ESPRIT VENTILATOR
SERVICE MANUAL

Part Number 580-1000-02
Revision A

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1 INTRODUCTION AND INTENDED USE

The Esprit Mechanical Ventilator is a microprocessor-controlled, electrically powered mechanical ventilator. It is intended for use by qualified medical personnel to provide continuous or intermittent ventilatory support for adult and pediatric patients as prescribed by a physician. The Esprit Mechanical Ventilator is intended for use in either invasive or non-invasive applications.

The Esprit Mechanical Ventilator meets or exceeds all applicable safety requirements, consensus guidelines, US regulatory statutes, and international regulatory standards for life support mechanical ventilation devices.

Read this manual thoroughly prior to performing service or maintenance on the Esprit Mechanical Ventilator. This manual contains advanced troubleshooting, calibration, and maintenance instructions for the Esprit Mechanical Ventilator Service Manual. All maintenance and repair work should be performed by qualified biomedical technicians who have received appropriate training and authorization to provide maintenance, repair, and service for the Esprit Mechanical Ventilator.

Review the accompanying operators manual and become familiar with Esprit Mechanical Ventilator operation before running tests, checking operational readiness or initiating patient use. Important, essential information about ventilator safety and operation is included in the operators manual.

For additional information about accessories or related equipment, such as humidifiers and remote alarm systems, refer to the appropriate instruction manual prior to operating with the Esprit Mechanical Ventilator.

WARNING - Patients on life-support equipment should be visually monitored by competent medical personnel, since life-threatening circumstances may arise that may not activate alarms. The operator should heed all appropriate alarms and follow the instructions and warnings in this service manual. Always check life-support equipment for proper operation before use.

A complete listing of all applicable warnings and cautions are provided in the Esprit Ventilator Operator's Manual. Review these notices thoroughly before operating the ventilator.

1.1 Recommended Tools and Test Equipment

The recommended tools, test equipment and service materials needed to properly service and maintain the Esprit Ventilator are listed in Table 1.1. Alternate test equipment may be used provided it is equivalent to the recommended test equipment and meets the requirements stated in Table 1.2.

Table 1-1: Recommended Test Equipment, Tools and Service Materials

Description	Manufacturer and Model (incl. Respironics Part No. if applicable)
Test Equipment	
Digital Multimeter (DMM) accurate to 3 decimal places	Local Supplier
Pneumatic calibration analyzer capable of measuring low pressure (cmH2O), high pressure (PSI), flow rate (LPM), and volume (liters)	Allied Healthcare RT-200 or equivalent. **Note: The barbed fitting and nut, which are accessories for the RT-200, are required for high pressure measurements.**
Electrical Safety Analyzer	Ohmic Instruments SI-100 or equivalent
Oxygen Monitor with accuracy of ± 2%	Lifecare Oxygen Analyzer/Alarm (P/N 28-001) or equivalent
Ventilator Accessories	
Test Lung – 1 Liter	P/N C06-657 or equivalent
Tubing, silicon, 3/16 in. ID x 6.5 feet, PAP	P/N C06-686 or equivalent
Reusable Adult Patient Circuit Tubes (qty 2) 60" Smooth Bore	Smooth-Bor 403-60 or equivalent
Reusable Patient Wye 22 mm OD/15mm ID	Local Supplier
Rubber Cork	P/N 1001735 or equivalent
Coupling, silicone rubber	P/N C06-348 or equivalent
Tee, plastic w/ silicon rubber coupling	P/N C06-260 or equivalent
Connector, plastic, 22 mm OD	P/N C06-335 or equivalent
Adapter, O2 Sensor	P/N 1001736 or equivalent
Hand Tools and Materials	
Pliers	Local Supplier
Needle Nosed Pliers	Local Supplier
Metric Hex Key Set (rounded ends) 1.5 mm to 4 mm	Local Supplier
Standard Hex Key Set (rounded ends) .050 to 5/32"	Local Supplier
Pen size Flat head screwdriver	Local Supplier
Pen size Phillips-head screwdriver	Local Supplier
# 2 Flat head screwdriver	Local Supplier
# 3 Flat head screwdriver	Local Supplier
# 2 Phillips head screwdriver	Local Supplier

Table 1-2: Recommended Test Equipment, Tools and Service Materials

Description	Manufacturer and Model (incl. Respironics Part No. if applicable)
Hand Tools and Materials (Cont.)	
5/16" open end wrench	Local Supplier
¼" open end wrench	Local Supplier
11/16" open end wrench	Local Supplier
# 10 metric open end or box wrench	Local Supplier
½" open end wrench	Local Supplier
7/16" open end wrench	Local Supplier
7/32" socket wrench or socket wrench	Local Supplier
9/32" socket wrench with removable 6" extension bar	Local Supplier
3/16" open end wrench or socket wrench	Local Supplier
5.5 mm open end wrench	Local Supplier
7 mm open end wrench	Local Supplier
8 mm box **ratchet**	Local Supplier
# 10 mwtric open end wrench	Local Supplier
# 10 metric socket wrench	Local Supplier
Nurses Call Test Cable	P/N 1001375
Angled tweezers	Local Supplier
Wire cutters	Local Supplier
Tie Wraps (medium)	P/N 500-1000-62
Tie Wraps (small)	P/N 500-1000-66
Tie Wrap Gun	Local Supplier
Thread Tape	Local Supplier
Loctite 222	P/N 98-016
Krytox 240AZ Grease	P/N 35-408
Oxygen Regulator Pressure Test Adapter	P/N 1001376
Static Dissipative Field Service Kit	Local Supplier
Mild detergent	Local Supplier
PC or Laptop (only needed for downloading software)	Required: Windows 95 or greater, Serial Port and Disk Drive
Standard RS-232 Null ModemCable (9-pin)	Local Supplier

Table 1-3: Specifications for Equivalent Test Equipment

Unit of Measurement	Range	Accuracy
Pressure	1 to 20 cmH2O	± 1% of reading or ± 2 digits @ 21.1°C (70°F) ± 2% or reading or ± 2 digits @ 15° to 35°C
	20 to 250 cmH2O	± 0.5% of reading or 2 digits @ 21.1°C (70°F) ± 1.5% or reading or ± 2 digits @ 15° to 35°C
	0 to 100 psi	± 0.5% of reading or 2 digits @ 21.1°C (70°F) ± 1.5% or reading or ± 2 digits @ 15° to 35°C
Flow (standard)	0 to 5 LPM	± 2% of reading or ± 2 digits
	5 to 180 LPM	± 1% of reading or ± 1 digits
Volume (BTPS corrected)	0 to 3 liters	± 1% of reading or ± 1 digit
Voltage dc	± 5V to ± 15V	± 2% of reading
ac	2 to 230V	± 2% of reading

2 WARNINGS AND CAUTIONS

Throughout this manual, the following definitions apply.

WARNING: A condition that could cause injury to a patient or operator if the operating instructions in this manual are not followed correctly.

CAUTION: A condition that could cause damage to, or shorten the service life of, the Esprit Mechanical Ventilator.

2.1 Summary of Warnings and Cautions.

WARNING – Emergency air intake near the Oxygen Water Trap/Inlet Filter Assembly should not be obstructed.

WARNING - The patient must be disconnected from the ventilator before entering the diagnostic mode since normal ventilation is suspended.

WARNING - Do not use a ventilator that has failed SST without verifying operational readiness by other means. Doing so may place a patient at risk.

WARNING - Never initiate an SST while the patient is connected to the ventilator. The high airway pressures generated during SST can injure a patient.

WARNING - Do not use a ventilator that has failed EST without verifying operational readiness by other means. Doing so may place a patient at risk.

WARNING - Never initiate an EST while the patient is connected to the ventilator. The high airway pressures and gas flows generated during EST can injure a patient.

WARNING - Never troubleshoot while a patient is connected to the ventilator since normal operation is suspended.

WARNING – If the ventilator has been in operation, the heater conductor may be hot.

WARNING – Use caution when removing the filter since the heater conductor may be hot.

WARNING – To prevent disease transmission, use protective equipment when handling contaminated bacterial filters or other patient accessories.

WARNING – Always disconnect external AC and DC power sources and high-pressure oxygen sources from the ventilator before servicing.

WARNING – Verify that the AC and external DC power sources are disconnected from the ventilator since the Power Supply contains voltage components.

WARNING – Verify that the AC and external DC power sources are disconnected from the ventilator since the Backlight Inverter PCBA generates high voltage.

WARNING – Verify that the AC and external DC power sources are disconnected from the ventilator since the AC Distribution Panel contains high voltage components.

WARNING - Explosion hazard. Do not operate the ventilator in the presence of flammable anesthetic agents.

CAUTION – The 10,000 Hour PM Kit is to be installed only by a qualified service technician. The kit includes installation instructions and replacement parts.

CAUTION – Always ensure that you are following proper ESD grounding procedures before handling Static Sensitive Devices (SSD).

CAUTION – Be careful not to pull or crimp any cables, tubes or wires.

CAUTION - Troubleshooting and repair should be performed only by a qualified service technician.

CAUTION - Do not modify oxygen D.I.S.S. connector on rear panel. Use only Medical grade O2.

3 Esprit Ventilator Theory of Operation

3.1 System Overview

The Esprit mechanical ventilator is a microprocessor-controlled device capable of delivering air, oxygen, or a mixture of air and oxygen to the patient's lungs in a predetermined manner to augment or replace the work normally performed by the patient's respiratory system. It employs all of the electro-mechanical control circuits, flow and pressures monitors and software programs necessary to perform breath delivery as either a flow or pressure controller.

The Esprit mechanical ventilator also includes a graphical user interface, built-in internal blower, integral air-oxygen blender, and is capable of operating from a 40 to 90 psig (276-621 kPa) medical grade oxygen source at a 200 LPM (BTPS) maximum flow. It also includes multiple communications interfaces and an internal power supply capable of running off of 100 to 240 VAC 50/60 Hz or 24 VDC.

3.2 Pneumatic System

The Esprit mechanical ventilator device pneumatic system consists of the following subsystems illustrated in Figure 3-1:

- Internal Blower (Air Source)
- Inspiratory Module
- Heated Exhalation Filter Assembly
- Exhalation Valve Assembly
- Electromechanical Controls
- User Interface, including front panel indicators and keys, touch screen and graphical user interface.

The internal blower assembly generates the air pressure necessary for breath delivery, consequently an external, medical grade source of compressed air is not required. Wall oxygen pressure is regulated by an internal regulator.

The CPU controls the blower valve, oxygen valve and exhalation valve through their respective motor controller PCBAs based on the operator selected parameters. As flow is delivered to the patient, these gases are monitored by the air and oxygen flow sensors and two pressure sensors which provide feedback to the CPU. The gases are mixed in the inspiratory module before being delivered to the patient.

The pressure relief and safety valves, located in the inspiratory module, provide for patient safety in the event of an over-pressure condition or during any component or system failure which could potentially interfere with the patient's ability to breathe when connected to the ventilator.

WARNING -Emergency air intake near the Oxygen Water Trap/Inlet Filter Assembly should not be obstructed.

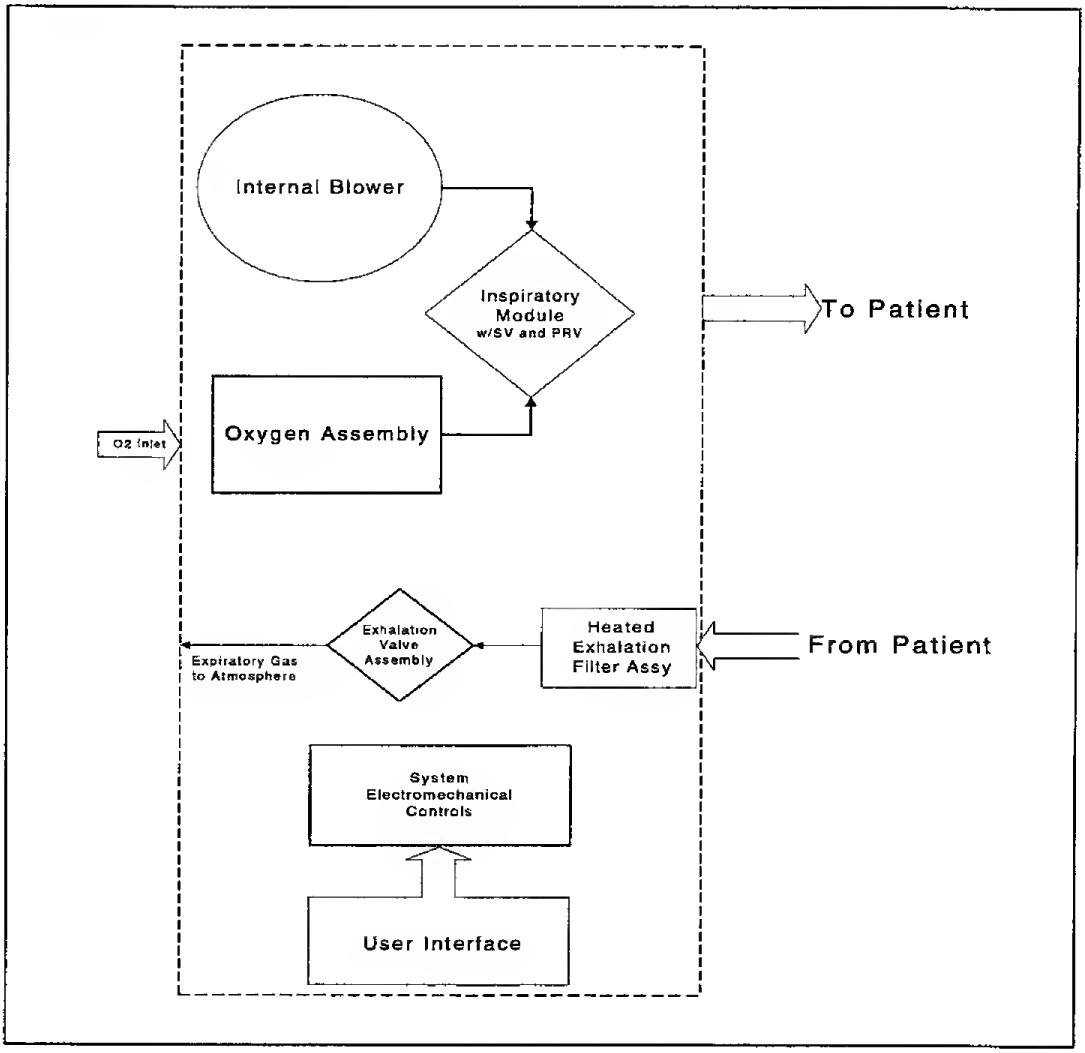


Figure 3-1: Pneumatic System Block Diagram

The exhalation filter conditions expired gas, reducing the risk of contamination or component damage due to bacteria or moisture in expired gases. The filter is housed in a heater which reduces the amount of moisture to the downstream components. During exhalation, the exhaled gas from the patient circuit travels through the heated exhalation filter prior to contact with the exhalation valve and expiratory flow sensor and is then vented to atmosphere.

The Esprit ventilator pneumatic system consists of the pneumatic components shown in Figure 3-2. Components called out in the schematic are cross-referenced in the accompanying pneumatic legend (see Table 3-1).

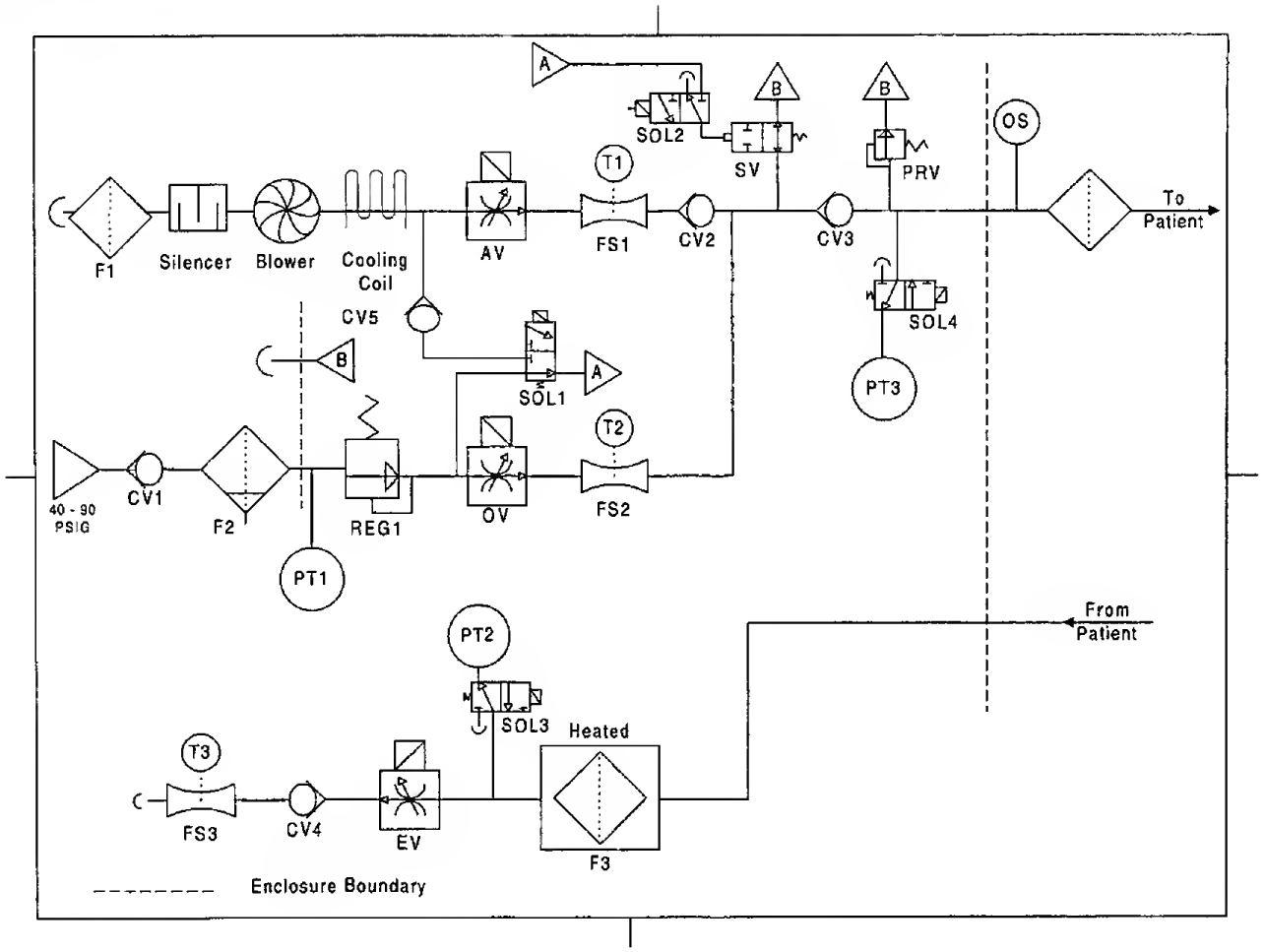


Figure 3-2: Pneumatic Schematic

Table 3-1: Pneumatic Schematic Legend

Component Name	Pneumatic Schematic Label
Air Inlet Filter	F1
Cooling Fan Filter	Not Shown
Muffler	Silencer
Blower	Blower
Cooling Coil	Cooling Coil
Air Valve Assembly	AV
Air Flow Sensor	FS1, T1
Air System Check Valve	CV2
Oxygen Inlet Connector	O2
Oxygen Inlet Check Valve	CV1
Oxygen Water Trap/Inlet Filter Assembly	F2
Oxygen Supply Pressure Switch	PS1
Oxygen Regulator	REG1
Oxygen Valve Assembly	OV
Oxygen Flow Sensor	FS2, T2
Crossover Solenoid	SOL1
Cross Contamination Check Valve	CV5
Safety Valve Pilot Solenoid	SOL2
Safety Valve	SV
Inspiratory Non-Rebreathing Check Valve	CV3
Pressure Relief Valve	PRV
Oxygen Sensor	OS
Inspiratory Pressure Transducer	PT3
Inspiratory Pressure Transducer Solenoid	SOL4
Heated Exhalation Filter	F3
Exhalation Pressure Transducer	PT2
Exhalation Pressure Transducer Solenoid	SOL3
Exhalation Non-Rebreathing Check Valve	CV4
Exhalation Valve Assembly	EV
Exhalation Flow Sensor	FS3, T3

3.3 Delivery System

The Delivery System contains components which condition and control the flow delivered to the patient based upon operator selected parameters. Blower draws room air through the blower inlet filter and the muffler and outputs flow to the Air Valve. Oxygen input pressure is monitored by a pressure switch. Wall oxygen is then filtered, regulated down to 23 psi (1.5 kPa), and fed to the Oxygen Valve and the Crossover Solenoid. The Air and Oxygen Valves are controlled by the microprocessor based upon continuous feedback from the Air and Oxygen Flow Sensors.

3.3.1 Blower Inlet Filter (F1)

The Air Inlet Filter removes coarse particulate from the ambient air as it is entrained into the Blower assembly. Under normal usage, the filter has a minimum life of 10,000 hours assuming it is regularly cleaned.

3.3.2 Cooling Fan Filter

The Fan-Cooling Filter removes coarse particulate from ambient air entrained by the cooling fan. Under normal usage, the filter has a minimum life of 10,000 hours assuming it is regularly cleaned.

3.3.3 Muffler (Silencer)

The Muffler reduces the noise of air flow into the Blower by channeling the air through a baffled system lined with sound absorbing material.

3.3.4 Blower

The Blower draws room air though the air inlet filter and outputs the air source for patient delivery and the pilot pressure for actuation of a pneumatically piloted Safety Valve.

The Blower contains a DC motor and a series of stator and impeller assemblies. It is capable of providing at least 200 Lpm of flow.

Blower speed is automatically adjusted to account for differences in gas density due to altitude. The altitude can be adjusted from the Hardware screen in the diagnostics mode.

3.3.5 Cooling Coil

The Cooling Coil is a copper tube connected to the outlet of the Blower. It reduces the temperature of the gas from the Blower before reaching the Air Valve.

3.3.6 Cooling Coil Fan

A 24VDC cooling fan removes the heat dissipated by the Cooling Coil.

3.3.7 Air Valve (AV)

The Air Valve Assembly contains a stepper motor which meters air flow from the Blower to achieve the target flow under CPU control based upon operator selected parameters. It can deliver up to 200 Lpm of flow.

3.3.8 Air Flow Sensor (FS1)

The Air Flow Sensor measures flow from the Air Valve. This measurement is used to provide closed loop control of the Air Valve and for computations of the flow/volume delivered to the patient.

A thermistor, contained in the flow sensor, measures the temperature of the air and provides the microprocessor with information to compensate the delivered flow.

3.3.9 Oxygen Inlet Connector (O2)

The Oxygen Inlet Connector provides a connection point for an external oxygen gas supply of 40 psig (280 kPa) and 90 psig (621 kPa). It is country specific.

3.3.10 Oxygen Inlet Check Valve (CV1)

The Oxygen Supply Check Valve, contained in the Oxygen Inlet Connector, prevents air from the Air Delivery Subsystem from contaminating the oxygen source in the event the Oxygen Valve cannot be closed.

3.3.11 Oxygen Water Trap/ Inlet Filter Assembly (F2)

The Oxygen Water Trap/Inlet Filter Assembly consists of a filter to remove particulate (both dry and liquid) from the oxygen gas supply, a bowl with drain for accumulated water and an Oxygen Inlet Connector.

3.3.12 Oxygen Supply Pressure Switch (PS1)

The Oxygen Supply Pressure Switch is part of the Oxygen Regulator assembly and provides a digital signal to the Sensor PCBA indicating whether or not adequate supply pressure is present at the oxygen inlet.

The Oxygen Supply Pressure Switch closes if the measured pressure is greater than 40 psig (276 kPa) and opens if the measured pressure is less than 35 psig (241.3 kPa) resulting in a Low O2 Supply alarm.

3.3.13 Oxygen Regulator (REG 1)

The Oxygen Regulator reduces the oxygen supply pressure to the proper inlet pressure for the Oxygen Valve (23 psig (1.5 kPa)). It also supplies this regulated pressure to the Crossover Solenoid, which pilots the Safety Valve.

3.3.14 Oxygen Valve (OV)

The Oxygen Valve Assembly contains a stepper motor which meters flow from the Oxygen Regulator to achieve the target flow under CPU control based upon operator selected parameters. t can deliver up to 200 Lpm of flow.

3.3.15 Oxygen Flow Sensor (FS2)

The Oxygen Flow Sensor measures the flow from the Oxygen Regulator. This measurement is used to provide closed loop control of the Oxygen Valve and for computations of the flow/ volume delivered to the patient.

A thermistor, contained in the flow sensor, measures the temperature of the oxygen and provides the microprocessor with information to compensate the delivered flow.

3.3.16 Crossover Solenoid (SOL 1)

The Crossover Solenoid is a 3-way valve which provides either air or oxygen as pilot pressure for closing the Safety Valve during normal ventilation.

SOL 1 is normally de-energized piloting the safety valve with oxygen. If oxygen pressure is lost, SOL 1 is energized providing the safety valve with air.

3.3.17 Cross Contamination Check Valve (CV5)

The Cross Contamination Check Valve prevents the oxygen supply from being contaminated in the event of a leak in the Crossover Solenoid.

3.4 Inspiratory System

The Inspiratory System contains a manifold which provides a blending point for the air and oxygen flow. It also serves as a connection point for the pressure transducers through a series of solenoids.

Several components designed to ensure patient safety, such as the Pressure Relief Valve, Safety Valve, Safety Valve Pilot Solenoid (SOL 2), Air System Check Valve (CV2) and the Inspiratory Non-rebreathing Check Valve (CV3) are housed in the manifold.

3.4.1 Safety Valve Pilot Solenoid (SOL 2)

The Safety Valve Pilot Solenoid either places the output of the Crossover Solenoid to the Safety Valve, or vents the pilot pressure line to atmosphere.

During normal operation, SOL 2 is energized allowing pressure from the Crossover Solenoid to close the Safety Valve. During a high priority alarm condition such as an occlusion or ventilator failure mode (Vent Inop), SOL 2 is de-energized which opens the Safety Valve allowing the patient to breathe room air.

3.4.2 Safety Valve (SV)

The Safety Valve contains a spring loaded diaphragm which is piloted by Safety Valve Pilot Solenoid (SOL 2). Under normal conditions the SV is closed allowing the delivered flow to reach the patient. In the event of a high priority alarm condition such as an occlusion, ventilator failure (Vent Inop) or loss of power, pilot pressure is removed, opening the SV and allowing the patient to breathe room air through the safety port located at the rear of the ventilator.

3.4.3 Air System Check Valve (CV2)

The Air System Check Valve (CV2) prevents oxygen from entering the air delivery system in the event the Blower is shutdown.

3.4.4 Inspiratory Non-rebreathing Check Valve (CV3)

The Inspiratory Non-Rebreathing Check Valve prevents the patient from exhaling through the inspiratory limb during a Safety Valve open condition thereby preventing the rebreathing of exhaled gas.

3.4.5 Pressure Relief Valve (PRV)

The Pressure Relief Valve provides a backup to the operator adjustable high-pressure alarm preventing excessive pressures in the patient circuit. The PRV is spring loaded limiting the maximum cracking pressure to 130 – 140 cmH2O.

3.4.6 Oxygen Sensor (OS)

The Oxygen Sensor is an optional device which is installed at the inspiratory outlet, between the 22 mm port and the inspiratory bacteria filter. It is a galvanic device which provides a measurement of the oxygen concentration of the gas being blended by the oxygen and air valves from 21 and 100%. The output signal from the sensor is used for the high and low O2 concentration alarms. When the sensor is installed the alarms are active and will provide the operator both visual and audible alarm signals if the measured O2 concentration is more than 6% above or below the set O2% value.

3.4.7 Inspiratory Pressure Transducer (PT3)

The Inspiratory Pressure Transducer is used to monitor system pressure from the inspiratory side of the patient circuit while the exhalation pressure transducer is being auto-zeroed, ensuring uninterrupted pressure monitoring. It is also used along with the exhalation pressure transducer, to detect patient circuit occlusions.

3.4.8 Inspiratory Pressure Transducer Solenoid (SOL 4)

The Inspiratory Pressure Transducer Solenoid periodically vents the exhalation pressure transducer to atmosphere, because the zero voltage of the inspiratory pressure transducer may drift slightly over time. Periodically venting the transducer to atmosphere and making a measurement allows for the compensation of zero drift, and improves the overall accuracy of the pressure measurement.

During normal operation, SOL 4 is de-energized applying patient circuit pressure to the inspiratory pressure transducer. During an autozero, SOL 4 is energized venting the transducer to atmosphere. This occurs during the Power On Self Test (POST), at the beginning of a breath one minute after POST, six minutes after POST, eleven minutes after POST and then once every hour thereafter.

3.5 Exhalation System

The Exhalation System conditions, filters and monitors the exhaled gas. It contains the Heated Exhalation Filter, Exhalation Pressure Transducer Solenoid, Exhalation Valve, Exhalation Non-Rebreathing Check Valve and the Exhalation Flow Sensor.

3.5.1 Heated Exhalation Filter (F3)

The Heated Exhalation Filter is comprised of a heater and a bacteria filter. The heater protects the exhalation flow sensor and exhalation system components from condensation by heating the exhaled gases, which have been cooled in the exhalation limb, above the dew point.

The exhalation bacteria filter protects the exhalation flow sensor and exhalation system component from contaminants and filters exhaled gases prior to venting them to atmosphere.

3.5.2 Exhalation Pressure Transducer (PT2)

The Exhalation Pressure Transducer measures the patient circuit pressure from the exhalation side of the patient circuit. During normal operation PT2 is the primary transducer used for the measurement of patient pressure data such as, Peak Inspiratory Pressure (PIP), Mean Airway Pressure (MAP), End Inspiratory Pressure, and Auto-PEEP.

In addition, the exhalation pressure transducer provides the monitoring data necessary to accomplish closed loop control. It is used, along with the inspiratory pressure transducer, to detect patient circuit occlusions.

3.5.3 Exhalation Pressure Transducer Solenoid (SOL 3)

The Exhalation Pressure Transducer Solenoid provides a method of periodically venting the exhalation pressure transducer to atmosphere, because the zero voltage of the exhalation pressure transducer may drift slightly over time. Periodically venting the transducer to atmosphere and making a measurement allows for the compensation of zero drift, and improves the overall accuracy of the pressure measurement.

During normal operation, SOL 3 is de-energized applying patient circuit pressure to the exhalation pressure transducer. During an autozero, SOL 3 is energized venting the transducer to atmosphere. This occurs during the Power On Self Test (POST), at the end of a breath one minute after POST, six minutes after POST, eleven minutes after POST and then once every hour thereafter.

3.5.4 Exhalation Non-Rebreathing Check Valve (CV4)

The Exhalation Non-Rebreathing Check Valve prevents the patient from inspiring room air through the exhalation limb of the patient circuit. During normal operation, it blocks the exhalation system from atmosphere allowing the patient to trigger a breath.

3.5.5 Exhalation Valve (EV)

The Exhalation Valve Assembly contains a stepper motor. At the beginning of an inspiration, the valve is shut creating a closed circuit, allowing the patient system to pressurize. It is opened at the beginning of exhalation allowing system pressure to be vented to atmosphere.

The Exhalation Valve also regulates PEEP and EPAP levels during the exhalation phase of a breath.

3.5.6 Exhalation Flow Sensor (FS3)

The Exhalation Flow Sensor measures the flow leaving the ventilator. This flow includes any patient exhaled gases as well as tubing compliance volume. The exhaled flow measurement is used for computations of flow/volume coming from the patient and the circuit.

A thermistor, contained in the flow sensor, measures the temperature of the gas and provides the microprocessor with information to compensate for the measured flow.

3.6 Ventilator System Electronics

3.6.1 Overview

The electronic system is illustrated in Figure 3-3.

The ventilator is supplied with a 100 - 240VAC power source or an external 24VDC back-up power source, which is routed to the power supply. The power supply conditions this input voltage and distributes it to the Main PCBA to power the digital electronics, electro-pneumatic components and the displays. AC power is routed to the humidifier port on 100 - 120V units only.

The Central Processing Unit (CPU), located on the CPU PCBA, along with the programs stored in memory, controls the interaction of the pneumatic and electronic subsystems. The CPU uses inputs from electro-pneumatic sensors and the operator to control the flow, pressure and volume of air and oxygen to be delivered to the patient. Is also controls the alarms.

The CPU interfaces with the pneumatics and display through a group of daughter boards which are vertically mounted on the Main PCBA. These include the Digital PCBA, Analog PCBA, VGA Controller PCBA and three Motor Controller PCBAs.

The digital control signals from the CPU are sent to the Analog PCBA where they are converted into analog signals and sent to the Blower Controller PCBA via the Main PCBA and Sensor PCBA. The Stepper Motor PCBAs are linked to the CPU via the Clock Serial Interface (CSI). The analog signals to the Blower are further conditioned by the Blower Controller PCBA.

Analog data from the flow and pressure sensors is conditioned and converted by the Sensor PCBA and sent to the Analog PCBA where it is read by the CPU.

Ventilator data from the CPU is conditioned by the Man-Machine Interface (MMI) PCBA and displayed on a touch screen liquid crystal display (LCD).

3.6.2 Main PCBA

The CPU and other ventilator logic interact through the system data, address and control buses located on the Main PCBA. The Main PCBA receives input signals from various keys on the console or touch screen display and sends them to the CPU. It also contains signal inputs for the non-maskable interrupt signal (MB_INP8), running on AC (MB_INP10) and running on external battery (MB_INP11).

The Main PCBA receives control signals from the CPU and outputs them to various pneumatic components and console indicators. Certain signals at received from the Digital PCBA and sent to the alarm silence indicator, 100% oxygen indicator, run on AC, run on external battery and internal battery status.

A normally open and normally closed relay resides on the Main PCBA. This relay is used to signal the remote nurses call alarm.

Interface connectors are mounted to the Main PCBA. These include the RS-232, parallel printer, analog and remote alarm connectors which allow external devices to be connected to the ventilator.

Other signals routed by the Main PCBA are the reset, MMI PCBA reset, Sensor PCBA reset, PCMCIA reset, primary alarm, primary alarm failure detection logic, back-up alarm, remote alarm, printer, PCMCIA interface, POST timer, CSI signals and the battery backed +5V.

3.6.3 CPU PCBA

The CPU PCBA contains the microprocessor, memory, I/O ports and associated control circuitry necessary to control the ventilator. The functional circuits contained on the CPU PCBA are as follows:

- V851 Microprocessor with a 25 Mhz clock.
- Static RAM which stores ventilator data
- EEPROM which stores patient settings
- Flash memory containing ventilator configuration data
- Internal RS-232 port to receive and transmit ventilator data to the touch screen
- Non-Maskable Interrupt (NMI) which signals the CPU a power source has been lost or interrupted.
- 5 msec Bus Timer provides system timing function and hardware operation monitoring.
- 169 msec Watchdog Timer provides software operation monitoring.
- Bus to the Main PCBA.

3.6.4 Analog PCBA

The Analog PCBA performs a digital-to-analog (DAC) conversion of signals from the CPU to the Blower Controller PCBA and analog output port.

The Analog PCBA connects directly to the system bus located on the Main PCBA.

