alarms.*	Internal problem with the ventilator.	If problem reoccurs, immediately contact a certified Pulmonetic Systems' service technician.
Repeated **SBT > f/Vt** alarms**.**	Total Breath Rate (**f**) exceeds the set **SBT > f/Vt** alarm value.	Check **SBT > f/Vt** alarm value. (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for instructions).
	Patient Circuit leak.	Run a Leak test and reseat or replace the leaking parts or connections. (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for instructions).
	Internal problem with the ventilator.	If problem reoccurs, immediately contact a certified Pulmonetic Systems' service technician.
Repeated **SBT < f/Vt** alarms**.**	Total Breath Rate (**f**) is less than the set **SBT < f/Vt** alarm value.	Check **SBT < f/Vt** alarm value. (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for instructions).
	Patient Circuit leak.	Run a Leak test and reseat or replace the leaking parts or connections. (See *Leak Test* in Chapter 2 for instructions).
	Internal problem with the ventilator.	If problem reoccurs, immediately contact a certified Pulmonetic Systems' service technician.

Symptoms	Possible Causes	What to Do
ALARM Test Audible alarm too loud.	Alarm volume set too high.	Set the alarm volume under the Extended Features Menu. (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for an explanation of the **ALARM VOL** feature.)
ALARM Test Audible alarm too soft.	Alarm volume set too low.	Set the alarm volume under the Extended Features Menu. (See the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual for an explanation of the **ALARM VOL** feature.)
	Defective alarm sounder.	Replace the alarm sounder. (See *page 8-55* for instructions).
	Alarm sounder blocked.	Check the alarm sounder opening in the right side of the ventilator to verify the opening is not blocked.
ALARM Test Alarm does not sound.	Alarm sounder blocked.	Check the alarm sounder opening in the right side of the ventilator to verify the opening is not blocked.
	Alarm sounder disconnected.	Open the back of the ventilator and verify the alarm sounder is properly connected. (See *page 8-55* for instructions).
	Defective alarm sounder.	Replace the alarm sounder. (See *page 8-55* for instructions).
	Defective power board.	Replace the power board. (See *Power Board Assembly* in Chapter 8 for instructions).
Alarm Test Confirming audible chirp does not sound.	Audible alarm did not sound long enough before test was terminated.	Repeat the Alarm Test and allow audible alarm to sound for at least 2 seconds before pushing the **Select** button.
	Defective power board.	Replace the power board. (See *Power Board Assembly* in Chapter 8 for instructions)
Display Test A display or LED does not illuminate.	Misaligned LED.	If displays are operating but misaligned, remove the main board and realign the LEDs or displays. See *Main Board Assembly* in Chapter 8 for instructions.
	Defective LED or display. Defective main board.	If a display is not operating during the display test, replace the main board. See *Main Board Assembly* in Chapter 8 for instructions.

Symptoms	Possible Causes	What to Do
Control Test No message is displayed when some control buttons are pressed.	Wrong model selected in maintenance mode.	Verify the correct **MODEL** has been selected in **VENT MTNCE**. See *Chapter 6 - Maintenance & Calibration.*
Control Test Correct message is not displayed when **Set Value** knob is turned, or incorrect message is displayed.	Rotary switch is disconnected. Defective rotary switch.	Verify the rotary switch is properly connected. If necessary, replace the rotary switch assembly. See *Rotary Switch (Set Value Knob) Assembly* in Chapter 8 for instructions.
	Defective main board.	Replace the main board. See *Main Board Assembly* in Chapter 8 for instructions.
Control Test The name of a button control is not displayed when the control is pressed or an incorrect control name is displayed.	Front panel ribbon cable not properly connected.	Remove the power board to access the ribbon cable connection on the main board. Disconnect and reconnect the front panel ribbon cable connector. See *Main Board Assembly* in Chapter 8 for instructions. Handle the ribbon cable carefully to avoid scratching or damaging it.
	Front panel ribbon cable damaged. Defective switch.	Replace the front panel. See *Front Panel* in Chapter 8 for instructions
	Defective main board.	Replace the main board. See *Chapter 8 - Main Board Assembly* for instructions.
LEAK Test Leak test fails.	Circuit connections or accessories are leaking. Wye is not properly capped.	Reseat or replace the leaking circuit parts, accessories or connections. Verify the wye is securely capped. See *Leak Test* in Chapter 2 for instructions.
	Internal flexible tubing occluded or pinched. Internal flexible tubing has pinhole leaks or leaking at connections.	This problem will often be accompanied by **XDCR FAULT**. Open the vent and verify that none of the flexible tubes connected to the solenoid manifold or analog board are pinched or leaking. See *Internal Flexible Tubing* in Chapter 8 for routing information.
	Over pressure relief valve leaking. Subambient relief valve leaking. Flow valve leaking.	Replace the flow valve. See *Flow Valve Assembly* in Chapter 8 for instructions.
	VHome setting does not match flow valve.	Correct the VHome setting. See *Chapter 6 - Maintenance & Calibration.*
LEAK Test Leak test fails with **LEAK --- FAIL** message.	Internal problem with the turbine.	Verify wiring to turbine. Replace turbine manifold or motor PCBA.

Symptoms	Possible Causes	What to Do
Leak Test - Hi and Low Flow transducer ports (in Chapter 6 – Calibration)	Leaky or disconnected internal tubing. Solenoid manifold mal-functioning	Check tubing connections. Check for leaks in tubing. Replace damaged tubing. Reconnect as necessary. Replace Solenoid Manifold.
O_2 Leak Test (in Chapter 6 – Calibration)	Malfunctioning O_2 Blender	Replace O_2 Blender
Vent Inop Alarm Test Audible alarm too soft.	Alarm sounder blocked.	Check the alarm sounder opening in the right side of the ventilator to verify the opening is not blocked.
Vent Inop Alarm Test Alarm does not sound.	Alarm sounder blocked.	Check the alarm sounder opening in the right side of the ventilator to verify the opening is not blocked.
	Sounder fails to sound.	Replace sounder. (See *Alarm Sounder Assembly* in Chapter 8 for instructions)
	Power PCBA does not drive sounder.	Replace Power PCBA. (See *Power Board Assembly* in Chapter 8 for instructions)
Vent Inop Alarm Test LED portion of Vent Inop Alarm test fails.	Vent Inop LED fails to illuminate.	Replace Main PCBA. (See *Main Board Assembly* in Chapter 8 for instructions)
	Power PCBA does not drive Vent Inop LED.	Replace Power PCBA. (See *Power Board Assembly* in Chapter 8 for instructions)
Vent Inop Alarm Test Vent Inop alarm audible tone and/or LED did not last 15 seconds (fail).	Power PCBA is defective.	Replace Power PCBA. (See *Power Board Assembly* in Chapter 8 for instructions)
Vent Inop Alarm Test Vent Inop alarm tone and/or LED fails test.	Unknown	Discontinue use of the ventilator and contact Pulmonetic Systems for information.
Vent Inop Alarm Test Confirming audible chirp does not sound	Audible alarm did not sound long enough before test was terminated.	Repeat the Vent Inop Alarm Test and allow audible alarm to sound for at least 15 seconds before pushing **Silence Reset**. (See *Vent Inop Alarm* Test in Chapter 2)
	Defective power board.	Replace Power PCBA. (See *Power Board Assembly* in Chapter 8 for instructions)
WDOG Test Vent does not reset when watchdog test is performed.	Defective main board.	Replace the main board. See *Main Board Assembly* in Chapter 8 for instructions.

Symptoms	Possible Causes	What to Do
Delivered pressure higher than set pressure on test lung.	Pressure> 40 cmH_2O used on small test lung (Pulmonetic Systems or Siemens 190.)	The compliance characteristics of some small test lungs (Pulmonetic Systems or Siemens 190) cause incorrect readings when high pressures are used. For these lungs, use pressures under 40 cmH_2O or change to a larger lung.
Monitored volumes very high on test lung.	Test lung with small aperture connected directly to wye.	Some test lungs have a narrow opening or a restrictor which may cause jetting and cause the flow differential to be read incorrectly. To reduce the jetting effect, add a short extension between the test lung and the wye if clinically advisable.
	Very small ET tube connected directly to wye.	A very small ET tube connected directly to the wye may cause jetting and cause the flow differential to be read incorrectly. To reduce the jetting effect, add a short larger bore extension between the ET tube and the wye if clinically advisable.

Chapter 8 - Component Removal and Replacement

This section contains detailed procedures for the removal and replacement of all major components of the LTV® 1200/1150 ventilator.

WARNING

Ventilator Service and Repair - Only service technicians who have been trained and certified by Pulmonetic Systems to service the LTV® 1200/1150 ventilator are authorized to perform repairs or maintenance on LTV® 1200/1150. Do not attempt to repair or replace any part of the ventilator unless you are trained and certified to do so by Pulmonetic Systems. Personal injury could result.

CAUTION

Electronic and Mechanical Parts - The LTV® 1200/1150 ventilator contains delicate electronic and mechanical parts that must be handled properly to avoid damage. Follow the instructions carefully and make sure to observe all instructions.

Anti-static Precautions - Always wear a grounded anti-static wrist strap when handling the ventilator with the case open. Electrostatic discharge can damage the internal electronics.

NOTE

When servicing the ventilator, always refer to the *Back Panel, Reinstallation* instructions in this chapter for a comprehensive list of components that should be replaced or updated or tasks that must be completed before closing up the ventilator.

Training and Authorization

This manual is only intended for use by service personnel who have been trained and authorized by Pulmonetic Systems. Do not perform any of the procedures in this manual unless you are trained and authorized for service on LTV® 1200/1150 ventilators.

Service Record

Any time service is performed on the LTV® 1200/1150 ventilator, a Service Record form should be filled out and returned to Pulmonetic Systems. This enables complete tracking of replacement part lots and allows Pulmonetic Systems to maintain comprehensive service history records.

Complete a Service Record form for all types of service, including part replacement and calibration. A sample of a Service Record form is shown in *Appendix C - Service Record Form.*

Tools

A list of the tools required to remove and replace various components contained within the LTV® ventilators is located at the beginning of the removal/replacement instructions for each of the particular components to be serviced. For a complete list of tools required to perform all Maintenance and Calibration processes or Component Removal and Replacement procedures, see *Appendix E - Reference Information.*

Calling for Assistance

If a problem occurs while maintaining the LTV® 1200/1150 ventilator or if you require additional information you can contact a trained technical support representative at:

Cardinal Health

Pulmonetic Systems

17400 Medina Rd., Suite 100

Minneapolis, Minnesota 55447-1341

Phone:	(763) 398-8500
Office Fax:	(763) 398-8400
Customer Care Center Phone:	(800) 754-1914, ext. 2
Customer Care Center Fax:	(763) 398-8403
Sales/Marketing E-mail:	info@pulmonetic.com
Customer Care Center E-mail:	service@pulmonetic.com
Pulmonetic Systems Website:	http://www.pulmonetic.com

Before removing the back panel

CAUTION

Opening the ventilator - Always turn the ventilator **OFF** and remove the external power before opening the ventilator case or attempting to service the ventilator.

Anti-static precautions - Always wear a grounded anti-static wrist strap when handling the ventilator with the case open. Electrostatic discharge (ESD) can damage ventilator electronics.

Before replacing the back panel

Several checks must be made before reinstalling the back panel. Follow the guidelines listed under *Back Panel, Reinstallation* in this chapter.

After performing any maintenance

After performing maintenance on the LTV® 1200/1150, the tests detailed in *Chapter 9 - Final Checkout Test* must be run. Some maintenance procedures also require that the LTV® 1200/1150 ventilator be partially or completely recalibrated.

CAUTION

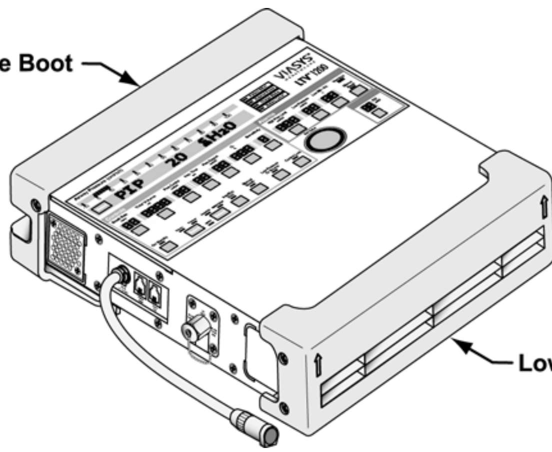
Verification of operation - After opening the ventilator and performing any maintenance, verify proper operation of the ventilator by performing the checks and calibrations recommended in *Chapter 9 - Final Checkout Test.*

Boots, Protective

Rubberized protective boots are installed on the top and bottom of all current versions of LTV® ventilators to protect against accidental shocks and strikes to the casing.

This section is divided into four sub-sections to accommodate the removal, replacement, or installation of the boots under the following conditions:

- **Temporary Removal** (to allow removal of the back panel)
- **Permanent Removal** (for permanent removal of the boots)
- **Reinstallation** (to reinstall boots after ventilator maintenance)
- **New Installation** (to install new boots where they were not previously installed)

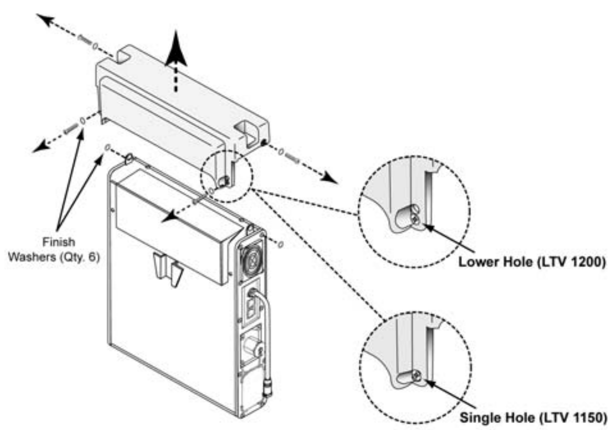


> **WARNING**
>
> **Mounting Screw Use** – Internal damage to the ventilator may result if the wrong length mounting screws are used when installing or removing external accessories.
>
> **Accessory Mounting Screws** - Refer to the information supplied with the replacement screws kit, P/N 11149, to determine the appropriate screws to use when removing or exchanging external accessories on an LTV® 1200/1150 ventilator.

Parts required for replacement:	Tools required:
• None **Replace if damaged:** • Finish Washers (6) P/N 10191, or 19119-001, or 19119-002[23]	• Phillips screwdriver with torque meter

To temporarily remove the upper protective boot[24]:

1) Carefully support the disconnected ventilator in an upright position on a clean, dry surface.
2) Using a Philips screwdriver, remove the two flat-head mounting screws and finish washers in the legs of the upper boot and the two flat-head mounting screws and finish washers in the sides of the upper boot, as indicated in the illustration.
3) Retain the screws and finish washers for reuse when the upper boot is reinstalled.
4) Remove the upper boot.

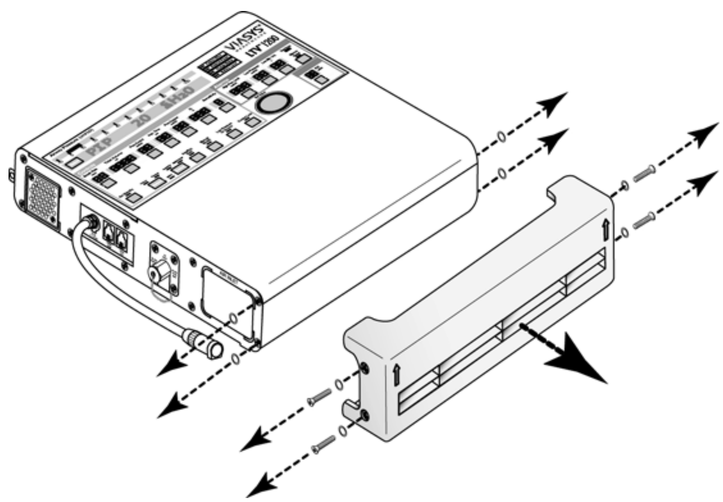


[23] Contained in Pulmonetic Systems Replacement Screws kit, P/N 11149.

[24] *See Appendix E - Reference Information, External Accessories Screw Location, Type and* Length for additional information.

To temporarily remove the Lower Protective Boot[25]:

1) Lay the ventilator down (front up) and use a Philips-head screwdriver to remove the four flat-head mounting screws and finish washers in the sides of the lower boot, as indicated in the illustration below.
2) Retain the screws and finish washers for reuse when the lower boot is reinstalled.
3) Remove the lower boot.



[25] *See Appendix E - Reference Information, External Accessories Screw Location, Type and* Length for additional information.

Parts required for replacement:	Tools required:
• Replacement Screws Kit, 11149 **Replace if damaged:** • Finish Washers (6) P/N 10191, or 19119-001, or 19119-002[26]	• Phillips screwdriver with torque meter

To permanently remove the Upper Protective Boot[27]:

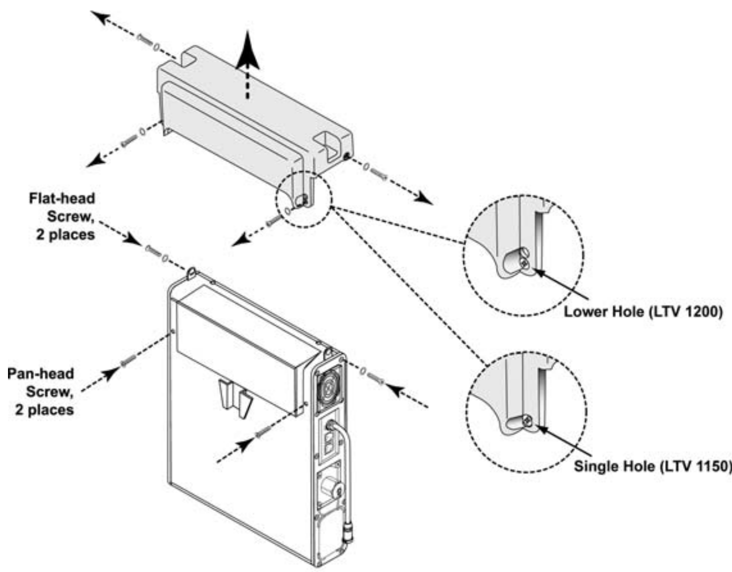
1) Carefully support the disconnected ventilator in an upright position on a clean, dry surface.
2) Using a Philips screwdriver, remove the two flat-head mounting screws and finish washers in the legs of the upper boot and the two flat-head mounting screws and finish washers in the sides of the upper boot, as shown in the illustration on the next page.
3) Remove the upper boot and insert and thread two **1/4" pan-head** mounting screws of the correct length into the screw holes in the ventilator's back panel, as shown in the illustration on the next page.

WARNING

Specific boot screw location – Make sure that the correct screw is being used before tightening down. Using a screw of the wrong length in this location can cause the ventilator to malfunction resulting in possible harm to the patient.

[26] Contained in Pulmonetic Systems Replacement Screws kit, P/N 11149.

[27] *See Appendix E - Reference Information, External Accessories Screw Location, Type and* Length for additional information.



4) Insert and thread two **1/4” flat-head mounting screws** with finish washers into the screw holes in the ventilator’s side panels, as shown in the illustration.
   - Finish washers should be already in place.
5) Torque tighten the mounting screws to these specified values
   - Torque tighten the screws **in the back panel** of the ventilator to **60 in-oz** (0.42 Nm)
   - Torque tighten the two screws **in the sides** of the ventilator to **20 in-oz** (0.14 Nm)

CAUTION

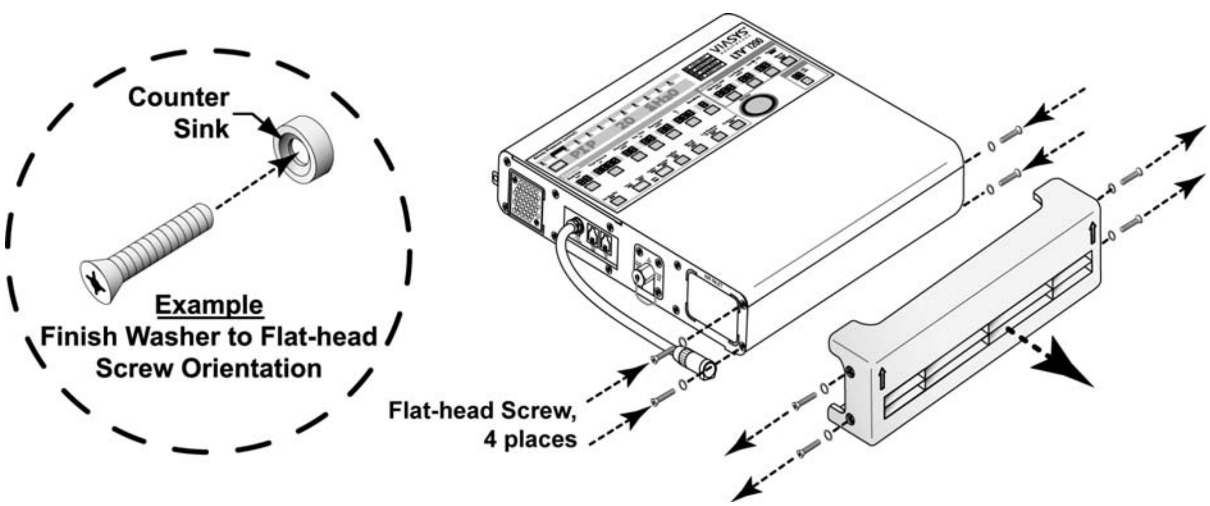
Damage to finish washers -Do not over tighten screws to avoid damage to the finish washers.

To permanently remove the lower protective boot[28]:

1) Lay the ventilator down (front up) and use a Philips-head screwdriver to remove the four flat-head mounting screws and finish washers in the sides of the Lower Protective Boot, as indicated in the illustration below.
2) Remove the lower boot and insert and thread four **1/4” flat-head** mounting screws with finish washers into the screw holes in the ventilator’s side panels, as indicated in the illustration below.
   - Finish washers should be already in place.
3) Torque tighten all four screws to **20 in-oz** (0.14 Nm)

CAUTION

Damage to finish washers -Do not over tighten screws to avoid damage to the finish washers.



[28] *See Appendix E - Reference Information, External Accessories Screw Location, Type and* Length for additional information.

Parts required for replacement:	Tools required:
• Replacement Screws Kit, 11149 **Replace if damaged:** • Finish Washers (6) P/N 10191, or 19119-001, or 19119-002[29]	• Phillips screwdriver with torque meter

To reinstall the Upper Protective Boot[30]:

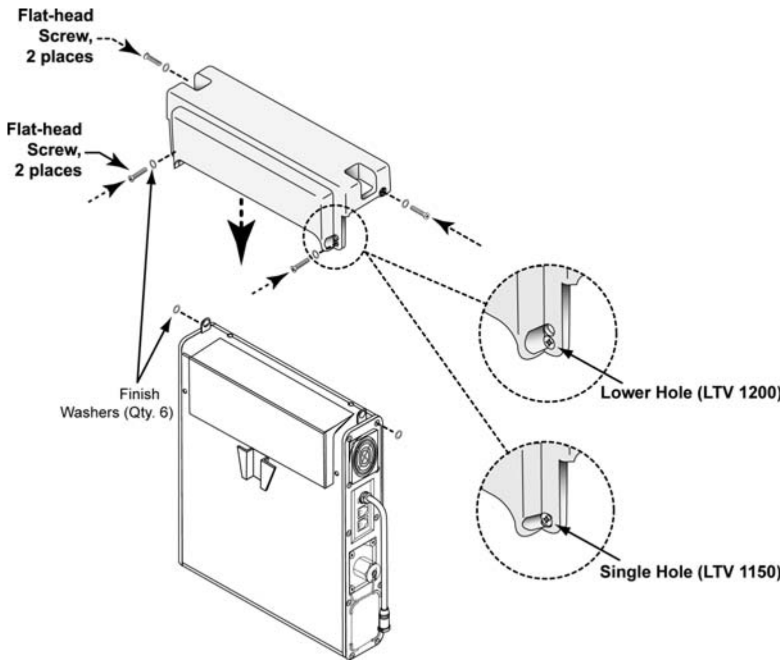
1) Carefully place and support the disconnected ventilator in an upright position on a clean, dry surface.
2) Orient the upper protective boot over the ventilator as shown in the illustration on the next page. Move the boot down into position on the top of the ventilator and align its four screw holes with the corresponding holes in the ventilator back and side panels.
3) Insert and thread two **1/2" 4-40 flat-head** mounting screws with finish washers through the screw holes in the sides of the upper boot, as indicated in the illustration on the next page.
4) Insert and thread two **3/8" flat-head** mounting screws, with finish washers, through the screw holes in the legs of the upper boot, as indicated in the illustration on the next page.

WARNING

Specific boot screw location –Using a screw of the wrong length in this location can cause the ventilator to malfunction resulting in possible harm to the patient.

[29] Contained in Pulmonetic Systems Replacement Screws Kit, P/N 11149

[30] *See Appendix E - Reference Information, External Accessories Screw Location, Type and* Length for additional information.



5) Torque tighten the mounting screws to these specified values.

- Torque tighten the screws **in the legs** of the boot to **60 in-oz** (0.42 Nm)
- Torque tighten the screws **in the sides** of the boot to **20 in-oz** (0.14 Nm)

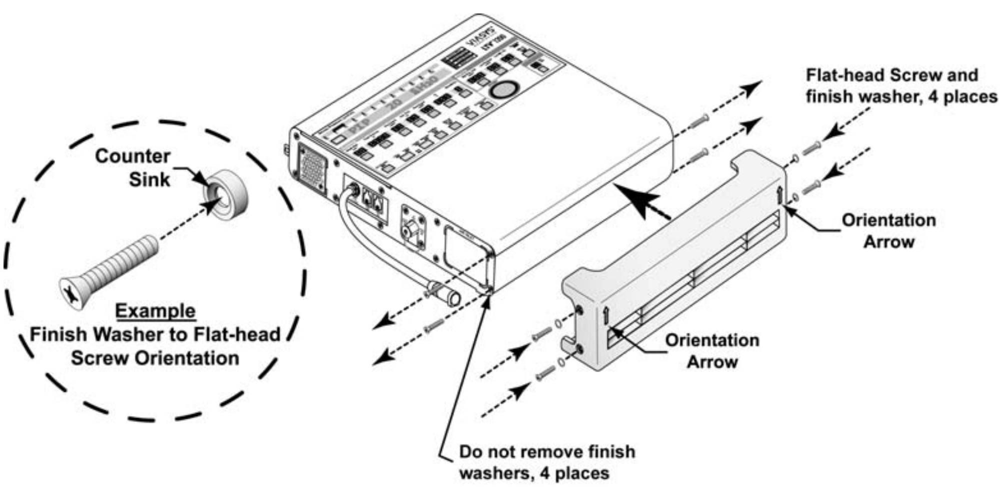
> **CAUTION**
>
> **Damage to finish washers** -Do not over tighten screws to avoid damage to the finish washers.

To reinstall the lower protective boot[31]:

1) Lay the ventilator down (front up) and orient the lower boot to the ventilator as shown in the illustration below.
2) Move the boot into position on the bottom of the ventilator and align its four screw holes with the corresponding holes in the ventilator side panels.
   - Ensure the orientation arrows on the bottom of the boot are aligned "up", as shown below (LTV® 1200 only).
3) Insert and thread four **1/2" 4-40 flat-head mounting screws** with finish washers through the screw holes in the sides of the lower boot; as indicated in the illustration below.
4) Torque tighten all four screws in the boot to **20 in-oz** (0.14 Nm).

CAUTION

Damage to finish washers -Do not over tighten screws to avoid damage to the finish washers.



[31] *See Appendix E - Reference Information, External Accessories Screw Location, Type and* Length for additional information.

Parts Required for Installation:	Tools required:
• **LTV® 1200** Protective Boot, Upper (1) P/N 11421[32] • **LTV® 1200** Protective Boot, Lower (1) P/N 11420[32] • **LTV® 1150** Protective Boot, Upper (1) P/N 19033-001 • **LTV® 1150** Protective Boot, Lower (1) P/N 19032-001 • Replacement Screws Kit, P/N 11149 **Replace if damaged:** • Finish Washers (6) P/N 10191, or 19119-001, or 19119-002[33]	• Phillips screwdriver with torque meter

To install the Upper Protective Boot[34]:

1) Carefully support the disconnected ventilator in an upright position on a clean, dry surface.
2) Using a Phillips-head screwdriver, remove the two upper back panel pan-head and two side panel flat-head mounting screws indicated in the illustration on the next page.
   - Do not remove the mating finish washers.
3) Orient the upper boot over the ventilator as shown in the illustration on the next page. Move the boot down into position on the top of the ventilator and align its four screw holes with the corresponding holes in the ventilator back and side panels.
4) Insert and thread two **1/2" flat-head mounting screws** with finish washers through the screw holes in the sides of the upper boot, as indicated in the illustration on the next page.
5) Insert and thread two **3/8" flat-head mounting screws** with finish washers, through the screw holes in the legs of the upper boot, as indicated in the illustration on the next page.

WARNING

Specific boot screw location – Make sure that the correct screw is used before tightening down. Using a screw of the wrong length in this location can cause the ventilator to malfunction resulting in possible harm to the patient.

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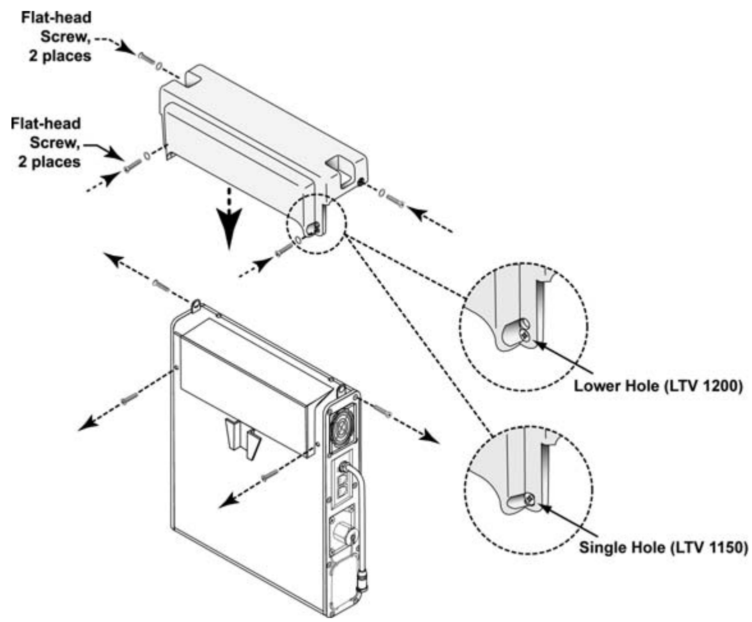
[32] Contained in Pulmonetic Systems Protective Boots Installation Kit, P/N 11550

[33] Contained in Pulmonetic Systems Replacement Screws kit, P/N 11149.

[34] *See Appendix E - Reference Information, External Accessories Screw Location, Type and* Length for additional information.



6) Torque tighten the mounting screws to these specified values

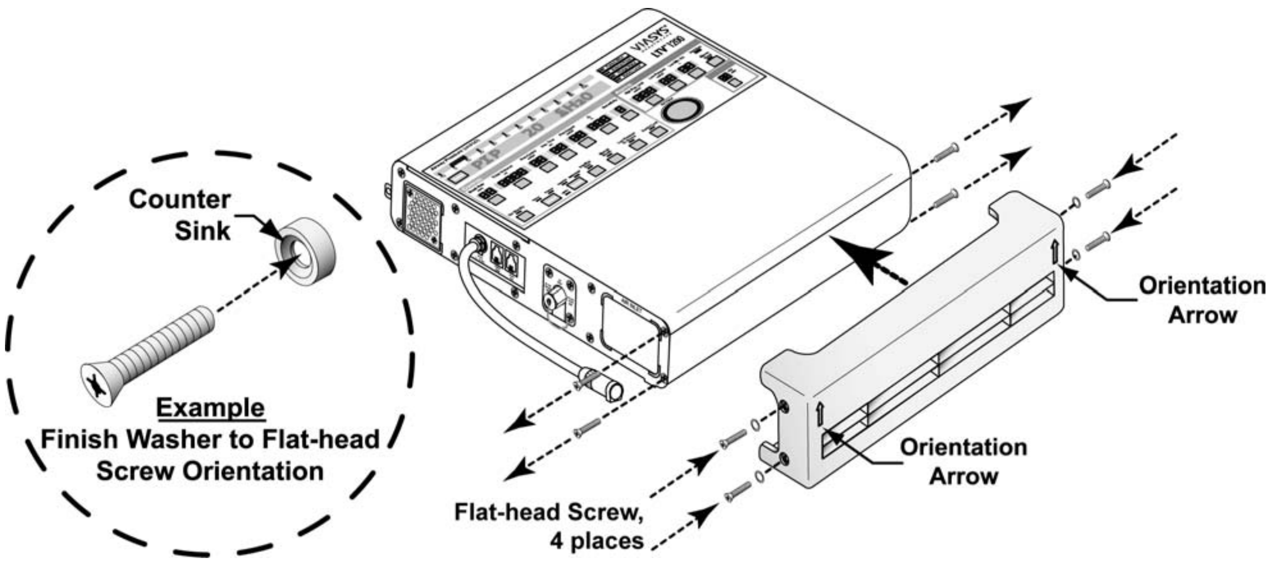
- Torque tighten the screws **in the legs** of the boot to **60 in-oz** (0.42 Nm)
- Torque tighten the screws **in the sides** of the boot to **20 in-oz** (0.14 Nm)

CAUTION

Damage to finish washers -Do not over tighten screws to avoid damage to the finish washers.

To install the lower protective boot[35]:

1) Lay the ventilator down (front up) and use a Philips-head screwdriver to remove the four flat-head mounting screws in the ventilator's side panels, as indicated in the illustration below.
   - Do not remove the mating finish washers.
2) Orient the lower boot to the ventilator as shown in the illustration below. Move the boot into position on the bottom of the ventilator and align its four screw holes with the corresponding holes in the ventilator side panels.
   - Ensure the orientation arrows on the bottom of the boot are aligned "up", as shown below.
3) Insert and lightly thread four **1/2" flat-head mounting screws** with finish washers through the screw holes in the sides of the lower boot; as indicated in the illustration below.
4) Torque tighten all four screws in the boot to **20 in-oz** (0.14 Nm).



CAUTION

Damage to finish washers - Do not over tighten screws to avoid damage to the finish washers.

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35 *See Appendix E - Reference Information, External Accessories Screw Location, Type and* Length for additional information.

Parts Required for Installation:	Tools required:
Components The current LTM™ to LTV® mounting assembly, p/n 17916-001, which contains: • LTM™ to LTV® mounting bracket (1), p/n 17918-001 • LTM™ to LTV® mounting block (1), p/n 17917-001 • LTV® external accessories screw kit (1), p/n 11149 • #4-40 X 3/8" pan-head mounting screws (5), p/n 10879 • #4-40 X 5/16" pan-head mounting screw (1), p/n 11356 (not needed for the LTV® 1200/1150) • Instruction sheet, LTM™ to LTV® mounting bracket (1), p/n 18081-001	• Phillips screwdriver with torque meter • 7/64" Allen wrench

In order to accommodate an LTM™ Graphics Monitor, an LTM/ LTV® mounting assembly must be attached to the LTV®1200/1150 ventilator.

To access internal components of the LTV® ventilator for service, the mounting bracket must be removed.

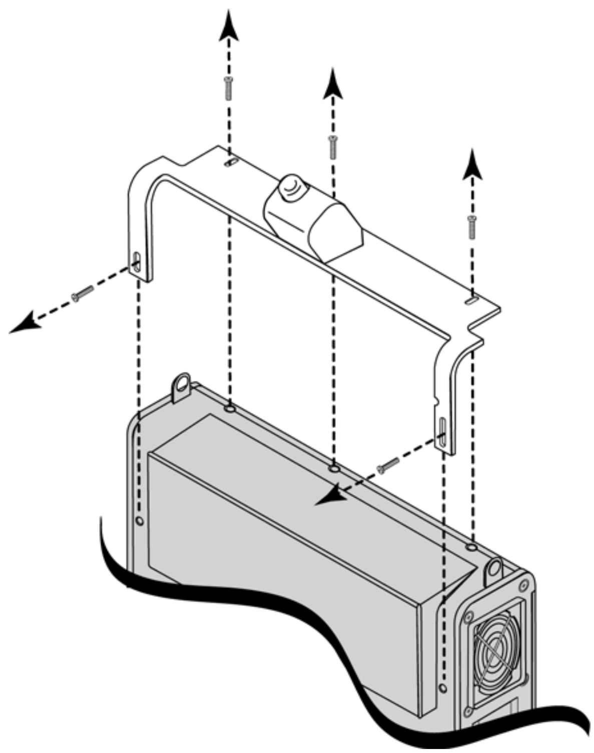
This section is divided into four sub-sections to accommodate the removal, replacement, or installation of the LTM/ LTV® mounting bracket under the following conditions:

- **Temporary Removal** (to allow removal of the back panel for access)
- **Permanent Removal** (to permanently remove the bracket)
- **Reinstallation** (to replace bracket after ventilator maintenance)
- **Installation** (if a mounting assembly was not previously installed)

Temporary removal (current model LTM)

Parts required for replacement:	Tools required:
• None	• Phillips screwdriver with torque meter

1) Use a small Philips screwdriver and remove the five back panel mounting screws and the LTM mounting assembly, as shown. Retain the screws for reuse when the mounting assembly is reinstalled.

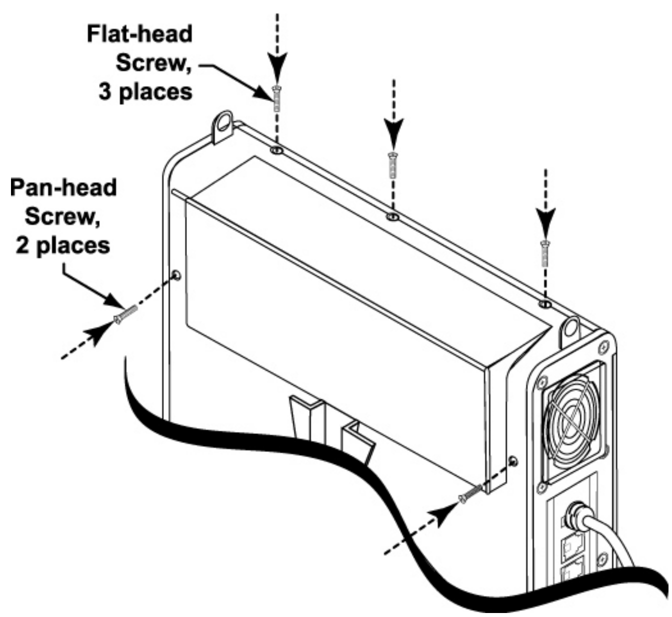


LTM mounting assembly permanent removal (current LTM)

Parts required for replacement:	Tools required:
• Replacement Screws Kit, P/N 11149	• Phillips screwdriver with torque meter

1) Remove the LTM/ LTV® mounting assembly (see instructions on *page 8-17)*.
2) Insert five 1/4” back panel replacement mounting screws (from the replacement screws kit, P/N 11149) and torque tighten to **60 in-oz** (0.42 Nm).
3) You may need to apply some pressure to the back panel and housing to correctly align the threads and insert the screws.

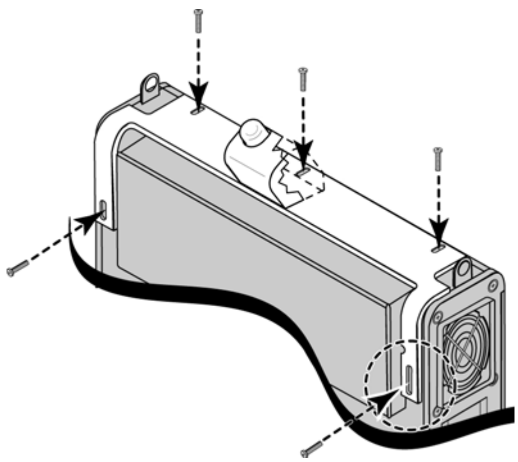
> **WARNING**
>
> **Mounting Screw Use** – Internal damage to the ventilator with resulting harm to the patient. may result if the wrong length mounting screws are used when installing or removing external accessories.



LTM mounting assembly re-installation (current LTM)

Parts required for replacement:	Tools required:
• Replacement Screws Kit, P/N 11149	• Phillips screwdriver with torque meter

1) Position the ventilator and mounting assembly as shown in the illustration below.
2) Place the mounting assembly onto the ventilator and align the screw slots with the corresponding screw holes in the ventilator.



3) Insert and thread five #4-40 X 3/8” pan-head screws (P/N 10879) through the screw slots in the legs and top of the mounting bracket, as indicated in the illustration.

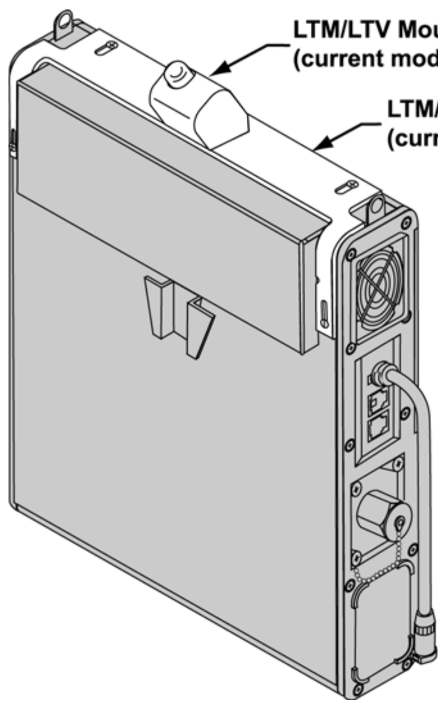
4) Torque tighten all five mounting screws to **60 in-oz** (0.42 Nm). You may need to apply some pressure to the back panel and housing to correctly align the threads and insert the screws.

LTM mounting assembly new installation (current LTM)

Remove the upper boot (if installed). See *Boots, Protective* in this chapter for instructions.

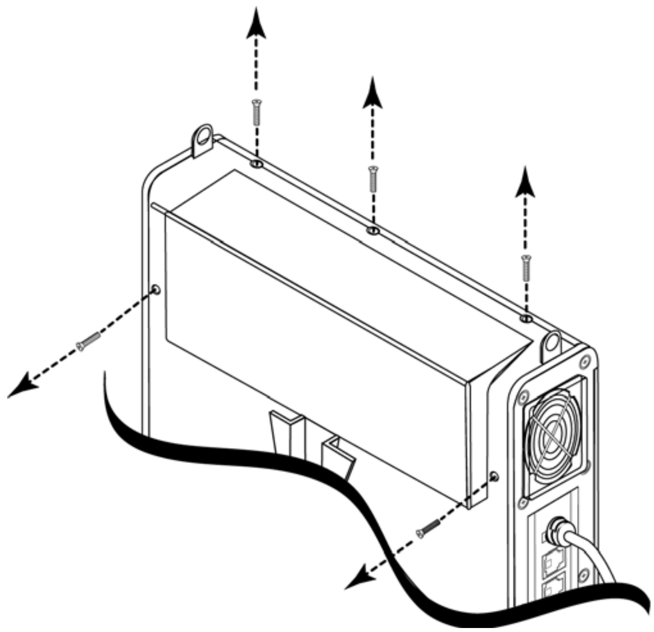
> **WARNING**
>
> **Mounting screw use** – Internal damage to the ventilator may result if the wrong length mounting screws are used when installing or removing external accessories.
>
> **Accessory mounting screws -** Refer to the information supplied with replacement screws kit, P/N 11149, to determine the appropriate accessory mounting screws or accessory replacement screws to use when removing or exchanging external accessories on an LTV® 1200/1150 ventilator.

The following illustration shows the correct orientation and placement of the LTM mounting assembly when attached to the LTV® ventilator.

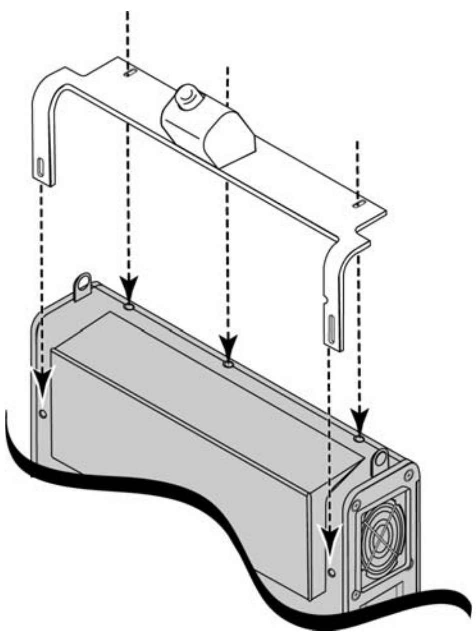


To attach the LTM mounting assembly (p/n 17916-001):

1) Place the disconnected ventilator on a clean, dry surface.
2) Use a Philips screwdriver and remove the five screws from the top and back panel of the ventilator, as indicated in the illustration.



3) Position the ventilator and mounting bracket as shown in the illustration.

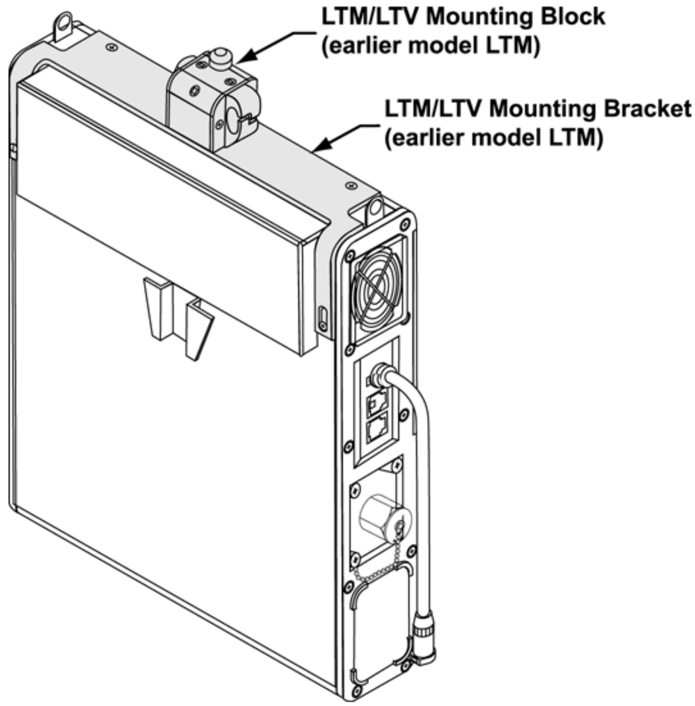


> ⚠ **WARNING**
>
> **Mounting Screw Use** – Internal damage to the ventilator may result if the wrong length mounting screws are used when installing or removing external accessories.

4) Place the mounting bracket onto the ventilator and align the mounting bracket screw slots with the corresponding screw holes in the ventilator.
5) Insert and thread five #4-40 X 3/8" pan-head screws (P/N 10879) through the screw slots in the legs and top of the mounting bracket, as indicated in the illustration.
6) Torque tighten all five mounting screws to **60 in-oz** (0.42 Nm). You may need to apply some pressure to the back panel and housing to correctly align the threads and insert the screws

LTM/LTV® mounting bracket (earlier model LTM)

Earlier model LTM Graphics Monitors require a two piece mounting assembly as shown below.

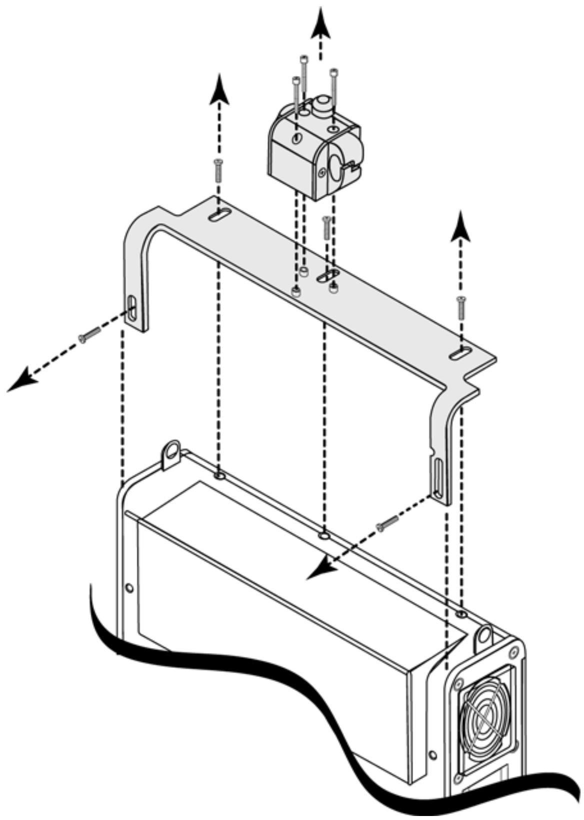


> **WARNING**
>
> **Mounting screw use** – Internal damage to the ventilator may result if the wrong length mounting screws are used when installing or removing external accessories.
>
> **Accessory mounting screws** - Refer to the information supplied with the replacement screws kit, P/N 11149, to determine the appropriate accessory mounting screws or accessory replacement screws to use when removing or exchanging external accessories on an LTV® 1200/1150 ventilator.

Parts required for replacement:	Tools required:
• None	• Phillips screwdriver with torque meter • 7/64” Allen wrench

To temporarily remove the LTM/LTV mounting bracket:

1) Lay the disconnected ventilator on a clean dry surface. Use a 7/64” Allen wrench to remove the three mounting block screws and mounting block, as shown below.
   - Retain the screws for reuse when the mounting block is reinstalled.



2) Use a small Philips screwdriver and remove the five ventilator back panel mounting screws and LTM/ LTV® mounting bracket, as shown. Retain the screws for reuse when the Mounting bracket is reinstalled.

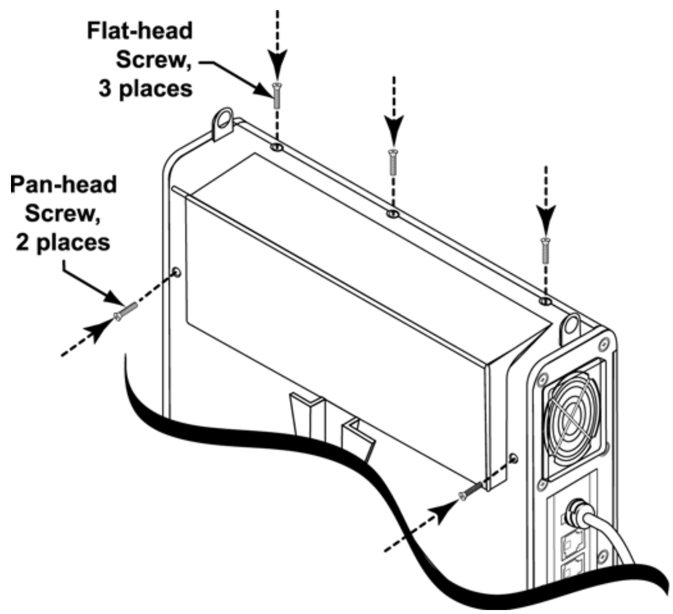
Parts required for replacement:	**Tools required:**
• Replacement Screws Kit, P/N 11149	• Phillips screwdriver with torque meter

To permanently remove the LTM/LTV® mounting bracket:

1) Remove the LTM/ LTV® mounting block and bracket (see instructions on *page 8-23*).
2) Insert five 1/4” back panel replacement screws (from the replacement screws kit, P/N 11149) and torque tighten to **60 in-oz** (0.42 Nm).
3) You may need to apply some pressure to the back panel and housing to correctly align the threads and insert the screws.

WARNING

Specific bracket replacement screw location –Use of incorrect length screws can cause ventilator failure with resulting harm to the patient.



Parts required for replacement:	**Tools required:**
• Replacement Screws Kit, P/N 11149 **Replace if damaged:** • LTM/ LTV® mounting bracket, P/N 11125 • LTM/ LTV® mounting Block, P/N 11146	• Phillips screwdriver with torque meter • 7/64” Allen wrench

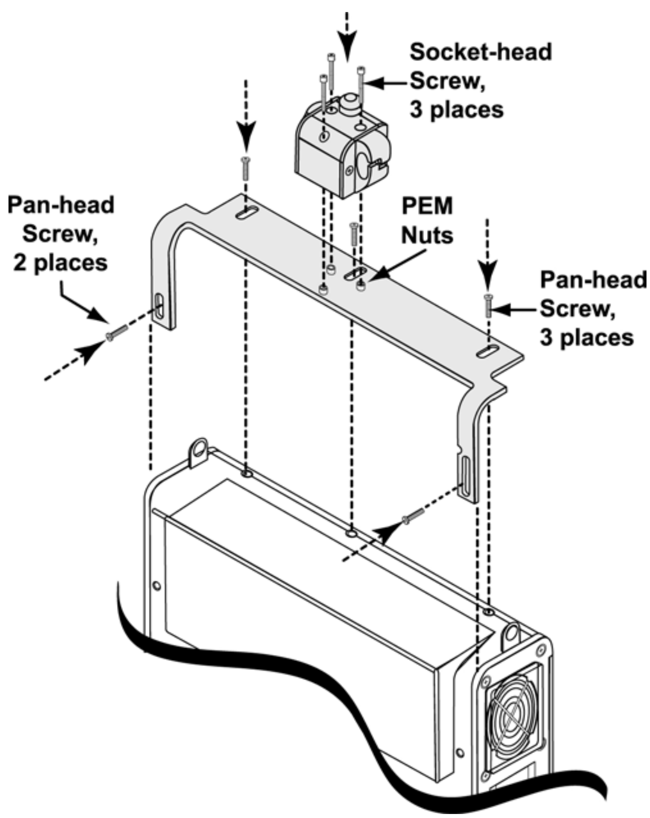
To reinstall the LTM/LTV® mounting bracket:

1) Orient the ventilator and mounting bracket as shown. Position the bracket on the ventilator and align its screw slots with the screw holes in the ventilator back panel.
2) Insert five #4-40, 3/8” ventilator back panel mounting screws (P/N 10879) and torque tighten to **60 in-oz** (0.42 Nm). You may need to apply some pressure to the back panel and housing to correctly align the threads and insert the screws.

WARNING

Screw location –Use of incorrect screws can cause ventilator failure and harm to the patient.

3) Orient the mounting block to the mounting bracket as shown. Align its three counter bored screw holes to the corresponding PEM® nuts on the bracket.
4) Insert three mounting block screws, use a 7/64” Allen-wrench and torque tighten to **60 in-oz** (0.42 Nm).

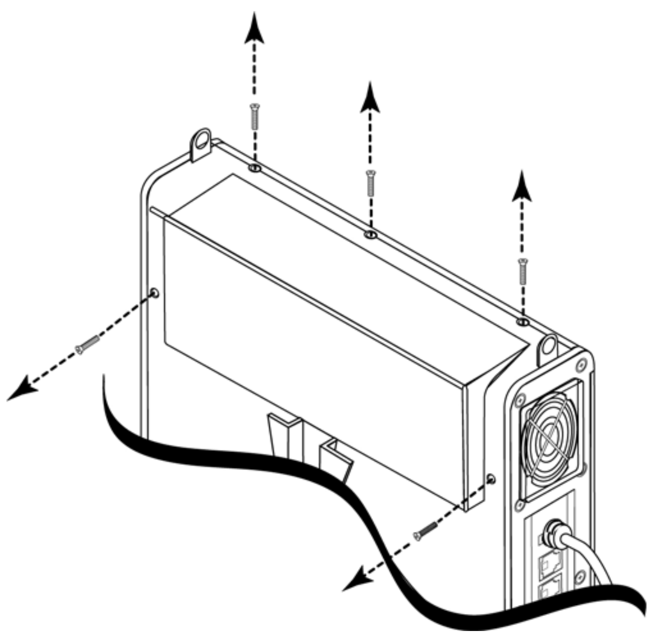


Parts Required for Installation:	Tools required:
• LTM/ LTV® mounting block (1), P/N 11146[36] • LTM/ LTV® mounting bracket (1), P/N 11125[36] • Replacement screws kit, P/N 11149	• Phillips screwdriver with torque meter • 7/64" Allen wrench

To install the LTM/LTV® mounting bracket[37]:

If LTV® protective boots are installed on the ventilator, the upper boot must be removed in order to mount the LTM/ LTV® mounting bracket. See *page 8-7* for instructions.

1) Lay the disconnected ventilator on a clean dry surface, use a Philips screwdriver and remove the five back panel mounting screws, as shown in the illustration below.



2) Orient the ventilator and mounting bracket as shown in the illustration on the next page, position the bracket on the ventilator and align its screw slots with the corresponding screw holes in the ventilator back panel.

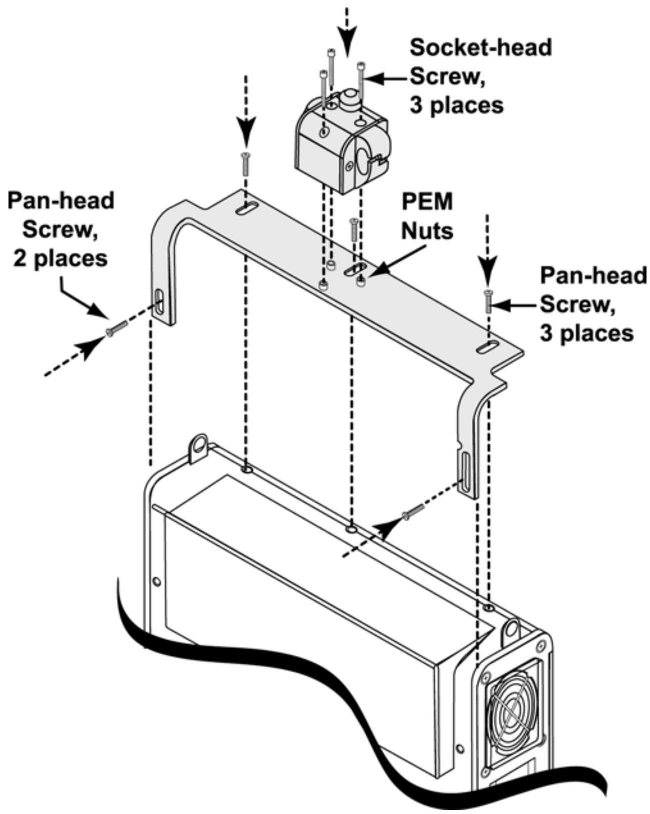
[36] Contained in Pulmonetic Systems LTM to LTV® Mount Assembly Kit, P/N 11003.

[37] *See Appendix E - Reference Information, External Accessories Screw Location, Type and* Length for additional information.

WARNING

Bracket screw location –Use of incorrect screws can cause ventilator failure with resulting harm to the patient.

3) Insert five #4-40 3/8” back panel mounting screws (P/N 10879) and torque tighten to **60 in-oz** (0.42 Nm). You may need to apply some pressure to the back panel and housing to correctly align the threads and insert the screws.

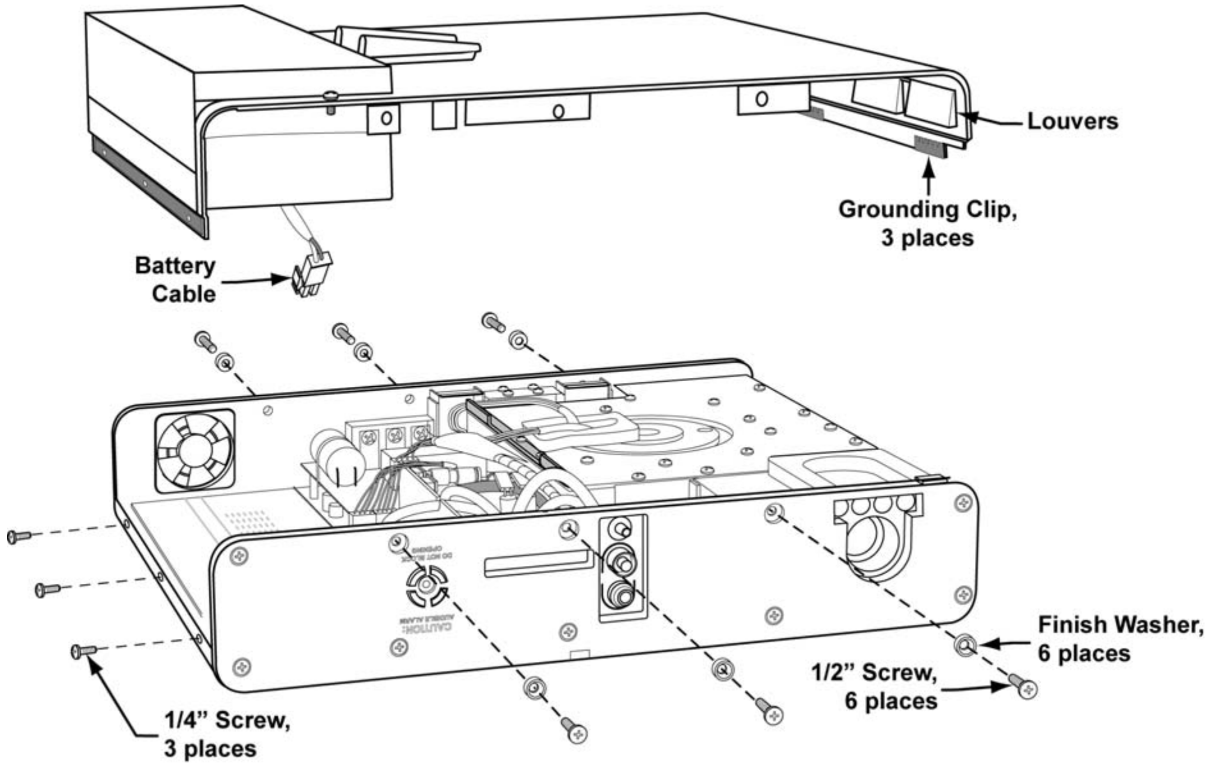


4) Orient the mounting block to the mounting bracket as shown in the illustration, and align its three counter bored holes to the corresponding PEM® nuts on the bracket.
5) Insert three mounting block screws, use a 7/64” Allen-wrench and torque tighten to **60 in-oz** (0.42 Nm).

Back Panel

Back Panel, Removal

1) If installed, remove the LTV® protective boots (see instructions on *page 8-5*) and the LTM/ LTV® mounting bracket (see instructions on *page 8-23*).
2) Turn the ventilator face down. Remove the 6 flat-head screws and gray finish washers from the right and left sides of the ventilator as shown (3 from each side).
3) Remove the 3 flat-head screws from the top of the ventilator as shown.



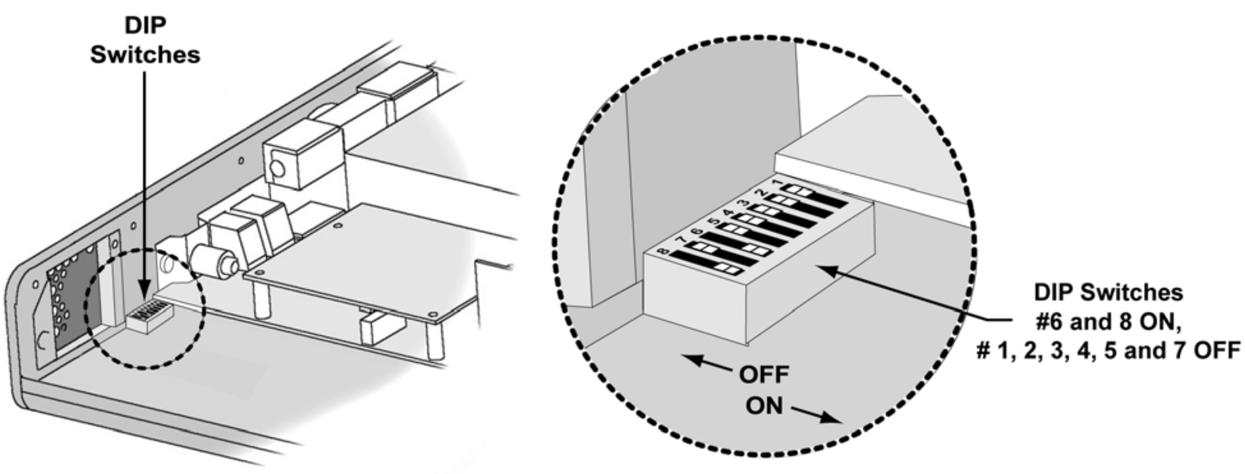
4) Lift the back panel off by separating the back panel at the top edge, pulling up gently and sliding the bottom edge out from under the connecting upper-Weldment edge at the bottom of the case. Remove the back panel carefully so the long tab extending to the oxygen blender is not bent or damaged.
5) Turn the back panel on edge and set it beside the ventilator (the battery cable connecting the back to the power board is still attached.)
6) To completely free the back panel, disconnect the internal battery cable from the power board.

Parts required for replacement:	Tools required:
Replace if damaged: • 1/4" Flat head Screw (3) P/N 10430 • 1/2" Flat head Screw (6) P/N 10338 • Finish Washer (6) P/N 10191, or 19119-001, or 19119-002 • Grounding Clips (3) P/N 10752 • Thermo Conductive Pad P/N 11441 • Conductive Silicon Gasket P/N 10882 • Loctite 4541 Adhesive P/N 10773 • Back Panel P/N 18536-001[38]	• Phillips screwdriver with torque meter • Grounded anti-static wrist strap • O_2 Sampling Tube, P/N 10544[39]

NOTE

If you have not performed the calibrations shown in Chapter 6 you will need to measure the turbine speed as shown on *page 6-21* before replacing the back panel. This is required in order to complete the Final Checkout tests in Chapter 9.

1) Before replacing the back panel, verify that any DIP switch settings have been restored to their correct positions as shown below.



2) Turn the ventilator face down.
3) Check the serial number on the back of the ventilator to ensure it matches the number found on the inside of the ventilator near the fan assembly. If the serial numbers do not match, locate the correct back panel for the ventilator before continuing.

---

38 Contact Pulmonetic Systems for back panel replacement information and proper labeling information.
39 O_2 Sampling Tube, P/N 10544, ~10.0" long, 0.125" O.D. X 0.079 I.D. clear polycarbonate tubing.

4) Verify the thermo conductive pad is applied to the inside of the back panel. If it is not, apply one. See instructions on *page 8-129* to install.

5) Visually inspect all flexible tubes to verify there are no tears, rips, pinholes or loose connections.

6) Verify that the loop of tubing connecting the Flow Differential transducer to the solenoid manifold does not loop past the edge of the power PCBA.

7) Verify that no tubing is kinked or twisted, and that it will not be pinched when compressed by the back panel. Refer to the routing instructions, tables and diagrams beginning on *page 8-33* to check the tubing routing. **Always check ALL tube routing for kinks or compression that might result in restricted flows prior to closing the ventilator.**

8) Inspect the grounding clips on the back panel and replace if they are missing or not making good connections. Missing or damaged grounding clips should be replaced using Loctite 4541 Adhesive.

9) Verify the grounding clips connected to the oxygen blender are aligned correctly inside the housing (clips should not be visible when screws are tightened down). (LTV® 1200 only) See *O2 Blender Assembly* in Chapter 8.

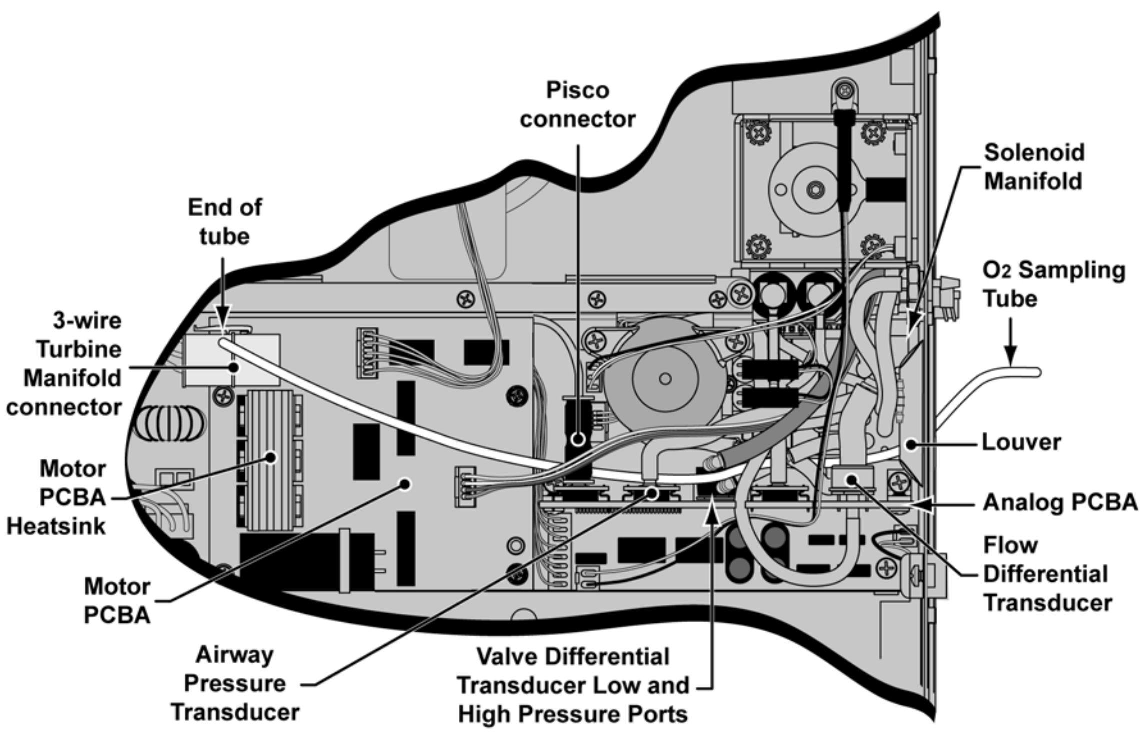
10) Verify the power cable for the oxygen blender is properly routed under the motor board, behind the connection bus to the power board (LTV® 1200 only).

11) Verify that the power cables for the turbine, sounder, fan Assembly, oxygen blender, flow valve and solenoid manifold jumper cable are securely attached and not pinched, interfering, or in a position to be pinched against the back panel.

NOTE

An O_2 Sampling Tube[40] used for testing internal oxygen enrichment (oxygen leakage) during General Checkout testing, must be installed before replacing the ventilator's back panel. See *General Checkout* in Chapter 9 – Final Checkout Test for test requirements.

12) Route an O_2 Sampling Tube as shown in the illustration;
    - through the louver in the side panel,
    - between the Solenoid Manifold and the Analog PCBA,
    - under the Flow Differential Transducer,
    - over the tube attached to Solenoid Manifold port # 9 (side port),
    - between the Valve Differential Transducer low and high pressure ports,
    - under the Airway Pressure Transducer port,
    - under the Pisco connector,
    - over the Motor PCBA,
    - beside the Motor PCBA Heatsink and,
    - on top of the 3-wire Turbine Manifold connector



[40] O_2 Sampling Tube, P/N 10544, ~10.0" long, 0.125" O.D. X 0.079 I.D. clear polycarbonate tubing.

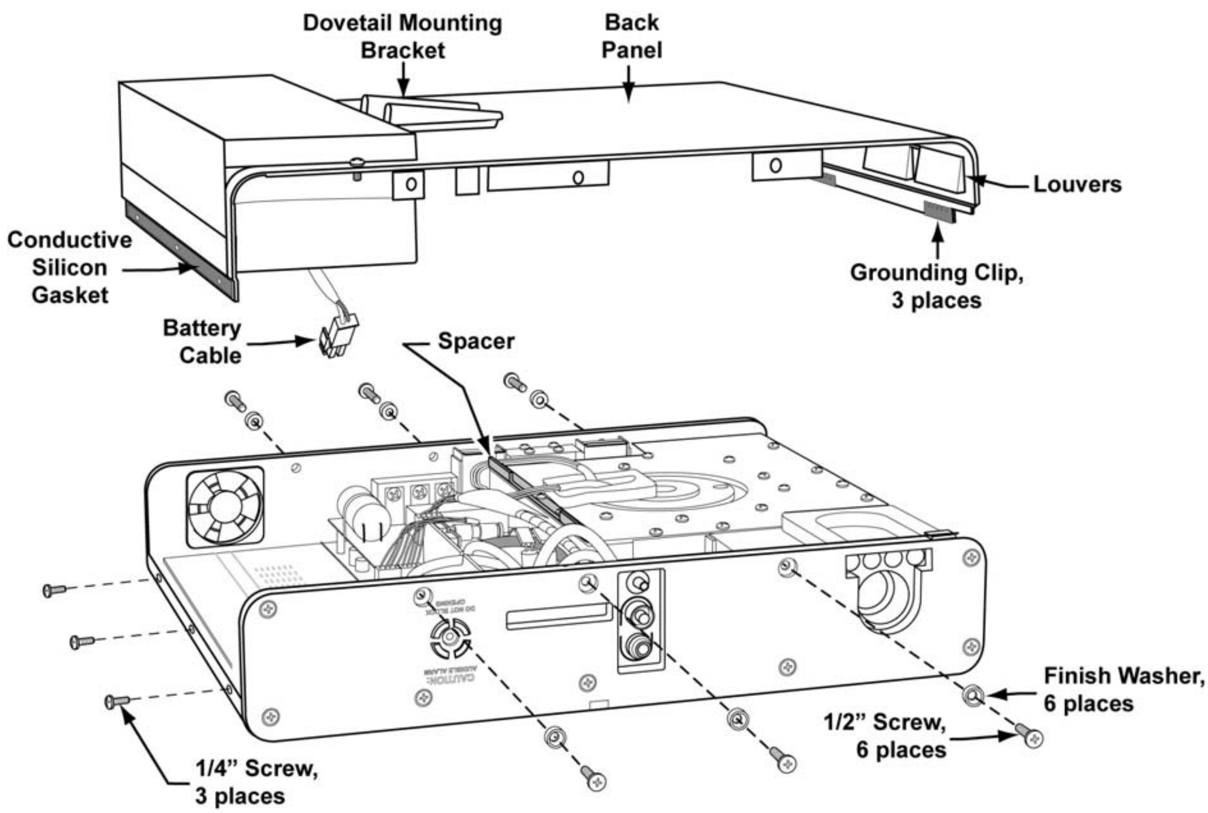
13) Inspect the conductive silicon gasket located on the outside surface of the top of the back panel where the three 1/4” screws secure the back panel to the ventilator. If the gasket is damaged or missing, replace it with a new one.

14) If the internal battery cable is disconnected, reconnect the battery cable to the power board. To do so, place the back panel on its side with the battery cable facing down and the battery compartment indexed towards the open area in the top of the ventilator.

15) While supporting the back panel, connect the male 2-wire lead connector from the battery assembly to the 2-wire female connector on the power board. Be sure to correctly orient the keyed latch on the connector. When correctly connected, the connector will snap into place.

16) Position the back panel over the ventilator. Slide the bottom edge of the back panel beneath the connecting upper-Weldment edge at the bottom of the case. Be sure that the louvers in the bottom edge of the back panel are hooked under the bypass tube from the turbine to the flow valve.

17) Align the back panel so the long tab over the oxygen blender lines up correctly. Check that the battery leads are clear of the motor board heat sink and the side of the ventilator. Be careful not to pinch the flexible tubes or the battery leads while sliding the back panel into place.



18) Replace the three 1/4” flat-head screws in the top of the ventilator as shown. Torque to **60 in-oz** (0.42 Nm).

19) Replace the 6 x 1/2” flat-head screws and gray finish washers in the right and left sides of the ventilator as shown (3 in each side). Torque to **20 in-oz** (0.14 Nm).

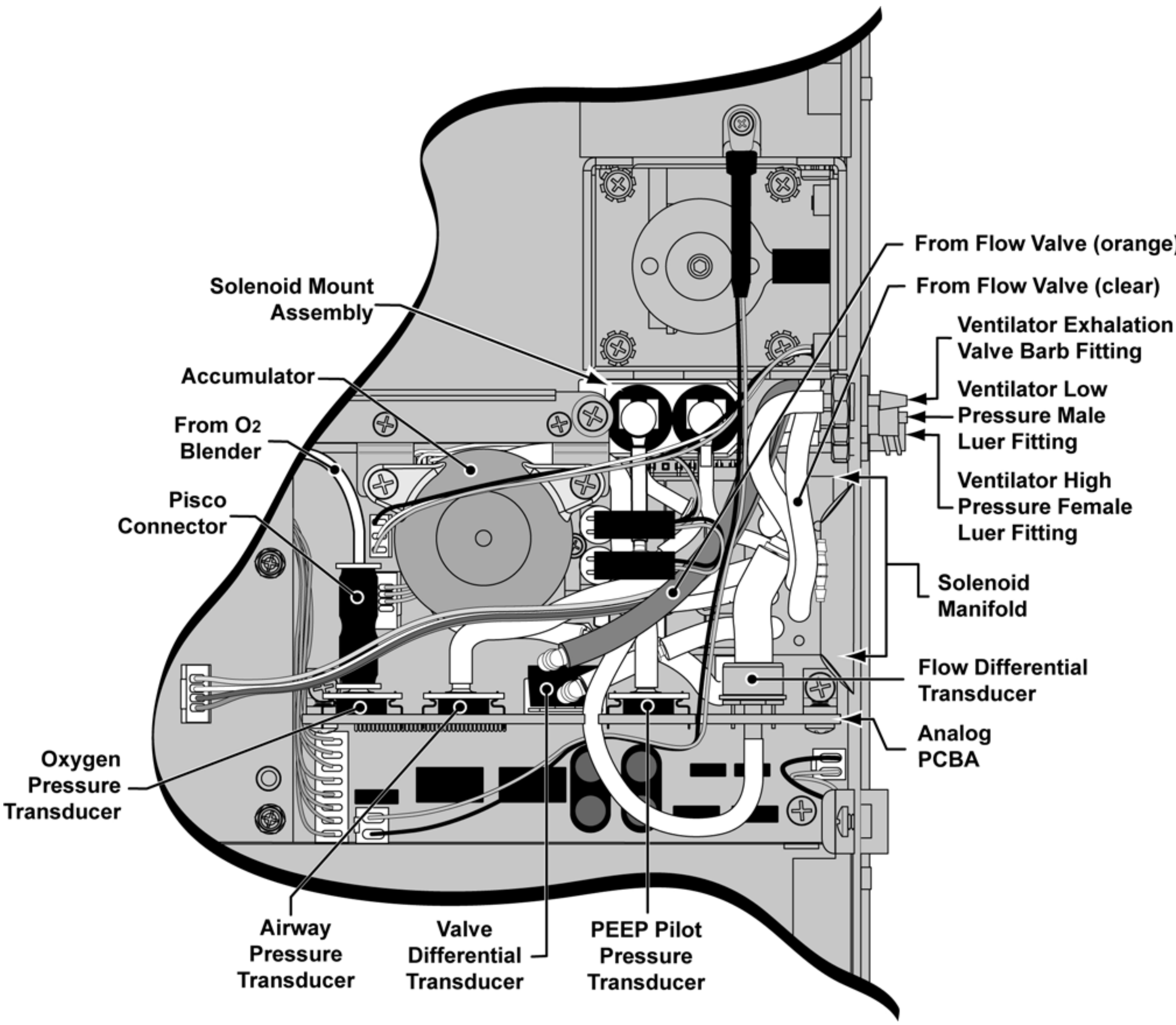
20) If previously installed, replace the LTV® Protective Boots (see instructions on *page 8-10*) and the LTM Mounting bracket (see instructions beginning on *page 8-16*).

Internal Flexible Tubing

Anytime service of internal components is performed on an LTV® ventilator and internal tubing has been removed, it must be reattached as originally configured in order to ensure the proper operation of the ventilator.

Pulmonetic Systems recommends that technicians review and become familiar with the existing tubing configuration ***prior*** to removing individual tubes and strictly adhere to the replacement instructions provided when reattaching them (point to point and layering).

Tubing Overview Diagram



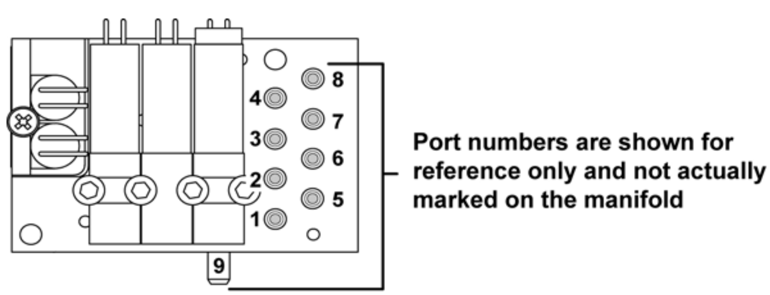
Tubing Table

Tubing P/N	Material /Color	Diameter	Length	Qty	Installed Location
11834	Silicone /Clear	0.188" (0.005m) O.D. 0.094" (0.002m) I.D.	0.62" (± 0.1") 0.016m	2	One between elbow fitting from high pressure port on valve diff. transducer (PT7) & tee fitting ***and***; One between port #7 on solenoid manifold & elbow fitting
			1.10" (± 0.1") 0.028m	1	Between port #1 on solenoid manifold & tee fitting
			1.75" (± 0.1") 0.045m	2	One between port #9 (side port) on solenoid manifold & tee fitting; ***and*** One between port #4 on solenoid manifold & side panel low pressure flow transducer port
			2.06" (± 0.1") 0.052m	1	One between port A on accumulator & tee fitting
			2.40" (± 0.1") 0.061m	2	Between port #8 on solenoid manifold & side panel high pressure flow transducer port; ***and*** One between port #6 on solenoid manifold & side panel exhalation valve fitting
			3.25" (± 0.1") 0.083m	1	Between port #3 on solenoid manifold & airway pressure transducer (PT6)
10458	Silicone /Clear	0.156" (0.004m) O.D. 0.094" (0.002m) I.D.	3.70" (± 0.1") 0.094m	1	Between port B on accumulator & PEEP pilot pressure transducer (PT2)
			4.70" (± 0.1") 0.118m	1	Between port #2 on solenoid manifold & flow diff. transducer (PT4)
10456	Silicone /Clear	0.125" (0.003m) O.D. 0.063" (0.002m) I.D.	0.50" (± 0.1") 0.013m	3	One between tee fitting & bottom leg of wye fitting; ***and*** One between high pressure port on valve diff. transducer (PT7) & elbow fitting; ***and*** One between low pressure port on valve diff. transducer (PT7) & elbow fitting
			0.85" (± 0.1") 0.022m	1	Between plug fitting & bottom pilot-in port.
			1.00" (± 0.1") 0.025m	2	One between wye fitting & middle pilot-in port; ***and*** One between wye fitting & bottom pilot-out port
			1.60" (± 0.1") 0.041m	1	Between tee fitting & top pilot-in port
			1.75" (± 0.1") 0.045m	1	Between middle pilot-out port & tee fitting at side panel exhaust vent slot

Tubing P/N	Material /Color	Diameter	Length	Qty	Installed Location
10626	Silicone /Clear	0.281" (0.007m) O.D. 0.156" (0.004m) I.D.	0.85" (± 0.1") 0.022m	1	Between elbow fitting & flow diff. transducer (PT4)
			10.75" (± 0.1") 0.273m	1	Between elbow fitting on turbine manifold & elbow fitting on flow valve
10544	Polycarb /Clear	0.125" (0.003m) O.D. 0.079" (0.002m) I.D.	7.50" (+0.5" / - 0.0") 0.191m	1	Between O_2 blender & Pisco connector on O_2 pres. transducer (PT5)
10455	Silicone /Clear	0.219" (0.005m) O.D. 0.094" (0.002m) I.D.	5.00" (± .250") 0.152m	1	Between flow valve top nylon fitting & port # 5 on solenoid manifold
10957	Silicone /Orange	0.219" (0.005m) O.D. 0.094" (0.002m) I.D.	5.50" (± .250") 0.140m	1	Between flow valve bottom nylon fitting & elbow fitting from valve diff. transducer (PT7)

Solenoid Manifold Tube Routing Table

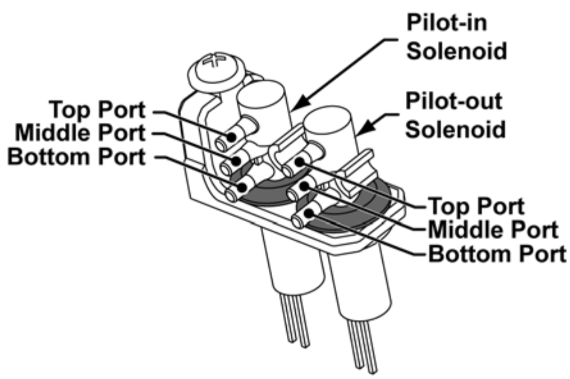
Solenoid Manifold Port Number	Port Tubing Routed	Tubing P/N
#1	Onto the high pressure port on the Valve Differential Transducer (PT7) • through a tee & elbow subassembly	11834
#2	Onto the Flow Differential Transducer (PT4)	10458
#3	Onto the Airway Pressure Transducer (PT6)	11834
#4	Onto the side panel low pressure Flow Transducer port • male Luer fitting on outside of panel	11834
#5	From the Flow Valve (clear tubing)	10455
#6	Onto side panel Exhalation Valve port • barbed fitting on outside of panel	11834
#7	Onto the Flow Differential Transducer • through a tube & elbow subassembly	11834
#8	Onto the side panel high pressure Flow Transducer port • female Luer fitting on outside of panel	11834
#9	Onto Accumulator port A • through a tube & tee subassembly	11834



Solenoid Manifold

Solenoid Mount Tube Routing Table

Solenoid	Port	Port Tubing Routing	Tubing P/N
Pilot-in	Top	Through a filter subassembly onto the tee fitting in a tee & elbow subassembly attached to Solenoid Manifold port # 1	10456
Pilot-in	Middle	Through a wye subassembly onto the tee fitting in a tube & tee subassembly attached to Solenoid Manifold port # 9	10456
Pilot-in	Bottom	Into a plug subassembly	10456
Pilot-out	Top	N/A (nothing attached to this port)	-
Pilot-out	Middle	To a tee fitting positioned next to the louver on the side panel	10456
Pilot-out	Bottom	Through a wye subassembly onto the tee fitting in a tube & tee subassembly attached to Solenoid Manifold port # 9	10456



Solenoid Mount Assembly

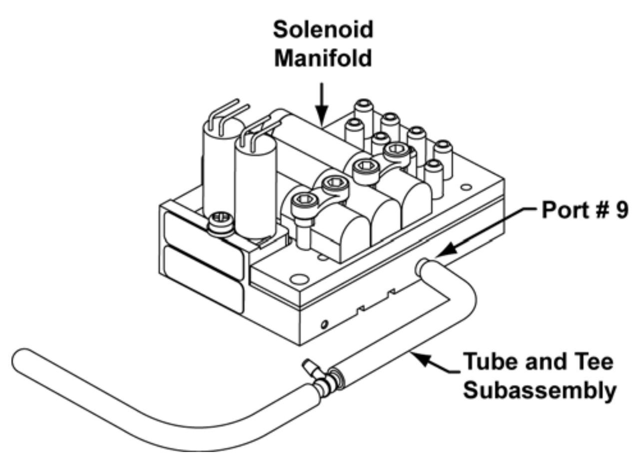
Parts required for replacement:	Tools required:

• None
Replace if damaged:
• Flexible tubing[41]
• Elbow fitting (1) P/N 11592
• Elbow fitting (2) P/N 10958
• Tee fitting (3) P/N 18186-001
• Wye fitting (1) P/N 18185-001
• Plug fitting (1) P/N 18187-001
• Restrictor (1) P/N 18551-022
• Filter (1) P/N 18552-001
• Cable assembly (1) P/N 18530-001
	• Grounded anti-static wrist strap
	• Measuring tool (Calipers, Ruler, etc) 0" thru 11" range
	• Pliers - long round nose, smooth jaws – ESD safe
	• Torque Driver(s) – 20 in-oz thru 120 in-oz range with;
	  • # 1 Phillips Bit
	  • 1/4" Nut Driver

To remove internal flexible tubing:

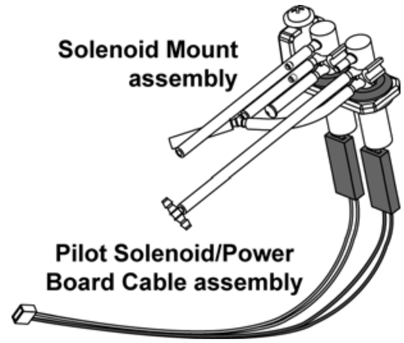
1) Remove the ventilator back panel and disconnect the internal battery cable from the Power PCBA (see instructions on *page 8-28*).
2) Review and become familiar with the existing tubing configuration ***prior*** to removing individual tubes and strictly adhere to the replacement instructions when reattaching them (point to point and layering).
3) Remove only the tubing or components that needs replaced, upgraded, or removed in order to access other components requiring service.
   - all tubing is interference fit onto individual ports, elbows or tees and can be removed by gently twisting the tube and pulling it off.

4) To avoid damaging tubing and expedite replacement;
   - do not remove the Tube and Tee subassembly attached to solenoid manifold port # 9 (side port) until either the Analog PCBA or Solenoid Manifold is removed and then only when necessary to replace individual tubes or components of the subassembly itself



41 See *Tubing Table* in this chapter for detailed descriptions and part numbers of individual flexible tubes.

- the Solenoid Mount (p/n 18607-001) and Pilot Solenoid/Power Board Cable subassemblies (p/n 18530-001) with attached tubing only needs to be disassembled when it is necessary to replace individual tubes or components within the subassemblies themselves



To replace internal flexible tubing:

The LTV® 1200/1150 ventilator contains additional components/tubing and consequently a more complex tube routing configuration than other LTV® model ventilators. Detailed replacement instructions are necessary and are based on the assumption that some or all of the tubing, the Accumulator, Solenoid Mount assembly, Manifold to Back Panel Spacer, and Analog PCBA or Solenoid Manifold has been removed from the ventilator.

Beginning with subassembly construction and initial tube attachment requirements to the Solenoid Manifold and Solenoid Mount assemblies, the instructions are grouped together and sequenced as necessary to accommodate all required tubing point to point connections, routing and layering configurations.

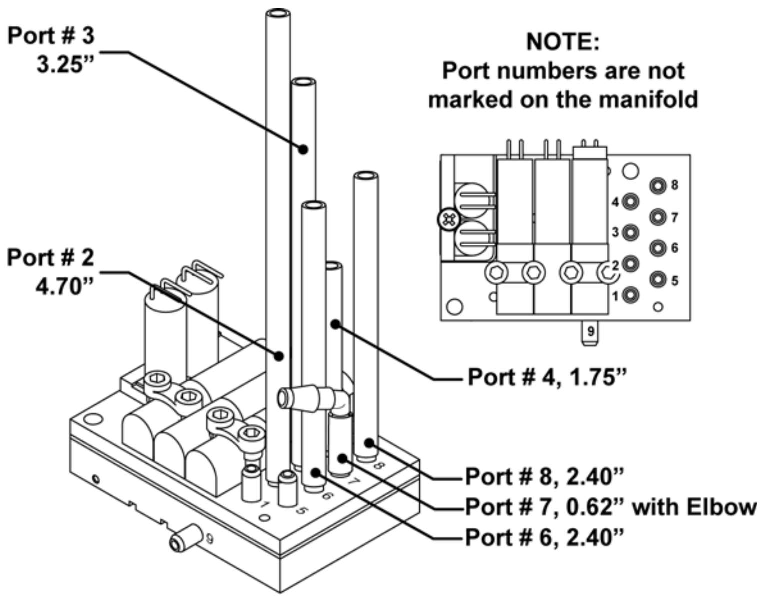
1) Inspect all flexible tubes for excessive wear, tears or cuts and replace if worn or damaged.
   - See *Tubing Table* in this chapter for detailed descriptions and part numbers of individual flexible tubes.
2) Route and reattach or replace the removed tubes (per the following instructions) by gently twisting and pushing the ends of the tubes onto the appropriate ports, elbows or tees.

CAUTION

Final Tubing Check - Anytime internal flexible tubing is removed or replaced, check to ensure <u>all</u> tubes have been correctly routed (point to point and layering), are fully connected on the ports or fittings, and do not have any holes or tears in them. If necessary, gently reposition the tubing to eliminate possible kinks or occlusions.

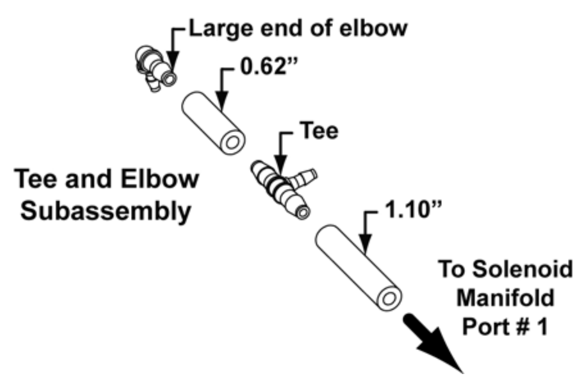
Solenoid Manifold Preparation:

1) Attach tubing to the Solenoid Manifold P/N 18528-001 ports;
    - Port # 2 – 4.70” of tubing P/N 10458
    - Port # 3 – 3.25” of tubing P/N 11834
    - Port # 4 – 1.75” of tubing P/N 11834
    - Port # 6 – 2.40” of tubing P/N 11834
    - Port # 8 – 2.40” of tubing P/N 11834
2) Insert the smaller end (O.D.) of Elbow fitting P/N 11592 into 0.62” of tubing P/N 11834 and attach the tubing to manifold port # 7.

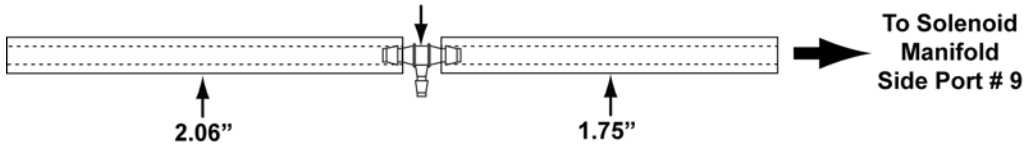


Solenoid Manifold

3) Construct a Tee & Elbow subassembly, as follows;
    - Insert Tee fitting P/N 18186-001 into 1.10” and 0.62” of tubing P/N 11834
    - Insert the larger end (O.D.) of the Elbow fitting P/N 10958 into the open end of the 0.62” of tubing (ensure that the open ends of the elbow and tee fittings are rotated 90° from each other, as shown)



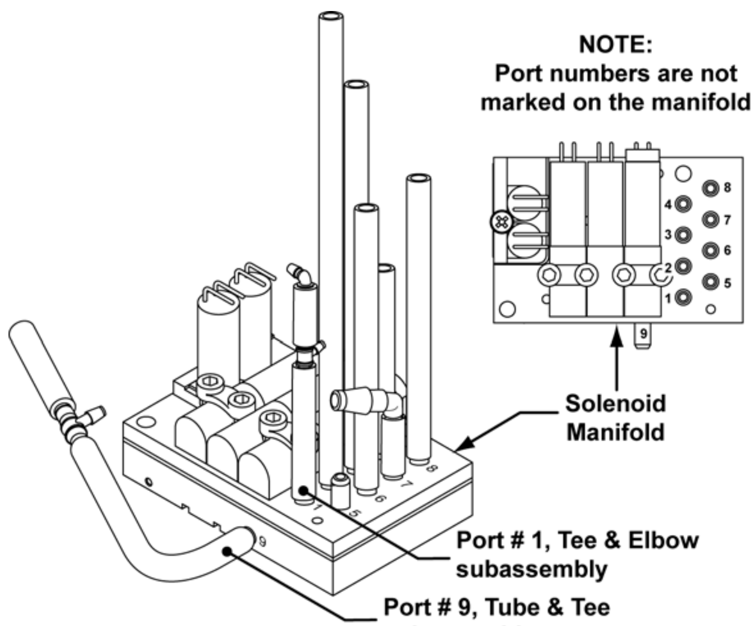
4) Construct a Tube and Tee subassembly, as follows;
   - Insert Tee fitting P/N 18186-001 into 2.06” and 1.75” of tubing P/N 11834
   - Attach the open end of the 1.75” tubing to manifold side port # 9



Tube and Tee Subassembly

5) Attach the Tee & Elbow subassembly to solenoid manifold port # 1, oriented as shown, with;
   - the open end of the tee facing towards the tube on port # 2
   - the open end of the elbow facing towards the Purge Solenoids

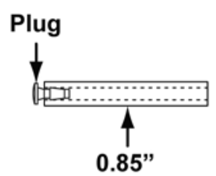
6) Attach the Tube and Tee subassembly to solenoid manifold port # 9, so that the open end of the tee is oriented as shown when the tubing is bowed over as shown.



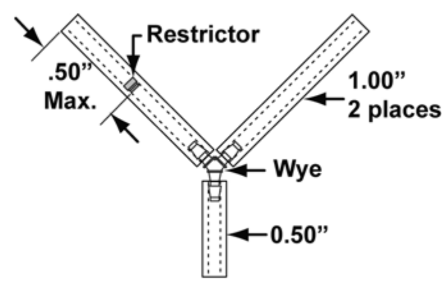
7) As applicable, install the Solenoid Manifold onto the Power PCBA (see instructions on *page 8-119*).

Solenoid Mount Preparation:

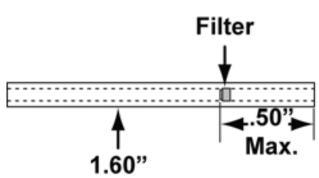
1) Construct a Plug subassembly, as follows:
    - fully insert Plug fitting P/N 18187-001 into 0.85” tubing P/N 10456
2) Construct a Wye subassembly, as follows:
    - attach a 1.00” tubing P/N 10456 to each top end (2) of Wye fitting P/N 18185-001 and a 0.50” tubing P/N 10456 to the bottom end
    - insert Restrictor P/N 18551-022 (red in center) up to a maximum of 0.50” into either one of the top tubes (big end inserted last)
3) Construct a Filter subassembly, as follows:
    - insert Filter P/N 18552-001 (screen in center) up to a maximum of 0.50” into a 1.60” tubing P/N 10456 (tapered end inserted first)
4) Construct a Tee subassembly, as follows:
    - fully insert Tee fitting P/N 18186-001 into 1.75” tubing P/N 10456



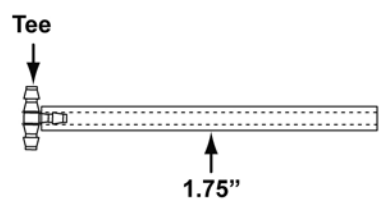
Plug Subassembly



Wye Subassembly

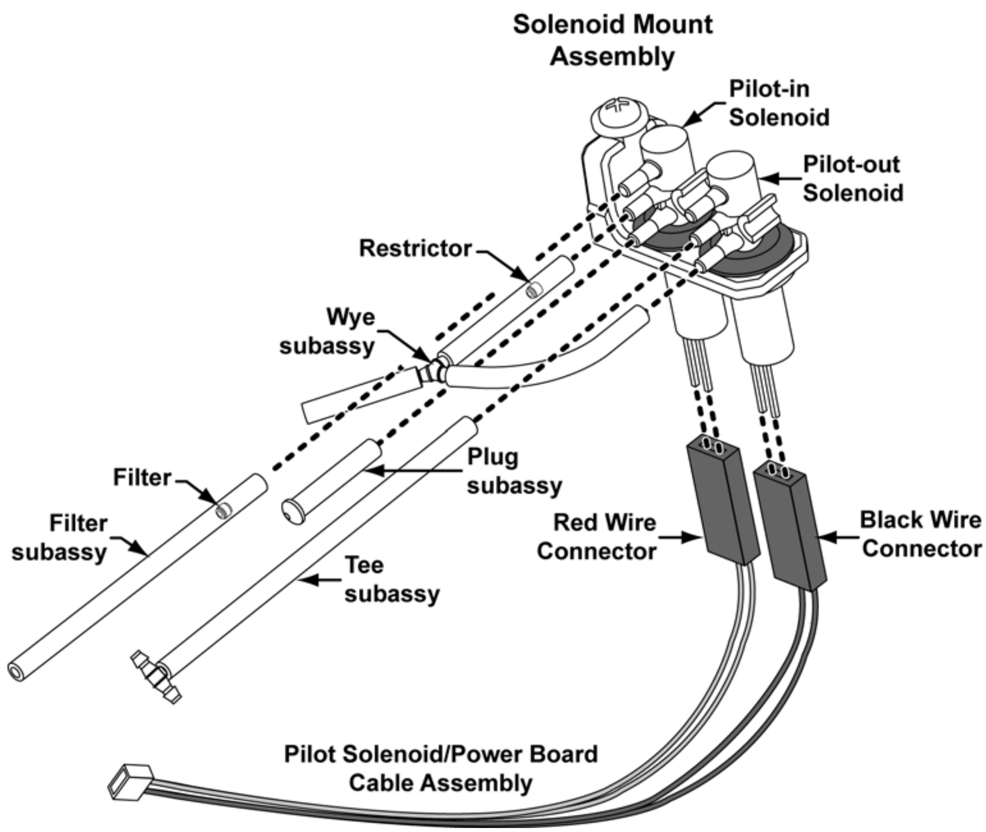


Filter Subassembly



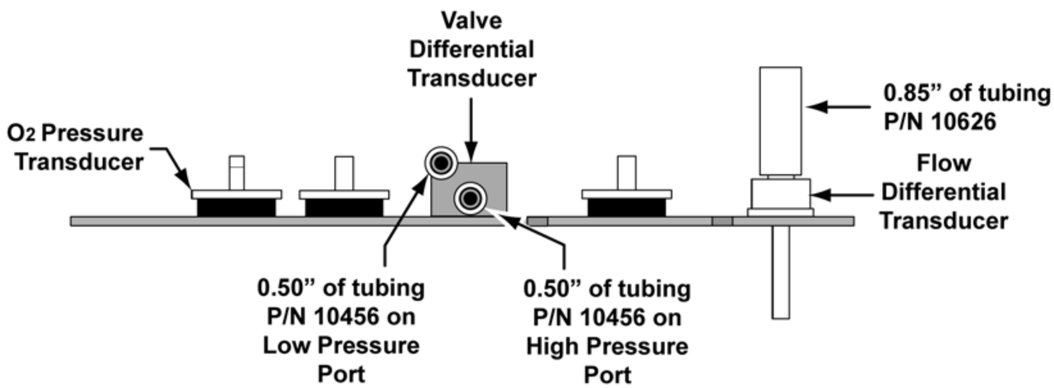
Tee Subassembly

5) Attach subassemblies to the Solenoid Mount assembly, as follows:
   - attach the open end of the Plug subassembly tube to the bottom port of the Pilot-in solenoid on the Solenoid Mount P/N 18607-001
   - attach the end of the Wye subassembly tube with the installed restrictor onto the middle port of the Pilot-in solenoid (restrictor will slide farther into tube during attachment)
   - attach the other top tube of the Wye subassembly onto the bottom port of the Pilot-out solenoid
   - attach the end of the Filter subassembly tube with the filter onto the top port of the Pilot-in solenoid (filter will slide farther into tube during attachment)
   - attach the open end of the Tee subassembly to the middle port of the Pilot-out solenoid
   - attach the Pilot Solenoid/Power Board Cable assembly P/N 18530-001, two red wire connector onto the Pilot-in solenoid leads and the two black wire connector onto the Pilot-out solenoid leads



Analog PCBA Preparation:

1) As applicable, prepare the Analog PCBA P/N 18242-001 for installation, as follows:
    - attach 0.50” of tubing P/N 10456 to the high and low pressure ports (onto at least two-thirds of the height of the fittings) on the Valve Differential Transducer
    - attach 0.85” of tubing P/N 10626 onto the Flow Differential Transducer

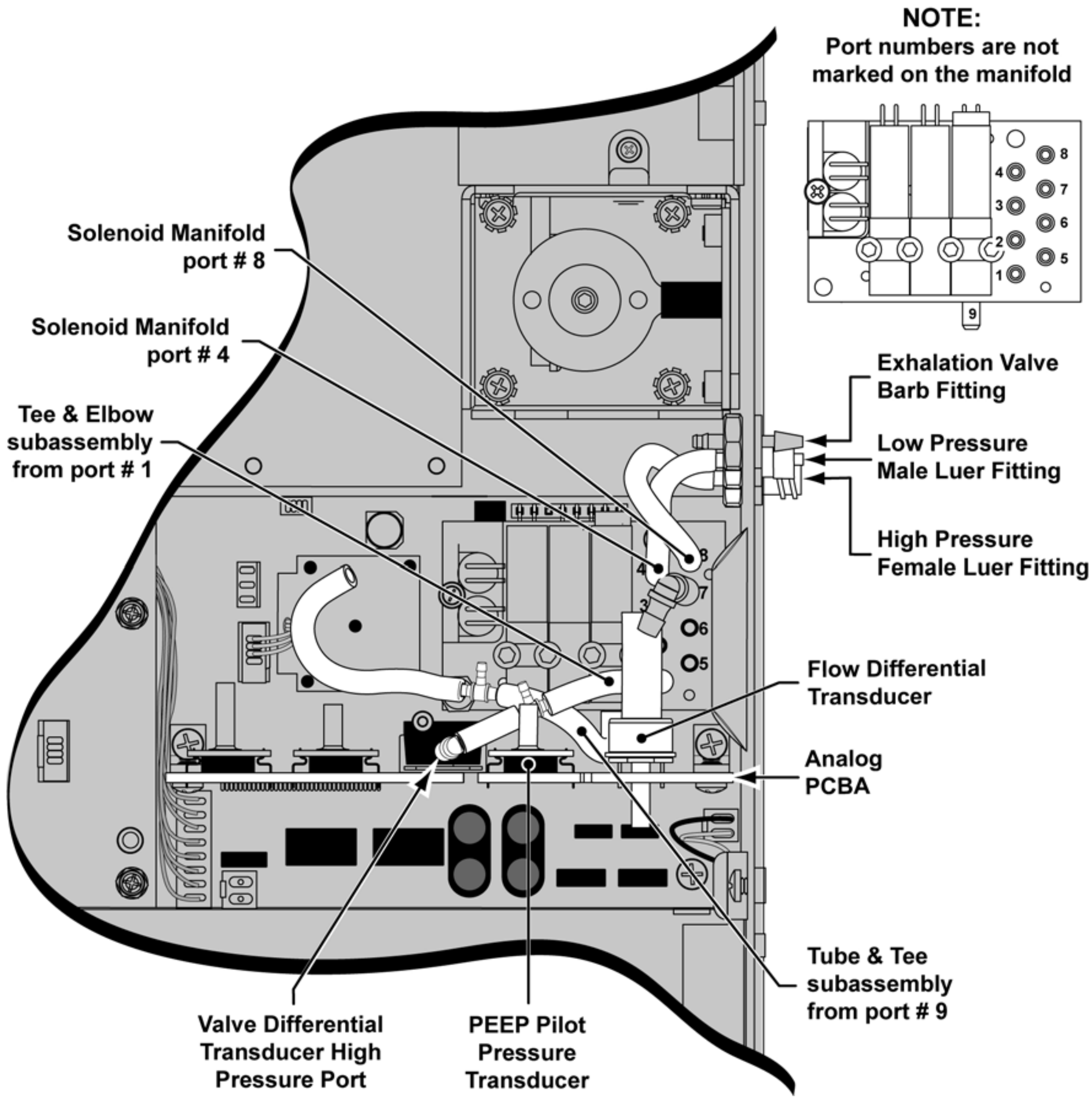


2) As applicable, install the Analog PCBA (see instructions on *page 8-57*).

Solenoid Manifold, Analog PCBA and External Port Tubing Installation:

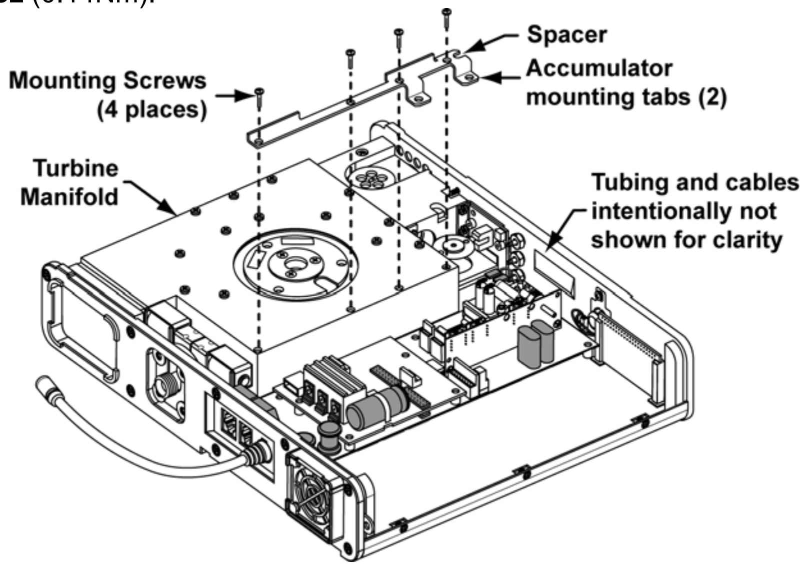
> **NOTE**
> Some previously attached manifold tubing is not shown for clarity of pertinent instructions.

1) Attach Solenoid Manifold port tubing, as follows;
   - port # 4 onto ventilator side panel Low Pressure port
   - port # 8 <u>over</u> tubing from port # 4 and onto ventilator side panel High Pressure port
2) Insert the elbow fitting attached to the Tee and Elbow subassembly on Solenoid Manifold Port # 1 into the tubing on the High Pressure port on the Valve Differential Transducer.
   - the Tee and Elbow subassembly is routed <u>under</u> the Flow Differential Transducer and PEEP Pilot Pressure Transducer ports and <u>over</u> the Tube and Tee subassembly from Solenoid Manifold side port # 9

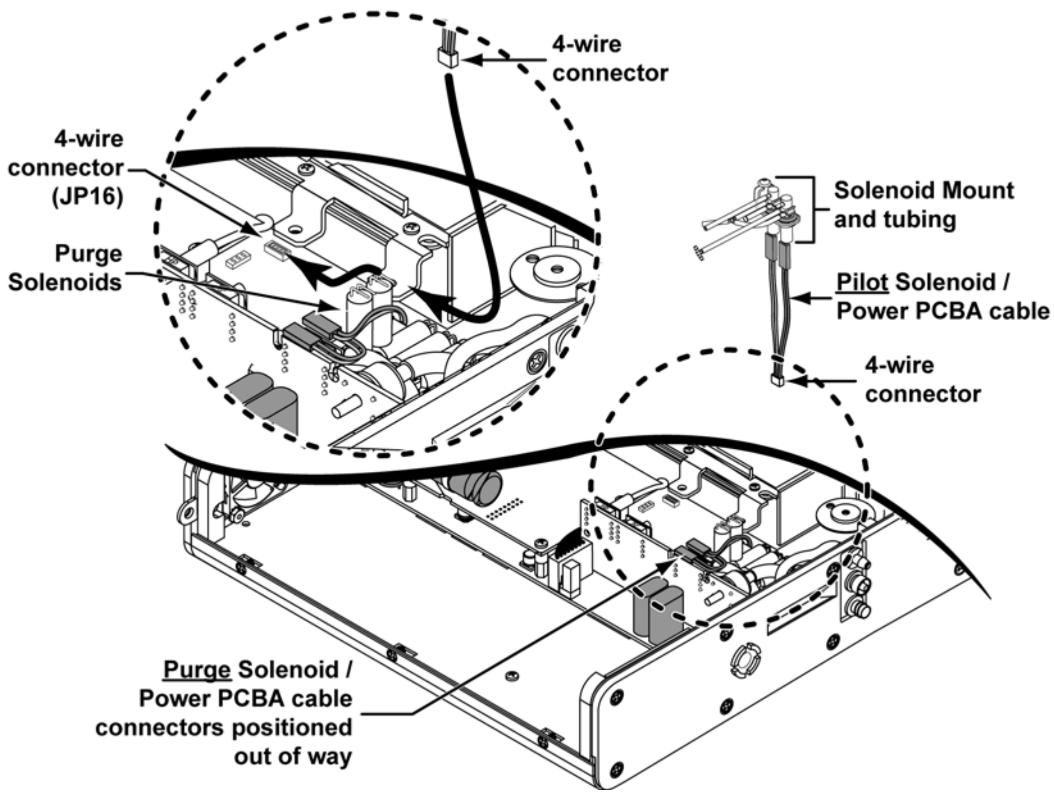


Solenoid Mount and Subassemblies Installation:

1) Position the Manifold to Back Panel Spacer P/N 18142-001 on the Turbine Manifold, align the mounting holes, insert four 7/16" pan-head screws and torque tighten each to **20 in-oz** (0.14Nm).



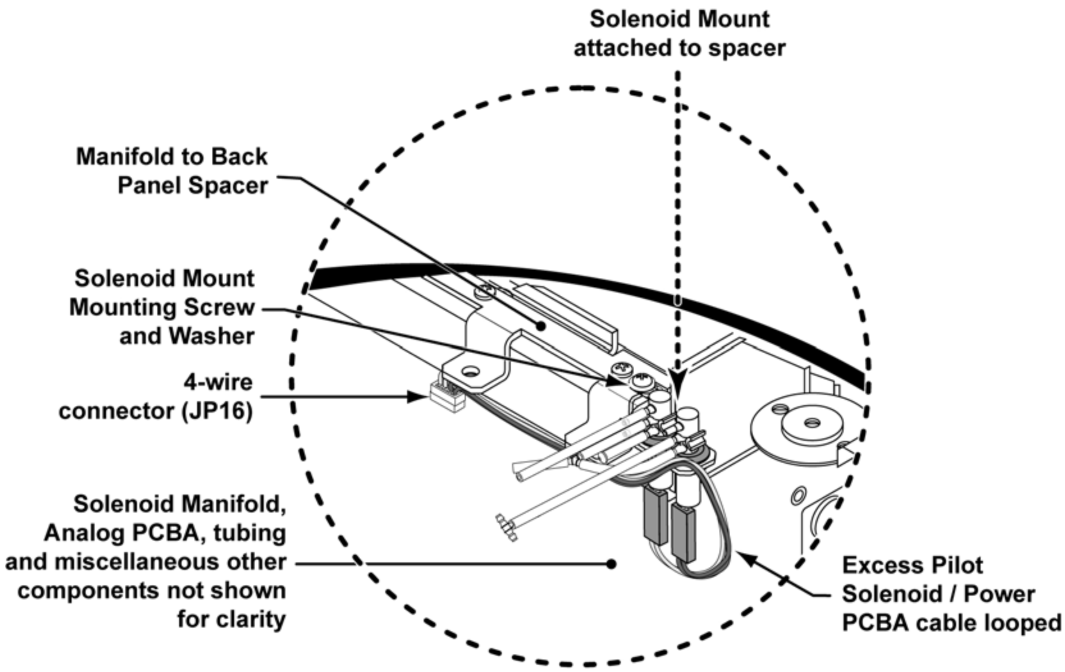
2) Position the Purge Solenoid/Power PCBA cable connectors temporarily out of the way (as shown) and route the 4-wire cable on the Pilot Solenoid/Power PCBA cable assembly <u>under</u> the Accumulator mounting tab on the Manifold to Back Panel Spacer and <u>between</u> the Purge Solenoids and the Turbine Manifold. Attach the connector to the 4-wire connector (**JP16)** on the Power PCBA. The connector is keyed to fit only one way and will snap into place when properly aligned.



3) Align and lower the Solenoid Mount assembly into the cavity between the Solenoid Manifold and the Flow Valve assembly.

- as the assembly is lowered into position, loop and position the excess Pilot Solenoid / Power PCBA cable as shown in the illustration

4) Attach the Solenoid Mount assembly to the end of the Manifold to Back Panel Spacer using the screw (P/N 17682-103, 4-24 X 3/8" pan-head) and washer (P/N 18032-001) on the Solenoid Mount.



5) Align and hold the Solenoid Mount parallel to the Solenoid Manifold (so that it does not touch it) and torque tighten the screw to **120 in-oz** (0.84Nm).

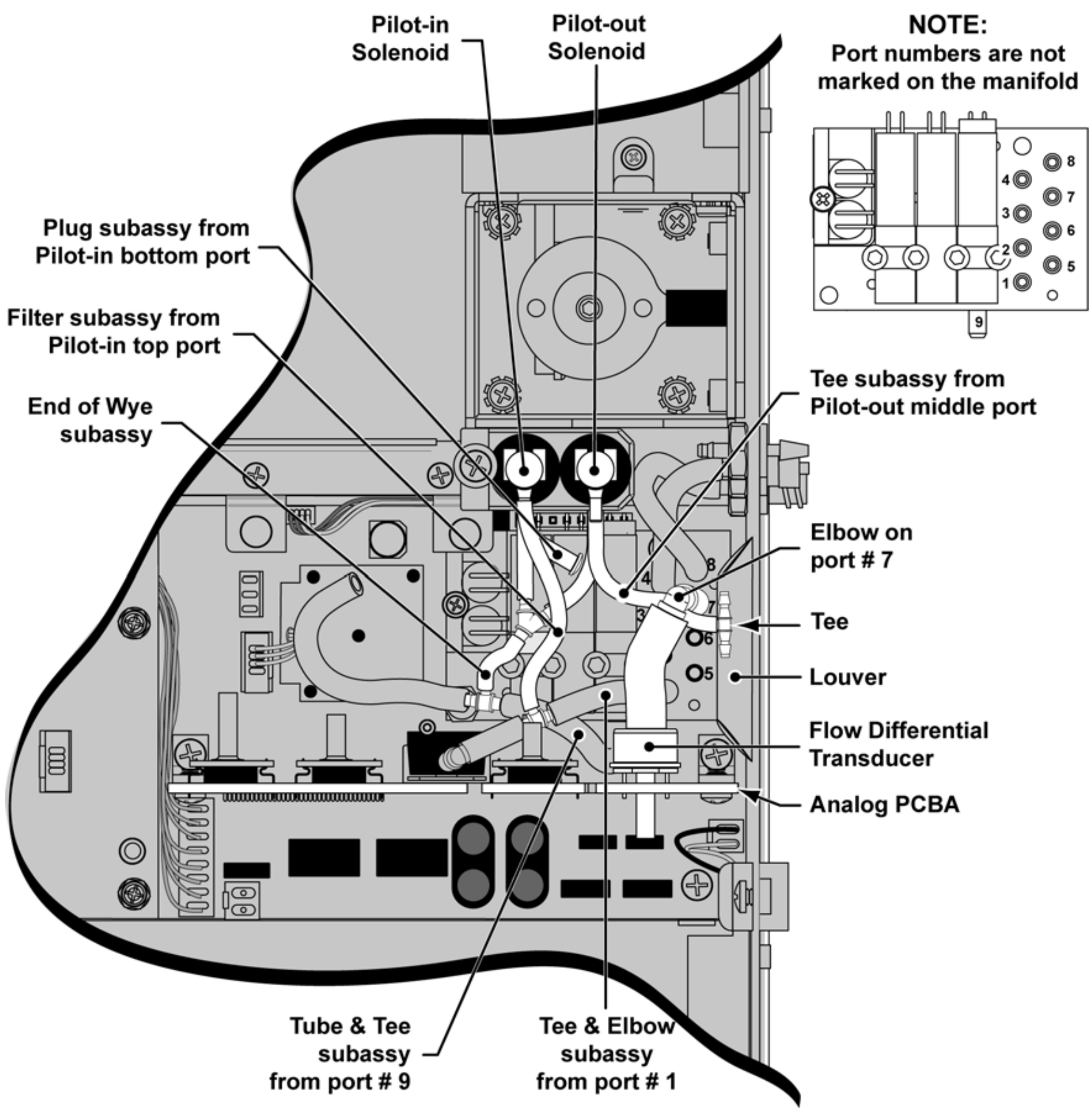
6) Connect the open end of the Wye subassembly tubing onto the tee fitting in the Tube and Tee subassembly attached to Solenoid Manifold port # 9.

7) Connect the open end of the Filter subassembly onto the tee fitting in the Tee and Elbow subassembly attached to Solenoid Manifold port # 1.

8) Route the Tee subassembly <u>between</u> the tubes on Solenoid Manifold ports # 3 and # 4, <u>under</u> the elbow fitting on port # 7 and <u>between</u> Solenoid Manifold ports # 6 and # 7.

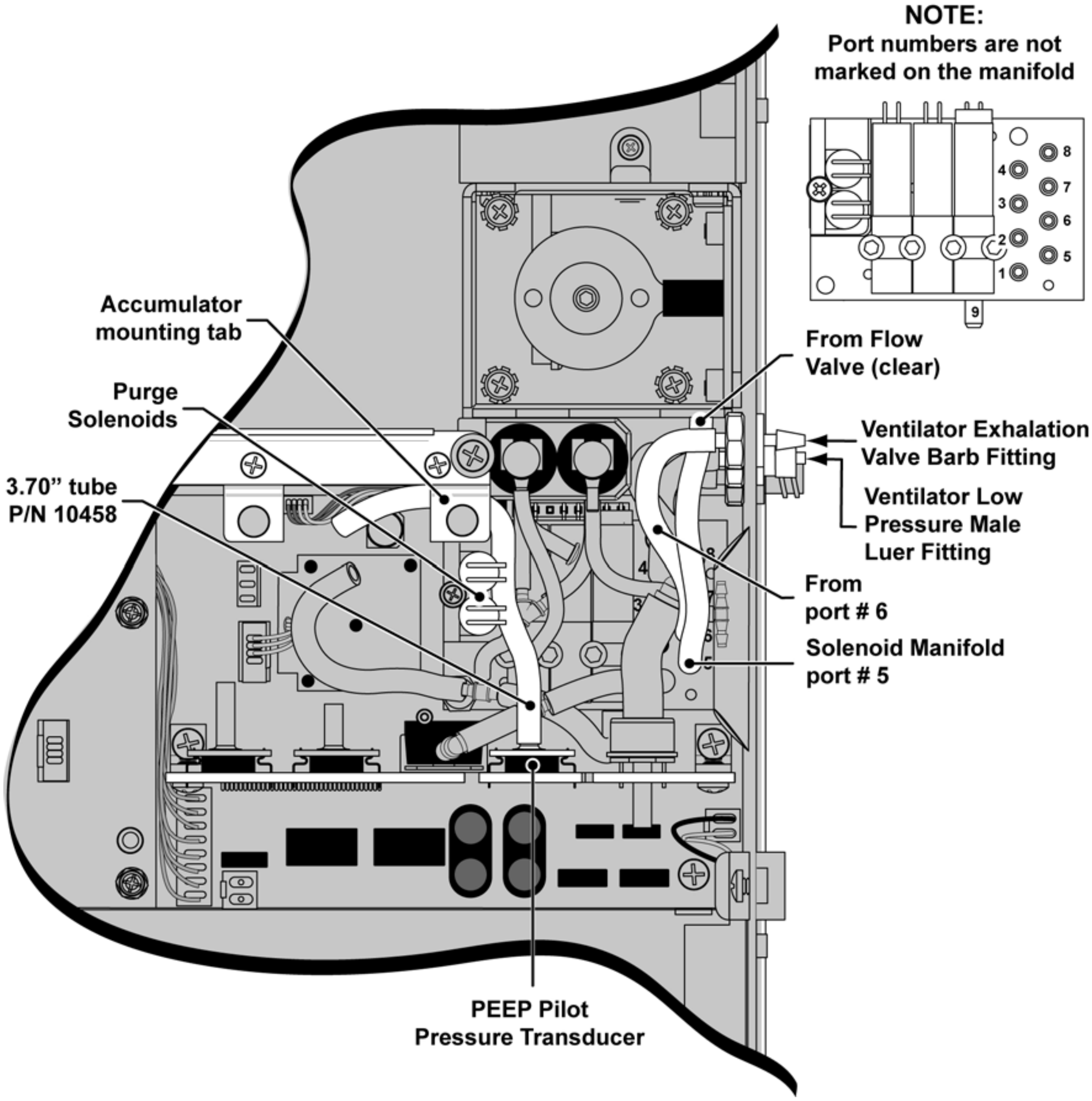
   - the tee on the end of the tube must be positioned at the opening of the Louver to the outside of the LTV®

9) Insert the elbow fitting attached to the tubing on Solenoid Manifold port # 7 into the tubing attached to the Flow Differential Transducer on the Analog PCBA.



Accumulator Installation:

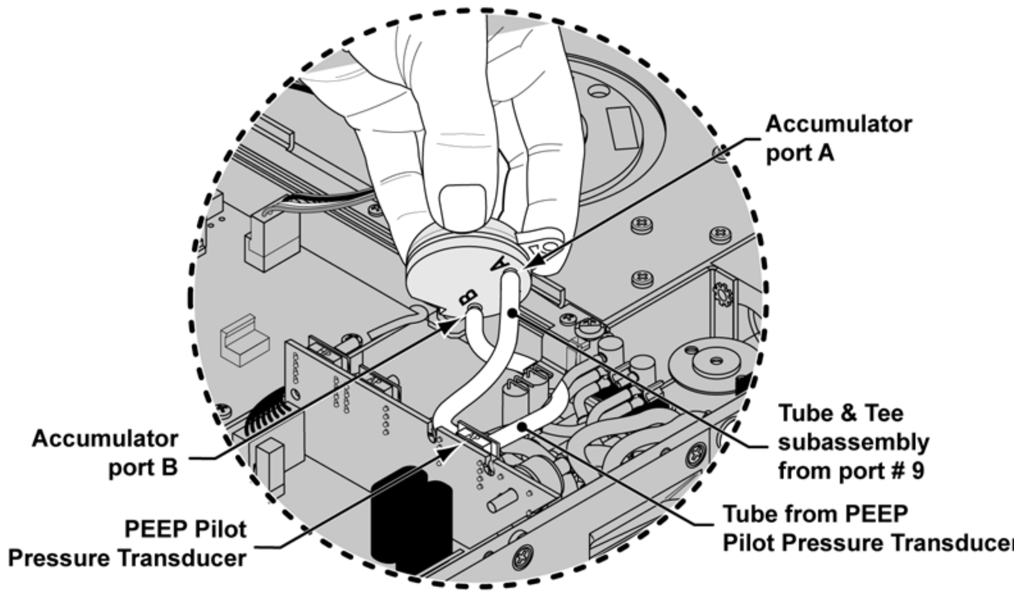
1) Attach a 3.70" long precut silicone tube (P/N 10458) onto the PEEP Pilot Pressure Transducer port. Position the balance of the tube beside the Purge Solenoids, over previously installed tubing, and under the Accumulator mounting tab on the Manifold to Back Panel Spacer, as shown.
2) Route the clear tube from the Flow Valve between the ventilator side panel Exhalation Valve and Low Pressure ports, over previously installed tubing, and onto Solenoid Manifold port # 5.
3) Attach the tube from Solenoid Manifold port # 6 over the clear tube from the Flow Valve and onto the ventilator side panel Exhalation Valve port.



4) Position and hold the Accumulator above the mounting tabs on the Manifold to Back Panel Spacer, as shown.

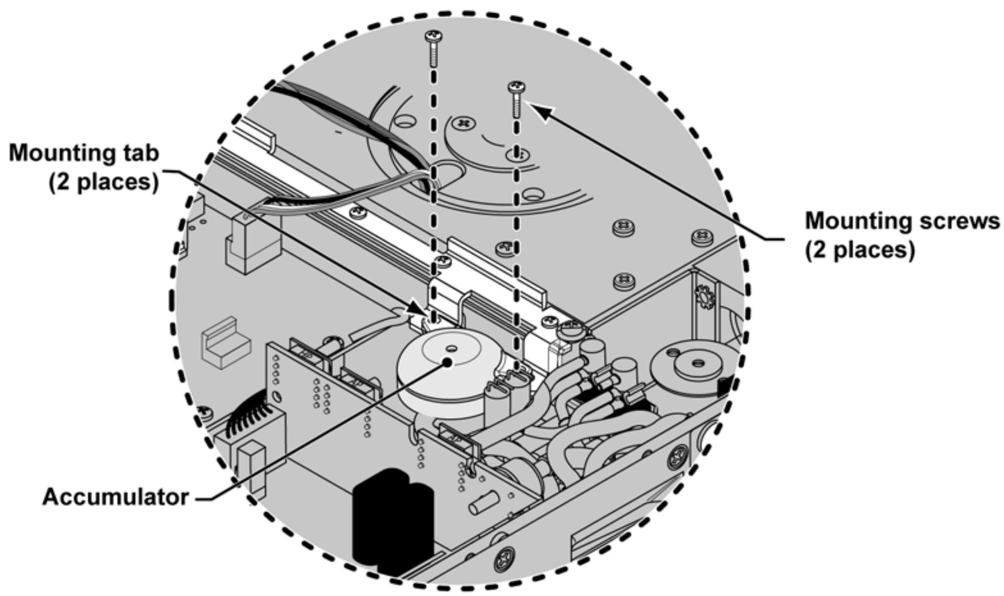
5) Attach the open end of the Tube and Tee subassembly from Solenoid Manifold port # 9 onto port A of the Accumulator.

6) Attach the open end of the 3.70” tube from the PEEP Pilot Pressure Transducer onto port B of the Accumulator.