The functional circuits contained on the Analog PCBA are as follows:

- Digital to Analog Converter (DAC) (8 bit) converts digital signals from the CPU to analog for the Blower and external devices such as chart recorders and bedside monitors.
- CSI Channel Select Logic generates signals that select the air, oxygen and exhalation motor controller PCBAs. It also selects the air, oxygen and exhalation flow sensor look up tables contained on the CPU PCBA.
- Retrieves converted data from the Sensor PCBA.

3.6.5 Digital PCBA

The Digital PCBA conditions serial port signals coming from and going to the CPU PCBA. It also contains control circuitry for the power fail alarm, primary alarm, back-up alarm, RS-232 port and rotary encoder. PCMCIA drives the local address, data and control bus when the ventilator is connected to an external PC.

Digital outputs include:

- Alarm silence indicator
- 100% oxygen indicator
- Running on AC
- Running on external battery
- Internal battery status
- Printer ready
- Printer direction
- PCMCIA CD 1&2

Digital inputs include:

- ADC out of range
- Air present
- Oxygen present

3.6.6 VGA Controller PCBA

The VGA Controller PCBA contains the Date and Real Time Clock and LCD VGA Display Controller drivers.

3.6.7 Blower Controller PCBA

The Blower Controller PCBA drives the speed of the Blower motor based on analog input conditioned by the Analog PCBA. It includes a lock-up sensing circuit, which monitors the Hall-effect sensors in the Blower motor ensuring that the Blower is operating properly. If the Blower seizes, the lock-up sensing circuit shuts off power to the Blower.

3.6.8 Motor Controller PCBAs

There are three Motor Controller PCBAs; one for the air valve, one for the oxygen valve and one for the exhalation valve. There is no physical distinction between these three boards. They are differentiated by the slot they occupy on the Main PCBA:

- Exhalation Valve: Slot CN11
- Oxygen Valve: Slot CN12
- Air Valve: Slot CN13

The Motor Controller PCBAs drive the step positions of the three valves based on input from the CPU.

3.6.9 Sensor PCBA

The Sensor PCBA contains an Analog to Digital Converter (ADC) which converts analog signals from various pneumatic components and the power supply to digital signals for the CPU. Signals include:

- air flow
- air flow temperature
- oxygen flow
- oxygen flow temperature
- exhalation flow
- exhalation flow temperature
- inspiratory and exhalation pressure
- oxygen supply pressure
- FIO2
- enclosure temperature
- internal battery presence
- enclosure oxygen voltage
- diagnostic switch
- Blower Controller PCBA

Voltage monitors indicate over-voltage and under voltage conditions. LEDs corresponding to specific voltage conditions are as follows:

D3	D4	D5	D6	D7	D8
-12V under	+12V under	+24V under	Sensor PCBA +5V under	Sensor PCBA +5V over	MMI PCBA +5V under

D9	D10	D11	D12	D13	D49
MMI PCBA +5V over	+10V under	+10V over	Main PCBA +5V over	Main PCBA +5V under	Power Fail

3.6.10 Man Machine Interface (MMI) PCBA

The Man-Machine Interface PCBA interfaces the console, VGA Display, rotary encoder and touch screen to the CPU via the Main PCBA. it also contains control circuitry for the primary and back-up alarms.

3.6.11 Power Supply

The Power Supply converts AC voltage to DC voltage to be used by the system electronics. It is a switching power supply which allows 100V to 240VAC (50/60 Hz) to be connected to the ventilator. This voltage is converted to +5V, ± 12V and 29VDC.

Power fail logic and charging circuitry for the back-up battery are contained in the power supply.

In the absence of AC voltage, the power supply converts the +24V DC input voltage from an external battery to +5V, ± 12V and +24VDC.

3.6.12 Backlight Inverter PCBA

The Backlight Inverter PCBA converts 5V to approximately 500V to drive the backlight on the VGA Display Assembly.

3.6.13 Real-Time Clock Battery

The Real Time Clock Battery is a 3.6V lithium battery, which supplies power to the real time clock on the VGA Controller PCBA when ventilator power is turned off.

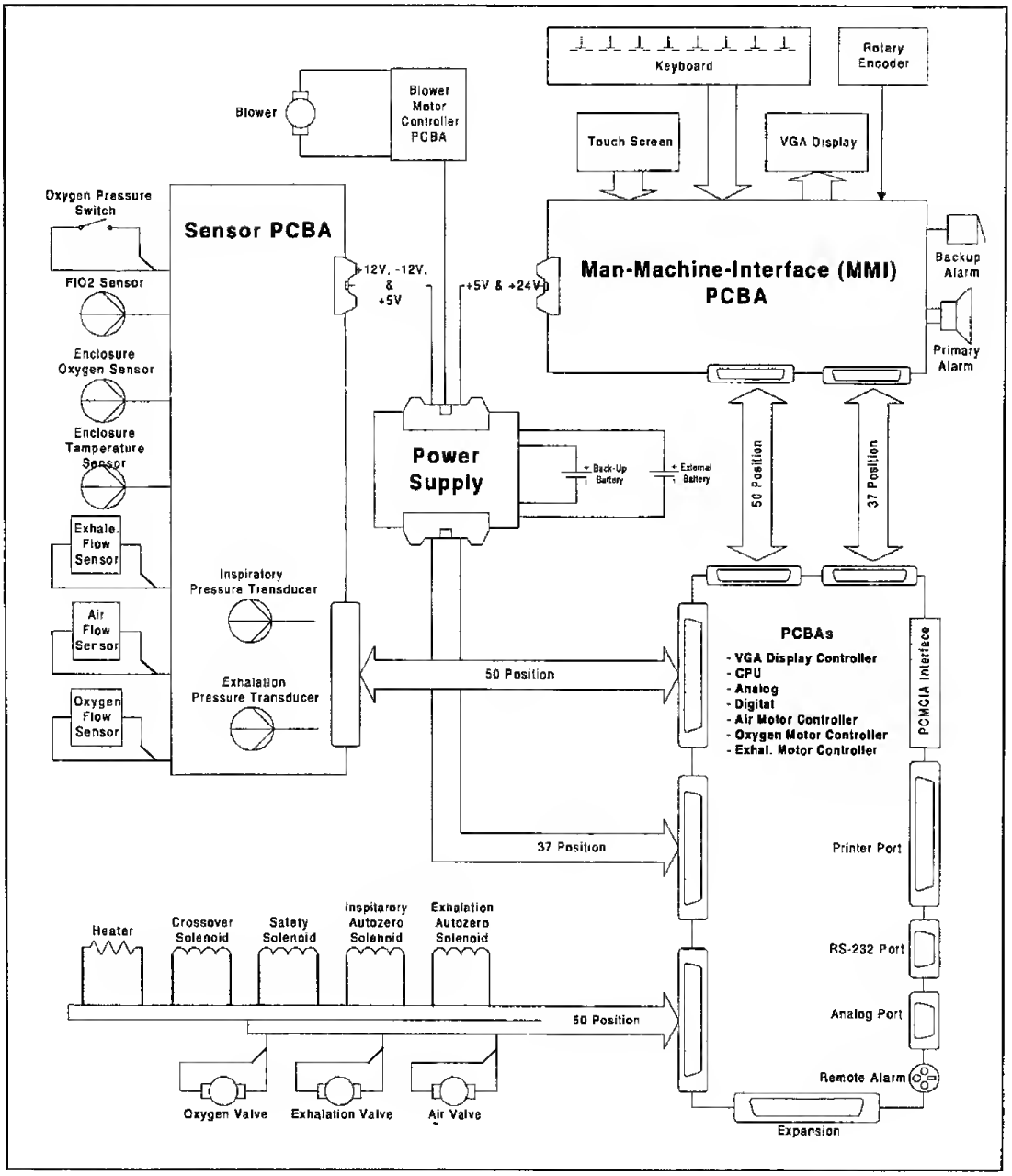


Figure 3-3: Electronic System Diagram

4 Periodic Maintenance

Procedures for cleaning, sterilizing and periodic maintenance must be performed to ensure consistent ventilator operation. Except for the 10,000 Hour Preventative Maintenance Kit, all maintenance tasks are typically performed by hospital personnel. Refer to the Chapter 11 in the Esprit Ventilator Operator's Manual, P/N 580-1000-01 (English), for periodic care and maintenance procedures. Table 4-1 shows the Periodic Maintenance Schedule.

Table 4-1 : Periodic Maintenance Schedule

Frequency	Component	Maintenance
Required Daily	Inspiratory Bacteria Filter Exhalation Bacteria Filter	• Check filter for occlusions, cracks and tears. • Ensure that the ventilator functions normally with them in place. • Monitor performance of disposable filters and replace as needed. • Measure resistance of reusable filters after sterilization.
	Oxygen Water Trap	• Check and empty as required.
250 Hours	Blower Inlet Filter and Air Intake Filter	• Inspect and clean.[1]
6 months	Main Flow Bacteria Filter and Exhalation Bacteria Filter (reusable filters only)	• Replace and destroy reusable filters
10,000 Hours	• Oxygen Inlet Filter • Air Inlet Filter • Cooling Fan Filter • Muffler Assembly • Real Time Clock Battery • Blower	10,000 Hour Preventative Maintenance Kit[2] P/N 1001733

CAUTION

The 10,000 Hour PM Kit is to be installed only by a qualified service technician. The kit includes installation instructions and replacements parts.

NOTES

1. **Clean the Blower Inlet and Air Intake filters more often than every 250 hours if necessary since some environments contain larger amounts of lint and dust.**
2. **Contents of the 10,000 Hour PM Kit are subject to change.**

5 Ventilator Diagnostic Programs & Test

The Esprit Ventilator is equipped with a diagnostic screen which allows a qualified operator or technician to:

- Run a Short Self Test
- Run an Extended Self Test
- Check the software revision of the ventilator and certain components
- Change the time and date
- Enable or disable the automatic patient circuit compliance feature
- Set the proper altitude
- Check diagnostic codes
- Control pneumatic components and voltages

The diagnostic screen includes a hardware diagnostic screen which facilitates troubleshooting in the event of a Short Self Test failure, an Extended Self Test failure or a Performance Verification failure.

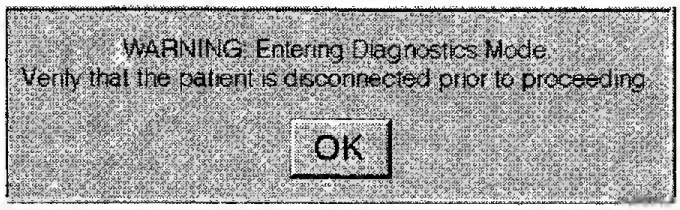
WARNING - The patient must be disconnected from the ventilator before entering the diagnostic mode since normal ventilation is suspended.

CAUTION - Troubleshooting and repair should be performed only by a qualified service technician.

5.1 Accessing Diagnostic Tests

Ensure that the Mains Switch/Circuit Breaker, located on the ventilator back panel is in the ON (**I**) position.

To access the Esprit ventilator diagnostics, simultaneously press the **ALARM RESET** and **100% O2** keys on the console for approximately 5 seconds while turning ventilator power on. The following message will appear on the screen:



Touch the **OK** key to enter the diagnostic mode.

5.2 User Configuration

The User Configuration screen allows the operator to:

- Change the date and time
- Enable or disable the automatic patient circuit compliance compensation feature
- Set the proper altitude
- Check and delete diagnostic codes.

To access the User Configuration screen, touch the **USER CONFIG** key on the diagnostic screen. The following screen (see Figure 5-1) will appear:

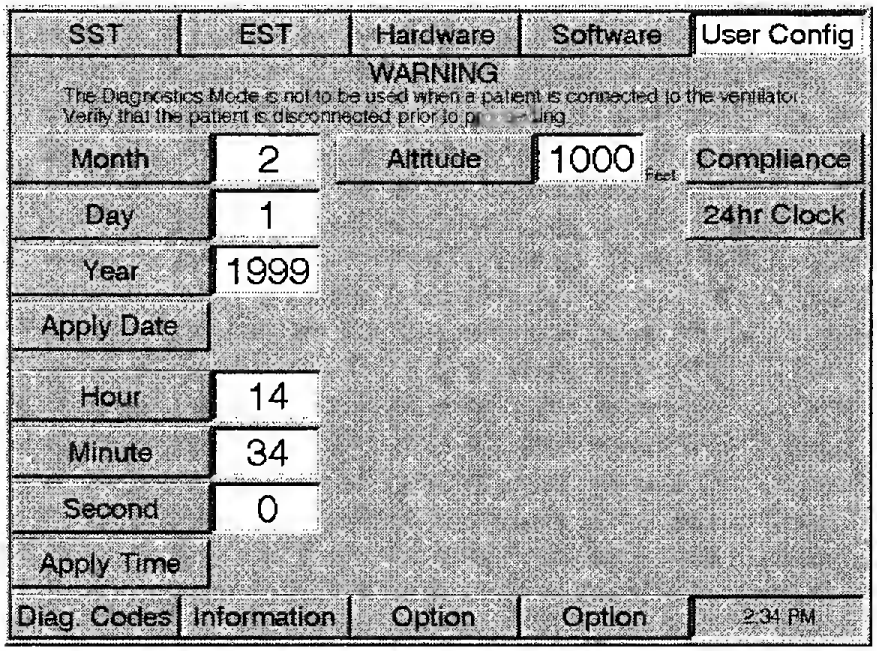


Figure 5-1: User Configuration

5.2.1 Changing the Date and Time

To change the date or time:

1. Touch the desired date or time key.
2. Touch the **INCREASE** or **DECREASE** key, or rotate the control knob, to change the value.
3. Touch the **ACCEPT** key to confirm the change.
4. Touch the **APPLY DATE** and **APPLY TIME** keys to enable the change.

Note: The APPLY DATE and APPLY TIME keys must be touched or else the changes will not be enabled.

5.2.2 Setting the Time Format

The 24 Hr Clock key allows the operator or technician to set the displayed time in a standard (ex: 1:15 PM) or military (ex: 13:15) format.

Touch the **24 Hr CLOCK** key to toggle between standard and military formats. Observe the time display in the lower right hand corner of the diagnostic screen to confirm the format.

5.2.3 Altitude

The altitude key allows the operator or technician to set the altitude per the location of the ventilator. This factor ensures a more accurate tidal volume delivery.

To adjust the altitude:

1. Verify the altitude using an altimeter, if available, or estimate the altitude in feet above sea level.
2. Touch the **ALTITUDE** key
3. Touch the **INCREASE** or **DECREASE** key, or rotate the control knob, to change the value. The double arrows provide a coarse adjustment while the single arrows provide a fine adjustment.

5.2.4 Compliance Enable

Flow calculations and Blower control are affected by a compliance correction factor. The compliance correction factor is employed to compensate for volume loss in the patient breathing circuit due to the compressible volume of the tubing.

The Compliance Enable key allows the operator to enable or disable the patient tubing compliance value measured during the SST or EST.

Touch the **COMPLIANCE** key to toggle between Compliance – enabled (white) and Compliance – disabled (gray).
Compliance (enabled) means that the tubing compliance volume will be added to the delivered volume. Compliance (disabled) means that the tubing compliance value will not be added to the delivered volume.

Typically, the compliance will be disabled during performance testing and enabled during normal operation.

5.3 Short Self Test (SST)

The Short Self Test (SST) verifies the integrity of the patient circuit tubing by measuring the leak rate and the compliance. Some hardware is also tested such as the safety valve, flow sensor tables, auto-zero solenoids and check valve 3.

The SST should be performed before putting a patient on the ventilator or whenever the patient circuit is changed.

WARNING - Do not use a ventilator that has failed SST without verifying operational readiness by other means. Doing so may place a patient at risk.

WARNING - Never initiate an SST while the patient is connected to the ventilator. The high airway pressures generated during SST can injure a patient.

5.3.1 Equipment Required for the SST

An adult patient circuit assembly and a rubber cork are needed to perform a SST.

5.3.2 Running the SST

1. Connect the patient circuit to the ventilator.
2. Touch the **SST** key on the diagnostic screen.
3. Touch the **START SST** key to begin the test.
4. When prompted, unplug the patient wye and touch the **OK** key.
5. When prompted, plug the patient wye with the cork and touch the **OK** key.
6. When SST is completed successfully, touch the **OK** key.

5.4 The Extended Self Test (EST)

The Extended Self Test (EST) verifies the overall functional integrity of the ventilator by testing the following hardware subsystems and components against other internal components:

- Air Delivery System - Air valve controller and flow sensor
- Oxygen Delivery System - Oxygen valve controller and flow sensor
- Exhalation System - Exhalation valve controller and flow sensor
- Check valves – CV2 and CV3
- Pressure Relief Valve
- Blower
- Crossover Circuit
- Pressure Transducers and Oxygen Pressure Switch
- Safety Valve Circuit
- Console Keys
- Rotary Knob
- Primary and Backup Audio
- Oxygen Sensor
- Oxygen Supply Switch
- Heated Exhalation Filter Back pressure
- LED Test
- Touch screen Test

The EST should be performed during Preventative Maintenance, a Performance Verification or if the operational integrity of the ventilator is in question.

WARNING - Do not use a ventilator that has failed EST without verifying operational readiness by other means. Doing so may place a patient at risk.

WARNING - Never initiate an EST while the patient is connected to the ventilator. The high airway pressures and gas flows generated during EST can injure a patient.

5.4.1 Equipment Required for the Extended Self Test

An adult patient circuit assembly, a rubber cork and a regulated oxygen source are needed to perform an EST. An optional external oxygen sensor is also needed to perform the automatic oxygen sensor test

5.4.2 Running the Extended Self Test

1. Verify that the bacteria filters and O2 sensor are connected to the ventilator.
2. Connect the patient circuit to the ventilator.
3. Touch the **EST** key on the diagnostic screen (see
4. Figure 5-2).
5. Touch the **START EST** key to begin test.
6. When prompted, unplug the patient wye and touch the **OK** key.
7. When prompted, plug the patient wye with the cork and touch the **OK** key.
8. When prompted, connect oxygen source to the ventilator and touch the **OK** key. If the ventilator is already connected to an oxygen source, this prompt will not appear.
9. When prompted, disconnect oxygen source from the ventilator and touch the **OK** key.
10. When prompted, reconnect oxygen source to the ventilator and touch the **OK** key.
11. When prompted, disconnect the patient circuit from the heated exhalation filter and touch the **OK** key.
12. When the message "Is the primary audio alarm active?" is displayed, touch the **YES** key if the alarm is sounding, or **NO** if it is not.

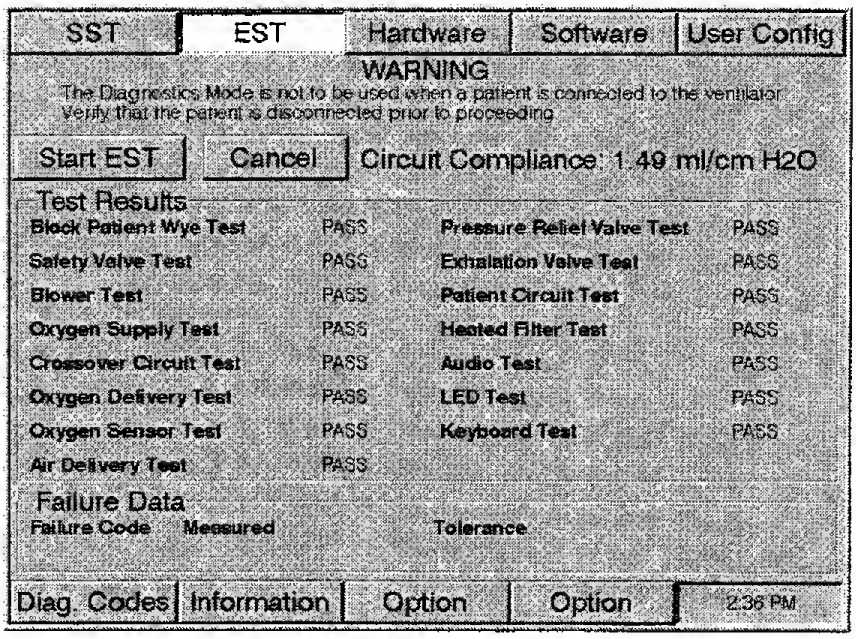


Figure 5-2: EST Screen.

13. When the message "Is the backup audio alarm active?" is displayed, touch the **YES** if the alarm is sounding, or **NO** if it is not.
14. When the message "Is the remote alarm connected?" is displayed, touch **YES** if it is, or **NO** if it is not.
15. When the message "Is the remote alarm active?" is displayed, touch the **YES** if the alarm is sounding, or **NO** if it is not.
16. Press the keys on the console as prompted.
17. When EST is completed successfully, touch the **OK** key.

5.5 Software Identification

The Software screen identifies the:

- Serial number of the ventilator
- Part number and version of the Flash and One Time Programmable (OTP) software
- Version of the air stepper valve, oxygen stepper valve, exhalation stepper valve, and display
- Part number of the air, oxygen and exhalation flow sensors

To access the software screen, touch the **SOFTWARE** key on the diagnostic screen (see Figure 5-3).

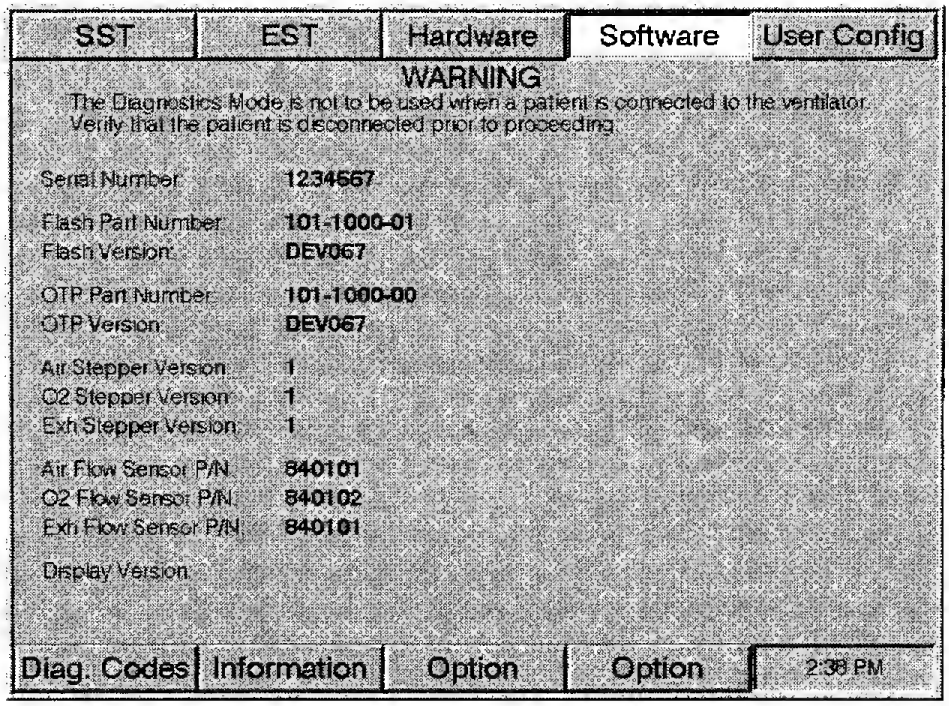


Figure 5-3: Software Screen

5.6 Diagnostic Codes

The Esprit Ventilator generates two types of diagnostic codes; System and SST/EST.

System codes are generated when the microprocessor detects a fault during normal operation. This could be the result of a failure during a Power On Self Test (POST), in the execution of a software routine, or a catastrophic hardware failure which may compromise the proper operation of the ventilator.

SST and EST codes are generated if a failure occurs during a Short or Extended Self Test. The diagnostic codes and code descriptions for SST and EST are identical except that SST codes are preceded by a "2" and EST codes are preceded by a "3." Example: If code "106" occurred during a SST it would be logged as "2106." If it occurred during an EST, it would be logged as "3106."

5.6.1 Accessing Diagnostic Codes

To access the diagnostic codes, touch the **DIAG. CODES** key on the diagnostic screen. There are six columns of information (see Figure 5-4).

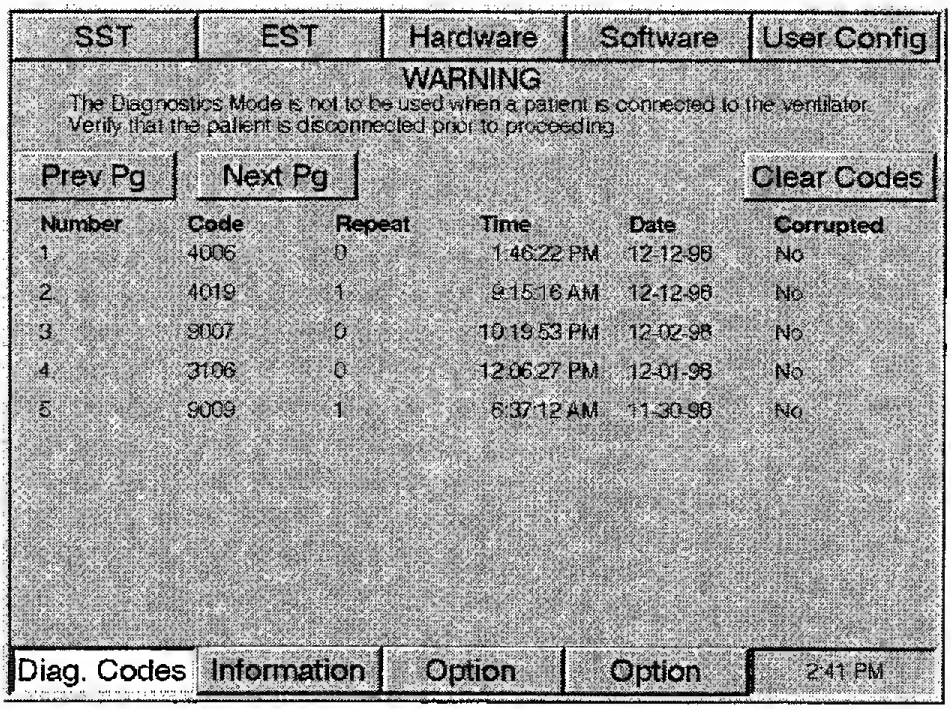


Figure 5-4: Diagnostic Code Screen

1. **Number:** Diagnostic codes are numbered with the most recent code in the first position.
2. **Code:** The code number assigned to a specific failure. These codes are helpful in determining the cause of a failure.
3. **Repeat:** If the same code occurs consecutively, it will not be displayed again but rather incremented in the repeat column. For example, if code 1002 occurs three consecutive times, it will be logged as code 1002 and the repeat column will show a 2. The repeat column will continue to increment until a different code occurs.
4. **Time:** Diagnostic codes are time stamped in the following format; hour/minute/second (example: 09:15:23).
5. **Date:** Diagnostic codes are date stamped in the following format; month/day/year (example: 03/12/98).
6. **Corrupted:** The microprocessor regularly cross checks the data in memory. If it determines that the diagnostic code in memory has been corrupted it will log a "Yes" indicating that its validity is suspect.

5.6.1.1 Next Page and Previous Page Keys

The ventilator can log up to 20 error codes but can only display 10 on the screen at a time. Touch the **NEXT PAGE** key to scroll forward to refer to the next group of codes or the **PREV PAGE** key to scroll back.

5.6.1.2 Clear Codes Key

The Clear Codes key allows a service technician to delete the codes.

To delete the codes, touch the **CLEAR CODES** key. The following message will appear on the screen:

Are you sure you want to clear the codes?
YES NO

Touch YES to clear the codes, or NO to keep the codes and exit the clear codes screen.

NOTE: Diagnostic codes provide the primary means of fault diagnosis. They should only be deleted by a qualified service technician.

5.6.2 Interpreting Diagnostic Codes

Diagnostic codes provide the primary means of fault diagnoses. When an error is detected, a code will be stored in memory and displayed on the Diagnostic Code screen in the diagnostic mode. Table 5-1 lists the System diagnostic codes, code descriptions and the recommended repair procedures. Table 5-2 lists the SST and EST diagnostic codes.

Note: The Recommended Repair column lists the most probable source of the failure first, in most cases. Try the first recommendation. If that doesn't work, try the next one, etc.

5.6.2.1 System Diagnostic Codes

Table 5-1: System Diagnostic Codes

Diagnostic Code	Code Description	Recommended Repair
0	Empty Record	Call Technical Support
1	Ventilator Restart	Occurs when unit is turned ON – No action required
2	Ventilator Shutdown	Occurs when unit is turned OFF No action required
3	Diagnostic Startup	Occurs when diagnostics is invoked – No action required
4	Unknown Restart	1. Check +5V Supply – Replace Power Supply if low. 2. Replace CPU PCBA 3. Replace Main PCBA 4. Replace Sensor PCBA 5. Replace Cable, Main to Sensor
5	Depleted Back-up Battery	Connect AC power cord and allow battery to charge.
1001	Bus Activity Monitor Test Failure	1. Replace CPU PCBA 2. Replace Cable, Main to Sensor 3. Replace Sensor PCBA 4. Replace Main PCBA
1002	Watchdog Timer Test Failure	1. Replace CPU PCBA 2. Replace Cable, Main to Sensor 3. Replace Sensor PCBA 4. Replace Main PCBA

Table 5-1: System Diagnostic Codes

Diagnostic Code	Code Description	Recommended Repair
1003	Processor Test Failure	Replace CPU PCBA
1004	OTP CRC Failure	Replace PCU PCBA
1005	Flash CRC Failure	1. Download software 2. Replace CPU PCBA
1006	Internal RAM Test Failure	Replace CPU PCBA
1007	External RAM Test Failure	Replace CPU PCBA
1008	Maximum System Resets Exceeded	1. Check +5V Supply – Replace Power Supply if low. 2. Replace CPU PCBA 3. Replace Main PCBA 4. Replace Sensor PCBA 5. Replace Cable, Main to Sensor
1009	POST Inhalation Autozero Test Failure	1. Replace Sensor PCBA 2. Replace Cable, Main to Sensor
1010	POST Exhalation Autozero Test Failure	1. Replace Sensor PCBA 2. Replace Cable, Main to Sensor
1011	POST OTP Flash Compatibility Test Failure	1. Download software. 2. Replace CPU PCBA.
1012	Air Valve Liftoff Failure	1. Replace Air Valve 2. Replace Air Motor Controller PCBA 3. Replace Main PCBA
1013	Oxygen Valve Liftoff Failure	1. Replace Oxygen Valve 2. Replace Oxygen Motor Controller PCBA 3. Replace Main PCBA
1014	POST Timer/24V Failure	1. Cycle power to the ventilator 2. Check the Diag. Codes screen per Section 5.6.1. If the Repeat column is > 2, replace the Main PCBA. If the Repeat column is < 2, replace the Power Supply. 3. Replace CPU PCBA.
2000	SST Passed	No action required
3000	EST Passed	No action required
4002	RAM Test	Replace CPU PCBA
4003	ADC/DAC Test	1. Replace Analog PCBA 2. Replace Cable, Main to Sensor 3. Replace Sensor PCBA
4004	Inhalation Autozero Failure	1. Check Inhalation Solenoid per Section 5.10.6. 2. Replace Sensor PCBA 3. Replace 3 Station Solenoid Assembly 4. Replace Cable, Main to Sensor 5. Replace Main PCBA

Table 5-1: System Diagnostic Codes

Diagnostic Code	Code Description	Recommended Repair
4005	Exhalation Autozero Failure	1. Check Inhalation Solenoid per Section 5.10.6. 2. Replace Sensor PCBA 3. Replace 3 Station Solenoid Assembly 4. Replace Cable, Main to Sensor 5. Replace Main PCBA.
4006	High Temperature	1. Check that both cooling fans are operating properly – replace as necessary. 2. Check Blower Inlet Filter and Air Intake Filter – clean or replace as necessary. 3. Replace Sensor PCBA
4007	Exhalation Valve Stuck Open	1. Replace Exhalation Motor Controller PCBA 2. Replace Exhalation Valve Assembly 3. Replace Exhalation Flow Sensor 4. Replace Exhalation Flow Sensor Cable. 5. Replace Main PCBA
4008	Air Valve Stuck Open	1. Check Air Valve per Section 5.10.4. 2. Replace Air Motor Controller PCBA 3. Replace Air Valve Assembly 4. Replace Air Flow Sensor. 5. Replace Air Flow Sensor Cable. 6. Replace Main PCBA
4009	Oxygen Valve Stuck Open	1. Check Oxygen Valve per Section 5.10.1. 2. Replace Oxygen Motor Controller PCBA. 3. Replace Oxygen Valve Assembly. 4. Replace Oxygen Flow Sensor. 5. Replace Oxygen Flow Sensor Cable. 6. Replace Main PCBA
4010	Air Valve Stuck Closed	1. Check Air Valve per Section 5.10.4. 2. Replace Air Motor Controller PCBA 3. Replace Air Valve Assembly 4. Replace Air Flow Sensor. 5. Replace Air Flow Sensor Cable. 6. Replace Main PCBA

Table 5-1: System Diagnostic Codes

Diagnostic Code	Code Description	Recommended Repair
4011	Oxygen Valve Stuck Closed	1. Check Oxygen Valve per Section 5.10.1. 2. Replace Oxygen Motor Controller PCBA. 3. Replace Oxygen Valve Assembly. 4. Replace Oxygen Flow Sensor. 5. Replace Oxygen Flow Sensor Cable. 6. Replace Main PCBA
4012	Exhalation Valve Stuck Closed	1. Replace Exhalation Motor Controller PCBA 2. Replace Exhalation Valve Assembly 3. Replace Exhalation Flow Sensor 4. Replace Exhalation Flow Sensor Cable. 5. Replace Main PCBA
4013	OTP CRC	Replace PCU PCBA
4014	Flash CRC	1. Download software 2. Replace CPU PCBA
4015	Primary Alarm Failure	1. Replace Primary Alarm 2. Check Cable, MMI to Primary Alarm. Replace as necessary. 3. Replace Digital PCBA
4018	Flow Table CRC	1. Enter the diagnostic mode then turn unit off and on. 2. Replace CPU PCBA.
4019	Air Valve Error	1. Check Air Valve per Section 5.10.4. 2. Replace Air Motor Controller PCBA 3. Replace Air Valve Assembly 4. Replace Main PCBA
4020	Oxygen Valve Error	1. Check Oxygen Valve per Section 5.10.1. 2. Replace Oxygen Motor Controller PCBA. 3. Replace Oxygen Valve Assembly. 4. Replace Main PCBA
4021	Exhalation Valve Error	1. Replace Exhalation Motor Controller PCBA 2. Replace Exhalation Valve Assembly 3. Replace Main PCBA
4022	Blower Temperature Too High	1. Check that cooling coil fan is working. 2. Replace Blower 3. Replace Sensor PCBA

Table 5-1: System Diagnostic Codes

Diagnostic Code	Code Description	Recommended Repair
7000, 7002	Power Failure, Power Fail	Replace Power Supply
7004 – 7014	Various combinations of +12V, –12V and Power Fail Failures	Replace Power Supply
7016 – 7030	Various combinations of 24V, +12V, -12V and Power Fail Failures.	Replace Power Supply
7032 – 7062	Sensor PCBA +5V Failure and/or various combinations of +12V, -12V, 24V and Power Fail Failures	1. Replace Sensor PCBA 2. Replace Power Supply
7064 – 7094	MMI PCBA +5V Failure and/or various combinations of +12V, -12V, 24V and Power Fail Failures	1. Replace MMI PCBA 2. Replace Power Supply
7096 – 7126	MMI PCBA +5V Failure and/or various combinations of Sensor PCBA +5V, +12V, -12V, 24V, Power Fail Failure.	1. Replace MMI PCBA 2. Replace Sensor PCBA 3. Replace Power Supply
7128 – 7158	Various combinations of +10V, +12V, -12V, 24V and Power Fail Failures.	Replace Power Supply
7160 – 7190	+10V Failure and various combinations of Sensor PCBA +5V, +12V, -12V, 24V and Power Fail Failures.	1. Replace Sensor PCBA 2. Replace Power Supply
7192 – 7222	+10V Failure and various combinations of MMI PCBA +5V, +12V, -12V, 24V and Power Fail Failures.	1. Replace MMI PCBA 2. Replace Power Supply
7224 – 7254	+10V Failure and various combinations of MMI PCBA +5V, Sensor PCBA +5V, +12V, -12V, 24V and Power Fail Failures.	1. Replace Sensor PCBA 2. Replace MMI PCBA 3. Replace Power Supply.
8001	Recoverable Anomaly	Call Technical Support
8002	Alarm Corrupt Status	Call Technical Support
9001	Flash Programming Error	1. Run EST 2. Replace CPU PCBA

Table 5-1: System Diagnostic Codes

Diagnostic Code	Code Description	Recommended Repair
9002	Flow Sensor Mismatch	1. Enter the diagnostic mode then turn the unit off and on. 2. Run EST to identify problem flow sensor then replace flow sensor. 3. Replace CPU PCBA.
9003	Flow Sensor Failure	1. Run EST to identify problem flow sensor. 2. Replace faulty flow sensor. 3. Replace faulty flow sensor cable. 4. Replace Sensor PCBA. 5. Replace Analog PCBA 6. Replace Main PCBA.
9004	Pressure Sensor Failure	1. Replace Sensor PCBA 2. Replace Analog PCBA
9005	Sensor Failure	Call Technical Support
9007	Air Flow Sensor Cable misconnected to the Oxygen Connector (J10) on Sensor PCBA	Connect Air Flow Sensor Cable to J12 on Sensor PCBA
9008	Oxygen Flow Sensor Cable misconnected to the Air (J12) or Exhalation (J11) Connector on Sensor PCBA	Connect Oxygen Flow Sensor Cable to J10 on Sensor PCBA
9009	Flow Sensor Calibration Data Out of Range	Replace the Flow Sensor recently replaced

5.6.2.2 SST/EST Diagnostic Codes

NOTE: The diagnostic codes and code descriptions for SST and EST are identical except that SST codes are preceded by a "2" and EST codes are preceded by a "3." Example: If code "106" occurred during a SST it would be logged as "2106." If it occurred during an EST, it would be logged as "3106."