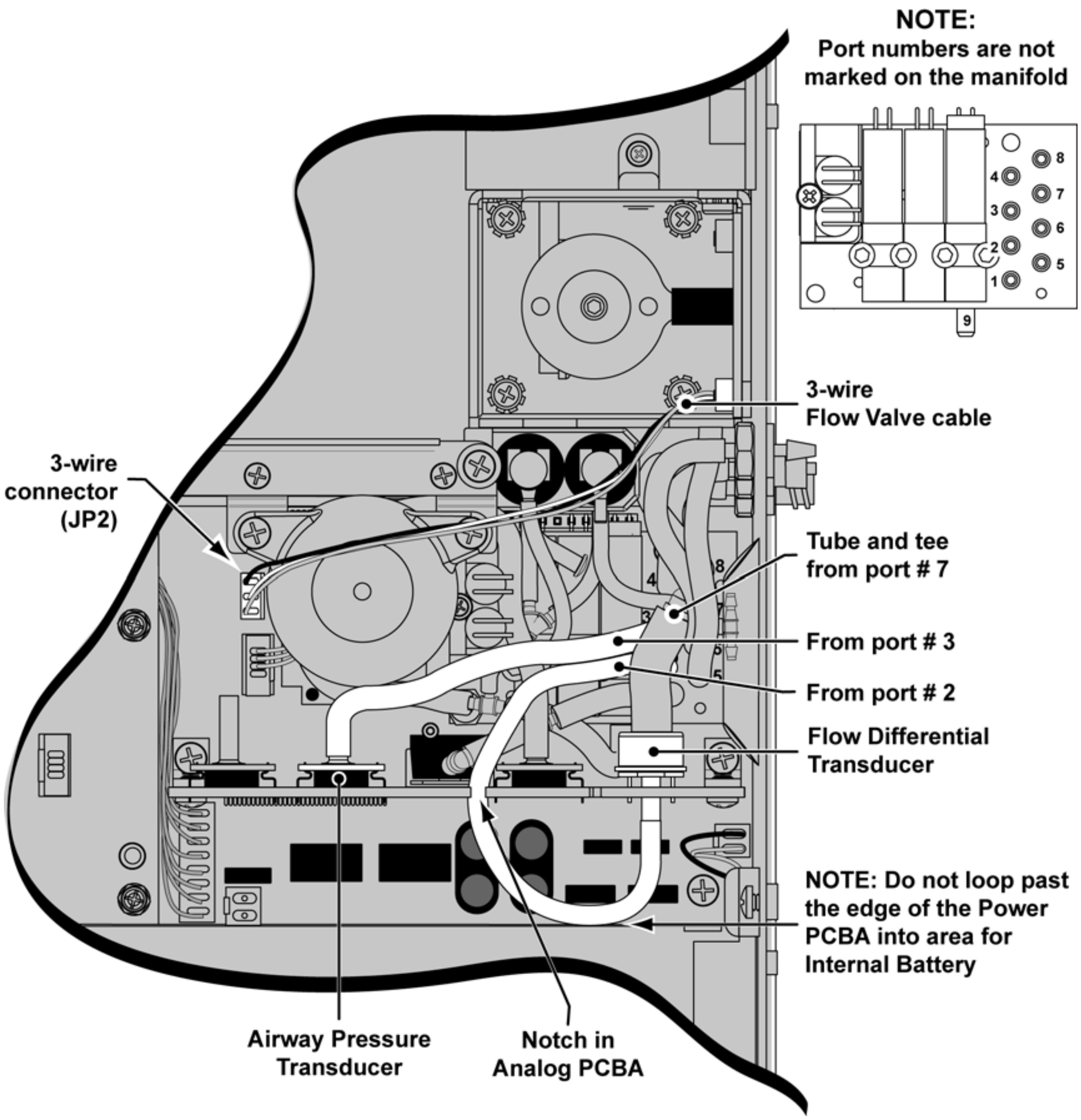
7) Align and lower the Accumulator into position on the spacer mounting tabs.
   - verify the tubing from ports A and B are not kinked and do not overlap

8) Insert two 7/16” pan-head screws (P/N 10433) through the Accumulator mounting tabs and torque tighten to **60 in-oz** (0.42 Nm).

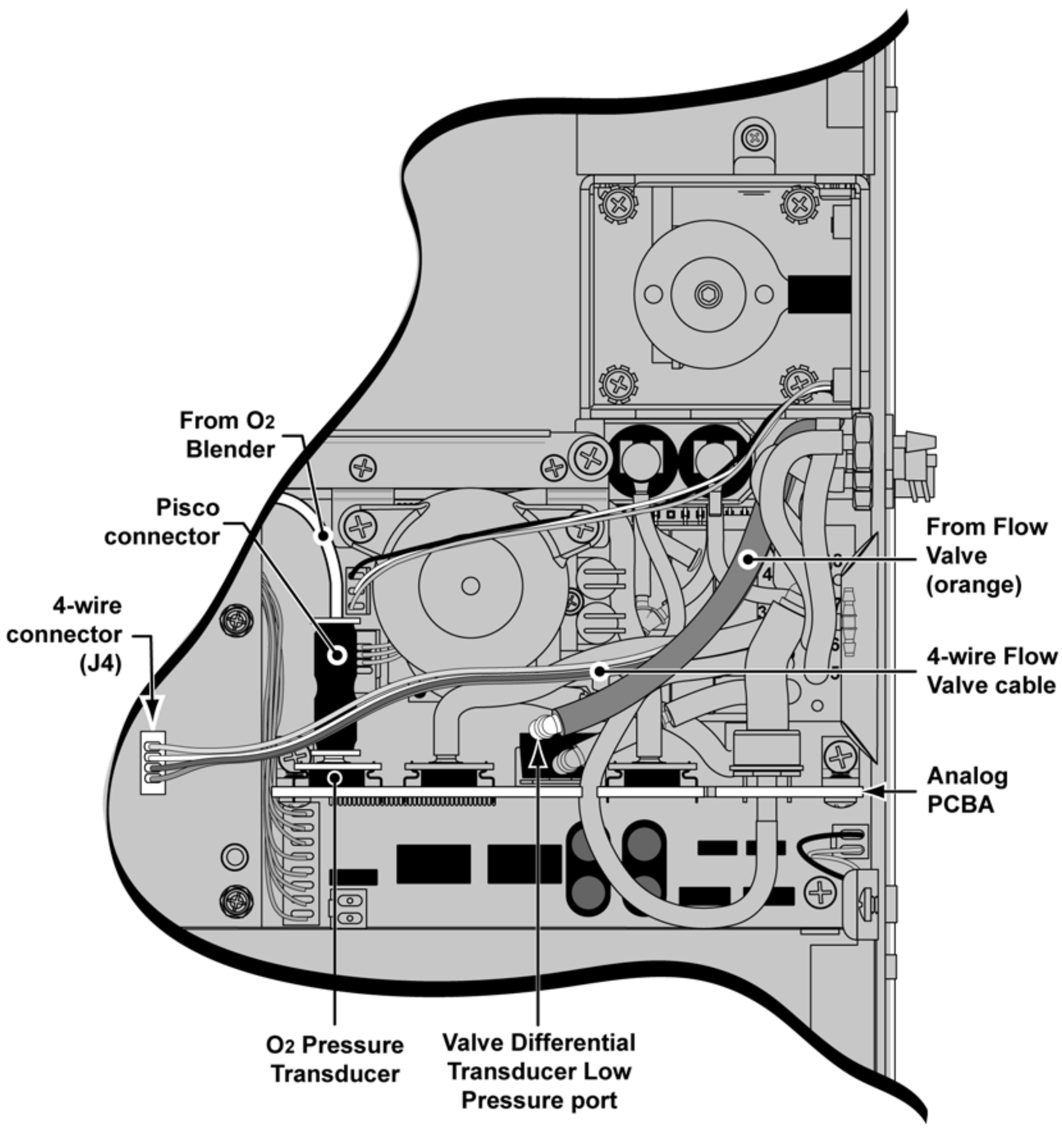


Final Tubing and Cable Installation:

1) Route the tube from Solenoid Manifold port # 3 under the tube and tee attached to Solenoid Manifold port # 7, over previously installed tubing and onto the Airway Pressure Transducer port, as shown.
2) Route the tube from Solenoid Manifold port # 2 under the tube and tee attached to Solenoid Manifold port # 7, over the previously attached tubing, through the notch in the Analog PCBA and onto the Flow Differential Transducer port, as shown.
   - do not loop past the edge of the Power PCBA into the area for the Internal Battery
3) Route the 3-wire, Flow Valve cable from the Flow Valve over previously installed tubing and the Accumulator. Attach the connector to the 3-wire connector (**JP2**) on the Power PCBA, as shown. The connector is keyed to fit only one way and will snap into place when properly aligned.



4) Attach the Pisco connector onto the O_2 Pressure Transducer port on the Analog PCBA, as shown (LTV® 1200 only).
5) Insert the tube from the O_2 Blender straight into the top of the Pisco connector (at least 1/2”), as shown (LTV® 1200 only).
    - gently pull the Pisco connector (~2-lbs force) while holding the Analog PCBA in place, then pull the tube while holding the Pisco connector to ensure they are both properly attached
6) Route the 4-wire Flow Valve cable over previously installed tubing and attach the connector to the 4-wire connector (**J4**) on the Motor PCBA, as shown. The connector is keyed to fit only one way and will snap into place when properly aligned.
    - for clarity, a warning label (“WARNING, DO NOT DISCONNECT WHILE UNIT IS ON!”) attached to the 4-wire cable is intentionally not shown in the following illustration
7) Route the orange tube (with elbow) from the Flow Valve over previously installed tubing and onto the Valve Differential Transducer Low Pressure port, as shown.



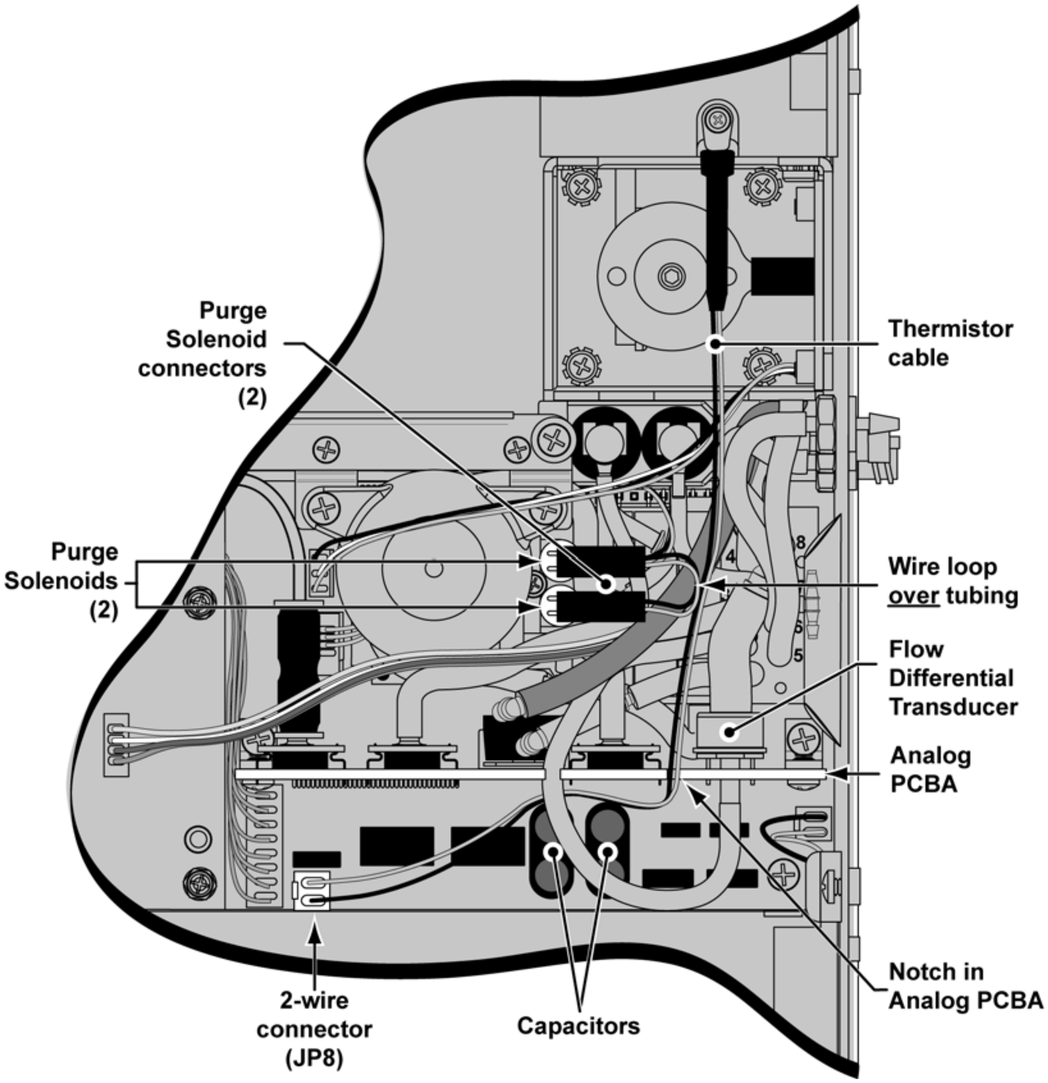
8) Route the 2-wire, Thermistor cable from the Flow Valve <u>over</u> previously installed tubing,

- <u>through</u> the notch in the Analog PCBA,
- <u>between</u> the Analog PCBA and the capacitors on the Power PCBA and
- <u>under</u> the tube attached to the Flow Differential Transducer.

Attach the connector to the 2-wire connector (**JP8**) on the Power PCBA, as shown. The connector is keyed to fit only one way and will snap into place when properly aligned.

9) Attach the Purge Solenoid connectors (2) onto the Purge Solenoids (either connector onto either solenoid), with the wire loop <u>over</u> previously installed tubing, as shown.

- hold the Purge Solenoids in-place while attaching the cable connectors



CAUTION

Final Tubing Check - Anytime internal flexible tubing is removed or replaced, check to ensure <u>all</u> tubes have been correctly routed (point to point and layering), are fully connected on the ports or fittings, and do not have any holes or tears in them. If necessary, gently reposition the tubing to eliminate possible kinks or occlusions.

Accumulator

Parts required for replacement:	Tools required:
• Accumulator P/N 18144-001 **Replace if damaged:** • 7/16” Pan Head screws (2) P/N 10433	• Phillips screwdriver with torque meter • Grounded anti-static wrist strap

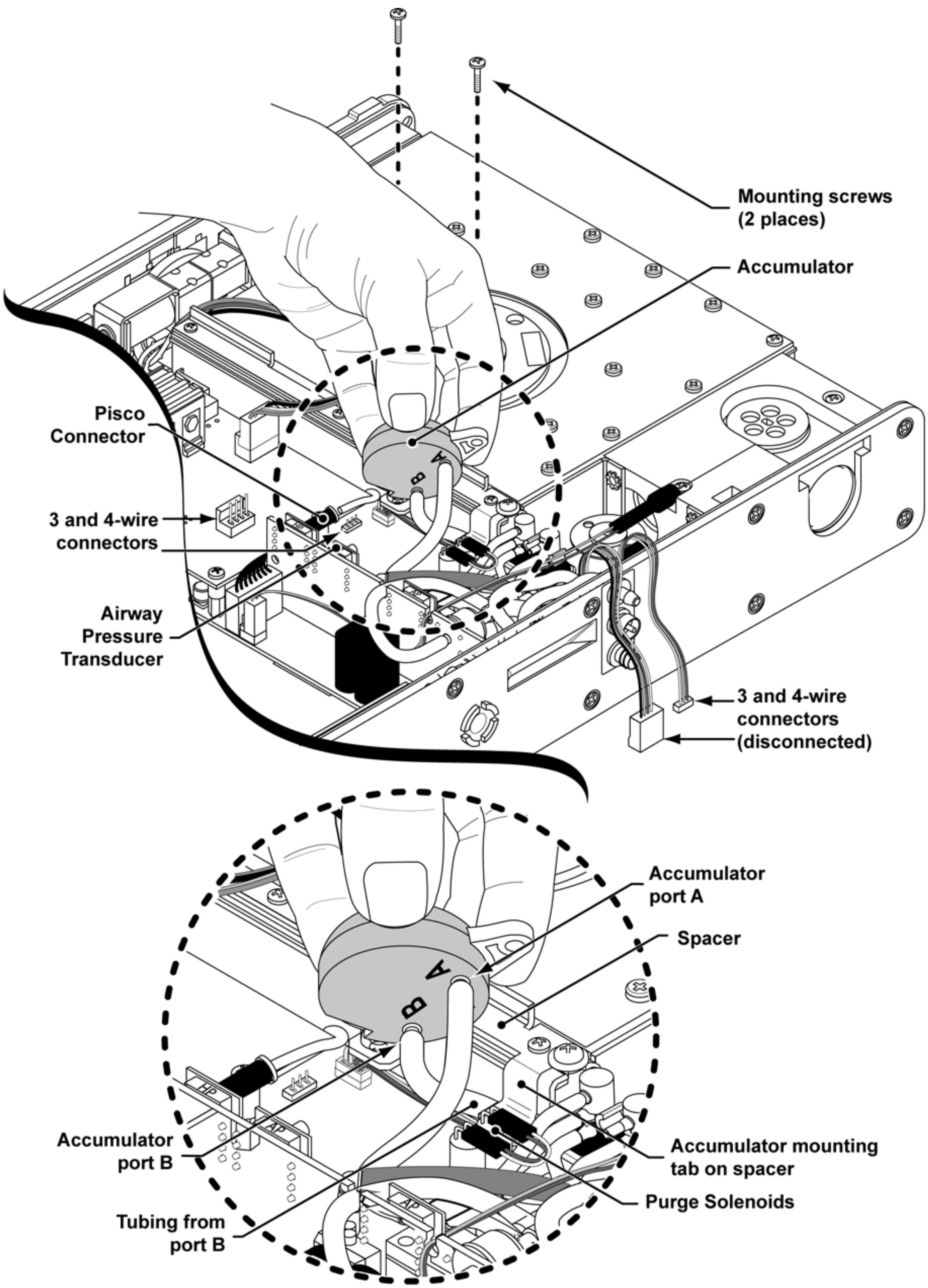
To remove the accumulator:

1) Remove the ventilator back panel and disconnect the internal battery cable from the power board (see instructions on *page 8-28*).
2) Disconnect the 4-wire flow valve connector from the motor board.
3) Disconnect the Pisco connector from the oxygen pressure transducer on the analog board (LTV® 1200 only).
4) Disconnect the 3-wire flow valve connector from the power board.
5) Disconnect the flexible tube from the airway pressure transducer on the analog board.
6) Remove the two (2) screws that secure the accumulator to the turbine manifold spacer, and remove the accumulator from the spacer.
7) Disconnect the flexible tubes from the bottom of the accumulatoras shown.

To replace the accumulator:

1) Reconnect the flexible tubes to the accumulator.
2) Tuck the flexible tube from Port B of the accumulator down between the purge solenoids and the turbine manifold spacer. Attach the accumulator to the spacer using two (2) 7/16” pan head screws (P/N 10433) and verify the tubing from ports A and B are not kinked and do not overlap. Torque the mounting screws to **60 in-oz** (0.42 Nm).
3) Reconnect the flexible tube to the airway pressure transducer on the analog board.
4) Reconnect the 3-wire flow valve connector to the power board. The connector is keyed to fit only one way and will snap into place when properly aligned.
5) Reconnect the Pisco connector to the oxygen pressure transducer on the analog board (LTV® 1200 only).
6) Reconnect the 4-wire flow valve connector to the motor board. The connector is keyed to fit only one way and will snap into place when properly aligned.
7) Install an O_2 Sampling Tube[42]. See *Back Panel, Reinstallation* in Chapter 8 – Component Removal and Replacement for detailed instructions.
8) Reconnect the battery and replace the back panel (see instructions *page 8-29*).

[42] O_2 Sampling Tube, P/N 10544, ~10.0” long, 0.125” O.D. X 0.079 I.D. clear polycarbonate tubing.



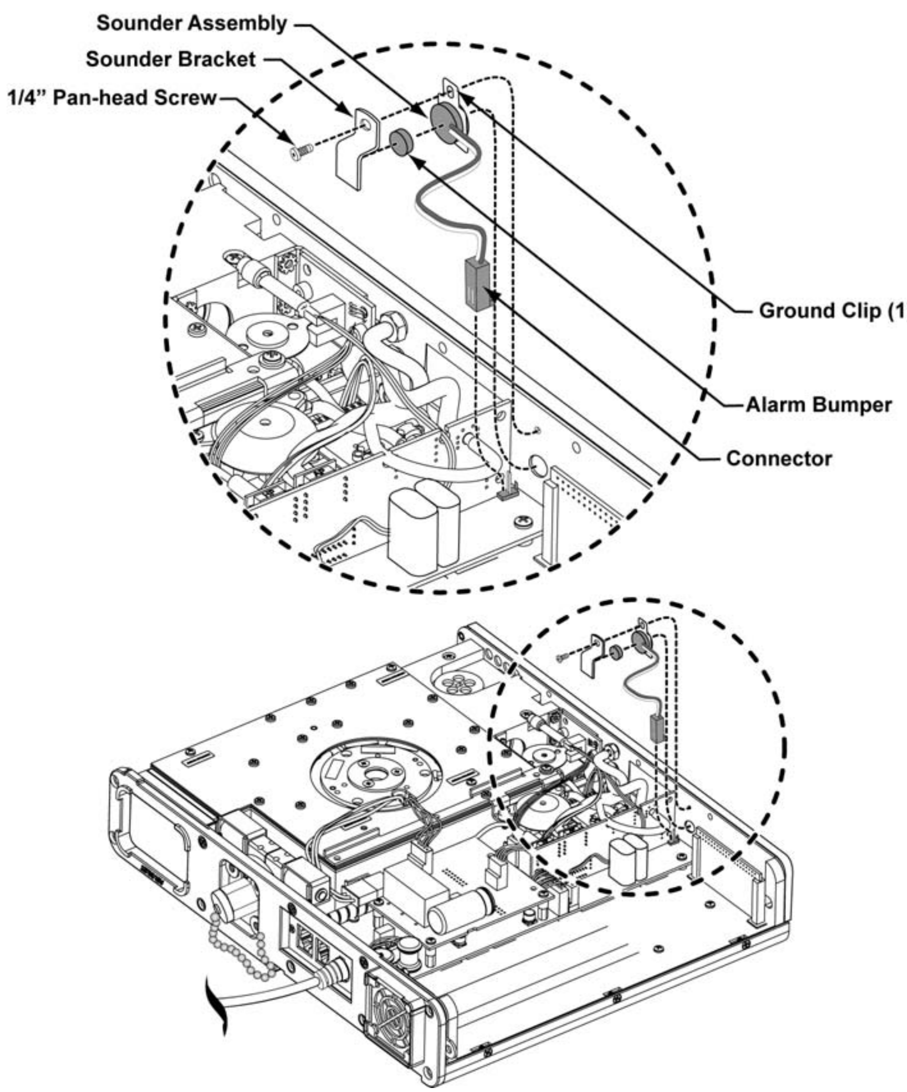
Mounting screws
(2 places)
Accumulator
Pisco
Connector
3 and 4-wire
connectors
Airway
Pressure
Transducer
3 and 4-wire
connectors
(disconnected)
Accumulator
port A
Spacer
Accumulator
port B
Tubing from
port B
Accumulator mounting
tab on spacer
Purge Solenoids

Alarm Sounder Assembly

Parts required for replacement:	Tools required:
• Sounder Bracket P/N 10119 • Sounder Assembly P/N 17432-001 **Replace if damaged:** • Alarm Bumper P/N 10573 • 1/4" Pan-head Screw (1) P/N 10435	• Phillips screwdriver with torque meter • Grounded anti-static wrist strap

To replace the Sounder Assembly:

1) Remove the ventilator back panel and disconnect the internal battery cable from the power board (see instructions on *page 8-28*). Remove the left and right soft side panels.
2) Disconnect the 2-wire sounder connector from the power board.
3) Remove the 1/4" pan-head screw from the sounder bracket, as shown.

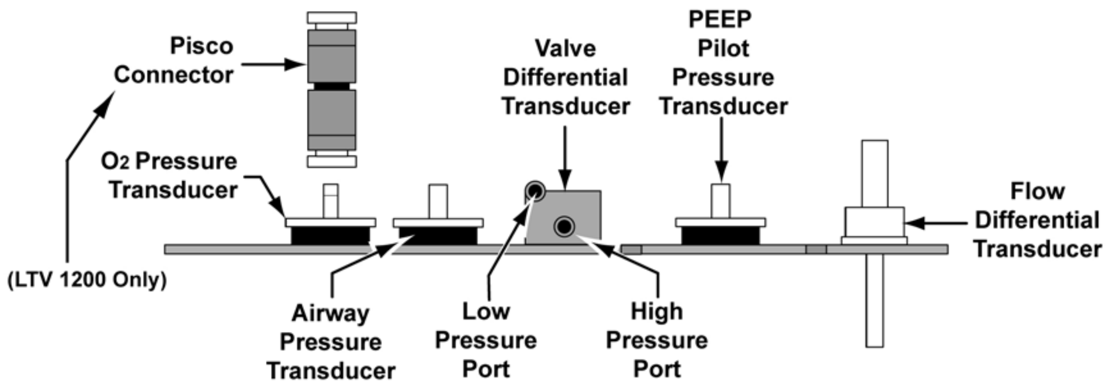


4) Remove the sounder bracket.
5) Remove the sounder assembly and alarm bumper.

6) Place the sounder assembly in the cut-out in the right side of the upper weldment.
7) Line the sounder bracket up with the sounder and the mounting hole in the side panel. Orient the sounder assembly so that the slot in the grounding clip aligns with the hole in the sounder bracket, as shown.
8) Replace the pan-head screw in the sounder bracket and torque tighten to **60 in-oz** (0.42 Nm).
9) Connect the 2-wire lead connector on the sounder assembly to the 2 pin male connector on the power board. The small legs on the sounder assembly wire connector should be indexed towards the vertical tab on the power board connector. When properly seated, it will snap into place.
10) Install an O_2 Sampling Tube[43]. See *Back Panel, Reinstallation* in Chapter 8 – Component Removal and Replacement for detailed instructions.
11) Verify that no tubing is kinked or twisted, and that it will not be pinched when compressed by the back panel. Refer to the configuration instructions, tables and diagrams beginning on *page 8-33* to check the tubing routing. Always check ALL tube routing for kinks or compression that might result in restricted flows prior to closing the ventilator.
12) Reconnect the internal battery and replace the back panel (see *page 8-29*).

[43] O_2 Sampling Tube, P/N 10544, ~10.0” long, 0.125” O.D. X 0.079 I.D. clear polycarbonate tubing.

Parts required for replacement:	**Tools required:**
• Analog PCBA Assembly P/N 18242-001 **Replace if damaged:** • Pisco connector P/N 10543	• Phillips screwdriver with torque meter • Grounded anti-static wrist strap



To replace the analog board:

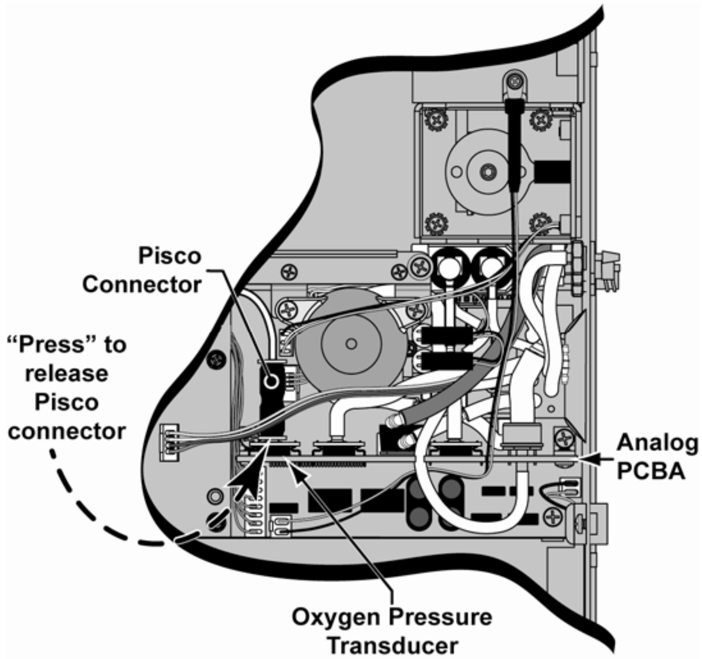
1) Remove the back panel of the ventilator and disconnect the internal battery cable (see instructions on *page 8-28*).
2) Detach the 6 flexible tubes from the analog board (one orange tube from the flow valve, one tube from the accumulator and 4 from the solenoid manifold.

> **NOTE**
> **Tubing Configurations -** When disconnecting tubes, note their positions and review the internal flexible tube routing tables, instructions and diagrams beginning on *page 8-33.*

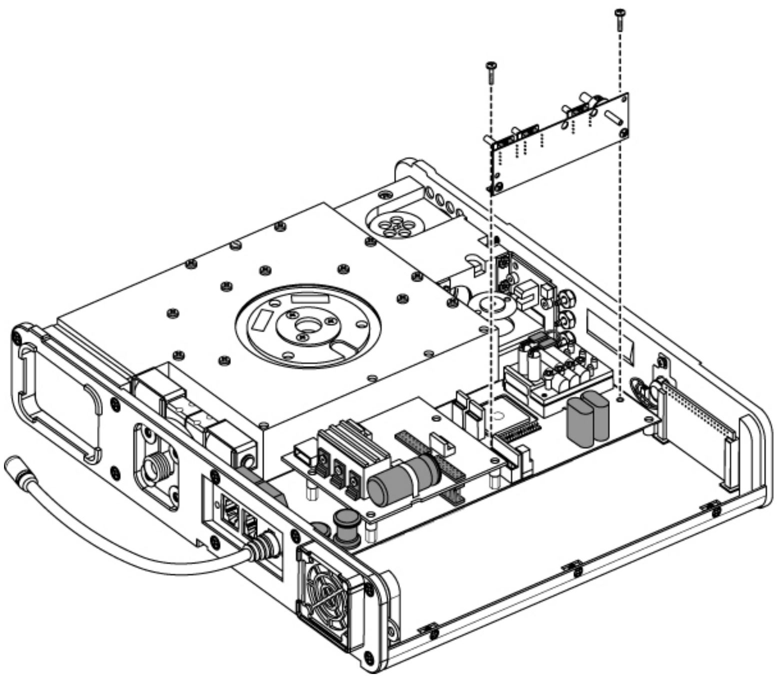
3) Disconnect the 4-wire flow valve connector from the motor board.

4) Disconnect the Pisco connector from the oxygen pressure transducer. To do this, pinch the collar on the Pisco connector away from the Analog board as shown (LTV® 1200 only).

5) Disconnect the 2-wire flow valve thermistor cable from the power board.

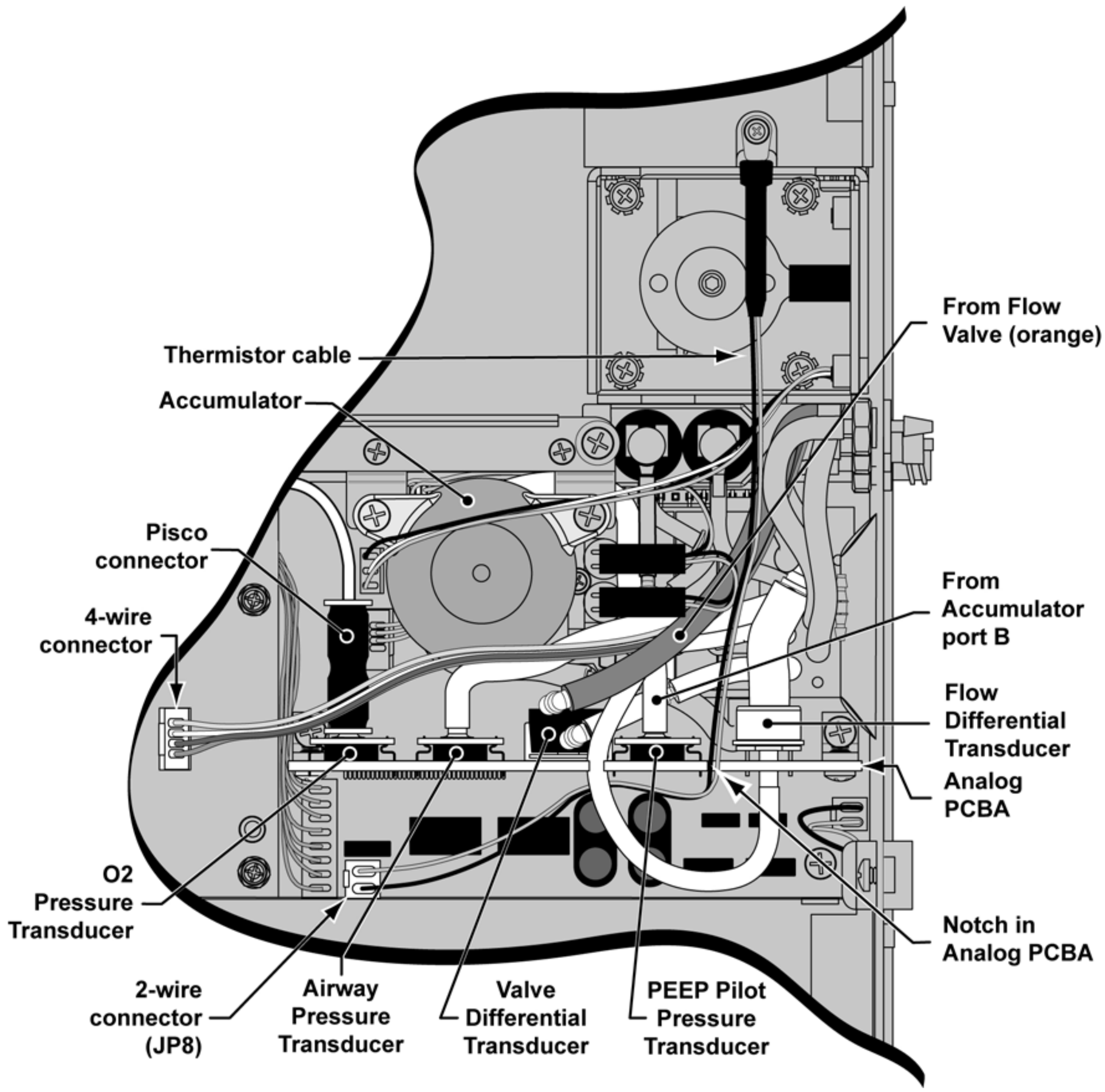


6) Remove the two green screws that attach the analog board to the power board and remove the analog board.



Analog board installation:

1) Insert the new analog board and secure with the two green mounting screws. Screws should be torqued to **60 in-oz** (0.42 Nm).



2) Reconnect the Pisco connector to the oxygen pressure transducer (LTV® 1200 only).
3) Reattach the 6 flexible tubes to the new analog PCBA following the internal flexible tube routing tables, diagrams and instructions on *page 8-33*.
   - To the valve differential transducer (high side) from the tee fitting to port #1 of the solenoid manifold
   - To the pilot pressure transducer from port B of the accumulator
   - To the flow differential transducer (large diameter port) from port #7 of the solenoid manifold
   - To the flow differential transducer (small diameter port) from port #2 of the solenoid manifold (through the notch in the analog board).
   - To the airway pressure transducer from port #3 of the solenoid manifold
   - To the valve differential transducer (low side, furthest from the board) from the flow valve (orange tube).

4) Reconnect the 4-wire flow valve connector to the motor board. The connector is keyed to fit in only one way and will snap into place when properly aligned.
5) Reconnect the 2-wire flow valve thermistor cable to the power board.
6) Inspect all flexible tubes for tears at the connecting ends and replace worn or damaged tubes if necessary.
7) Install an O_2 Sampling Tube[44]. See *Back Panel, Reinstallation* in Chapter 8 – Component Removal and Replacement for detailed instructions.
8) Verify that no tubing is kinked or twisted, and that it will not be pinched when compressed by the back panel. Refer to the routing instructions, tables and diagrams beginning on *page 8-33* to check the tubing routing. Always check ALL tube routing for kinks or compression that might result in restricted flows prior to closing the ventilator.
9) Reconnect the internal battery and replace the back panel (see *page 8-29*).

[44] O_2 Sampling Tube, P/N 10544, ~10.0" long, 0.125" O.D. X 0.079 I.D. clear polycarbonate tubing.

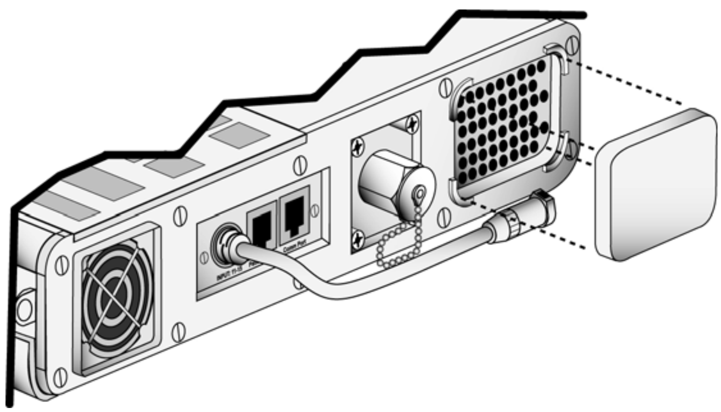
External Inlet Filter

The external inlet filter should be removed and cleaned once a month. If the ventilator is being operated in high dust or humidity environments, it may need to be cleaned more often. If the filter is damaged or can not be thoroughly cleaned, it should be replaced.

Parts required for replacement:	Tools required:
Replace if damaged: • Inlet Filter, Reticulated Foam P/N 10258	• Mild cleanser • Soft cleaning brush

To clean or replace the External Inlet filter:

1) Gently pinch the external inlet filter and remove it from its housing on the left side of the ventilator.



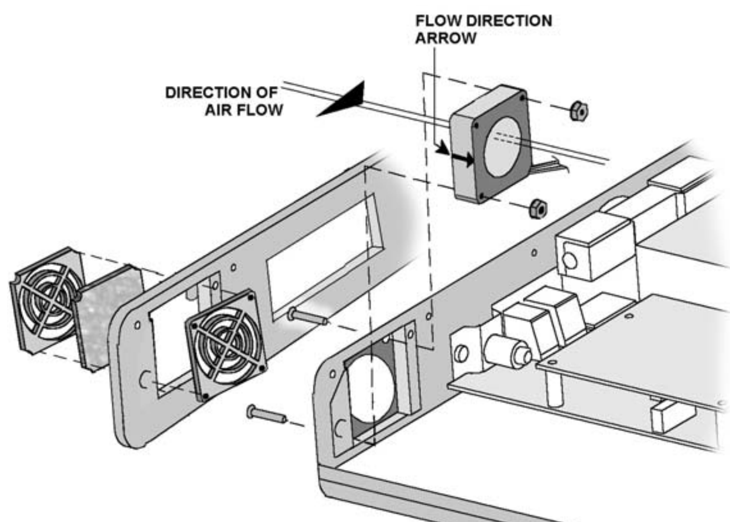
2) Clean the filter using a mild cleanser and warm water. Rinse the filter thoroughly to remove all traces of the cleanser and gently wring it out. Allow the filter to dry completely before replacing it in the ventilator.
3) Inspect the filter for damage. If the filter is not intact, shows signs of damage or cannot be completely cleaned, replace it with a new filter.
4) Replace the filter by tucking it into its housing on the left side of the vent. Make sure the filter lies flat and is seated all the way into the housing.

Fan Assembly

Parts required for replacement:	Tools required:
• Fan Assembly P/N 10675, or 14725-001[45] **Replace if damaged:** • 5/8" Flat-head Screw (2) P/N 10499 • Nut (2) P/N 10342	• Phillips screwdriver with torque meter • Grounded anti-static wrist strap

To replace the fan assembly:

1) Remove the back panel of the ventilator and disconnect the internal battery cable (see *page 8-28*).
2) Disconnect the fan connection from the power board. Care should be taken to be sure the DIP switch settings are not changed. DIP switches are located directly below the fan assembly.
3) Remove the left soft side.
4) Remove the 2 screws and nuts holding the fan assembly.
5) Remove the fan assembly.
6) Install the new fan assembly oriented so the fan label faces the inside of the vent and the fan wires are in the corner closest to the power board. **Flow direction indicator should be directed towards the inside of the unit.**



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FAN HOUSING

7) Replace the 2 screws (P/N 10499) and nuts (P/N 10342) holding the fan assembly in place. Screws should be torqued to **40 in-oz** (0.28 Nm). Care should be taken to be sure the DIP switch settings are not changed. DIP switches are located directly below the fan assembly.
8) Connect the 2-wire connector from the fan to the power board. The connector is keyed to fit in only one direction and will snap into place when properly connected.
9) If the fan grill bracket has been removed, replace it in the left soft side and replace the left soft side. Replace the fan filter and fan filter grill.
10) Install an O_2 Sampling Tube[46]. See *Back Panel, Reinstallation* in Chapter 8 – Component Removal and Replacement for detailed instructions.
11) Reconnect the battery and replace the back panel (see *page 8-29*).

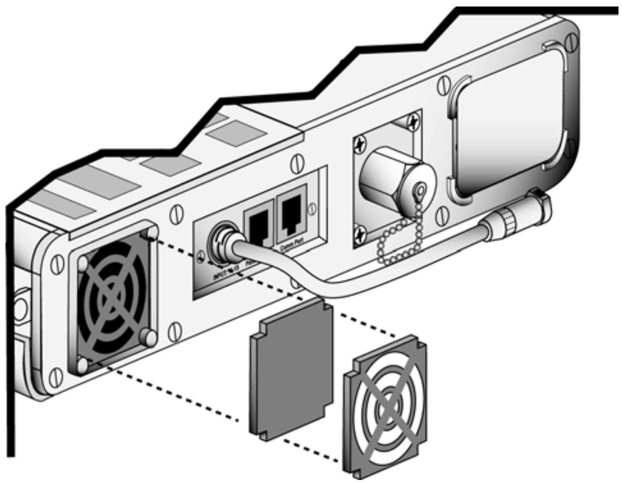
[45] Fan Assembly, P/N 14725-001 must be installed with 05.04 or higher version software.
[46] O_2 Sampling Tube, P/N 10544, ~10.0" long, 0.125" O.D. X 0.079 I.D. clear polycarbonate tubing.

Cleaning the Fan Filter

The fan filter should be removed and cleaned at least once a month. If the ventilator is being operated in high dust or humidity environments, it may need to be cleaned more often. If the filter is damaged or can not be thoroughly cleaned, it should be replaced.

To clean the fan filter

1) Using a small screwdriver or long nose pliers, detach the fan filter grill from its housing.
2) Remove the fan filter by gently pinching the foam filter and pulling it out.



NOTE

If you touch the fan blades while removing the fan filter grill or filter, a **HW FAULT** may occur. This is normal. Clear the **HW FAULT** alarm by using the **Silence Reset** button.

3) Gently bathe the filter in a solution of a mild liquid detergent and warm water.
4) Remove all detergent by thoroughly rinsing the filter in warm water.
5) Examine the filter for damage (discard and replace if necessary) and allow it to thoroughly air dry before reinstallation.
6) Reinstall the filter.
7) Reposition the filter grill over the filter and apply light pressure until it fully seats ("clicks") into the filter housing.

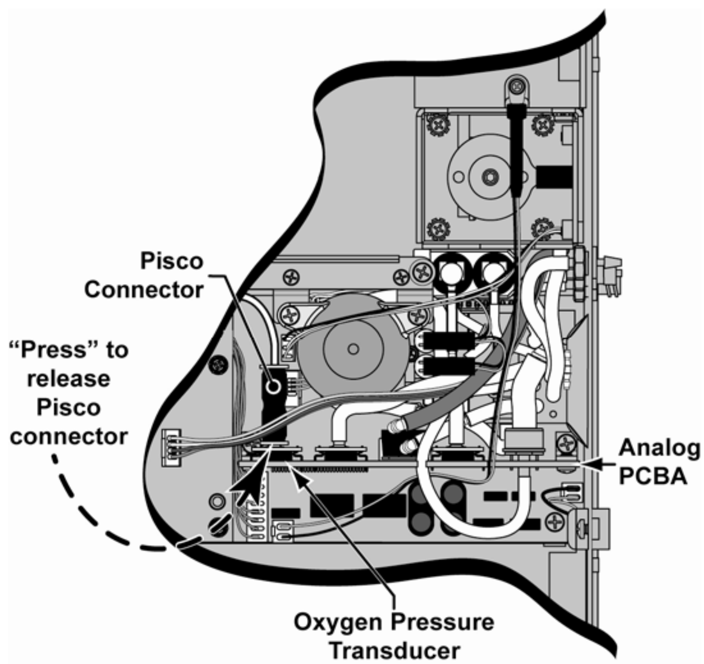
CAUTION

Wet or Damp Filters - Do not install a wet or damp filter into the LTV® 1200/1150. This could damage the ventilator.

Parts required for replacement:	**Tools required:**
• Flow Valve Assembly P/N 10019 • Silicone Gel Lubricant P/N 10123[47] • Thermistor Cable P/N 11399 **Replace if damaged:** • Sealing Gasket P/N 10175 • 1 3/4" Pan-head Screw (2) P/N 10434	• Phillips screwdriver with torque meter • Grounded anti-static wrist strap • Flow Valve Insertion Tool[37] (Mylar) P/N 14206

To remove the flow valve assembly:

1) Remove the ventilator back panel and disconnect the internal battery cable from the power board (see instructions on *page 8-28*).
2) Disconnect the 4-wire flow valve connector from the motor board.
3) Disconnect the Pisco connector from the oxygen pressure transducer on the analog board as shown (LTV® 1200 only).
4) Disconnect the 3-wire flow valve connector from the power board.
5) Disconnect the orange flow valve tube from the analog board and the tube connecting the flow valve to the solenoid manifold at port #5.



NOTE

Tubing Configurations - When disconnecting tubes, note their positions and review the internal flexible tube routing tables, instructions and diagrams beginning on *page 8-33*.

If tubing needs to be replaced, consult the tables and instructions in *Internal Flexible Tubing* beginning on *page 8-33* for tubing diameters, lengths and routing diagrams.

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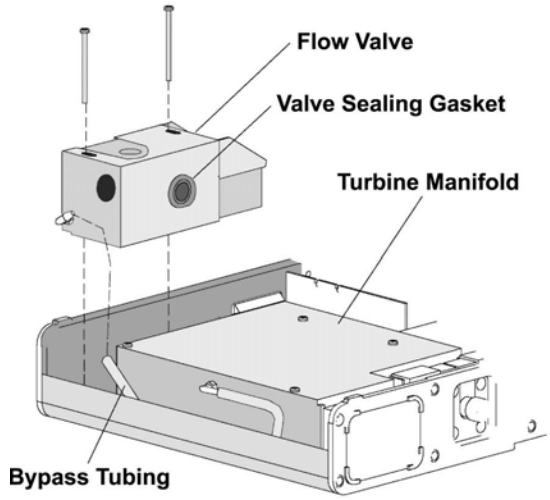
[47] The Silicone Gel Lubricant and Flow Valve Insertion Tool are available separately, or as part of the Maintenance and Calibration Kit, P/N 11566.

6) Remove the 2 screws from the body of the flow valve.
7) Lift the flow valve up and out of the ventilator case.
8) Disconnect the bypass tubing from the connector at the base of the flow valve.



Flow Valve Cleaning Procedure

In certain cases, dust and other particulates may gather on the Poppet of the Flow Valve. This can lead to a slight decrease in flow, and therefore delivered volume, which is most noticeable when the calculated peak flow (Vcalc) is relatively low (< 30 LPM). In these situations, cleaning of the Flow Valve poppet is an acceptable repair action.

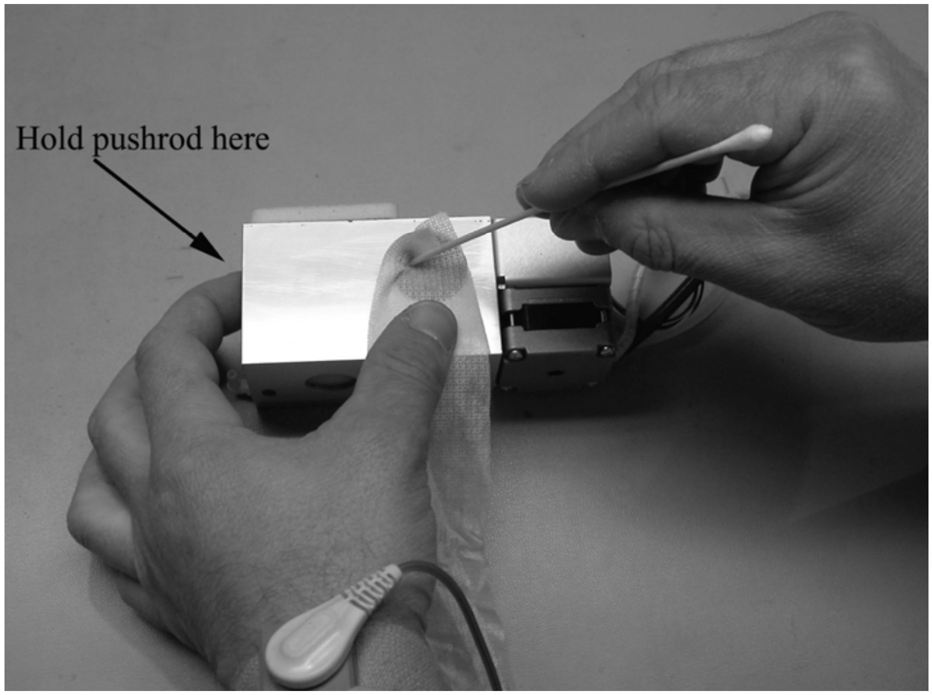
1) Position the Flow Valve Assembly as in FIGURE 1.

2) Press and hold the Flow Valve Push Rod inward at the rear of Flow Valve Assembly, such that the Flow Valve Poppet is positioned as far towards the step motor as allowed.

3) Use a <u>non-metallic</u> object, such as a wood handled cotton tip applicator, to insert a .75” X 6.75” (approximate dimension) alcohol saturated, <u>lint free</u> wipe into the gap between the poppet and the seat (FIGURE 1).

> **NOTE**
> Appropriate width strips may be cut from a single wipe and moistened, if necessary, with Isopropyl Alcohol (Isopropanol, 2-Propanol) of better than 90% purity.

FIGURE 1



4) Wrap the alcohol wipe around the Flow Valve Poppet as shown below in FIGURE 2, and pull forward and back several times to wipe the surface of the Flow Valve Poppet (See FIGURE 3 for detail of Poppet surface.)

FIGURE 2

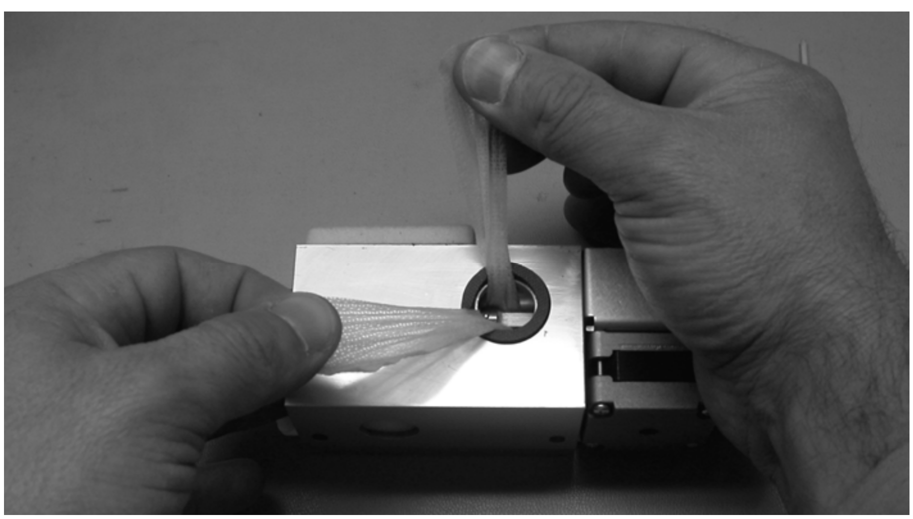
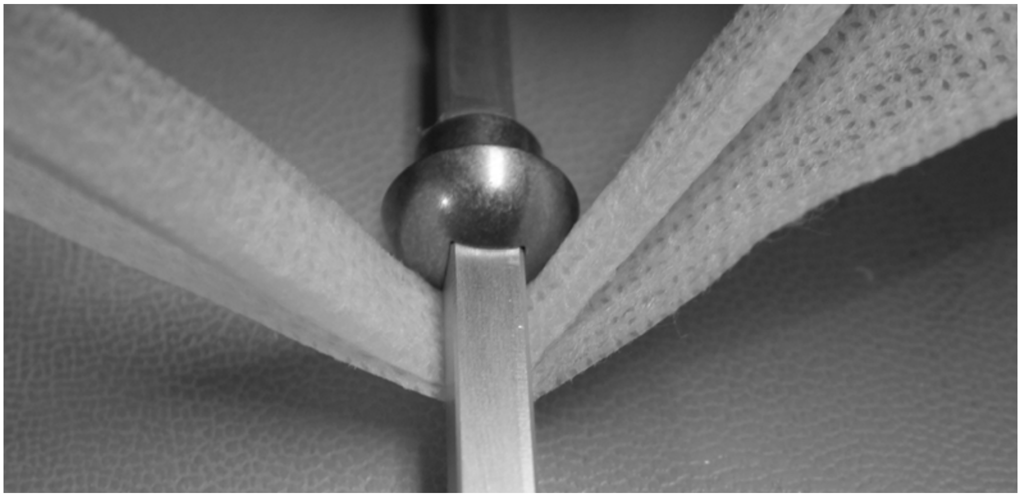


FIGURE 3



5) To remove the alcohol wipe, lightly push the opposite (Step motor) end of the push rod while gently pulling on the wipe. This aids in removing foreign matter from the Flow Valve seat.

6) Using a fresh alcohol wipe, repeat Steps 1 through 5 several times, or more if needed, to remove all substances from the Flow Valve Poppet surface.

7) Re-install Flow Valve Assembly into ventilator following the instructions in this chapter.

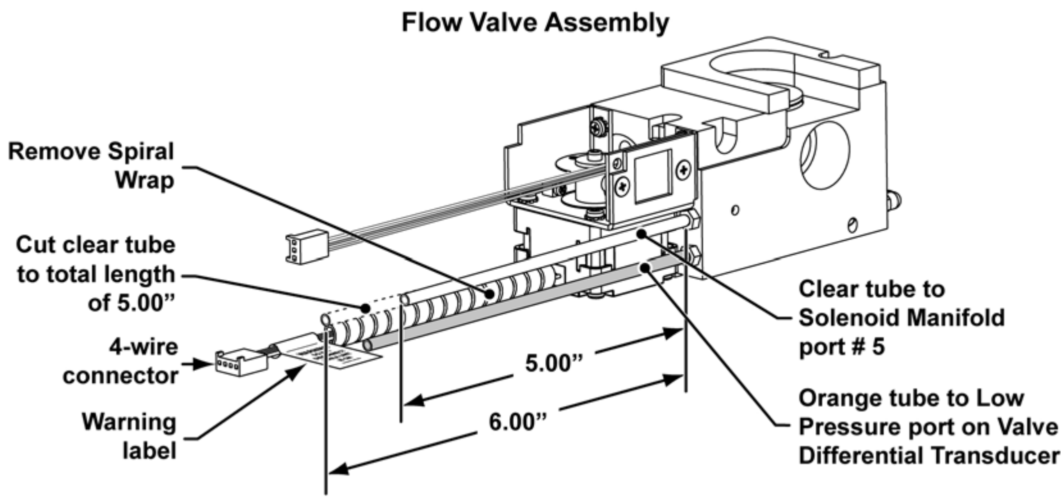
8) Measure the delivered flow of the ventilator by performing Step 8- *Servo Test* of the *Performance Checkout*, as outlined in *Chapter 9 – Performance Checkout*.

9) If measured flow is not within the specified limits, recalibrate the Flow Valve per *Chapter 6 Flow Valve Calibration* and repeat the *Servo Test* of the *Performance Checkout.*

10) If measured flow continues to be outside of the specified limits, replace the Flow Valve Assembly following the instructions in this chapter.

Flow Valve preparation:

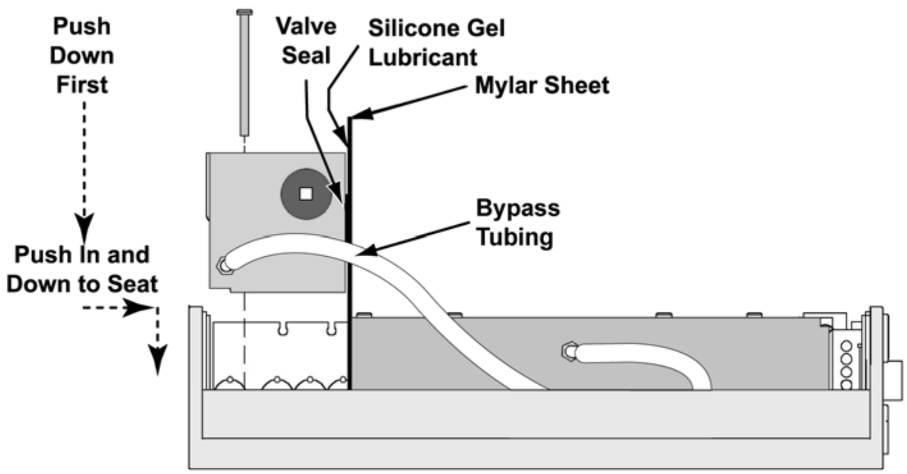
1) If replacing the *same* Flow Valve, skip to the next section.
2) If installing a *new* Flow Valve, P/N 10019, measure the length of the clear silicone tube attached to the port above the orange silicone tube (see illustration).
   - new Flow Valve assemblies are shipped with 6.00" clear silicone tubing to accommodate use on most LTV® ventilators
   - For use with LTV® 1200/1150 ventilators, the tube must be cut to a total length of 5.00" ± 0.250" prior to installing the new Flow Valve



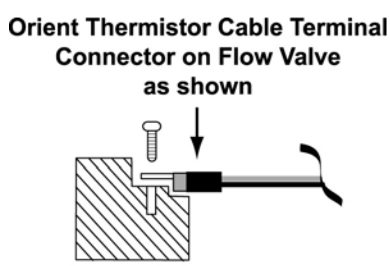
3) New Flow Valve assemblies are also shipped with Spiral Wrapping on the 4-wire connector cable. For use with LTV® 1200/1150 ventilators, the Spiral Wrap must be gently removed prior to installing the Flow Valve (<u>*unwrap*</u>, do not pull on, or strain the wiring).
   - <u>do</u> <u>not</u> remove the Warning label from the 4-wire connector cable

To replace the flow valve assembly:

1) Connect the bypass tubing to the connector at the base of the new flow valve.
2) Apply a small amount of silicone gel lubricant to the flat surface area on the valve sealing gasket. Apply a small amount of silicone gel lubricant to the Mylar sheet insertion tool.
3) Place the Mylar sheet insertion tool against the turbine manifold where it will contact the flow valve sealing gasket. This will allow the flow valve to be slipped into place without rolling or damaging the valve sealing gasket.

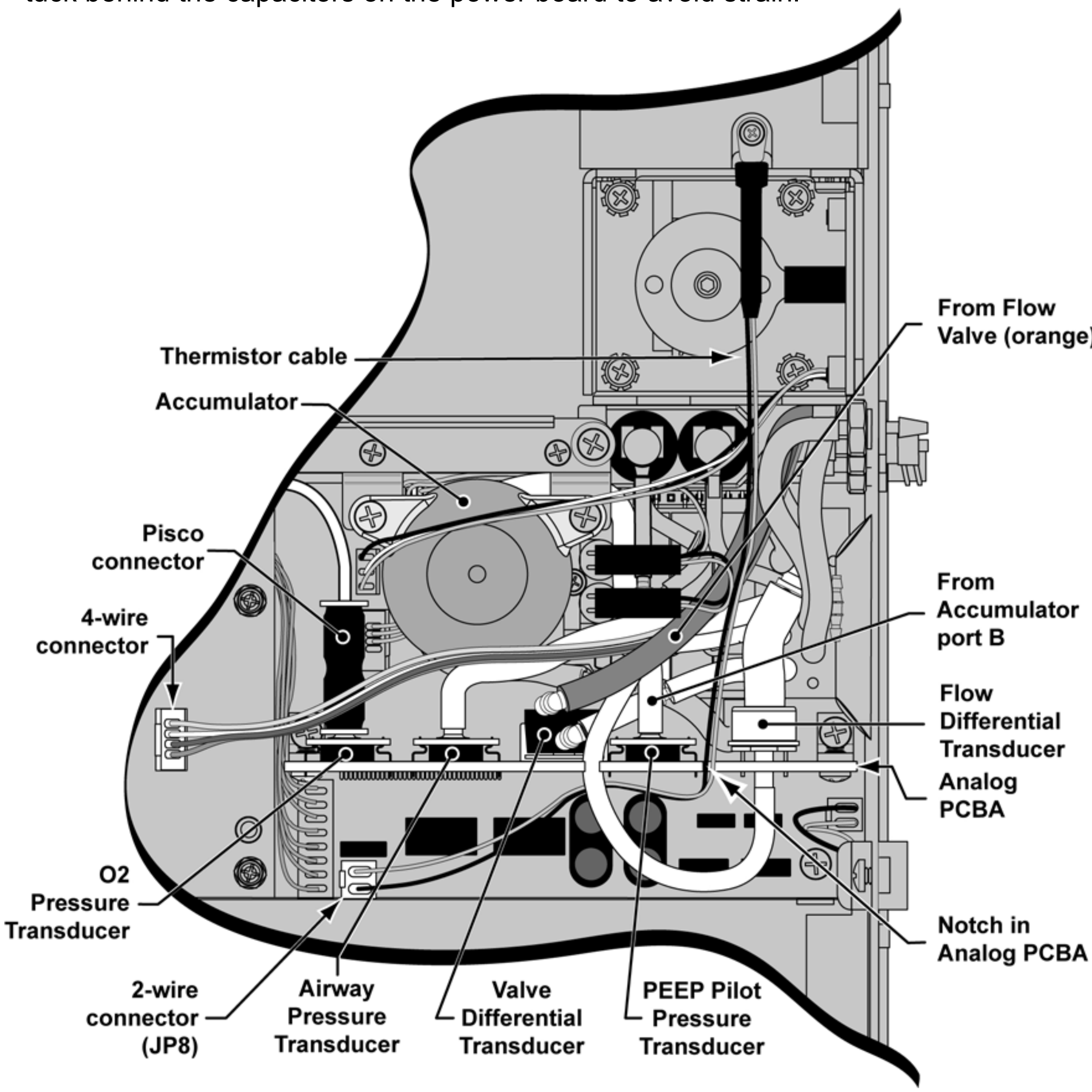


4) Slide the new flow valve assembly into place. Be sure not to catch any tubing or wiring under the manifold while it is being installed. The flow valve must be lined up so the screw seats on the inside of the upper weldment fit into the keyed slots in the bottom of the flow valve assembly.
5) Once the screw seats are in the slots, the flow valve body must be pressed towards the turbine manifold and then down so the screw seats slip into the mating holes in the bottom of the flow valve assembly.
6) Attach the terminal connector of the Thermistor Cable P/N 11399 with the orientation crimp side down as shown below. Screws should be torqued to **60 in-oz** (0.42 Nm).



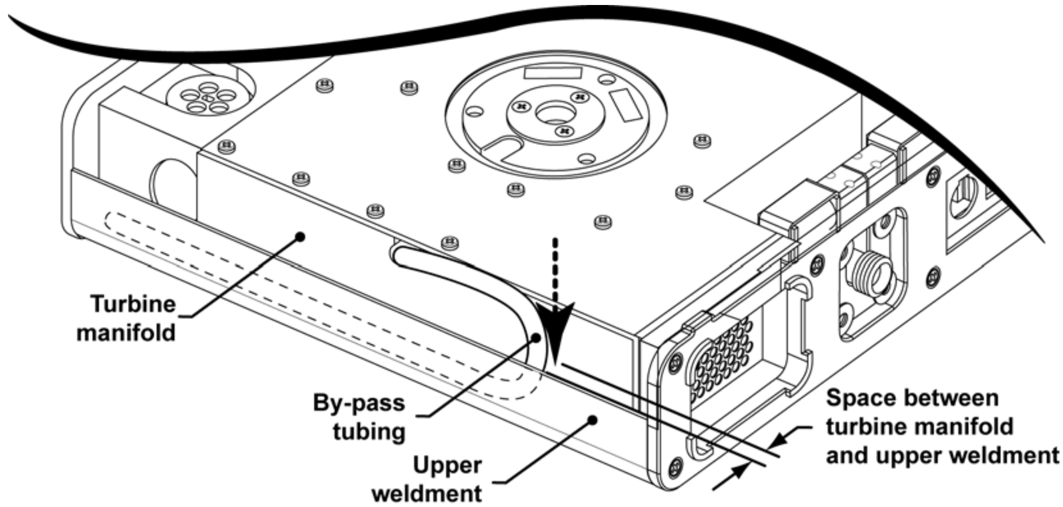
Cutaway View of Flow Valve

7) Carefully route the Thermistor Cable between the tubing, through the notch in the analog PCBA, and connect it to **JP8** on the power board as shown. The cable should tuck behind the capacitors on the power board to avoid strain.



> **NOTE**
> Make certain the Thermistor Cable does not interfere with the flow valve operation and that it does not strain the tubing connected to the solenoid manifold and analog PCBA.