Table 5-2: SST/EST Diagnostic Codes

Diagnostic Code	Code Description	Recommended Repair
100	Test Canceled by User	No action required
101	Air Stepper Valve Out of Range	1. Check Air Valve per Section 5.10.4. 2. Replace Air Motor Controller PCBA 3. Replace Air Valve Assembly 4. Replace Main PCBA
102	O2 Stepper Valve Out of Range	1. Check Oxygen Valve per Section 5.10.1. 2. Replace Oxygen Motor Controller PCBA. 3. Replace Oxygen Valve Assembly. 4. Replace Main PCBA
103	Air Flow Outside Range	1. Check Air Valve per Section 5.10.4. 2. Replace Air Motor Controller PCBA. 3. Replace Air Valve Assembly 4. Replace Air Flow Sensor. 5. Replace Air Flow Sensor Cable. 6. Replace Main PCBA
104	O2 Flow Outside Range	1. Check Oxygen Valve per Section 5.10.1. 2. Replace Oxygen Motor Controller PCBA. 3. Replace Oxygen Valve Assembly. 4. Replace Oxygen Flow Sensor. 5. Replace Oxygen Flow Sensor Cable. 6. Replace Main PCBA
105	Exhalation Flow Outside Range	1. Replace Exhalation Motor Controller PCBA 2. Replace Exhalation Valve Assembly 3. Replace Exhalation Flow Sensor 4. Replace Main PCBA

Table 5-2: SST/EST Diagnostic Codes

Diagnostic Code	Code Description	Recommended Repair
106	Patient Circuit Leak	1. Remove inspiratory bacteria filter and external oxygen sensor and try another patient circuit. 2. Hold thumb over outlet of exhalation valve while rerunning leak test. If leak stops, replace exhalation valve.
107	Inhalation Pressure Too Low	1. Check Inhalation Pressure Transducer per Section 5.10.17. 2. Check for kinks or cuts in the tube between Inhalation Solenoid and Inhalation Pressure Sensor. 3. Replace Sensor PCBA.
108	Exhalation Pressure Outside Range	1. Check Exhalation Pressure Transducer per Section 5.10.17. 2. Check for kinks or cuts in the tube between Exhalation Solenoid and Exhalation Pressure Sensor. 3. Replace Sensor PCBA.
109	Check Valve 2 Leak	Check CV2 per Section 5.10.12. Replace as necessary.
110	Check Valve 3 Leak	1. Check CV3 per Section 5.10.13. Replace as necessary. 2. Check for patient circuit leaks.
111	Oxygen Not Connected	1. Check that oxygen (minimum of 40 PSI/276 kPa) is connected to the ventilator. 2. Try another oxygen hose. 3. Check Oxygen Pressure Switch per Section 5.10.18. 4. Replace Oxygen Regulator Assembly.
112	O2 Not Disconnected	1. Check that oxygen is disconnected. 2. Check Oxygen Pressure Switch per Section 5.10.18. 3. Replace Oxygen Regulator Assembly.
113	FIO2 Sensor 100% Sample Range	1. Replace Oxygen Sensor. 2. Replace Oxygen Sensor Cord. 3. Replace Cable, FIO2 Sensor to Sensor PCBA. 4. Replace Sensor PCBA. 5. Replace Analog PCBA.

Table 5-2: SST/EST Diagnostic Codes

Diagnostic Code	Code Description	Recommended Repair
114	FIO2 Sensor 100% Average Range	1. Replace Oxygen Sensor. 2. Replace Oxygen Sensor Cord. 3. Replace Cable, FIO2 Sensor to Sensor PCBA. 4. Replace Sensor PCBA. 5. Replace Analog PCBA.
115	Primary Audio Not Sounding	1. Verify the correct key was pressed. 2. Replace Primary Alarm. 3. Replace Digital PCBA 4. Replace MMI PCBA 5. Replace the Cable, Primary Alarm to MMI PCBA 6. Replace Main PCBA
116	Backup Audio Not Sounding	1. Verify the correct key was pressed during EST. 2. Replace the Back-Up Alarm. 3. Replace Digital PCBA 4. Replace MMI PCBA 5. Replace the Cable, Back-Up Alarm to MMI PCBA 6. Replace Main PCBA
117	Crossover Circuit Fault	1. Check Crossover Solenoid per Section 5.10.9. 2. Replace 3 Station Solenoid Assembly 3. Replace Main PCBA
118	Blower Not Off Switch	1. Check Blower per Section 5.10.16. 2. Replace Blower Controller PCBA. 3. Replace Sensor PCBA. 4. Replace Main PCBA.
119	Blower Not OFF DAC	1. Check Voltage Wrap per Section 6.5.3. 2. Check Blower per Section 5.10.16. 3. Replace Blower Controller PCBA. 4. Replace Analog PCBA. 5. Replace Sensor PCBA.
120	Relief Valve Crack Flow Pressure Too High	1. Check Pressure Relief Valve per Section 5.10.8. Adjust if necessary. 2. Replace Inspiratory Manifold Assembly 3. Replace Sensor PCBA.

Table 5-2: SST/EST Diagnostic Codes

Diagnostic Code	Code Description	Recommended Repair
121	Relief Valve Crack Flow Pressure Not Stable	1. Check Pressure Relief Valve per Section 5.10.8. 2. Recalibrate Pressure Relief Valve. 3. Replace Inspiratory Assembly 4. Replace Sensor PCBA. 5. Replace Analog PCBA.
122	Relief Valve Crack Flow Pressure Too Low	1. Check Pressure Relief Valve per Section 5.10.8. 2. Recalibrate Pressure Relief Valve. 3. Replace Inspiratory Assembly 4. Replace Sensor PCBA. 5. Replace Analog PCBA.
123	O2 Flow Crack Flow Outside Range (149 steps)	1. Replace Oxygen Motor Controller PCBA. 2. Replace Oxygen Valve Assembly.
124	O2 Flow Full Flow Outside Range (2000 steps)	1. Replace Oxygen Motor Controller PCBA. 2. Replace Oxygen Valve Assembly.
125	Difference between Air and Exhalation Flow	1. Check Air and Exhalation flows per Sections 5.10.5 and 5.10.10. Replace appropriate flow sensor(s) as necessary 2. Replace Sensor PCBA. 3. Replace Analog PCBA. 4. Replace Main PCBA
126	Difference between O2 and Exhalation Flow	1. Check Oxygen and Exhalation flows per Section 5.10.2. and 5.10.10. Replace appropriate flow sensor(s) as necessary 2. Replace Sensor PCBA. 3. Replace Analog PCBA 4. Replace Main PCBA
127	Heated Filter Back Pressure Range	1. Replace the exhalation bacteria filter. 2. Check for occlusions in the patient circuit.
128	Circuit Compliance Range	1. Remove inspiratory bacteria filter and external oxygen sensor and try another patient circuit. 2. Replace Sensor PCBA. 3. Replace Analog PCBA.

Table 5-2: SST/EST Diagnostic Codes

Diagnostic Code	Code Description	Recommended Repair
129	Pressure Leak Range	1. Remove inspiratory bacteria filter and external oxygen sensor and try another patient circuit. 2. Rerun test while holding thumb over outlet of exhalation valve while rerunning leak test. If leak stops, replace exhalation valve. 3. Replace Sensor PCBA 4. Replace Analog PCBA.
130	Safety Valve Cannot Open	1. Check Safety Valve and Safety Valve Solenoid per Section 5.10.7. 2. Replace 3 Station Solenoid Assembly. 3. Install Safety Valve Kit. 4. Replace Inspiratory Manifold Assembly.
131	Patient Wye Not Blocked	1. Check that patient wye is blocked. 2. Check for disconnection in patient circuit. 3. Hold thumb over outlet of exhalation valve while rerunning test. If test passes, replace exhalation valve
132	Keyboard Key Not Responding	1. Replace MMI PCBA. 2. Replace Cable, Main PCBA to MMI PCBA 3. Replace Bezel Assembly 4. Replace Main PCBA 5. Replace CPU PCBA
133	Rotary Knob Not Responding	1. Replace Rotary Encoder. 2. Replace MMI PCBA. 3. Replace Cable, Main PCBA to MMI PCBA 4. Replace Main PCBA 5. Replace CPU PCBA
134	Air Flow Sensor Cannot Calibrate	1. Enter the diagnostic mode then turn unit off and on. 2. Replace CPU PCBA 3. Replace Air Flow Sensor 4. Replace Sensor PCBA. 5. Replace Analog PCBA.

Table 5-2: SST/EST Diagnostic Codes

Diagnostic Code	Code Description	Recommended Repair
135	O2 Flow Sensor Cannot Calibrate	1. Enter the diagnostic mode then turn unit off and on. 2. Replace CPU PCBA 3. Replace Oxygen Flow Sensor 4. Replace Sensor PCBA. 5. Replace Analog PCBA.
136	Exhalation Flow Sensor Cannot Calibrate	1. Enter the diagnostic mode then turn unit off and on. 2. Replace CPU PCBA 3. Replace Exhalation Flow Sensor 4. Replace Sensor PCBA. 5. Replace Analog PCBA.
137	Air Flow Sensor Verify Calibration Failure	1. Enter the diagnostic mode then turn unit off and on. 2. Replace CPU PCBA 3. Replace Air Flow Sensor 4. Replace Sensor PCBA. 5. Replace Analog PCBA.
138	O2 Flow Sensor Verify Calibration Failure	1. Enter the diagnostic mode then turn unit off and on. 2. Replace CPU PCBA 3. Replace Oxygen Flow Sensor 4. Replace Sensor PCBA. 5. Replace Analog PCBA.
139	Exhalation Flow Sensor Verify Calibration Failure	1. Enter the diagnostic mode then turn unit off and on. 2. Replace CPU PCBA 3. Replace Exhalation Flow Sensor 4. Replace Sensor PCBA. 5. Replace Analog PCBA.
140	Flow Sensors Cannot Erase Table	1. Replace CPU PCBA
141	Inhalation Autozero Solenoid Cannot Open	1. Check Inhalation Solenoid per Section 5.10.6. 2. Replace 3 Station Solenoid Assembly 3. Replace Sensor PCBA. 4. Replace Analog PCBA
142	Exhalation Autozerô Solenoid Cannot Open	1. Check Exhalation Solenoid per Section 5.10.6. 2. Replace 3 Station Solenoid Assembly 3. Replace Sensor PCBA. 4. Replace Analog PCBA.

Table 5-2: SST/EST Diagnostic Codes

Diagnostic Code	Code Description	Recommended Repair
143	Air Stepper Position Open Outside Range	1. Replace Air Motor Controller PCBA 2. Replace Air Valve Assembly 3. Replace Cable, Main to Motors 4. Replace Main PCBA 5. Replace CPU PCBA.
144	Air Stepper Position Mid Outside Range	See Code 143
145	Air Stepper Position Close Outside Range	See Code 143
146	O2 Stepper Position Open Outside Range	1. Replace Oxygen Motor Controller PCBA 2. Replace Oxygen Valve Assembly 3. Replace Cable, Main to Motors. 4. Replace Main PCBA. 5. Replace CPU PCBA.
147	O2 Stepper Position Mid Outside Range	See Code 146
148	O2 Stepper Position Close Outside Range	See Code 146
149	Exhalation Stepper Position Open Outside Range	1. Replace Exhalation Motor Controller PCBA 2. Replace Exhalation Valve Assembly 3. Replace Cable, Main to Motors. 4. Replace Main PCBA. 5. Replace CPU PCBA.
150	Exhalation Stepper Position Mid Outside Range	See Code 149
151	Exhalation Stepper Position Close Outside Range	See Code 149
152	Patient Wye Not Unblocked	1. Check that patient wye is unblocked. 2. Try new inspiratory bacteria filter. 3. Check for occlusion in the inspiratory limb of the patient circuit.

Table 5-2: SST/EST Diagnostic Codes

Diagnostic Code	Code Description	Recommended Repair
153	Touch Screen Failure	1. Verify the correct key was touched during EST. 2. Clean screen and bezel 3. Replace Touch Screen/LED Assembly. 4. Replace Digital PCBA. 5. Replace MMI PCBA. 6. Replace Main PCBA
154	LED Illumination Failure	1. Verify the correct key was pressed during EST. 2. Replace Bezel Assembly 3. Replace Digital PCBA 4. Replace MMI PCBA 5. Replace Main PCBA
155	Remote Alarm Did Not Sound	1. Verify correct key was touched during EST. 2. Check Nurses Call per Section 6.5.8. 3. Replace Main PCBA.

5.6.3 Information

Currently undefined.

5.6.4 Option Keys

The two option keys are reserved for future expansion.

5.7 Hardware Diagnostics

The hardware diagnostics screen allows the qualified service technician to, 1) set specific air and oxygen flows, 2) incrementally open and close the exhalation valve, 3) adjust various analog and digital voltages, 4) control power to the blower, filter heater and 24 volt components, and 5) exercise the solenoids. This screen is useful in pinpointing a faulty component(s) in the event of a SST failure, EST failure or Performance Verification failure.

5.7.1 Controllable Hardware

Controllable hardware is segregated into four functional groups on the Hardware screen: 1) Flow Control, 2) Voltage Control, 3) On/Off, and 4) Solenoids. The following components and voltages can be individually manipulated (see Figure 5-5):

Group 1: Flow Control

Air: The **AIR** key controls the flow rate of the air controller. This allows the technician to set a specific air flow from 0 to 200 LPM.

Oxygen: The **OXYGEN** key controls the flow rate of the oxygen controller. This allows a technician to set a specific oxygen flow from 0 to 200 LPM.

Exhalation: The **EXHALATION** key controls the steps of the exhalation valve. This allows the technician to open or close the exhalation valve from 0 (fully open) to 1800 (fully closed) steps.

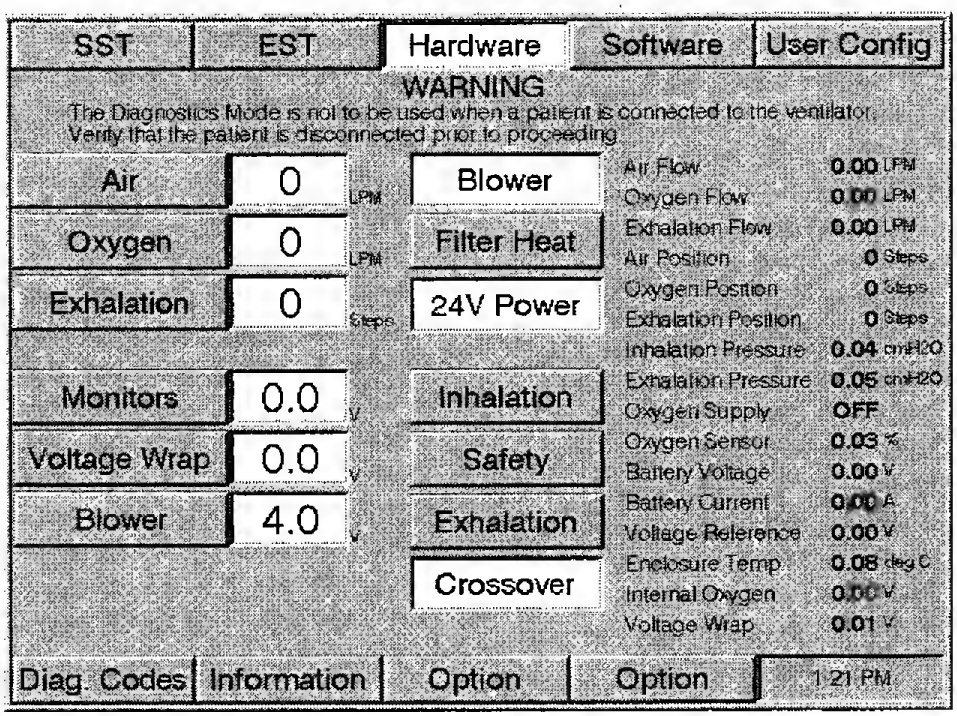


Figure 5-5: Initialized Hardware Screen

Group 2: Voltage Control

Monitors: Provides adjustable analog flow, pressure and volume voltages (from 0 - 5V) for external monitors. This allows the technician to test the flow and pressure sensor DAC voltages.

Voltage Wrap: Allows the technician to adjust the blower DAC voltage from 0 to 5V. This can be compared with the ADC output voltage which is shown in the Voltage Wrap display.

Blower: Allows the technician to adjust the blower voltage from 0 to 5V.

Group 3: On/Off

Blower: The **BLOWER** key turns the blower on and off.

Filter: The **FILTER** key turns the filter heater on and off.

24V Power: The **24V POWER** key allows the technician to turn all pneumatic components on and off simultaneously without disturbing the display.

Group 4: Solenoids

Inhalation: The **INHALATION** key opens and closes the solenoid (SOL 4) which pilots the inhalation pressure sensor.

Safety: The **SAFETY** key opens and closes the solenoid (SOL 2) which pilots the safety valve.

Exhalation: The **EXHALATION** key opens and closes the solenoid (SOL 3) which pilots the exhalation pressure sensor.

Crossover: The **CROSSOVER** key opens and closes the crossover solenoid (SOL 1) which pilots the safety valve with air or oxygen through the safety solenoid.

5.8 Status Displays

The displays located on the right side of the screen provide real time feedback on the status of various flows, pressures, voltages and temperatures as measured by the internal flow, pressure, voltage and temperature sensors (see Figure 5-5).

Air Flow: Displays the measurement of flow passing through the air flow sensor.

Oxygen Flow: Displays the measurement of flow passing through the oxygen flow sensor.

Exhalation Flow: Displays the measurement of flow passing through the exhalation flow sensor.

Air Position: Displays the position (in steps) of the blower (air) valve for the established flow.

Oxygen Position: Displays the position (in steps) of the oxygen valve for the established flow.

Exhalation Position: Displays the position (in steps) of the exhalation valve.

Inhalation Pressure: Displays the pressure measured by the inhalation pressure sensor.

Exhalation Pressure: Displays the pressure measured by the exhalation pressure sensor.

Oxygen Supply: Oxygen inlet pressure switch verifies that an external oxygen source is connected to the ventilator.

Oxygen Sensor: Displays the oxygen concentration as measured by the external oxygen sensor.

Battery Voltage: Displays back-up or external battery voltage.

Voltage Reference: Reference voltage for the DAC.

Enclosure Temp.: Displays the temperature inside the enclosure as measured by the temperature sensor located on the Sensor PCBA.

Internal Oxygen: Displays the oxygen concentration within the enclosure in volts as measured by the oxygen sensor located on the Sensor PCBA.
Voltage Wrap: Provides a cross reference of the A/D voltage to the blower DAC voltage.

5.9 Software Download Instructions

The Esprit Ventilator contains Non-Volatile memory which allows the software to be upgraded electronically with a Personal Computer (PC) or laptop computer.

5.9.1 Downloading Software into the Ventilator

1. Turn PC ON and ventilator OFF.
2. Double-click on the SETUP.EXE icon on the PC to access the software download program (see Figure 5-6).

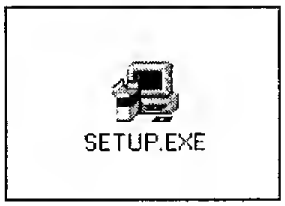


Figure 5-6: Software Download Icon

3. An introduction screen will appear on the PC (see Figure 5-7). Click on NEXT to continue or CANCEL to abort the program.

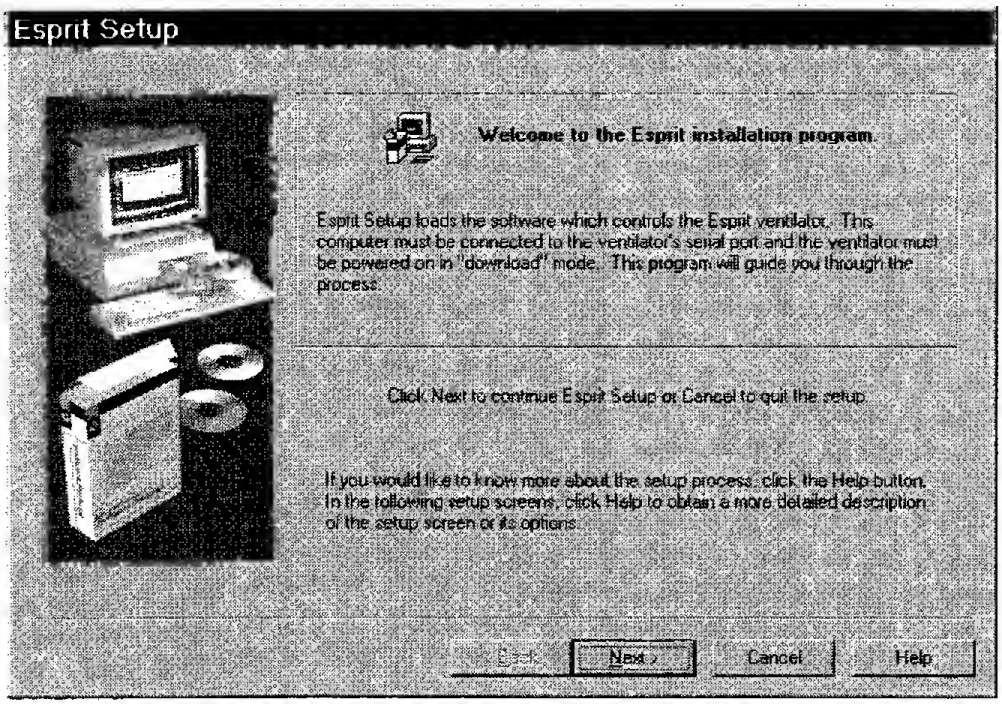


Figure 5-7: Software Download Intro Screen

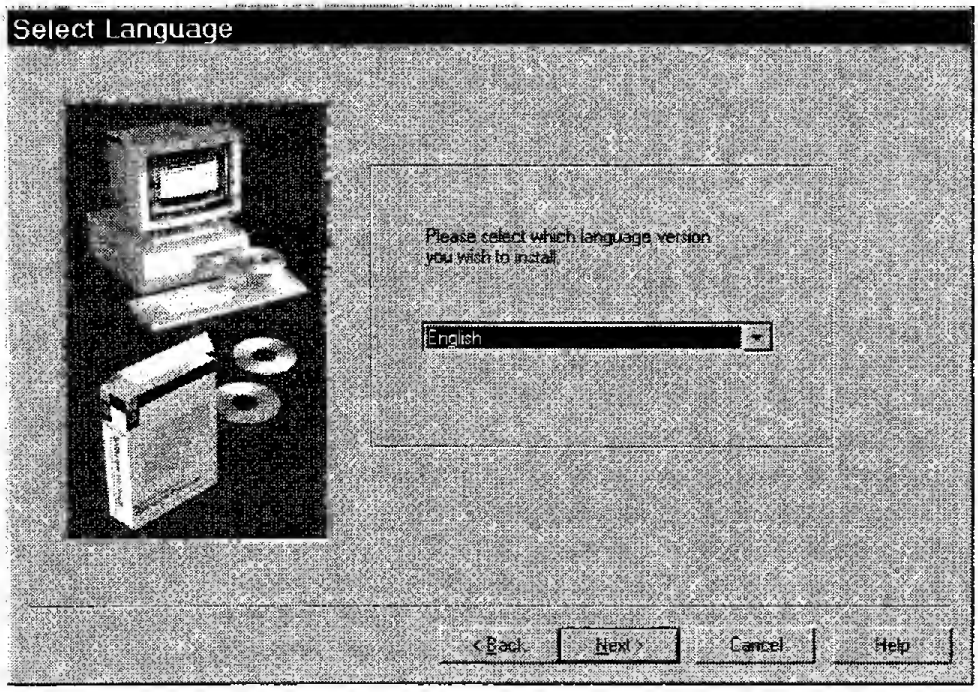


Figure 5-8: Software Download Language Screen

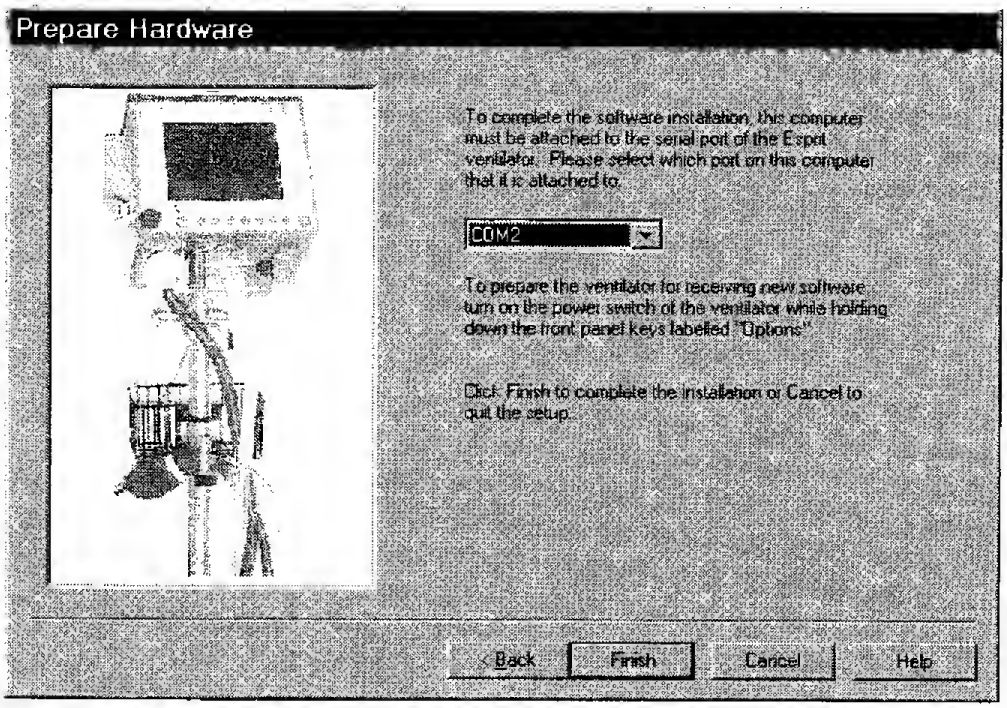


Figure 5-9: Software Download COM Port Screen

4. Choose the language then click NEXT (see Figure 5-8).
5. Connect the Standard RS-232 Null Modem Cable between the serial port of the PC and the serial port of the ventilator.
6. Specify which port is being used on the PC (see Figure 5-9).
7. Simultaneously press both **OPTION** keys on the ventilator console for 5 seconds while turning the ventilator ON, then click FINISH on the PC (see Figure 5-9).

   Note: The download sequence will begin. In approximately 10 minutes the PC will display a completion message indicating that the software has been successfully downloaded.

8. After a successful download, the ventilator will automatically reboot. The ventilator screen will display the following messages and then enter the Diagnostics Mode.

   - Initializing memory, please wait
   - Initialization Complete
   - Programming flow sensor tables, please wait .
   - Programming Complete

   If there is a communication problem between the PC and the ventilator, the following message will appear (see Figure 5-10). Check the cable connection then try the download sequence again.

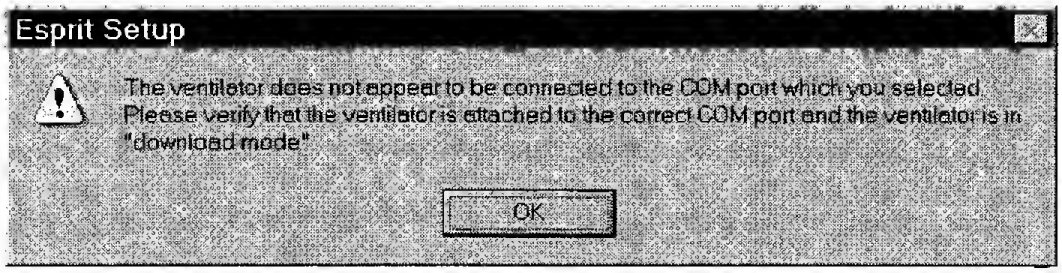


Figure 5-10: Software Download Communication Error

9. When the download is complete, click **OK** on the PC screen.
10. Touch the **SOFTWARE** key on the ventilator screen.
11. ***Check*** that the *Flash Version* is the same as the version in your PC.
12. Set the Altitude per Section 5.2.3.
13. Enable the Complaince factor per Section 5.2.4.
14. Disconnect the serial cable from the ventilator.
15. Perform an EST.

5.10 Pneumatic Component Troubleshooting

The following tests are intended to facilitate component troubleshooting in the event of a Short Self Test failure, an Extended Self Test failure or a Performance Verification failure. They are not intended to be run in consecutive order like the tests in the Performance Verification, but only as needed.

WARNING: Never troubleshoot while a patient is connected to the ventilator since normal operation is suspended.

WARNING: Explosion hazard. Do not operate the ventilator in the presence of flammable anesthetic agents.

All troubleshooting is to be performed from the Hardware screen within the ventilator diagnostic mode. To access the Hardware screen:

1. Simultaneously press the **ALARM RESET** and **100% O2** keys on the ventilator console for 5 seconds while turning ventilator power on.
2. When prompted, touch the **OK** key to enter the diagnostics mode.

   Note: Always perform an EST and log diagnostic codes before troubleshooting.

3. Perform an EST and log the diagnostic codes.
4. Touch the **HARDWARE** key to access the hardware screen.

NOTE:

- **It is assumed that each of the following tests will begin in an initialized state; i.e. all adjustable parameters set to zero, Blower voltage set to 4V (the Blower voltage may vary depending upon the altitude setting), Blower (ON), Filter (OFF) 24V Power (ON), Crossover solenoid (energized) (white) and all other solenoids de-energized (gray) (see Figure 5-5).**
- **At the end of each test be sure to return the screen to its initialized state (see Figure 5-5).**

5.10.1 Oxygen Valve

1. Connect a wall or bottled oxygen source to the ventilator.
2. Disconnect the bacteria filter, patient circuit tube and oxygen sensor tee from the ventilator inspiratory outlet.
3. Touch the **USER CONFIG** key and note the altitude.
4. Touch the **HARDWARE** key.
5. Energize the **SAFETY** solenoid (white).
6. Set the **OXYGEN** flow to 1 LPM.
7. ***Check*** that the Oxygen Position display reads 185 to 425 steps.
8. Set the **OXYGEN** flow to 180 LPM.
9. ***Check*** that the Oxygen Position display is within the proper range per Table 6-3 in Chapter 6.
10. Disconnect the oxygen source from the ventilator.
11. Set the **OXYGEN** flow to 100 LPM and then back to 0 LPM to relieve any trapped O2 pressure.
12. Return screen to its original configuration (see Figure 5-5).

5.10.2 Oxygen Flow Sensor

1. Connect a wall or bottled oxygen source to the ventilator.
2. Connect RT-200 High Flow Range port to the ventilator per Figure 6-5 (Chapter 6).
3. Set RT-200 Peak/Continuous function to CONTINUOUS.
4. Set RT-200 High Range Gas Flow to 180 LPM O2. Zero the RT-200.
5. Energize the **SAFETY** solenoid (white).
6. Set **OXYGEN** flow to 20 LPM.
7. ***Check*** that the RT-200 display and the ventilator Oxygen Flow display reads 18 to 22 LPM
8. Set **OXYGEN** flow to 50 LPM.
9. ***Check*** that the RT-200 display and the ventilator Oxygen Flow display reads 45 to 55 LPM
10. Set **OXYGEN** flow to 100 LPM.
11. ***Check*** that the RT-200 display and the ventilator Oxygen Flow display reads 90 to 110 LPM.
12. Set **OXYGEN** flow to 120 LPM.
13. ***Check*** that the RT-200 display and the ventilator Oxygen Flow display reads 108 to 132 LPM
14. Set **OXYGEN** flow to 165 LPM.
15. ***Check*** the RT-200 display and the ventilator Oxygen Flow display reads 148.5 to 181.5 LPM.
16. Set **OXYGEN** flow to 0 LPM.
17. ***Check*** that the RT-200 display and the ventilator Oxygen Flow display reads 0 $\pm$ 0.1 LPM
18. Disconnect the oxygen source from the ventilator.
19. Set the **OXYGEN** flow to 100 LPM and then back to 0 LPM to relieve any trapped O2 pressure.
20. Return screen to its original configuration (see Figure 5-5).

5.10.3 Oxygen Regulator

1. Disconnect the bacteria filter, patient circuit tube and oxygen sensor tee from the ventilator inspiratory outlet.
2. Connect a wall or bottled oxygen source to the ventilator.
3. Set RT-200 Peak/Continuous function to CONTINUOUS.
4. Set RT-200 High Pressure Range to 100 PSI. Zero the RT-200.
5. Connect RT-200 Positive High Pressure Port to the Oxygen Valve pressure port (see Figure 5-11).