8) Loop the bypass tubing down into the space between the manifold and the bottom edge of the upper weldment as shown so that it will not be pinched when the back of the ventilator is replaced.



9) Connect the orange tube to the valve differential transducer low pressure port on the analog board (furthest from the board).

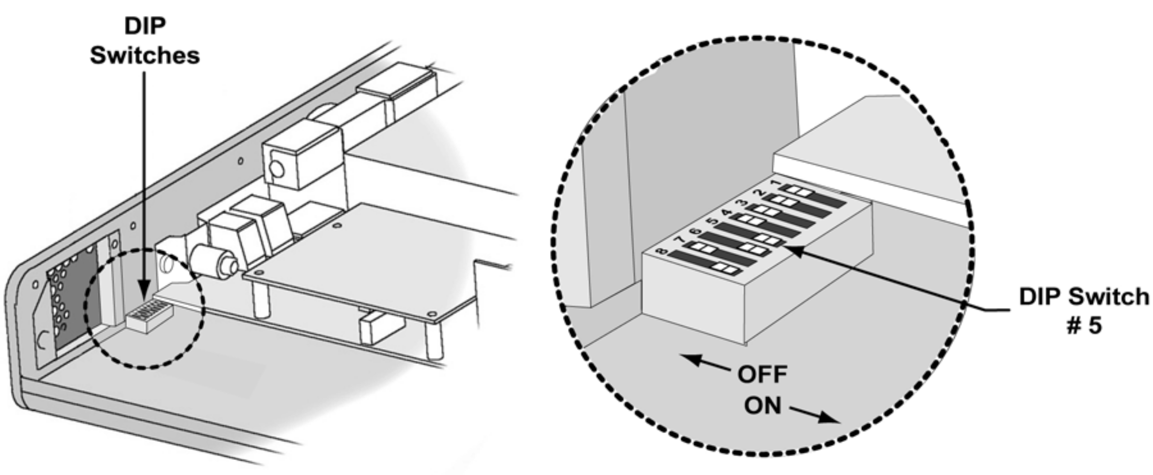
10) Connect the clear flexible tube from the flow valve to port #5 on the solenoid manifold. See internal flexible tube routing tables, instructions and diagrams on *page 8-33*.

11) Connect the 3-wire connector to the power board and the 4-wire connector to the motor board. Both connectors are keyed to install in one direction only and will snap into place when properly connected.

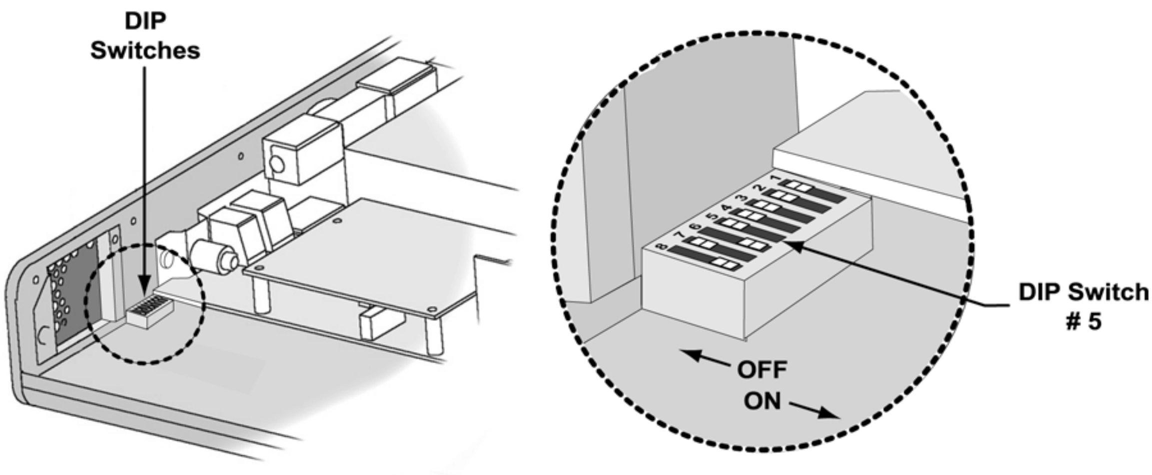
12) Reconnect the Pisco connector to the oxygen pressure transducer on the analog board (LTV® 1200 only). See internal flexible tube routing tables, instructions and diagrams on *page 8-33*.

13) Reconnect the internal battery (see instructions on *page 8-29*).

14) Set dip switch 5 to the **ON** position, power up the ventilator and enter the **FLOW VALVE** menu (see instructions on *page 6-35*.)



15) Select the VHome setting printed on the VHome label of the flow valve.
16) Enter the **TEMP COMP** menu and make sure that temperature compensation is set to **TCOMP ON.**
17) Power the ventilator off and set dip switch 5 to the **OFF** position (see instructions on *page 6-5*).



18) Install an O_2 Sampling Tube[48]. See *Back Panel, Reinstallation* in Chapter 8 – Component Removal and Replacement for detailed instructions.
19) Verify that no tubing is kinked or twisted, and that it will not be pinched when compressed by the back panel. Refer to the configuration instructions, tables and diagrams beginning on *page 8-33* to check the tubing routing. Always check ALL tube routing for kinks or compression that might result in restricted flows prior to closing the ventilator.
20) Reconnect the internal battery and replace the back panel (see *page 8-29*).

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[48] O_2 Sampling Tube, P/N 10544, ~10.0" long, 0.125" O.D. X 0.079 I.D. clear polycarbonate tubing.

Parts required for replacement:	Tools required:
• **LTV® 1200** Membrane Switch Panel P/N 17513-001 • **LTV® 1150** Membrane Switch Panel P/N 17513-006 • **LTV® 1200** Overlay Panel English P/N 17914-001 • **LTV® 1150** Overlay Panel English P/N 18985-001	• Phillips screwdriver with torque meter • Dental pick or flat tip screwdriver • Grounded anti-static wrist strap • 120 in-oz Torque Screwdriver

To remove the front panel:

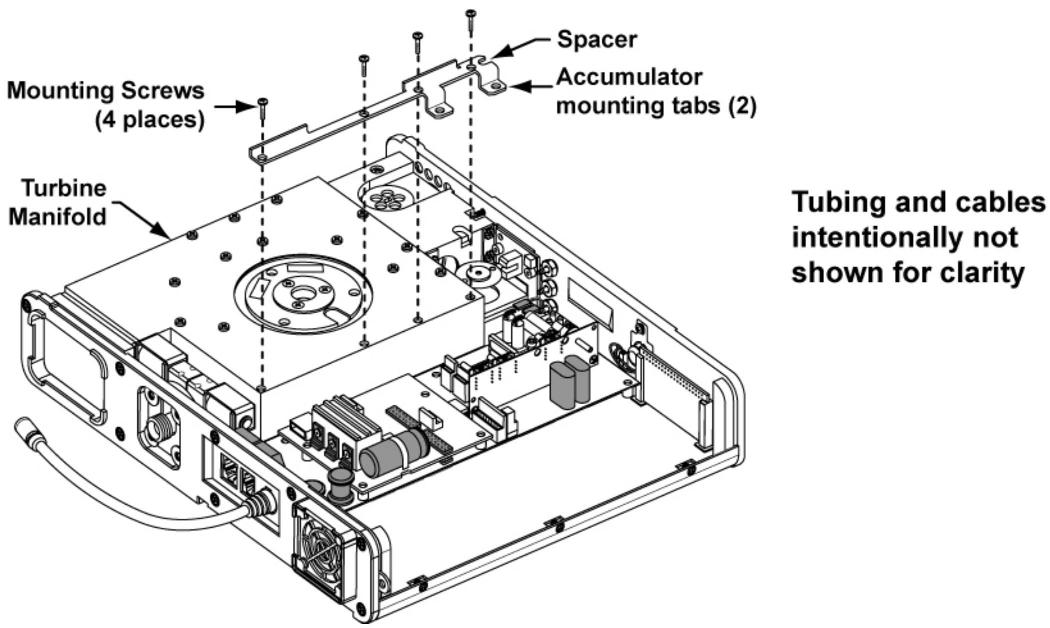
1) Remove the back panel of the ventilator and disconnect the internal battery cable (see instructions on *page 8-28*).
2) Remove the motor board (see instructions on *page 8-93*).

> **NOTE**
> **Tubing Configurations -** When disconnecting tubes, note their positions and review the internal flexible tube routing tables, instructions and diagrams beginning on *page 8-33*.
> If tubing needs to be replaced, consult the tables and instructions in *Internal Flexible Tubing* beginning on *page 8-33* for tubing diameters, lengths and routing diagrams.

3) Disconnect the Pisco connector from the oxygen transducer on the analog board. (LTV® 1200 only) See diagram on *page 8-57.*
4) Disconnect the 2-wire fan connector, 3-wire flow valve connector, 4-wire rotary switch connector, and 2-wire sounder connector from the power board.
5) Remove the sounder assembly (see instructions on *page 8-55*).
6) Disconnect the 8-wire oxygen blender connector from the power board (LTV® 1200 only).
7) Disconnect the 2-wire flow valve thermistor cable from the power board.
8) Remove the flow valve assembly (see instructions on *page 8-65*).
9) Disconnect the three (3) flexible tubes from the Flow Xducer and Exh Valve fittings on the side panel of the ventilator.

10) Remove the accumulator from the turbine manifold spacer.

11) Remove the four (4) screws securing the turbine manifold spacer to the turbine manifold assembly. Loosen or remove the single screw securing the solenoid mount assembly and remove the two screws holding down the accumulator. Move the solenoid mount assembly and the accumulator from the spacer. Remove the spacer and set aside away from the ventilator.



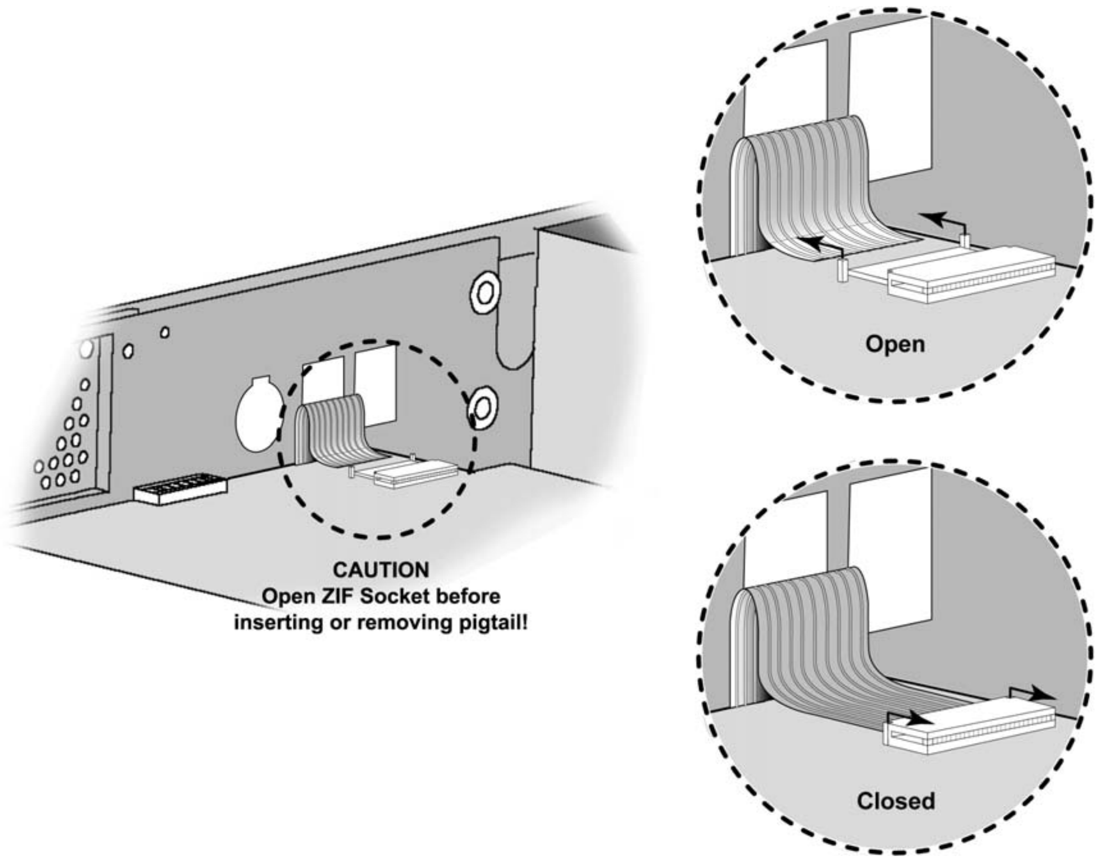
NOTE
The analog board, solenoid manifold and solenoid mount assembly cable may be left attached to the power board.

12) Remove the power board (see instructions on *page 8-104*). The analog board may be left attached to the power board. Be careful not to catch the power board on the sounder bracket while removing it.

CAUTION

Damage to contacts - Handle the ribbon cable carefully to prevent any damage to the silver contact area. Attempting to remove or attach the ribbon cable without opening the ZIF connector will damage the cable and may require replacement of the front membrane panel.

13) Slide the ZIF connector on the keypad ribbon cable open as shown below and carefully remove the ribbon cable from the connector.

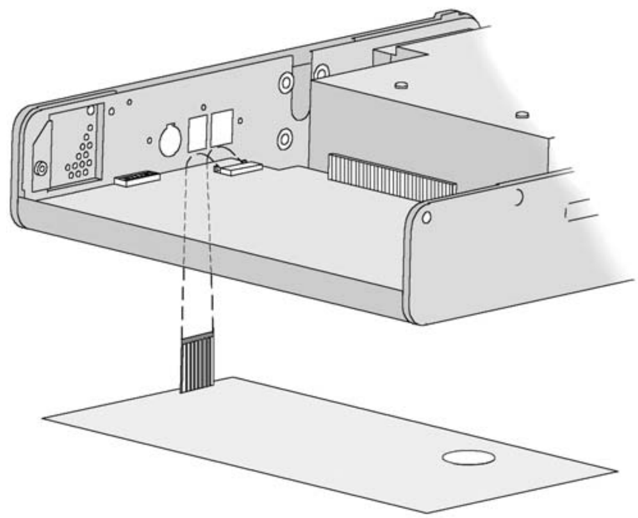


14) Using a dental pick or flat tip screwdriver, lift one corner of the membrane panel and overlay. Pull the membrane panel and overlay away from the upper weldment. Removing the panel will destroy it.

15) Remove all adhesive or panel parts from the front of the upper weldment. **The surface must be clean and free of obstructions before installing the new panel.** Any unevenness on the surface of the upper weldment could damage the new panel or cause it to operate incorrectly.

Installing a new front panel assembly:

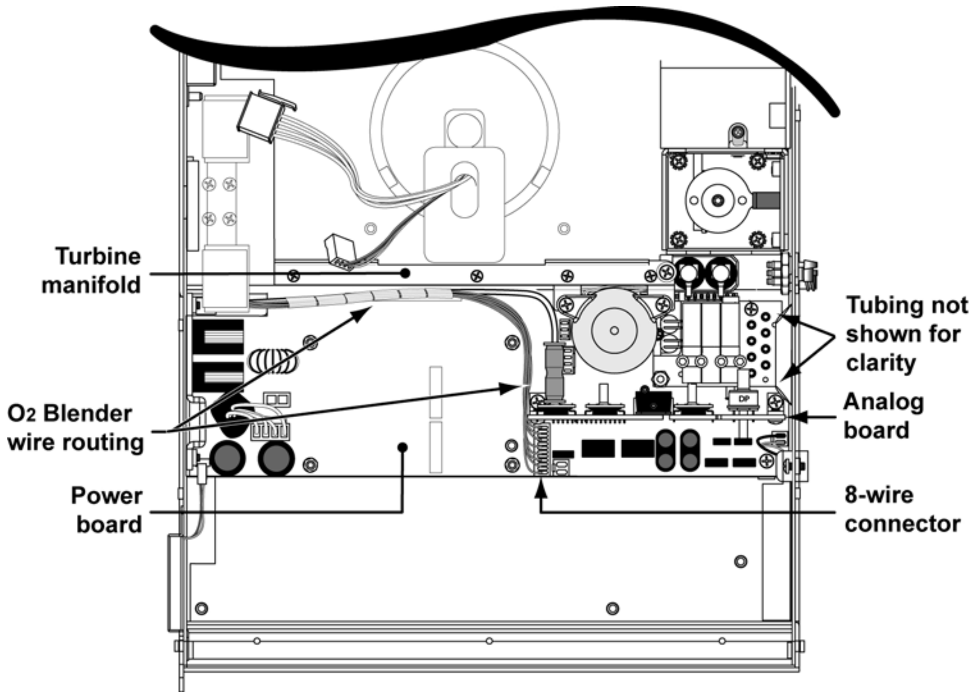
1) Remove the protective backing from the **bottom side only** of the new membrane panel.
2) Hold the upper weldment upright against a well-lit backdrop to assist in aligning the membrane panel with the cutouts in the upper weldment.
3) **Handle the ribbon cable carefully to prevent any damage to the silver contact area.** Carefully slide the ribbon cable out through the slot in the upper weldment.



4) **Be very careful when aligning the membrane panel -** once it is applied, it cannot be removed without destroying it. Carefully align the membrane panel with the upper weldment, making sure the cutout for the rotary switch is centered over the well in the upper weldment and that all display windows align over the corresponding openings. Press the membrane panel into place making sure the adhesive is well seated in all places.
5) Turn the ventilator over. Reconnect the ribbon cable (see instructions on *page 8-85*). **Be careful not to scratch the ribbon cable.**
6) Replace the power board (see instructions on *page 8-104*).
7) Replace the alarm sounder, (see instructions on *page 8-55*).
8) Reconnect the 2-wire fan connector, 4-wire rotary switch connector, and 2-wire sounder connectors to the power board. These are keyed connectors and can only be installed in one direction. They will snap into place when properly connected.
9) Reconnect the flexible tubes to the Flow Xducer and Exh Valve fittings on the side panel of ventilator following the internal flexible tube routing tables, instructions and diagrams on *page 8-33*. Inspect all flexible tubes for tears at the connecting ends and replace worn or damaged tubes if necessary.

> **NOTE**
> **Tubing Configurations -** If tubing is worn or damaged and needs to be replaced, consult the tables and instructions in *Internal Flexible Tubing* beginning on *page 8-33* for tubing diameters, lengths and routing diagrams.

10) Reconnect the 8-wire oxygen blender connector to the power board (LTV® 1200 only).



11) Ensure that the flexible tube from port B on the accumulator is tucked between the purge solenoids and the turbine manifold. Reattach the turbine manifold spacer to the turbine manifold using the four (4) 7/16" pan head screws (P/N 10433). Torque to **20 in-oz** (0.14 Nm).
12) Reattach the solenoid mount assembly using one .125 ID x .3125 OD washer (P/N 18032-001) and one 4-24 x 3/8" pan head screw (P/N 17682-001). Torque the screw to **120 in-oz** (0.84 Nm).
13) Reattach the accumulator to the spacer using two (2) 7/16" pan head screws P/N 10433. Screws should be torqued tightened to **60 in-oz** (0.42 Nm).
14) Replace the motor board. Use care when aligning the pass through connectors (see instructions on *page 8-93*).
15) Reinstall the flow valve assembly and reconnect the orange and clear flow valve tubing (see instructions on *page 8-65*).
16) Reconnect the 3-wire flow valve connector to the power board. The connector is keyed to fit in only one direction and will snap into place when properly connected.
17) Reconnect the Pisco connector to the oxygen transducer on the analog board (LTV® 1200 only).
18) Reconnect the 4-wire connector from the flow valve and the 3-wire and 5-wire connectors from the turbine to the motor board. The connectors are keyed to fit in only one direction and will snap into place when properly connected.
19) Reconnect the 2-wire flow valve thermistor cable and the 4-wire flow valve connector to the power board.

20) Install an O_2 Sampling Tube[49]. See *Back Panel, Reinstallation* in Chapter 8 – Component Removal and Replacement for detailed instructions.

21) Verify that no tubing is kinked or twisted, and that it will not be pinched when compressed by the back panel. Refer to the routing instructions, tables and diagrams beginning on *page 8-33* to check the tubing routing. **Always check ALL tube routing for kinks or compression that might result in restricted flows prior to closing the ventilator.**

22) Reconnect the internal battery and replace the back panel (see *page 8-29*).

23) Enter the Ventilator Checkout menu by powering up the ventilator while holding the **Select** button. Run the Display Test (see instructions on *page 2-4*). Running this test assists in the proper alignment of the overlay panel.

24) While running the display test, install the overlay panel on the front of the ventilator. Remove the paper backing from the top side of the membrane panel, and apply the overlay over the membrane panel. Carefully align the overlay panel with the upper weldment, making sure the cutout for the rotary switch is centered over the well in the upper weldment and that all display windows align over the corresponding openings. Press the overlay panel into place making sure the adhesive is well seated in all places.

[49] O_2 Sampling Tube, P/N 10544, ~10.0" long, 0.125" O.D. X 0.079 I.D. clear polycarbonate tubing.

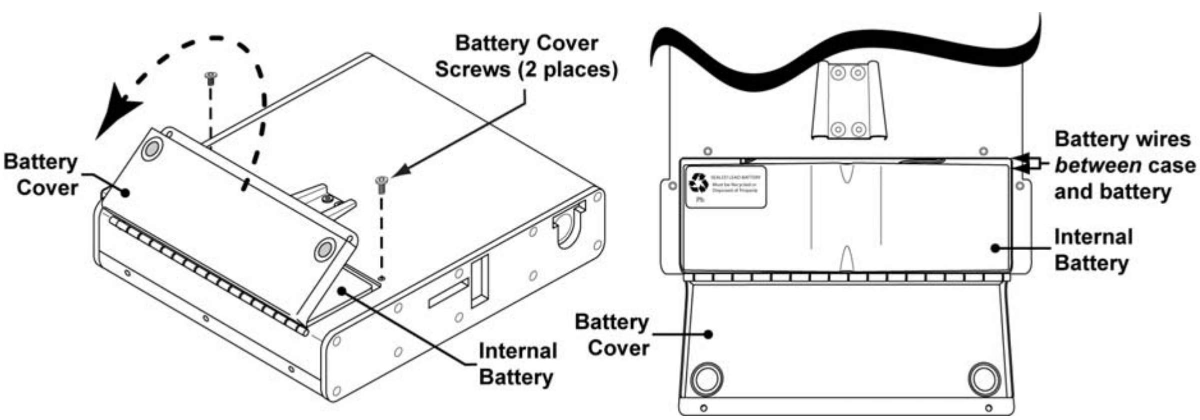
Parts required for replacement:	Tools required:
• LTV® 1200/1150 Internal Replacement Battery P/N 18634-001.	• Torque driver (120 in-oz/0.84 Nm) • 3/32” Hex bit

CAUTION

Internal Battery Use - The internal battery is intended for use in LTV® ventilators during short periods while switching between external power supply connections, emergency situations or short duration transports. The length of time the ventilator will operate on battery power is a function of many factors such as settings, charge level and condition or age of the battery; therefore, the use of the internal battery as a standard operating practice is not recommended.

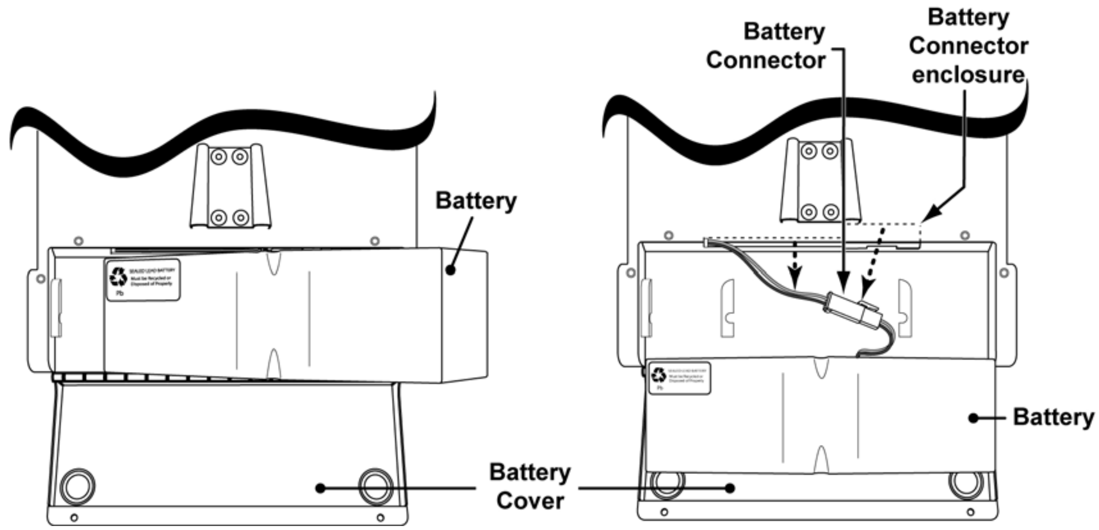
To remove and replace the battery pack:

1) Position the LTV® 1200/1150 ventilator as shown (front side down) on a clean, dry work surface and use a 3/32” hex bit to remove both button socket head cap screws (2, p/n 18296-001) from the Battery Cover.

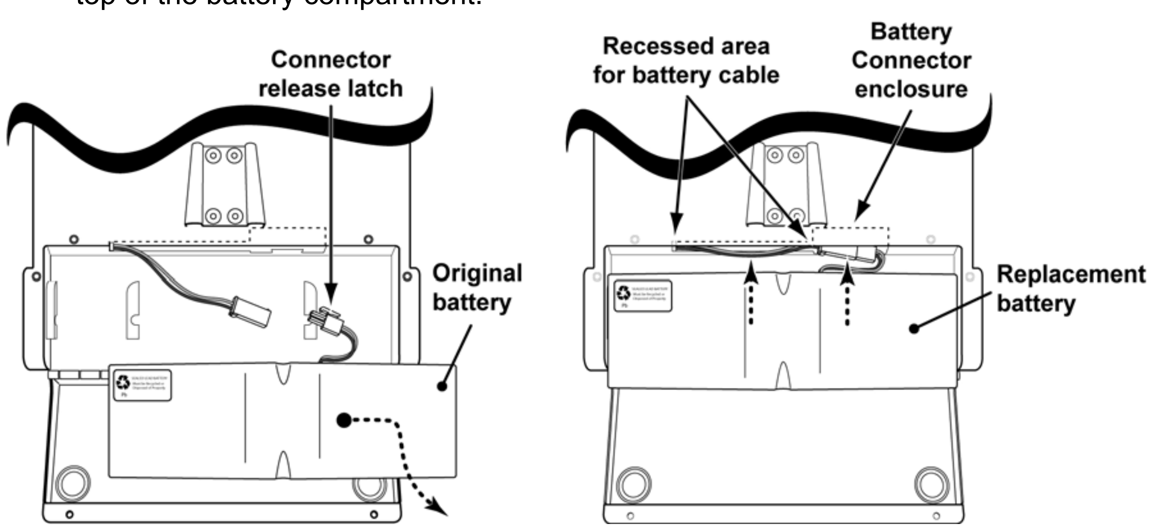


2) Open the cover and take note of how the battery connector wires are positioned between the side of the case and the battery.

3) Lift the battery out of the battery compartment and while moving it over to sit on the open battery cover, gently pull on the battery wires to remove the battery connector and cable from their protective enclosures.



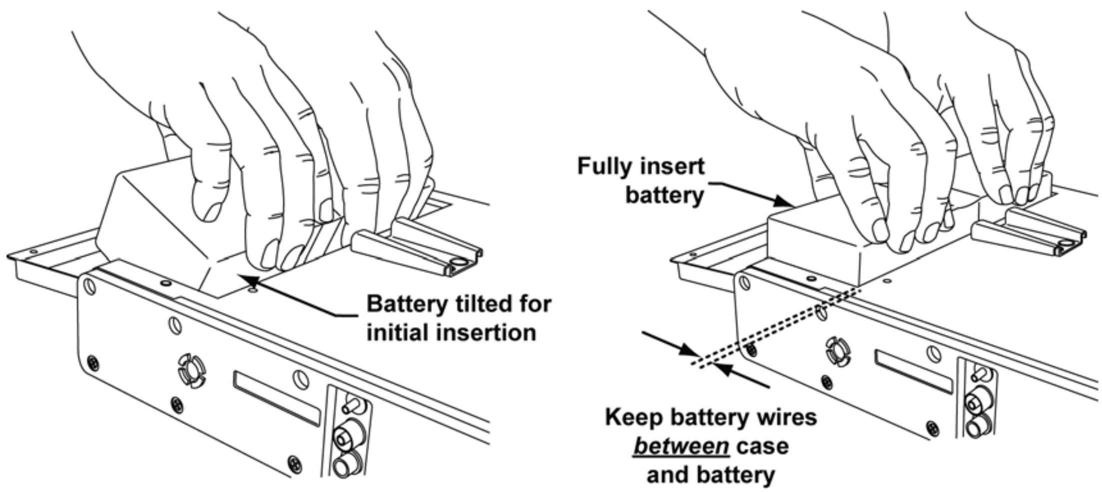
4) Press the connector release latch, disconnect the battery wire connector and set the original battery aside.
5) Set the replacement battery on the battery cover and reconnect the battery connector.
6) Position the battery over the compartment, fully insert the connector into the connector enclosure and route the cable into the recessed area under the lip at the top of the battery compartment.



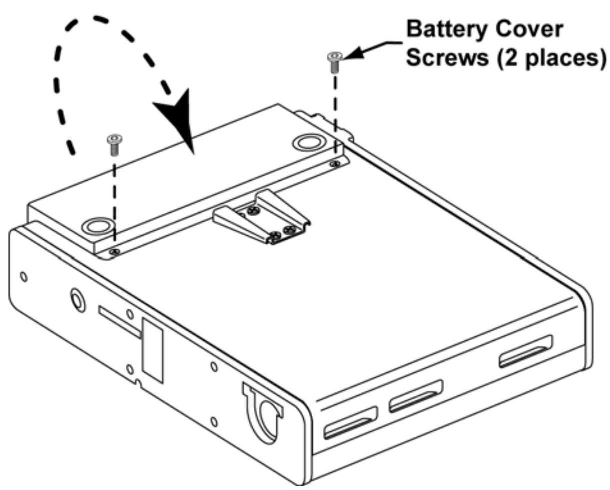
7) Ensure that the battery connector and battery cable are fully inserted into their enclosures, tilt the battery as shown and begin inserting it into the battery compartment.

8) Straighten the battery and continue pressing down until it is fully seated in the battery compartment.

    - keep the battery connector wires between the case and the side of the battery (not under, or above the battery).



9) Close the battery cover, replace the battery cover screws and use a torque driver and 3/32" hex bit to torque tighten to **120 in-oz** (0.84Nm).



10) Prior to initial use of the ventilator, charge the replacement battery by plugging the ventilator into an AC power source for 24 hours and check for proper operation by performing testing as specified in the *Checkout Test Selection* table in *Chapter 9 - Final Checkout Test.*

To preserve maximum battery life:

- Fully recharge the Internal Battery every 2 months while the ventilator is in storage. Recharge the battery by plugging the ventilator into an AC power source for 24 hours. If the LTV® battery **Charge Status** LED is not illuminated green within 24 hours, or if it is illuminated red, immediately contact a certified Pulmonetic Systems' service technician or Pulmonetic Systems.
- Store the ventilator at temperatures less than 60°C (140°F).
- A new battery should be charged on standby for 24 hours prior to use on a patient.

CAUTION

Storage Temperature - Storing the LTV® ventilator and/or the internal battery at temperatures above 60°C (140°F) for long periods can damage the internal battery and cause expected battery duration to degrade.

Battery Disposal:

The LTV® 1200/1150 ventilator's internal battery, P/N 18608-001, is a sealed lead acid battery. Some jurisdictions consider these batteries hazardous materials subject to special disposal regulations. Contact the proper agency for information on permissible methods of disposing of used batteries.

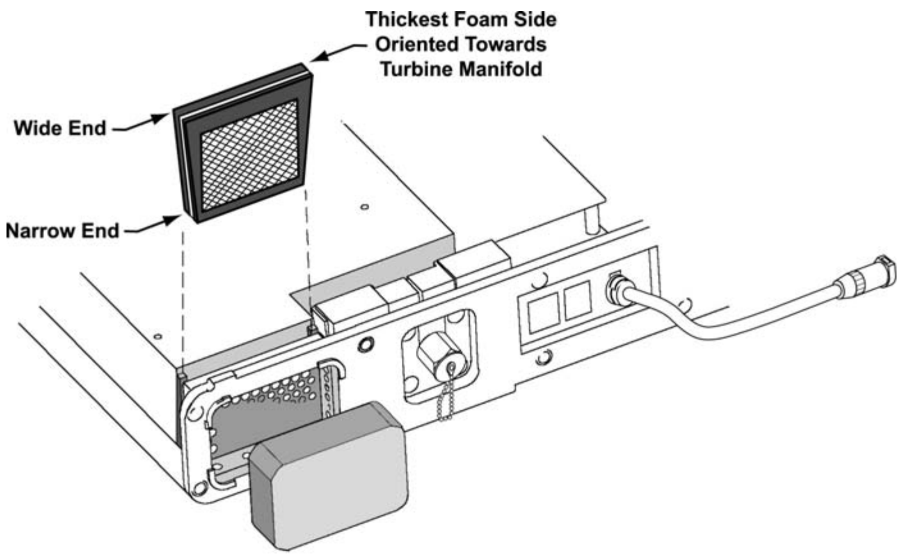
Internal Inlet Filter

The interior inlet filter should be removed and cleaned every 2 years or 10,000 hours. If the filter is damaged or can not be thoroughly cleaned, it should be replaced.

Parts required for replacement:	**Tools required:**
Replace if damaged: • Interior Inlet Filter P/N 10629	• Phillips screwdriver with torque meter • Flat tip screwdriver or dental pick • Grounded anti-static wrist strap • Mild cleanser • Soft cleaning brush

To clean or replace the interior inlet filter:

1) Remove the back panel of the ventilator and set it on its side beside the ventilator (see instructions on *page 8-28*).
2) Remove the internal inlet filter by lifting the edge carefully using your fingers or a flat tip screwdriver or dental pick if necessary. Be careful not to damage the edge of the filter, as it must seal against the adjacent surfaces.
3) Clean the filter using a gentle cleanser and a soft brush. Dry the filter completely.
4) Inspect the filter for damage. If the filter screen is not intact, shows signs of damage or if the edge is damaged, replace with a new filter.
5) Orient the filter as shown (with the thickest foam side facing in, toward the turbine manifold), and install the filter by sliding it **narrow end first** in between the External Inlet filter housing and the turbine manifold. The filter must seat completely so the top surface is flush with the turbine manifold.



6) Install an O_2 Sampling Tube[50]. See *Back Panel, Reinstallation* in Chapter 8 – Component Removal and Replacement for detailed instructions.
7) Reconnect the internal battery (if disconnected) and replace the back panel (see instructions on *page 8-29*).

[50] O_2 Sampling Tube, P/N 10544, ~10.0” long, 0.125” O.D. X 0.079 I.D. clear polycarbonate tubing.

Parts required for replacement:	Tools required:
• Main PCBA Assembly P/N 18233-001 or P/N 14791-001[51] **Replace if damaged:** • 1/4" Pan-head Screw (3) P/N 10435 • 3/16" Hex Standoffs (2) P/N 11543	• Phillips screwdriver and hex driver with torque meter • Grounded anti-static wrist strap

NOTE

When ordering a replacement Main PCBA assembly, be prepared to identify the serial number of the ventilator being serviced and the total usage hours on the unit. This will be required for programming the board prior to shipping.

To replace the Main Board:

1) Remove the back panel of the ventilator and disconnect the internal battery cable (see instructions on *page 8-28)*.
2) Remove the fan assembly (see instructions on *page 8-63)*.
3) Remove the motor board (see instructions on *page 8-93)*.

NOTE

Tubing Configurations - When disconnecting tubes, note their positions and review the internal flexible tube routing tables, instructions and diagrams beginning on *page 8-33*.

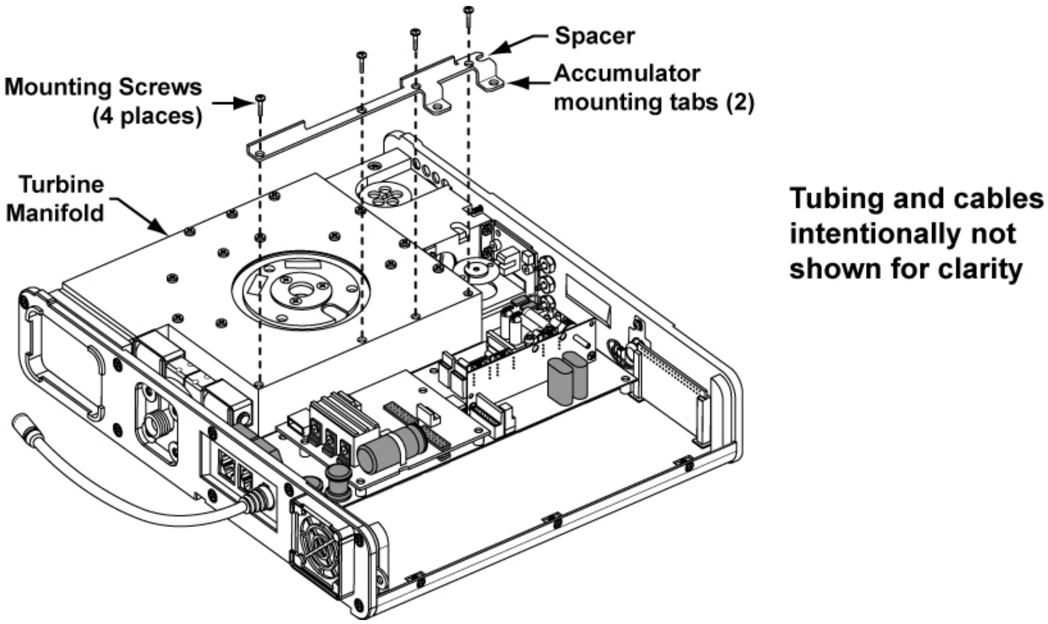
If tubing needs to be replaced, consult the tables and instructions in *Internal Flexible Tubing* beginning on *page 8-33* for tubing diameters, lengths and routing diagrams.

4) Disconnect the Pisco connector from the oxygen pressure transducer on the analog board (LTV® 1200 only).
5) Disconnect the 2-wire fan connector, 2-wire flow valve thermistor cable, 3-wire flow valve connector, 4-wire rotary switch connector, 8-wire oxygen blender connector (LTV® 1200 only), and 2-wire sounder connector from the power board.
6) Remove the sounder assembly (see instructions on *page 8-55*).
7) Remove the flow valve assembly (see instructions on *page 8-65*).
8) Disconnect the three (3) flexible tubes from the Flow Xducer and Exh Valve fittings on the side panel of the ventilator.

[51] Main PCBA Assembly, P/N 14791-001 must be installed with 05.07 or higher version software.

9) Remove the two (2) screws that secure the accumulator to the turbine manifold spacer, and remove the accumulator from the spacer.

10) Remove the four (4) screws that secure the turbine manifold spacer to the turbine manifold assembly.



11) Remove or loosen the one (1) screw that secures the solenoid mount assembly to the turbine manifold spacer, remove the solenoid mount assembly from the spacer, and set spacer aside, away from the ventilator.

NOTE

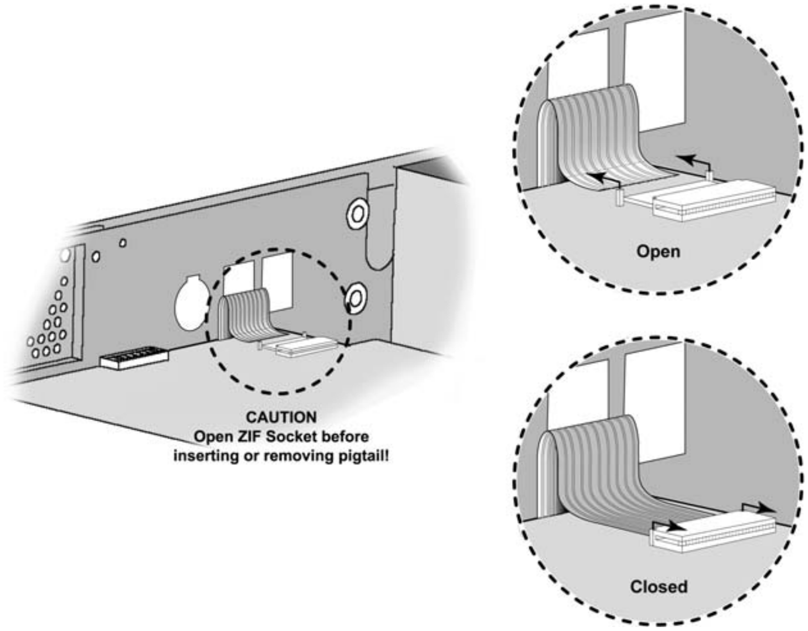
The analog board, solenoid manifold and the solenoid mount assembly cable may be left connected to the power board.

12) Remove the power board (see instructions on *page 8-104*). Take care not to catch the power board on the sounder bracket while removing it.

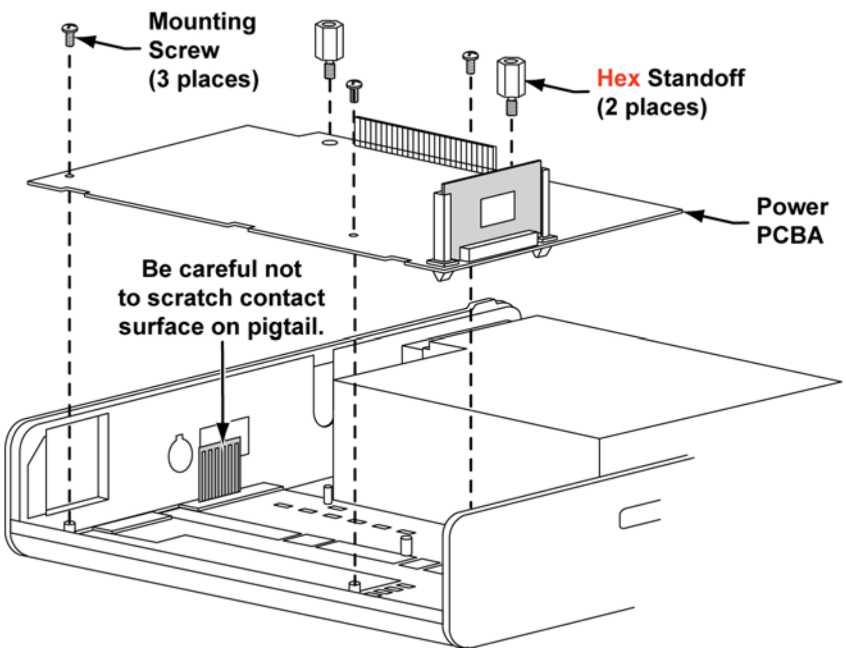
13) Slide the ZIF connector on the keypad ribbon cable open and carefully remove the ribbon cable from the connector.

CAUTION

Contact damage - Handle the ribbon cable carefully to prevent any damage to the silver contact area. Attempting to remove the ribbon cable without opening the ZIF connector will damage the ribbon cable and may require replacing the front membrane panel.



14) Remove the 3 main board mounting screws and the two hex standoffs.



15) Hold the ribbon cable out of the way and remove the main board.

> **CAUTION**
> **Damage to the ribbon cable -** Do not scratch the ribbon cable with the edge of the board even minor scratches on the connections can cause the keypad connections to fail.

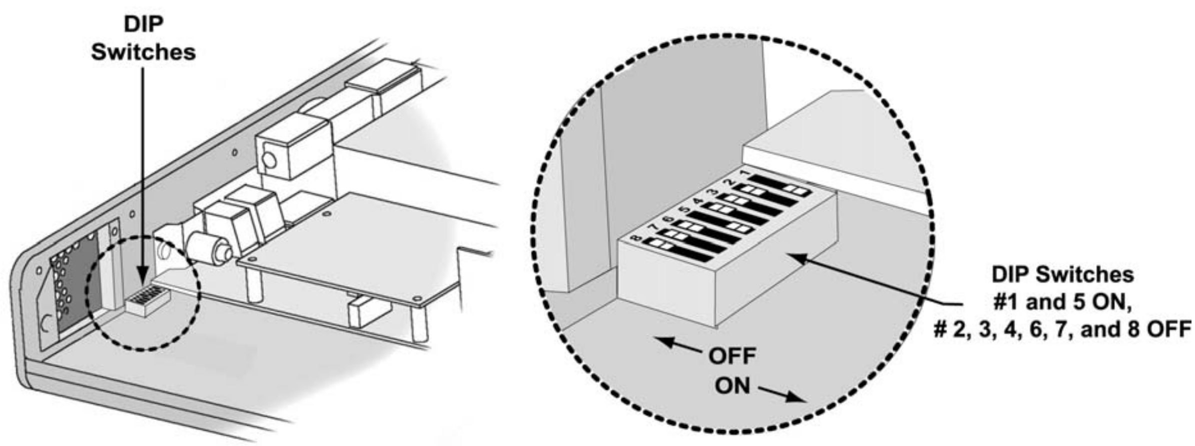
16) Remove the memory board from the main board (see instructions on *page 8-91*).

17) Hold the ribbon cable out of the way and install the new main board. **Be careful not to scratch the ribbon cable with the edge of the board.** When the main board is correctly aligned, the LEDs and displays will pop into place in the cutouts in the upper weldment.
18) Replace the three (3) 1/4" pan-head main board mounting screws (P/N 10435) and reinsert the two (2) 3/16" hex standoffs (P/N 11543) into the holes on the main board on each side of the 64-pin header. Torque-tighten screws and hex standoffs to **60 in-oz** (0.42 Nm).
19) Open the ZIF connector on the main board as shown in the illustration on the previous page. Carefully slide the keypad ribbon cable into the open ZIF connector on the main board. Once the ribbon cable is fully inserted, slide the ZIF connector closed.

CAUTION

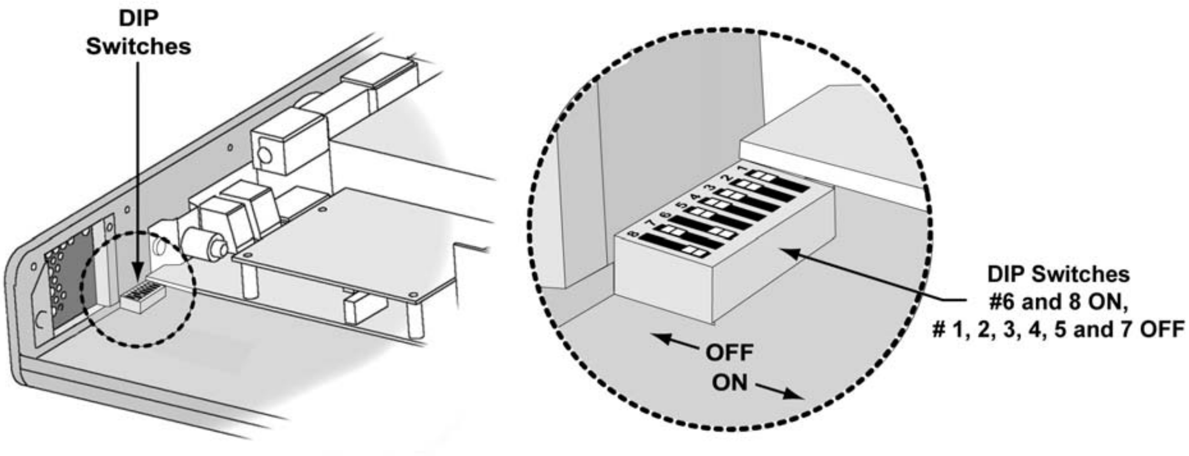
Damage to the ribbon cable - Attempting to insert the ribbon cable into a closed ZIF connector will damage the ribbon cable and you may have to replace the front membrane panel.

20) Reattach the memory board to the main board (see instructions on *page 8-91*).
21) Replace the power board, (see instructions on *page 8-104).*
22) Replace the alarm sounder, (see instructions on *page 8-55).*
23) Reconnect the 4-wire rotary switch connector, and 2-wire sounder connectors to the power board. These keyed connectors can only be installed in one direction and will snap into place when properly connected.
24) With main board, power board, and memory boards installed, move dip switches #1 and #5 to the **ON** position and all other dip switches to the **OFF** position.



25) Connect the AC adapter to the power pigtail connected to the power board. Press the **ON** button and all LEDs will be illuminated. Check the LED alignment. If alignment is required, remove the AC power adapter then adjust the main board and LEDs as needed.

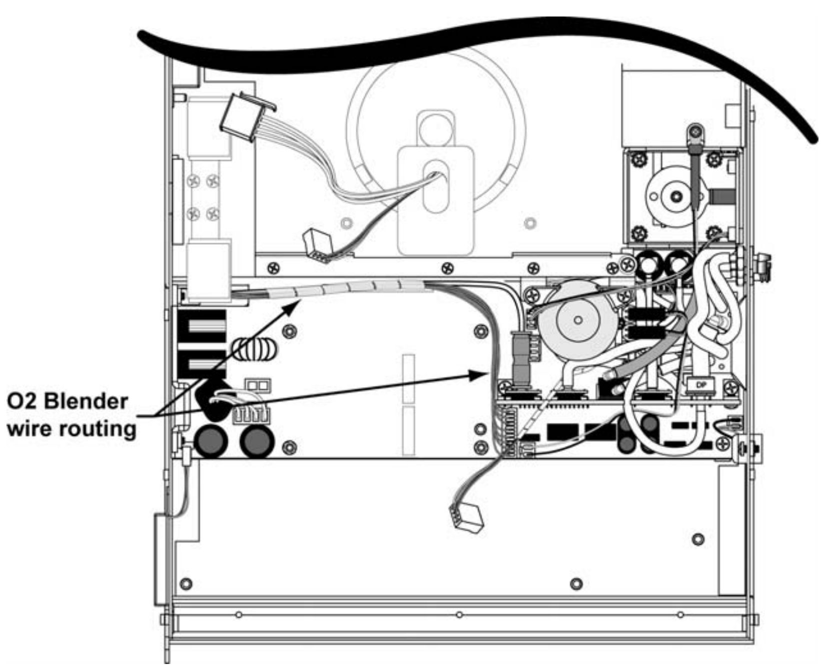
26) When LEDs are aligned, return all DIP switches to the default positions.



27) Reconnect the flexible tubes to the Flow Xducer and Exh Valve fittings on the side panel of the ventilator following the diagrams, tables and instructions beginning on *page 8-33*. Inspect all flexible tubes for tears at the connecting ends and replace worn or damaged tubes if necessary.

> **NOTE**
>
> **Tubing Configurations -** When disconnecting tubes, note their positions and review the internal flexible tube routing tables, instructions and diagrams beginning on *page 8-33*.
>
> If tubing needs to be replaced, consult the tables and instructions in *Internal Flexible Tubing* beginning on *page 8-33* for tubing diameters, lengths and routing diagrams.

28) Replace the fan assembly (see instructions on *page 8-63*).
29) Reconnect the 8-wire oxygen blender connector to the power board. Route as shown (LTV® 1200 only).



30) Ensure that the flexible tube from port B of the accumulator is tucked between the purge solenoids and the turbine manifold. Replace the turbine manifold spacer using four (4) 7/16” pan-head screws (P/N 10433), Torque-tightened to **60 in-oz** (0.42 Nm).

31) Replace the accumulator (see *Accumulator* on page *8-53*).

32) Replace the solenoid mount assembly (see *Solenoid Mount Assembly* on page *8-125*).

33) Replace the motor board. Use care when aligning the pass through connectors (see instructions on *page 8-93*).

34) Reinstall the flow valve assembly and reconnect the orange and clear flow valve tubing (see instructions on *page 8-65*).

35) Reconnect the 3-wire flow valve connector to the power board. The connector can only be installed in one direction and will snap into place when properly connected.

36) Reconnect the Pisco connector to the oxygen pressure transducer on the analog board (LTV® 1200 only).

37) Reconnect the 4-wire connector from the flow valve and the 3-wire and 5-wire connectors from the turbine to the motor board. These connectors can only be installed in one direction and will snap into place when properly connected.

38) Reconnect the 2-wire flow valve temperature connector to the power board. The connector can only be installed in one direction and will snap into place when properly connected.

39) Install an O_2 Sampling Tube[52]. See *Back Panel, Reinstallation* in Chapter 8 – Component Removal and Replacement for detailed instructions.

40) Verify that no tubing is kinked or twisted, and that it will not be pinched when compressed by the back panel. Refer to the routing instructions, tables and diagrams beginning on *page 8-33* to check the tubing routing. Always check ALL tube routing for kinks or compression that might result in restricted flows prior to closing the ventilator.

41) Reconnect the internal battery and replace the back panel (see *page 8-29*).

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[52] O_2 Sampling Tube, P/N 10544, ~10.0” long, 0.125” O.D. X 0.079 I.D. clear polycarbonate tubing.

Memory Board

The memory board contains the software that operates the ventilator. The memory board should need to be replaced only when upgrading the software to a new version. It is a generally a good practice to upgrade the ventilator software to the most current released version at the time the ventilator is being serviced. This will ensure the advantage of all new features and reliability improvements.

> **CAUTION**
>
> **Software Version–** Never install a version of software lower than the version originally installed. Erroneous operation may result from the installation of incompatible software. Generally, LTV® ventilator software is designed to be backwards-compatible.

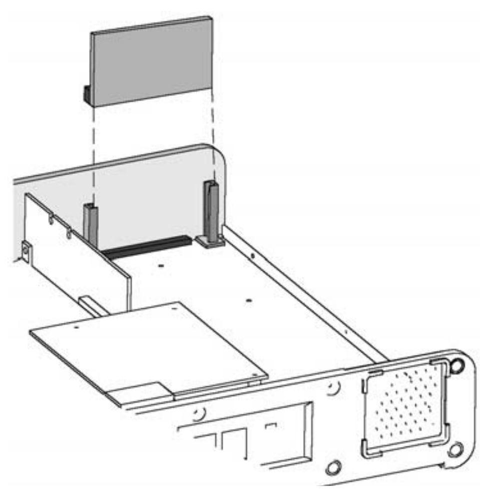
Parts required for replacement:	**Tools required:**
• Programmed Memory PCBA P/N 17476-001	• Phillips screwdriver with torque meter • Grounded anti-static wrist strap

To remove the Memory Board:

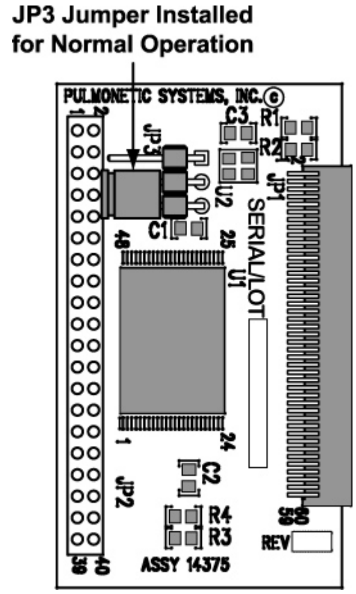
1) Remove the ventilator back panel and disconnect the internal battery cable from the power board (see instructions on *page 8-28*).

> **CAUTION**
>
> **Anti-static precautions** - It is especially important to observe ESD (Electro Static Discharge) precautions whenever handling the memory board. Always wear a grounded anti-static wrist strap when handling the ventilator with the case open.

2) Remove the programmed memory PCBA from its supporting rails by gripping the corners firmly between two fingers and pulling upwards.



Installing the new memory board:



1) Verify jumper is installed in the **Normal Operation** position of the **JP3** connector (as shown), prior to installing the memory board.
2) Install the new memory board by lining the edges up in the supporting rails and sliding it into position. Be sure the connector on the memory board is oriented correctly to line up with the mating connector on the main PCBA. Press the board in place until the connectors are firmly seated.
3) Install an O_2 Sampling Tube[53]. See *Back Panel, Reinstallation* in Chapter 8 – Component Removal and Replacement for detailed instructions.
4) Reconnect the internal battery and replace the back panel (see instructions on *page 8-29*).
5) To verify the new software version, power up the vent and enter the Extended Features menu. Select **VENT OP** and rotate the knob until the **VER** string is displayed. Verify that the version string displayed matches the version of the newly installed software on the memory board.
6) After upgrading the LTV® software version, check each of the LTV® configuration settings (see *Configuration*, *page 6-33*).
7) Upgrading LTV® software will require recalibration of the LTV® ventilator. (see *Calibration*, *page 6-6)*.

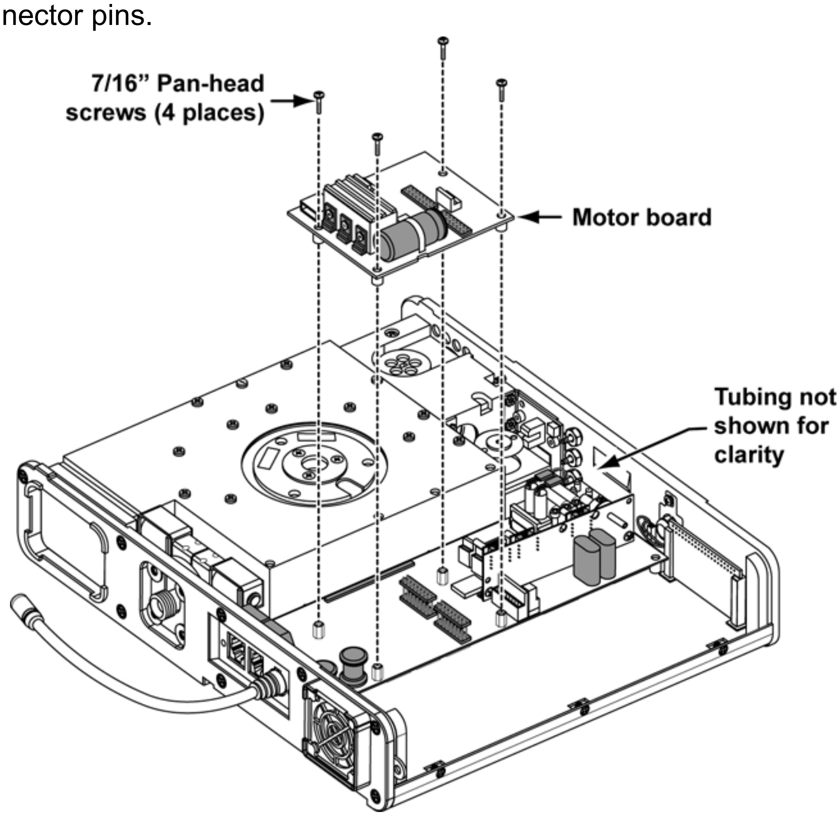
[53] O_2 Sampling Tube, P/N 10544, ~10.0” long, 0.125” O.D. X 0.079 I.D. clear polycarbonate tubing.

Motor Board Assembly

Parts required for replacement:	Tools required:
• Motor PCBA Assembly P/N 10135-002 **Replace if damaged:** • 7/16" Pan-head Screw (4) P/N 10433	• Phillips screwdriver with torque meter • Grounded anti-static wrist strap

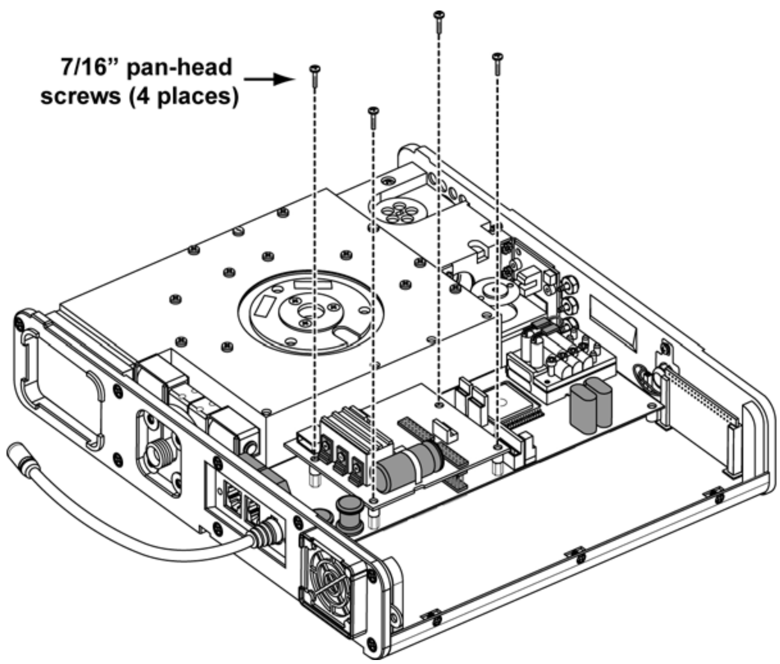
To replace the Motor Board:

1) Remove the back panel of the ventilator and disconnect the internal battery cable (see instructions on *page 8-28*).
2) Disconnect the 4-wire connector from the flow valve and the 3-wire and 5-wire connectors from the turbine.
3) Remove the 4 motor board mounting screws.
4) Pull the motor board straight up and off the mating power board connectors. Be careful to pull the motor board up evenly and without rocking side to side or bending the power board connector pins.



Installing the motor board:

1) Verify the power board mating connector pins are straight and undamaged.
2) Install the new motor board by placing it on the four threaded stand-offs on the power board. Align the board so that the connector pins on the power board are indexed into the mating connector holes in the motor board.
3) Using finger pressure, press straight down on the motor board directly above the pins and mating connectors for the power board. The motor board should seat on the power board so that the pins on the power board visibly protrude through the top of the connector on the motor board.
4) Thread four screws (P/N 10433, 7/16" pan-head) into the mounting holes in the motor board and torque-tighten to **60 in-oz** (0.42 Nm).



5) Reconnect the 4-wire connector from the flow valve and the 3-wire and 5-wire connectors from the turbine. The connectors are keyed to fit in only one direction and will snap into place when properly connected.
6) Install an O_2 Sampling Tube[54]. See *Back Panel, Reinstallation* in Chapter 8 – Component Removal and Replacement for detailed instructions.
7) Verify that no tubing is kinked or twisted, and that it will not be pinched when compressed by the back panel. Refer to the routing instructions, tables and diagrams beginning on *page 8-33* to check the tubing routing. **Always check ALL tube routing for kinks or compression that might result in restricted flows prior to closing the ventilator.**
8) Reconnect the internal battery and replace the back panel (see *page 8-29*).

[54] O_2 Sampling Tube, P/N 10544, ~10.0" long, 0.125" O.D. X 0.079 I.D. clear polycarbonate tubing.

O_2 Blender Assembly / O_2 Block

Parts required for replacement:	Tools required:
• O_2 Blender Assembly P/N 15079-001 or O_2 Block with Fittings P/N 18345-001 • Cable Tie P/N 10466 • O_2 Donut Seal P/N 10603 • RTV P/N 10122 • Silicone Gel Lubricant P/N 10123[55] **Replace if damaged:** • Thermo Conductive Pad P/N 10129 • Sealing Gasket P/N 10175 • Damping Grommets (4) P/N 10266 • Grounding Clips (4) P/N 10752 • Green O_2 Port Cover (O_2 Block) P/N 14446	• Phillips screwdriver with torque meter • Grounded anti-static wrist strap • Small dykes or cutters • Mild cleanser • Cable tie tool • Flow Valve Insertion Tool (Mylar) P/N 14206 • Torque screwdriver (120 in-oz/0.84 Nm)

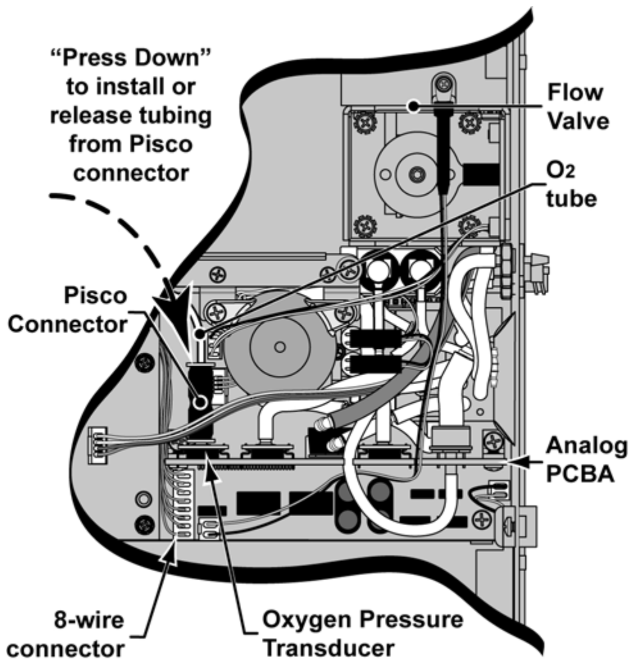
When replacing the O_2 blender assembly (LTV® 1200) or O_2 Block (LTV® 1150), it is easiest to remove several components and replace them together. These will be done in the following order:

- Remove the back panel and disconnect the battery
- Remove the left soft side
- Remove the motor board (LTV® 1200 only)
- Remove the flow valve
- Remove the turbine manifold and oxygen blender/O_2 Block as a unit
- Disconnect the oxygen blender/O_2 Block from the turbine manifold
- Connect the new oxygen blender/O_2 Block to the turbine manifold
- Replace the oxygen blender/O_2 Block and turbine manifold as a unit
- Replace the flow valve
- Replace the motor board
- Replace the left soft side
- Reconnect the battery and replace the back panel

[55] In the European Union, Loctite® 8104 may be substituted as an equivalent compound.