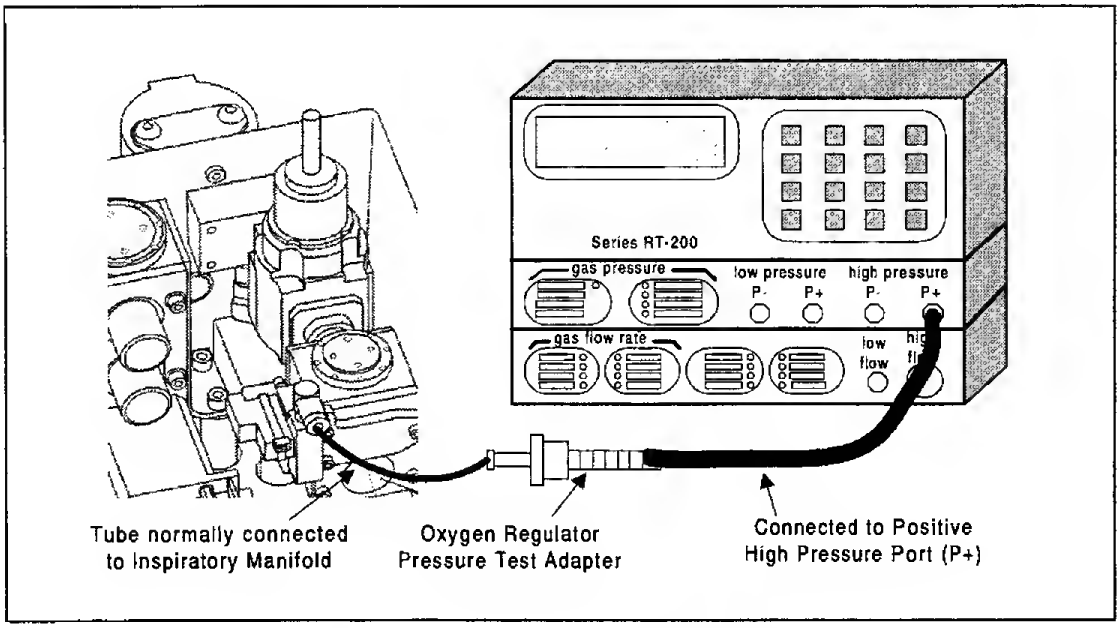


Figure 5-11: Oxygen High Pressure Connection

6. De-energize the **BLOWER** (On/Off) (gray).
7. De-energize the **CROSSOVER** solenoid (gray).
8. Set **OXYGEN** flow to 180 LPM.
9. ***Check*** that the RT-200 display reads 23 ± 1 PSI. If not, adjust the oxygen regulator pressure:
   a. Loosen the locking nut.
   b. Turn the adjusting shaft clockwise to increase or counterclockwise to decrease then tighten the locking nut.
   c. Set **OXYGEN** flow to 0 LPM then back to 180 LPM.
   d. ***Check*** that the regulator pressure is still 23 ± 1 PSI. Repeat steps a – d if necessary.
10. Disconnect the oxygen source from the ventilator.
11. Set the **OXYGEN** flow to 100 LPM and then back to 0 LPM to relieve any trapped O2 pressure.
12. Return screen to its original configuration (see Figure 5-5).

5.10.4 Air Valve

1. Disconnect the bacteria filter, patient circuit tube and oxygen sensor tee from the ventilator inspiratory outlet.
2. Touch the **USER CONFIG** key and note the altitude.

3. Touch the **HARDWARE** key.
4. Energize the **SAFETY** solenoid (white).
5. Set **AIR** flow to 1 LPM.
6. ***Check*** that the Air Position display reads 215 to 425 steps.
7. Set **AIR** flow to 180 LPM.
8. ***Check*** that the Air Position display is within the proper range per Table 6-3 in Chapter 6.
9. Return screen to its original configuration (see Figure 5-5).

5.10.5 Air Flow Sensor

1. Connect RT-200 High Flow Range port to the ventilator per Figure 6-5 (Chapter 6).
2. Set RT-200 Peak/Continuous function to CONTINUOUS.
3. Select RT-200 High Range Gas Flow setting for 180 LPM Air. Zero the RT-200.
4. Energize the **SAFETY** solenoid (white).
5. Set **AIR** flow to 20 LPM.
6. ***Check*** that the RT-200 display and the ventilator Air Flow display reads 18 to 22 LPM
7. Set **AIR** flow to 50 LPM.
8. ***Check*** that the RT-200 display and the ventilator Air Flow display reads 45 to 55 LPM
9. Set **AIR** flow to 100 LPM.
10. ***Check*** that the RT-200 display and the ventilator Air Flow display reads 90 to 110 LPM.
11. Set **AIR** flow to 120 LPM.
12. ***Check*** that the RT-200 display and the ventilator Air Flow display reads 108 to 132 LPM
13. Set **AIR** flow to 165 LPM.
14. ***Check*** that the RT-200 display and the ventilator Air Flow display reads 148.5 to 181.5 LPM.
15. Set **AIR** flow to 0 LPM.
16. ***Check*** that the RT-200 display and the ventilator Air Flow display reads 0 $\pm$ 0.1 LPM
17. Return screen to its original configuration (see Figure 5-5).

5.10.6 Inhalation and Exhalation Solenoids

1. Connect the patient circuit to the ventilator and block the wye with cork.
2. Energize the **SAFETY** solenoid (white).
3. Set **EXHALATION** valve to 2000 steps.
4. Set **AIR** flow to 2 LPM.
5. ***Check*** that the pressure on the Inhalation Pressure and Exhalation Pressure displays increases to greater than 30 cmH2O.
6. Energize the **INHALATION** solenoid (white).
7. ***Check*** that the Inhalation Pressure display reads 0 $\pm$ 0.1 cmH2O.
8. Energize the **EXHALATION** solenoid (white).
9. ***Check*** that the Exhalation Pressure display reads 0 $\pm$ 0.1 cmH2O.
10. Return screen to its original configuration (see Figure 5-5).

5.10.7 Safety Valve and Safety Solenoid

1. Connect the patient circuit to the ventilator and block the wye with cork.
2. Set **EXHALATION** valve to 2000 steps.
3. Set **AIR** flow to 2 LPM.
4. ***Check*** that the Inhalation Pressure display reads 0 $\pm$ 0.1 cmH2O.
5. Energize the **SAFETY** solenoid (white).

6. ***Check*** that the pressure on the Inhalation Pressure display is greater than 30 cmH2O.
7. Return screen to its original configuration (see Figure 5-5).

5.10.8 Pressure Relief Valve

1. Set the RT-200 Low Pressure Range to 250 cmH2O. Zero the RT-200.
2. Set RT-200 Peak/Continuous function to CONTINUOUS.
3. Connect the RT-200 Low Positive Pressure Range port to the patient circuit per Figure 6-2 (Chapter 6).
4. Remove the test lung then block the wye.
5. Energize the **SAFETY** solenoid (white).
6. Set **EXHALATION** valve to 2000 steps.
7. Set **AIR** flow to 2 LPM.
8. ***Check*** that the pressure on the RT-200 increases to 130 – 140 cmH2O. If not, adjust the relief pressure:
   a. Turn the pressure relief valve hex cap clockwise to decrease or counterclockwise to increase pressure.
   b. Once the target pressure is achieved, disconnect the test lung to relieve system pressure then reconnect it.
   c. ***Check*** that the pressure on the RT-200 increases to 130 – 140 cmH2O. Repeat steps a – c as necessary.
9. Return screen to its original configuration (see Figure 5-5).

5.10.9 Crossover Solenoid

1. Disconnect the oxygen source from ventilator.
2. Set the **OXYGEN** flow to 100 LPM and then back to 0 LPM to relieve any trapped O2 pressure.
3. Connect patient circuit to ventilator and block wye with a cork.
4. Energize the **SAFETY** solenoid (white).
5. Set **EXHALATION** valve to 2000 steps.
6. Set **AIR** flow to 2 LPM.
7. ***Check*** that the pressure in the Inhalation Pressure display increases to greater than 30 cmH2O.
8. Remove cork from the wye.
9. De-energize the **CROSSOVER** solenoid (gray), then block the wye.
10. ***Check*** that the Inhalation Pressure display reads 0 ± 0.1 cmH2O.
11. Return screen to its original configuration (see Figure 5-5).

5.10.10 Exhalation Flow Sensor

1. Connect RT-200 High Flow Range port to the ventilator per Figure 6-1 (Chapter 6).
2. Set RT-200 Peak/Continuous function to CONTINUOUS.
3. Select RT-200 High Range Gas Flow setting for 180 LPM Air. Zero the RT-200.
4. Energize the **SAFETY** solenoid (white).
5. Set **AIR** flow to 20 LPM.
6. ***Check*** that the RT-200 display and the ventilator Exhalation Flow display reads 18 to 22 LPM.
7. Set **AIR** flow to 50 LPM.
8. ***Check*** that the RT-200 display and the ventilator Exhalation Flow display reads 45 to 55 LPM.
9. Set **AIR** flow to 100 LPM.
10. ***Check*** that the RT-200 display and the ventilator Exhalation Flow display reads 90 to 110 LPM.

11. Set **AIR** flow to 120 LPM.
12. ***Check*** that the RT-200 display and the ventilator Exhalation Flow display reads 108 to 132 LPM.
13. Set **AIR** flow to 165 LPM.
14. ***Check*** the RT-200 display and the ventilator Exhalation Flow display reads 148.5 to 181.5 LPM.
15. Set **AIR** flow to 0 LPM.
16. ***Check*** that the RT-200 display and the ventilator Exhalation Flow display reads 0 ± 0.1 LPM.
17. Return screen to its original configuration (see Figure 5-5).

5.10.11 Check Valve 1

1. Disconnect the oxygen hose from the ventilator oxygen inlet port.
2. Connect patient circuit to the ventilator and block the wye.
3. Energize the **SAFETY** solenoid (white).
4. Set the **EXHALATION** valve to 2000 steps.
5. Set the **OXYGEN** flow to 200 LPM.
6. Set the **AIR** flow to 2 LPM.
7. ***Check*** that the pressure in the Inhalation Pressure display increases to greater than 30 cmH2O.
8. Apply soapy water to the ventilator oxygen inlet port. No bubbles should form.
9. Wipe oxygen inlet port dry.
10. Return screen to its original configuration (see Figure 5-5).

5.10.12 Check Valve 2

1. Connect a wall or bottled oxygen source to the ventilator.
2. Connect patient circuit to the ventilator, then block the wye.
3. Energize the **SAFETY** solenoid (white).
4. De-energize the **CROSSOVER** solenoid (gray).
5. De-energize the **BLOWER** (gray).
6. Set the **EXHALATION** valve to 2000 steps.
7. Set the **AIR** flow to 200 LPM.
8. Set the **OXYGEN** flow to 2 LPM.
9. ***Check*** that the pressure in the Inhalation Pressure display increases to greater than 30 cmH2O.
10. ***Check*** that the Air Flow display reads 0 ± 0.1 LPM.
11. Return screen to its original configuration (see Figure 5-5).

5.10.13 Check Valve 3

1. Disconnect the oxygen hose from the ventilator oxygen inlet port.
2. Unscrew the bowl from the bottom of the O2 water trap/inlet filter assembly.
3. Connect the patient circuit to the ventilator, then block the wye.
4. Energize the **SAFETY** solenoid (white).
5. Set the **EXHALATION** valve to 2000 steps.
6. Set the **AIR** flow to 2 LPM.
7. ***Check*** that the Inhalation Pressure display increases to greater than 30 cmH2O.
8. Set the **AIR** flow to 0 LPM.

9. Set the **OXYGEN** flow to 200 LPM.
10. ***Check*** that the Oxygen Flow display reads 0 ± 0.1 LPM.
11. Install the bowl back onto the O2 water trap/inlet filter assembly.
12. Return screen to its original configuration (see Figure 5-5).

5.10.14 Check Valve 4

WARNING: To prevent contamination, be sure to use two clean filters per steps 1 and 2.

1. Replace the exhalation bacteria filter with a new, clean filter.
2. Connect an adult patient tube to the exhalation bacteria filter then connect the other end to a new bacteria filter.

Note: The flow arrow on the filter should be pointing away from the ventilator.

3. **Gently** inhale from the bacteria filter.
4. ***Check*** that the Exhalation Flow display reads 0 ± 0.1 LPM.
5. Return screen to its original configuration (see Figure 5-5).

5.10.15 Filter Heater

WARNING: If the ventilator has been in operation, the heater conductor may be hot.

1. Touch the **FILTER** key to turn the filter heater ON.

NOTE: This test assumes a cool filter heater. If the ventilator has been operating in the ventilation mode, the filter heater should already be hot. If so, skip steps 1 and 2.

2. Wait 15 minutes, then remove the filter heater.
3. Remove the exhalation filter. It should be very warm to the touch.
4. Reinstall the filter and heater.
5. Return screen to its original configuration (see Figure 5-5).

5.10.16 Blower

1. Connect RT-200 High Flow Range to the ventilator per Figure 6-5 (Chapter 6).
2. Set RT-200 Peak/Continuous function to CONTINUOUS.
3. Select RT-200 High Range Gas Flow setting for 180 LPM Air. Zero the RT-200.
4. Energize the **SAFETY** solenoid (white).
5. Set the **AIR** flow to 165 LPM.
6. ***Check*** that the RT-200 reads 148.5 to 181.5 LPM.
7. Touch the **BLOWER** (On/Off) key (gray) to turn the Blower off.
8. ***Check*** that the blower stops and the RT-200 reads 0 ± 0.1 LPM.
9. Return screen to its original configuration (see Figure 5-5).

5.10.17 Inhalation and Exhalation Pressure Transducers

1. Connect patient circuit with test lung to the ventilator.

2. Connect the RT-200 Low Positive Pressure Range port to the patient circuit per Figure 6-2 (Chapter 6).
3. Set RT-200 Peak/Continuous function to CONTINUOUS.
4. Set the RT-200 Low Pressure Range to 250 cmH2O. Zero the RT-200.
5. Energize the **SAFETY** solenoid (white).
6. Set **EXHALATION** valve to 2000 steps.
7. Set **AIR** flow to 1 LPM. Immediately set the **AIR** flow to 0 LPM *but do not touch the* ***Accept*** *key.*
8. When RT-200 pressure reads 20 ± 5 cmH2O, touch the **Accept** key.
9. ***Check*** that the Inhalation Pressure and Exhalation Pressure displays read within ± 10% of the RT-200 display.
10. Set **AIR** flow to 2 LPM. Immediately set the **AIR** flow to 0 LPM *but do not touch the* ***Accept*** *key.*
11. When the RT-200 pressure reads 100 ± 5 cmH2O, touch the **Accept** key.
12. ***Check*** that the Inhalation Pressure and Exhalation Pressure displays read within ± 10% of the RT-200 pressure display.
13. Return screen to its original configuration (see Figure 5-5).

5.10.18 Oxygen Pressure Switch

1. Connect a wall or bottled oxygen source to the ventilator. The Oxygen Supply display should read ON.
2. Disconnect the oxygen source from the ventilator.
3. Set the **OXYGEN** flow to 100 LPM and then back to 0 LPM to relieve any trapped O2 pressure.
4. The **Oxygen Supply** display should read OFF.
5. Return screen to its original configuration (see Figure 5-5)

5.10.19 External Oxygen Sensor

Perform the Oxygen Percentage Test (Test 11) in the Chapter 6 Performance Verification.

6 Performance Verification

The Performance Verification (PV) verifies the integrity of the sensors and other critical components in the ventilator using external measurement devices. The entire PV should be performed:

- After every preventative maintenance servicing,
- Whenever the top enclosure is removed and a component is replaced.

6.1 Test Equipment Required

The test equipment listed in Table 6-1 is required for the performance verification.

NOTE: Check the calibration status of test equipment before using it.

Table 6-1 : Required Test Equipment

Description	Recommended Manufacturer/Model
Electrical Safety Analyzer	Ohmic Instruments SI-100 or equivalent
Pneumatic meter capable of measuring high pressure (psi), low pressure (cmH2O), flow rate (LPM), volume (Liters BTPS)	Allied Corporation RT-200 or equivalent
Oxygen analyzer	Lifecare Oxygen Analyzer/Alarm (P/N 28-001) or equivalent
Stop Watch	Local Supplier
Digital multimeter (DMM) accurate to three decimal places	Local Supplier

6.2 Service Accessories Required

The Service Accessories listed in Table 6-2 are required for the performance verification.

Table 6-2: Service Accessories Required

Description	Quantity	Part No.
*Adult Patient Circuit Tube 60" Smooth Bore	2	P/N 1001734
* Patient Circuit Wye 22 mm	1	P/N 1001738
Test Lung	1	P/N 1001737
Coupling, silicon	2	P/N 06-348
Tee, Plastic w/ silicon coupling	1	P/N 06-260
Connector, 22 mm OD	1	P/N 06-335

* Assemble these together to make an adult patient circuit.

Table 6-2: Service Accessories Required

Description	Quantity	Part No.
Rubber Cork	1	P/N 1001735
Nurses Call Test Cable	1	P/N 1001375
Oxygen Sensor Adapter	1	P/N 1001736
Tubing, silicon, 3/16" ID x 6.5 ft. PAP	1	P/N 06-686

6.3 Preliminary Ventilator Cleaning and Inspection

Before servicing the ventilator, clean and inspect it as follows:

WARNING: To prevent disease transmission, use protective equipment when handling contaminated bacterial filters or other patient accessories.

1. Remove the humidifier from the ventilator, if applicable.
2. Visually inspect the exterior of the ventilator for damage. Replace damaged parts as needed.
3. Clean the ventilator exterior per Chapter 11 of the Esprit Operator's Manual, P/N 580-1000-01.
4. Remove and inspect the Cooling Fan Filter. Clean or replace the filter if necessary per Chapter 11 of the Esprit Operator's Manual, P/N 580-1000-01.
5. Remove and inspect the Air Inlet Filter. Clean or replace the filter if necessary per Chapter 11 of the Esprit Operator's Manual, P/N 580-1000-01
6. Inspect the oxygen water trap / inlet filter. Empty water trap and replace filter if necessary.
7. Simultaneously press the **ALARM RESET** and **100% O2** keys on the console for 5 seconds while turning on the ventilator to invoke the diagnostic screen.
8. Touch the **OK** key when prompted.
9. Touch the **SOFTWARE** key on the diagnostic screen and record the ventilator configuration information on the Performance Verification Checkout Form (Section 6.8).
10. Record the time on the elapsed time meter on the Performance Verification Checkout Form (Section 6.8).
11. Turn the ventilator OFF.

6.4 Preliminary RT-200 Setup

The RT-200 should always be in BTPS when measuring volume and ATP when measuring flow. To set BTPS or ATP:

1. Press the RESET key, then press 00 and <enter>.
2. Use 0 to scroll between STD, ATP and BTPS. Press <enter> to lock selection, then press ZERO.

6.5 Performance Verification Procedures

WARNING: Explosion hazard. Do not operate the ventilator in the presence of flammable anesthetic agents.

CAUTION: Do not modify oxygen D.I.S.S. connector on rear panel. Use only Medical grade O2.

NOTES:

- **When running a complete performance verification, perform the following tests in order to ensure logical fault diagnoses.**
- **In the event of a failure, reference Section 6.7 for troubleshooting instructions.**

6.5.1 Electrical Safety Test (Test 1)

The electrical safety test verifies that the ground resistance, and forward and reverse leakage current are within specified limits.

Note: When connecting the electrical safety analyzer to the ventilator ground, use the ground lug (equipotential) at the rear of the ventilator.

1. ***Check*** that the ground resistance ≤ 0.1 Ohm.
2. ***Check*** that the cooling fan is operating properly.
3. ***Check*** that the forward and reverse leakage current is ≤ 100µA (on units connected to 100 – 120V), or ≤ 300µA (on units connected to 220 – 240V).
4. Turn the ventilator OFF.

6.5.2 Extended Self Test (Test 2)

The Extended Self Test (EST) verifies the operational integrity of the ventilator using sensors within the ventilator. For more information about EST refer to Section 5.4.

WARNING: Never initiate an EST while a patient is connected to the ventilator. The high airway pressure and gas flows generated during EST can injure a patient.

WARNING: Do not use a ventilator that has failed EST without verifying operational readiness by other means. Doing so may place a patient at risk.

NOTE: If the ventilator fails EST, repair the unit then repeat and pass EST before continuing on to Test 3. Refer to Section 5.6.4.

1. Connect a wall or bottled oxygen source to the ventilator.
2. Connect the patient circuit to the ventilator. **Attach the ventilator's external oxygen sensor and inspiratory bacteria filter.**
3. Simultaneously press the **ALARM RESET** and **100% O2** keys on the console for 5 seconds while turning on the ventilator to invoke the diagnostic screen.
4. Touch the **OK** key when prompted.
5. Touch the **EST** key on the diagnostic screen.

6. Touch the **START EST** key to begin EST, then follow the prompts on the screen. EST must pass before continuing. If EST fails, log Diag. Codes on the Performance Verification Checkout Form in Section 6.8.
7. When EST is successfully completed, touch the **USER CONFIG** key on the screen.

NOTE: The Compliance factor must be disabled during the Performance Verification.

8. The Compliance key must be gray (disabled). If it is white, touch the **COMPLIANCE** key.
9. ***Check*** that the altitude setting is accurate. If not, correct it. **Write down the altitude.** This value will be needed for Test 4 and Test 5.
10. Remain in the diagnostics mode.

6.5.3 Voltage Wrap Test (Test 3)

This test verifies that the DAC/ADC voltage wrap is within specifications.

1. Touch the **HARDWARE** key.
2. Set the **VOLTAGE WRAP** voltage to 4V.
3. ***Check*** that the Voltage Wrap display reads 4 ± 54mV.
4. Set the **VOLTAGE WRAP** voltage to 2.5V.
5. ***Check*** that the Voltage Wrap display reads 2.5 ± 52.5mV.
6. Set the **VOLTAGE WRAP** voltage to 1V.
7. ***Check*** that the Voltage Wrap display reads 1 ± 51mV.
8. Set the **VOLTAGE WRAP** voltage to 0V.
9. Remain in the diagnostic mode.

6.5.4 Air Flow Accuracy Test (Test 4)

This test verifies the accuracy of the air and exhalation flow sensors and function of the blower (air) valve.

1. Disconnect the oxygen source from the ventilator.
2. Set the RT-200 Peak/Continuous function to CONTINUOUS.
3. Set RT-200 to ATP (Refer to Section 6.4).
4. Set the RT-200 High Flow Range to 180 LPM Air Flow. Zero the RT-200.
5. Energize the **SAFETY** solenoid (white)
6. Set the **AIR** flow to 1 LPM.
7. ***Check*** that the Air Position display reads 215 to 425 steps.
8. Connect the RT-200 to the ventilator per Figure 6-1.
9. Set the **AIR** flow to 20 LPM.
10. ***Check*** that the RT-200 reads 18 to 22 LPM.
11. ***Check*** that the Air Flow and Exhalation Flow displays read 18 to 22 LPM
12. Set the **AIR** flow to 50 LPM.

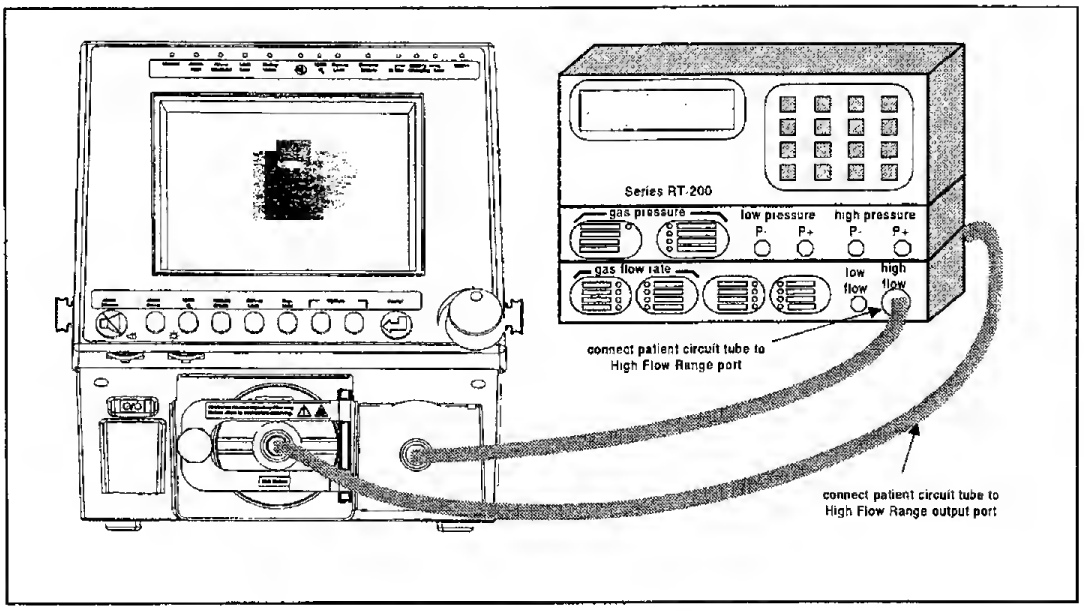


Figure 6-1: Flow Accuracy Test Configuration

13. ***Check*** that the RT-200 reads 45 to 55 LPM
14. ***Check*** that the Air Flow and Exhalation Flow displays read 45 to 55 LPM.
15. Set the **AIR** flow to 100 LPM.
16. ***Check*** that the RT-200 reads 90 to 110 LPM
17. ***Check*** that the Air Flow and Exhalation Flow displays read 90 to 110 LPM.
18. Set the **AIR** flow to 120 LPM.
19. ***Check*** that the RT-200 reads 108 to 132 LPM
20. ***Check*** that the Air Flow and Exhalation Flow displays read 108 to 132 LPM.
21. Set the **AIR** flow to 165 LPM.
22. ***Check*** that the RT-200 reads 148.5 to 181.5 LPM
23. ***Check*** that the Air Flow and Exhalation Flow displays read are 148.5 to 181.5 LPM.
24. Set the **AIR** flow to 0 LPM.
25. ***Check*** that the RT-200 reads 0 to 0.1 LPM
26. ***Check*** that the Air Flow and Exhalation Flow displays read 0 $\pm$ 0.1 LPM.
27. Disconnect the tube from the ventilator inspiratory outlet.
28. Set the **AIR** flow to 180 LPM.
29. ***Check*** that the Air Position display is within the proper range per Table 6-3
30. ***Check*** that the Internal Oxygen display reads 553 to 583 mV.
31. Set the **AIR** flow to 0 LPM.
32. Remain in the diagnostic mode.

Table 6-3 : Blower Valve and Oxygen Valve Step Ranges at 180 LPM

Altitude Setting on Ventilator	Air Position Display	Oxygen Position Display
0 – 2000 ft.	930 – 1215 steps	1175 – 1525 steps
2001 – 4000 ft.	910 – 1190 steps	1145 – 1490 steps
4001 – 6000 ft.	890 – 1165 steps	1120 – 1455 steps
6001 – 8000 ft.	875 – 1145 steps	1090 – 1420 steps
8001 – 10,000 ft.	855 – 1125 steps	1060 – 1385 steps

6.5.5 Oxygen Flow Accuracy Test (Test 5)

This test verifies the accuracy of the oxygen flow sensor and function of the oxygen valve.

1. Reconnect the oxygen source to the ventilator.
2. Set the RT-200 High Flow Range to 180 LPM O2 Flow. Zero the RT-200.
3. Set the **OXYGEN** flow to 1 LPM.
4. ***Check*** that the Oxygen Position display reads 185 to 425 steps.
5. Connect the RT-200 to the ventilator per Figure 6-1.
6. Set the **OXYGEN** flow to 20 LPM.
7. ***Check*** that the RT-200 reads 18 to 22 LPM.
8. ***Check*** that the Oxygen Flow display reads 18 to 22 LPM.
9. Set the **OXYGEN** flow to 50 LPM.
10. ***Check*** that the RT-200 reads 45 to 55 LPM
11. ***Check*** that the Oxygen Flow display reads 45 to 55 LPM.
12. Set the **OXYGEN** flow to 100 LPM.
13. ***Check*** that the RT-200 reads 90 to 110 LPM
14. ***Check*** that the Oxygen Flow display reads 90 to 110 LPM.
15. Set the **OXYGEN** flow to 120 LPM.
16. ***Check*** that the RT-200 reads 108 to 132 LPM
17. ***Check*** that the Oxygen Flow display reads 108 to 132 LPM.
18. Set the **OXYGEN** flow to 165 LPM.
19. ***Check*** that the RT-200 reads 148.5 to 181.5 LPM
20. ***Check*** that the Oxygen Flow display reads are 148.5 to 181.5 LPM.
21. Set the **OXYGEN** flow to 0 LPM.
22. ***Check*** that the RT-200 reads 0 to 0.1 LPM
23. ***Check*** that the Oxygen Flow display reads 0 $\pm$ 0.1 LPM.
24. Disconnect the tube from the ventilator inspiratory outlet.
25. Set the **OXYGEN** flow to 180 LPM.
26. ***Check*** that the Oxygen Position display is within the proper range per Table 6-3.
27. Set the **OXYGEN** flow to 0 LPM.
28. Remain in the diagnostic mode.

6.5.6 Pressure Accuracy Test (Test 6)

This test verifies the accuracy of the inhalation and exhalation pressure transducers.

Note: The steps are time dependent. Review steps prior to execution.

1. Connect the RT-200 to the ventilator per Figure 6-2.
2. Set the RT-200 Low Pressure Range to 250 cmH2O Low Pressure. Zero the RT-200.
3. Set the **EXHALATION** valve to 2000 steps.
4. Set the **AIR** flow to 1 LPM. Immediately set the air flow to 0 LPM *but do not touch the* ***Accept*** *key.*
5. When pressure on the RT-200 builds to 20 ± 5 cmH2O, touch the **Accept** key.
6. ***Check*** that the Inhalation Pressure and Exhalation Pressure displays read ± 10% of the reading on the RT-200.
7. Remove the test lung and plug the tee.
8. Set the **AIR** flow to 1 LPM. Immediately set the air flow to 0 LPM *but do not touch the* ***Accept*** *key.*
9. When pressure on the RT-200 builds to 100 ± 5 cmH2O, touch the **Accept** key.
10. ***Check*** that the Inhalation Pressure and Exhalation Pressure displays read ± 10% of the reading on the RT-200.
11. ***Check*** that the Internal Oxygen display reads ≤ 583 mV.
12. Turn the ventilator OFF. Unplug the tee and reconnect the test lung. Do not disconnect the patient circuit.

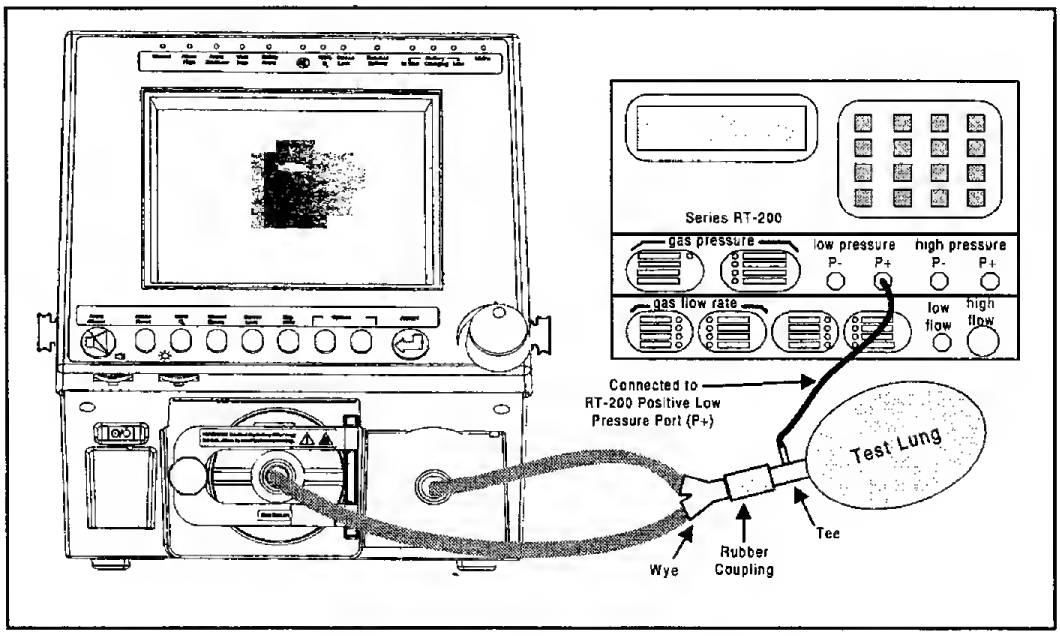


Figure 6-2: Pressure Accuracy Test Configuration

6.5.7 PEEP System Test (Test 7)

This test verifies the integrity of the PEEP system.

1. Turn the ventilator ON.

NOTE: The ventilator must be in Volume Ventilation (Assist/Control mode). This is indicated by the message "ACTIVE MODE: VOLUME - A/C" which appears in the upper left-hand corner of the screen.

2. Configure the ventilator per Figure 6-3 and Figure 6-4.
3. Set the RT-200 Low Pressure Range to 20 cmH2O. Zero the RT-200.
4. Set the **RATE** to 1 BPM.
5. Touch the **PATIENT DATA** key. Reset any alarms if necessary.
6. Press the **MANUAL BREATH** key and wait for the breath to complete. Repeat 3 times.
7. During exhalation, ***check*** that the RT-200 display and the End. Exp. Pressure display reads 4.5 to 5.5 cmH2O.
8. Touch the **VCV SETTINGS** key and set **PEEP** to 10 cmH2O.
9. Touch the **PATIENT DATA** key.
10. Press the **MANUAL BREATH** key and wait for the breath to complete. Repeat 3 times.
11. During exhalation, ***check*** that the RT-200 display and the End. Exp. Pressure display reads 9 to 11 cmH2O.
12. Disconnect the patient pressure tube from the RT-200 then set the RT-200 Low Pressure Range to 250 cmH2O. Zero the RT-200, then reconnect the pressure tube to the RT-200.
13. Touch the **VCV SETTINGS** key and set **PEEP** to 35 cmH2O.
14. Touch the **PATIENT DATA** key. Reset any alarms if necessary.
15. Press the **Manual Breath** key and wait for the breath to complete. Repeat 3 times.
16. During exhalation, ***check*** that the RT-200 display and the End. Exp. Pressure display reads 31.5 to 38.5 cmH2O.