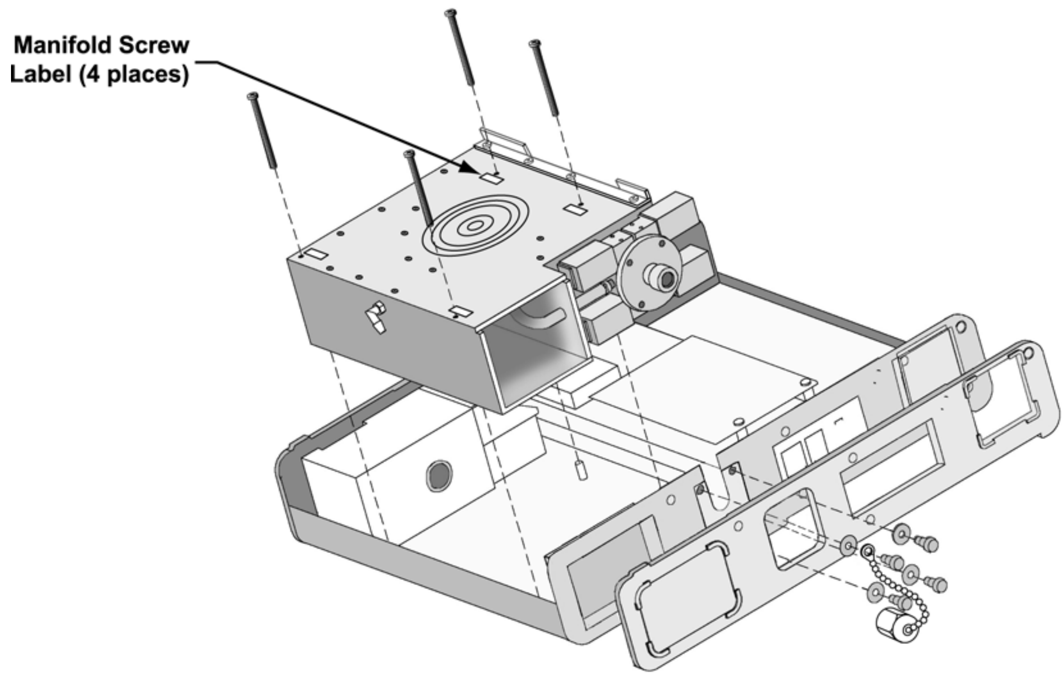
To remove the Turbine Manifold and Oxygen blender/O_2 Block:

1) Remove the back panel and disconnect the battery (see instructions on *page 8-28*).
2) Remove the left soft side (see instructions on *page 8-116*).
3) Remove the motor board (LTV® 1200 only) (see instructions on *page 8-93*).
4) Disconnect the O_2 blender 8-wire connector from the power board (LTV® 1200 only).
5) Disconnect the O_2 tube from the Pisco connector on the oxygen pressure transducer on the analog board as shown (LTV® 1200 only).



6) Remove the flow valve (see instructions on *page 8-65*).
7) Remove the two (2) screws securing the accumulator to the turbine manifold spacer and loosen or remove the one (1) screw securing the solenoid mount assembly. Detach the accumulator and the solenoid mount assembly from the spacer.

8) Remove the four (4) black screws from the turbine manifold.
9) Remove the four (4) blender mounting screws and metal washers from the left side of the ventilator.



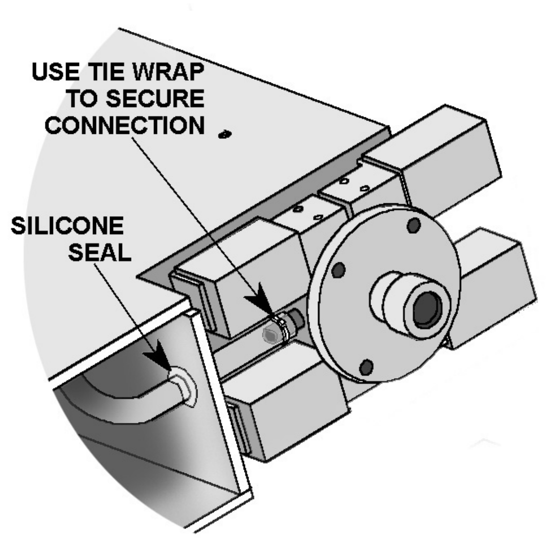
10) Remove the oxygen blender/O_2 Block, turbine manifold and interior inlet filter. Be careful not to dislodge the grounding straps and grommets that are between the oxygen blender and the side of the ventilator case.
11) The thermo conductive pad beneath the turbine may adhere to the turbine when it is removed, or may remain attached to the case. If the thermo conductive pad remains attached to the case, check it for damage or hardening and replace it if necessary. If the pad comes out with the turbine, replace it with a new pad.

To replace the thermo conductive pad:

1) Peel the thermo conductive pad off.
2) If there is adhesive residue left on the inside of the upper weldment or the turbine assembly, remove it by washing with a mild cleaner.
3) Remove the protective backing from the smooth side of the new thermo conductive pad and center it on the turbine surface.
4) Remove the protective cover from the thermo conductive pad.

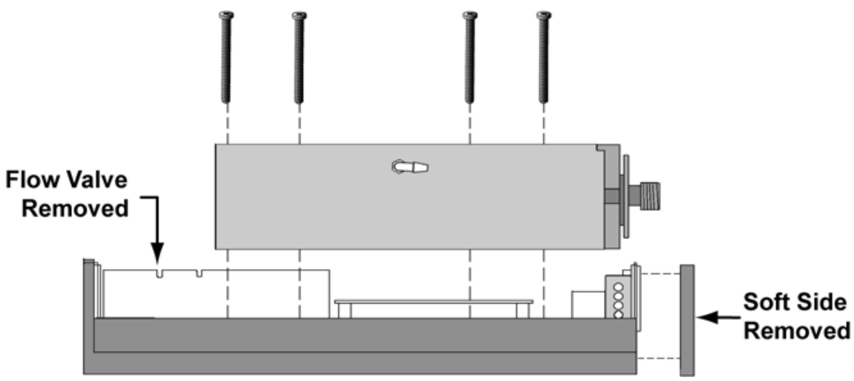
To connect the Turbine Manifold to a new Oxygen Blender/O_2 Block:

1) Handle the manifold and blender/O_2 Block carefully so as not to break the silicone seal around the oxygen tube entering the manifold. If this seal is damaged, repair with RTV silicone adhesive.
2) Cut the cable tie around the tube connection to the oxygen blender/O_2 Block. Separate the oxygen blender/O_2 Block and turbine manifold.
3) Make a loose loop with a cable tie and slide it over the tube that connects the turbine manifold to the oxygen blender/O_2 Block. Connect the tube to the barbed fitting on the oxygen blender/O_2 Block.
4) Using a cable tie tool, tighten the cable tie to 2 tension. The cable tie tool should trim the tail off close to the connector.

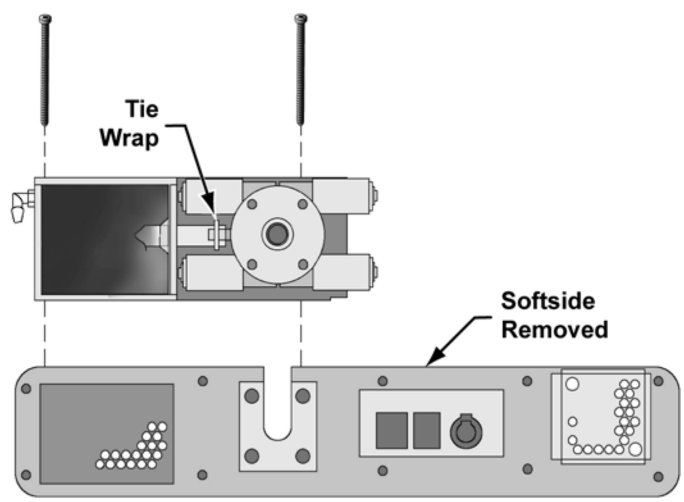


To install the Turbine Manifold and Oxygen Blender/O_2 Block:

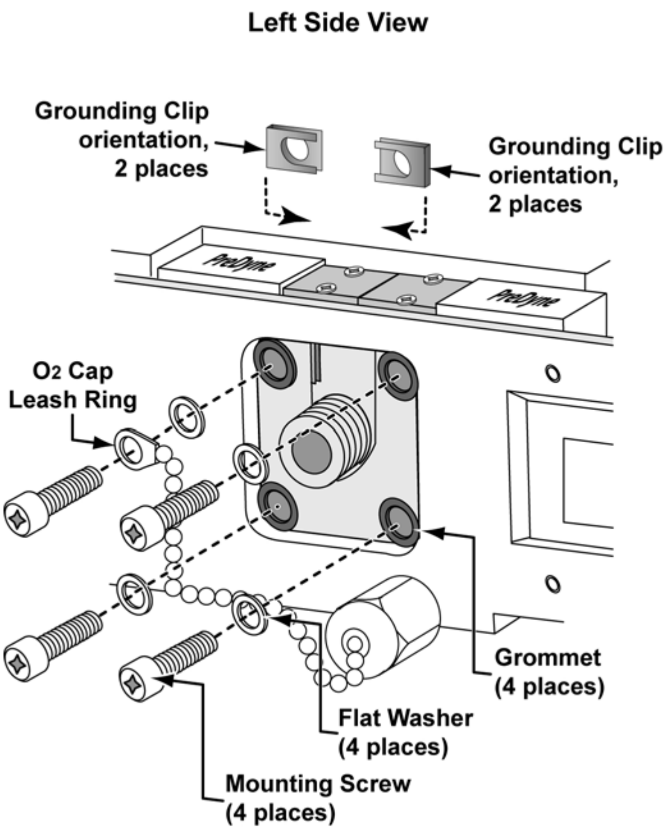
1) Slide the turbine manifold and oxygen blender/O_2 Block into place. Be sure not to catch any tubing or wiring under the manifold while it is being installed.

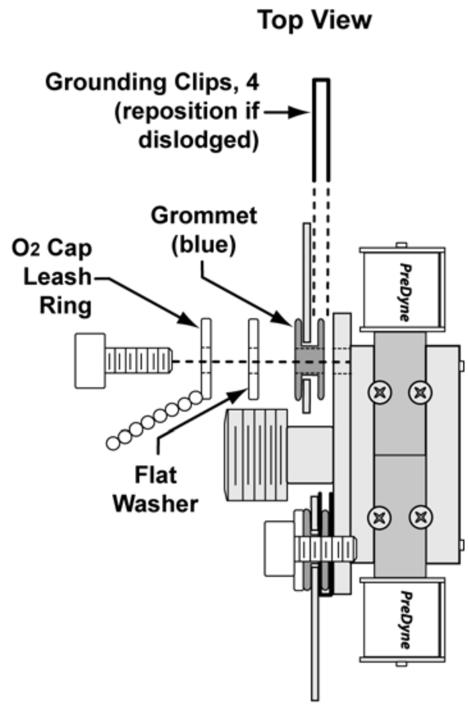


2) Replace the 4 black screws (P/N 10918B) into the turbine manifold. Torque to **20 in-oz** (0.14 Nm).



3) Check the blue rubber grommets (P/N 10630) and grounding clips (P/N 10752) on the oxygen blender mounting (4 each) for wear and replace if necessary (LTV® 1200 only).





4) **For the LTV® 1200:** Replace the four (4) blender mounting screws (P/N 10176), O_2 blender cap, and four (4) flat metal washers (P/N 10594). The grounding clips should be positioned over the inside lip of the grommets, aligned with the edge of the side panel and oriented as shown in the illustrations. Screws should be torqued to **60 in-oz** (0.42 Nm).

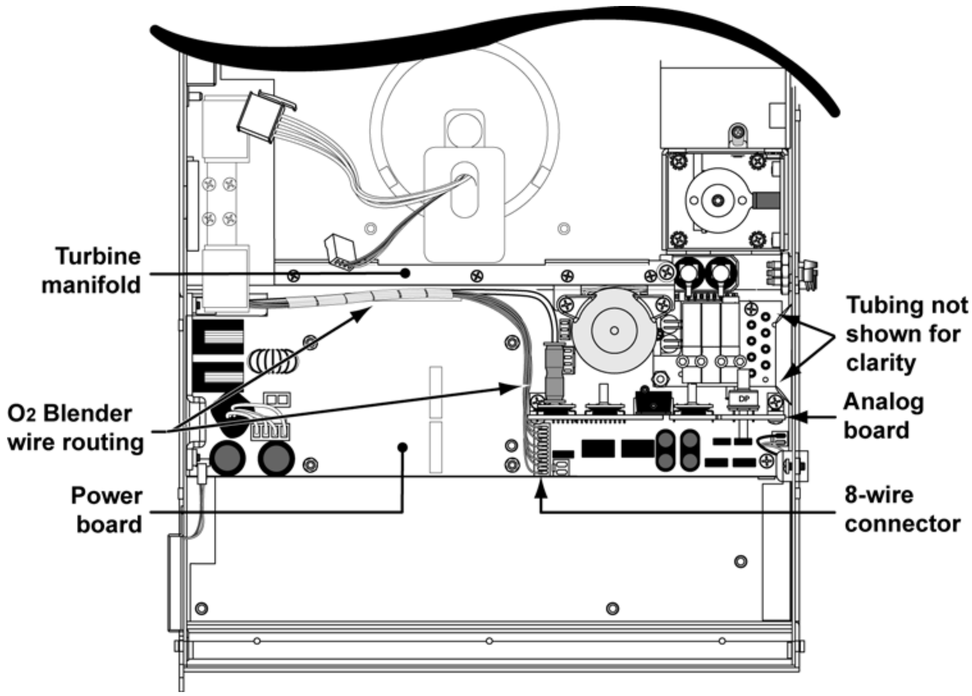
   For the LTV® 1150: Replace the four (4) O_2 Block mounting screws (P/N 10627), Green O_2 port cap (P/N 14446), and four (4) plastic shoulder washers (P/N 10630). Screws should be torqued to **60 in-oz** (0.42 Nm).

NOTE

If the upper clips are not properly aligned with the edge of the side panel, the back panel of the ventilator will not seat correctly. Use a straight edged screwdriver or pick to prevent each grounding clip from turning as the mounting screws are tightened (LTV® 1200 only).

5) Connect the 8-wire connector from the oxygen blender to the power board. The connector is keyed to fit in only one direction and will snap into place when properly connected (LTV® 1200 only).

6) Tuck the wrapped wires and oxygen tube down along the side of the turbine manifold against the power board (LTV® 1200 only).



7) Replace the motor board (LTV® 1200 only) (see instructions on *page 8-93*).

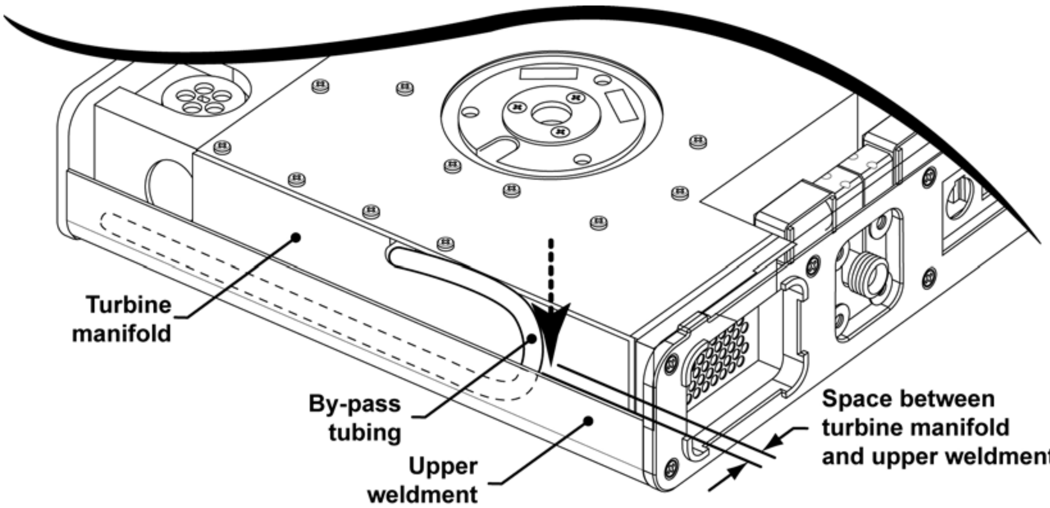
8) Connect the 3-wire and 5-wire connectors from the turbine to the motor board. The connectors are keyed to fit in only one direction and will snap into place.

9) Replace the single (1) screw and washer attaching the solenoid mount assembly to the turbine manifold spacer. See instructions on *page 8-127*. Torque the screw to **120 in-oz** (0.84Nm).

10) Inspect the orange seal on the side of the flow valve. If it is damaged, remove and replace it with a new seal as follows: Peel the old seal off the flow valve. Remove any old adhesive from the flow valve using a mild detergent and dry the valve side. Remove the protective backing from the flow valve seal and press it into place.

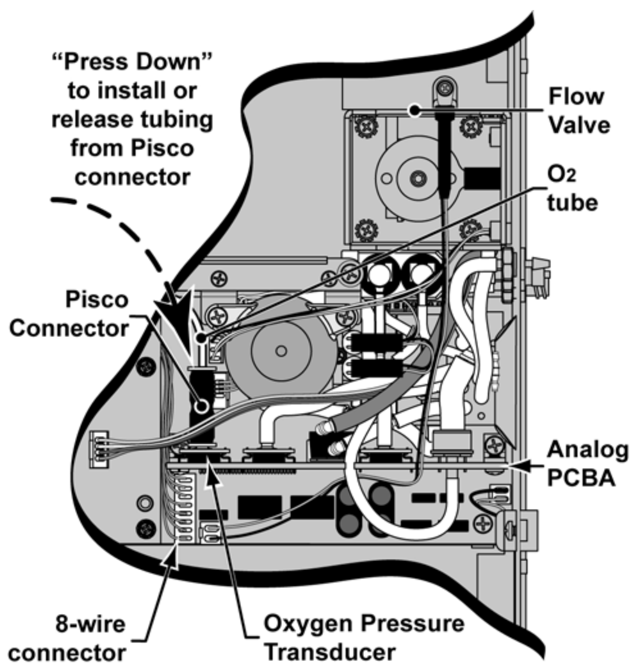
11) Replace the flow valve (see instructions on *page 8-65*).

12) Connect the bypass tubing from the flow valve to the barbed elbow at the bottom of the turbine manifold. The tubing should be looped into the space between the bottom of the manifold and the bottom edge of the upper weldment so that it is out of the way and will not be pinched when the back of the ventilator is replaced.



13) Replace the two (2) 7/16” pan-head screws securing the accumulator to the turbine manifold spacer. See instructions on *page 8-53.* Torque both screws to **60 in-oz** (0.42 Nm).
14) Reconnect the 3-wire flow valve connector to the power board. The connector is keyed to fit in only one direction and will snap into place when properly connected.

15) **LTV® 1200 Only:** Insert the O_2 tube from the blender into (at least 1/2”) the Pisco connector attached to the oxygen pressure transducer on the analog board. Gently pull (~2-lbs force) the tube while holding the Pisco connector to ensure it is properly attached.
    - If the tube is not inserted correctly, it will detach when a high pressure oxygen source is connected to the ventilator



16) Reconnect the orange tube from the flow valve to the valve differential transducer low pressure port on the analog board (furthest from the board).
17) Reconnect the clear flexible tube from the flow valve to port #5 on the solenoid manifold.
18) Reconnect the 4-wire flow valve connector to the motor board and the 2-wire flow valve temperature connector to the power board. The connector is keyed to fit in only one direction and will snap into place when properly connected.
19) Replace the internal inlet filter (see instructions on *page 8-84*).
20) Replace the left soft side (see instructions on *page 8-116*).
21) Install an O_2 Sampling Tube[56]. See *Back Panel, Reinstallation* in Chapter 8 – Component Removal and Replacement for detailed instructions.
22) Verify that no tubing is kinked or twisted, and that it will not be pinched when compressed by the back panel. Refer to the routing instructions, tables and diagrams beginning on *page 8-33* to check the tubing routing. **Always check ALL tube routing for kinks or compression that might result in restricted flows prior to closing the ventilator.**
23) Reconnect the internal battery and replace the back panel (see *page 8-29*).

[56] O_2 Sampling Tube, P/N 10544, ~10.0” long, 0.125” O.D. X 0.079 I.D. clear polycarbonate tubing.

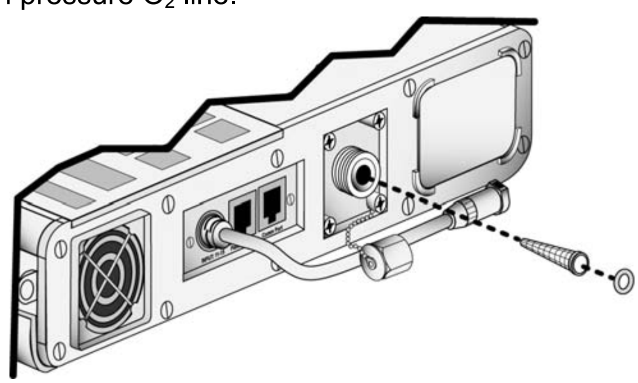
O_2 Blender Filter (LTV® 1200 only)

The O_2 inlet filter should be cleaned or replaced every 10,000 hours or 2 years of service or more frequently if needed. If the ventilator is operated with a low grade or contaminated O_2 source, the O_2 inlet filter may need to be replaced more often. If the filter is damaged or cannot be thoroughly cleaned, it should be replaced.

Parts required for replacement:	Tools required:
Replace if damaged: • Oxygen Blender Filter P/N 14313 • O-Ring P/N 10609	• Dental pick • Mild cleanser • Soft brush

To clean or replace the O_2 inlet filter:

1) Disconnect the high pressure O_2 hose from the oxygen block on the left side of the ventilator.
2) Using a pick, remove the rubber O-ring from inside the O_2 inlet port. Tip the ventilator to allow the O_2 inlet filter to slide out.
3) To clean the filter, use a mild cleaner, warm water and a soft brush. Rinse the filter thoroughly to remove all traces of the cleanser. Allow the filter to dry completely before replacing it in the ventilator.
4) Inspect the filter for damage. If the filter cannot be completely cleaned or shows signs of damage replace it with a new filter and O-ring.
5) Replace the filter by sliding it back into the O_2 inlet port. Replace the O-ring, making sure it is completely tucked under the retaining lip on the inside of the O_2 inlet port.
6) Reconnect the high pressure O_2 line.



Parts required for replacement:	Tools required:
• Power PCBA P/N 18120-001 or P/N 14944-001	• Phillips screwdriver with torque meter • Grounded anti-static wrist strap • P/N 11599 – Power PCB Separator[57] • 1/4" Nut driver adapter for torque wrench • 120 in-oz (0.84 Nm) torque screwdriver

To replace the Power PCBA and DC Cord Pigtail related hardware

WARNING

Mounting Screw Use – Be sure to use the correct length mounting screws as specified in the instructions or internal damage to the ventilator may result.

1) Remove the back panel of the ventilator and disconnect the internal battery cable (see instructions on *page 8-28*).
2) Remove the motor board (see instructions on *page 8-93*). Retain screws for reinstallation.

NOTE

Tubing Configurations - When disconnecting tubes, note their positions and review the internal flexible tube routing tables, instructions and diagrams beginning on *page 8-33* .

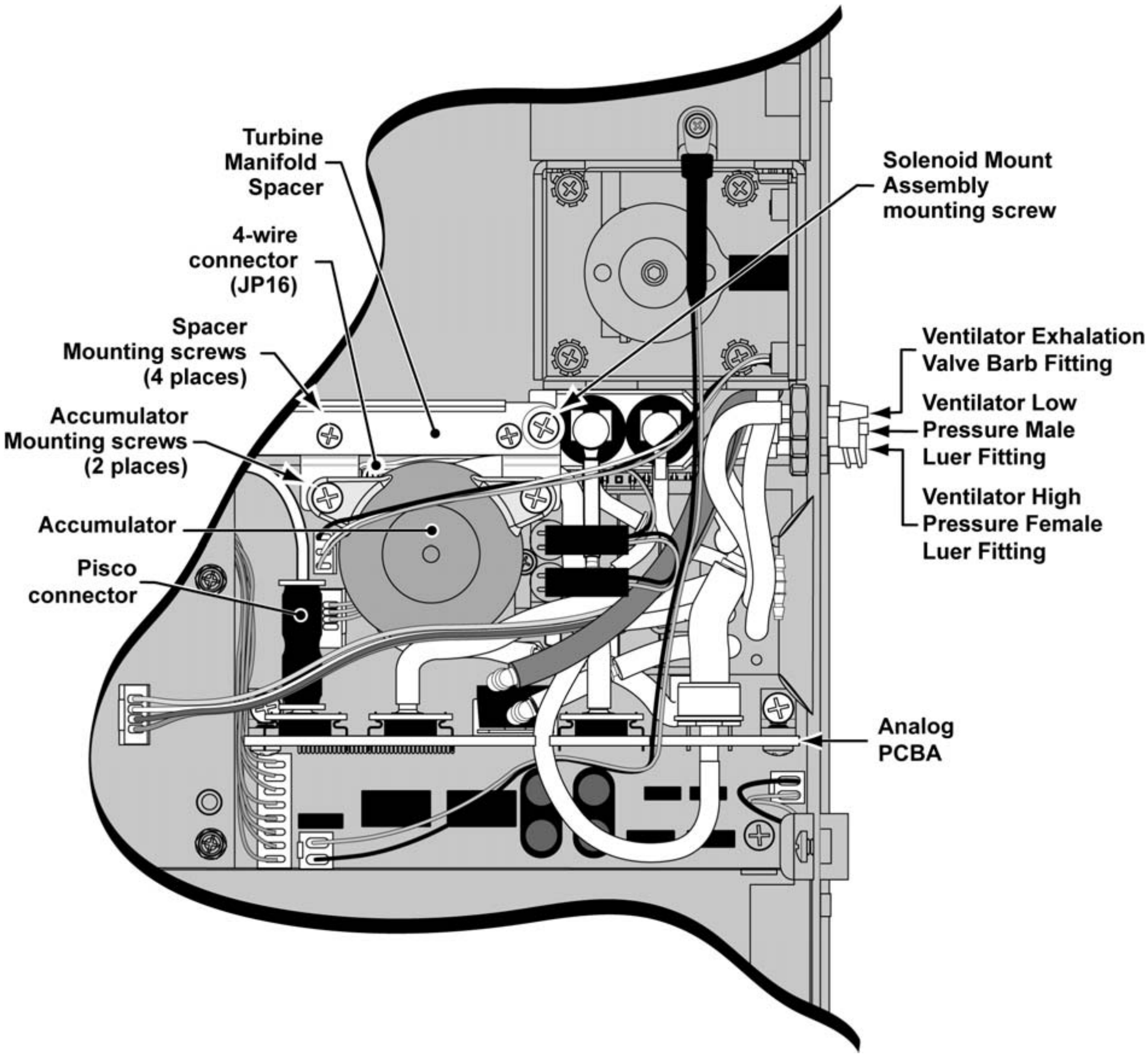
If tubing needs to be replaced, consult the tables and instructions in *Internal Flexible Tubing* beginning on *page 8-33* for tubing diameters, lengths and routing diagrams.

3) Disconnect the Pisco connector from the oxygen pressure transducer on the analog board (LTV® 1200 only).
4) Disconnect the 2-wire fan connector, 3-wire flow valve connector, 4-wire rotary switch connector, 8-wire O_2 blender (LTV® 1200 only), 2-wire flow valve temperature, and 2-wire sounder connectors from the power board.
5) Remove the alarm sounder (see instructions on *page 8-55*).
6) Remove the flow valve assembly (see instructions on *page 8-65*).
7) Disconnect the three (3) flexible tubes from the Flow Xducer and Exh Valve fittings on the side of the ventilator.

[57] The Power PCB Separator tool is available separately, or as part of the Maintenance Calibration Kit, P/N 11566.

8) Remove or loosen the one (1) screw with washer that secures the solenoid mount assembly to the spacer.

9) Remove the two (2) screws attaching the accumulator to the spacer and remove the accumulator from the turbine manifold spacer.

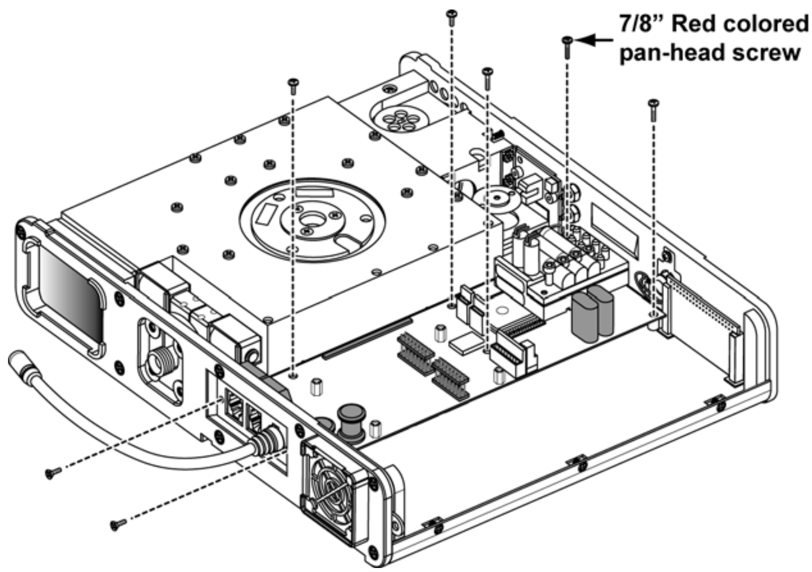


10) Remove the four (4) screws that secure the turbine manifold spacer to the turbine manifold. Carefully remove the turbine manifold spacer and set it aside, away from the ventilator.

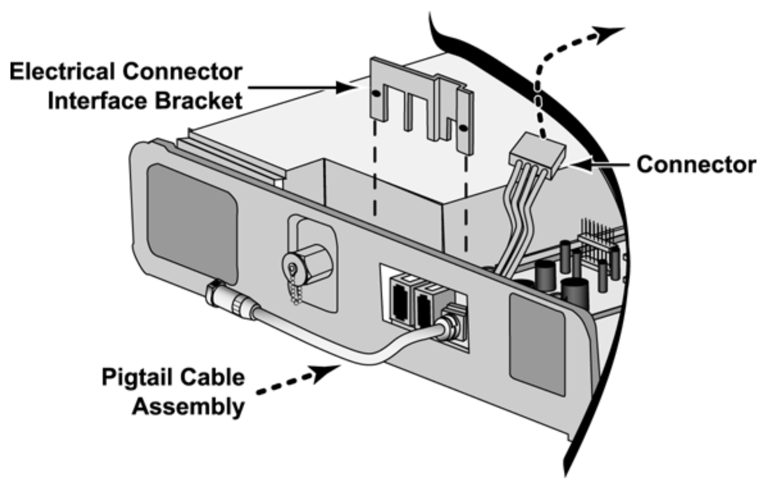
11) Remove the analog board (see instructions on *page 8-57*).

12) Disconnect the 4-wire solenoid mount connector from **JP16** on the power board.

13) Remove the power board mounting screws (2 attaching the power board and/or the Pigtail cable assembly to the side panel from the outside (retain) and five (5) located on the face of the board). See illustration below.



14) Pull the pigtail connector interface bracket straight up and off the power board connectors and the molded strain relief portion of the pigtail cable assembly.

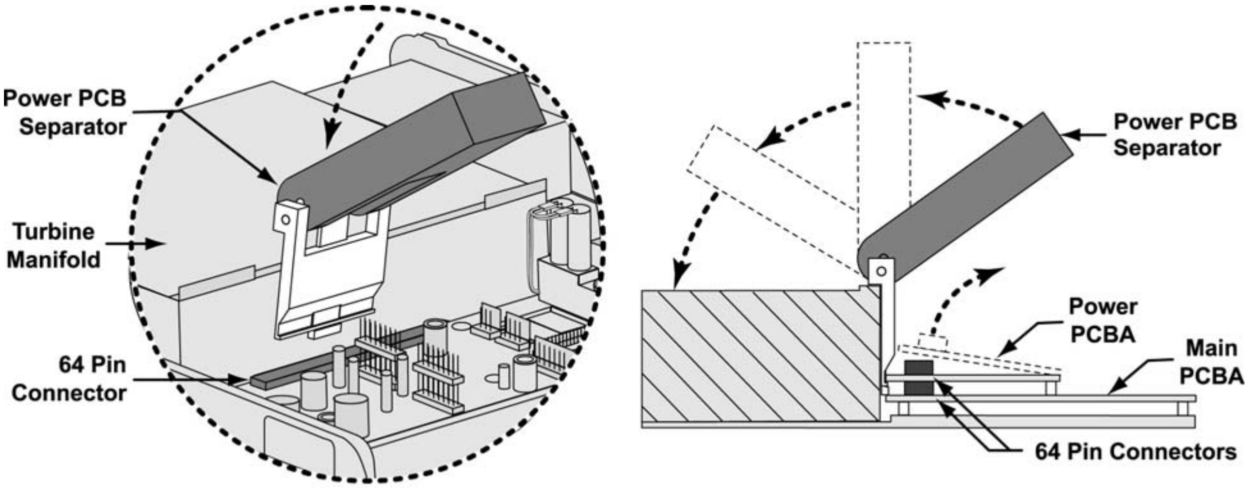


15) Disconnect the 4-wire pigtail cable assembly connector from **JP6** on the power board and slide the pigtail cable assembly out of the keyed-round hole of the upper weldment and set aside.

16) Disconnect the two 2-wire connectors from the purge solenoids and remove the mounting nut from the solenoid manifold.

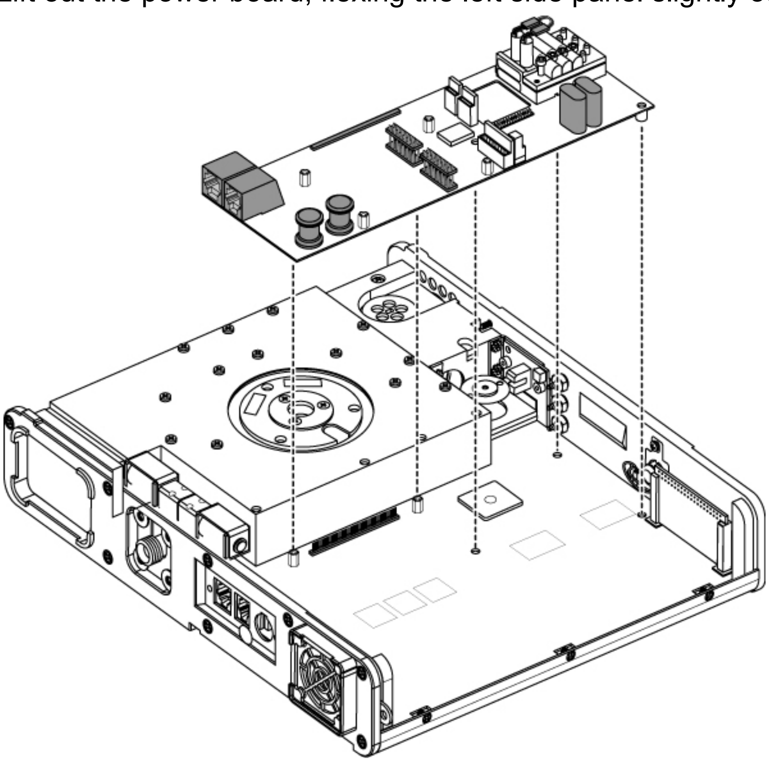
17) Insert a power PCB separator tool (P/N 11599) into the gap between the edge of the power board and the turbine manifold, at the approximate mid-point of the 64-pin connector (see ***Detail*** illustration on next page). The tool may need to be moved left or right along the gap to insert.

18) Position the back surface of the lower portion of the tool against the turbine manifold with the lowest edge of the tool resting on the main PCBA below the power board. Hold the lower portion of the tool against the turbine manifold and rotate the handle backwards and down toward the top surface of the turbine manifold to separate the power and main PCBA mating connectors (see ***Cut-away*** *illustration* below).



Detail **Cut-away**

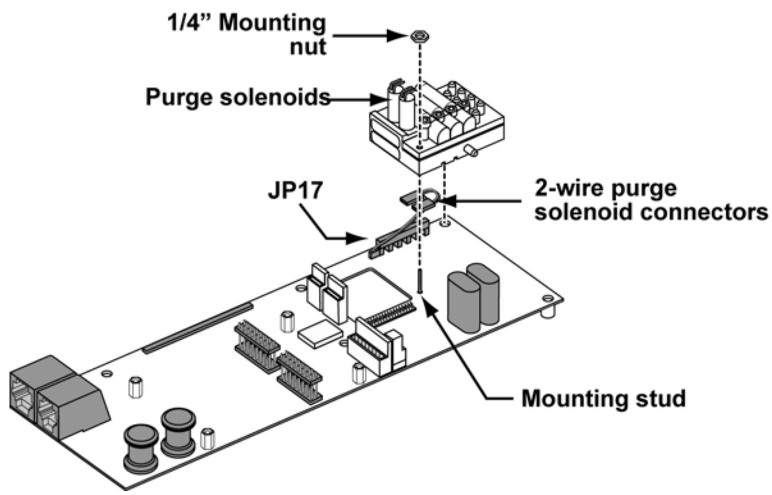
19) Lift out the power board, flexing the left side panel slightly out of the way.



NOTE

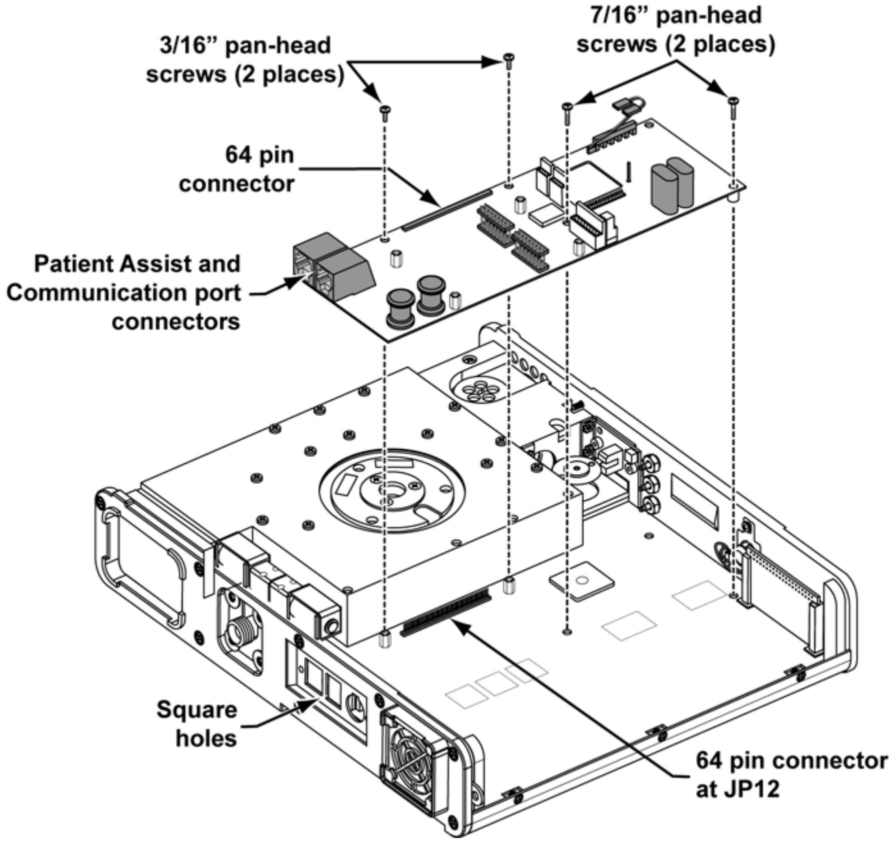
The solenoid mount assembly, accumulator, and remaining tubing may be left attached to the solenoid manifold assembly.

20) Remove the solenoid manifold from the power board.

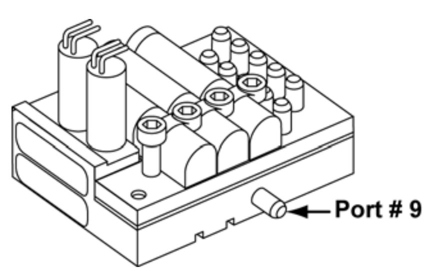


Installing a new power board:

1) Place the power board over the main PCBA. Align the two external connectors (patient assist and comm. port) with the two square holes in the side of the upper weldment and align the 64-pin female connector on the power PCBA with the 64-pin male connector on the main PCBA (see illustration).



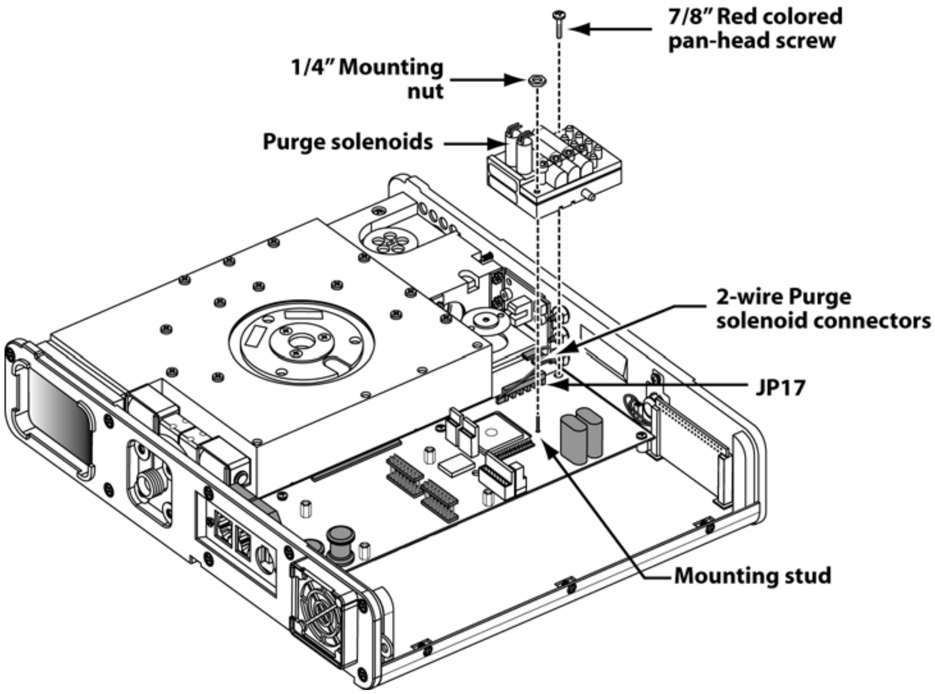
2) Attach the power board to the main PCBA by pressing down directly on the **JP12**, 64-pin header. The power board should seat on the main PCBA such that the pins on the main PCBA are visible through the top of the connector on the power board.
3) Thread two 3/16" pan-head screws (P/N 14372) through the power board into the standoffs on either side of the 64-pin female connector on the power board. Torque-tighten to **60 in-oz** (0.42 Nm).
4) Insert two 7/16" pan-head screws (P/N 10433), one into the mounting hole closest to **U36** on the power board and one into the mounting hole nearest the sounder location. Torque-tighten both screws to **60 in-oz** (0.42 Nm).
5) If removed, reconnect the flexible tube from the tee and port A of the accumulator, to port #9 on the front of the solenoid manifold.



6) Slide the solenoid manifold. over the threaded mounting stud on the power board. Align the solenoid leads with the **JP17** connector on the power board being installed and press the solenoid manifold into place.

7) Insert a 7/8” red colored pan-head solenoid manifold mounting screw (P/N 10607R), as shown and torque-tighten to **20 in-oz** (0.14 Nm).

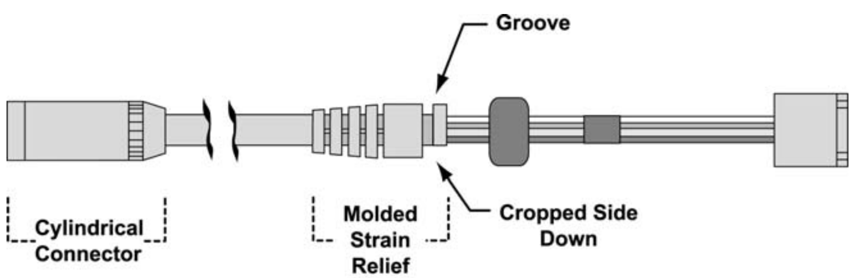
8) Thread one 1/4” solenoid manifold mounting nut (P/N 10342) onto the power board mounting stud protruding through the solenoid manifold as shown in the illustration, torque-tighten to **20 in-oz** (0.14 Nm)



CAUTION

Do not over tighten the mounting screws. Over tightening of the mounting screw or nut may result in leaks on the solenoid manifold.

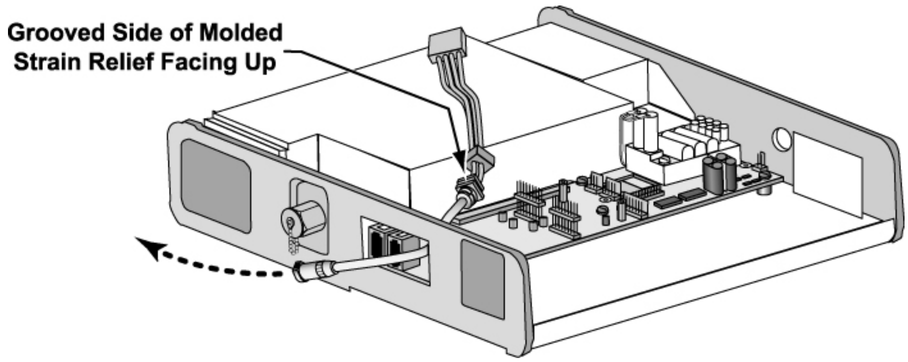
9) Orient the pigtail cable assembly so the <u>grooved</u> side of the molded strain relief is facing up, as shown.



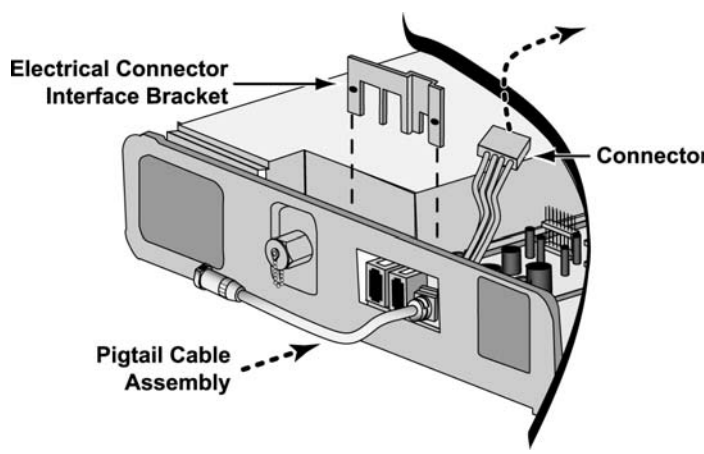
Pigtail Cable Assembly

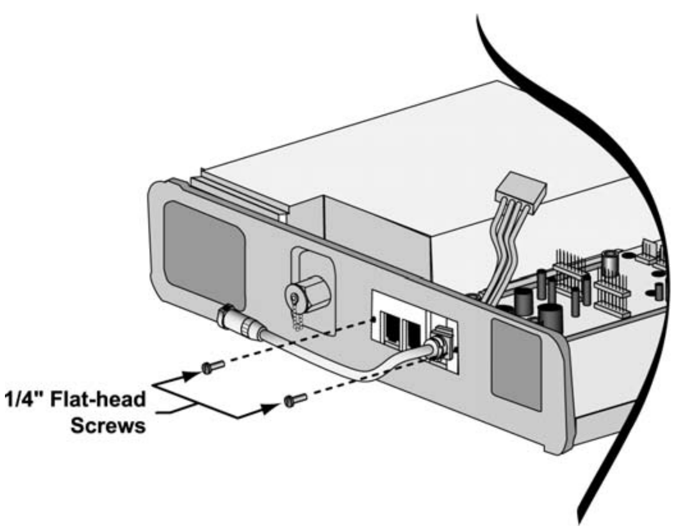
10) Insert the cylindrical connector-end of a pigtail cable assembly over the power board and through the keyed-round hole of the upper weldment from the inside of the upper weldment.

11) Slide the pigtail cable assembly through the hole in the upper weldment until the strain relief protrudes through the keyed-round hole in the upper weldment.



12) Slide the electrical connector interface bracket down through the recess in the molded strain relief of the pigtail cable assembly.

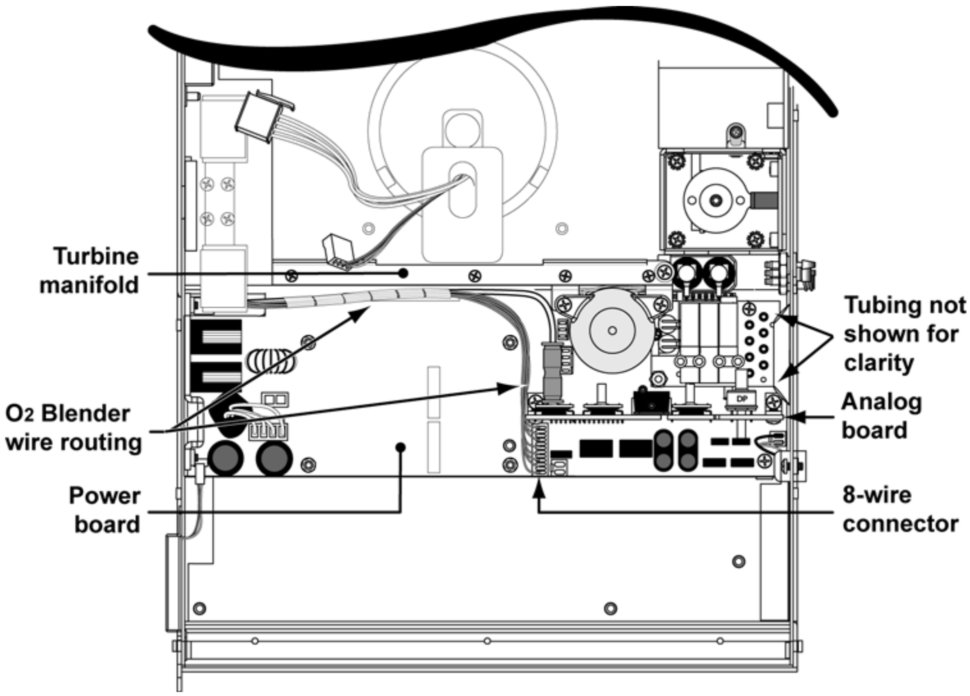




13) Insert and thread two 1/4" flat-head screws (P/N 10430) through holes in the left sidewall of the upper weldment and into the threaded bosses on the electrical connector interface bracket. Torque-tighten both screws to **60 in-oz** (0.42 Nm).

14) Plug the 4-wire connector of the pigtail cable assembly onto the **JP6** connector on the power board. Fold the wires of the pigtail cable assembly back toward the cavity for the internal battery.

15) Reconnect the 8-wire blender connector. Tuck the wrapped wires and oxygen tube down along the side of the turbine manifold against the power board (LTV® 1200 only).

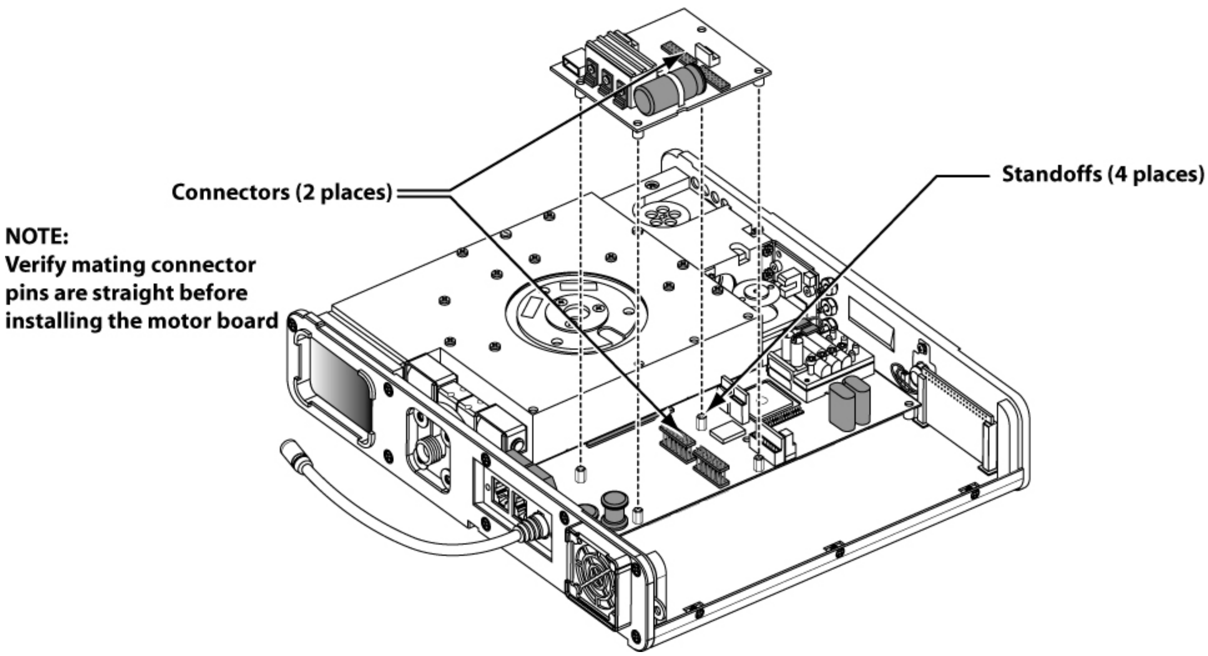


16) Verify the power board mating connector pins are straight and place the Motor PCBA on the four threaded stand-offs on the power board and orientated such that the connector pins on the power board are indexed into the matching connector holes in the Motor PCBA.

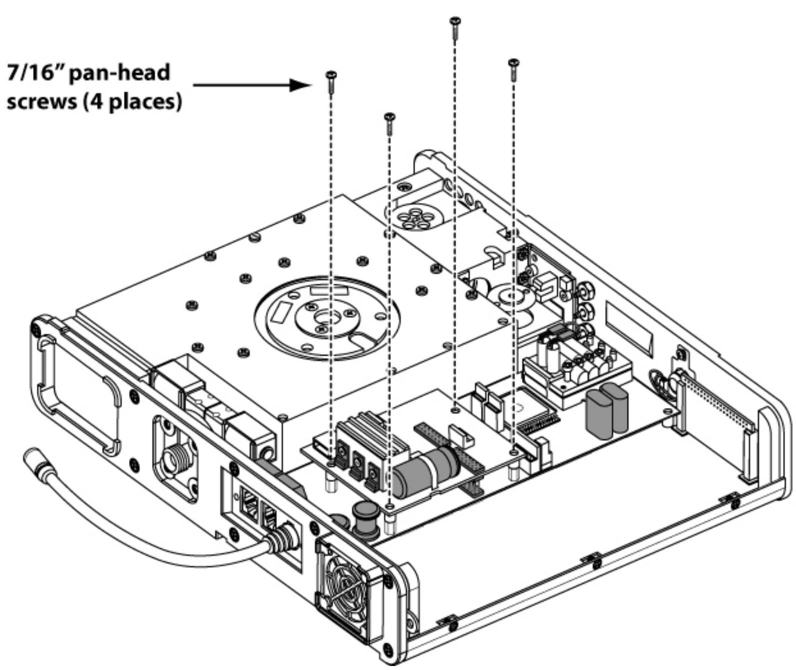
17) Using finger pressure, press down on the Motor PCBA at the location directly above the pins and connector for the power board.

NOTE

When the Motor PCBA is correctly seat on the power board, the pins on the power board should visibly protrude through the top of the connector on the Motor PCBA.



18) Thread four 7/16" pan-head screws (P/N 10433) into the mounting holes in the Motor PCBA and torque-tighten to **60 in-oz** (0.42 Nm).

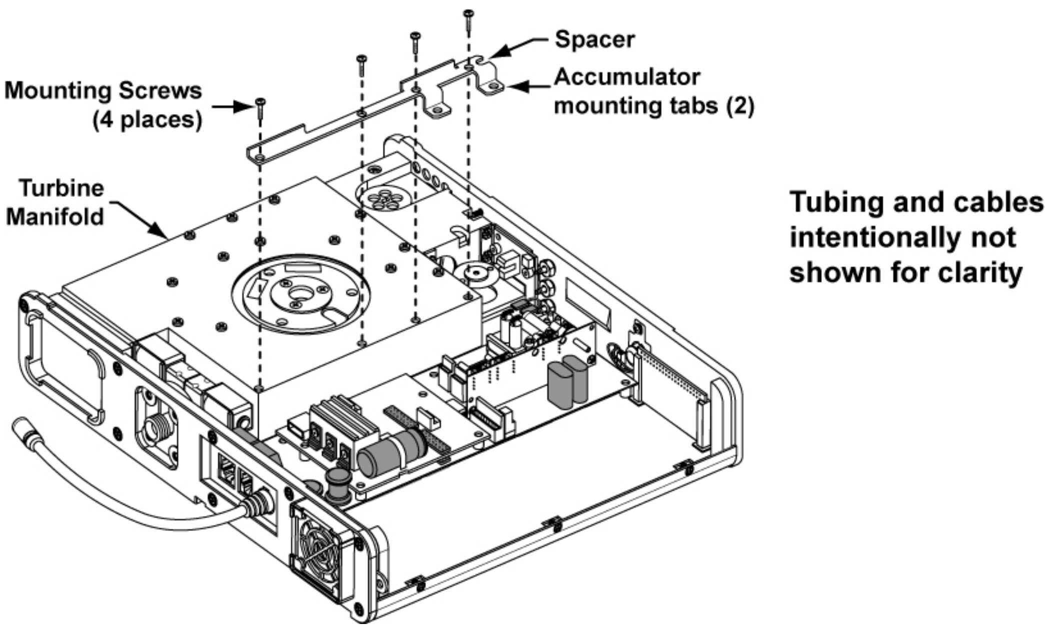


19) Replace the alarm sounder, (see instructions on *page 8-55*).

20) Reconnect the 2-wire fan connector, solenoid mount assembly 4-wire connector, 4-wire rotary switch connector and 2-wire sounder connectors to the power board. The connectors are keyed to fit in only one direction and will snap into place when properly connected.

21) Replace the analog board and install two 1/4" Green colored pan-head mounting screws (P/N 10435G). Torque-tighten to **60 in-oz** (0.42 Nm). See *page 8-57* for instructions.

22) Ensure that the flexible tube from port B of the accumulator is tucked between the purge solenoids and the turbine manifold. Replace the turbine manifold spacer using four (4) 7/16" pan head screws (P/N 10433). Torque tighten to **20 in-oz** (0.14 Nm).



23) Connect the purge solenoid cables from the power board to the purge solenoids. Orientation does not matter.

24) Reattach the solenoid mount assembly to the turbine manifold spacer using the single (1) screw and washer. See instructions on *page 8-125*. Torque the screw to **120 in-oz** (0.84Nm).

25) Reattach the accumulator to the turbine manifold spacer using the two (2) 7/16" pan head screws. See instructions on *page 8-53*. Torque both screws to **60 in-oz** (0.42 Nm).

26) Reconnect the three (3) flexible tubes to the Flow Xducer and Exh Valve fittings on the side panel of the ventilator.

27) Reinstall the flow valve assembly (see instructions on *page 8-65*).

28) Reconnect the flexible tubes to the solenoid manifold following the internal flexible tube routing table, instructions and diagrams beginning on *page 8-33*. **Inspect all the flexible tubes for tears at the connecting ends and replace worn or damaged tubes if necessary.**

NOTE

Tubing Configurations - When disconnecting tubes, note their positions and review the internal flexible tube routing tables, instructions and diagrams beginning on *page 8-33*.

If tubing needs to be replaced, consult the tables and instructions in *Internal Flexible Tubing* beginning on *page 8-33* for tubing diameters, lengths and routing diagrams.

29) Reconnect all flexible tubing to the analog board. See instructions on *page 8-57*.

30) Reconnect the 3-wire and 5-wire connectors from the turbine to the motor board. The connectors are keyed and will snap into place when properly connected.

31) Reconnect the 3-wire flow valve connector to the power board. The connector is keyed and will snap into place when properly connected.

32) Reconnect the Pisco connector to the oxygen pressure transducer on the analog board (LTV® 1200 only).

33) Reconnect the 4-wire flow valve connector to the motor board and the 2-wire flow valve temperature connector to the power board. The connectors are keyed and will snap into place when properly connected.

34) Install an O_2 Sampling Tube[58]. See *Back Panel, Reinstallation* in Chapter 8 – Component Removal and Replacement for detailed instructions.

35) Verify that no tubing is kinked or twisted, and that it will not be pinched when compressed by the back panel. Refer to the routing instructions, tables and diagrams beginning on *page 8-33* to check the tubing routing. **Always check ALL tube routing for kinks or compression that might result in restricted flows prior to closing the ventilator.**

36) Reconnect the internal battery and replace the back panel (see *page 8-29*).

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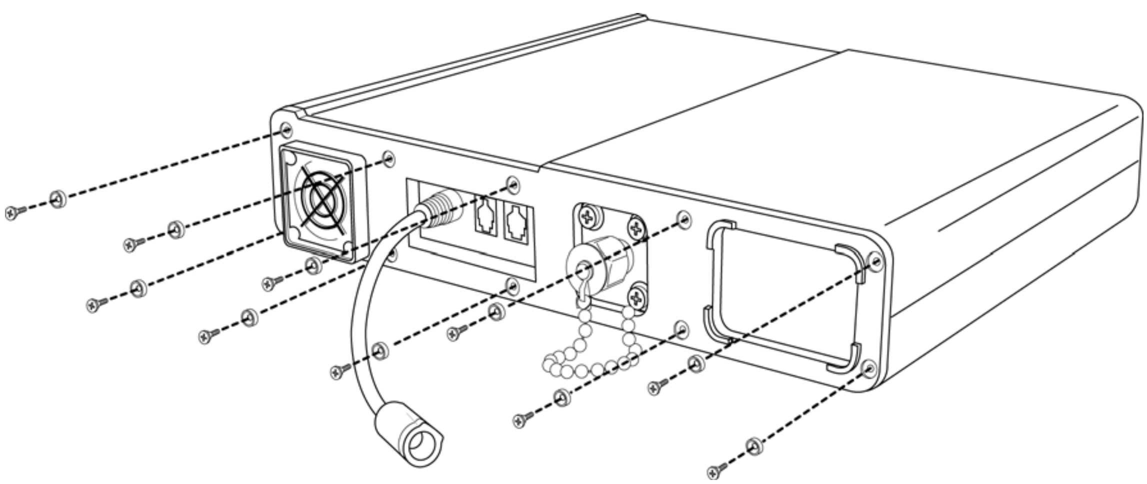
[58] O_2 Sampling Tube, P/N 10544, ~10.0” long, 0.125” O.D. X 0.079 I.D. clear polycarbonate tubing.

Right and Left Soft Side Panels

Parts required for replacement:	**Tools required:**
Replace if damaged: • **LTV® 1200** Left Soft Side P/N 10105 • **LTV® 1200** Right Soft Side P/N 10106 • **LTV® 1150** Left Soft Side P/N 10105-002 • **LTV® 1150** Right Soft Side P/N 10106-002 • 1/2" Flat-head Screw (3 each side) P/N 10338 • 1/4" Flat-head Screw (7 each side) P/N 10430 • Finish Washer (10 each side) P/N 10191, or 19119-001, or 19119-002 • Handle Attachment (1 each side) P/N 10118	• Phillips screwdriver with torque meter • Grounded anti-static wrist strap

To replace the right or left soft side panel:

1) Remove the 10 flat-head screws and gray finish washers from the right or left side of the ventilator as shown.
2) Pull off the soft side panel and set aside the handle attachment.
3) Position the new soft side panel and the handle attachment. Replace the 3 1/2" flat-head screws and finish washers in the 3 center holes on the bottom side of the ventilator.
4) Replace the 7 1/4" flat-head screws and gray finish washers in the remaining holes. Screws should be torqued to **20 in-oz** (0.14 Nm).