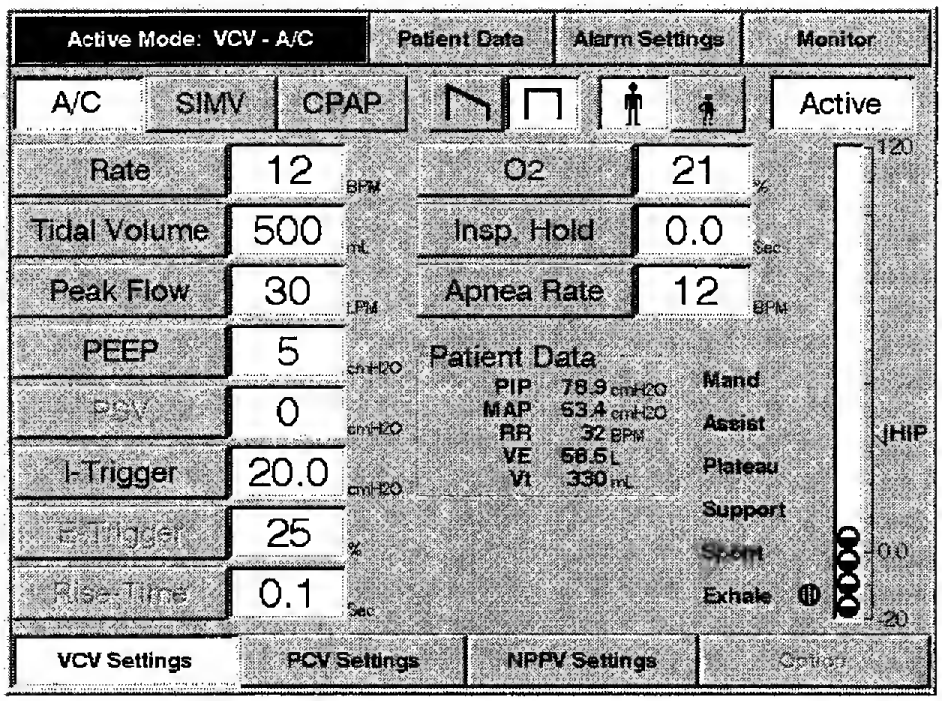


Figure 6-3: Ventilator Parameter Settings

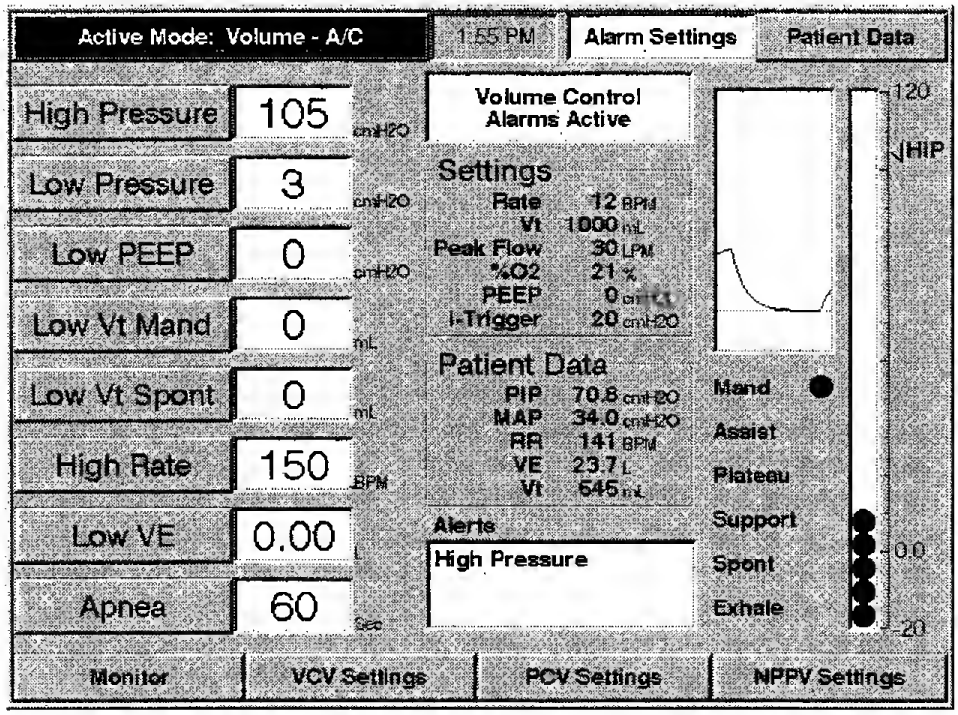


Figure 6-4: Alarm Limit Settings

6.5.8 Alarm Volume Control and Nurses Call Test (Test 8)

This test verifies the performance of the alarm volume control and nurse's call alarm.

1. Rotate the alarm volume control knob fully counterclockwise.
2. Configure the ventilator per Figure 6-3 and Figure 6-4.
3. Set the DMM to measure resistance.
4. Connect the black wire to the common port and the red wire to the Ω port on the DMM.
5. Connect the Nurse Call Test Cable to the nurse's call jack at the rear of the ventilator.
6. ***Check*** that no ventilator alarms are active (press the Alarm Reset key if necessary) and the DMM reads infinite resistance (open circuit).
7. Remove the red wire from the DMM and connect the white wire in its place.
8. ***Check*** that no ventilator alarms are active (press the Alarm Reset key if necessary) and the DMM reads 0 Ω (closed circuit).
9. Disconnect the test lung from the wye to create a Low Pressure alarm.
10. Slowly rotate the alarm volume control knob clockwise.
11. ***Check*** that the alarm volume steadily increases as the knob is rotated.
12. ***Check*** that the DMM reads infinite resistance (open circuit).
13. Remove the white wire from the DMM and connect the red wire in its place.
14. ***Check*** that the DMM reads 0 Ω (closed circuit).
15. Replace the test lung on the wye.
16. ***Check*** that the audio alarm is automatically silenced.
17. Remove the adapter from the nurse's call jack.

6.5.9 Maximum Flow Delivery Test (Test 9)

This test verifies that the ventilator is able to deliver at least 140 LPM of air and oxygen.

1. Configure the ventilator per Figure 6-3 and Figure 6-4.
2. Connect the RT-200 to the ventilator as shown in Figure 6-5.
3. Set the RT-200 Peak/Continuous function to PEAK.
4. Set the RT-200 High Flow Range for 180 LPM Air Flow. Zero the RT-200 during exhalation.
5. Set the **PEAK FLOW** to 140 LPM.
6. Set the **TIDAL VOLUME** to 2500 ml.
7. When the ventilator delivers a breath ***check*** that the RT-200 reads 126 to 154 LPM.
8. Set the **O2%** to 100.
9. Set the RT-200 High Flow Range for 180 LPM oxygen flow. Zero the RT-200.
10. When the ventilator delivers a breath ***check*** that the RT-200 reads 126 to 154 LPM.
11. Leave the RT-200 attached.

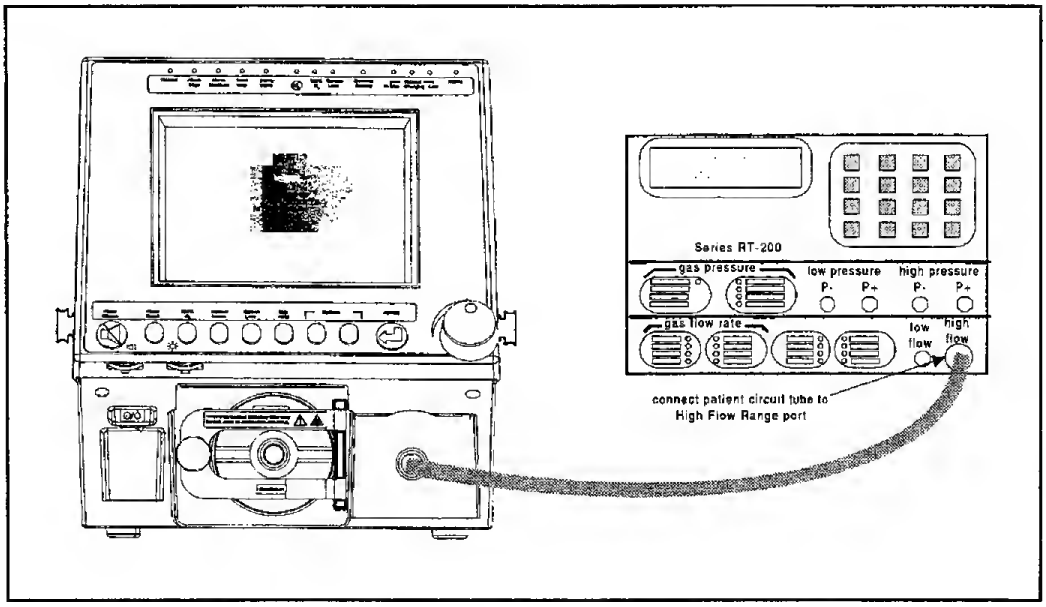


Figure 6-5: Maximum Flow Test Configuration

6.5.10 Gas Volume Accuracy Test (Test 10)

This test verifies the accuracy of the tidal volume delivered to the patient.

1. Configure the ventilator per Figure 6-3 and Figure 6-4.
2. Set **PEAK FLOW** to 60 LPM.
3. Set **TIDAL VOLUME** to 1000 ml.
4. Set RT-200 to BTPS (see Section 6.4).
5. Set the RT-200 Peak/Continuous function to CONTINUOUS.
6. Set the RT-200 Volume Range for 3 L Air Volume. Zero the RT-200 during exhalation.
7. After three breaths, ***check*** that the RT-200 reads .90 to 1.10 L.
8. Change flow pattern to **Ramp**.
9. After three breaths, ***check*** that the RT-200 reads .90 to 1.10 L.
10. Set the **PEAK FLOW** to 30 LPM.
11. Set the **TIDAL VOLUME** to 250 ml.
12. After three breaths, ***check*** that the RT-200 reads .22 to .28 L.
13. Change flow pattern to **SQUARE.**
14. After three breaths, ***check*** that the RT-200 reads .22 to .28 L.
15. Set the **PEAK FLOW** to 140 LPM.
16. Set the **TIDAL VOLUME** to 2500 ml.
17. After three breaths, ***check*** that the RT-200 reads 2.25 to 2.75 L.
18. Change flow pattern to **RAMP**.
19. After three breaths, ***check*** that the RT-200 reads 2.25 to 2.75 L.
20. Set the RT-200 Volume Range to 3 L O2 Volume. Zero the RT-200 during exhalation.
21. Set the **O2** percentage to 100%.
22. After five breaths, ***check*** that the RT-200 reads 2.25 to 2.75 L.
23. Change flow pattern to **SQUARE**.
24. After three breaths, ***check*** that the RT-200 reads 2.25 to 2.75 L.
25. Set the **PEAK FLOW** to 60 LPM.

26. Set the **TIDAL VOLUME** to 1000 ml.
27. After three breaths, ***check*** that the RT-200 reads .90 to 1.10 L.
28. Change flow pattern to **RAMP**.
29. After three breaths, ***check*** that the RT-200 reads .90 to 1.10 L.
30. Set the **TIDAL VOLUME** to 250 ml.
31. Set the **PEAK FLOW** to 30 LPM.
32. After three breaths, ***check*** that the RT-200 reads .22 to .28 L.
33. Change flow pattern to **SQUARE**.
34. After three breaths, ***check*** that the RT-200 reads .22 to .28 L.

6.5.11 Oxygen Accuracy Test (Test 11)

This test verifies the accuracy of the percentage of oxygen delivered to the patient.

1. Calibrate the external oxygen monitor.
2. Remove the inspiratory bacteria filter from the ventilator.
3. Connect the external oxygen monitor in series with the ventilator oxygen sensor per Figure 6-6.
4. Configure the ventilator per Figure 6-3 and Figure 6-4.

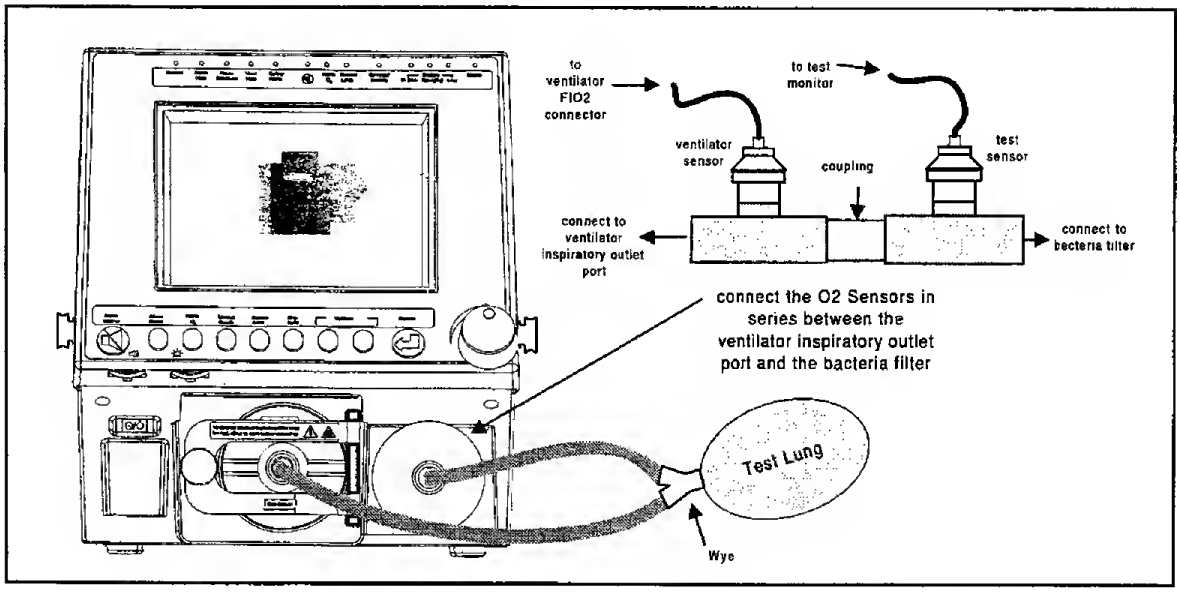


Figure 6-6: External Oxygen Sensor Connection

5. Set **APNEA RATE** to 15 BPM.
6. Set the **RATE** to 15 BPM.
7. Touch the **PATIENT DATA** key.
8. After 10 breaths, ***check*** that the external oxygen test monitor reads 18 to 24%.
9. ***Check*** that the O2 display on the ventilator Patient Data screen reads 18 to 24%.
10. Touch the **VCV SETTINGS** key and set the **O2%** to 30.
11. Touch the **PATIENT DATA** key.
12. After 5 breaths, ***check*** that the external oxygen test monitor reads 27 to 33%.
13. ***Check*** that the O2 display on the ventilator Patient Data screen reads 27 to 33%.
14. Touch the **VCV SETTINGS** key and set the **O2%** to 60.
15. Touch the **PATIENT DATA** key.

16. After 5 breaths, ***check*** that the external oxygen test monitor reads 57 to 63%.
17. ***Check*** that the O2 display on the ventilator Patient Data screen reads 57 to 63%.
18. Touch the **VCV SETTINGS** key and set the **O2%** to 80.
19. Touch the **PATIENT DATA** key.
20. After 5 breaths, ***check*** that the external oxygen test monitor reads 77 to 83%.
21. ***Check*** that the O2 display on the ventilator Patient Data screen reads 77 to 83%.
22. Touch the **VCV SETTINGS** key and set the **O2%** to 100.
23. Touch the **PATIENT DATA** key.
24. After 5 breaths, ***check*** that the external oxygen test monitor reads 97 to 103%.
25. ***Check*** that the **O2** display on the ventilator Patient Data screen reads 97 to 103%.

6.5.12 Heated Exhalation Bacteria Filter Test and Power Fail Alarm (Test 12)

This test verifies the integrity of the exhalation filter heater system and the power fail alarm.

WARNING: Use caution when removing the filter since the heater conductor could be hot.

1. With the ventilator turned ON, unplug the power cord from the AC outlet.
2. ***Check*** that the audible alarm sounds and start the stopwatch.
3. Remove the exhalation bacteria filter from the ventilator.
4. ***Check*** that it is warm to the touch.
5. Reinstall the exhalation bacteria filter.
6. ***Check*** that the audible alarm is still sounding after 2 minutes.
7. Turn ventilator power switch OFF.
8. ***Check*** that the audible alarm was silenced.
9. Plug the ventilator into an AC outlet.

6.6 Returning Ventilator to Operation

After a successful Performance Verification return the ventilator to an operational state.

1. Remove all test equipment, tools and materials from ventilator.
2. Enter the diagnostic mode by simultaneously pressing the **ALARM RESET** and **100% O2** keys on the console for approximately 5 seconds while turning ventilator power on.
3. Touch the **OK** key when prompted.
4. Touch the **USER CONFIG** key on the screen.
5. Touch the **COMPLIANCE** key to change it back to white (enabled).
6. ***Check*** that the altitude, time and date are set properly. If not, adjust per Sections 5.2.1., 5.2.2. and 5.2.3.
7. Rerun electrical safety tests (Test 1) if any repairs were made.
8. Reconnect the original patient circuit and inspiratory bacteria filter to the ventilator.
9. Run an EST.
10. Turn ventilator OFF.

6.7 Performance Verification Troubleshooting/Repair

The following troubleshooting procedures are to be used in the event of a test failure during the Performance Verification procedure. It is assumed that the external measurement devices such as the RT-200, are calibrated and functioning properly.

CAUTION: Troubleshooting and repair should be performed only by a qualified service technician.

6.7.1 Test 1: Electrical Safety Test

Step Failed	Recommended Repair
1	1. Try another AC outlet. 2. Check for secure connections of AC Mains ground wires on the AC Distribution Panel and Power Supply. 3. Check for visible damage to the power cord. Replace if necessary.
2	1. Check that the fan wires are properly seated in connector J2 on the Blower Controller PCBA. 2. Replace the Fan. 3. Replace the Motor Controller PCBA.
3	1. Check that all peripheral devices such as humidifiers are disconnected from the ventilator. 2. Check for secure connections of AC Mains ground wires on the AC Distribution Panel and Power Supply. 3. Check for visible damage to the power cord. Replace if necessary. 4. Replace Power Supply.

6.7.2 Test 2: Extended Self Test

Refer to Section 5.6.2 for EST repairs.

6.7.3 Test 3: Voltage Wrap Test

Step Failed	Recommended Repair
3, 5, 7	1. Replace Analog PCBA. 2. Replace Sensor PCBA 3. Replace CPU PCBA. 4. Replace the Main PCBA.

6.7.4 Test 4: Air Flow Accuracy Test

Step Failed	Recommended Repair
7, 29	1. Confirm correct altitude setting. 2. Check that nothing is connected to the ventilator inspiratory outlet. 3. Replace Air Motor Controller PCBA. 4. Replace Air Valve Assembly.
10, 11, 13, 14, 16, 17, 19, 20, 22, 23, 25, 26	1. Replace Air Flow Sensor if air flow is out of range, or Exhalation Flow Sensor if exhalation flow is out of range. 2. Replace Sensor PCBA. 3. Replace Analog PCBA. 4. Replace Air Motor Controller PCBA. 5. Replace Air Valve Assembly.
30	1. Replace Sensor PCBA 2. Replace Analog PCBA. 3. Replace Main PCBA.

6.7.5 Test 5: Oxygen Flow Accuracy Test

Step Failed	Recommended Repair
4, 26	1. Confirm correct altitude setting. 2. Check that nothing is connected to the ventilator inspiratory outlet. 3. Check and adjust, if necessary, Oxygen Regulator pressure per Section 5.10.3. 4. Replace Oxygen Motor Controller PCBA. 5. Replace Oxygen Valve Assembly.
7, 8, 10, 11, 13, 14, 16, 17, 19, 20, 22, 23	1. Replace Oxygen Flow Sensor. 2. Replace Sensor PCBA. 3. Replace Analog PCBA 4. Replace Oxygen Motor Controller PCBA 5. Replace Oxygen Valve Assembly.

6.7.6 Test 6: Pressure Accuracy Test

Step Failed	Recommended Repair
6, 10	1. Replace the Sensor PCBA 2. Replace Analog PCBA 3. Replace the Main PCBA
11	1. Check fittings on Oxygen Regulator Assembly, Oxygen Valve Assembly and O2 Flow Sensor with soapy water solution such as snoop. Be sure to wipe dry residual solution. 2. Replace Sensor PCBA. 3. Replace Analog PCBA.

6.7.7 Test 7: PEEP System Test

Step Failed	Recommended Repair
7, 11, 16	1. Check for leaks in patient circuit. 2. Replace Exhalation Valve Assembly. 3. Replace Exhalation Motor Controller PCBA 4. Replace Sensor PCBA. 5. Replace Analog PCBA

6.7.8 Test 8: Alarm Volume Control and Nurses Call

Step Failed	Recommended Repair
6, 8, 12, 14	1. Check that Nurse's Call Test Cable is working properly. 2. Replace Main PCBA
11	1. Replace Alarm Volume Potentiometer 2. Replace MMI PCBA 3. Replace Primary Alarm 4. Replace Main PCBA
16	1. Replace Digital PCBA 2. Replace Main PCBA.

6.7.9 Test 9: Maximum Flow Delivery Test

Step Failed	Recommended Repair
7	1. Check that Air Inlet Filter is clean. 2. Check Blower per Section 5.10.16., replace Blower if necessary 3. Replace Blower Controller PCBA 4. Replace Air Motor Controller PCBA. 5. Replace Air Valve Assembly 6. Replace Main PCBA.
10	1. Check that oxygen source pressure is at least 40 PSI (276 kPa) 2. Try a different oxygen hose 3. Replace the Oxygen Inlet Filter 4. Check and adjust oxygen regulator pressure per Section 5.10.3. Replace Oxygen Regulator Assembly if necessary. 5. Replace Oxygen Motor Controller PCBA 6. Replace Oxygen Valve Assembly 7. Replace Main PCBA

6.7.10 Test 10: Gas Volume Accuracy Test

Step Failed	Recommended Repair
7, 9, 12, 14, 17, 19	1. Make sure Compliance function is OFF (see Section 5.2.4.). 2. Replace Air Flow Sensor 3. Replace Sensor PCBA. 4. Replace Analog PCBA 5. Replace Air Valve Assembly. 6. Replace Air Motor Controller PCBA.
22, 24, 27, 29, 32, 34	1. Make sure Compliance function of OFF (see Section 5.2.4.). 2. Replace Oxygen Flow Sensor 3. Replace Sensor PCBA. 4. Replace Analog PCBA. 5. Replace Oxygen Valve Assembly. 6. Replace Oxygen Motor Controller PCBA.

6.7.11 Test 11: Oxygen Percentage Accuracy Test

Step Failed	Recommended Repair
8, 12, 16, 20, 24	1. Check that test monitor is calibrated 2. Replace test monitor sensor. 3. Try another test monitor
9, 13, 17, 21, 25	1. Replace oxygen sensor and cord on the ventilator. 2. Replace Sensor PCBA 3. Replace FIO2 Cable (P/N 610-1000-02) 4. Replace Oxygen Motor Controller PCBA 5. Replace Oxygen Valve Assembly

6.7.12 Test 12: Heated Exhalation Bacteria Filter and Power Failure Alarm Test

Step Failed	Recommended Repair
2, 6	1. Replace Back-Up Alarm 2. Replace Digital PCBA 3. Replace Cable (P/N 610-1000-13)
4	1. Check approximately 29 Volts on cable labeled HEATER 2. Replace Filter Heater Assembly 3. Replace Main PCBA.
6	1. Replace Main PCBA 2. Replace Digital PCBA
8	1. Replace Digital PCBA

6.8 Performance Verification Data Form

This form is to be completed whenever a Performance Verification (PV) is performed. The test numbers on the form correspond to the test numbers in the Performance Verification Procedures (Section 6.5). **Make copies of this form for data collection.**

Date of Service: _____

Customer Name: _____

Customer Address: _____

_____

Customer Account No.: _____

Section 6.3: Preliminary Ventilator Cleaning and Inspection — circle one

Step 2	Was the ventilator damaged?	YES	NO
	If yes, provide a brief description of damage and repair::		
Step 3	Cleaned ventilator exterior.	YES	NO
Step 4	Inspected cooling fan filter.	YES	NO
Step 5	Inspected Air Inlet Filter.	YES	NO
Step 6	Inspected Oxygen Water Trap/Inlet Filter	YES	NO

Step 9	Serial Number:	
	Flash Part Number:	
	Flash Version:	
	Air Stepper Version:	
	Oxygen Stepper Version:	
	Exhalation Stepper Version:	
	Air Flow Sensor P/N:	
	Oxygen Flow Sensor P/N:	
	Exhalaiton Flow Sensor P/N:	
	Display Version:	
Step 10	Elapsed Timer Meter:	

Test 1: Electrical Safety Test — circle one — actual value if FAIL

Step 1	Is cooling fan operating properly?	PASS	FAIL	
Step 2	Ground resistance	PASS	FAIL	
Step 3	Forward leakage current:	PASS	FAIL	
	Reverse leakage current:	PASS	FAIL	

Test 2: Extended Self Test — circle one

Step 6	Did EST pass?	YES	NO

DIAGNOSTIC CODES:

No.	Code	Repeat	Time	Date	Corrupted
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Test 3: Voltage Wrap Test — circle one — actual value if FAIL

Step 3	Voltage Wrap at 4 V	PASS	FAIL	V
Step 5	Voltage Wrap at 2.5 V	PASS	FAIL	V
Step 7	Voltage Wrap at 1 V	PASS	FAIL	V

Test 4: Air Flow Accuracy Test — circle one — actual value if FAIL

Step 7	Air Position Display	PASS	FAIL	Steps
Step 10	RT-200 flow display at 20 LPM	PASS	FAIL	LPM
Step 11	Air Flow display at 20 LPM	PASS	FAIL	LPM
	Exhalation Flow display at 20 LPM	PASS	FAIL	LPM
Step 13	RT-200 flow display at 50 LPM	PASS	FAIL	LPM
Step 14	Air Flow display at 50 LPM	PASS	FAIL	LPM
	Exhalation Flow display at 50 LPM	PASS	FAIL	LPM
Step 16	RT-200 flow display at 100 LPM	PASS	FAIL	LPM
Step 17	Air Flow display at 100 LPM	PASS	FAIL	LPM
	Exhalation Flow display at 100 LPM	PASS	FAIL	LPM
Step 19	RT-200 flow display at 120 LPM	PASS	FAIL	LPM
Step 20	Air Flow display at 120 LPM	PASS	FAIL	LPM
	Exhalation Flow display at 120 LPM	PASS	FAIL	LPM
Step 22	RT-200 flow display at 165 LPM	PASS	FAIL	LPM
Step 23	Air Flow display at 165 LPM	PASS	FAIL	LPM
	Exhalation Flow display at 165 LPM	PASS	FAIL	LPM
Step 25	RT-200 flow display at 0 LPM	PASS	FAIL	LPM

Test 4: Air Flow Accuracy Test (cont.)		circle one		actual value if FAIL
Step 26	Air Flow display at 0 LPM	PASS	FAIL	LPM
	Exhalation Flow display at 0 LPM	PASS	FAIL	LPM
Step 29	Air Position Display	PASS	FAIL	Steps
Step 30	Internal Oxygen Display	PASS	FAIL	mV

Test 5: Oxygen Flow Accuracy Test		circle one		actual value if FAIL
Step 4	Oxygen Position Display	PASS	FAIL	Steps
Step 7	RT-200 flow display at 20 LPM	PASS	FAIL	LPM
Step 8	Oxygen Flow display at 20 LPM	PASS	FAIL	LPM
Step 10	RT-200 flow display at 50 LPM	PASS	FAIL	LPM
Step 11	Oxygen Flow display at 50 LPM	PASS	FAIL	LPM
Step 13	RT-200 flow display at 100 LPM	PASS	FAIL	LPM
Step 14	Oxygen Flow display at 100 LPM	PASS	FAIL	LPM
Step 16	RT-200 flow display at 120 LPM	PASS	FAIL	LPM
Step 17	Oxygen Flow display at 120 LPM	PASS	FAIL	LPM
Step 19	RT-200 flow display at 165 LPM	PASS	FAIL	LPM
Step 20	Oxygen Flow display at 165 LPM	PASS	FAIL	LPM
Step 22	RT-200 flow display at 0 LPM	PASS	FAIL	LPM
Step 23	Oxygen Flow display at 0 LPM	PASS	FAIL	LPM
Step 26	Oxygen Position Display	PASS	FAIL	Steps

Test 6: Pressure Accuracy Test		circle one		actual value if FAIL
Step 6	RT-200 Pressure display			cmH2O
	Inhalation Pressure display	PASS	FAIL	cmH2O
	Exhalation Pressure Display	PASS	FAIL	cmH2O
Step 10	RT-200 Pressure display			cmH2O
	Inhalation Pressure display	PASS	FAIL	cmH2O
	Exhalation Pressure Display	PASS	FAIL	cmH2O
Step 11	Internal Oxygen display	PASS	FAIL	mV

Test 7: PEEP System Test

		circle one		actual value if FAIL
Step 7	RT-200 Pressure display @ 5 cmH2O PEEP	PASS	FAIL	cmH2O
	End Exhalation Pressure display @ 5 cmH2O PEEP	PASS	FAIL	cmH2O
Step 11	RT-200 Pressure display @ 10 cmH2O PEEP	PASS	FAIL	cmH2O
	End Exhalation Pressure display @ 10 cmH2O PEEP	PASS	FAIL	cmH2O
Step 16	RT-200 Pressure display @ 35 cmH2O PEEP	PASS	FAIL	cmH2O
	End Exhalation Pressure display @ 35 cmH2O PEEP	PASS	FAIL	cmH2O

Test 8: Alarm Volume Control & Nurses Call Test

		circle one	
Step 6	DMM reads infinite resistance with no alarms	PASS	FAIL
Step 8	DMM reads 0Ω with no alarms	PASS	FAIL
Step 11	Alarm volume steadily increases	PASS	FAIL
Step 12	DMM reads infinite resistance with alarm	PASS	FAIL
Step 14	DMM reads 0Ω with alarm	PASS	FAIL
Step 16	Audio alarm is automatically silenced	PASS	FAIL

Test 9: Maximum Flow Delivery Test

		circle one		actual value if FAIL
Step 7	RT-200 Air reads 126 – 154 LPM	PASS	FAIL	LPM
Step 10	RT-200 O2 reads 126 – 154 LPM	PASS	FAIL	LPM

Test 10: Gas Volume Accuracy Test

		circle one		actual value if FAIL
Step 7	RT-200 Air reads 0.90 – 1.10 L (square wave)	PASS	FAIL	L
Step 9	RT-200 Air reads 0.90 – 1.10 L (ramp wave)	PASS	FAIL	L
Step 12	RT-200 Air reads 0.22 – 0.28 L (ramp wave)	PASS	FAIL	L
Step 14	RT-200 Air reads 0.22 – 0.28 L (square wave)	PASS	FAIL	L
Step 17	RT-200 Air reads 2.25 – 2.75 L (square wave)	PASS	FAIL	L
Step 19	RT-200 Air reads 2.25 – 2.75 L (ramp wave)	PASS	FAIL	L
Step 22	RT-200 O2 reads 2.25 – 2.75 L (ramp wave)	PASS	FAIL	L
Step 24	RT-200 O2 reads 2.25 – 2.75 L (square wave)	PASS	FAIL	L
Step 27	RT-200 O2 reads 0.90 – 1.10 L (square wave)	PASS	FAIL	L
Step 29	RT-200 O2 reads 0.09 - 1.10 L (ramp wave)	PASS	FAIL	L
Step 32	RT-200 O2 reads 0.22 – 0.28 L (ramp wave)	PASS	FAIL	L
Step 34	RT-200 O2 reads 0.22 – 0.28 L (square wave)	PASS	FAIL	L

Test 11: Oxygen Accuracy Test **circle one** **actual value if FAIL**

Step 8	External O2 monitor reads 18 – 24%	PASS	FAIL	%
Step 9	Ventilator O2 Display reads 18 – 24%	PASS	FAIL	%
Step 12	External O2 monitor reads 27 – 33%	PASS	FAIL	%
Step 13	Ventilator O2 Display reads 27 – 33%	PASS	FAIL	%
Step 16	External O2 monitor reads 57 – 63%	PASS	FAIL	%
Step 17	Ventilator O2 Display reads 57 – 63%	PASS	FAIL	%
Step 20	External O2 monitor reads 77 – 83%	PASS	FAIL	%
Step 21	Ventilator O2 Display reads 77 – 83	PASS	FAIL	%
Step 24	External O2 monitor reads 97 -- 103%	PASS	FAIL	%
Step 25	Ventilator O2 Display reads 97 – 103%	PASS	FAIL	%

Test 12: Heated Exhalation Filter & Power Fail Alarm Test **circle one**

Step 2	Audible alarm sounds	PASS	FAIL
Step 4	Exhalation bacteria filter is warm to the touch	PASS	FAIL
Step 6	Audible alarm is sounding after 2 minutes	PASS	FAIL
Step 8	Audible alarm was silenced	PASS	FAIL

circle one

Did the Performance Verification pass?	YES	NO

_____ _____

Technician's Signature Date

7 Component Removal/ Installation Procedures

WARNING: Always disconnect external AC and DC power sources and high-pressure oxygen sources from the ventilator before servicing.

CAUTION: Always be sure to follow proper Electro-Static Discharge (ESD) grounding procedures before handling Static Sensitive Devices (SSD).

CAUTION: Troubleshooting and repair should be performed only by a qualified service technician.

7.1 Sub-assembly and Component Removal/ Installation Flow Chart

The following flow charts show the order in which the sub-assemblies and components can be removed from the ventilator. Reverse the order for installation.

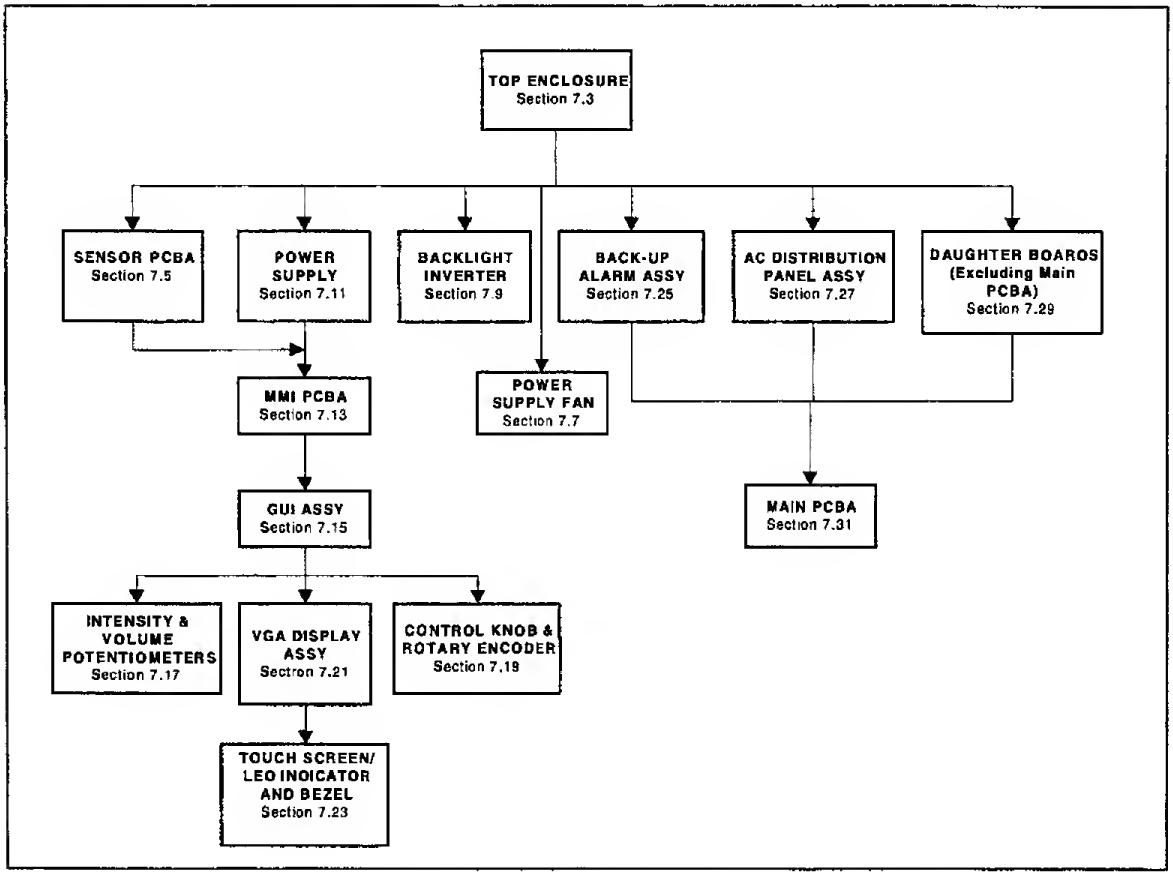


Chart 7-1: Top Enclosure Component Removal Flow Chart

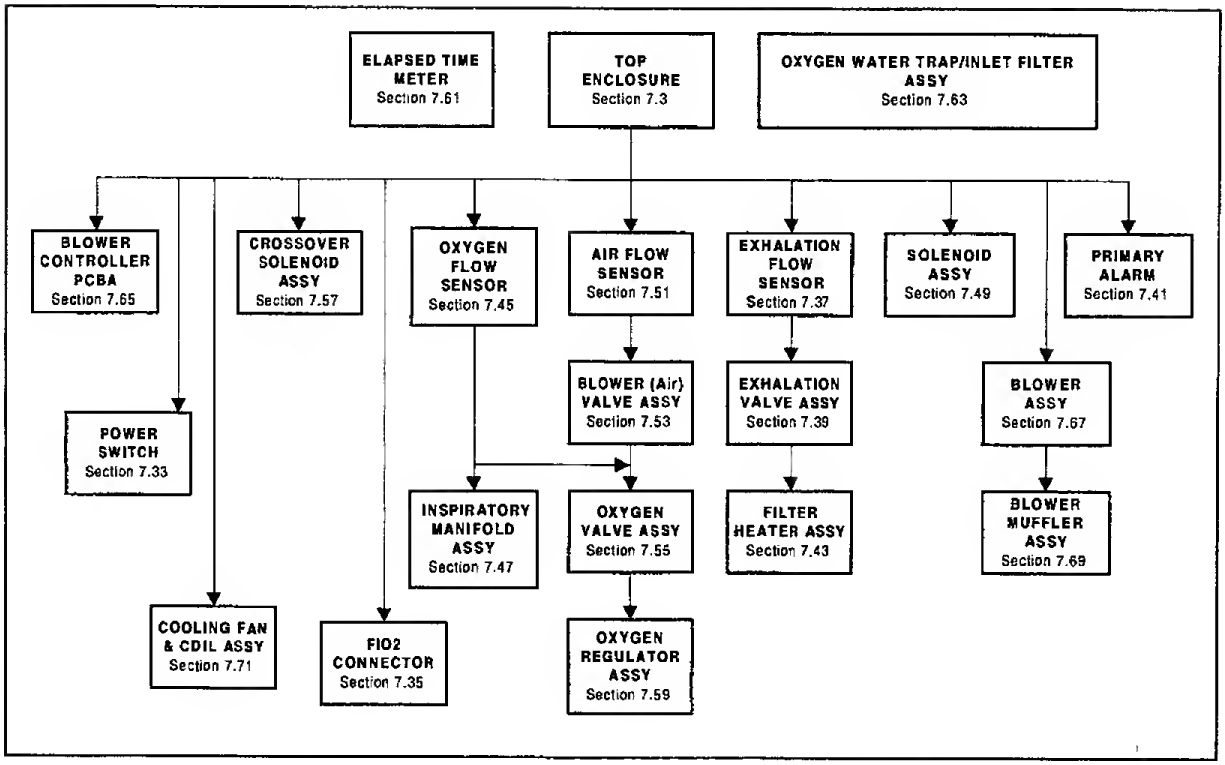


Chart 7-2: Bottom Enclosure Component Removal Flow Chart

7.2 Tools Required

Refer to Table 1-1: Recommended Test Equipment, Tools and Service Materials.

7.3 Removal of Top Enclosure

(Refer to Figure 7-1)

1. Turn ventilator power OFF.
2. Disconnect the AC power source and oxygen source from the ventilator.
3. Remove all ancillary devices such as humidifiers and flex arms from the side rails.
4. Disconnect all external cables from the ventilator.
5. Place unit on a sturdy bench.
6. Remove six screws and washers from the side rails.
7. Carefully hang the rear of the unit over the table to access the two rear screws then remove four screws and washers holding the top enclosure to the bottom enclosure. **NOTE: The two rear screws are located at the rear corners.**
8. With the display facing you, carefully lift the top enclosure and place it upside down and to the right of the bottom enclosure. **CAUTION: Be careful not to pull on the cables and wires when removing the top enclosure.**

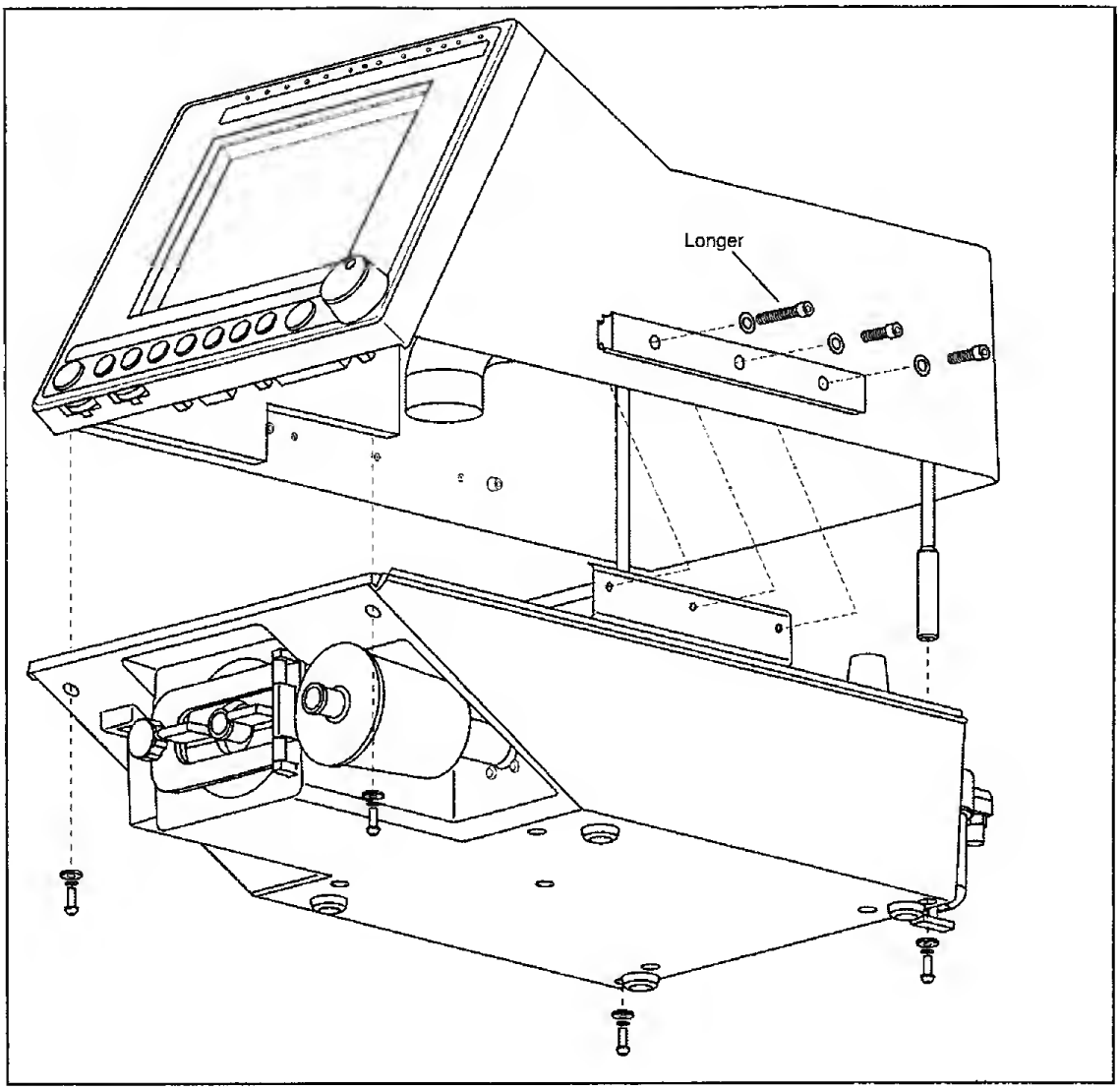


Figure 7-1: Top Enclosure

7.4 Installation of Top Enclosure

(Refer to Figure 1 unless specified otherwise)

1. Carefully lift the top enclosure and place it over the bottom enclosure. Make sure the transfer tube is aligned onto the vent output port. **CAUTION: Be careful not to pull or crimp any cables, tubes or wires.**
2. Fasten the enclosures together using four screws and washers at the bottom.
3. Install six screws and washers on the side rails. **Note: The two longer screws are fastened to the holes toward the front of the unit.**
4. Reconnect the oxygen source, AC power source, and ancillary devices to the ventilator.

7.5 Removal of Sensor PCBA

(Refer to Figure 7-2)

1. Remove the Top Enclosure (see Section 7.3).
2. Remove the cables from the connectors on the Sensor PCBA in the order shown on the table below:

Table 7-1: Sensor PCBA Cable Connections

Reference Designator on Sensor PCBA	Reference Designator on Cable
J1	SEN J1
J5 and J6	* N/A – black wires from O2 pressure switch
J9	SEN J9
J2	SEN J2
J7	SEN J7
J12	SEN J12
J10	SEN J10
J11	SEN J11
J8	SEN BRD J8
J3 and J4	* SENSOR BRD J3 & J4

* Polarity is unimportant. Either wire can be connected to either terminal.

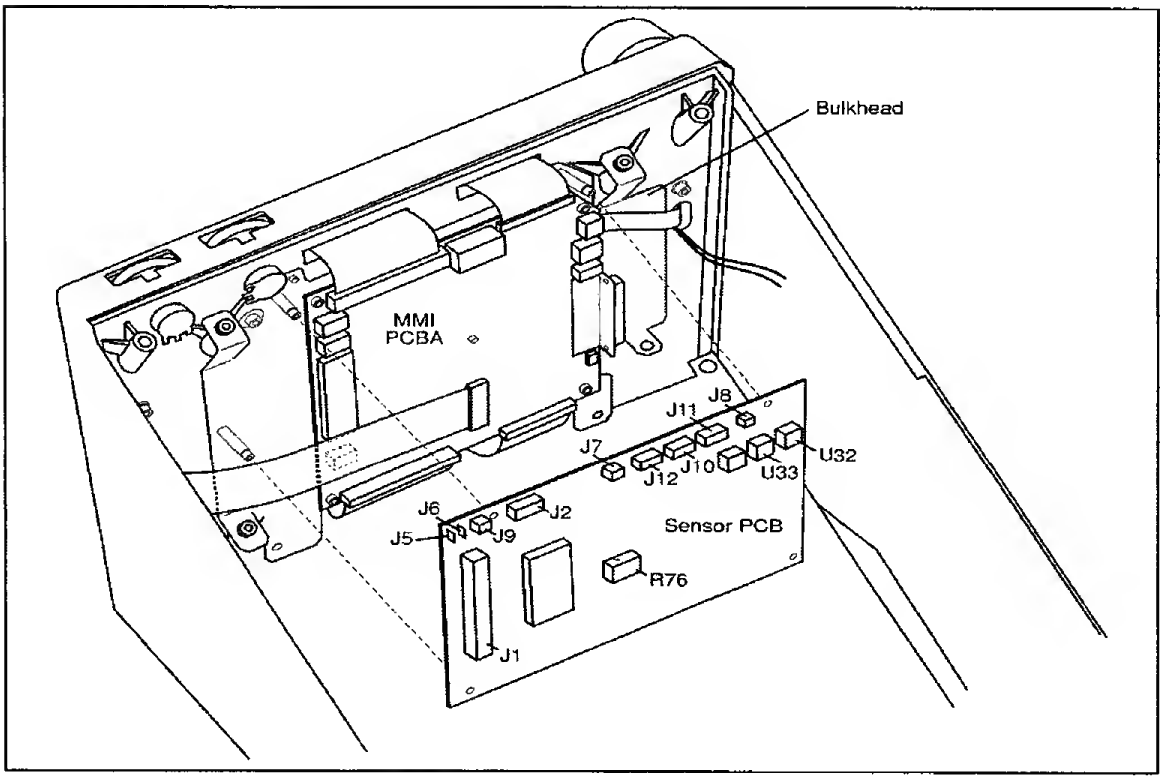


Figure 7-2: Sensor PCBA

3. Disconnect the exhalation solenoid tube from pressure sensor U32 and the inhalation solenoid tube from pressure sensor U33 on the Sensor PCBA. **Note: Do not pull on the tube. Pry it from the sensor.**
4. Unsnap the Sensor PCBA from the top two posts and then the bottom two. Remove the Sensor PCBA. **NOTE: Be careful not to damage the R76 potentiometer when removing the Sensor PCBA.**

7.6 Installation of Sensor PCBA

Note: The GUI Assembly, MMI PCBA and Power Supply must be installed before the Sensor PCBA can be installed.

1. Reverse removal procedures.

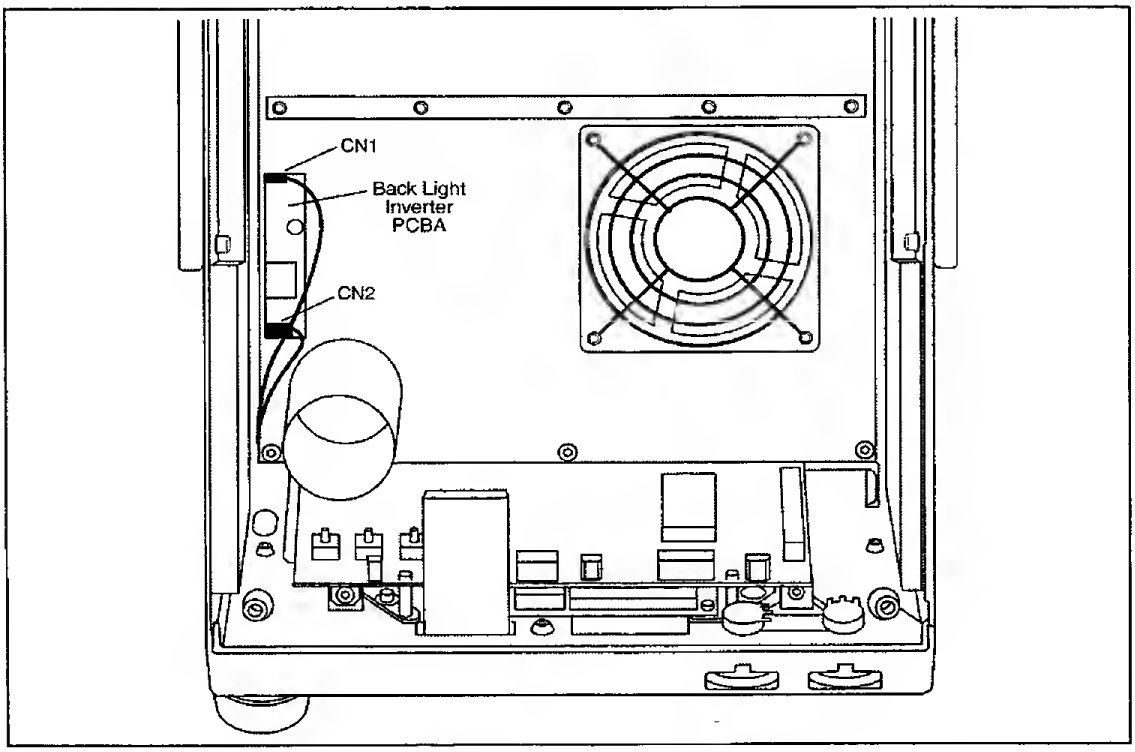


Figure 7-3: Backlight Inverter PCBA Connections

7.7 Removal of Power Supply Fan

(Refer to Figure 5 unless specified otherwise)

1. Remove the Top Enclosure (see Section 7.3).
2. Disconnect both cables from the Backlight Inverter PCBA (see Figure 7-3).
3. Disconnect the power supply fan cord from the cable (FAN).

4. Remove five screws holding the power supply shroud then remove the shroud (see Figure 7-5).
5. Remove the four nuts, screws and twelve washers holding the fan to the power supply shroud then remove the grill.

7.8 Installation of Power Supply Fan

1. Reverse removal procedures. **Note: Make sure the flow direction arrow on the fan is pointing *away* from the power supply and fan cord is routed along the ridge on the power supply shroud.**

7.9 Removal of Backlight Inverter PCBA

WARNING: Verify that the AC and external DC power sources are disconnected from the ventilator since the Backlight Inverter PCBA generates high voltage.

(Refer to Figure 7-3)

1. Remove the Top Enclosure (see Section 7.3).
2. Disconnect both cables from the CN1 and CN2 connectors on the Backlight Inverter PCBA.
3. Remove two screws fastening the PCBA to the power supply shroud then remove the PCBA.

7.10 Installation of Backlight Inverter PCBA

(Refer to Figure 7-3)

1. Fasten the PCBA to the shroud using two screws. Note the orientation of the CN1 and CN2 connectors.
2. Connect the white and pink cable to connector CN2.
3. Connect cable (BCKLT) to connector CN1.
4. Install the Top Enclosure (see Section 7.4).

7.11 Removal of Power Supply

WARNING: Verify that the AC and external DC power sources are disconnected from the ventilator since the Power Supply contains high voltage components.

(Refer to Figure 7-4 unless specified otherwise)

1. Remove the Top Enclosure (see Section 7.3).
2. Disconnect both cables from the Backlight Inverter PCBA (see Figure 7-3).
3. Disconnect the power supply fan cord from the cable (FAN).
4. Remove five screws holding the power supply shroud then remove the shroud (see Figure 7-5).
5. Disconnect the green, brown and blue wires from the TB1 connector on the Power Supply. **Note: Back-off the screws in the connector until they are flush with the top of the connector.**
6. Disconnect the thin black and red wires from the TB3 connector on the Power Supply. Do not remove the thick black ground wire.

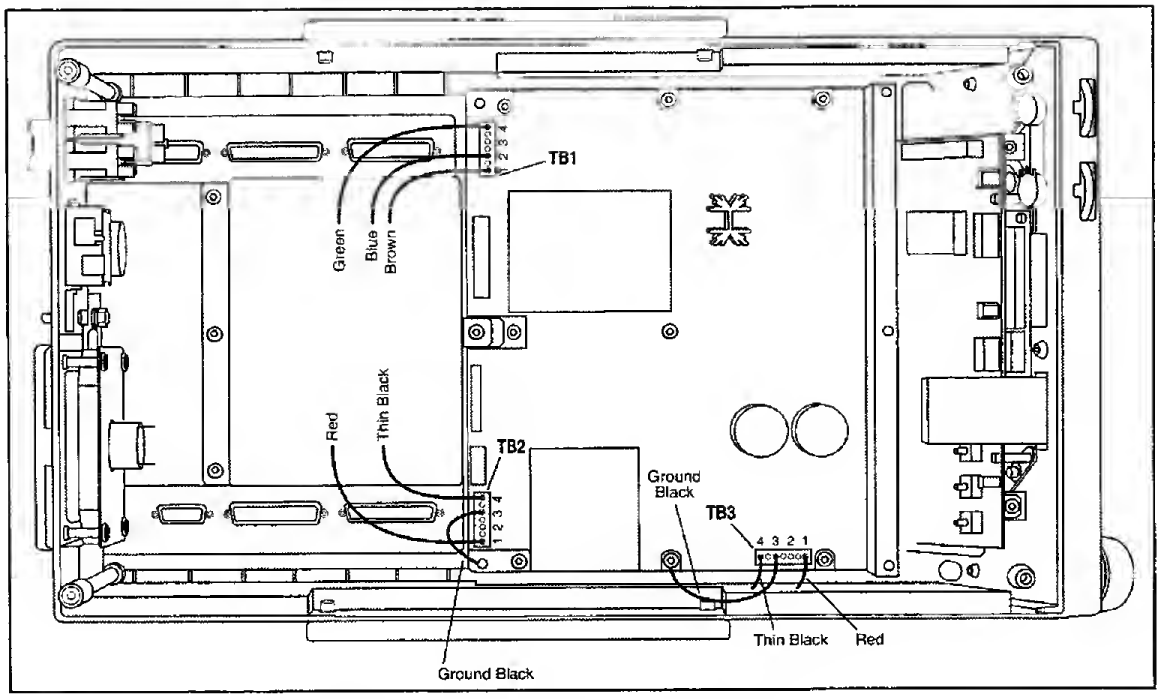


Figure 7-4: Power Supply Wire Connections

7. Disconnect the thin black and red wires from the TB2 connector on the Power Supply. Do not remove the thick black ground wire.
8. Remove eight screws holding down the Power Supply.
9. Partially remove the Power Supply and disconnect the cables from connectors J1, J2 and J3 then completely remove.

7.12 Installation of Power Supply

Note: The GUI Assembly and MMI PCBA must be assembled first.

(Refer to Figure 7-4 unless specified otherwise)

1. Fasten the Power Supply to the Top Enclosure using eight screws. Connect the black ground wire from connector TB3. **Note: Make sure no cables are routed underneath the power supply before fastening. Note: Do not tighten screws until all are installed.**

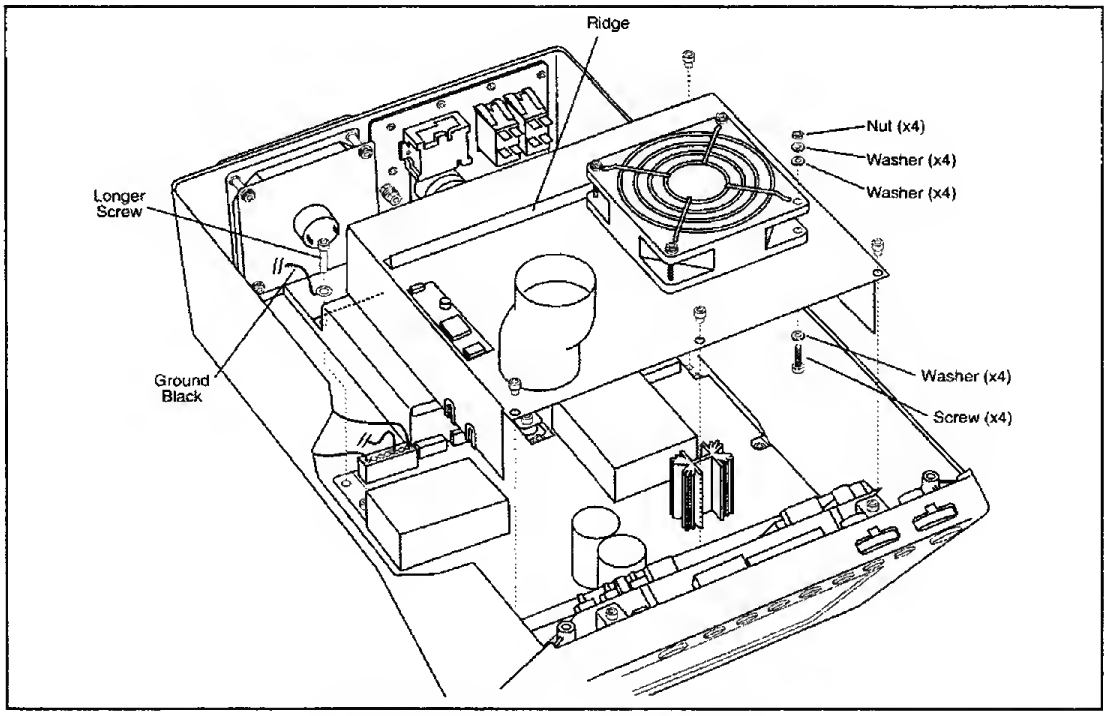


Figure 7-5: Power Supply Shroud and Fan

2. Connect cables (PSU J1, PSU J2 and PSU J3) to connectors J1, J2 and J3 respectively on the Power Supply. Note: Observe that no pins from connector J1 are showing once the cable is connected.

   CAUTION: Ensure that the wires mentioned in steps 3 – 5 are connected properly per Figure 7-4.

3. Connect red and black wires (PSU TB3) to connector TB3. Ensure wires are pushed completely into connector TB3 before torquing. Once assembled, the red and black wires should be perpendicular to the TB3 connector.
4. Connect red and black wires (PSU TB2) to connector TB2. Ensure wires are pushed completely into connector TB2 before torquing.
5. Connect blue, green and brown wires from the AC Mains panel to connector TB1. Ensure wires are pushed completely into connector TB1 before torquing.
6. Install the shroud. **Note: Ensure that the red and black wires from TB3 rest inside the slots on the shroud and that no other cables are pinched. Note: All cable assemblies and wires must be routed between the shroud and the top enclosure wall.**
7. Fasten the black ground wire with longer screw to the shroud (see Figure 7-5).
8. Fasten the shroud with the remaining four screws (see Figure 7-5).
9. Connect the white and pink cable to connector CN2 on the Backlight Inverter PCBA (see Figure 7-3).

10. Connect cable (BCKLT) to connector CN1 on the Backlight Inverter PCBA (see Figure 7-3).
11. Install the Top Enclosure (see Section 7.4).

7.13 Removal of MMI PCBA

(Refer to Figure 7-6)

1. Remove the Top Enclosure (see Section 7.2).
2. Remove the Sensor PCBA (see Section 7.5)
3. Remove the Power Supply (see Section 7.11).
4. Remove the cables from the connectors on the MMI PCBA in the order shown in Table 7-2.

Table 7-2 : MMI PCBA Cable Connections

Reference Designator on MMI PCBA	Reference Designator on Cable
J7	N/A – Ribbon cable from VGA Display. **Note: When disassembling, lift the ears on the connector before pulling cable.When reassembling, the black side faces the MMI PCBA. DO NOT USE A TOOL.**
J4	MMI J4
J8	MMI J8
J5	MMI J5
J9	MMI J9
J3	MMI J3
J11	N/A – Ribbon cable from VGA Display. **Note: When disassembling, lift the ears on the connector before pulling cable. DO NOT USE A TOOL.**
J12	N/A – Ribbon cable from VGA Display. **Note: When disassembling, lift up black snap then pull cable upward. DO NOT USE A TOOL.**
J10	N/A – Ribbon cable from VGA Display
J1	MMI J1
J15	MMI J15

5. Remove four screws holding the MMI PCBA to the plate.
6. Partially remove the MMI PCBA. Do not pull.
7. Remove two screws holding the cable (MMI J14) to the J14 connector then disconnect the cable and remove it from the U-brace.

8. Disconnect the cable (MMI J2) from connector J2.
9. Disconnect ribbon cables from connectors J6 and J13 then completely remove MMI PCBA.

7.14 Installation of MMI PCBA

Note: The GUI Assembly must be installed.
Note: Make sure the ribbon cables from the GUI Assembly are not twisted.

(Refer to Figure 7-6 unless specified otherwise)

1. Connect the ribbon cable to connector J6. Tug on the cable to ensure it is properly seated.
2. Connect ribbon cable to connector J13. Check that no pins can be seen when connected, then snap cover shut.
3. Reverse removal procedures beginning with step 8.

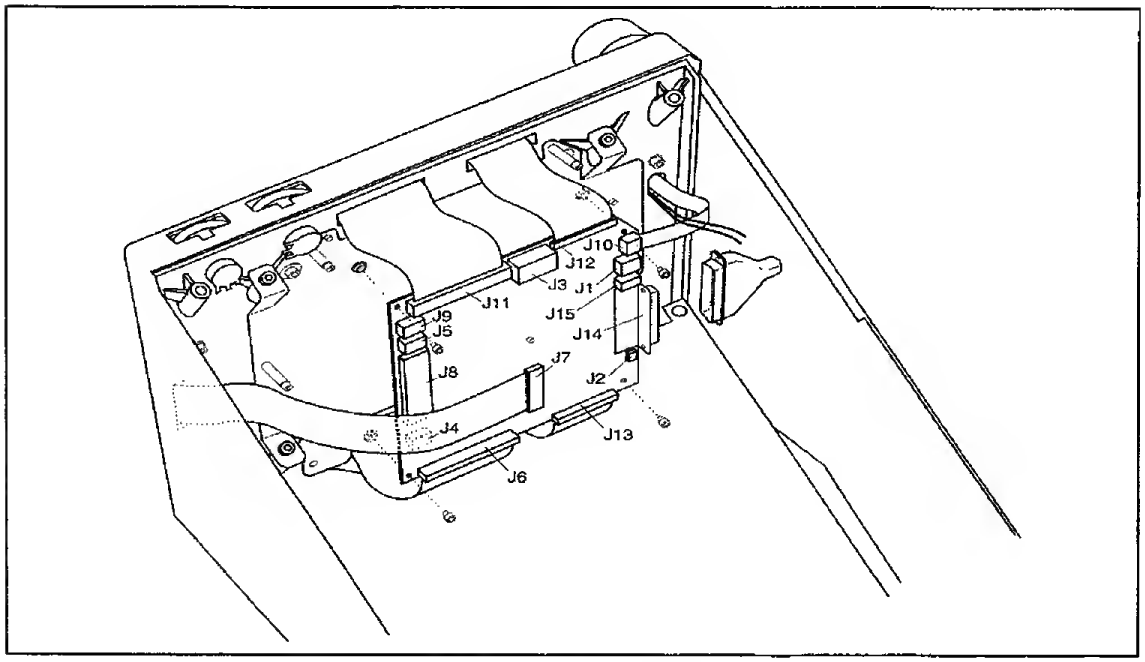


Figure 7-6: MMI PCBA

7.15 Removal of GUI Assembly

(Refer to Figure 7-7)

1. Remove the Top Enclosure (see Section 7.3)
2. Remove the Sensor PCBA (see Section 7.5)
3. Remove the Power Supply (see Section 7.11).
4. Remove the MMI PCBA (see Section 7.13).
5. Loosen the set screw holding the brightness and volume knobs.
6. Remove four vertical screws holding the front bulkhead to the Top Enclosure.

7. Remove four screws and washers holding the front bulkhead to the Top Enclosure Assembly then remove the bulkhead.
8. Carefully remove the GUI assembly from the Top Enclosure.

7.16 Installation of GUI Assembly

(Refer to Figure 7-8 unless specified otherwise)

1. Assemble knobs to brightness and volume potentiometers. Knobs should be flush against the nut. Make sure the hex screw on the knob makes contact with the flat part of the shaft on the intensity potentiometer.
2. Feed cables 1 – 5 through the slots in the top enclosure, then hang the GUI Assembly over the brightness and volume knobs.
3. Feed ribbon cables 6 and 7 through the remaining slots in the Top Enclosure then engage the GUI assembly onto the Top Enclosure. Make sure all ribbon cables are not twisted.
4. Install the front bulkhead using 4 screws (see Figure 7-7). Make sure the strips from the EMI foil are between the bulkhead and the Top Enclosure.

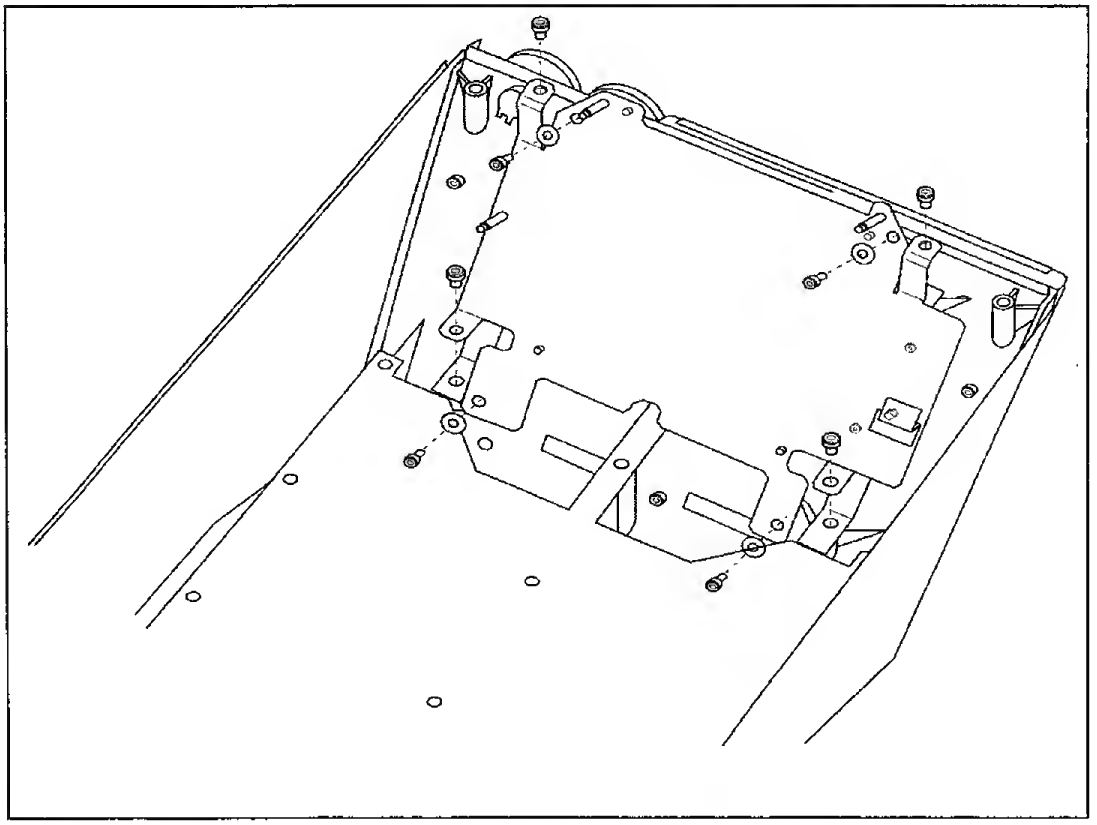


Figure 7-7: GUI Bulkhead

5. Install the remaining four screws and washers (see Figure 7-7). Make sure the intensity and volume knobs can turn freely. Readjust if necessary. Do not overtighten screws.
6. Install the MMI PCBA (see Section 7.14).
7. Install the Power Supply (see Section 7.12).
9. Install the Sensor PCBA (see Section 7.6)
10. Install the Top Enclosure (see Section 7.4).

7.17 Removal of Intensity and Volume Potentiometers

(Refer to Figure 7-9)

1. Remove the Top Enclosure (see Section 7.3)
2. Remove the Sensor PCBA (see Section 7.5)
3. Remove the Power Supply (see Section 7.11).
4. Remove the MMI PCBA (see Section 7.13).
5. Remove the GUI Assembly (see Section 7.15).
6. Remove the nut(s) and washer(s) holding the potentiometer(s) then remove the potentiometer(s).