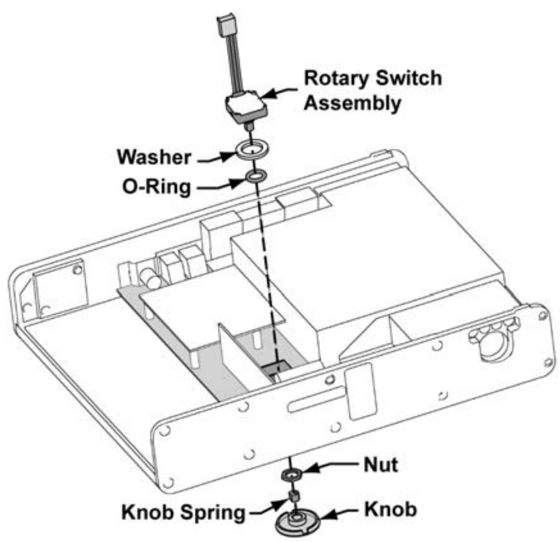


Rotary Switch (Set Value Knob) Assembly

Parts required for replacement:	Tools required:
• Rotary Switch Replacement Kit P/N 14271 • Rotary Switch (with hex nut) P/N 11190[59] • Washer P/N 11644[59] • O-Ring P/N 11645[59] • **LTV® 1200** Knob and Spring P/N 18334-001[59] • **LTV® 1150** Knob and Spring P/N 19037-001[59]	• Phillips screwdriver with torque meter • 2 small flat tip screwdrivers or dental picks • 1/2" nut driver adapter for torque wrench • 13mm nut driver adapter for torque wrench • Grounded anti-static wrist strap

To remove and replace the Rotary Switch assembly:

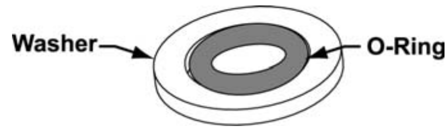
1) With the ventilator face up, gently pry the knob off the rotary switch shaft using dental picks or small flat-edged screwdrivers. There are 2 notches in the underside of the knob to make this easier. Be careful not to damage the edge of the faceplate around the knob.
2) Remove the ventilator back panel and disconnect the internal battery cable (see instructions on *page 8-28*).
3) Disconnect the 4-wire flow valve connector from the motor board.
4) Disconnect the Pisco connector from the oxygen pressure transducer on the analog board. See diagram on *page 8-33.*
5) Disconnect the 3-wire flow valve connector from the power board.
6) Disconnect the flexible tubing from the airway pressure transducer on the analog board.
7) Remove the two (2) screws securing the accumulator to the turbine manifold spacer.
8) Move the accumulator, 4-wire flow valve cable and the tubing from the airway pressure transducer aside.
9) Disconnect the rotary switch cable connector from the power board.
10) Use a 13 mm nut driver to remove and discard the retaining nut from the front of the ventilator.



[59] Contained in Rotary Switch Replacement Kit P/N 14271

11) Carefully remove and discard the rotary switch assembly washer and O-ring from the back of the ventilator through the openings in the power and main boards.

12) Place the O-Ring (P/N 11645) inside the Washer (P/N 11644), insert them through the openings in the power and main boards and center both over the Rotary Knob shaft cutout in the upper weldment.



13) Insert the new rotary switch assembly (P/N 11190) through the openings in the power and main boards so the shaft extends through the O-ring, washer and cutout in the upper weldment. The switch assembly should be oriented so the wire leads are towards the same side of the ventilator as the oxygen blender.

14) Hold the switch in-place and thread the hex nut onto the rotary switch shaft. Use a 13mm nut driver and torque-tighten the nut to **40 in-oz** (0.28 Nm).

15) Connect the switch assembly connector to the power board. The connector is keyed to fit in only one direction and will snap into place when properly connected.

16) Attach the accumulator to the turbine manifold spacer using the two (2) 7/16" pan head screws (P/N 10433. Torque to **60 in-oz** (0.42 Nm).

17) Reconnect the tubing to the airway pressure transducer on analog board.

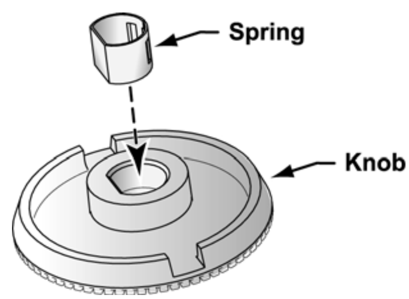
18) Reconnect the 3-wire flow valve connector to the power board. The connector is keyed and will snap into place when properly aligned.

19) Reconnect the Pisco connector to the oxygen pressure transducer on the analog board.

20) Reconnect the 4-wire flow valve connector to the motor board. The connector is keyed and will snap into place when properly aligned.

21) If you are replacing the knob, check the new knob to be sure the knob spring is installed in the back of the knob. If not, press the knob spring into the center of the hole on the back of the knob.

22) Press the knob onto the rotary switch shaft, lining up the flat area of the knob spring with the flat area of the shaft. When completely in place, the knob should be flush with the faceplate of the ventilator.



23) To verify the new rotary switch is operating correctly, turn the ventilator on, select a control then increase and decrease the control setting. The control should operate normally.

24) Install an O_2 Sampling Tube[60]. See *Back Panel, Reinstallation* in Chapter 8 – Component Removal and Replacement for detailed instructions.

25) Reconnect the internal battery and replace the back panel (see instructions on *page 8-29).*

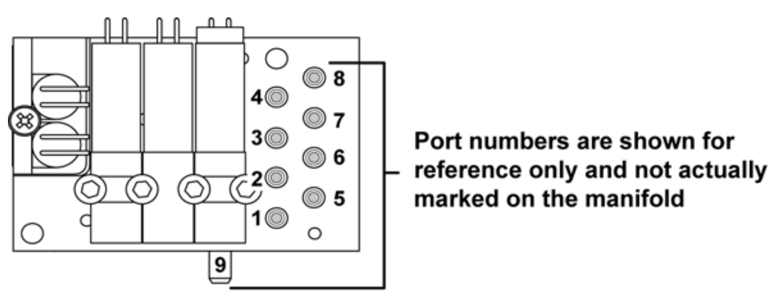
[60] O_2 Sampling Tube, P/N 10544, ~10.0" long, 0.125" O.D. X 0.079 I.D. clear polycarbonate tubing.

Solenoid Manifold Assembly

Parts required for replacement:	Tools required:
• Solenoid Manifold Assembly P/N 18528-001	• Phillips screwdriver with torque meter • 1/4” Nut Driver adapter for torque wrench • Grounded anti-static wrist strap • Torque screwdriver (120 in-oz/0.84 Nm)

Solenoid Manifold Tube Routing Table

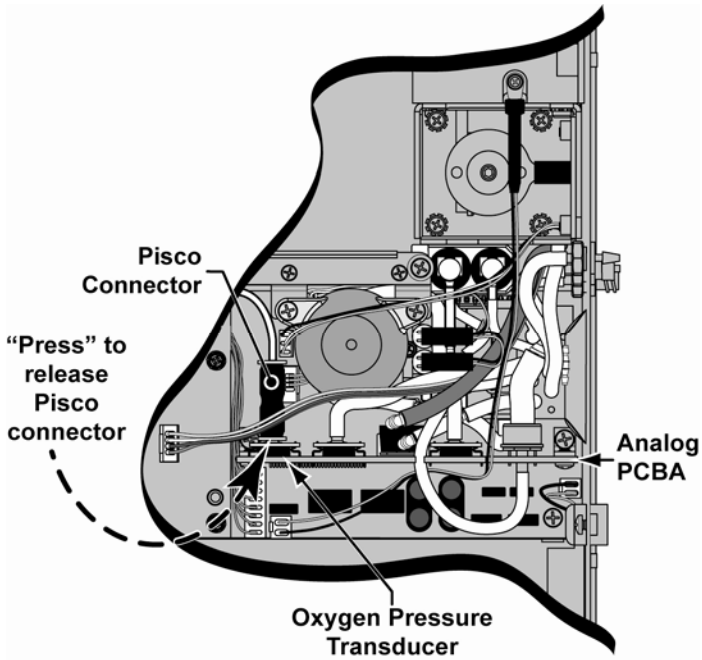
Solenoid Manifold Port Number	Port Tubing Routed	Tubing P/N
#1	Onto the high pressure port on the Valve Differential Transducer (PT7) • through a tee & elbow subassembly	11834
#2	Onto the Flow Differential Transducer (PT4)	10458
#3	Onto the Airway Pressure Transducer (PT6)	11834
#4	Onto the side panel low pressure Flow Transducer port • male Luer fitting on outside of panel	11834
#5	From the Flow Valve (clear tubing)	10455
#6	Onto side panel Exhalation Valve port • barbed fitting on outside of panel	11834
#7	Onto the Flow Differential Transducer • through a tube & elbow subassembly	11834
#8	Onto the side panel high pressure Flow Transducer port • female Luer fitting on outside of panel	11834
#9	Onto Accumulator port A • through a tube & tee subassembly	11834



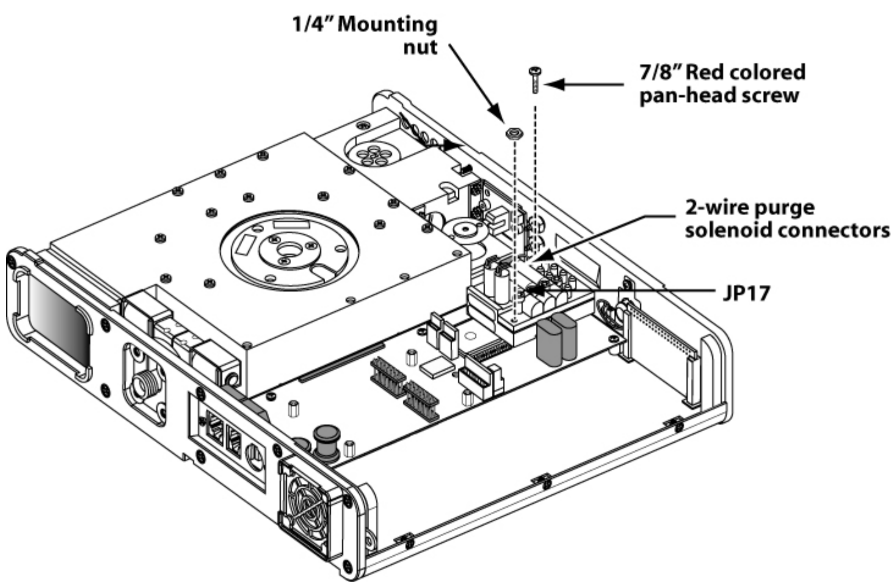
Solenoid Manifold

> **NOTE**
> **Tubing Configurations -** When disconnecting tubes, note their positions and review the internal flexible tube routing tables, instructions and diagrams beginning on *page 8-33*.

To replace the Solenoid Manifold:



1) Remove the back panel of the ventilator and disconnect the internal battery cable (see instructions on *page 8-28*).
2) Disconnect the 4-wire flow valve connector from the motor board.
3) Disconnect the Pisco connector from the analog board (LTV® 1200 only).
4) Disconnect the 3-wire flow valve connector from the power board.
5) Disconnect the 2-wire thermistor cable from the power board.
6) Disconnect all flexible tubing from the analog board (see *page 8-60* for list).
7) Remove the analog board. See instructions on *page 8-57.*
8) Remove the two (2) screws securing the accumulator to the turbine manifold spacer.
9) Disconnect the two 2-wire connectors from the Purge Solenoids.
10) Remove the flow valve assembly (see instructions on *page 8-65*).
11) Disconnect the three (3) flexible tubes from the Flow Xducer and Exh Valve fittings on the side panel of the ventilator.
12) Loosen the one (1) screw with washer that secures the solenoid mount assembly to the spacer.
13) Remove the four (4) screws attaching the turbine manifold spacer, remove the spacer and set aside away from the ventilator.
14) Disconnect the flexible tube from port #1 of the solenoid manifold.
15) Remove the mounting screw and hex-nut from the solenoid manifold.



16) Remove the solenoid manifold from the power board, disconnect the flexible tube from port #9, and separate the solenoid mount assembly from the solenoid manifold.

NOTE

Tubing Configurations - When disconnecting tubes, note their positions and review the internal flexible tube routing tables, instructions and diagrams beginning on *page 8-33*.

If tubing needs to be replaced, consult the tables and instructions in *Internal Flexible Tubing* beginning on *page 8-33* for tubing diameters, lengths and routing diagrams.

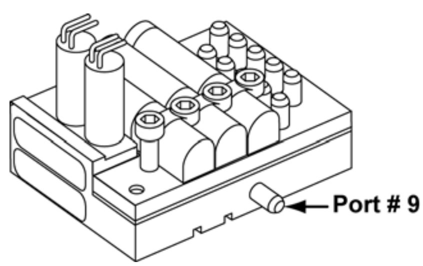
17) Disconnect all flexible tubing from the solenoid manifold.

WARNING

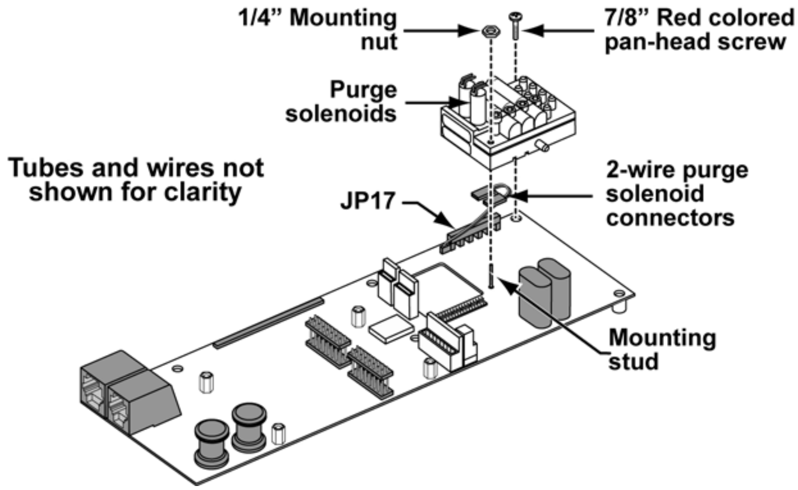
Mounting Screw Use – Make sure the correct length mounting screws are used as specified in the instructions or internal damage to the ventilator may result.

Installing the new solenoid manifold:

1) Reattach the flexible tubes to the solenoid manifold ports #2, #3, #4, #6, #7, and #8, following the tube routing table at the beginning of this section and the tube routing instructions and diagrams beginning on *page 8-33*. Inspect all flexible tubes for tears at the connecting ends and replace worn or damaged tubes if necessary.
2) Reattach the small diameter tube from the tee fitting and port A of the accumulator to port # 9 on the front of the new solenoid manifold.



3) Slide the solenoid manifold over the threaded mounting stud on the power board, carefully align the solenoid contact pins with the **JP17** connector on the power board and press the solenoid manifold into place. Make sure that the contact pins are correctly located in the **JP17** receptacle.



4) Thread one 1/4” solenoid manifold mounting nut (P/N 10342) onto the power board mounting stud protruding through the solenoid manifold and replace the red solenoid manifold mounting screw, as shown. Torque tighten both to **20 in-oz** (0.14 Nm).

5) Position the flexible tube from port “B” of the accumulator so that it is tucked down between the purge solenoids and the turbine manifold spacer and attach the turbine manifold spacer to the turbine manifold. Check to make sure the tube does not get pinched as you tighten down the four (4) 7/16” spacer screws (P/N 10433). Torque the screws to **20 in-oz** (0.14 Nm).

6) Attach the solenoid mount assembly to the spacer using one (1) 4-24 x 3/8” pan head screw (P/N 17682-001). Torque to **120 in-oz** (0.84 Nm). See *page 8-45* for wire routing instructions.

7) Attach the accumulator to the spacer using two (2) 7/16” pan head screws (P/N 10433). Torque to **60 in-oz** (0.42 Nm).

8) Reattach the flexible tube from the tee and elbow subassembly to port #1 of the solenoid manifold.

9) Carefully position the small diameter flexible tube with tee fitting, under the elbow connected to port #7 of the solenoid manifold (routing instructions and diagrams beginning on *page 8-33.* Inspect all flexible tubes for tears at the connecting ends and replace worn or damaged tubes if necessary.

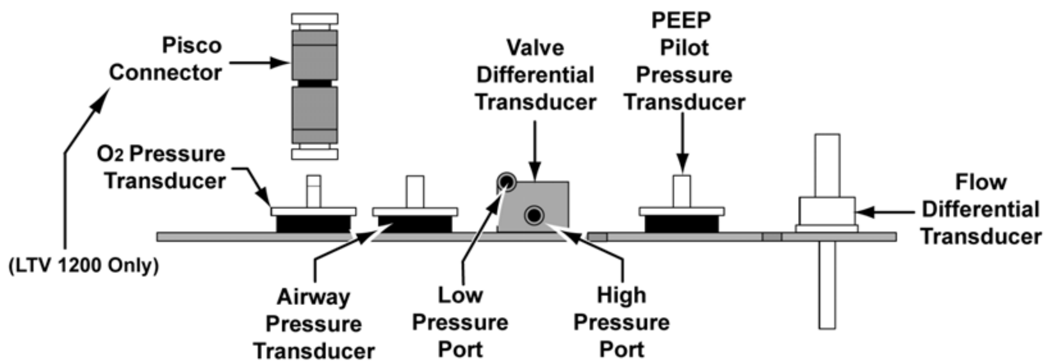
10) Install the analog board using two 1/4” green pan head screws (P/N 10435G). Screws should be torqued to **60 in-oz** (0.42 Nm). See instructions on *page 8-57.*

11) Referring to the diagrams and tables beginning on *page 8-33*, reattach the flexible tube from the tee and elbow subassembly, from port #1 on the solenoid manifold to the high pressure port of the flow valve differential transducer on the analog board (the port closest to the analog board). The other tee tubing branch attaches to the top port of the “pilot in” solenoid.

12) Reattach the three (3) flexible tubes to the Flow Xducer and Exh Valve fittings on the side panel of the ventilator.

13) Reinstall the flow valve assembly (see instructions on *page 8-65*).

14) Reattach the flexible tube from port B of the accumulator to the pilot pressure transducer on the analog board.



15) Reconnect the 2-wire connectors to the purge solenoids (orientation does not matter).

16) Reattach the flexible tubes from ports #2 and #7 of the solenoid manifold to each side of the differential pressure transducer on the analog board (route the smaller diameter tube through the adjacent notch in the analog board).

17) Reattach the tube from port #3 of the solenoid manifold to the airway pressure transducer on the analog board.

18) Reconnect the 3-wire flow valve connector to the power board. The connector is keyed to fit in only one direction and will snap into place when properly connected.

19) Reconnect the Pisco connector to the oxygen pressure transducer on the analog board (LTV® 1200 only).

20) Reattach the orange tube from the flow valve to the low side port of the flow valve differential transducer on the analog board (port furthest from the board).

21) Reconnect the clear tube from the flow valve to port #5 of the solenoid manifold.

22) Reconnect the 4-wire flow valve connector to the motor board and the 2-wire flow valve Thermistor cable to the power board. The connectors are keyed to fit in only one direction and will snap into place when properly connected.

23) Install an O_2 Sampling Tube[61]. See *Back Panel, Reinstallation* in Chapter 8 – Component Removal and Replacement for detailed instructions.

24) Verify that no tubing is kinked or twisted, and that it will not be pinched when compressed by the back panel. Refer to the routing instructions, tables and diagrams beginning on *page 8-33* to check the tubing routing. **Always check ALL tube routing for kinks or compression that might result in restricted flows prior to closing the ventilator.**

25) Reconnect the internal battery and replace the back panel (see *page 8-29*).

[61] O_2 Sampling Tube, P/N 10544, ~10.0" long, 0.125" O.D. X 0.079 I.D. clear polycarbonate tubing.

Solenoid Mount Assembly

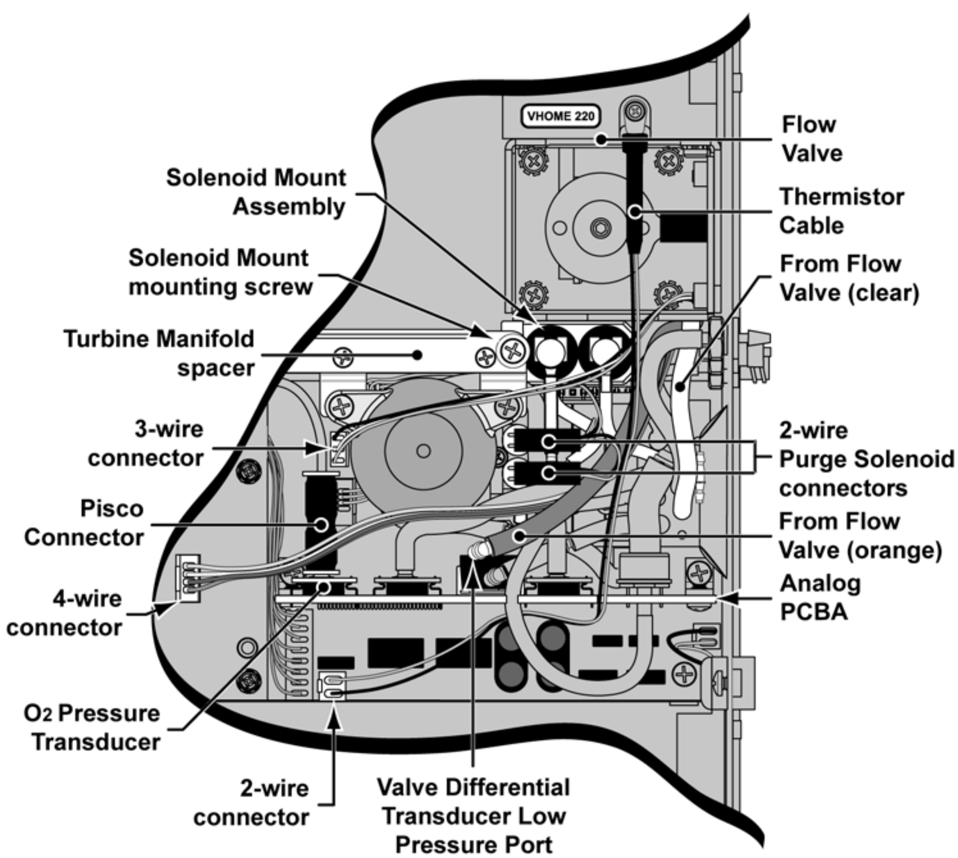
Parts required for replacement:	Tools required:
• Solenoid Mount Assy. P/N 18607-001 **Replace if damaged:** • (4-24 X 3/8 Pan Head) Screw P/N 17682-103 • (.125 I.D. X .3125 O.D.) Washer P/N 18032-001 • Cable Assy., Pilot Solenoids to Power Board, P/N 18530-001	• Phillips screwdriver with torque meter • Grounded anti-static wrist strap • 120 in-oz Torque Screwdriver

NOTE

Prior to disconnecting or removing any of the tubes, note their positions and review the tube routing configurations tables, instructions and diagrams beginning on *page 8-33.*

To remove the solenoid mount assembly:

1) Disconnect the 4-wire flow valve connector from the motor board.
2) Disconnect the Pisco connector from the oxygen pressure transducer of the analog board. (LTV® 1200 only) See instructions on *page 8-57.*
3) Disconnect the 3-wire flow valve connector from the power board.
4) Remove the flow valve assembly (see instructions on *page 8-65*).
5) Disconnect the 2-wire connectors from the purge solenoids.



6) Loosen or remove the one (1) screw that secures the solenoid mount assembly to the turbine manifold spacer, and remove the solenoid mount assembly from the spacer.

> **NOTE**
> When removing the tubes from the pilot-in solenoid, make sure that the small brass filter and restrictor remain in the tubes.

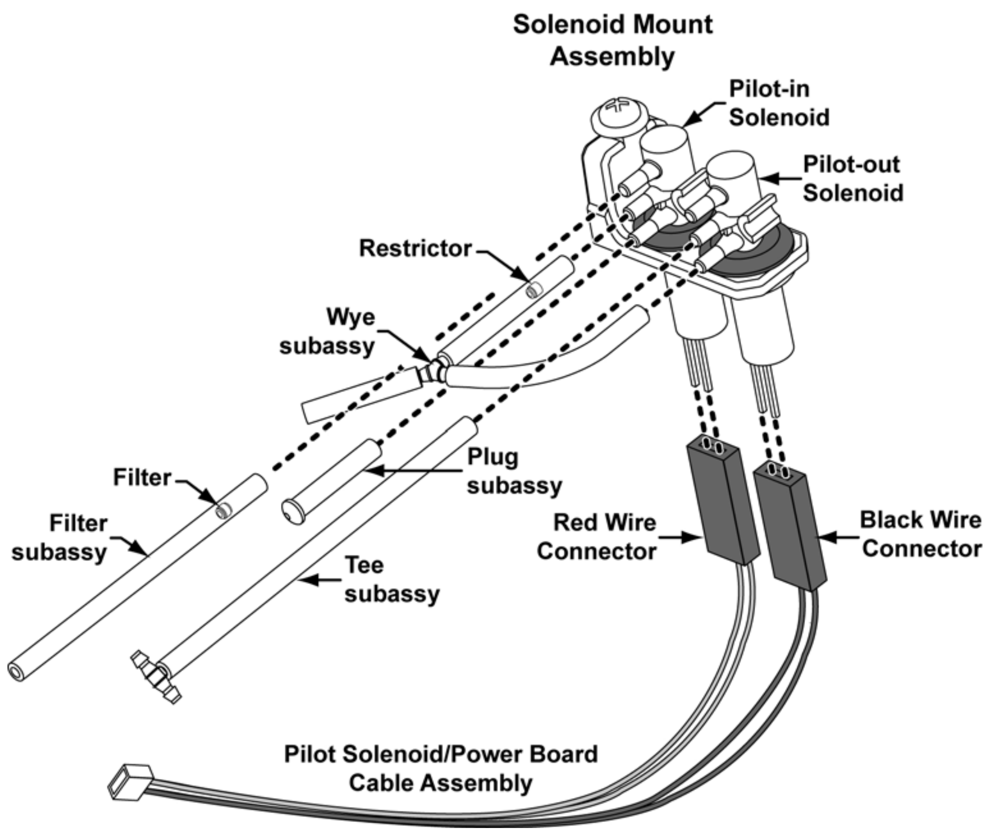
7) Remove the three (3) tubes from the pilot-in solenoid, and the two (2) tubes from the pilot-out solenoid.

8) Disconnect the two (2) wire connectors from the pilot-in and pilot-out solenoids.

To replace the solenoid mount assembly:

1) Reconnect the 2-wire connector (red wires) to the pilot-in solenoid, and the 2-wire connector (black wires) to the pilot-out solenoid.

2) Reconnect the flexible tubes to the pilot-in and pilot-out solenoids following the internal flexible tube routing tables, instructions and diagrams beginning on *page 8-33.*



3) Refer to *page 8-45* for detailed instructions, and attach the solenoid mount assembly to the turbine manifold spacer.

4) Reconnect the two 2-wire connectors to the purge solenoids. Orientation does not matter.

5) Reinstall the flow valve assembly (see instructions on *page 8-65*).

6) Reconnect the 3-wire flow valve connector, to the power board. The connector is keyed to fit in only one direction and will snap into place when properly connected.

7) Reconnect the Pisco connector to the oxygen pressure transducer on the analog board (LTV® 1200 only).

8) Reconnect the 4-wire flow valve connector to the motor board. The connector is keyed to fit in only one direction and will snap into place when properly connected.

9) Reconnect the orange flow valve tube to the flow valve differential pressure transducer of the analog board and the clear flow valve tube to port #5 of the solenoid manifold assembly.

10) Reconnect the 2-wire flow valve temperature connector to the power board. The connector is keyed to fit in only one direction and will snap into place when properly connected.

11) Install an O_2 Sampling Tube[62]. See *Back Panel, Reinstallation* in Chapter 8 – Component Removal and Replacement for detailed instructions.

12) Verify that no tubing is kinked or twisted, and that it will not be pinched when compressed by the back panel. Refer to the routing instructions, tables and diagrams beginning on *page 8-33* to check the tubing routing. **Always check ALL tube routing for kinks or compression that might result in restricted flows prior to closing the ventilator.**

13) Reconnect the internal battery and replace the back panel (see *page 8-29*).

[62] O_2 Sampling Tube, P/N 10544, ~10.0" long, 0.125" O.D. X 0.079 I.D. clear polycarbonate tubing.

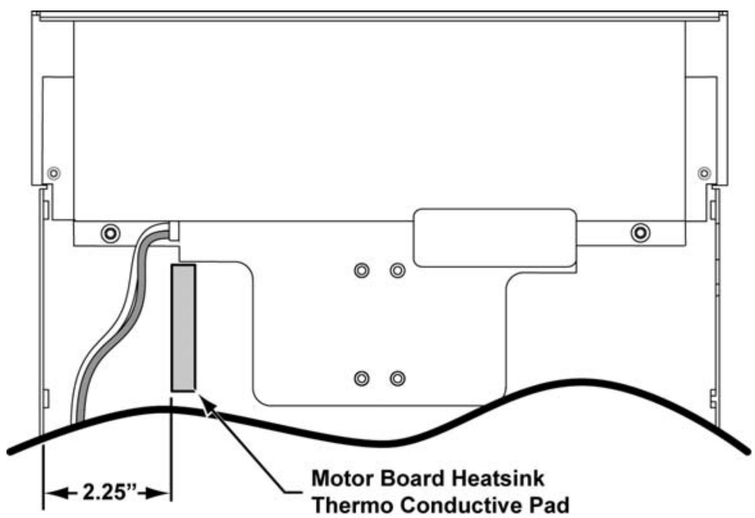
Thermo Conductive Motor Board Heatsink Pad

Thermo conductive pads should be replaced any time they have hardened, and at 30,000 hours. The motor board heat sink pad is located on the inside of the back panel.

Parts required for replacement:	Tools required:
• Thermo Conductive Motor Board Heatsink Pad P/N 18341	• Phillips screwdriver with torque meter • Grounded anti-static wrist strap • Mild cleanser

To replace the thermo conductive pad on the inside of the back panel:

1) Remove the back panel of the ventilator and disconnect the internal battery cable (see instructions on *page 8-28)*.
2) Peel the thermo conductive pad off the inside of the back panel.
3) If there is any adhesive residue left on the inside of the back panel, remove it by washing with a mild cleanser.
4) Remove the protective backing from the new thermo conductive pad and place it on the inside surface of the back panel as shown.



5) Remove the protective cover from the face of the thermo conductive pad.
6) Install an O_2 Sampling Tube[63]. See *Back Panel, Reinstallation* in Chapter 8 – Component Removal and Replacement for detailed instructions.
7) Verify that no tubing is kinked or twisted, and that it will not be pinched when compressed by the back panel. Refer to the routing instructions, tables and diagrams beginning on *page 8-33* to check the tubing routing. **Always check ALL tube routing for kinks or compression that might result in restricted flows prior to closing the ventilator.**
8) Reconnect the internal battery and replace the back panel (see *page 8-29*).

[63] O_2 Sampling Tube, P/N 10544, ~10.0" long, 0.125" O.D. X 0.079 I.D. clear polycarbonate tubing.

Thermo Conductive Turbine Pad

Thermo conductive pads should be replaced any time they have hardened, and at least at the 30,000 hour service. The turbine heat sink pad is located between the inside of the upper weldment and the turbine.

Parts required for replacement:	**Tools required:**
• Thermo Conductive Turbine Pad P/N 10129	• Phillips screwdriver with torque meter • Grounded anti-static wrist strap • Mild cleanser

To replace the thermo conductive turbine pad, see instructions for removing and replacing the turbine manifold on *page 8-130*.

Turbine Manifold

Parts required for replacement:	Tools required:
• Turbine Manifold Assembly P/N 11490 • Cable Tie P/N 10466 • O_2 Donut Seal P/N 10603 • Silicone Gel Lubricant P/N 10123[64] • RTV Silicone Adhesive P/N 10122 **Replace if damaged:** • Thermo Conductive Pad P/N 10129 • Sealing Gasket P/N 10175 • Damping Grommets (4) P/N 10266 • Grounding Clips (4) P/N 10752 • Green O_2 Port Cover (O_2 Block) P/N 14446	• Phillips screwdriver with torque meter • Grounded anti-static wrist strap • Small dykes or cutters • Mild cleanser • Cable tie tool • Flow Valve Insertion Tool (Mylar) P/N 14206 • Torque screwdriver (120 in-oz/o.84 Nm)

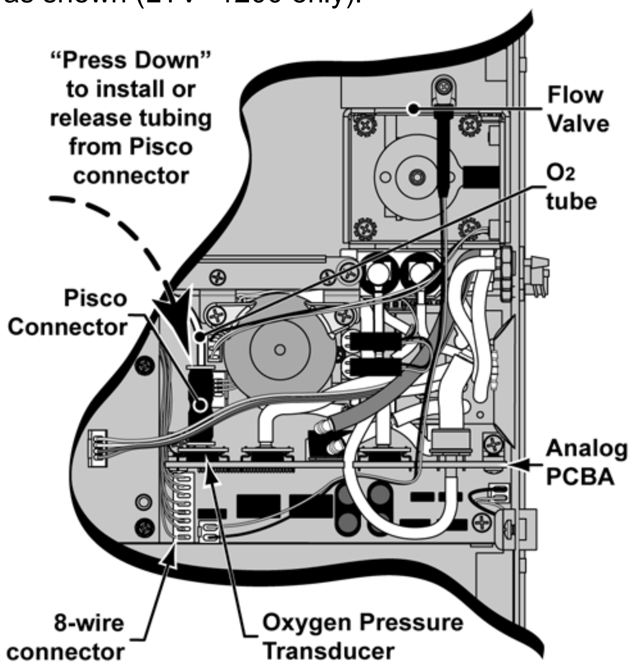
When replacing the turbine manifold assembly, it is easiest to remove several components and replace them together. These will be done in the following order:

- Remove the back panel and disconnect the battery
- Remove the left soft side
- Remove the motor board
- Remove the flow valve
- Remove the turbine manifold and oxygen blender as a unit
- Disconnect the oxygen blender (LTV® 1200) or O_2 Block (LTV® 1150) from the turbine manifold
- Connect the new oxygen blender (LTV® 1200) or O_2 Block (LTV® 1150) to the turbine manifold
- Replace the oxygen blender (LTV® 1200) or O_2 Block (LTV® 1150) and turbine manifold as a unit
- Replace the flow valve
- Replace the motor board
- Replace the left soft side
- Reconnect the battery and replace the back panel

[64] In the European Union, Loctite® 8104 may be substituted as an equivalent compound.

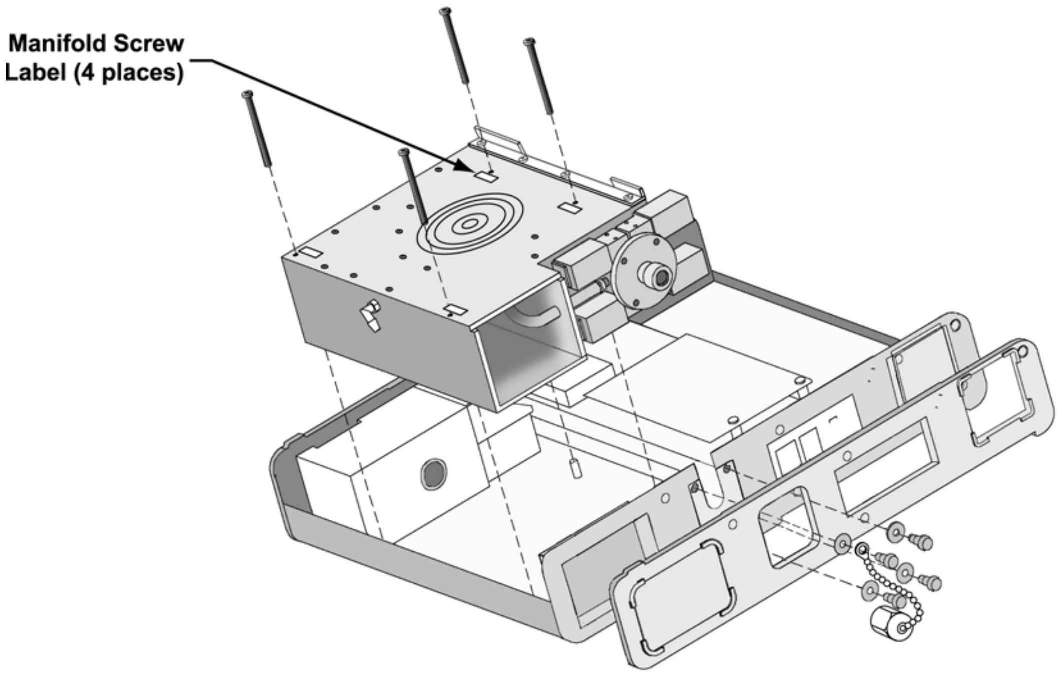
To remove the Turbine Manifold and Oxygen blender or O_2 Block:

1) Remove the back panel and disconnect the battery (see instructions on *page 8-28*).
2) Remove the left soft side (see instructions on *page 8-116*).
3) Remove the motor board (see instructions on *page 8-93*).
4) Disconnect the O_2 blender 8-wire connector from the power board (LTV® 1200 only).
5) Disconnect the O_2 tube from the Pisco connector on the oxygen pressure transducer on the analog board as shown (LTV® 1200 only).



6) Remove the flow valve and disconnect the by-pass tubing from the base of the turbine manifold (see instructions on *page 8-65*).
7) Remove the two (2) screws securing the accumulator to the turbine manifold spacer and loosen the one (1) screw and washer securing the solenoid mount assembly. Detach the accumulator and the solenoid mount assembly from the spacer.

8) Remove the four (4) black screws from the turbine manifold.



9) Remove the four (4) blender / O_2 Block mounting screws and washers from the left side of the ventilator.

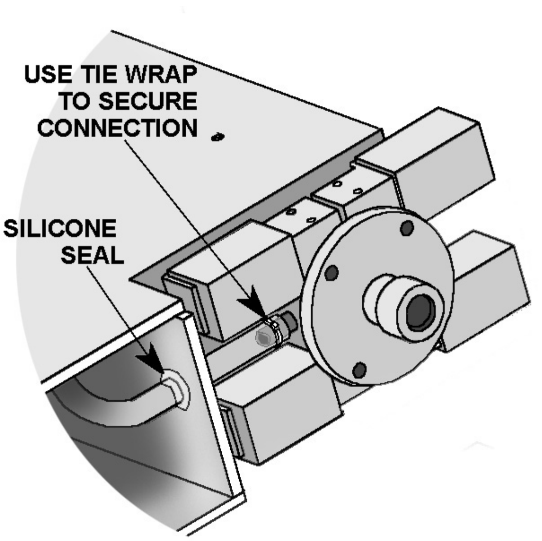
10) Remove the oxygen blender (LTV® 1200) or O_2 Block (LTV® 1150), turbine manifold and interior inlet filter. Be careful not to dislodge the grounding straps and grommets that are between the oxygen blender and the side of the ventilator case.

11) The thermo conductive pad beneath the turbine may adhere to the turbine when it is removed, or may remain attached to the case. If the Thermo Conductive Pad remains attached to the case, check it for damage or hardening and replace it if necessary. If the pad comes out with the turbine, replace it with a new pad.

To replace the thermo conductive pad:

1) Peel the thermo conductive pad off.
2) If there is adhesive residue left on the inside of the upper weldment or the turbine assembly, remove it by washing with a mild cleaner.
3) Remove the protective backing from the smooth side of the new thermo conductive pad and center it on the turbine surface.
4) Remove the protective cover from the thermo conductive pad.

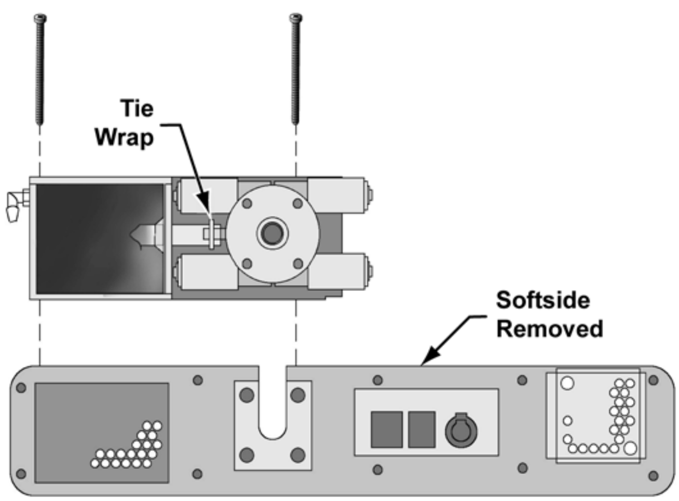
To connect the new Turbine Manifold to the Oxygen Blender or O_2 Block:



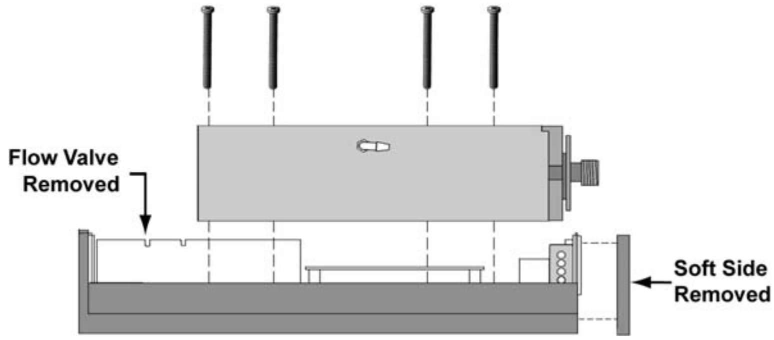
1) Handle the manifold and blender carefully so as not to break the silicone seal around the oxygen tube entering the manifold. If this seal is damaged, repair with RTV silicone adhesive.
2) Cut the cable tie around the tube connection to the oxygen blender (LTV® 1200) or O_2 Block (LTV® 1150). Separate the oxygen blender or O_2 Block and turbine manifold.
3) Make a loose loop with a cable tie and slide it over the tube that connects the turbine manifold to the oxygen blender (LTV® 1200) or O_2 Block (LTV® 1150). Connect the tube to the barbed fitting on the oxygen blender or O_2 Block.
4) Using a cable tie tool, tighten the cable tie to 2 tension. The cable tie tool should trim the tail off close to the connector.

To install the Turbine Manifold and Oxygen Blender or O_2 Block:

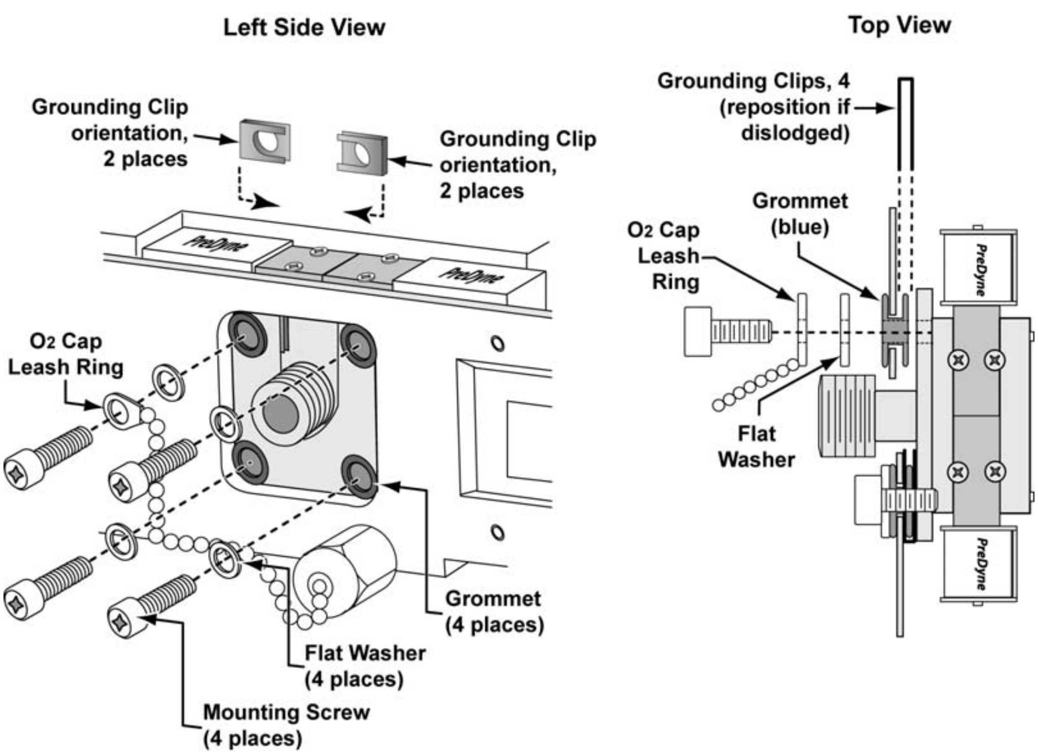
1) Slide the turbine manifold and oxygen blender (LTV® 1200) or O_2 Block (LTV® 1150) into place. Be sure not to catch any tubing or wiring under the manifold while it is being installed.



2) Replace the 4 black pan-head screws (P/N 10918B) into the turbine manifold. Screws should be torqued to **20 in-oz** (0.14 Nm).



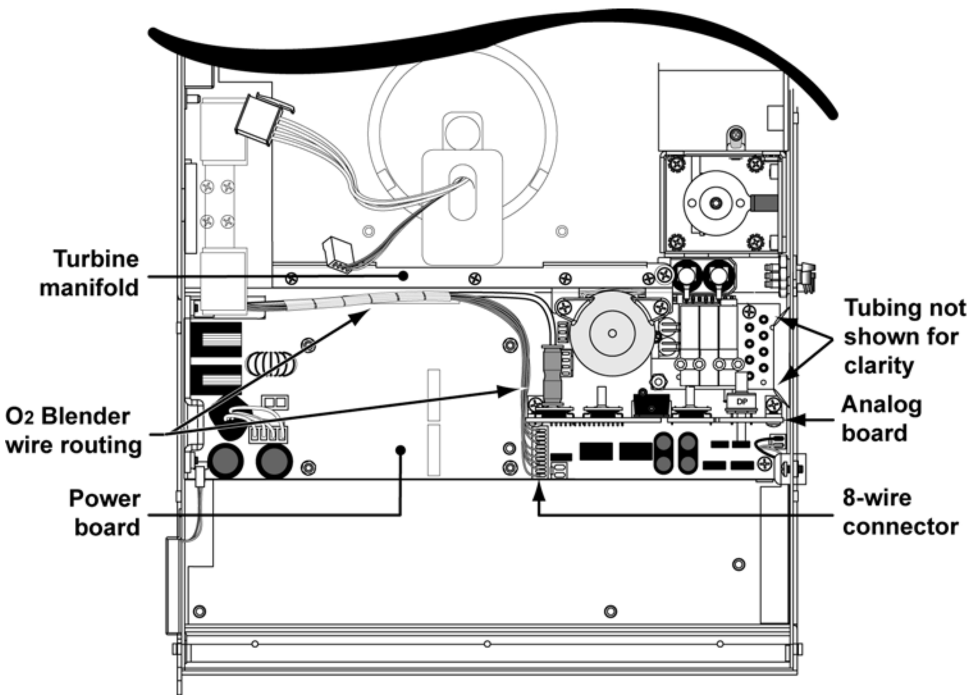
3) Check the blue rubber grommets (P/N 10630) and grounding clips (P/N 10752) on the oxygen blender mounting (4 each) for wear and replace if necessary (LTV® 1200 only).



4) **For the LTV® 1200:** Replace the four (4) blender mounting screws (P/N 10176), O_2 blender cap, and four (4) flat metal washers (P/N 10594). The grounding clips should be positioned over the inside lip of the grommets, aligned with the edge of the side panel and oriented as shown in the illustrations. Screws should be torqued to **60 in-oz** (0.42 Nm).
For the LTV® 1150: Replace the four (4) O_2 Block mounting screws (P/N 10627), Green O_2 port cap (P/N 14446), and four (4) plastic shoulder washers (P/N 10630). Screws should be torqued to **60 in-oz** (0.42 Nm).

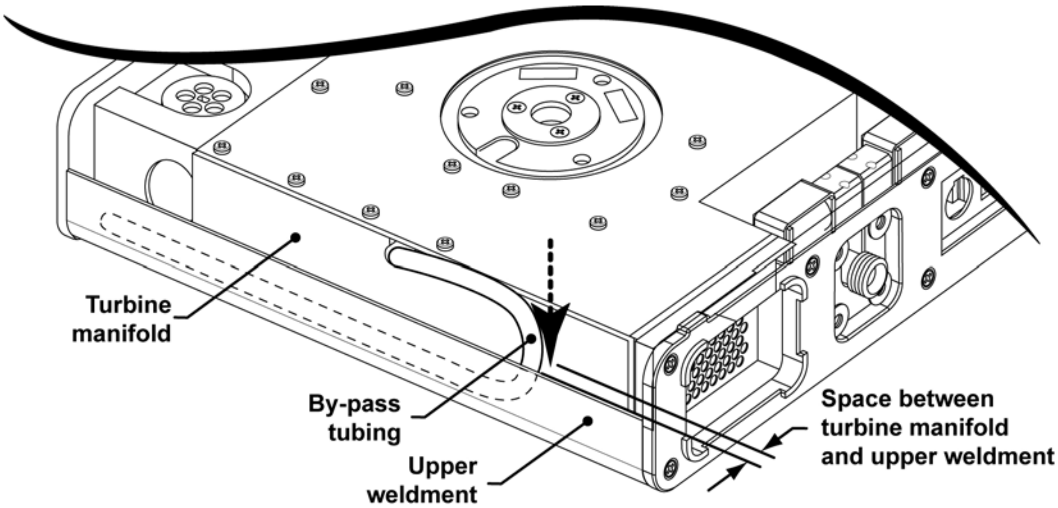
> **NOTE**
> If the upper clips are not properly aligned with the edge of the side panel, the back panel of the ventilator will not seat correctly. Use a straight edged screwdriver or pick to prevent each grounding clip from turning as the mounting screws are tightened (LTV® 1200 only).

5) Connect the 8-wire connector from the oxygen blender to the power board. The connector is keyed to fit in only one direction and will snap into place (LTV® 1200 only).
6) Tuck the wrapped wires and oxygen tube down along the side of the turbine manifold, against the power board (LTV® 1200 only).



7) Replace the motor board (see instructions on *page 8-93*).
8) Connect the 3-wire and 5-wire connectors from the turbine to the motor board. The connectors are keyed to fit in only one direction and will snap into place.
9) Replace the single (1) screw and washer attaching the solenoid mount assembly to the turbine manifold spacer. See instructions on *page 8-127*. Torque the screw to **120 in-oz** (0.84Nm).
10) Inspect the orange seal on the side of the flow valve. If it is damaged, remove and replace it with a new seal as follows: Peel the old seal off the flow valve. Remove any old adhesive from the flow valve using a mild detergent and dry the valve side. Remove the protective backing from the flow valve seal and press it into place.
11) Replace the flow valve (see instructions on *page 8-65*).

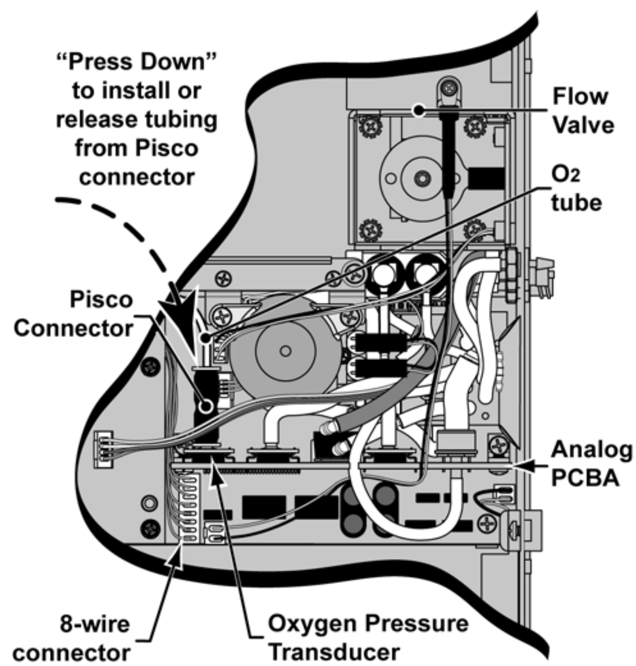
12) Connect the bypass tubing from the flow valve to the barbed elbow at the bottom of the turbine manifold. The tubing should be looped into the space between the bottom of the manifold and the bottom edge of the upper weldment so that it is out of the way and will not be pinched when the back of the ventilator is replaced.



13) Replace the two (2) 7/16” pan-head screws securing the accumulator to the turbine manifold spacer. See instructions on *page 8-53* Torque both screws to **60 in-oz** (0.42 Nm).

14) Reconnect the 3-wire flow valve connector to the power board. The connector is keyed to fit in only one direction and will snap into place when properly connected.

15) (LTV® 1200 only) Insert the O_2 tube from the blender into (at least 1/2”) the Pisco connector attached to the oxygen pressure transducer on the analog board. Gently pull (~2-lbs force) the tube while holding the Pisco connector to ensure it is properly attached.
    - If the tube is not inserted correctly, it will detach when a high pressure oxygen source is connected to the ventilator



16) Reconnect the orange tube from the flow valve to the valve differential transducer low pressure port on the analog board (furthest from the board).

17) Reconnect the clear flexible tube from the flow valve to port #5 on the solenoid manifold.

18) Reconnect the 4-wire flow valve connector to the motor board and the 2-wire flow valve temperature connector to the power board. The connectors are keyed to fit in only one direction and will snap into place when properly connected.

19) Replace the internal inlet filter (see instructions on *page 8-84*).

20) Replace the left soft side (see instructions on *page 8-116*).

21) Install an O_2 Sampling Tube[65]. See *Back Panel, Reinstallation* in Chapter 8 – Component Removal and Replacement for detailed instructions.

22) Verify that no tubing is kinked or twisted, and that it will not be pinched or compressed by the back panel. Refer to the instructions, tables and diagrams beginning on *page 8-33* to check the tubing routing. **Always check ALL tube routing for kinks or compression that might result in restricted flows prior to closing the ventilator.**

23) Reconnect the internal battery and replace the back panel (see *page 8-29*).

[65] O_2 Sampling Tube, P/N 10544, ~10.0" long, 0.125" O.D. X 0.079 I.D. clear polycarbonate tubing.

Chapter 9 - FINAL CHECKOUT TEST

This section provides a set of checkout tests that should be performed after modifications have been made to the ventilator. Checkout worksheets are provided after the test instructions for recording the results of each checkout test.

Checkout Test Selection

The following matrix shows what tests should be performed based on what parts have been replaced. Note that Calibration and Power Checkout must be done while the back panel is off the ventilator. No checkout tests are required when changing the External Inlet filter, the O_2 Inlet filter, and the fan filter.

Part Replaced	Calibration Required	Power Checkout	General Checkout	Performance Checkout	12 Hour Burn-in
Alarm Sounder			X		
Analog Board Assembly	X	X	X	X	X
Fan Assembly			X		X
Flow Valve Assembly	X		X	X	X
Front Panel	X		X		X
Interior Inlet filter			X		
Internal Battery Pack		X[66]			
Internal Flexible Tubing	X		X	X	
Main Board Assembly	X	X	X	X	X
Membrane/Overlay	X	X	X	X	X
Memory Board Assembly	X		X	X	X
Motor Board Assembly	X		X	X	X
O_2 Blender Assembly	X		X	X	X
Pigtail		X	X	X	X
Power Board Assembly	X	X	X	X	X
Rotary Knob Assembly			X	X	
Solenoid Manifold	X		X	X	X
Thermo Conductive Pad			X		
Turbine Manifold			X	X	X
Ventilator Back Panel			X		

[66] When replacing the Internal Battery, only Power Checkout test steps 2A and 2B are required to be performed.

General Checkout

Tools required:
• Calibrated O_2 Analyzer • Compressed O_2 source with a 0-80 PSI (0-5.51 bar) regulator • Patient Circuit, Adult, without PEEP • 1 liter or greater test lung with compliance of 10ml/cmH_2O, resistance of 5 cm/L/sec • Calibrated Digital Multi-Meter • Patient Assist Cable, Normally Closed, P/N 10779[67] • Patient Assist Cable, Normally Open, P/N 10780[67] • O_2 Sampling Tube, P/N 10544[68]

> **CAUTION**
> **O_2 Sampling Tube -** An O_2 Sampling Tube for measuring internal oxygen levels during General Checkout testing must be installed prior to performing internal O_2 % testing. Do not force the tube through the side of the ventilator, or damage to the internal tubing and components will occur. See *Back Panel, Reinstallation* in Chapter 8 – Component Removal and Replacement for detailed instructions.

1) Connect the AC adapter to a valid AC power source and to the ventilator. Connect the patient circuit and test lung to the ventilator. Do not connect the oxygen supply at this time.
2) Run the Ventilator Checkout VENT CHECK Tests.

Test	**Result**
A) Alarm	Audible alarm must activate for minimum 2 seconds. Confirming audible chirp must activate after alarm is silenced.
B) Display	All displays must illuminate (except Vent Inop).
C) Control	As each button is pressed, the correct label must be displayed in the monitor windows. This includes rotating the knob left and right. Leave the **Select** button until last.
D) Leak	Ventilator and circuit must pass the leak test (remove the test lung and occlude patient wye). For instructions on how to perform leak test, See *Ventilator Checkout Tests* in Chapter 2.
E) Vent Inop alarm	Power down the ventilator. Audible alarm must sound and **Vent Inop** LED must illuminate continuously for at least 15 seconds after powering down the ventilator. Confirming audible chirp must activate after alarm is silenced.

[67] The Patient Assist Cables are available separately, or as part of the Maintenance Calibration Kit, P/N 11566.
[68] O_2 Sampling Tube, P/N 10544, ~10.0” long, 0.125” O.D. X 0.079 I.D. clear polycarbonate tubing.

> **NOTE**
> When the Extended Features PRESETS, PTNT QUERY menu option is set to QUERY ON and the ventilator is powered up in normal ventilation mode, ventilation and alarm activation are suspended and the message **SAME PATIENT** is displayed after completing POST tests.
> Press the **Select** button to enable the suspended alarms and begin ventilation with the settings in use during the last power cycle, or set the PTNT QUERY menu option to QUERY OFF.

3) Power the ventilator up and observe the POST tests. All POST tests must complete normally.

   A) Audible alarm is on for 1 second.

   B) Confirming audible chirp occurs after alarm.

   C) All displays (except **Vent Inop**) are lit for 3 seconds.

   D) The POST messages are flashed in the message window.
      - **CPU**
      - **SRAM**
      - **INT VECTOR**
      - **ROM CRC**
      - **EEPROM**

   E) When the POST tests are successfully passed, ventilation begins within 20 seconds. Power down the ventilator.

4) Disconnect the ventilator from all external power sources. Power the ventilator up from the internal battery and observe the POST tests. All POST tests must complete normally.

   A) Audible alarm is on for 1 second.

   B) Confirming audible chirp occurs after alarm.

   C) All displays (except **External Power**, **Charge Status**, and **Vent Inop**) are lit for 3 seconds.

   D) The POST messages are briefly flashed in the message window.
      - **CPU**
      - **SRAM**
      - **INT VECTOR**
      - **ROM CRC**
      - **EEPROM**

   E) When the POST tests are successfully passed, ventilation begins within 20 seconds with a Power Lost alarm.

5) Reconnect the external power AC adapter and verify the audible alarm terminates. Press the **Silence Reset** button to clear the alarm and perform the following tests:

Ventilator Settings and Procedure	Performance Requirement
A) Set the vent to the following settings and operate for at least two minutes: **Mode:** Volume, Assist/Ctrl **Low Press O_2:** Off (LTV® 1200) **Breath Rate:** 12 **Tidal Volume:** 500 **Insp. Time:** 1.0 sec **Pressure Support:** 0 **O_2%:** 21 (LTV® 1200) **Sensitivity:** 3 **High Pressure Limit:** 100 **Low Pressure Alarm:** 5 **Low Min Vol:** 1.0 **PEEP:** 5 cmH_2O **High PEEP Alarm:** Off **Low PEEP Alarm:** Off **High f Alarm:** Off	Selected Monitors should read as follows: **Exhaled Tidal Volume (Vte)**: 383 to 633 ml **I:E Ratio** : 1:3.8 to 1:4.2 **Total Breath Rate (f)**: 12 bpm **Total Minute Vol (VE)**: 4.6 to 7.6 L No alarms activate
B) Set the O_2% control to 22% (LTV® 1200 only).	**LOW O2 PRES** alarm activates
C) Reset O_2% to 21% and clear the alarm (LTV® 1200 only). Set the **Low Min Vol** alarm to 10 L.	**LOW MIN VOL** alarm activates
D) Reset the **Low Min Vol** alarm to 1.0 and clear the alarm. Set the Low Pressure alarm to 60.	**LOW PRES** alarm activates
E) Reset the **Low Pressure** alarm to 5 and clear the alarm. Set the **High Pres Limit** to 10 cmH_2O below the Peak Inspiratory Pressure.	**HIGH PRES** alarm activates.
F) Reset the **High Pres. Limit** alarm to 100 and clear the alarm.	
G) Connect a 50 ± 2 PSIG oxygen source to the inlet port of the oxygen blender and set the O_2% setting to 60%. Connect an external oxygen monitor to the patient circuit (LTV® 1200 only).	External oxygen monitor should read 55 to 65% O_2 No alarms activate.
H) Reset **O_2%** control to 21 and disconnect the oxygen source and monitor (LTV® 1200 only).	

I) Disconnect the high pressure sense line from the ventilator.	**DISC/SENSE** alarm activates on the next breath.
J) Reconnect the pressure sense lines and clear the alarm.	
K) Change control settings as follows: **Mode:** Pressure, Assist/Control **Breath Rate:** 10 **Pressure Control:** 45 **Insp. Time:** 1.5 sec **PEEP:** 5 Let the ventilator deliver several breaths to stabilize.	Selected Monitors should read as follows: **PIP**: 46 to 54 cmH_2O No alarms activate.
L) Return to normal ventilation mode. Disconnect AC Adapter from ventilator.	**POWER LOST** alarm activates. **Battery Level** LED illuminates showing the charge level. Ventilator continues to operate from the internal battery.
M) Clear the **POWER LOST** alarm. Turn the ventilator off. Wait 15 seconds.	After the ventilator is turned off, the **Vent Inop** alarm sounds continuously for a minimum duration of 15 seconds. **Vent Inop** LED illuminates continuously for a minimum duration of 15 seconds.
N) Clear the **Vent Inop** alarm. Test is complete.	Confirming audible chirp must activate after alarm is silenced.

6) Perform a Patient Assist Port response test.

A) Connect a Patient Assist Cable, Normally Closed (P/N 10779) to the ventilator Patient Assist port, reconnect the AC adapter, power the ventilator up and clear all alarms.	
B) Use a Digital Multi-Meter to measure the resistance at the 1/4" plug of the Patient Assist Cable.	Resistance ≤2.3 ohm[69]
C) Create a High Pressure alarm by changing the **High Pres. Limit** setting to 5 and measure the plug resistance.	Resistance >1.0 mega ohms

[69] This measurement can best be obtained using the relative (delta) measurement of a DMM.

D)	Return the **High Pres. Limit** setting to 100 and clear all alarms.	
E)	Turn the ventilator off, leaving the audible alarm sounding and measure the plug resistance.	Resistance >1.0 mega ohms
F)	Press the **Silence Reset** button to clear the audible alarm and measure the plug resistance.	Resistance ≤2.3 ohm
G)	Disconnect the Patient Assist Cable, Normally Closed (P/N 10779) and connect a Patient Assist Cable, Normally Open (P/N 10780) to the ventilator Patient Assist port.	
H)	Turn the ventilator back on in breathing mode, clear all alarms and measure the plug resistance.	Resistance >1.0 mega ohms
I)	Create a High Pressure alarm by changing the **High Pres. Limit** setting to 5 and measure the plug resistance.	Resistance ≤2.3 ohm[70]
J)	Return the **High Pres. Limit** setting to 100 and clear all alarms.	
K)	Turn the ventilator off, leaving the audible alarm sounding and measure the plug resistance.	Resistance ≤2.3 ohm
L)	Press the **Silence Reset** button to clear the audible alarm and measure the plug resistance.	Resistance >1.0 mega ohms.

7) Check date, time and usage by operating the ventilator using the test lung for 1 hour.

A)	Set the date to the current date.	Note the current date and date format.
B)	Set the time to **23:15**.	
C)	Note the current usage meter.	
D)	Run the ventilator connected to a test lung for 1 hour.	Verify that no alarms occur.
E)	Power the vent off and on. Check the date.	Date has incremented correctly.
F)	Check the time.	Time has incremented correctly.

[70] This measurement can best be obtained using the relative (delta) measurement of a DMM.

G) Note the current usage meter.	Usage Meter has incremented correctly.
H) Reset the time to current time.	

NOTE

O_2 may exhaust from Air Inlet filter Port and falsely elevate reading. Do not permit exhausted O_2 to enter via the fan intake.

8) Perform an Internal Oxygen Enrichment (oxygen leakage) test.

A) Connect an oxygen sensor with a pump to draw flow through the O_2 Sampling Tube[71] installed prior to replacing the back panel. **For the LTV® 1200:** Connect a 50 ± 2 PSIG oxygen source to the inlet port of the ventilator's Oxygen Blender and set the O_2 % setting of the ventilator to 100%. **For the LTV® 1150:** Connect the O2 inlet port to an oxygen source providing 1.0 to 1.5 PSIG of oxygen. Operate the ventilator for a minimum of 2 minutes. While monitoring the peak O_2 % value, extract the tube approximately 0.5 inch per breath.	Peak % O_2 measurement taken from inside the unit must be $<$ 25%.

[71] O_2 Sampling Tube, P/N 10544, ~10.0" long, 0.125" O.D. X 0.079 I.D. clear polycarbonate tubing.

LTV® 1200/1150 SERIAL NUMBER:	______________	**CONDUCTED BY:**	______________
MEMORY BOARD SOFTWARE VER.:	______________	**DATE:**	______________

TEST DESCRIPTION	STEP #	MEAS. VALUE	REQUIREMENT	PASS / FAIL
Ventilator Checkout ("VENT CHECK")				
Alarm	2)A)		Audible alarm tone must activate	
			Confirming audible chirp must activate after alarm is silenced.	
Display	2)B)		All displays must light except **Vent Inop**	
Control	2)C)		Correct messages displayed in window	
Leak	2)D)		Record value displayed ("**X.X PASS/FAIL**")	
Vent Inop alarm	2)E)		Audible alarm must sound continuously for 15 seconds and **Vent Inop** LED must illuminate continuously for 15 seconds	
			Confirming audible chirp must activate after alarm is silenced.	
Power On Self-Test - External Power				
Audible alarm	3)A)		Verify audible alarm sounds for 1 sec	
	3)B)		Confirming audible chirp occurs after alarm	
Display Illumination	3)C)		All LEDS except **Vent Inop** illuminate for 3 seconds	
Test Messages:	3)D)		Each message displayed for less than 3 sec	
Begin Normal Operation	3)E)		Within 20 seconds of power ON	
Power On Self-Test - Battery Power				
Audible alarm	4)A)		Verify audible alarm sounds for 1 sec	
	4)B)		Confirming audible chirp occurs after alarm	
Display Illumination	4)C)		Illuminate for 3 seconds	
Test Messages:	4)D)		Each message displayed for less than 3 sec	
Begin Normal Operation	4)E)		Within 20 seconds of power ON	
Volume Operation				
Settings: Volume Mode / Assist/Ctrl Low Pres O_2 = Off (LTV® 1200 only) BPM = 12 Tidal Volume = 500 Inspiratory Time = 1.0 Pressure Support = 0 O_2 % = 21(LTV® 1200 only) Sensitivity = 3 High Pressure Limit = 100 Low Pressure alarm = 5 Low Minute Volume = 1.0 PEEP = 5 cmH_2O High PEEP = Off Low PEEP = Off High f = Off	5)A)		Monitors should read as follows: Vte: 383 to 633 ml	
			I:E Ratio: 1:3.8 to 1:4.2	
			f: 12 bpm	
			VE: 4.6 to 7.6 L	
			No alarms are occurring	

LTV® 1200/1150 SERIAL NUMBER: ____________

TEST DESCRIPTION	STEP #	MEAS. VALUE	REQUIREMENT	PASS / FAIL
Alarm Settings				
Low O_2 Pres alarm (LTV® 1200 only)	5)B)			
Set O_2% to 22% (LTV® 1200 only)			Alarm must activate immediately	
Low Minute Volume alarm	5)C)			
LMV alarm set to 10			Alarm must activate at start of next breath	
Low Pressure alarm	5)D)			
LP alarm set to 60 cmH_2O			Alarm must activate at end of the next inspiration	
High Pressure alarm	5)E)			
HP alarm 10 cmH_2O below monitored PIP			Alarm must activate on the next breath	
O_2 Enrichment (LTV® 1200 only)				
O_2 Inlet pressure @ 50 ± 2 PSIG, %O_2 @ 60%	5)G)		External O_2 monitor = 55% to 65%.	
			No alarms activate.	
Disc / Sense Alarm				
High side sense line disconnected from unit	5)I)		Alarm must activate at start of next inspiration	
Pressure Operation				
Control Settings: Pressure Assist / Control Breath Rate = 10 Pressure Control = 45 Insp. Time = 1.5 PEEP = 5	5)K)		Monitors should read as follows: PIP: 46 to 54 cmH_2O	
			No alarms activate.	
Power Alarm				
Return to normal ventilation mode. Disconnect AC adapter from ventilator	5)L)		POWER LOST alarm activates.	
			Battery Level LED illuminates showing the charge level.	
			Ventilator continues to operate from internal battery	
Vent Inop Alarm				
Clear the POWER LOST alarm. Turn the ventilator off. Wait 15 seconds.	5)M)		After the ventilator is turned off, the **Vent Inop** alarm sounds continuously for a minimum duration of 15 seconds.	
			Vent Inop LED illuminates continuously for a minimum duration of 15 seconds.	
Clear the Vent Inop alarm. Test is complete.	5)N)		Confirming audible chirp must activate after alarm is silenced	

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TEST DESCRIPTION	STEP #	MEAS. VALUE	REQUIREMENT	PASS / FAIL
Patient Assist Port				
Connect Patient Assist Cable, Normally Closed (P/N 10779), reconnect AC adapter, power ventilator up and clear all alarms.	6)A)			
Measure plug resistance.	6)B)		Resistance ≤2.3 ohm	
Change **High Pres Limit** setting to 5 (create alarm) and measure plug resistance.	6)C)		Resistance >1.0 mega ohms	
Return **High Pres Limit** setting to 100 and clear all alarms.	6)D)			
Turn ventilator off, leaving alarm sounding and measure plug resistance.	6)E)		Resistance >1.0 mega ohms	
Press **Silence Reset** to clear alarm and measure plug resistance.	6)F)		Resistance ≤2.3 ohm	
Disconnect Patient Assist Cable, Normally Closed (P/N 10779) and connect Patient Assist Cable, Normally Open (P/N 10780).	6)G)			
Power ventilator up, clear alarms and measure plug resistance.	6)H)		Resistance >1.0 mega ohms	
Change **High Pres Limit** setting to 5 (create alarm) and measure plug resistance.	6)I)		Resistance ≤2.3 ohm	
Return **High Pres Limit** setting to 100 and clear all alarms.	6)J)			
Turn ventilator off, leaving alarm sounding and measure plug resistance.	6)K)		Resistance ≤2.3 ohm	
Press **Silence Reset** button to clear alarm and measure plug resistance.	6)L)		Resistance >1.0 mega ohms.	
Burn In				
Set Current Date	7)A)		Current Date: Date Format:	
Set Time to **23:15**	7)B)		Time is 23:15:	
Note Usage Meter	7)C)		Note usage meter	
Operate ventilator on test lung for 1 Hr	7)D)		No alarms occur.	
Power vent off and on, Check Date	7)E)		Date has incremented correctly.	
Check Time	7)F)		Time has incremented correctly.	
Verify Usage Meter	7)G)		Usage meter has incremented correctly.	
Oxygen Enrichment (oxygen leakage)				
LTV® 1200: Connect a 50 ± 2 PSIG oxygen source to the ventilator. Set the O_2 % setting to 100%. **LTV® 1150:** Connect a 1.0 to 1.5 PSIG oxygen source to the ventilator. Operate for a minimum of 2 minutes. Extract the tube approximately 0.5 inch per breath.	8)A)		Peak % O_2 measurement taken from inside the unit must be $<$ 25%.	

Tools required:
• Internal Battery Test Cable[72], P/N 11472 • External Battery Test Cable[72], P/N 11474 • Variable 10 Amp DC voltage source

NOTE

When the Extended Features PRESETS, PTNT QUERY menu option is set to QUERY ON and the ventilator is powered up in normal ventilation mode, ventilation and alarm activation are suspended and the message **SAME PATIENT** is displayed after completing POST tests.
Press the **Select** button to enable the suspended alarms and begin ventilation with the settings in use during the last power cycle, or set the PTNT QUERY menu option to QUERY OFF.

1) Perform a Battery Level test. With the ventilator OFF, remove external power and replace the internal battery with the variable DC voltage source, using the internal battery test cable.

Ventilator Settings and Procedure	Performance Requirement
A) Replace battery with the variable DC voltage source set between 14.8V and 15.0V and turn the ventilator on. Silence the Power Lost alarm.	• Normal operation. • **Battery level** LED is green. • Only **POWER LOST** alarm activates.
B) Slowly reduce voltage until LTV® **Battery Level** LED changes to amber.	• Normal operation. • DC voltage source is 11.9V ± 0.238 (2%) • **BAT LOW** alarm • Audible alarm sounds.
C) Slowly reduce voltage until the LTV® **Battery Level** LED changes to red.	• Normal operation. • DC voltage source is 11.5V ± 0.230 (2%) • **BAT EMPTY** alarm. • Audible alarm sounds.
D) Slowly reduce voltage until the LTV® **Battery Level** LED extinguishes.	• DC voltage source is 10.0V ± 0.200 (2%) • **Vent Inop** LED illuminated. • Audible alarm sounds.
E) Remove DC voltage source and test cable. Reconnect the internal battery.	

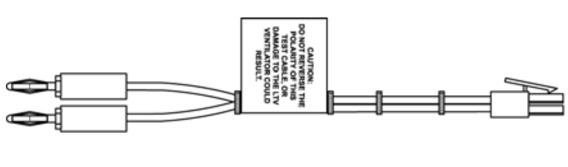
2) Perform a Battery Duration/Battery Charge test [73].

A) Remove external power and operate unit from its internal battery until it shuts down. Confirm **Vent Inop** LED is lit and audible alarm is sounding. Connect external power, clear alarms and allow the unit to operate normally and charge the battery for a minimum of 8 hours.	• **BAT LOW, BAT EMPTY**, and **Vent Inop** alarms sound • When the unit shuts down confirm **Vent Inop** LED is lit and **Vent Inop** alarm sounds

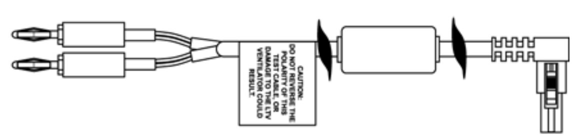
[72] The Internal Battery Test Cable and the External Battery Test Cable are available separately or as part of the Maintenance Calibration Kit, P/N 11566.

[73] It is normal for a **RESET** alarm to occur at the conclusion of POST after performing the Watchdog test, Battery Duration test, or any other test that which causes the ventilator to go inoperative (other than pressing and holding the On/Standby button). Press the Silence/Reset button twice to clear the alarm.

B) With this charged battery, remove external power, clear the power lost alarm and allow ventilator to operate continuously, using the following settings: **Mode:** Volume, Assist/Ctrl **Breath Rate:** 15 **Tidal Volume:** 800 **Insp. Time:** 1.5 sec **PEEP:** 5	• **Battery Level** LED is green upon removing external power. • Unit must operate continuously for a minimum of 40 minutes.
C) With ventilator ON, disconnect the internal battery. Confirm **Vent Inop** LED is lit and alarm is sounding. Reconnect external power (AC adapter) and clear Reset alarm.	• **Charge Status** LED is red.
D) Reconnect the internal battery.	• **Charge Status** LED is flashing amber for a few minutes (maximum 1 hour), and then goes solid amber.
3) Perform an External Power test.	
A) Continue with the external AC adapter connected to the ventilator.	• Ventilator runs normally. • **External Power** LED shows green. • **Charge Status** LED is lit or flashing.
B) Remove external power, clear power lost alarm. Connect an external DC power source with a voltage between 14.8V and 15.0V, using the external battery test cable.	• Ventilator runs normally. • **External Power** LED shows green. • **Charge Status** LED is lit or flashing.
C) Slowly reduce the external DC voltage until the **External Power** LED shows amber.	• Ventilator runs normally. • External voltage is 11.0V $\pm$ 0.220 (2%) • **Charge Status** LED is lit or flashing. • A **POWER LOW** alarm occurs. • Audible alarm sounds.
D) Slowly reduce the external DC voltage until the **External Power** LED extinguishes.	• Ventilator runs normally. • External voltage is 9.5V $\pm$ 0.190 (2%) • **Charge Status** LED is off. • A **POWER LOST** alarm occurs. • Audible alarm sounds. • **Battery Level** LED is lit.
E) Remove external battery test cable and replace with external power AC adapter. Power down the ventilator using the **On/Standby** button.	



Internal Battery Test Cable, P/N 11472



External Battery Test Cable, P/N 11474

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MEMORY BOARD SOFTWARE VER.:	______________	**DATE:**	______________

TEST DESCRIPTION	STEP #		REQUIREMENT	PASS / FAIL
Battery Level Test				
Replace battery with the 10A DC voltage source set between 14.8V and 15.0V and turn unit on. Clear the power lost alarm.	1)A)		Normal operation	
			Battery Level LED is green	
			Only **POWER LOST** alarm activates	
Slowly reduce voltage until battery LED changes to amber.	1)B)		Normal operation	
			DC voltage source is 11.9V ± 0.238 (2%)	
			BAT LOW and Audible alarm	
Slowly reduce voltage until battery LED changes to red.	1)C)		Normal operation	
			DC voltage source is 11.5V ± 0.230 (2%)	
			BAT EMPTY and Audible alarm	
Slowly reduce voltage until **Battery Level** LED extinguishes.	1)D)		DC voltage source is 10.0V ± 0.200 (2%)	
			Vent Inop LED illuminated**.**	
			Audible alarm sounds.	
Remove DC voltage source and reconnect the internal battery.	1)E)			
Battery Duration/Battery Charge Test				
Run unit from internal battery until it shuts down. Charge from external power while operating for a minimum of 8 hours.	2)A)		**Vent Inop** LED lights and audible alarm sounds	
Remove external power and operate unit from internal battery. Use settings: **Mode:** Volume, Assist/Ctrl **Breath Rate:** 15 **Tidal Volume:** 800 **Insp. Time:** 1.5 sec **PEEP:** 5	2)B)		B**attery Level** LED is green upon removing external power. Normal operation from internal battery for minimum of 40 minutes.	
Disconnect the internal battery, re-connect external AC adapter. Clear Reset alarm.	2)C)		**Charge Status** LED is red	
Reconnect the internal battery.	2)D)		**Charge Status** LED flashes amber for a few minutes, and then goes solid amber.	
External Power Test				
With external AC adapter connected	3)A)		Normal operation	
			External Power LED is green	
			Charge Status LED is lit or flashing	
Remove external power, clear power lost alarm. Connect an external DC power source with a voltage between 14.8V and 15.0V	3)B)		Normal operation	
			External Power LED is green	
			Charge Status LED is lit or flashing	

LTV® 1200/1150 SERIAL NUMBER: ____________

TEST DESCRIPTION	STEP #		REQUIREMENT	PASS / FAIL
Slowly reduce the external DC voltage until the **External Power** LED shows amber.	3)C)		Normal operation	
			External voltage is 11.0V ± 0.220 (2%)	
			Charge Status LED is lit or flashing	
			POWER LOW and Audible alarm	
Slowly reduce the external DC voltage until the **External Power** LED extinguishes.	3)D)		Normal operation	
			External voltage is 9.5V ± 0.190 (2%)	
			Charge Status LED is off	
			POWER LOST and Audible alarm	
			Battery Level LED is lit	
Remove external battery test cable and replace with external power AC adapter. Power down the ventilator using the **On/Standby** button.	3)E)			

Tools required:
• Turbine Pressure Test Adapter[74], P/N 11567 • Oxygen Analyzer • 0-80 PSIG O_2 Supply (LTV® 1200 only) • 0-50 cmH_2O Air Supply • 2 L test lung (or two 1 L test lungs in parallel) • Calibrated Spirometer • Patient Circuit, Adult-without PEEP • Stopwatch or breath rate meter • LTM II (P/N 17746-001) / LTM (P/N 11000) or Service Cable P/N 11485[74]

When doing a performance checkout, **always:**

- Allow the vent to warm up by operating at nominal settings for 1 hour, or warm up to ≥ 95° F in Servo mode with 10 Lpm at 4000 rpm settings, before beginning the performance checkout.
- After changing the control values for each test, allow ventilator to operate for 3 minutes.

> **NOTE**
> When the Extended Features PRESETS, PTNT QUERY menu option is set to QUERY ON and the ventilator is powered up in normal ventilation mode, ventilation and alarm activation are suspended and the message **SAME PATIENT** is displayed after completing POST tests.
> Press the **Select** button to enable the suspended alarms and begin ventilation with the settings in use during the last power cycle, or set the PTNT QUERY menu option to QUERY OFF.

1) Perform a Tidal Volume test.

Settings	Requirements
A) Set the ventilator as follows: **PEEP**: 5 cmH_2O **Tidal Volume**: 1500 ml **Breath Rate**: 6 **Insp Time** to 6.0 seconds	• Average measured volume (BTPD) must be 1500 ± 150 ml. • Average monitored tidal volume (Vte on the display) must be ±15% of average measured volume.
B) Set the ventilator as follows: **Tidal Volume**: 1500 ml **Breath Rate**: 8 **Insp Time**: 3.0 seconds	• Average measured volume (BTPD) must be 1500 ± 150 ml. • Average monitored tidal volume (Vte) must be ±15% of average measured volume.
C) Set the ventilator as follows: **Tidal Volume**: 1500 ml **Breath Rate**: 10 **Insp Time**: 1.5 seconds	• Average measured volume (BTPD) must be 1500 ± 150 ml. • Average monitored tidal volume (Vte) must be ±15% of average measured volume.

[74] The Turbine Pressure Test Adapter and Service Cable are available separately or as part of the Maintenance Calibration Kit, P/N 11566.

2) Perform a Breath Rate test.

A) Set the ventilator as follows:

Tidal Volume: 1500 ml

Breath Rate: 10

Insp Time: 3.0 seconds

B) Measure breath rate or the period between the start of two consecutive breaths.	• Measured breath rate must be 10.0 ± 1.0 or the interval must be 6.0 ± 0.5 sec.

3) Perform a Pressure Control test.

A) Set the ventilator as follows:

Pressure Control: 45 cmH2O and
Control Mode: Pressure

Rise Time: under the **VENT OP** menu as required (1 through 9, depending on test lung used), to achieve 50 cmH2O pressure

B) Measure the steady-state pressure during inspiration (measured from 0 pressure baseline).	• Measured steady-state pressure must be 46 to 54 cmH_2O.

4) Perform a Sensitivity test.

A) Set the ventilator as follows:

Sensitivity: 2 Lpm

PEEP: 5

Breath Rate: 6

Tidal Volume: 700

Inspiration Time: 2.0

Control Mode: Volume

B) Set **Leak Compensation**: OFF	
Press and hold the **Select** button	• Status monitor window displays **ALARM OP**
Rotate **Set Value** knob	• Status monitor window displays **VENT OP**
Press **Select** button and rotate **Set Value** knob	• Status monitor window displays **LEAK COMP**
Press **Select** button and rotate **Set Value** knob	• Status monitor window displays **COMP OFF**
Press **Select** button and press **Control Lock** button (2) times.	
C) Observe the **Patient Effort** LED on the upper right hand side of the ventilator control panel while creating a 4 Lpm leak past the patient wye momentarily during the exhalation portion of the respiratory cycle.	• The **Patient Effort** LED should momentarily flash and an inspiration should immediately begin. • If the **Patient Effort** LED does not flash and/or an inspiration is not given immediately: This condition constitutes a failure of the sensitivity test.

D)	Set **Leak Compensation:** ON	
	Press the **Sensitivity** button and rotate **Set Value** knob	• Status monitor displays "**-**" (sensitivity deactivated).
	Press and hold the **Select** button	• Status monitor displays **ALARM OP**
	Rotate the **Set Value** knob	• Status monitor window displays **VENT OP**
	Press the **Select** button and rotate the **Set Value** knob	• Status monitor window displays **LEAK COMP**
	Press the **Select** button and rotate the **Set Value** knob	• Status monitor window displays **COMP ON**
	Press the **Select** button and press the **Control Lock** button (2) times.	
E)	Create a 6 Lpm leak past the patient wye and wait for at least (2) full breath cycles. Set the **Sensitivity** value to 4 Lpm. Observe **Patient Effort** LED on the upper right side of the ventilator control panel for at least 30 seconds.	• The **Patient Effort** LED should not flash during and following the sensitivity being set to 4 Lpm. • If the **Patient Effort** LED flashes: This condition represents a failure of the sensitivity test.
F)	While monitoring the **Patient Effort** LED, disconnect the test lung momentarily <u>during the exhalation portion</u> of the breath cycle.	• The **Patient Effort** LED should momentarily flash and an inspiration should immediately begin. • If the **Patient Effort** LED does not flash and/or an inspiration is not given immediately after the momentary disconnection of the test lung: This condition represents a failure of the sensitivity test.

5) Perform a PEEP test.

A)	Set the ventilator as follows: **Tidal Volume**: 500 **Breath Rate**: 10 **Inspiration Time**: 1.0 **Control Mode**: Volume **PEEP**: 0	• Measured PEEP must be 0 ± 1 cmH2O. • Displayed PEEP must be 0 ± 1 cmH2O.
B)	Set the **PEEP** to 20	• Measured PEEP must be 20 ± 2 cmH2O. • Displayed PEEP must be 20 ± 2 cmH2O.
C)	Set the **PEEP** to 5	• Measured PEEP must be 5 ± 1 cmH2O. • Displayed PEEP must be 5 ± 1 cmH2O.

6) Perform a Real-time Transducer test. Turn the ventilator off. Turn the ventilator on while holding the **Select** button. Clear the **REMOVE PTNT** alarm, and then turn to the **RT XDCR DATA** menu and press **Select**. Turn the **Set Value** knob to display the required data.

Airway Pressure Transducer	
A) Open all connections to ambient air to apply 0 cmH_2O to high flow XDCR port.	• **AP** display must read 0 ± 0.5 cmH_2O.
B) Apply 50 cmH_2O ± 2 cmH_2O to high flow XDCR port.	• **AP** display must read the applied pressure ± 2 cmH_2O.
Flow Transducer Wide	
C) Open all connections to ambient air to apply 0 cmH_2O to both flow XDCR ports.	• **FDw** display must read 0 ± 0.5 cmH_2O
D) Apply 15 cmH_2O ± 0.5 cmH_2O to high flow XDCR port.	• **FDw** display must read the applied pressure ± 0.5 cmH_2O
E) Apply 15 cmH_2O to high and low flow XDCR port. Record the FDw value. Open all connections to ambient air.	• **FDw** display must read 0 ± 0.5 cmH_2O
Flow Valve Differential Transducer	
F) Turn the ventilator off. Turn the ventilator on while holding the **Select**, **Control Lock**, and **Manual Breath** buttons (3-finger mode[75]). Clear the **REMOVE PTNT** alarm, then turn to the **VENT MTNCE** menu and press **Select**.	
G) Press **Select** to enter the Servo menu, use the **Set Value** knob to select **ON,** and press **Select**. Set step position (listed under Tidal Volume) to 500 and turbine speed (listed under High Press alarm) to 10. Return to the **RT XDCR DATA** menu and view **FVd**.	• **FVd** display must read 0 ± 0.5 cmH_2O
H) Set step position to 100 and turbine speed to 4000. Return to the **RT XDCR DATA** menu and view **FVd**.	• **FVd** display must read ≥ 14 cmH_2O
O_2 Transducer (LTV® 1200 only)	
I) Open O_2 connections to ambient. View the O_2 reading under the RT XDCR DATA menu.	• **O_2** display must read 0 ± 0.5 PSIG
J) Apply 50 ± 2 PSIG to O_2 inlet port.	• **O_2** display must read the applied pressure ± 2 PSIG

[75] Using the 3-finger technique enables a modified mode of VENT MTNCE in which testing may be performed, but Calibration procedures and changing Configuration settings can not.

7) Perform a Patient Outlet Pressure test. Enter the **SERVO** menu.

Calculate Actual Turbine Speed (T/S)

A) With the ventilator operating in Servo Mode, set step position (listed under Tidal Volume) to **500**, and O_2% to **21%** (Oxygen setting for LTV® 1200 only).

B) Check the measured turbine speed (T/S) value noted during the turbine speed calibration test in Chapter 6.

C) If the measured T/S is less than 4000 RPM, then subtract it from 4000 to determine the adjustment which needs to be made to the set turbine speed. Add this adjustment value to 4000 to determine the *actual* turbine speed setting for this test. Note this *actual* T/S value.

D) If the measured T/S value is greater than 4000 RPM, subtract 4000 from it to determine the turbine speed adjustment value. Subtract this adjustment value from 4000 to determine turbine speed setting for this test. Note this *actual* turbine speed value.

Example: If the measured T/S value is 3750, the adjustment value is +250 and the *actual* turbine speed setting should be 4250.

If the measured T/S value is 4250, the adjustment value is -250 and the *actual* turbine speed setting should be 3750.

Measure Patient Outlet Pressure at Actual Turbine Speed (T/S)

E) Press **High Pres. Limit** and rotate the **Set Value** knob to display the *actual* turbine speed value obtained above.

F) Set up the ventilator as follows:

- Connect a 22mm adapter (P/N 10570) to the patient outlet port of the ventilator.
- Connect a hose from the 22mm adapter to a test hose connected to a manometer.
- Using pinch clamps (P/N 11529), block any other hoses branching from the test hose.

G) Wait for the manometer to reach a stable value (usually about one minute) before taking a reading.	• Pressure must be ≥ 55 cmH_2O at actual T/S

H) Record the pressure and the actual T/S values on the Performance Checkout Worksheet. Remove the 22mm adapter from the ventilator.

I) If the outlet pressure value is less than this value, troubleshoot (see *Chapter 7 - Troubleshooting*). For assistance, call Pulmonetic Systems technical support using the contact information at the front of this manual.

8) Perform a Servo test.

Connect the ventilator to a high pressure oxygen source. Connect an oxygen sensor to the 22 mm outlet port on the right side of the ventilator (for fastest response), or to the Patient Circuit Wye.

> **NOTE**
> Oxygen source and tested O_2% only apply to the LTV® 1200 model. When testing the LTV® 1150 model, set turbine speed and flow only.

A) Set flow (listed under **Insp. Time**) to 10, turbine speed (listed under High Press alarm) to 4000, and % O_2 to 30, O_2 Inlet to 40 PSI. Press **Manual Breath**.	• Flow (BTPD) must be 10 ± 0.5 Lpm[76] • % O_2 must be 30 ± 3%.
B) Set flow to 10, turbine speed to 5000, and % O_2 to 90, O_2 Inlet to 50 PSI. Press **Manual Breath**.	• Flow (BTPD) must be 10 ± 0.5 Lpm[76] • % O_2 must be 90 ± 5%.
C) Set flow to 50, turbine speed to 4000, and % O_2 to 60, O_2 Inlet to 60 PSI. Press **Manual Breath**.	• Flow (BTPD) must be 50 ± 7.5 Lpm • % O_2 must be 60 ± 5%.
D) Set flow to 90, turbine speed to 7000, and % O_2 to 90, O_2 Inlet to 50 PSI. Press **Manual Breath**.	• Flow (BTPD) must be 90 ± 13.5 Lpm • % O_2 must be 90 ± 5%.
E) Return flow setting to 10 Lpm.	

9) Perform a Solenoids test.

A) Set the step position to100, turbine speed to 4000, and turn on only the **ExhPilot** solenoid. After reading, turn the **ExhPilot** solenoid off.	• Pressure at the exhalation drive port must be 0 ± 0.1 cmH_2O before and ≥ 14 cmH_2O after activating the solenoid.
B) Set the step position to 100, turbine speed to 4000, and turn only the **Purge** solenoid on. After reading, turn the **Purge** solenoid off.	• Pressure at the High and Low flow XDCR ports must be 0 ± 0.1 cmH_2O before and ≥ 14 cmH_2O after activating the solenoid.
C) Turn the **PPin** and **PPout** solenoids on.	• Pressure at the exhalation drive port must be ≥ 14 cmH_2O.
D) Turn the **PPin** solenoid off. Set the turbine speed to 10 and monitor the **PPP** transducer reading.	• The **PPP** pressure displayed must be ± 0.5 cmH_2O of the applied pressure • Leakage rate must be ≤ 1 cmH_2O within one minute

[76] If Flow is not within the specified limits, recalibrate the Flow Valve (see page 6-25) and repeat the Performance Checkout tests.

E) Turn the **PPout** solenoid off.	• Pressure at the exhalation drive port must be 0.0 ± 0.1 cmH_2O.
F) Set **SERVO** to OFF. Apply 15 ± 0.5 cmH_2O to the high flow XDCR port, and turn the **Apres** solenoid on. After reading, turn the **Apres** solenoid off.	• **AP** and **FDw** display must read 0 ± 0.5 cmH_2O after activating the solenoid.
G) Apply and maintain 15 ± 0.5 cmH_2O pressure to the low and high flow XDCR port, turn the **Purge** solenoid on for 3 sec, and then turn it off.	• **FDw** display must read 0 ± 0.5 cmH_2O before and after activating the solenoid.
H) Apply 15 ± 0.5 cmH_2O to both the low and high flow XDCR ports, and turn the **ExhDiffP** solenoid on. After reading, turn the **ExhDiffP** solenoid off.	• **FDw** display must read 0 ± 0.5 cmH_2O before activating the solenoid and must equal **AP** ± 0.5 cmH_2O after.
I) Apply and maintain 15 cmH_2O pressure to the high flow XDCR port.	• **FDw** display must read 15 ± 0.5 cmH_2O.

10) Perform a Watchdog test [77].

A) Unit under test setup: **AC adapter** **VENT MTNCE** mode (using 3-finger mode[78]) **No alarms** **Patient circuit** attached **Test lung(s)** attached Navigate to **WDOG TEST** and press **Select**.	• Ventilator powers down, powers up, and successfully performs POST • Ventilator alarms, constant audible alarm and flashes **RESET** alarm • Clear alarms

11) Perform an LTM Compatibility test.

If an LTM Monitor is not available to perform this test, downloading the Event Trace onto a computer using the Service Cable Assembly and Instructions contained in P/N 11485 (available seperatly or as part of the Maintenance and Calibration Kit, P/N 11566) will also test for the proper function of the communication port.

[77] It is normal for a **RESET** alarm to occur at the conclusion of POST after performing the Watchdog test, Battery Duration test, or any other test that which causes the ventilator to go inoperative (other than pressing and holding the On/Standby button). Press the Silence/Reset button twice to clear the alarm.

[78] Using the 3-finger technique enables a modified mode of VENT MTNCE in which testing may be performed, but Calibration procedures and changing Configuration settings can not.

A)	Set the COM setting in Extended Features to **MONITOR**	
B)	Connect the LTM serial communication cable to the UUT **COMM PORT** on the left side of the UUT. Connect patient circuit and test lung or test lungs. Observe the icon and red exclamation mark for at least 30 seconds.	• Display of small LTV icon appears on the LTM. If the LTV® icon is not observed, or shown only intermittently, then this condition constitutes a FAIL for the LTM compatibility test. • (LTM with software 1.17 or earlier) A red exclamation mark is displayed to the right of the LTV® icon. The exclamation mark may be flashing.
C)	Press the **Wave** button on the LTM. **Select** the Wave screen.	• Waveforms are displayed in all three waveform charts. • The **Vte** value displayed to the left of the lower waveform chart on the LTM must be equal to the value shown in the LTV® status monitor window.
D)	Set the **Low Minute Volume** alarm to 99 Lpm.	• **LOW MIN VOL** alarm will occur. , • LTM status bar is flashing red with the text "Low Minute Volume" displayed.
E)	Reset the **Low Minute Volume** alarm by returning the **Low Min Vol** to its previous value and then pressing the **Silence Reset** button twice on the LTV®.	• Verify the red "Low Minute Volume" status bar is removed from the LTM.
F)	Disconnect the LTM serial communication cable from the LTV® **COMM PORT**.	

12) Perform a Flow Valve Leak for I/E Hold.

A)	Power up ventilator in **VENT MTNCE** mode (i.e.: using the "three finger mode[79]" hold down **Control Lock**, **Manual Breath** and **Select** while powering up the ventilator) enter **VENT MNTCE**.	
B)	Turn on **SERVO** mode.	
C)	Set the step position to 0 (in the **Tidal Volume** window)	
D)	Measure the flow at the **OUTLET** port of the ventilator.	• Flow must be less than 1 Lpm.

[79] Using the 3-finger technique enables a modified mode of VENT MTNCE in which testing may be performed, but Calibration procedures and changing Configuration settings can not.

LTV® 1200/1150 SERIAL NUMBER: ____________	**CONDUCTED BY:** ____________
MEMORY BOARD SOFTWARE VER.: ____________	**DATE:** ____________

TEST DESCRIPTION	STEP #	MEAS. VALUE	REQUIREMENT	PASS / FAIL
Tidal Volume				
Settings: **Volume**, **Assist / Control**, **PEEP**=5, **TV**=1500, **BPM**=6, **Insp Time**=6.0 seconds.	1)A)			
Average measured tidal volume			Average measured tidal volume (BTPD) = 1500 ± 150ml	
Average monitored tidal volume			Average displayed Vte = ± 15% of average measured tidal volume	
Settings: **Volume, Assist / Control**, **PEEP**=5, **TV**=1500, **BPM**= 8, **Insp Time** = 3.0 seconds.	1)B)			
Average measured tidal volume			Average measured tidal volume (BTPD) = 1500 ± 150ml	
Average monitored tidal volume			Average displayed Vte = ± 15% of average measured tidal volume	
Settings: **Volume**, **Assist / Control**, **PEEP**=5, **TV**=1500, **BPM**=10, **Insp Time** = 1.5 seconds	1)C)			
Average measured tidal volume			Average measured tidal volume (BTPD) = 1500 ± 150ml	
Average monitored tidal volume			Average displayed Vte = ± 15% of average measured tidal volume	
Breath Rate				
Settings: **Volume**, **Assist / Control**, **TV**=1500, **BPM**=10, **Insp Time** =3.0 sec	2)A)			
Period between start of 2 consecutive breaths	2)B)		Breath rate must be 10.0 ± 1.0 or measured interval must be 6.0 ± 0.5 sec.	
Pressure Control				
Settings: **Pressure**, **Assist / Control**, **P**=50, **Rise time**= "as required"[80]	3)A)			
Steady state pressure during inspiration	3)B)		Measured steady-state pres. = 50 ± 4 (46 to 54) cmH_2O	

[80] Set the RISE TIME under the VENT OP menu as required (1 through 9, depending on test lung used), to achieve 50 cmH_2O pressure.

LTV® 1200/1150 SERIAL NUMBER: ____________

TEST DESCRIPTION	STEP #	MEAS. VALUE	REQUIREMENT	PASS / FAIL
Sensitivity				
Settings: **Volume**, **PEEP**= 5, **BPM**=6, **TV**=700, **Insp Time**=2.0, **Sensitivity**= 2	4)A)			
LEAK COMPENSATION OFF:	4)B)			
Hold **Select** button			Status monitor displays **ALARM OP**	
Rotate **Set Value** knob			Status monitor displays **VENT OP**	
Press **Select** and rotate **Set Value**			Status monitor displays **LEAK COMP**	
Press **Select** and rotate **Set Value**			Status monitor displays **COMP OFF**	
Press **Select** and press **Control Lock** (2) times				
Observe the **Patient Effort** LED on the upper right hand side of the ventilator control panel while creating a 4 Lpm leak past the patient wye momentarily during the exhalation portion of the respiratory cycle.	4)C)		The **Patient Effort** LED should momentarily flash and an inspiration should immediately begin.	
LEAK COMPENSATION ON:	4)D)			
Press the **Sensitivity** button and rotate **Set Value** knob			Status monitor displays "-" (sensitivity deactivated)	
Hold **Select** button			Status monitor displays **ALARM OP**	
Rotate **Set Value** knob			Status monitor displays **VENT OP**	
Press **Select** and rotate **Set Value**			Status monitor displays **LEAK COMP**	
Press **Select** and rotate **Set Value**			Status monitor displays **COMP ON**	
Press **Select** and press **Control Lock** (2) times				
Create a 6 Lpm leak past the patient wye and wait for at least (2) full breath cycles. Set the **Sensitivity** to 4 Lpm.	4)E)		The **Patient Effort** LED should not flash during and following the sensitivity being set to 4 Lpm.	
While monitoring the **Patient Effort** LED, disconnect the test lung momentarily during the exhalation portion of the breath cycle.	4)F)		The **Patient Effort** LED should momentarily flash and an inspiration should immediately begin.	
PEEP Test				
Settings: **Volume**, **Assist / Control**, **TV**=500, **BPM**= 10, **Insp Time** = 1.0 seconds, **PEEP**= 0	5)A)		Measured PEEP must be 0 ± 1 cmH_2O	
			Displayed PEEP must be 0 ± 1 cmH_2O	
Settings: **Volume**, **Assist / Control**, **TV**=500, **BPM**= 10, **Insp Time** = 1.0 seconds, **PEEP**= 20	5)B)		Measured PEEP must be 20 ± 2 cmH_2O	
			Displayed PEEP must be 20 ± 2 cmH_2O	
Settings: **Volume**, **Assist / Control**, **TV**=500, **BPM**= 10, **Insp Time** = 1.0 seconds, **PEEP**= 5	5)C)		Measured PEEP must be 5 ± 1 cmH_2O	
			Displayed PEEP must be 5 ± 1 cmH_2O	

LTV® 1200/1150 SERIAL NUMBER: ____________

TEST DESCRIPTION	STEP #	MEAS. VALUE	REQUIREMENT	PASS / FAIL
Real-time Transducer Data				
Airway Pressure (**AP**):				
0 cmH_2O to high flow XDCR port	6)A)		**AP** display must read 0 ± 0.5 cmH_2O	
50 cmH_2O to high flow XDCR port	6)B)		**AP** display must read 50 ± 2 cmH_2O	
Flow Transducer Wide (**FDw**):				
0 cmH_2O to both flow XDCR ports	6)C)		**FDw** display must read 0 ± 0.5 cmH_2O	
15 cmH_2O to high flow XDCR port	6)D)		**FDw** display must read 15 ± 0.5 cmH_2O	
15 cmH_2O to high & low XDCR ports	6)E)		**FDw** display must read 0 ± 0.5 cmH_2O	
Flow Valve Differential Pressure:				
At step position 500, turbine speed 10	6)G)		**FVd** display must read 0 ± 0.5 cmH_2O	
At step position 100, turbine speed 4000	6)H)		**FVd** display must read ≥ 14 cmH_2O	
Oxygen Transducer (LTV® 1200 only):				
At 0 psig applied to O_2 inlet port	6)I)		**% O_2** display must read 0 ± 0.5 psig	
At 50 psig applied to O_2 inlet port	6)J)		**%O_2** display must read 50 ± 2 psig	
Patient Outlet Pressure				
Calculate *actual* turbine speed	7)D)		Enter *Actual* adjusted Turbine Speed	
Measure Patient Outlet pressure at actual turbine speed	7)H)		Must be ≥ 55 cmH2O	
Servo				
Flow @ 10, **Turbine** speed 4000, **% O_2** @ 30, **O_2 inlet pressure** 40 psig Press **Manual Breath**	8)A)		Flow (BTPD) must be 10 Lpm ± 0.5 Lpm	
			% O_2 must be 30 ± 3% (LTV® 1200 only)	
Flow @ 10, **Turbine** speed 5000, **%O_2** @ 90, O_2 **inlet pressure** 50 psig Press **Manual Breath**	8)B)		Flow (BTPD) must be 10 Lpm ± 0.5 Lpm	
			% **O_2** must be 90 ± 5% (LTV® 1200 only)	
Flow @ 50, **Turbine** speed 4000, **%O_2** @ 60, O_2 **inlet pressure** 60psig Press **Manual Breath**	8)C)		Flow (BTPD) must be 50 Lpm ± 7.5 Lpm	
			% **O_2** must be 60 ± 5% (LTV® 1200 only)	
Flow @ 90, **Turbine** speed 7000, **%O_2** @ 90, O_2 **inlet pressure** 50 psig Press **Manual Breath**	8)D)		Flow (BTPD) must be 90 Lpm ± 13.5 Lpm	
			% **O_2** must be 90 ± 5% (LTV® 1200 only)	

LTV® 1200/1150 SERIAL NUMBER: ____________

TEST DESCRIPTION	STEP #	MEAS. VALUE	REQUIREMENT	PASS / FAIL

Solenoids

TEST DESCRIPTION	STEP #	MEAS. VALUE	REQUIREMENT	PASS / FAIL
Step position 100, **turbine** speed 4000	9)A)			
ExhPilot solenoid deactivated (OFF):			Pressure at exhalation drive port must = 0 ± 0.1 cmH_2O	
ExhPilot solenoid activated (ON):			Pressure at exhalation drive port must be ≥14 cmH_2O	
Step position 100, **turbine** speed 4000	9)B)			
Purge solenoid deactivated (OFF):			Pressure at the High & Low flow transducer ports = 0 cmH_2O	
Purge solenoid activated (ON):			Pressure at the High & Low flow transducer ports ≥ 14 cmH_2O	
PPin and PPout solenoids activated (ON):	9)C)		Pressure at the exhalation drive port must be ≥14 cmH_2O	
Turbine speed 10	9)D)			
PPin solenoid deactivated (OFF):			**PPP** pressure displayed must be ± 0.5 of the applied pressure	
			Leakage rate must be ≤ 1 cmH_2O within one minute	
PPout solenoid deactivated (OFF):	9)E)		Pressure at exhalation drive port must = 0 ± 0.1 cmH_2O	
15 cmH_2O to high flow transducer port:	9)F)			
Apres solenoid activated (ON):			**AP**: 0 cmH_2O ± 0.5 after activation	
			FDw: 0 cmH_2O ± 0.5 after activation	
15 cmH_2O to low & high flow transducer ports: Pinch off inlet pressure, purge solenoid activated for 3 sec., then deactivate.	9)G)			
Calculated change in Pressure:			**FDw** display must not change by more than 0.5 cmH_2O before and after activating solenoid	
15 cmH_2O to low & high flow transducer port:	9)H)			
ExhDiffP solenoid deactivated (OFF):			**FDw** display must read 0 ± 0.5 cmH_2O	
ExhDiffP solenoid activated (ON):			**FDw** display must read AP ± 0.5 cmH_2O	
15 cmH_2O to high flow transducer port:	9)I)			
Pinch off the input pressure line			**FDw** display must read 15 ± 0.5 cmH_2O	

LTV® 1200/1150 SERIAL NUMBER: ____________

TEST DESCRIPTION	STEP #	MEAS. VALUE	REQUIREMENT	PASS / FAIL

Watchdog Test

Watch Dog activated	10)		CHECK: Unit shuts downs then restarts	

LTM Compatibility Test

Set COM setting to **MONITOR**	11)A)			
Connect the LTM serial com cable to the UUT COM PORT Connect patient circuit and test lung.	11)B)		Display of small LTV icon appears on the LTM. If the LTV® icon is not observed, or shown only intermittently, then this condition constitutes a FAIL for the LTM compatibility test (LTM with software 1.17 or earlier) A red exclamation mark is displayed to the right of the LTV® icon. The exclamation mark may be flashing.	
Press the **Wave** button and select the Wave screen	11)C)		3 waveforms are displayed **VTE** value on LTM is equal to value in LTV® status monitor	
Set **Low Minute Volume** alarm to 99	11)D)		LTM status bar flashes red with the text “**Low Minute Volume**” displayed.	
Reset **Low Minute Volume** alarm to previous value and press **Silence Reset** button twice on LTV®	11)E)		Red “Low Minute Volume” status bar is removed from LTM	
Disconnect LTM serial com cable	11)F)			
OR (If LTM is not available)				
Perform an Event Trace Download using P/N 11485.			Event Trace Data is successfully downloaded onto a personal computer.	

Flow Valve Leak for I/E Hold

Enter **VENT MTNCE**	12)A)			
Turn on **SERVO** mode	12)B)			
Set **step** position to 0	12)C)			
Measure flow at **OUTLET** port of LTV®	12)D)		Flow must be less than 1 Lpm	

Tools required:
1 liter or greater test lung

1) Perform a 12 hour Burn-in test.

- Connect the AC adapter to a valid AC power source
- Connect the patient circuit to the ventilator and to a test lung with a compliance of 10 ml/cmH_2O and a resistance of 5 cm/L/sec. Do not connect the Oxygen supply

NOTE
When the Extended Features PRESETS, PTNT QUERY menu option is set to QUERY ON and the ventilator is powered up in normal ventilation mode, ventilation and alarm activation are suspended and the message **SAME PATIENT** is displayed after completing POST tests.
Press the **Select** button to enable the suspended alarms and begin ventilation with the settings in use during the last power cycle, or set the PTNT QUERY menu option to QUERY OFF.

2) Power the ventilator up and set the ventilator controls to the settings shown below and on the next page. (Factory defaults with the High Pressure Limit value deliberately set high to avoid unwanted alarms.)

Front Panel Control Settings

Control	Setting	Control	Setting
Breath Rate	12 bpm	Low Minute Volume	2.5 Lpm
Tidal Volume	500 ml	Volume / Pressure	Volume
Pressure Control	1 cmH_2O	Ventilation Mode	Assist / Control
Inspiratory Time	1.5 sec	Insp/Exp Hold	Off
Pressure Support	1 cmH_2O	Low Pres O_2 Source (LTV® 1200 Only)	Off
O_2 % (O_2 Flush) (LTV® 1200 Only)	21%	Control Lock	On
Sensitivity	2 Lpm	PEEP	0 cmH_2O
High Pres Limit	100 cmH_2O	Data Display Scrolling	Auto-On
Low Pres	5 cmH_2O		

Extended Features, Default Settings

Feature	Default	Feature	Default
Alarm Volume	85 dBA	Patient Query	On
Apnea Interval	20 sec	Patient Size	INFANT
Com Setting	Data	PC Flow Term	Off
Control Unlock	Easy	PIP LED	On
Date Format	MM/DD/YYYY	Rise Time Profile	4
High f Alarm	High f Off	SBT Display f/Vt	On
High f Alarm Delay	30 sec	SBT FIO_2[80]	21%
High PEEP Alarm	PEEP + 5 cmH_2O	SBT High f Alarm	35 bpm
HP Alarm Delay	No Delay	SBT High f/Vt Alarm	105 bpm / l
Language	English	SBT Low f Alarm	10 bpm
Leak Compensation	On	SBT Low f/Vt Alarm	70 bpm / l
Low PEEP Alarm	PEEP - 5 cmH_2O	SBT Mode	Off
LPP Alarm	All Breaths	SBT Mode Run Time	20 min
NPPV Mode	Off	SBT PEEP	0 cmH_2O
O_2 Duration Cylinder[81]	2000 psi or 138 bar	SBT Pressure Support	10 cmH_2O
O_2 Duration Cylinder[79]	622liters	Var. Flow Term	25%
O_2 Flush Period[79]	3 min	Var. Time Term	1.5 sec
Patient Assist	Normal		

3) Run the ventilator connected to a test lung for 12 hours and verify that no alarms occur.
4) Return the ventilator settings to factory defaults (*see page E-11*) at the conclusion of the test.

[81] Available on the LTV® 1200 Only.

LTV® 1200/1150 SERIAL NUMBER:	______________	**CONDUCTED BY:**	______________
MEMORY BOARD SOFTWARE VER.:	______________	**DATE:**	______________

TEST DESCRIPTION	STEP #		REQUIREMENT	PASS / FAIL
12 Hour Burn-in				
Connect AC adapter and test lung.	1)			
Power ventilator up.	2)			
Set the ventilator controls to the settings listed.	2)			
Run the ventilator connected to a test lung for 12 hours.	3)		Verify that no alarms occur.	
Return the ventilator controls to the factory default settings.	4)			

Appendix A - Ventilator Specifications

Modes and Breath Types

Breath Types	Volume Control, Pressure Control, Pressure Support, Spontaneous
Modes	Control, Assist/Control, SIMV, CPAP, NPPV, Apnea Backup

Variable Controls

Control	Range	Tolerance
Backup Pressure Trigger	-3 cmH_2O	± 2 cmH_2O
Breath Rate	"--", 1 to 80 bpm	± 1 bpm or 10% of breath period, whichever is less
Date Format	mm/dd/yyyy, dd/mm/yyyy, yyyy/mm/dd	n/a
Display Select	Toggles between manual or automatic display scrolling and changes monitor displayed.	n/a
Inspiratory/Expiratory Hold	One push toggles monitor window display between normal display, INSP HOLD and EXP HOLD.	
	While INSP HOLD is displayed, a push and hold initiates an Inspiratory Hold.	6 seconds maximum
	While EXP HOLD is displayed, a push and hold initiates an Expiratory Hold.	6 seconds maximum
Inspiratory Time	0.3 to 9.9 seconds	± 0.05 seconds
Leak Compensation	On, Off	n/a
Language	English, Dansk, Deutsch, Español, Francais, Italiano, Norsk, Portugues, Svenska, Pyccкo	n/a
O_2 % (LTV® 1200 Only)	21% to 100%	O_2 % mean: 21% to 50%: ± 3 51% to 95%: ± 5 keep steady-state only
(O_2 Flush) (LTV® 1200 Only)	O_2: 95% Time: 1, 2, or 3 minutes	± 5 ± 0.1 sec

Control	Range	Tolerance
Patient Query	On, Off	n/a
PEEP/CPAP	0 to 20 cmH_2O	Uncalibrated
PIP LED Display	On, Off	n/a
Pressure Control	1 to 99 cmH_2O	± 2 cmH_2O or 8% whichever is greater, steady-state only
Pressure Control Flow Termination	On, Off	n/a
Pressure Support	"--", 1 to 60 cmH_2O	± 2 cmH_2O or 8% whichever is greater, steady-state only.
Set Date	01/01/1998 to 12/31/2097	n/a
Set Time	00:00:00 to 23:59:59	n/a
Sensitivity	1 to 9 Lpm, "-"	+ 1/- 0.5 Lpm for setting of 1; ± 1 Lpm for all other settings.
Tidal Volume	50 to 2000 ml	± 10% or 10 ml, whichever is greater for temperatures from 20°C to 30°C only, standard atmospheric pressure
Variable Flow Termination	10% to 40%	± 15% or 2 Lpm whichever is greater
Variable Rise Time	1 to 9	0.1 to 1.0 sec
Variable Time Termination	0.3 to 3.0 sec	± 0.1 sec
Bias Flow	10 Lpm during exhalation	± 10% or 1 Lpm, whichever is greater
SBT Start	On - Off	n/a
SBT PS	0-30 cmH_2O	± 2 cmH_2O or 8% whichever is greater, steady-state only.
SBT PEEP	0-20 cmH_2O	± 2 cmH_2O or 10%, whichever is greater
SBT FIO_2 (LTV® 1200 Only)	21-100%	O_2 % mean: 21% to 50%: ± 3 51% to 95%: ± 5 keep steady-state only
SBT minutes	15-120 minutes	n/a
SBT high f/Vt	70-900 bpm / l	± 20%
SBT low f/Vt	5-90	± 20%
SBT High f	15-80 bpm	± 1 bpm or within 5%, whichever is greater
SBT Low f	0-40 bpm	± 1 bpm or within 5%, whichever is greater
Display f/Vt	On - Off	n/a

Alarms

Variable Alarms

Control	Range	Tolerance
Apnea Interval	10 to 60 seconds	± 0.5 seconds
High Breath Rate	Rate: 5 - 80 bpm - HIGH f OFF	± 1 bpm or within 5% of breath period, whichever is greater.
	Time: 0 - 60 sec	± 0.1 seconds
High PEEP	3 to 20 cmH_2O above set PEEP	± 2 cmH_2O or ± 10%, whichever is greater.
Low PEEP	-3 to - 20 cmH_2O below set PEEP	± 2 cmH_2O or ± 10%, whichever is greater.
High Pressure Limit	5 to 100 cmH_2O	5 to 20 cmH_2O: ± 2 cmH_2O 21 to 100 cmH_2O: ± 4 cmH_2O
HP Alarm Delay	No Delay, 1 Breath, 2 Breaths	Only audible portion of alarm notification is delayed.
Low Minute Volume	0.1 to 99 liters	± 15% or the measured total breath rate times 15 ml, whichever is greater.
Low Peak Pressure	"- -", 1 to 60 cmH_2O	2 to 20 cmH_2O: ± 2 cmH_2O 21 to 60 cmH_2O: ± 4 cmH_2O
LPP Alarm	All Breaths, VC/PC Only	Select breath types Low Pressure alarm applies to.
SBT High f/Vt	Off, 70 – 900 bpm / l	± 2 cmH_2O or 10%, whichever is greater
SBT Low f/Vt	Off, 5 – 90 bpm / l	± 2%
SBT High f	Off, 15 – 80 bpm	± 1 bpm or within 5% of the breath period, whichever is greater
SBT Low f	Off, 1 – 40 bpm	± 1 bpm or within 5% of the breath period, whichever is greater

Fixed Alarms

Control	Range	Tolerance / Indicators	
Default Settings	EEPROM problem detected	n/a	
DISC/SENSE (Low Pressure Sense Line Disconnect)	Positive (exhaled) airway flow during first 200 ms of inspiration and exhaled tidal volume (Vte) of previous breath is more than 4000 ml	n/a	
DISC/SENSE (High Pressure Sense Line Disconnect)	Airway pressure changes by $\leq$ 1 cmH_2O during 200 ms after inspiratory start OR After initial 200 ms of inspiration airway pressure drops below 0.125 cmH_2O and can't be raised more than 0.5 cmH_2O in next 500 ms	$\pm$ 0.5 cmH_2O n/a	
External Power Lost	<9.5 V	$\pm$ 2%	
Hardware Fault	Hardware problem detected	n/a	
Internal Battery Empty	< 11.5 V	$\pm$ 2%	**Battery Level** LED Red and full volume audible alarm.
Internal Battery Low	< 11.9 V	$\pm$ 2%	**Battery Level** LED Amber
Oxygen Inlet Pres. High (LTV® 1200 Only)	High pres source: 85 PSIG Low pres source: 10 PSIG	$\pm$ 2 PSIG $\pm$ 1 PSIG	
Oxygen Inlet Pres. Low (LTV® 1200 Only)	< 35 PSIG	$\pm$ 2 PSIG	
Reset	Processor problem detected	n/a	
Transducer Fault	Autozero value outside manufacturer's specifications	n/a	
SBT Off	End of an SBT period	n/a	
SBT Time	Two minutes remaining in an SBT period	n/a	

,

Volume

Alarm Volume	60 to 80 dBA at one meter	$\pm$ 5 dBA	

Vent Inop

Ventilator Inoperative	Immediately upon a ventilator inoperative condition, the audible indicator will begin sounding with a steady tone and the **Vent Inop** LED shall illuminate. Depressing the alarm **Silence Reset** button will silence the audible indicator.

Mechanical Controls

Control	***Range***	***Tolerance***
Over Pressure Relief	≤125 cmH_2O	N/A
Sub-Ambient Relief	Pressure Drop: ≤ 5 cmH_2O	at 50 Lpm

Internal Compliance

Compliance	< 0.1 mL/cm

Monitors

Monitor	***Range***	***Tolerance***
Calculated Peak Flow	10 to 100 Lpm	2 Lpm or ± 10%, whichever is greater
Exhaled Tidal Volume	0 to 4000 ml	± 15% or 15 ml, whichever is greater
I:E Ratio, Measured	99:1 and 1:99 Based on the measured inspiratory / exhalation times	Accuracy for times are ± 50 ms or 5%, whichever is greater
I:E Ratio, Calculated	1:99 to 4.0:1 based on set breath rate and inspiratory time	± 5%
Mean Airway Pressure	0 to 99 cmH_2O	± 2 cmH_2O or 10%, whichever is greater
O_2 Cylinder Duration (LTV® 1200 Only)	0 - 99 hours and 59 minutes	- 0 / + 40%
Peak Inspiratory Pressure	0 to 120 cmH_2O	± 2 cmH_2O or 5%, whichever is greater
PEEP	0 to 99 cmH_2O	± 2 cmH_2O or 10%, whichever is greater
Total Breath Rate	0 to 250 breaths per minute	± 1 bpm or within 5% of the breath period, whichever is greater
Total Minute Volume	0 to 99.9 liters	± 15%, or the measured total breath rate times 15 ml, whichever is greater
SBT Minutes	1 – 120 minutes	± 0.1 seconds
f/Vt	0 – 4000	± 20%
and		
f	0 – 250bpm	Total breath rate: ± 1 bpm or within 5% of breath period, whichever is greater

Button Controls

Display	***Function***
Control Lock	Locks front panel controls, can be set to Easy or Hard unlocking
Manual Breath	Generates a machine breath

Standby/On	Puts ventilator in On or Standby state
Low Pressure O_2 Source (LTV® 1200 Only)	Selects Low Pressure O_2 Source
Silence Reset	Silences and resets alarms

Displays

Display	Range	Tolerance
Airway Pressure	-10 to 108 cmH_2O	± 3 cmH_2O or 5%, whichever is greater
Display Window	12 characters	n/a
Patient Effort	Green LED	n/a
Vent Inop	Red LED	n/a
External Power	Amber / Green LED	n/a
Charge Status	Red / Amber / Green LED	n/a
Battery Level	Red / Amber / Green LED	n/a
Usage Meter		
Usage Meter	1 to 139,000 hrs	Below 100 hrs: ± 10% Above 100 hrs: ± 5%

Packaging

Size	3” x 10” x 12” -OR- 3.25” x 10.5” x 13.5” with Protective Boots installed.
Weight	13.4 lbs -OR- 14.4 lbs with Protective Boots installed.

Sound Level

Sound Level	Shall not exceed 50 dBA (RMS) at one meter

Storage and Operating Conditions

Specification		Tolerance
Storage[82]		
Temperature	-20 to +60 degrees C	n/a
Humidity	10% to 95% Relative, non-condensing	n/a
Operating		
Temperature	+5 to +40 degrees C	n/a
Humidity	15% to 95% Relative, non-condensing	n/a

Orientation

The ventilator functions within its performance specifications when operated in any orientation.

Inlet Air Filtration

The ventilator air filter is removable and cleanable by the operator. All filter materials are FDA compliant for breathing circuits and meet burn requirements for UL 94HB.

[82] LTV® ventilators stored at temperatures outside of the specified Operating Temperature range are to be allowed to stabilize to within the operating temperature range before turning the ventilator on.

Storage and Operating Conditions (cont.)

Specification		Tolerance
Oxygen Inlet		
DISS or NIST Connector Inlet Pressure Range (LTV® 1200 Only)	40 to 80 PSIG	± 2 PSIG
Tapered Tubing Connector Inlet Pressure Range	0 to 10 PSIG	± 2 PSIG
Shock and Vibration		
The ventilator is designed to withstand shock and vibration in accordance with relevant requirements set forth in the following standards:		
IEC 68-2-27	Shock	
IEC 68-2-6	Vibration	
IEC 68-2-34	Vibration	
MIL-STD-810E	Shock, Ground Transport and Helicopter Transport Vibration	
Spillage		
The ventilator resists fluid spillage when tested in accordance with the relevant standards specified in IEC 601-1 Clause 44.3.		
External Surface Temperature		
External surfaces	< 50°C, ambient temperature of 35°C	n/a

Communications

Port	Connector	Specification
Communications	RS232, DB9 connector	Protocol Options: Data, Monitor, Printer, Modem
Patient Assist Call / Remote Alarm	RJ11-4	Closed contact resistance: ≤ 1 ohm

Equipment Classification

Classification	The ventilator is rated as Class II equipment per IEC 601-1 Clause 6.11
Type	The ventilator is specified as Type BF equipment per IEC 601-1 Clause 6.11

Power

Feature	Range		Tolerance / Indicators	
Input Voltage	11 to 15 VDC			
External Power				
AC Adapter	Input: 100 to 250 VAC, 50 to 60 Hz Output: 13 VDC		± 2.5%	
Full Power	Voltage ≥ 11.5 V		± 2%	Green LED
Low Power	Voltage < 11.0V and ≥ 9.5V		± 2%	Amber LED
External Power Off	Voltage < 9.5V		± 2%	LED off, switch to battery
Hysteresis	Ventilator shall not resume external power operation unless voltage is 11.5V		± 2%	
Nominal Current Draw	Startup: Running:	5.5 amps 3-4 amps		
Nominal Power Draw	Startup: Running:	66 watts 36 - 48 watts		
Leakage Current	Total leakage current to Earth ground for the ventilator with only approved accessories attached, shall not exceed 500 microAmps during normal operation, per IEC 601-1. Total leakage current to Earth ground for the ventilator shall not exceed one milliAmp when any single fault condition is present, per IEC 601-1.			
Ground Resistance	Total impedance between the ground contact at the inlet power connector and any accessible metal part shall not exceed 0.1 ohm, per IEC 601-1.			
Dielectric Strength	The ventilator shall be able to survive 1500 volts applied from either phase of the AC power inlet to Earth ground for a period of one minute, per IEC 601-1.			

Power (cont.)

Internal Battery

12V sealed lead acid battery. 4.5Ah.

Feature	Range	Tolerance / Indicators
Full Power	Green LED	
Medium Power	Amber LED	
Low Power	Red LED	
Charge Time	Battery shall be capable of being >90% charged within 8 hours, from fully discharged state to state indicated by green **Charge Status** LED.	When external power is present, and the vent is running at the nominal load
Charge Status	**Pre-Charge Qualification:**	**Flashing Amber LED**
	Battery Charging:	Amber LED
	Battery >90% Charged:	Green LED
	Battery Fault:	Red LED
Hysteresis	Ventilator shall not resume battery operation unless the battery voltage level is 11.8 V.	± 2%

Minimum battery duration following eight (8) hour charge to ventilator shutdown	**40 minutes**	**Nominal Load Settings:**	
Minimum time from battery full (green LED) to battery low (amber LED and **BAT LOW** alarm):	28 minutes	Mode	A/C
		PEEP	5
		Breath Rate (bpm)	15
Minimum time from battery low to battery empty (red LED and **BAT EMPTY** alarm):	8 minutes	O_2 %	21
		Tidal Volume (ml)	800
		Lung Compliance (ml/cmH_2O)	50
		Insp. Time (sec)	1.5
Minimum time from battery empty to “ventilator shutdown” (**Vent Inop** LED and **Vent Inop** alarm):	4 minutes	ET Resistance (cmH_2O/L/S)	5.87
		Sensitivity (Lpm)	2
		Battery Temp.	25 ^{o}C
DOT Requirements:	Unregulated, meets the requirements of 49 CFR 173, 159 (d).		

Agency Requirements

Regulatory Requirements

FDA Draft Reviewer Guidance for Ventilators, July, 1995.

Shipping Requirements

The ventilator, packed in its shipping container, conforms to the International Safe Transit Association requirements for packaged products weighing less than 100 pounds.

Appendix B - Glossary

Term	Definition
AC	Alternating Current.
Airway Circuit	The airway tubing that connects the ventilator and the patient.
Airway Pressure	The airway pressure measured at the exhalation valve.
Airway Pressure Display	A bar graph type display composed of 60 LEDs. This display shows the real-time airway circuit pressure from –10 cmH_2O to 108 cmH_2O.
Alarm	An audible and visual notification that an alarm condition has been met. Audible notification includes an oscillating or continuous tone. Visual notification may include flashing displays, illuminated LEDs, and text messages shown in the display window.
Apnea	Apnea occurs when the time between breath starts exceeds the set apnea interval.
Apnea Backup Ventilation	Apnea Backup Ventilation begins when an apnea alarm occurs and continues until the patient initiates 2 consecutive breaths or the alarm is canceled by an operator. Apnea Backup Ventilation is given in the Assist / Control mode.
Apnea Interval	The maximum period of time allowed between breath starts. If the time between breath starts exceeds this interval, an Apnea alarm occurs.
Assist / Control Mode	A mode of ventilation where the patient receives a minimum number of machine and assist breaths. The available breath types are Volume Control and Pressure Control.
Assist Breath	A volume or pressure breath that is initiated by the patient, and controlled and cycled by the ventilator. Assist breaths may occur in Assist / Control and SIMV modes.
Auto zero	The process of determining the transducer zero offset for ambient pressure.
Bias Flow	A continuous flow of gas through the airway circuit during the exhalation phase of the breath.
bpm	Breaths Per Minute.
Breath Period	The length of time between machine initiated breaths. The Breath Period is determined by the Breath Rate setting. For example, a Breath Rate of 6 would give a Breath Period of 10 seconds (60 seconds / 6 bpm).
Breath Rate, monitored (f)	The number of breaths given in a minute, including machine, assist, and patient breaths.
Breath Rate, set	The minimum number of machine breaths given in a minute.
BTPD	Body Temperature, Pressure Dry.
Circuit	See Airway Circuit.
Circuit Pressure	See Airway Pressure.
cmH_2O	Centimeters of water pressure. A unit of measure for pressure.