7.18 Installation of Intensity and Volume Potentiometers

1. Reverse removal procedures noting the orientation of potentiometers.

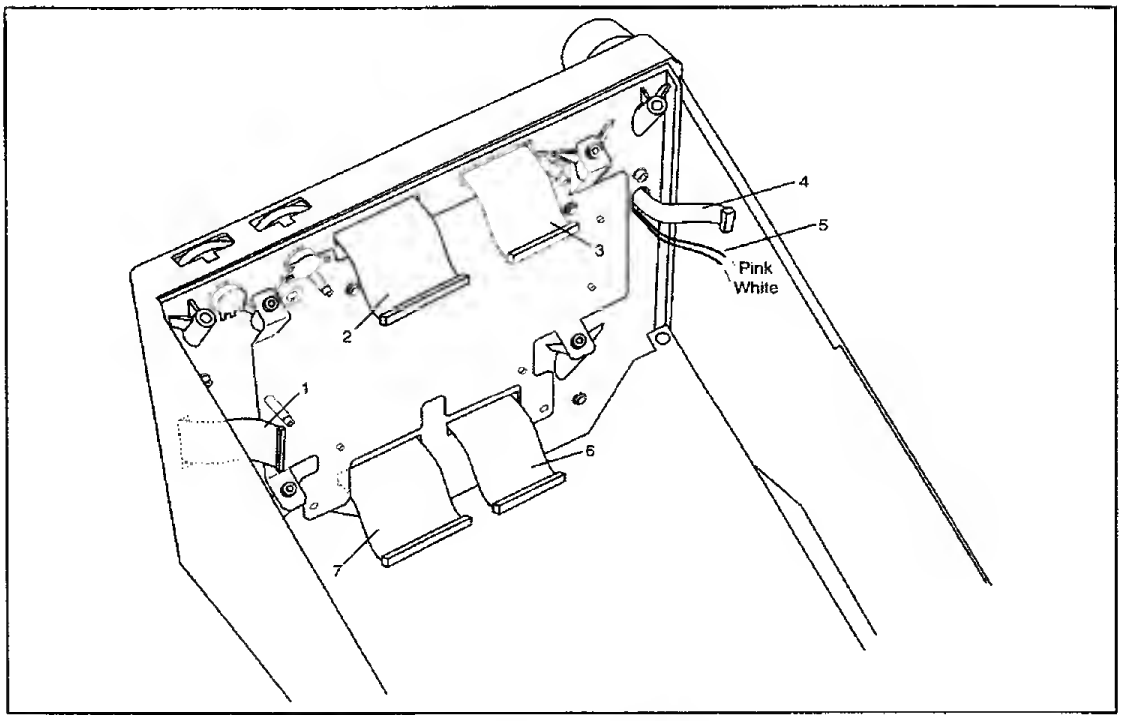


Figure 7-8: GUI Cables

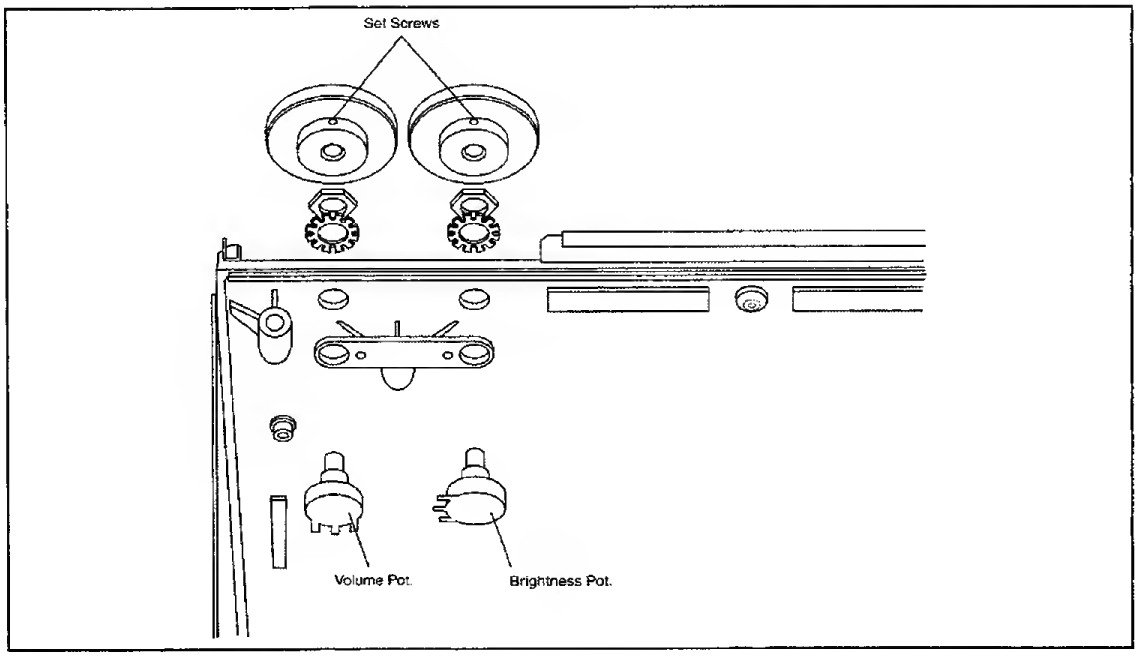


Figure 7-9: Volume and Intensity Potentiometers

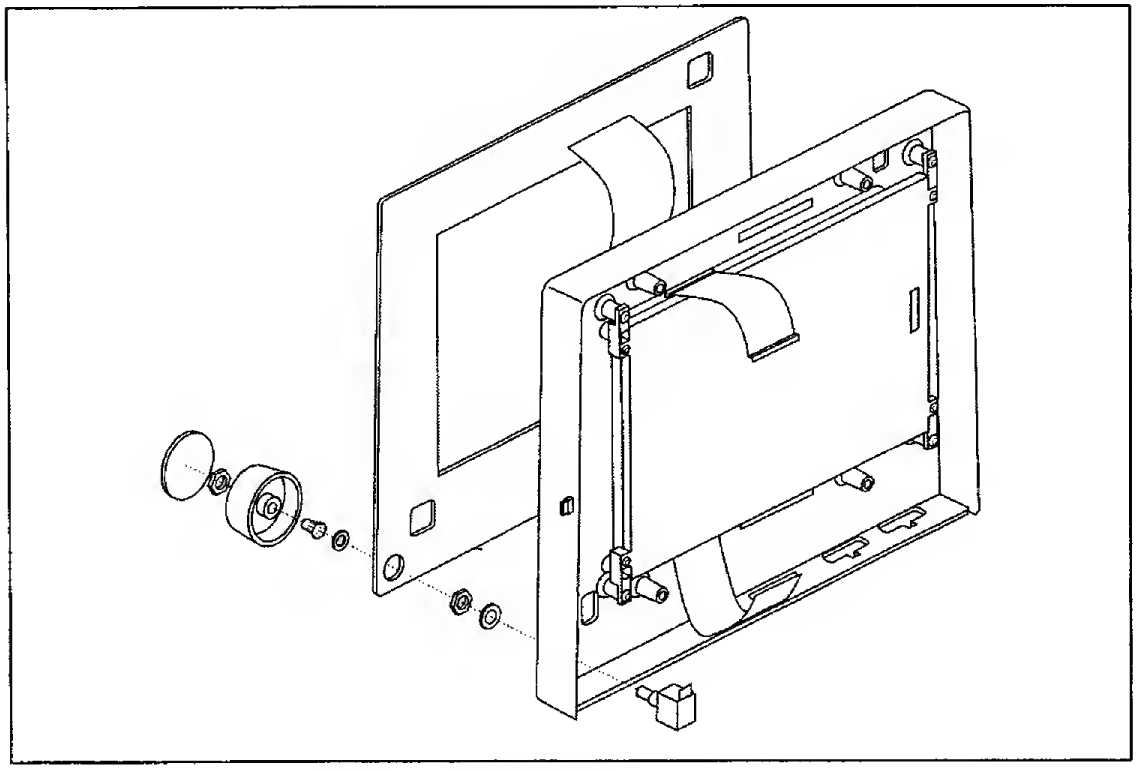


Figure 7-10: Control Knob Rotary Encoder

7.19 Removal of Control Knob Rotary Encoder

(Refer to Figure 7-10)

1. Remove the Top Enclosure (see Section 7.3).
2. Remove the Sensor PCBA (see Section 7.5)
3. Remove the Power Supply (see Section 7.11).
4. Remove the MMI PCBA (see Section 7.13).
5. Remove the GUI Assembly (see Section 7.15).
6. Pull the blue cover from the control knob.
7. Remove the nut holding the control knob, then remove the ferrule and washer.
8. Remove the nut and washer holding the Rotary Encoder to the bezel, then remove the Encoder.

7.20 Installation of Control Knob Rotary Encoder

1. Reverse removal procedures noting the orientation of the rotary encoder.

7.21 Removal of VGA Display Assembly

(Refer to Figure 7-11)

1. Remove the Top Enclosure (see Section 7.3).
2. Remove the Sensor PCBA (see Section 7.5)
3. Remove the Power Supply (see Section 7.11).
4. Remove the MMI PCBA (see Section 7.13).
5. Remove the GUI Assembly (see Section 7.15).
6. Remove four hex screws holding the VGA Display Assembly to the spacers, then remove the display.

7.22 Installation of VGA Display Assembly

1. Reverse removal procedures noting the orientation of the VGA Display Assembly in the bezel.

7.23 Removal of Touch Screen/LED Indicator Assembly and Bezel

(Refer to Figure 7-11)

1. Remove the Top Enclosure (see Section 7.3)
2. Remove the Sensor PCBA (see Section 7.5)
3. Remove the Power Supply (see Section 7.11).
4. Remove the MMI PCBA (see Section 7.13).
5. Remove the GUI Assembly (see Section 7.15).
6. Remove VGA Display Assembly (see Section 7.21)
7. Carefully pop out the Touch Screen/LED Indicator Assembly from the Bezel.

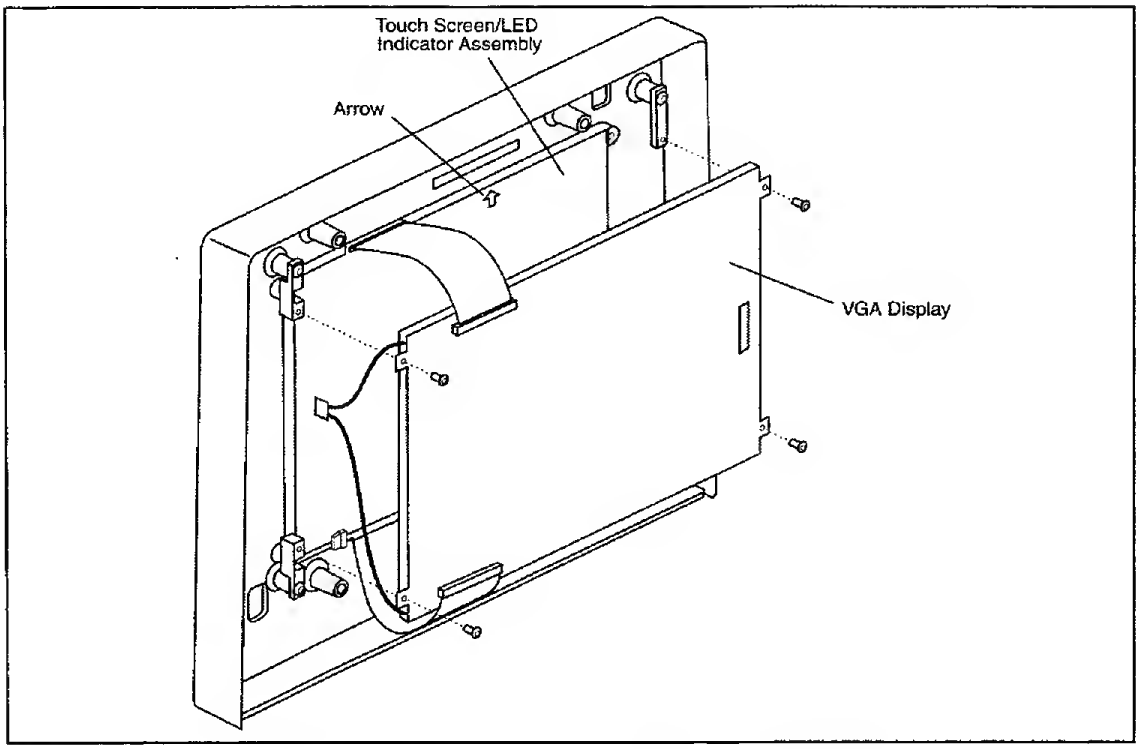


Figure 7-11: VGA Display and Touch Screen Assembly

7.24 Installation of Touch Screen/LED indicator Assembly and Bezel

1. Reverse removal procedures noting orientation of cables. **Note: The arrow on the Touch Screen/LED Indicator specifies the orientation.**

7.25 Removal of Back-Up Alarm

(Refer to Figure 7-12)

1. Remove the Top Enclosure (see Section 7.3).
2. Remove the outer alarm cover and mesh cooling fan filter.
3. Remove 4 screws holding the back-up alarm bracket, then separate components.
4. Disconnect the black and red wires (BU ALARM) from the alarm.
5. Remove the collar from the alarm then push the alarm from the bracket.

7.26 Installation of Back-Up Alarm

(Refer to Figure 7-12)

1. Inspect the EMI and mesh cooling fan filters. If dirty, clean both parts with warm water and wipe or blow dry.
2. Reverse removal procedures. **Note: Red wire connects to the positive lead and the black to the negative. Note the orientation of the EMI filter.**

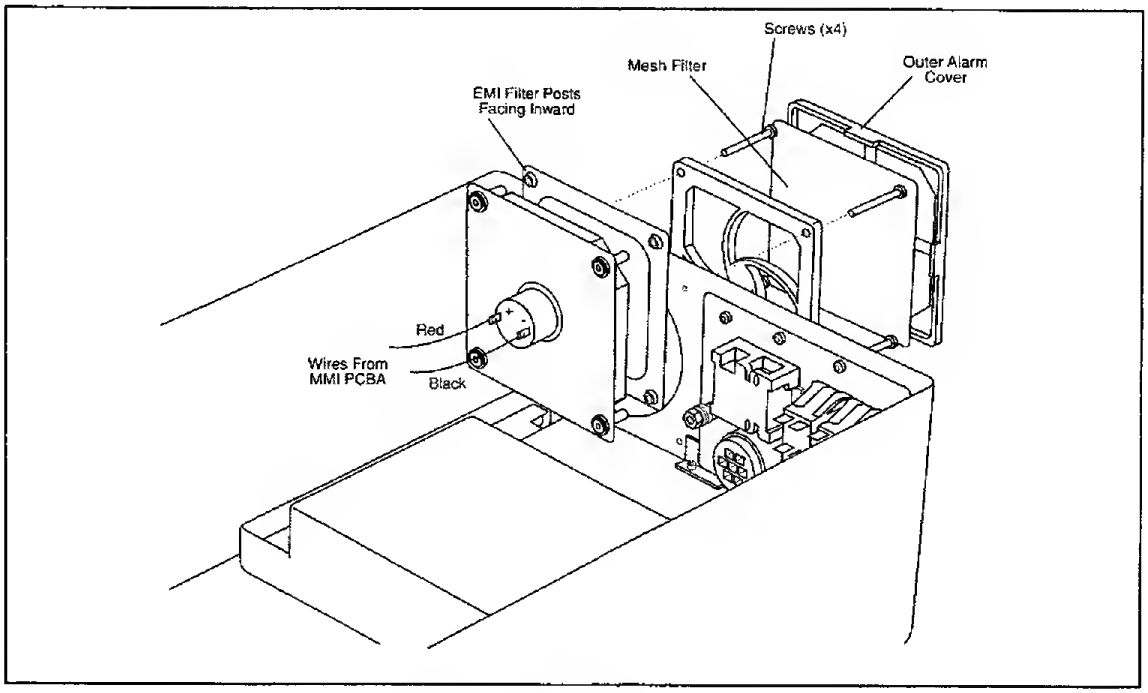


Figure 7-12: Back-Up Alarm

7.27 Removal of AC Distribution Panel

WARNING: Verify that the AC and external DC power sources are disconnected from the ventilator since the AC Distribution Panel contains high voltage components.

(Refer to Figure 7-13 unless specified otherwise)

1. Remove the Top Enclosure (see Section 7.3).
2. Remove ten screws and washers holding the AC Distribution Panel to the enclosure.
3. Remove the nut and washers holding the three ground wires to the ground lug and the ground lug to the Top Enclosure then remove the lug (see Figure 7-14).
4. Loosen the screw holding the L-bracket then lift the AC Distribution Panel and rest it outside the Top Enclosure (see Figure 7-14).

7.28 Installation of AC Distribution Panel

1. Reverse removal procedures noting that the AC Distribution Panel rests between the top enclosure and L-bracket.

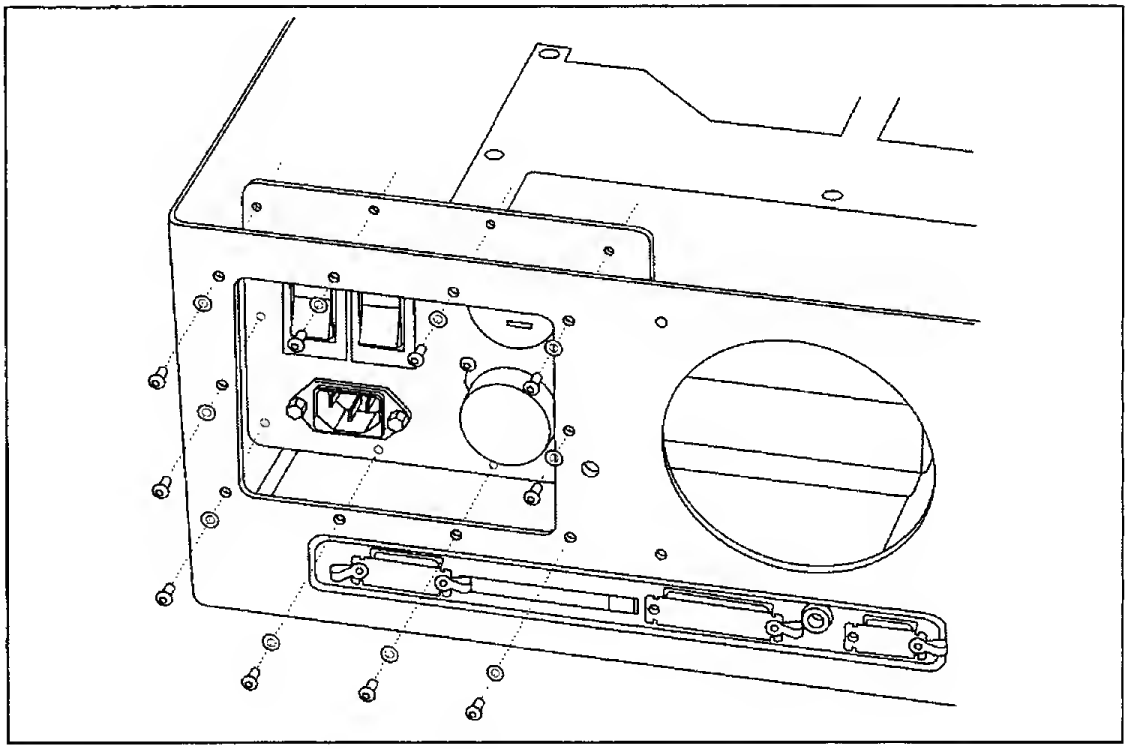


Figure 7-13: AC Distribution Panel (Front View)

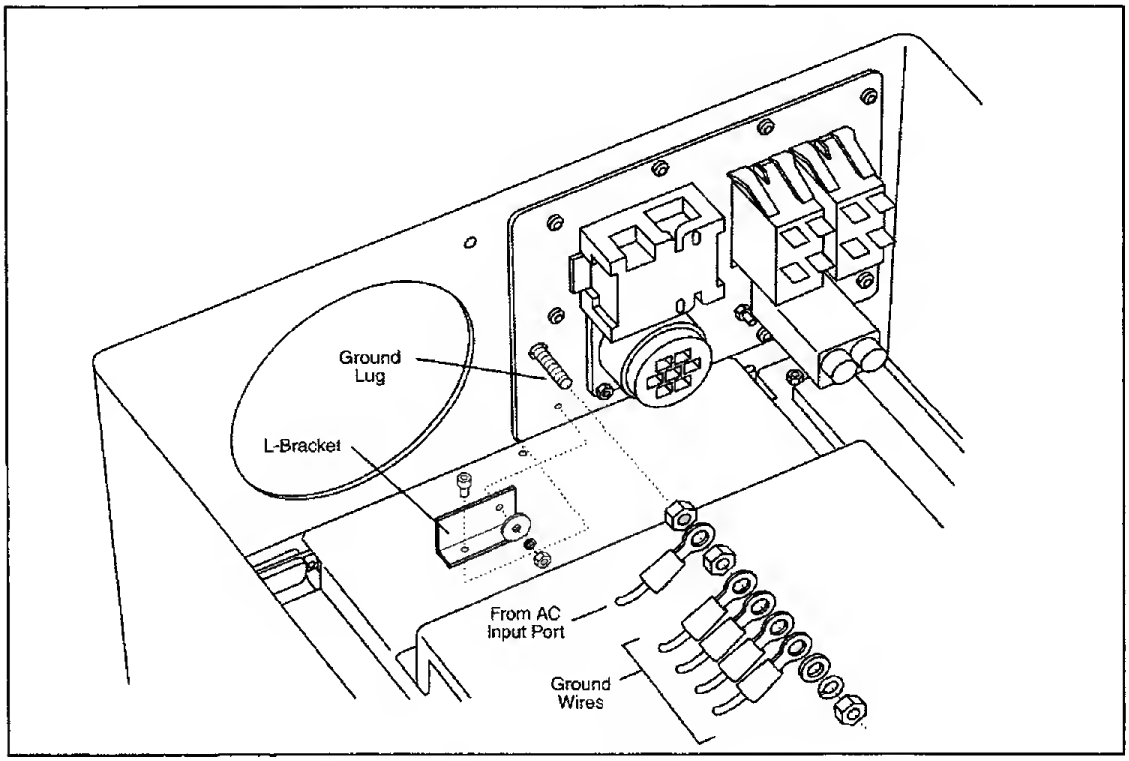


Figure 7-14: AC Distribution Panel (Rear View)

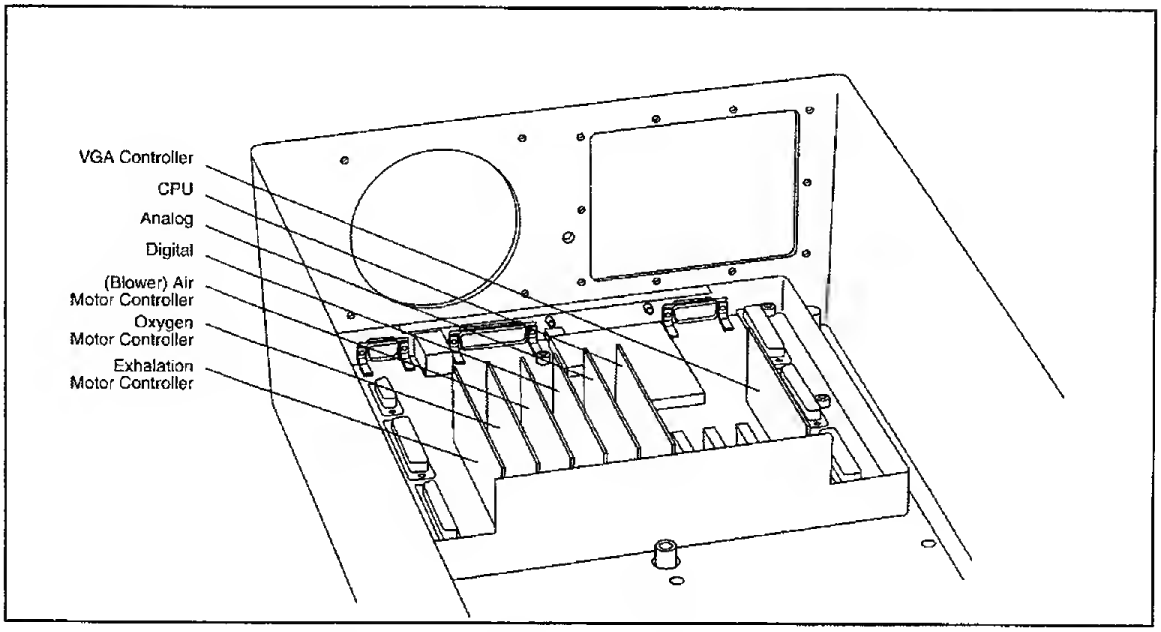


Figure 7-15: Printed Circuit Board Assemblies

7.29 Removal of Printed Circuit Boards (excluding Main PCBA)

(Refer to Figure 7-15)

1. Remove the Top Enclosure (see Section 7.3)
2. Loosen three captive screws and remove the screw holding the PCBA shroud cover, then remove the cover.
3. Remove desired PCBA by pulling up on two top corners using a slight rocking motion.

7.30 Installation of Printed Circuit Boards

Note: The Main PCBA must be installed first.

1. Reverse removal procedures.

7.31 Removal of Main PCBA

(Refer to Figure 7-16 unless specified otherwise)

1. Remove the Top Enclosure (see Section 7.3).
2. Remove all vertically mounted PCBAs on the Main PCBA and store individually in a conductive bag (see Section 7.29).
3. Remove the back-up alarm assembly per Section 7.25, but do not disconnect the red and black wires from the alarm.
4. Hang the alarm assembly over the edge of the Bottom Enclosure.
5. Remove the outer back-up alarm cover and mesh filter.
6. Remove the AC Distribution Panel (see Section 7.27).

7. Remove ten screws holding cables (MAIN CN21, MAIN CN9, MAIN CN7, MAIN CN10 and MAIN CN8), then disconnect cables. **Note: Pull on the connector not the cable.**
8. Remove twelve jackscrews from female connectors on the Main PCBA.
9. Remove the screw holding the L-bracket to the PCBA shroud then remove the L-bracket (see Figure 7-14).
10. Remove PCBA shroud.
11. Remove six jackscrews from the external connectors at the rear of the enclosure.
12. Remove nine screws holding the Main PCBA to the tray then remove the Main PCBA.

7.32 Installation of Main PCBA

1. Reverse removal procedures. **Note: Do not tighten jackscrews on the CNXX connectors until all are assembled.**

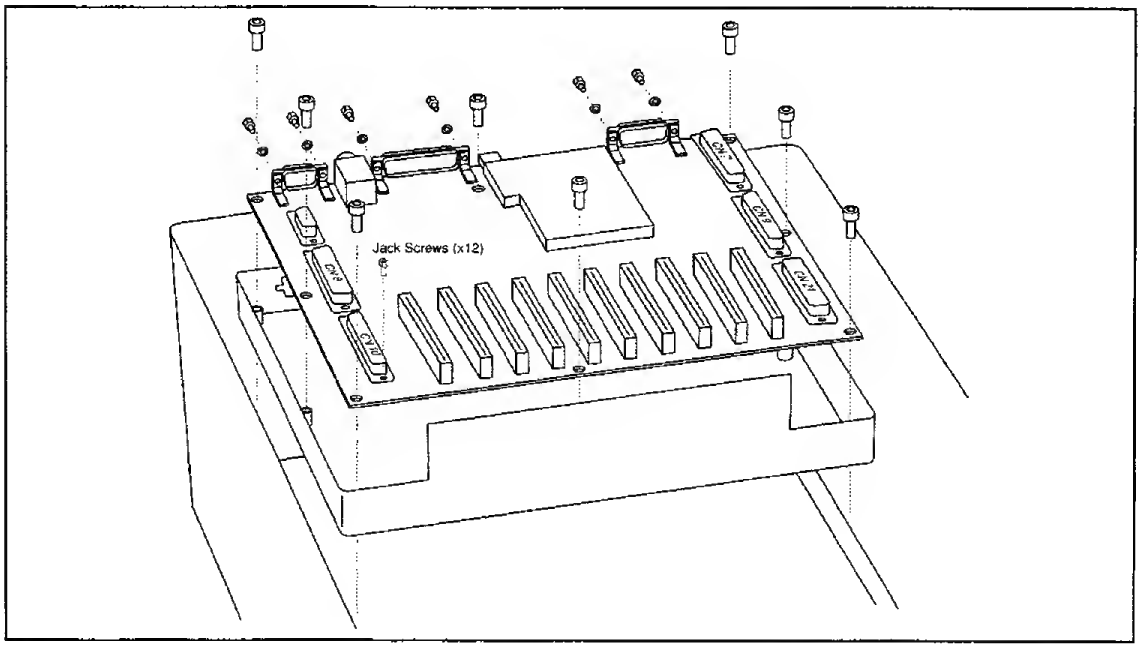


Figure 7-16: Main PCBA

7.33 Removal of Power Switch

(Refer to Figure 7-17)

1. Remove Top Enclosure (see Section 7.3).
2. Disconnect the cable (ON/OFF SW) from the Power Switch.
3. Press the flex clips on the side of the switch and push down to remove the switch.

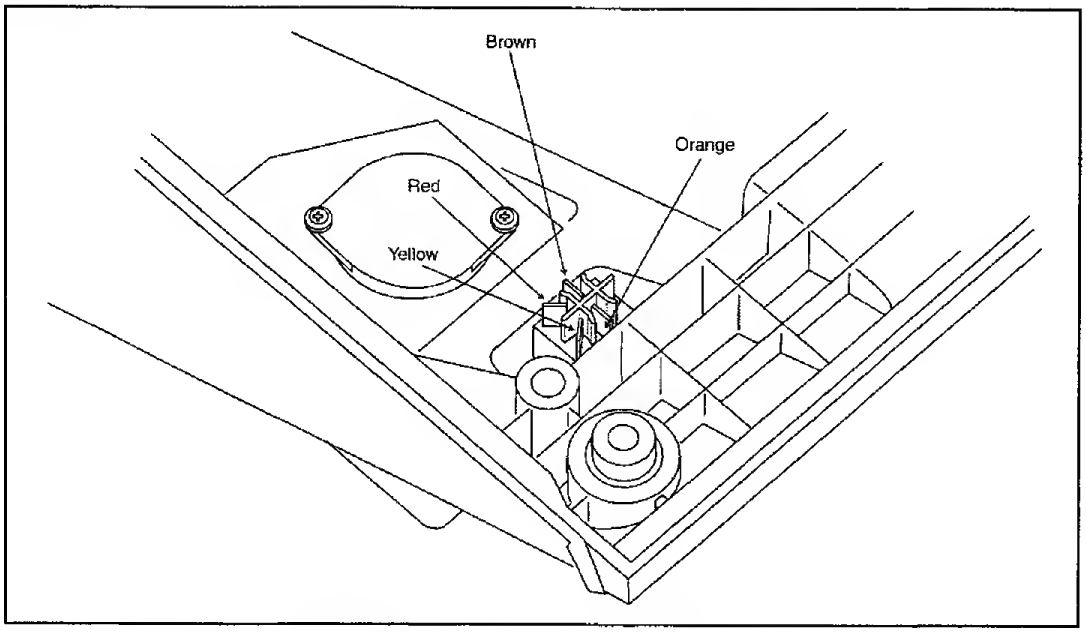


Figure 7-17: Power Switch Wire Connections

7.34 Installation of Power Switch

1. Reverse removal procedures noting the orientation of the switch.

7.35 Removal of FIO2 Connector

1. Remove Top Enclosure (see Section 7.3).
2. Cut the tie wrap binding the FIO2 cable near the Sensor PCBA.
3. Disconnect the cable (SEN J7) from the Sensor PCBA.
4. Remove the nut and washer holding the FIO2 Connector, then remove the connector.

7.36 Installation of FIO2 Connector

1. Reverse removal procedures.

7.37 Removal of Exhalation Flow Sensor

(Refer to Figure 7-18)

1. Remove the Top Enclosure (see Section 7.3).
2. Remove the Enclosure Brace.
3. Cut tie wrap holding the Exhalation Flow Sensor to the Exhalation Valve and the tie wrap holding the cable (EXH F/S) to the Exhalation Flow Sensor.
4. Disconnect cable (EXH F/S) from the Exhalation Flow Sensor.
5. Remove the screw holding the outlet manifold to the Exhalation Valve.
6. Remove the screw holding the outlet manifold to the Bottom Enclosure.
7. Push the flow sensor toward the vent port.

8. Wiggle the outlet block from the exhalation manifold then remove the Exhalation Flow Sensor.

7.38 Installation of Exhalation Flow Sensor

Note: The Filter Heater Assembly and Exhalation Valve Assembly must be installed first.

(Refer to Figure 7-18 unless otherwise specified)

1. Inspect the two o-rings on the exhalation output manifold for cracks or deformation. Replace as necessary. Lightly lubricate the o-rings. **Note: The CV4 check valve should remain inside the exhalation valve when the outlet manifold is removed. If it falls out, install it into the exhalation valve assembly per Figure 7-17.**
2. Gently push the Exhalation Flow Sensor through the ventilator output hole. The flow arrow on the sensor must point toward the ventilator outlet hole.
3. Fasten the output manifold to the Exhalation Valve using the screw.
4. Fasten the output manifold to the Bottom Enclosure using the screw.
5. Insert the flow sensor completely into the Exhalation Valve using a slight rotating motion and fasten with a tie wrap. Do not tighten the tie wrap with a tool. Hand tighten only.
6. Connect cable (EXH F/S) to the flow sensor and fasten with a tie wrap. Do not tighten the tie wrap with a tool. Hand tighten only.
7. Install Enclosure Brace.
8. Install Top Enclosure (see Section 7.4).