TERM	DEFINITION
Control Mode	A mode of ventilation where the patient receives a fixed number of machine breaths. In Control Mode, patient triggers are not allowed.
CPAP	Continuous Positive Airway Pressure. A positive pressure continually applied throughout the breath cycle.
CPAP Mode	A mode of ventilation where the patient triggers all breaths. Available breath types are Pressure Support and Spontaneous.
Display Window	A set of 12 dot-matrix displays used to show monitored data, alarm messages and Extended Feature menu items.
EEPROM	Electrically Erasable Programmable Read Only Memory. A type of memory that is used by the ventilator to maintain calibration data, control setting and other data when power is not applied to the ventilator.
EPAP	Expiratory Positive Airway Pressure. The positive gas pressure in the patient circuit during breath exhalation.
Event	Any condition noted in the ventilator's event trace. This may include both error conditions and normal operational events.
Exhaled Tidal Volume	See Tidal Volume.
Expiratory Hold	A maneuver which holds the expiratory phase of a delivered breath for a duration sufficient to determine the Auto PEEP of a patient.
Extended Features	A set of ventilator controls and options that are not associated with Front Panel controls. Extended Features are accessed through a menu shown in the display window.
F	See Breath Rate, monitored.
Flow	The rate at which gas is delivered to the patient, measured in Lpm.
Flow Trigger	A patient effort in which the amount of bias flow diverted into the patient's lungs exceeds the Sensitivity setting. A flow trigger will result in delivery of an Assist or Patient breath, according to the ventilation mode.
f/Vt	Total Breath Rate divided by the average Exhaled Tidal Volume.
f/Vt f	Total Breath Rate divided by the average Exhaled Tidal Volume, and the Total Breath Rate.
I:E Ratio, monitored	The ratio of inspiratory time to exhalation time for a breath. The smaller value is normalized to 1.
I:E Ratio, calculated	Calculated Inspiratory:Expiratory ratio, based upon the Inspiratory Time setting and the Breath Rate setting.
in-oz	Inch ounces. A measurement of torque.
Inspiratory Hold	A maneuver which holds the inspiratory phase of a volume delivered breath for a duration sufficient to determine **Δ Pres** pressure and static lung compliance of the patient.
IPAP	Inspiratory Positive Airway Pressure. The positive gas pressure in the patient circuit during breath inhalation.
L	Liters. A unit of measure for volume.
Leak Compensation	Leak Compensation improves triggering when a circuit leak is present.

TERM	**DEFINITION**
LED	Light Emitting Diode. An indicator that is illuminated on the Front Panel.
Lpm	Liters Per Minute. A unit of measure for flow.
Machine Breath	A volume or pressure breath that is initiated by the operator or the ventilator, and is controlled and cycled by the ventilator. Machine Breaths may occur in Control and Assist / Control modes. The operator may cause a machine breath in any mode using the **Manual Breath** button.
Manual Breath	A Machine Breath initiated by the operator pressing the **Manual Breath** button.
MAP	See Mean Airway Pressure.
Mean Airway Pressure, monitored (MAP)	Mean Airway Pressure. MAP is calculated for the most recent 60 seconds and is updated every 10 seconds.
Minimum Exhalation Time	The minimum time required for exhalation is 346 msec. Control settings are limited to ensure the Minimum Exhalation Time is provided. Breaths may not be triggered during the Minimum Exhalation Time.
Minimum Inspiratory Time	The minimum time required for inspiration is 300 msec. Control settings are limited to ensure the Minimum Inspiratory Time is provided.
Minute Volume, monitored (VE)	The average volume delivered to the patient for the last 60 seconds. VE is updated at the end of each breath and is calculated based on the last 8 breaths. All breath types are included.
msec	One one-thousandth of a second.
Nm	Newton meters. A measurement of torque equivalent to 0.007062 inch ounces.
Non Volatile Memory	Memory that is retained when ventilator is in Standby mode or powered off.
O_2	Oxygen.
Patient Breath	A Pressure Support or Spontaneous breath that is initiated by the patient, controlled by the ventilator and terminated by the patient. Patient breaths may occur in SIMV and CPAP ventilation modes.
Patient Effort	Any inspiratory effort by the patient.
Peak Inspiratory Pressure, monitored (PIP)	The maximum circuit pressure occurring during the inspiration and first 300 ms exhalation phase of a breath. PIP is measured at the patient wye.
PEEP	See Positive End Expiratory Pressure.
PIP	See Peak Inspiratory Pressure.
Positive End Expiratory Pressure, monitored (PEEP)	The circuit pressure measured at the end of the exhalation.
POST	Power On Self Tests. A set of self-tests the ventilator performs when turned on to verify the operational integrity of the Processor, Displays, Audible Alarm, Confirming Audible Chirp, SRAM, Program Memory and EEPROM (some tests require operator visual and/or audible verification).

TERM	DEFINITION
PreSet	A feature allowing ventilator parameters to be “preset” for an infant, pediatric, or an adult patient.
Pressure Control Breath	A machine or assist breath where the circuit pressure is elevated to a user-set pressure for a user-set period of time. Pressure Control Breaths have an optional flow termination criteria.
Pressure Support Breath	A patient breath where the circuit pressure is elevated to a user-set pressure and maintained there until flow decreases to a user-set percentage of the peak flow achieved. Pressure Support Breaths[83] may also be terminated by a user-set maximum time, or by exceeding 2 breath periods.
Pressure Trigger	A patient effort in which the proximal airway pressure dropped to, or below the set Sensitivity setting. A pressure trigger will result in delivery of an Assist or Patient breath, according to the ventilation mode.
PSIG	Pounds per Square Inch Gauge. A unit for measuring pressure. 1 PSIG = 0.7 bar.
rpm	Revolutions per minute. A unit for measuring turbine speed.
Scrolling, Monitor Data Display	Allows the user to display the monitored values statically or automatically scroll them. While scrolling is active, each monitored value will be displayed for 3 seconds then the next value will be automatically displayed.
SIMV	Synchronized Intermittent Mandatory Ventilation.
SIMV Mode	A mode of ventilation where a minimum number of Machine or Assist breaths are given, and the patient is allowed to trigger additional Patient breaths. Available Breath types are Volume Control, Pressure Control, Pressure Support, and Spontaneous.
Spontaneous Breath	A breath which the patient starts and cycles. Spontaneous breaths are cycled at 10% of peak flow, set variable time termination, or when they exceed 2 breath periods.
Spontaneous Breathing Trial (SBT)	A ventilation mode used to temporarily minimize ventilatory support and perform clinical assessments of a patient’s dependence on, or ability to be removed from positive pressure ventilation.
Tidal Volume, monitored (Vte)	The exhaled volume measured at the patient wye. Exhaled Volume is measured for all breath types.
Total Breath Rate, monitored (f)	The quantity of breaths given per minute; includes all breath types.
Transducer	An electromechanical device used to measure pressure or flow.
Vcalc	A monitor that displays the calculated peak flow for Volume Control breaths. Vcalc is calculated based on the set Tidal Volume and the Set Inspiratory Time.
VE	See Minute Volume, monitored.

[83] Pressure Control and Pressure Support breaths do not compensate for PEEP. Delivered pressure is controlled by the Pressure Control setting and is not affected by the PEEP setting. i.e.; A Pressure Control setting of 20cmH_2O and a PEEP setting of 10cmH_2O results in a maximum delivered pressure of 20cmH_2O.

TERM	DEFINITION
Volume Control Breath	A machine or assist breath where a user-set volume is delivered over a user-set time. Flow is delivered in a decelerating waveform where the peak and final flows are calculated so that the final flow is 50% of the peak flow.
Vte	See Tidal Volume, monitored.

Appendix C - SERVICE RECORD FORM

Any time service is performed on the LTV® 1200/1150 ventilator, a Service Record form should be filled out and returned to Pulmonetic Systems. This enables complete tracking of replacement part lots and allows Pulmonetic Systems to maintain comprehensive service history records.

A Service Record form should be filled out for all types of service, including part replacement and calibration. An example of a blank Service Record form can be found in this appendix. Contact Pulmonetic Systems to obtain a blank Service Rercord form to complete when servicing a LTV® Ventilator.

Fax, mail or e-mail the completed Service Record form to:

Cardinal Health

Pulmonetic Systems

17400 Medina Rd., Suite 100

Minneapolis, Minnesota 55447-1341

Phone:	(763) 398-8500
Office Fax:	(763) 398-8400
Customer Care Center Phone:	(800) 754-1914, Ext. 2
Customer Care Center Fax:	(763) 398-8403
Sales/Marketing E-mail:	info@pulmonetic.com
Customer Care Center E-mail:	service@pulmonetic.com
Pulmonetic Systems Website:	http://www.pulmonetic.com

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Return this completed form within 7 days of service to:

Cardinal Health - Pulmonetic Systems
17400 Medina Road, Suite 100
Minneapolis, MN USA 55447-1341
Fax: (763) 398-8592 Email: ltvservice@cardinalhealth.com

LTV® Service Record

LTV® Serial Number:		**RMA Number:**	
Service Technician:		**Date of Service**	
Servicing Company:		**Usage Hours:**	
Current LTV Customer:		**City, State/Country:**	

PM Required? ☐ **Yes** ☐ **No**

PM Performed? ☐ **Yes** ☐ **No**
PM Type ☐ **10k** ☐ **30k** ☐ **Silver** ☐ **Gold**

Upgrades Needed? ☐ **Yes** ☐ **No**
(If yes, please attach upgrades form)

Received vent with Software Version **Software Updated to Version**

CUSTOMER REPORTED COMPLAINT / MALFUNCTION *(add pages if necessary)*

Symptoms Reported By Customer / Reason(s) for Service:

Resolution to Reason for Service:

LIST EACH DETAILED PROBLEM AND RESOLUTION INDIVIDUALLY *(add pages if necessary)*

Problem #1 Identified During Service:

Resolution #1:

Problem #2 Identified During Service:

Resolution #2:

Problem #3 Identified During Service:

Resolution #3:

PSI TS Review	FOR INTERNAL USE ONLY	CC Data Entry
Date / Initials *(not required if PM only)*		Date / Initials

Sample of Service Form 17701-001, Rev H

LTV® Service Record

Serial Number __________

Critical Components Installed During This Service		
Part Number Installed	**Description**	**Lot Number Installed**
☐ **10136** ☐ **10643** ☐ **11803** ☐ **18242-001** (LTV1150, 1200)	**Analog Board**	
☐ **10019**	**Flow Valve**	
☐ **10140** (11636) ☐ **18608-001** (18634-001)	**Internal Battery** *(Include Lot and/or Date Code)*	
☐ **10135-002**	**Motor Board**	
☐ **14791-001** ☐ **18233-001**	**Main Board**	
☐ **14375 / 10137**	**Memory Board** ☐ New ☐ Reprogrammed	
☐ **15079-001**	**Oxygen Blender**	
☐ **15000** ☐ **18120-001**	**Power Board** Original Lot#	
☐ **10710** ☐ **14125** (LTV800) ☐ **18528-001** (LTV1150, 1200)	**Solenoid Manifold**	
☐ **11860 / 11490**	**Turbine Manifold**	
Non-Critical Components Installed During This Service		
Part Number Installed	**Description**	**Lot Number Installed**

Post Repair Calibration and Testing Completed *(reference current revision Service Manual for proper testing protocol)*			
☐	**Calibration**	☐	**Performance Checkout**
☐	**Power Checkout**	☐	**Burn-In**
☐	**General Checkout**		

Additional Notes (if additional space needed, record # of pages attached _____)	
Customer has refused repairs. This ventilator is not recommended for patient use until all appropriate repairs and testing are completed by a Pulmonetic Systems certified trained technician.	☐

Completion of this form certifies that all repairs, testing and parts recorded were performed in accordance with PSI requirements

Sample of Service Form 17701-001, Rev H

Appendix D - Event Trace

The Event Trace is a list of events recorded by the ventilator[84]. These events may be normal conditions, such as turning the ventilator on or off, or alarm conditions such as **HW FAULT** or **HIGH PRES**.

- Initial occurrences of events are recorded the first time they occur after power up, along with the date, time and associated data, if any.
- A second occurrence of the same type of event (same event code) will be recorded as a separate line item along with the latest date, time and associated data. The quantity of occurrences is increased by one (1) (i.e. a quantity of two (2) will be displayed).

NOTE

Event log entries are only one of many diagnostic tools used to troubleshoot the ventilator. Additional information is often required to accurately identify the root cause of a problem. See *Chapter 7 - Troubleshooting* for more information.

NOTE

Additional occurrences (3 or more) of the same type of event will update the secondary occurrence line items with the latest date, time, and associated data. The quantity of occurrences will be increased by one (1) for each additional occurrence (e.g. a quantity of 2 will be increased to 3).

To view the events:

1) Enter the Extended Features menu by pushing and holding the **Select** button for 3 seconds.
2) Turn the **Set Value** knob until **EVENT TRACE** is displayed. Press **Select**.
3) **xx:eventname** is displayed.

   xx is the chronological number of the event occurrence.
   eventname is the name of the event.

4) Highlight an event and press **Select**. **xx:EyCz** is displayed.

   xx is the chronological number of the event occurrence.
   y is the event code number of the event.
   z is the quantity of events: a quantity of 1 is displayed in the initial occurrence recording and a quantity of 2 or more in the secondary occurrence recordings of the same type of event.

[84] For downloading the Event Trace to a PC, a Service Cable (P/N 11485), is available. The cable may be ordered separately or as part of the Maintenance and Calibration Kit, P/N 11566.

5) Press **Select** and **xx:eventdate** is displayed.

xx	is the chronological number of the event occurrence.
eventdate	is the date of the event; **t**he date of the first occurrence is displayed in the initial occurrence recordings and the date of the latest occurrence in the secondary occurrence recordings of the same type of event. Date is displayed in the currently selected date format.

6) Press **Select** again, **xx:hh:mm:ss** is displayed.

xx	is the chronological number of the event occurrence.
hh:mm:ss	is the time of the first occurrence; the time of the first occurrence is displayed in the initial occurrence recordings and the time of the latest occurrence in the secondary occurrence recordings of the same type of event.

7) Press **Select**, **xx:data** is displayed.

xx	is the chronological number of the event occurrence.
data	is the data associated with the event; the data associated with the first occurrence is displayed in the initial occurrence recordings and the data associated with the latest occurrence in the secondary occurrence recordings of the same type of event.

NOTE

For some events, the data field will be blank.

8) Press the **Select** button to return to the initial display.
9) Turn the **Set Value** knob clockwise or counterclockwise to view other events.
10) To exit the **EVENT TRACE**, turn to **EXIT** and press the **Select** button or press **Control Lock**.

For more information about how these codes are used, see the LTV® 1200 or the LTV® 1150 Ventilator Operator's Manual or contact your Service Representative.

Event Codes

This section includes a list of the event codes that can be recorded in the Event Trace.

Event Codes by Code

Code	Event Name	Event	Associated Alarm
01	VENT 1	Power on	None
02	VENT 0	Power off	None
03	HOUR MTR	Set hour meter	None
04	VENT CHK	Set vent check	Entered VENT CHECK mode
05	APNEA 1	Apnea mode entered	APNEA
06	APNEA 0	Apnea mode exited	APNEA
07	*N/A*	*Not used*	
08	HIGH DIS	High side disconnect	DISC/SENSE
09	LOW DIS	Low side disconnect	DISC/SENSE
10	DISC 0	Circuit disconnect exited	DISC/SENSE
11	BATMPT1	Internal battery empty occurred	BAT EMPTY
12	BATMPT0	Internal battery empty exited	BAT EMPTY
13	BATLOW1	Internal battery low occurred	BAT LOW
14	BATLOW0	Internal battery low exited	BAT LOW
15	EXT LST1	External power lost occurred	POWER LOST
16	EXT LST0	External power lost exited	POWER LOST
17	EXT LOW1	External power low occurred	POWER LOW
18	EXT LOW0	External power low exited	POWER LOW
19	XDC FLT1	XDCR fault occurred	XDCR FAULT
20	XDC FLT0	XDCR fault exited	XDCR FAULT
21	O2 LOW 1	O_2 pressure low occurred	LOW O2 PRES
22	O2 LOW 0	O_2 pressure low exited	LOW O2 PRES
23	O2 HI 1	O_2 pressure high occurred	HIGH O2 PRES
24	O2 HI 0	O_2 pressure high exited	HIGH O2 PRES
25	DEFAULTS	Defaults, or Set Defaults occurred	DEFAULTS / DEFAULTS, SET
26	NO CAL	No calibration data found	NO CAL DATA
27	FAN FLT1	Fan fault occurred	HW FAULT
28	FAN FLT0	Fan fault exited	HW FAULT
29	*N/A*	*Not used*	
30	*N/A*	*Not used*	
31	INTRRPT1	Spurious interrupt occurred ms	RESET or RESET 1
32	INTRRPT2	Spurious interrupt occurred ls	RESET or RESET 1
33	AD MMTCH	ADC mismatch	HW FAULT

Code	Event Name	Event	Associated Alarm
34	AD MTCH1	ADC mismatch occurred	HW FAULT
35	AD MTCH0	ADC mismatch cleared	HW FAULT
36	SYNCER1	Stepper motor lost sync occurred	HW FAULT
37	SYNCER0	Stepper motor lost sync exited	HW FAULT
38	HOME ER1	Stepper motor home failure occurred	HW FAULT
39	HOME ER0	Stepper motor home failure exited	HW FAULT
40	EEPROM	EEPROM degraded	HW FAULT
41	CRC	Memory CRC check failed	RESET
42	HI PRES1	High pressure occurred	HIGH PRES
43	HI PRES0	High pressure exited	HIGH PRES
44	TBN ISTP	Turbine immediate stop occurred	HIGH PRES
45	TBN ZERO	Turbine set to zero flow occurred	HIGH PRES
46	TBN ESTP	Turbine emergency stop occurred	HIGH PRES
47	LOW VE 1	Low minute volume occurred	LOW MIN VOL
48	LOW VE 0	Low minute volume exited	LOW MIN VOL
49	LO PRES1	Low peak pressure occurred	LOW PRES
50	LO PRES0	Low peak pressure exited	LOW PRES
51	CLR EVNT	Event log cleared	N/A
52	CLR CTRL	Control settings cleared	N/A
53	SET DATE	Date set	N/A
54	SET TIME	Time set	N/A
55	*N/A*	*Not used*	
56	STACK	Stack overflow detected	RESET
57	POST	POST failure	RESET
58	RUNAWAY	Code runaway detected	RESET
59	WDOG TST	Watchdog test run	Vent Inop
60	CLR CAL	Calibration records cleared	N/A
61	XDCR NAR	Differential pressure transducer - Narrow channel fault	XDC FLT1
62	XDCR WID	Differential pressure transducer - Wide channel fault	XDC FLT1
63	XDCR BI	Differential pressure transducer - Bi-directional channel fault	XDC FLT1
64	XDCR AIR	Airway pressure transducer fault	XDC FLT1
65	ADC1 VAL	AD mismatch primary channel fault value	HW FAULT
66	TBN HSTP	Turbine Hold Stop occurred	HIGH PRES
67	LN VENT1	Shutdown for other than pressing On/Standby button	RESET
68	FLUSH ER	A problem is detected writing data to the EEPROM during system shutdown.	HW FAULT

Code	Event Name	Event	Associated Alarm
69	RAC ERR1	Problem detected with primary and/or redundant audible alarm circuitry	HW FAULT
70	RAC ERR0	Recovery from problem detected with primary and/or redundant audible alarm circuitry	HW FAULT
71	SNDRERR1	Alarm sounder error	HW FAULT
72	SNDRERR0	Recovery from alarm sounder error	HW FAULT
73	HIGH f1	High breath rate alarm occurred.	HIGH f
74	HIGH f0	High breath rate alarm recovered.	HIGH f
75	HI PEEP1	Monitored PEEP	HIGH PEEP
76	HI PEEP0	Monitored PEEP	HIGH PEEP
77	HI SBTf1	Total Breath Rate	SBT > f
78	HI SBTf0	Total Breath Rate	SBT > f
79	LO SBTf1	Total Breath Rate	SBT < f
80	LO SBTf2	Total Breath Rate	SBT < f
81	HI f/VtT1	Rapid Shallow Breathing Index	SBT > f/Vt
82	HI f/VtT0	Rapid Shallow Breathing Index	SBT > f/Vt
83	LO f/VtT1	Rapid Shallow Breathing Index	SBT < f/Vt
84	LO f/VtT0	Rapid Shallow Breathing Index	SBT < f/Vt
85	SBT1	N/A	N/A
86	MON f/Vt	f/Vt value at SBT exit	N/A
87	SBT0	SBT exit reason	N/A
88	CLR BREC	Reclaims all incorrectly recognized bad EEPROM records	N/A
89	LO PEEP1	Monitored PEEP	LOW PEEP
90	LO PEEP0	Monitored PEEP	LOW PEEP
91	NEW PTNT	New patient setup	N/A

Event Name	Code	Event	Associated Alarm
AD MMTCH	33	ADC mismatch	HW FAULT
AD MTCH0	35	ADC mismatch cleared	HW FAULT
AD MTCH1	34	ADC mismatch occurred	HW FAULT
ADC1 VAL	65	AD mismatch primary channel fault value	HW FAULT
APNEA 0	06	Apnea mode exited	APNEA
APNEA 1	05	Apnea mode entered	APNEA
BATLOW0	14	Internal battery low exited	BAT LOW
BATLOW1	13	Internal battery low occurred	BAT LOW
BATMPT0	12	Internal battery empty exited	BAT EMPTY
BATMPT1	11	Internal battery empty occurred	BAT EMPTY
CLR BREC	88	Reclaims all incorrectly recognized bad EEPROM records (software 5.01 only)	N/A
CLR CAL	60	Calibration records cleared	N/A
CLR CTRL	52	Control settings cleared	N/A
CLR EVNT	51	Event log cleared	N/A
CRC	41	Memory CRC check failed	RESET
DEFAULTS	25	Defaults, or Set Defaults occurred	DEFAULTS / DEFAULTS SET
DISC 0	10	Circuit disconnect exited	DISC/SENSE
EEPROM	40	EEPROM degraded	HW FAULT
EXT LOW0	18	External power low exited	POWER LOW
EXT LOW1	17	External power low occurred	POWER LOW
EXT LST0	16	External power lost exited	POWER LOST
EXT LST1	15	External power lost occurred	POWER LOST
FAN FLT0	28	Fan fault exited	HW FAULT
FAN FLT1	27	Fan fault occurred	HW FAULT
FLUSH ER	68	A problem is detected writing data to the EEPROM during system shutdown.	HW FAULT
HI f/VtT0	82	Rapid Shallow Breathing Index	SBT > f/Vt
HI f/VtT1	81	Rapid Shallow Breathing Index	SBT > f/Vt
HI PEEP0	76	Monitored PEEP	HIGH PEEP
HI PEEP1	75	Monitored PEEP	HIGH PEEP
HI PRES0	43	High pressure exited	HIGH PRES
HI PRES1	42	High pressure occurred	HIGH PRES
HI SBTf0	78	Total Breath Rate	SBT > f
HI SBTf1	77	Total Breath Rate	SBT > f
HIGH DIS	08	High side disconnect	DISC/SENSE

Event Name	Code	Event	Associated Alarm
HIGH f0	74	High breath rate alarm recovered	HIGH f
HIGH f1	73	High breath rate alarm occurred	HIGH f
HOME ER0	39	Stepper motor home failure exited	HW FAULT
HOME ER1	38	Stepper motor home failure occurred	HW FAULT
HOUR MTR	03	Set hour meter	None
INTRRPT1	31	Spurious interrupt occurred ms	RESET or RESET 1
INTRRPT2	32	Spurious interrupt occurred ls	RESET or RESET 1
LN VENT1	67	Shutdown for other than pressing On/Standby button	RESET
LO f/VtT0	84	Rapid Shallow Breathing Index	SBT < f/Vt
LO f/VtT1	83	Rapid Shallow Breathing Index	SBT < f/Vt
LO PEEP0	90	Monitored PEEP	LOW PEEP
LO PEEP1	89	Monitored PEEP	LOW PEEP
LO PRES0	50	Low peak pressure exited	LOW PRES
LO PRES1	49	Low peak pressure occurred	LOW PRES
LO SBTf1	79	Total Breath Rate	SBT < f
LO SBTf2	80	Total Breath Rate	SBT < f
LOW DIS	09	Low side disconnect	DISC/SENSE
LOW VE 0	48	Low minute volume exited	LOW MIN VOL
LOW VE 1	47	Low minute volume occurred	LOW MIN VOL
MON f/Vt	86	f/Vt value at SBT exit	N/A
NEW PTNT	91	New patient setup	N/A
NO CAL	26	No calibration data found	NO CAL DATA
O2 HI 0	24	O_2 pressure high exited	HIGH O2 PRES
O2 HI 1	23	O_2 pressure high occurred	HIGH O2 PRES
O2 LOW 0	22	O_2 pressure low exited	LOW O2 PRES
O2 LOW 1	21	O_2 pressure low occurred	LOW O2 PRES
POST	57	POST failure	RESET
RAC ERR0	70	Recovery from problem detected with primary and/or redundant audible alarm circuitry	HW FAULT
RAC ERR1	69	Problem detected with primary and/or redundant audible alarm circuitry	HW FAULT
RUNAWAY	58	Code runaway detected	RESET
SBT0	87	SBT exit reason	N/A
SBT1	85	N/A	N/A
SET DATE	53	Date set	N/A
SET TIME	54	Time set	N/A
SNDRERR0	72	Recovery from alarm sounder error	HW FAULT
SNDRERR1	71	Alarm sounder error	HW FAULT

Event Name	Code	Event	Associated Alarm
STACK	56	Stack overflow detected	RESET
SYNCER0	37	Stepper motor lost sync exited	HW FAULT
SYNCER1	36	Stepper motor lost sync occurred	HW FAULT
TBN ESTP	46	Turbine emergency stop occurred	HIGH PRES
TBN HSTP	66	Turbine Hold Stop occurred	HIGH PRES
TBN ISTP	44	Turbine immediate stop occurred	HIGH PRES
TBN ZERO	45	Turbine set to zero flow occurred	HIGH PRES
VENT 0	02	Power off	None
VENT 1	01	Power on	None
VENT CHK	04	Set vent check	Entered VENT CHECK mode
WDOG TST	59	Watchdog test run	Vent Inop
XDC FLT0	20	XDCR fault exited	XDCR FAULT
XDC FLT1	19	XDCR fault occurred	XDCR FAULT
XDCR AIR	64	Airway pressure transducer fault	XDC FLT1
XDCR BI	63	Differential pressure transducer - Bi-directional channel fault	XDC FLT1
XDCR NAR	61	Differential pressure transducer - Narrow channel fault	XDC FLT1
XDCR WID	62	Differential pressure transducer - Wide channel fault	XDC FLT1
N/A	55	*Not used*	
N/A	30	*Not used*	
N/A	29	*Not used*	
N/A	07	*Not used*	

XDC FLT1

Four binary digits, ABCD, where

A represents the Flow Differential narrow **(FDn)** transducer channel

B represents the Flow Differential wide **(FDw)** transducer channel

C represents the Flow Differential bi-directional **(FDb)** transducer channel

D represents the Airway Pressure **(AP)** transducer

and

1 = fault, 0 = okay

For example, 0100 represents a failed auto zero on the **FDw** channel.

HOME ER1

-1 or 1, where

-1 represents the clockwise direction

1 represents the counterclockwise direction

AD MMTCH, AD MTCH1

xx = A/D channel, where

0 = Flow Differential Narrow **(FDn)**

1 = Flow Differential Wide **(FDw)**

2 = Flow Valve Differential **(FVd)**

3 = Airway Pressure **(AP)**

4 = Oxygen Pressure **(O2)**

5 = not used

6 = Flow Valve Temperature **(FVt)**

7 = External Voltage **(EV)**

8 = Battery Voltage **(BV)**

9 = not used

10 = Flow Differential Bi-Directional **(FDb)**

11 = V ref/2 signal on power board

12 = V ref -ve signal on power board

13 = V ref +ve signal on power board

yyyy = signed difference of A/D 1 count – A/D 2 count

Appendix E - Reference Information

Conversion Factors

The following Reference Conversion Table provides conversion factors for converting between units.

To use this table:

Move across the table to find the starting unit of measure. Move down the table to reach the ending unit of measure. Multiply the starting unit of measure value by the number provided.

To \ From	PSI (lb / in^2)	BAR	Millibar Hectopascal	IN. HG (at 0ºC)	IN. H_2O (at 4ºC)	mmHG (at 0ºC)	mmH_2O (at 4ºC)	cmH_2O (at 4ºC)
PSI (lb / in^2)	1	14.5039	1.4504 x 10^{-2}	0.491159	3.6127 x 10^{-2}	1.933368 x 10^{-2}	1.4223 x 10^{-3}	1.4223 x 10^{-2}
BAR	6.8947 x 10^{-2}	1	1 x 10^{-3}	3.3865 x 10^{-1}	2.4908 x 10^{-3}	1.3332 x 10^{-3}	9.8068 x 10^{-5}	9.8068 x 10^{-4}
Millibar Hectopascal	68.947	1 x 10^{3}	1	33.865	2.4908	1.3332	9.8068 x 10^{-2}	0.98068
IN. HG (at 0ºC)	2.0360	29.529	2.9529 x 10^{-2}	1	7.3552 x 10^{-2}	3.9368 x 10^{-2}	2.8959 x 10^{-3}	2.8959 x 10^{-2}
IN. H_2O (at 4ºC)	27.680	401.47	0.40147	13.596	1	0.53525	3.9372 x 10^{-2}	0.39372
mmHG (at 0ºC)	51.7149	750.06	0.75006	25.401	1.8683	1	7.3558 x 10^{-2}	0.735558
mmH_2O (at 4ºC)	703.08	1.0197 x 10^{4}	10.197	345.32	25.399	13.595	1	10
cmH_2O (at 4ºC)	70.3	1019.7	1.0197	34.532	2.5399	1.3595	0.1	1

Extended Features Menus

Alarm Operations

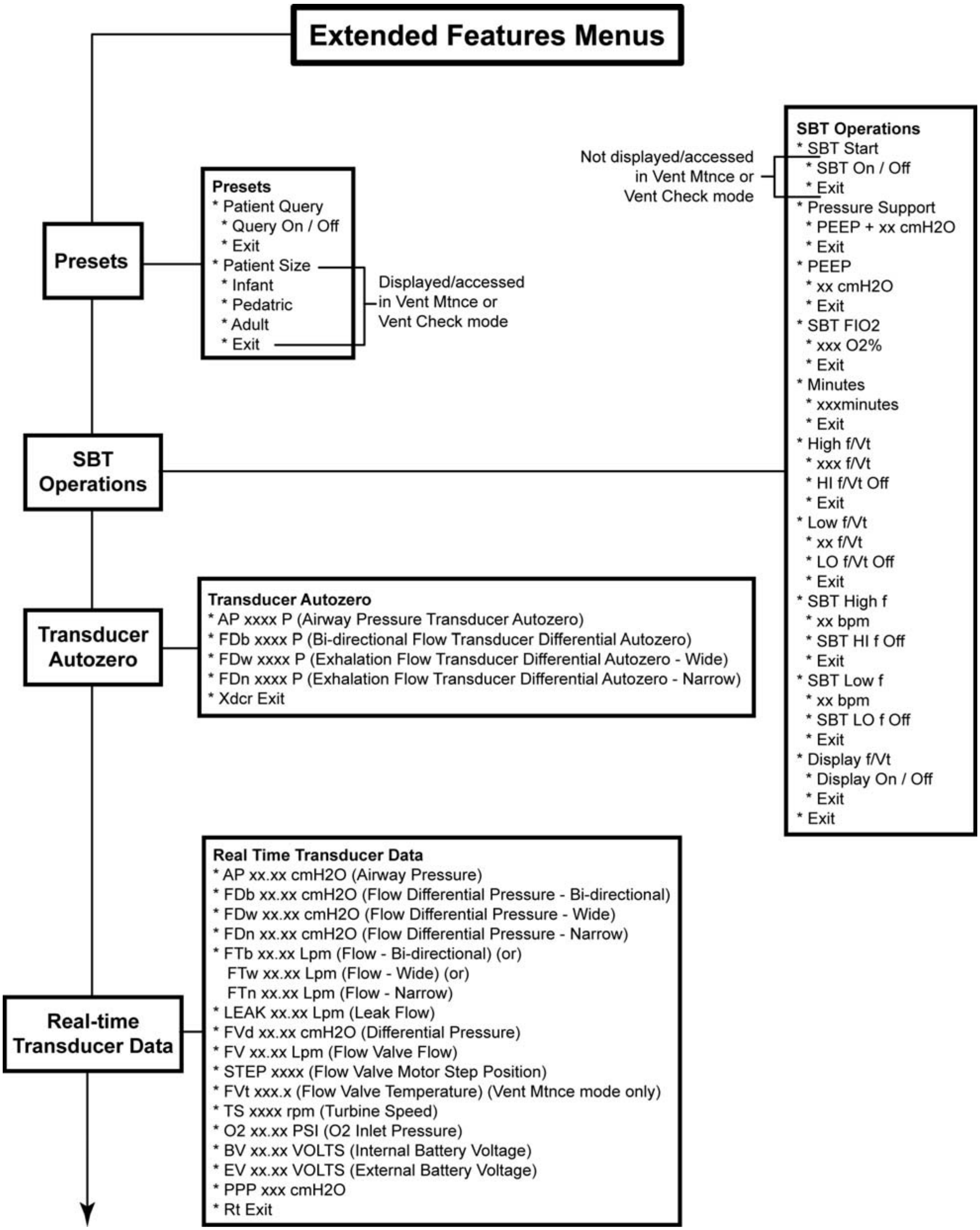
Alarm Operations
* Alarm Volume
  * Vol xx dBA
  * Vol Exit
* Apnea Interval
  * Apnea xx sec
  * Apnea Exit
* High Pressure Alarm Delay
  * No Delay
  * Delay 1 Brth
  * Delay 2 Brth
  * Delay Exit
* LPP Alarm
  * All Breaths
  * VC / PC Only
  * LPP Exit
* High f
  * f
  * Time
  * Exit
* High PEEP
  * HI PEEP Off
  * PEEP + xx cmH2O
  * Exit
* Low PEEP
  * LO PEEP Off
  * Exit
* Patient Assist
  * Pulse
  * Normal
  * Exit
* Exit

Ventilator Operations

Ventilator Operations
* Variable Rise Time
  * Profile x
  * Profile Exit
* Variable Flow Termination
  * % of Peak xx
  * % Exit
* Variable Time Termination
  * Term x.x sec
  * Term Exit
* PC Flow Termination
  * PC Flow On / Off
  * PC Flow Exit
* Leak Compensation
  * Comp On / Off
  * Comp Exit
* O2 Flush
  * x min
  * Exit
* Control Unlock
  * Unlock Easy / Hard
  * Unlock Exit
* Display Language
  * English
  * Dansk
  * Deutsch
  * Espanol
  * Francais
  * Italiano
  * Portugues
  * Svenska
  * Norsk
  * Русский
  * Lang Exit
* Version xx.xx (software)
* Usage xxxxx.x (hours)
* Communications Setting
  * Data
  * Monitor
  * Printer
  * Modem
  * Com Exit

Ventilator Operations (cont)
* Set Date
  * MM/DD/YYYY (or)
  * DD/MM/YYYY (or)
  * YYYY/MM/DD
  * Year xxxx
  * Month xx
  * Day xx
* Set Time
  * HH:MM:SS
  * Hour xx
  * Min xx
* Date Format
  * MM/DD/YYYY (or)
  * DD/MM/YYYY (or)
  * YYYY/MM/DD
  * Date Exit
* PIP LED Format
  * PIP LED On / Off
  * PIP LED Exit
* LTV 1200
  * S/N xxxxxx LTM
* Vhome xxx
* Defaults (displayed/accessed in Vent Mtnce or Vent Check mode)
  * Set Defaults
  * Default Exit
* O2 Cylinder Duration
  * Cyl Type
    * Size xxxx L
    * Exit
  * Cyl Pres
    * xxxx PSI
    * Exit
  * Calculate
    * O2 Dur> xx:xx
  * Exit
* Exit

Extended Features Map (continued)



Extended Features Menus

Event Trace

Event Trace
* xxx:Eventname
* Event Print
* Event Exit

Ventilator Checkout Tests

Displayed/accessed in Vent Mtnce or Vent Check mode

Ventilator Checkout Tests
* Alarm
* Display
* Control
* Leak
* Vent Inop Alarm Test (not displayed)
* Exit

Ventilator Maintenance

Displayed/accessed in Vent Mtnce or Vent Check mode

Ventilator Maintenance
* Calibration
  * Airway
  * Flow Differential
  * Valve Differential
  * PPP
  * O2 Inlet
  * Motor Drive
  * Cal Exit
* Servo
  * Servo Off / On
* Solenoid
  * ExhPilot Off / On
  * Purge Off / On
  * Apres Off / On
  * ExhDiffP Off / On
  * PPin Off / On
  * PPout Off / On
  * O2 #1 Off / On
  * O2 #2 Off / On
  * O2 #3 Off / On
  * O2 #4 Off / On
  * Exit
* Step Test
  * Pass x
  * Fail x
* Wdog Test

Ventilator Maintenance (cont.)
* Config
  * Model
    * LTV 1200
    * LTV 1000
    * LTV 900
    * LTV 950
    * LTV 800
    * LTV Exit
  * Flow Valve
    * VHome xxx
    * VHome Exit
  * Temp Comp
    * Tcomp Off / On
    * Tcomp Exit
  * Serial Num
    * S/N xxxxxx
  * NPPV PRI
    * NPPV PRI Off / On
  * Config Exit
* Clear
  * CLR Events
  * CLR Controls
  * CLR Cal
  * CLR Bad Rec
  * CLR All
  * CLR Exit
* Exit

External Accessories Screw Location, Type and Length

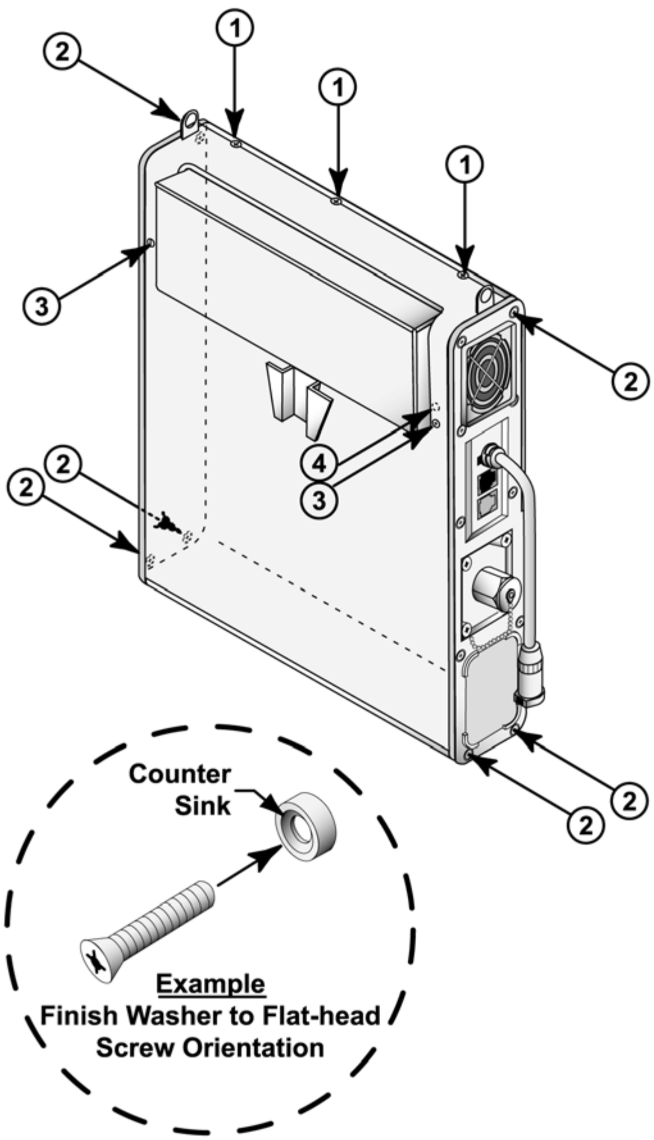
Damage to internal components of the ventilator can result if the wrong length mounting screws are used when permanently (or temporarily) removing or exchanging external accessories.

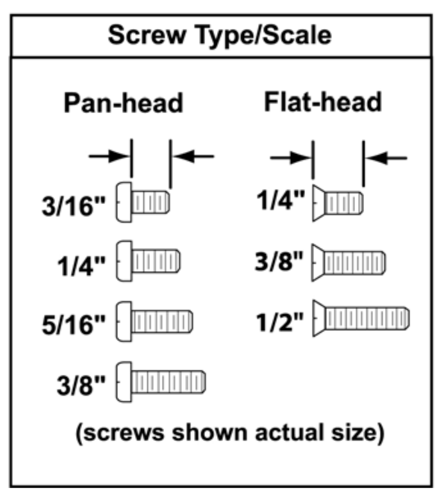
Refer to the information on the following page to determine the appropriate external accessories mounting screws or accessories replacement mounting screws location, type and length to use when removing or exchanging external accessories on an LTV® 1200/1150 ventilator.

> **WARNING**
> Internal damage to the ventilator may result if the wrong length mounting screws are used.

LTV External Accessories Mounting Screws Location, Type & Length
(Reference Pulmonetic Systems Replacement Screws Kit, P/N 11149)

LTV Ventilator Final Configuration Desired	Screw Location	Qty	Screw Description	Washer Used
Ventilator, with no external accessories installed.	1	3	1/4" Flat-head	None
	2	6	1/4" Flat-head	Finish-washer
	3	2	1/4" Pan-head	None
	4	1	3/16" Pan-head	None
Ventilator, with LTV/LTM Mounting Bracket installed	1	3	3/8" Pan-head	None
	2	6	1/4" Flat-head	Finish-washer
	3	2	3/8" Pan-head	None
	4	1	5/16" Pan-head	None
Ventilator, with Protective Boots installed (Ref. P/N 11509 for installation instructions)	1	3	1/4" Flat-head	None
	2	6	1/2" Flat-head	Finish-washer
	3	2	3/8" Flat-head	Finish-washer
	4	1	1/4" Flat-head	Finish-washer





The following Replacement Parts table provides the name and part number of all parts potentially used in the servicing of the LTV® 1200/1150 ventilator.

Replacement Part Name	Part Number
Accumulator	18144-001
Adhesive, Loctite 4541	10773
Adhesive, RTV Silicon	10122
LTV® 1200 Boot, Protective Lower	11420
LTV® 1200 Boot, Protective Upper	11421
LTV® 1150 Boot, Protective Lower	19032-001
LTV® 1150 Boot, Protective Upper	19033-001
Bracket, Electrical Connector Interface	11514
Bracket, Sounder	10119
Bumper, Alarm	10573
Cable, Pigtail Assembly	11498
Cable, Pilot Solenoids to Power PCBA	18530-001
Cable, Thermistor	11399
Clip, Grounding	10752
Connector, Pisco	10543
Elbow (3/32" x 1/16" tube, white nylon)	10958
Elbow (1/8” x 3/32” tube, white nylon)	11592
Fan Assembly	10675, or 14725-001[85]
Filter, 43 micron	18552-001
Filter, Inlet Reticulated Foam	10258
Filter, Interior Inlet	10629
Filter, Oxygen Blender	14313
Flow Valve Assembly	10019
Gasket, Conductive Silicon	10882
Gasket, Sealing	10175
Grommet, Damping	10266
Handle Attachment	10118
Internal Battery	18634-001
Kit, Dovetail Replacement	11493
Kit, Rotary Switch Replacement	14271
Kit, Screws Replacement	11149
LTV® 1200 Knob, Rotary Switch	10111

[85] Fan Assembly, P/N 14725-001 must be installed with 05.04 or higher version software.

Replacement Part Name	Part Number
LTV® 1150 Knob, Rotary Switch	19037-001
Label, Battery Replacement	18889-001
Label, Power	17420-001
Label, Transducer	10115
Label, Stepping Motor Connector	11322
Lubricant, Silicone Gel	10123
Mounting Block, *earlier* version LTM™	11146
Mounting Bracket, *earlier* version LTM™	11125
Mounting Block, *current* version LTM™	17917-001
Mounting Bracket, *current* version LTM™	17918-001
Nut, Fan Assembly & Solenoid Manifold Mounting	10342
O_2 Blender Assembly (LTV® 1200 only)	15079-001
O-Ring, O_2 inlet port (LTV® 1200 only)	10609
O_2 (Green) Port Cap (LTV® 1150 only)	14446
O-Ring, Rotary Switch	11645
Front Panel Replacement:	
LTV® 1200 *Switch, Membrane Panel*	17513-001
LTV® 1150 *Switch, Membrane Panel*	17513-006
LTV® 1200 *Overlay Panel English*	17914-001
LTV® 1150 *Overlay Panel English*	18985-001
Pad, Foot	10598
Pad, Memory PCBA Secure	10597
Pad, Motor PCBA Thermo Conductive	18341-001
Pad, Turbine Thermo Conductive	10129
PCBA, Analog	18242-001
PCBA, Main	18233-001, or 14791-001[86]
PCBA, Motor	10135-002
PCBA, Power	18120-001, or 14944-001
PCBA, Programmed Memory	17476-001
Plug, Nylon, 1/16” Tube	18187-001
Restrictor, By-Pass Tube	10625
Restrictor, brass, 0.78" O.D. X .0095 I.D.	18551-022
Screw, 1 3/4” Pan-head	10434
Screw, 1 7/8” Black colored Pan-head	10918B
Screw, 1/4” Flat-head	10430

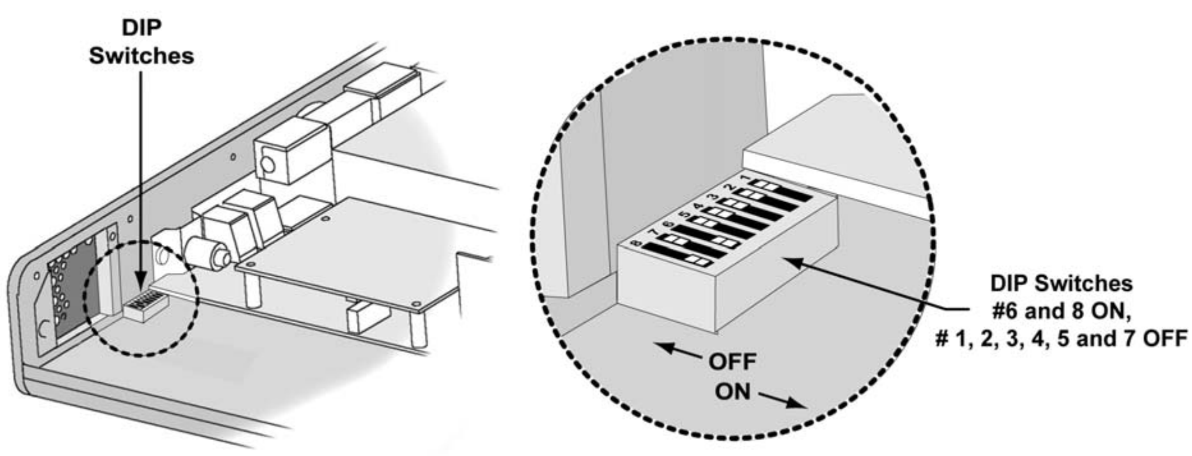
[86] Main PCBA Assembly, P/N 14791-001 must be installed with 05.07 or higher version software.

Replacement Part Name	Part Number
Screw, 1/4" Pan-head	10435
Screw, 3/16" Pan-head	14372
Screw, 3/8" Pan-head	18296-001
Screw, 3/4" Pan-head	10500
Screw, ½" Flat-head	10338
Screw, 1/4" Green colored Pan-head	10435G
Screw, 5/8" Flat-head	10499
Screw, 5/8" Yellow colored Pan-head	10437Y
Screw, 7/16" Pan-head	10433
Screw, 7/8" Red colored Pan-head	10607R
Screw, 1/8" Flat-head	14498
Screw, Shoulder 3/16"	10176
Seal, O_2 Donut	10603
Seal, Side	10881
LTV® 1200 Soft Side, Left	10105
LTV® 1200 Soft Side, Right	10106
LTV® 1150 Soft Side, Left	10105-002
LTV® 1150 Soft Side, Right	10106-002
Solenoid Manifold Assembly	18528-001
Solenoid Mount Assembly	18607-001
Spacer, Manifold to back panel	18142-001
Spring, Knob	10443
Standoff, 3/16" Hex	11543
Straps, Grounding	10593
Switch, Rotary (with hex nut)	11190
Tee, reducer 3/32-3/32-1/16" tubing, nylon	18186-001
Tie, Cable	10466
Turbine Manifold Assembly	11490
Washer, #8, Flat	10594
Washer, Rotary Switch Assembly	11644
Washer, Finish	10191 (Plastic), or 19119-001 (Metal), or 19119-002 (Metal)
Wrap, Spiral	10919
Wye, 1/16 tubing, nylon	18185-001
Sounder, Alarm	17432-001
Thermal conductive pad, Turbine Cap	14227

Settings, Dip Switch

The following Dip Switch Settings table provides DIP Switch factory set default information.

Dip Switch No.	Function	Default Setting
1	Force all LEDs to turn on. Use in conjunction with dip switch #5.	OFF
2	**Intended for factory use only** Force O_2 pressure to 50 psi regardless of inlet pressure.	OFF
3	**Intended for factory use only** Disallow dimming when on battery and no Front Panel activity after 60 seconds.	OFF
4	**Intended for factory use only**	OFF
5	OFF = Normal operation. ON = Maintenance mode (for calibration)	OFF
6	**Intended for factory use only** RTC clock battery connection.	ON
7	**Intended for factory use only** ON = Flash write enabled.	OFF
8	**Intended for factory use only** ON = Flash write protect.	ON



The following tables provide factory default information.

Control	Default
Breath Rate	12 bpm
Control Lock	On
Data Display Scrolling	Auto-On
High Pressure Limit	20 cmH_2O
Inspiratory/Expiratory Hold	Off
Inspiratory Time	1.5 sec
Low Minute Volume	2.5 Lpm
Low Pressure	5 cmH_2O
Low Pressure O_2 Source	Off
O_2 % (O_2 Flush)	21%
PEEP	0 cmH_2O
Pressure Control	1 cmH_2O
Pressure Support	1 cmH_2O
Sensitivity	2 Lpm
Tidal Volume	500 ml
Ventilation Mode	Assist/Control
Volume Pressure Mode	Volume

The factory-set default Extended Features settings are:

Feature	Default
Alarm Volume	85 dBA
Apnea Interval	20 sec
Com Setting[87]	Data
Control Unlock	Easy
Date Format	MM/DD/YYYY
High f Alarm	High f Off
High f Alarm Delay	30 sec
High PEEP Alarm	PEEP +5 cmH_2O
HP Alarm Delay	No Delay
Language	English
Leak Compensation	On
Low PEEP Alarm	PEEP -5 cmH_2O
LPP Alarm	All Breaths
NPPV Mode	Off
O_2 Duration Cylinder	2000 psi or 138 bar
O_2 Duration Cylinder	622 liters
O_2 Flush Period	3 min
Patient Assist	Normal
Patient Query	On
Patient Size	Infant
PC Flow Termination	Off
PIP LED	On
Rise Time Profile	4
SBT Display f/Vt	On
SBT FIO_2	21%
SBT High f Alarm	35 bpm
SBT High f/Vt Alarm	105 bpm / l
SBT Low f Alarm	10 bpm
SBT Low f/Vt Alarm	70 bpm / l
SBT Mode	Off
SBT Mode Run Time	20 min
SBT PEEP	0 cmH_2O
SBT Pressure Support	10 cmH_2O
Variable Flow Termination	25%
Variable Time Termination	1.5 sec

[87] This feature is <u>not</u> reset to default values when the **SET DEFAULTS** option is used in Extended Features.

Tools, Required

LTV® Service, Calibration and Testing require instrumentation tools or test equipment with documented calibrated traceability to NIST standards.

The instrumentation and test equipment must also have sufficient accuracies to attain industry standard performance levels.

Instrumentation accuracy is typically specified "percent of full scale" or "percent of reading".

The required minimum accuracy levels are typically the specification tolerance divided by four (4).

When minimum accuracy levels are not attainable, the specification's tolerance shall be "guard-banded" or reduced by the instrumentation's accuracy to maintain industry standard performance levels.

The following examples are provided to help illustrate the instrumentation and test equipment requirements.

Volume measurements

1500 ml

When measuring a volume of 1500 ml with a tolerance of ± 150 ml, the resulting minimum accuracy level for instrumentation would be 150 ml / 4 = 37.5 ml.

If the instrument accuracy is 2% of reading, at 1500 ml the resulting accuracy is 1500 ml x 2% = 30 ml. The resulting accuracy is less than the minimum accuracy level (37.5 ml) and is acceptable.

If the instrument accuracy is 2% of full scale and the instrument has a full scale of 2000 ml, the resulting accuracy is 2000 ml x 2% = 40 ml.

> Under these conditions, reduce the tolerance from ± 150 ml by the accuracy of the instrument (40 ml) for a "guard-banded" tolerance of 1500 ml ± 110 ml = 1390 ml to 1610 ml.

500 ml

When measuring a volume of 500 ml with a tolerance of ± 50 ml, the resulting minimum accuracy level for instrumentation would be 50 ml / 4 = 12.5 ml.

If the instrument accuracy is 2% of reading, at 500 ml the resulting accuracy is 500 ml x 2% = 10 ml. The resulting accuracy is less than the minimum accuracy level (12.5 ml) and is acceptable.

If the instrument accuracy is 2% of full scale and the instrument has a full scale of 1000 ml, the resulting accuracy is 1000 ml x 2% = 20 ml.

> Under these conditions, reduce the tolerance from ± 50 ml by the accuracy of the instrument (20 ml) for a "guard-banded" tolerance of 500 ml ± 30 ml = 470 ml to 530 ml.

300 ml

When measuring volume of 300 ml with a tolerance of ± 30 ml, the resulting minimum accuracy level for instrumentation would be 30 ml / 4 = 7.5 ml.

If the instrument accuracy is 2% of reading, at 300 ml the resulting accuracy is 300 ml x 2% = 6 ml. The resulting accuracy is less than the minimum accuracy level (7.5 ml) and is acceptable.

If the instrument accuracy is 2% of full scale and the instrument has a full scale of 500 ml, the resulting accuracy is 500 ml x 2% = 10 ml.

> Under these conditions, reduce the tolerance from ± 30 ml by the accuracy of the instrument (10 ml) for a "guard-banded" tolerance of 300 ml ± 20 ml = 280 ml to 320 ml.

Flow rate measurements

10 Lpm

When measuring a flow rate of 10 Lpm with a tolerance of ± 1.5 Lpm, the minimum accuracy level for instrumentation would be 1.5 Lpm / 4 = 0.375 Lpm.

If the instrument accuracy is 2% of reading, at 10 Lpm the resulting accuracy is 10 Lpm x 2% = 0.2 Lpm. The resulting accuracy is less than the minimum accuracy level (0.375 Lpm) and is acceptable.

If the instrument accuracy is 2% of full scale and the instrument has a full scale of 25 Lpm, the resulting accuracy is 25 Lpm x 2% = 0.5 Lpm.

> Under these conditions, reduce the tolerance from ± 1.5 Lpm by the accuracy of the instrument (0.5 Lpm) for a "guard-banded" tolerance of 10 Lpm ± 1.0 Lpm = 9.0 Lpm to 11.0 Lpm.

50 Lpm

When measuring a flow rate of 50 Lpm with a tolerance of ± 7.5 Lpm, the resulting minimum accuracy level for instrumentation would be 7.5 Lpm / 4 = 1.875 Lpm.

If the instrument accuracy is 2% of reading, at 50 Lpm the resulting accuracy is 50 Lpm x 2% = 1.0 Lpm. The resulting accuracy is less than the minimum accuracy level (1.875 Lpm) and is acceptable.

If the instrument accuracy is 2% of full scale and the instrument has a full scale of 100 Lpm, the resulting accuracy is 100 Lpm x 2% = 2.0 Lpm.

> Under these conditions, reduce the tolerance from ± 7.5 Lpm by the accuracy of the instrument (2.0 Lpm) for a "guard-banded" tolerance of 50 Lpm ± 5.5 Lpm = 44.5 Lpm to 55.5 Lpm.

90 Lpm

When measuring a flow rate of 90 Lpm with a tolerance of ± 13.5 Lpm, the resulting minimum accuracy level for instrumentation would be 13.5 Lpm / 4 = 3.375 Lpm.

If the instrument accuracy is 2% of reading, at 90 Lpm the resulting accuracy is 90 Lpm x 2% = 1.8 Lpm. The resulting accuracy is less than the minimum accuracy level (3.375 Lpm) and is acceptable.

If the instrument accuracy is 2% of full scale, and the instrument has a full scale of 100 Lpm the resulting accuracy is 100 Lpm x 2% = 2.0 Lpm. The resulting accuracy is less than the minimum accuracy level (3.375 Lpm) and is acceptable.

Oxygen blending percentage measurements

30%

When measuring oxygen blending of 30% with a tolerance of ± 3%, the resulting minimum accuracy level for instrumentation would be 3% / 4 = 0.75%.

If the instrument accuracy is 2% of reading, at 30% the resulting accuracy is 30% x 2% = 0.6%. The resulting accuracy is less than the minimum accuracy level (0.75%) and is acceptable.

If the instrument accuracy is 2% of full scale and the instrument has a full scale of 100%, the resulting accuracy is 100% x 2% = 2%.

> Under these conditions, reduce the tolerance from ± 3% by the accuracy of the instrument (2%) for a “guard-banded” tolerance of 30% ± 1% = 29% to 31%.

60%

When measuring oxygen blending of 60% with a tolerance of ± 5%, the resulting minimum accuracy level for instrumentation would be 5% / 4 = 1.25%.

If the instrument accuracy is 2% of reading, at 60% the resulting accuracy is 60% x 2% = 1.2%. The resulting accuracy is less than the minimum accuracy level (1.25%) and is acceptable.

If the instrument accuracy is 2% of full scale and the instrument has a full scale of 100%, the resulting accuracy is 100% x 2% = 2%.

> Under these conditions, reduce the tolerance from ± 5% by the accuracy of the instrument (2%) for a “guard-banded” tolerance of 60% ± 3% = 57% to 63%.

90%

When measuring oxygen blending of 90% with a tolerance of ± 5%, the resulting minimum accuracy level for instrumentation would be 5% / 4 = 1.25%.

If the instrument accuracy is 2% of reading, at 90% the resulting accuracy is 90% x 2% = 1.8%.

> Under these conditions, reduce the tolerance from ± 5% by the accuracy of the instrument (2%) for a “guard-banded” tolerance of 90% ± 3% = 87% to 93%.

Oxygen percentage measurement instrumentation and test equipment

Recommended instrumentation and test equipment for oxygen percentage measurements is paramagnetic based oxygen measurement devices.

From the LTV® 1200 or the LTV® 1150 Ventilator Operator’s Manual, regarding LTV® inspired oxygen (FIO_2) concentrations while ventilating a patient:

> ## WARNING
> **Inspired oxygen (FIO_2) concentration** – If exact concentrations of inspired oxygen are required to be delivered to the patient, it is recommended that an accurate oxygen analyzer with alarms be used.

General Tools:

The following general tools are required to perform various procedures on the LTV® 1200/1150 ventilator;

- Air supply, (0-50 cmH_2O)
- Allen wrench, 7/64"
- Amp meter, 10 amp to 60 Hz
- Compressed O_2 source (0-80 PSI regulator) (LTV® 1200)
- Compressed gas source (0-50 cmH_2O regulator)
- Dental pick
- Drill Bit, 3/16"
- Drill
- Multi-Meter, Digital
- Nut drivers, 3/16", 1/4", 1/2" & 13mm adapters for torque wrench
- O_2 Analyzer (calibrated)
- O_2 Supply (0-80 PSIG) (LTV® 1200)
- O_2 Inlet connector (LTV® 1200)
- Pliers, needle nose
- Pop Rivet tool[88]
- Pressure gauge (FSD >80 PSI) (LTV® 1200)
- Pressure manometer (0-100 cmH_2O)
- Screwdriver, Phillips with torque meter
- Screwdriver, Straight tip
- Spirometer (calibrated)
- Test Lung (2 Liter or other large-compliance reservoir) or
- Test Lungs (2 x 1 liter or greater)
- Cable tie tool
- Torque Screwdriver, 120 in-oz.
- Variable DC voltage source (10 Amp)
- Wrist strap, grounded anti-static
- Y-connector for test lungs

Unique Tools:

The following unique tools are required to perform various procedures on the LTV® 1200/1150 ventilator and are available from Pulmonetic Systems separately, or as part of the Maintenance and Calibration Kit, P/N 11566;

- Calibration Syringe Assembly — P/N 11471
- DISS to NIST fitting for high pressure O_2 port — P/N 10702 [89]
- Driver, Torque Dial Indicator — P/N 11574
- External Battery Test Cable Assembly — P/N 11474
- Flow Valve Insertion Tool — P/N 14206
- Internal Battery Test Cable Assembly — P/N 11472
- Lubricant, Silicone Compound — P/N 10123[90]
- O_2 Sampling Tube — P/N 10544[91]
- Patient Assist Cable, Normally Closed — P/N 10779
- Patient Assist Cable, Normally Open — P/N 10780
- Pinch Clamp — P/N 11529
- Power PCB Removal Tool — P/N 11599
- Service Cable Assembly — P/N 11485
- Stepper Motor Calibrator — P/N 10871
- Tube Adapter, 22mm — P/N 10696
- Turbine Pressure Test Adapter Assembly — P/N 11567

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[88] Pop Rivet tool capable of setting .114" diameter shaft, Pop Rivets.

[89] DISS/ NIST adapter required to comply with some international gas fittings (not included in kit, P/N 11566).

[90] In the European Union, Loctite® 8104 may be substituted as an equivalent compound.

[91] O_2 Sampling Tube, P/N 10544, ~10.0" long, 0.125" O.D. X 0.079 I.D. clear polycarbonate tubing (not included in kit, P/N 11566).

Airway Pressure (AP)

@ 50 cmH_2O	733 – 1570
Ambient	35-350

Flow Differential Bi-Directional (FDb)

@ -30 cmH_2O	64-3240
Ambient	3180-4045

Flow Differential Wide (FDw)

@ 30 cmH_2O	854 – 4030
Ambient	10 – 400

Flow Differential Narrow (FDn)

80 ± 70	10 - 150
Ambient	128-3968
4015 ± 70	3945 - 4085
Ambient	128-3968

Flow Valve Differential (FVd)

@ 15 cmH_2O	1915 – 2340 (For Software Version < 05.04) 1915 – 2521 (For Software Version ≥ 05.04)
Ambient	40 – 328

PEEP Pilot Pressure (PPP)

@ 30 cmH_2O	999 – 2493
Ambient	135 – 272

Oxygen Pressure (O_2) (LTV® 1200 only)

@ 50 PSI	900 – 1822
Ambient	122 – 246

Torque Values

The following Torque Values Table provides torque values used in the assembly of the LTV® 1200/1150 ventilator.

Assy./Part to be Torqued	In-oz[92] (Nm[93]) Torque Value
Accumulator to Turbine Manifold Spacer	60 in-oz (0.42 Nm)
Analog Board mounting screws (2)	60 in-oz (0.42 Nm)
Back Panel side mounting screws (6)	20 in-oz (0.14 Nm)
Back Panel top mounting screws (3)	60 in-oz (0.42 Nm)
Battery Cover screws (6)	60 in-oz (0.42 Nm)
Fan Assembly mounting screws (2)	40 in-oz (0.28 Nm)
Flow Valve Assembly mounting screws (2)	60 in-oz (0.42 Nm)
LTM/LTV® Mounting Bracket (5)	60 in-oz (0.42 Nm)
LTM/LTV® Mounting Block (3)	60 in-oz (0.42 Nm)
Main Board mounting screws (3)	60 in-oz (0.42 Nm)
Main Board mounting Hex –standoffs (2)	60 in-oz (0.42 Nm)
Manifold to back panel Spacer (4)	20 in-oz (0.14 Nm)
Motor Board mounting screws (4)	60 in-oz (0.42 Nm)
Oxygen Blender mounting screws (4)	60 in-oz (0.42 Nm)
Power Pigtail Interface bracket	60 in-oz (0.42 Nm)
Power Board mounting screws (except Solenoid Manifold screws) (4)	60 in-oz (0.42 Nm)
Protective Boot, Upper – Leg mounting screws (2)	60 in-oz (0.42 Nm)
Protective Boot, Upper – Side mounting screws (2)	20 in-oz (0.14 Nm)
Protective Boot, Lower – Side mounting screws (4)	20 in-oz (0.14 Nm)
Rotary Switch Assy. Mounting nut (1)	40 in-oz (0.28 Nm)
Soft Side Panel (right or left) mounting screws (10)	20 in-oz (0.14 Nm)
Solenoid Manifold mounting screw (1) and nut (1)	20 in-oz (0.14 Nm)
Solenoid Mount Assembly (1) screw with (1) washer	120 in-oz (0.84 Nm)
Sounder bracket mounting screw (1)	60 in-oz (0.42 Nm)
Turbine Manifold mounting screws (4)	20 in-oz (0.14 Nm)

[92] Inch ounces. A measurement of torque.
[93] Newton meters. A measurement of torque equivalent to 0.007062 inch ounces.

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