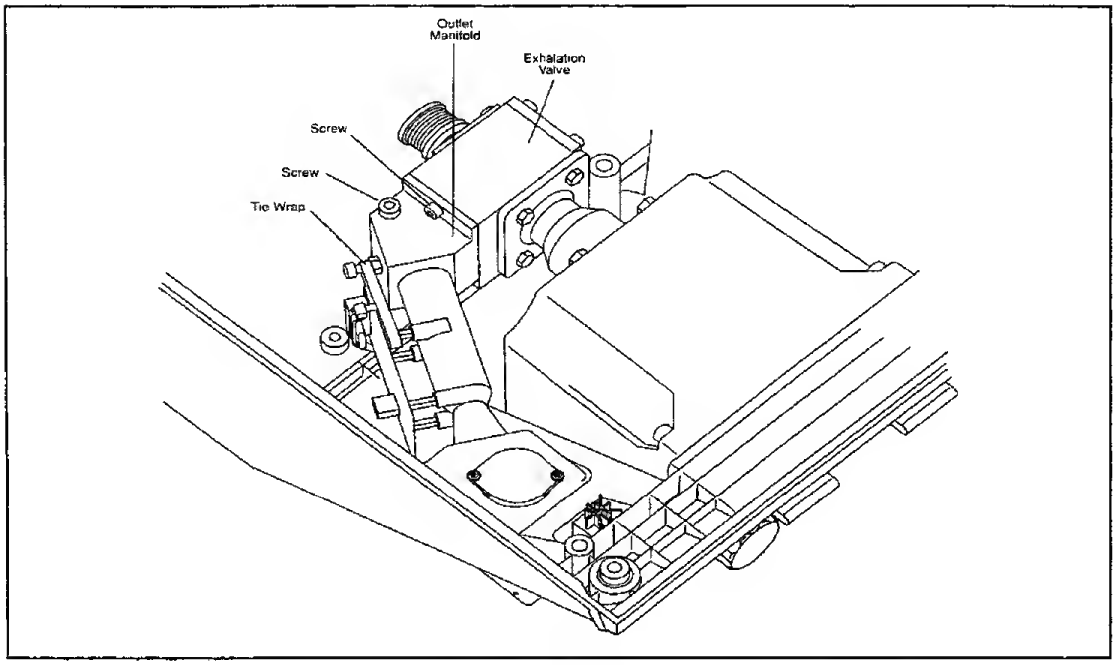


Figure 7-18: Exhalation Flow Sensor

7.39 Removal of Exhalation Valve Assembly

(Refer to Figure 7-19)

1. Remove the Top Enclosure (see Section 7.3).
2. Remove the Enclosure Brace.
3. Remove the Exhalation Flow Sensor (see Section 7.37).
4. Disconnect the white and black connectors on the Exhalation Valve from the cable (MTR EV).
5. Disconnect the transfer tube from the inspiratory manifold.
6. Remove four screws holding the Exhalation Valve to the heater inlet port then carefully remove the Exhalation Valve. **Note: Do not damage the coiled spring.**

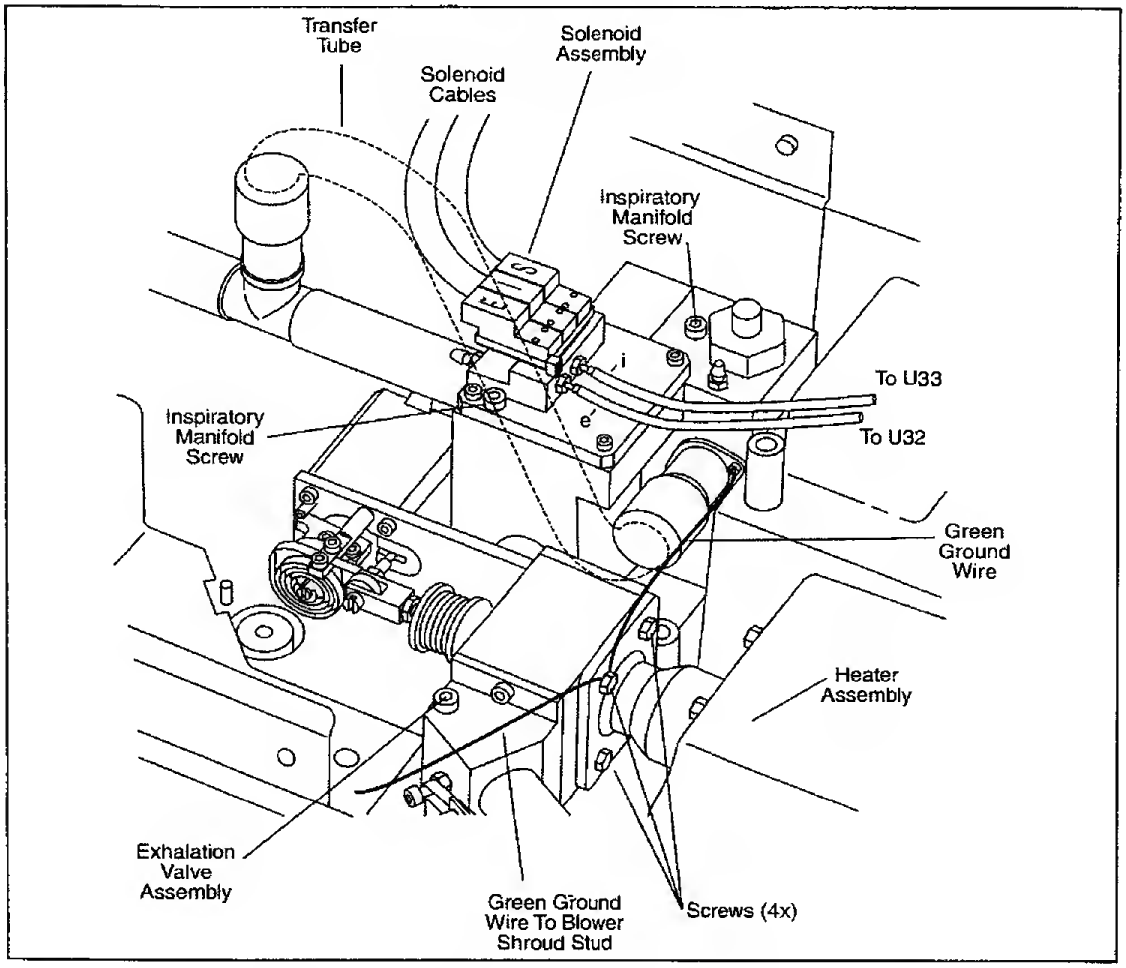


Figure 7-19: Exhalation Valve and Filter Heater Assembly

7.40 Installation of Exhalation Valve Assembly

NOTE: The Filter Heater Assembly must be installed first.

(Refer to Figure 7-19 unless specified otherwise)

1. Inspect the o-ring on the inlet port of the filter heater assembly for cracks or deformation. Replace as necessary. Lightly lubricate the o-ring.
2. Check that the CV4 check valve is oriented and seated properly (see Figure 7-20). **Important: CV4 must be oriented as shown in Figure 7-20.**
   Note: If installing a brand new exhalation valve skip this step since CV4 will already be assembled into the valve.
3. Fasten the Exhalation Valve to the Filter Heater Assembly using four screws. **Note: Be sure to connect the two green ground wires to the top screw closest to the Exhalation Flow Sensor.**
4. Connect the transfer tube to inspiratory manifold.
5. Route the two cables (MTR EV) from the Exhalation Valve under the aluminum transfer tube on the Oxygen Flow Sensor then connect them to the cable (MTR EV).
6. Install the Exhalation Flow Sensor (see Section 7.38).
7. Install the Enclosure Brace.
8. Install the Top Enclosure (see Section 7.4).

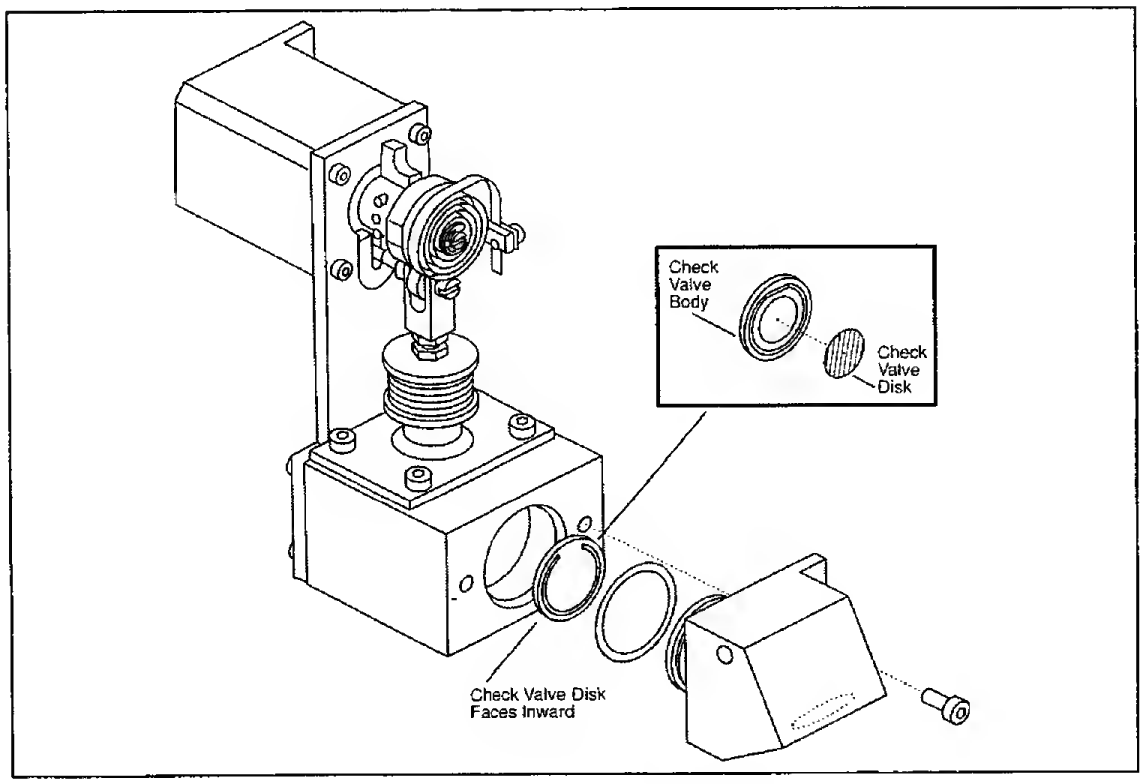


Figure 7-20: CV4 Check Valve Orientation

7.41 Removal of Primary Alarm

1. Remove the Top Enclosure (see Section 7.3).
2. Disconnect the primary alarm cable from the cable (P ALARM).
3. Remove two screws holding the alarm then remove the alarm.

7.42 Installation of Primary Alarm

1. Reverse removal procedures.

7.43 Removal of Filter Heater Assembly

(Refer to Figure 7-21 unless specified otherwise)

1. Remove the Top Enclosure (see Section 7.2).
2. Remove Enclosure Brace.
3. Remove the Exhalation Flow Sensor (see Section 7.37).
4. Disconnect the heater assembly cable (HEATER) from the mating cable (HEATER).
5. Disconnect the silicon tube from the tube nipple then push the Filter Heater Assembly out from the bottom enclosure.
6. Remove four screws holding the Exhalation Valve to the Heater Assembly (see Figure 7-19).

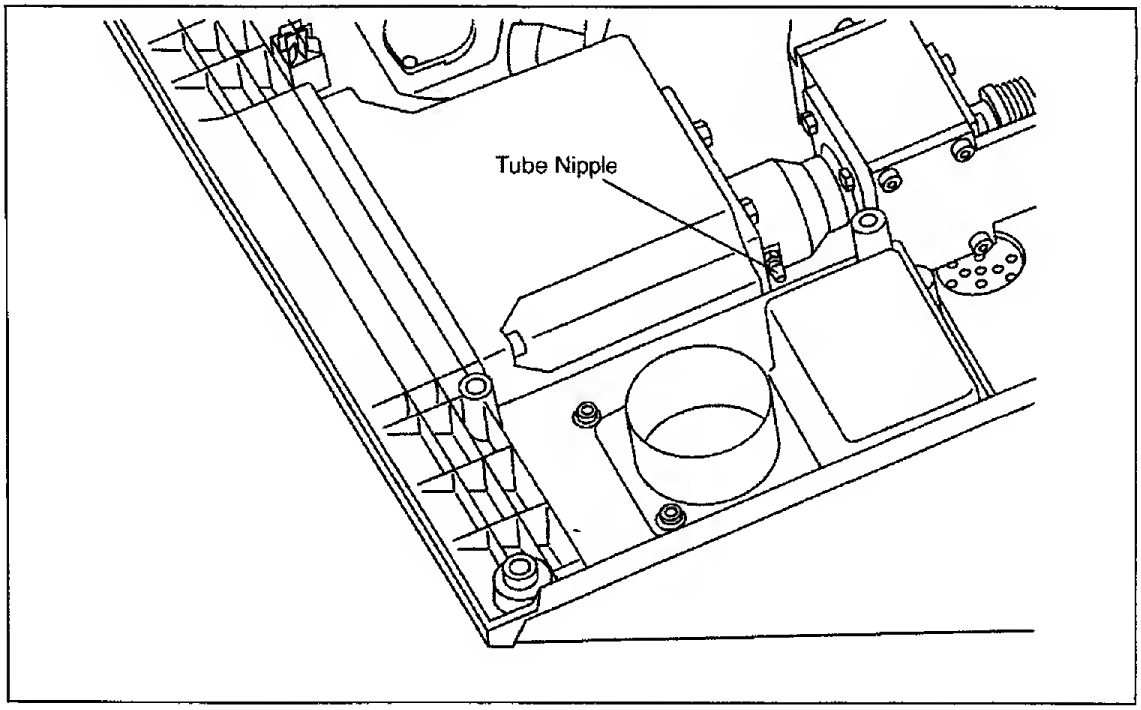


Figure 7-21: Filter Heater Tube Connection

7.44 Installation of Filter Heater Assembly

1. Reverse removal procedures.

7.45 Removal of Oxygen Flow Sensor

(Refer to Figure 7-24)

1. Remove the Top Enclosure (see Section 7.3).
2. Remove the Enclosure Brace.
3. Completely remove the retaining clip from the Oxygen Flow Sensor.
4. Cut the tie wrap holding the cable (O2 F/S) to the Oxygen Flow Sensor, then disconnect the cable.
5. Gently push the Oxygen Flow Sensor and the aluminum transfer tube toward each other then remove them.

7.46 Installation of Oxygen Flow Sensor

Note: The O2 Regulator Assembly, O2 Module Assembly and Inspiratory Manifold Assembly must be installed first.

(Refer to Figure 7-24)

1. Check the two o-rings on the aluminum transfer tube for cracks or deformation. Replace as necessary. Lightly lubricate the o-rings.
2. Slide the aluminum transfer tube onto the outlet of the flow sensor.
3. With the flow arrow pointing toward the inspiratory manifold, engage the flow sensor into the oxygen valve outlet port, then push the aluminum transfer tube into the inspiratory manifold. Make sure the flow sensor and aluminum transfer tube are pushed completely into their respective ports. **Note: The Oxygen Flow Sensor board must face up. Note: Route cables MTR O2, MTR BV and MTR EV underneath the Oxygen Flow Sensor.**
4. Place the retaining ring around the outlet of the flow sensor and fasten with screw.
5. Connect the cable labeled O2 F/S to the Oxygen Flow Sensor then tie wrap it to the circuit board. Pull the tie wrap snug. Do not tighten with a tie wrap gun.
6. Install the Enclosure Brace.
7. Install the Top Enclosure (see Section 7.4).

7.47 Removal of Inspiratory Manifold Assembly

(Refer to Figure 7-22 unless specified otherwise)

1. Remove the Top Enclosure (see Section 7.3).
2. Remove Enclosure Brace.
3. Remove the Oxygen Flow Sensor (see Section 7.45)
4. Disconnect the tubes from the Exhalation (E) and Inspiratory (I) solenoids (see Figure 7-19).
5. Disconnect tubes 1 – 4 from the inspiratory manifold.
6. Disconnect three cables (SAFETY SOL), (INSP SOL) and (EXHAL SOL) from the Solenoid Assembly (see Figure 7-19).
7. Remove two screws holding the inspiratory manifold (see Figure 7-19).

8. Remove the screw holding the green ground wire to the inspiratory manifold (see Figure 7-19).
9. Loosen the locking screw, but do not remove it.
10. Remove the silicon transfer tube # 5 from the inspiratory manifold inlet (see Figure 7-19).
11. Remove four screws and washers holding the inspiratory outlet port to the enclosure then pull the outlet port from the inspiratory manifold (see Figure 7-23).
12. Remove the inspiratory manifold.

7.48 Installation of Inspiratory Manifold Assembly

Note: The O2 Regulator Assembly and O2 Module Assembly must be installed first.

(Refer to the Figure identified in each step)

1. Check the two o-rings on the aluminum transfer tube for cracks or deformation. Replace as necessary. Lightly lubricate the o-rings (see Figure 7-24).
2. Install the inspiratory assembly using two screws. Engage a few threads but do not tighten at this time (see Figure 7-19).
3. Connect the silicon tube from the Air Flow Sensor to the male port on the inspiratory manifold (see Figure 7-23). **Note: Route cables MTR O2, MTR BV and MTR EV underneath the silicone tube.**
4. Install the Oxygen Flow Sensor (see Section 7.46).
5. Fasten the inspiratory manifold by tightening the two screws (see Figure 7-19). Torque to 5 in-lbs.
6. Connect the green ground wire to the inspiratory manifold using the screw previously removed (see Figure 7-19).

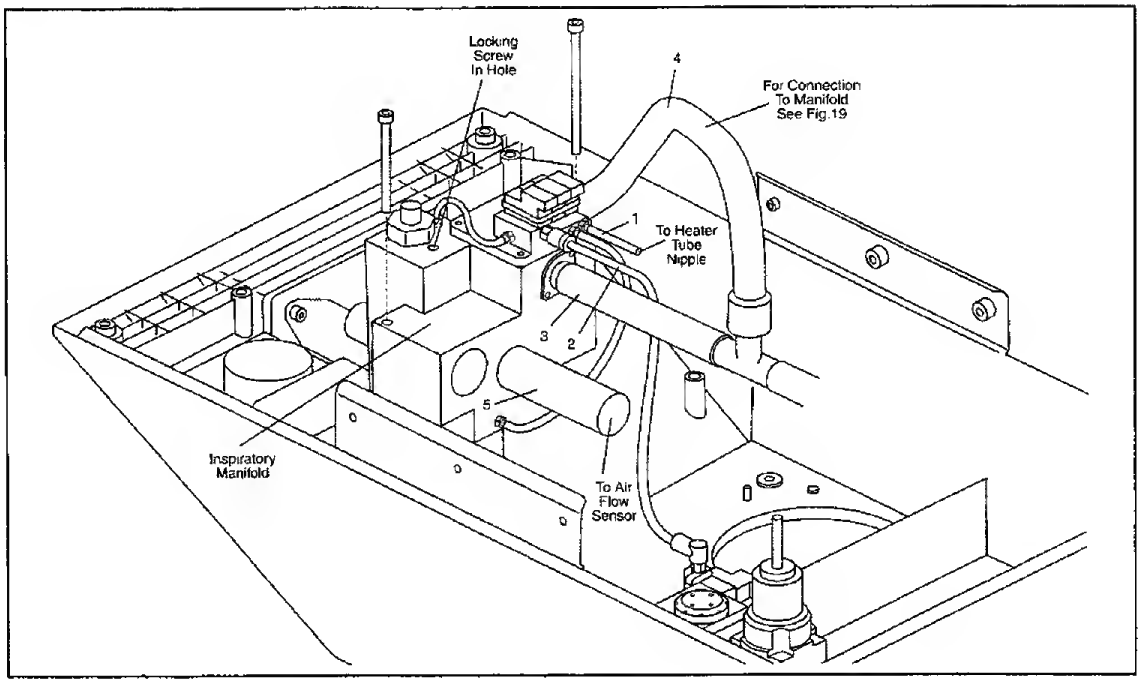


Figure 7-22: Inspiratory Manifold Assembly

8. Install four screws with washers near the inspiratory outlet port (see Figure 7-23).
9. Check the o-ring on the inspiratory outlet for cracks or deformations (see Figure 7-23). Replace as necessary. Lightly lubricate the o-ring.
10. Check that the CV3 check valve in the inspiratory outlet is oriented and seated properly (see Figure 7-23).
11. Insert the inspiratory port completely into the inspiratory manifold and fasten by tightening the locking screw (see Figure 7-22). Pull on the inspiratory outlet to ensure it does not come out or rotate.
12. Reconnect the Exhalation (E) and Inspiratory (I) tubes to their respective solenoids (see Figure 7-19)
13. Reconnect the silicon tubes 1 – 5 to the inspiratory manifold (see Figure 7-22).
14. Reconnect the cables labeled EXHAL SOL, INSP SOL and SAFETY SOL (see Figure 7-19).
15. Install the Enclosure Brace.
16. Install the Top Enclosure (see Section 7.4).

7.49 Removal of 3 Station Solenoid Assembly

(Refer to Figure 7-19)

1. Remove Top Enclosure (see Section 7.3).
2. Remove Enclosure Brace.
3. **Label six tubes connected to the Solenoid Assembly with tape so they can be reassembled properly, then disconnect them.**
4. Disconnect three cables (SAFETY SOL, INSP SOL and EXHAL SOL) and six tubes from the Solenoid Assembly.

5. Remove five screws holding the Solenoid Assembly to the inspiratory manifold, then remove the Solenoid Assembly. **Note: Do not remove the diaphragm, spring or o-ring.**

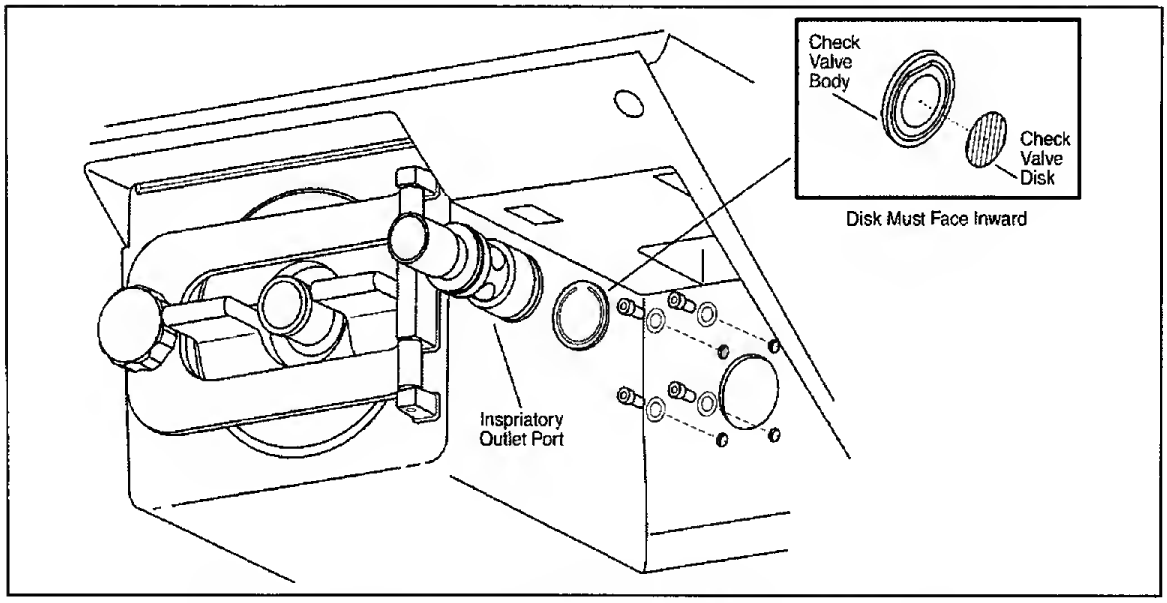


Figure 7-23: Inspiratory Outlet Port and CV3 Check Valve Orientation

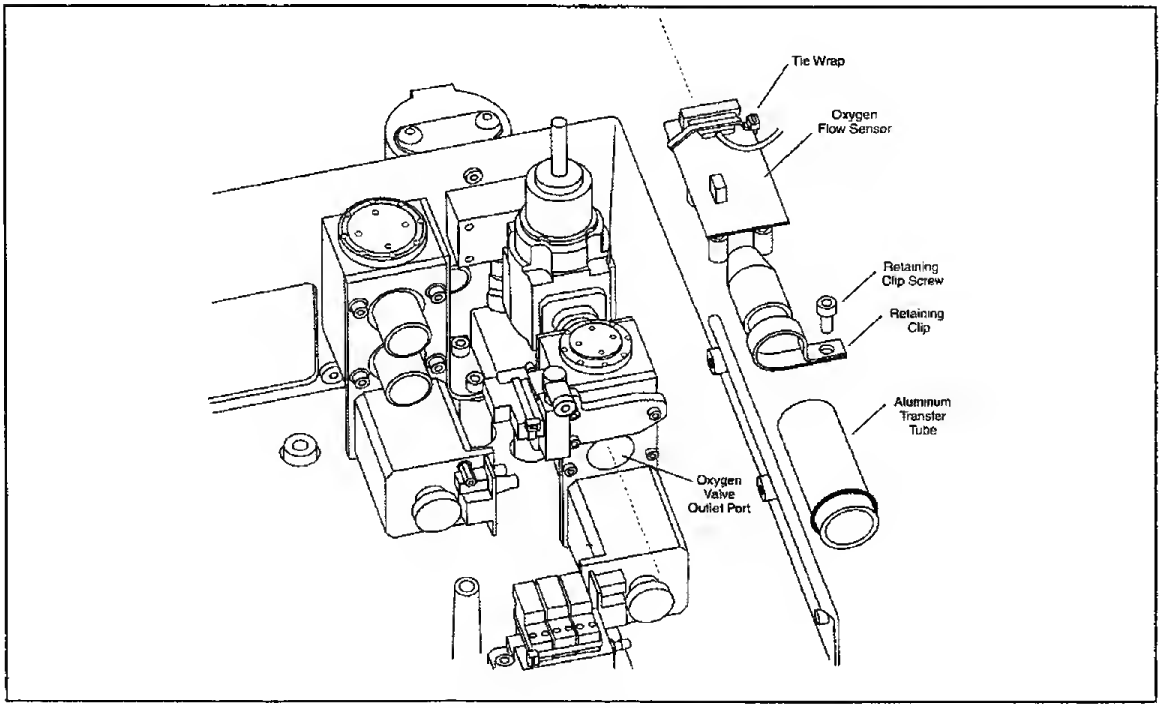


Figure 7-24: Oxygen Flow Sensor

7.50 Installation of 3 Station Solenoid Assembly

(Refer to Figure 7-19 unless specified otherwise)

1. Place the Solenoid Assembly on the Diaphragm and fasten with five screws. Torque screws to 5 in-lbs. **Note the orientation of the Solenoid Assembly on the inspiratory manifold.**
2. Reconnect six tubes and three cables (SAFETY SOL, INSP SOL and EXHAL SOL) to the Solenoid Assembly, **then remove the tape** (see Figure 7-19 and Figure 7-22).
3. Install Enclosure Brace.
4. Install Top Enclosure (see Section 7.4).

7.51 Removal of Air Flow Sensor

(Refer to Figure 7-25)

1. Remove the Top Enclosure (see Section 7.3).
2. Remove the Enclosure Brace.
3. Disconnect the transfer tube from the top port of the Blower (Air) Valve.
4. Disconnect the tube from the "Safety Valve Port" port then fold the tube/tee assembly away from air flow sensor.
5. Cut the tie wrap holding the cable (AIR F/S) to the flow sensor, then remove the cable from the flow sensor.
6. Loosen the screw holding the retaining clip until threads are disengaged.
7. Remove the flow sensor with silicone tubes attached. **Note: If air flow sensor is to be replaced, cut the tie wraps the remove the silicone tubes.**

7.52 Installation of Air Flow Sensor

Note: The O2 Regulator assembly and the Blower (Air) Valve must be installed first.

(Refer to Figure 7-25)

1. Assemble the flow sensor with silicone tubes attached between the bottom port of the Blower (Air) Valve and the bottom port on the Inspiratory Manifold. **Note: The flow sensor circuit board must face away from the blower. Note: The flow arrow must point toward the inspiratory manifold.**
2. Fasten the flow sensor to the bottom enclosure post using the retaining ring and screw.
3. Connect the cable labeled AIR F/S to the Air Flow Sensor then tie wrap it to the circuit board. Pull the tie wrap snug. Do not tighten with a tie wrap gun.
4. Reconnect the silicone tube from the tube/tee assembly to the "Safety Valve Port."
5. Connect the transfer tube to the top port of the Blower (Air) Valve.
6. Install the Enclosure Brace.
7. Install Top Enclosure (see Section 7.4).

7.53 Removal of Blower (Air) Valve Assembly

(Refer to Figure 7-26)

1. Remove the Top Enclosure (see Section 7.3).
2. Remove the Enclosure Brace.
3. Remove the Air Flow Sensor but do not cut the tie wrap or disconnect the AIR F/S cable from the flow sensor. (see Section 7.51).
4. Disconnect the two cables on the Blower (Air) Valve (MTR BV) from the mating cable (MTR BV).
5. Disconnect the silicon tube from the Crossover Solenoid Assembly.
6. Remove two screws holding the blower valve bracket, then carefully remove the Blower Valve.

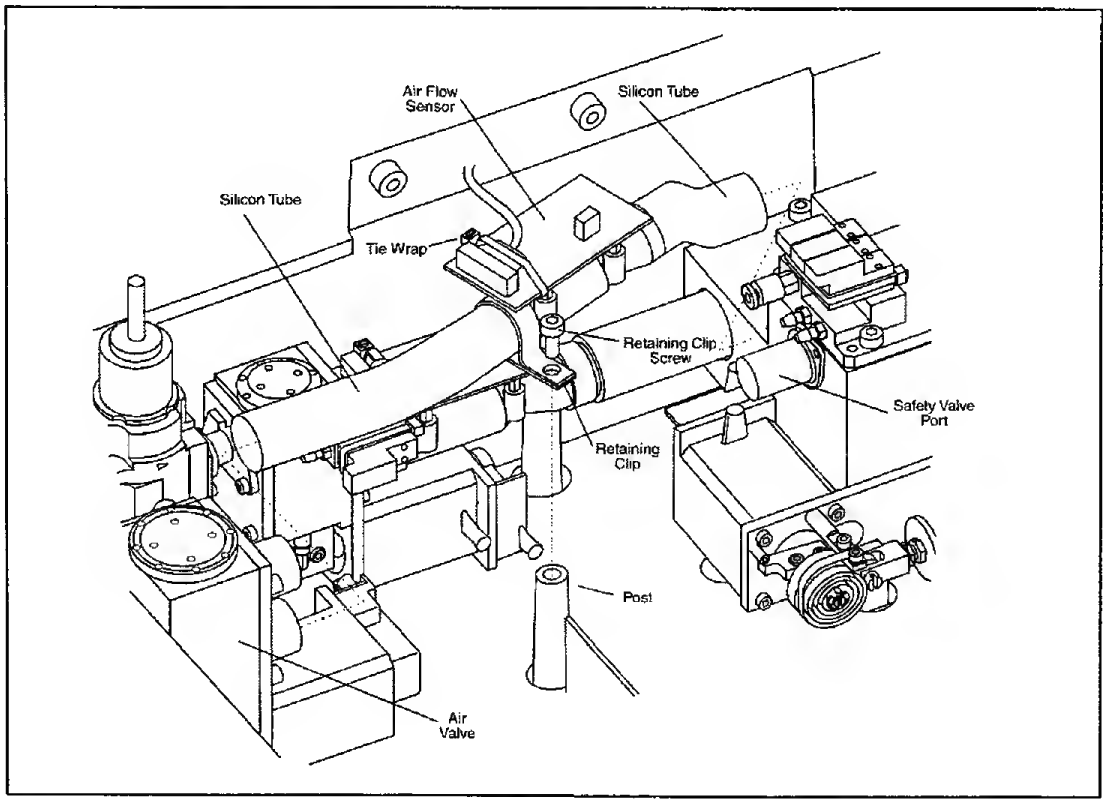


Figure 7-25: Air Flow Sensor

7.54 Installation of Blower (Air) Valve Assembly

Note: The Oxygen Regulator Assembly must be installed first.

1. Reverse removal procedures.

7.55 Removal of Oxygen Valve Assembly

(Refer to Figure 7-27 unless specified otherwise)

1. Remove the Top Enclosure (see Section 7.3).
2. Remove the Enclosure Brace.
3. Remove the Oxygen Flow Sensor (see Section 7.45), but do not cut the tie wrap or disconnect the cable (O2 F/S) from the flow sensor.
4. Remove the Air Flow Sensor but do not cut the tie wrap or disconnect the cable (AIR F/S) from the flow sensor (see Section 7.51).
5. Remove the Blower (Air) Valve Assembly (see Section 7.53).
6. Disconnect the two cables on the Oxygen Valve (MTR O2) from the mating cable (MTR O2).
7. Disconnect the cable (CROSS SOL) from the Crossover Solenoid Assembly.
8. Disconnect the red wire from the positive terminal and the black wire from the negative terminal of the Elapsed Time Meter.
9. Remove three screws holding the oxygen valve bracket.
10. Slowly pull the Oxygen Valve Assembly from the Oxygen Regulator.

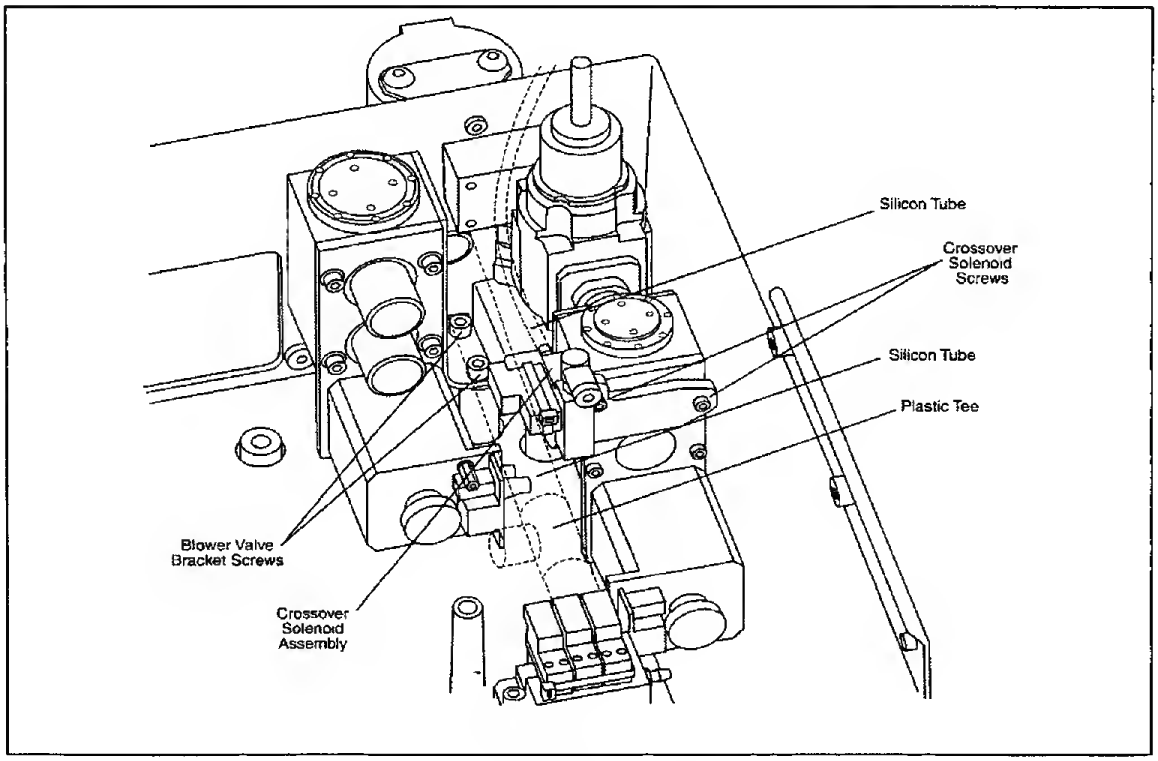


Figure 7-26: Blower (Air) Valve

7.56 Installation of Oxygen Valve Assembly

Note: The Oxygen Regulator Assembly must be installed first.

1. Inspect the two o-rings on the Oxygen Valve inlet and outlet ports for cracks or deformation. Replace as necessary. Lightly lubricate the o-rings.
2. Reverse removal procedures.

7.57 Removal of Crossover Solenoid Assembly

(Refer to Figure 7-26)

1. Remove the Top Enclosure (see Section 7.3).
2. Disconnect the cable (CROSS SOL) from the Crossover Solenoid Assembly.
3. Disconnect the silicon tube from the Crossover Solenoid Assembly.
4. Remove two screws holding the crossover solenoid assembly bracket to the Oxygen Valve, then remove the Crossover Solenoid Assembly.

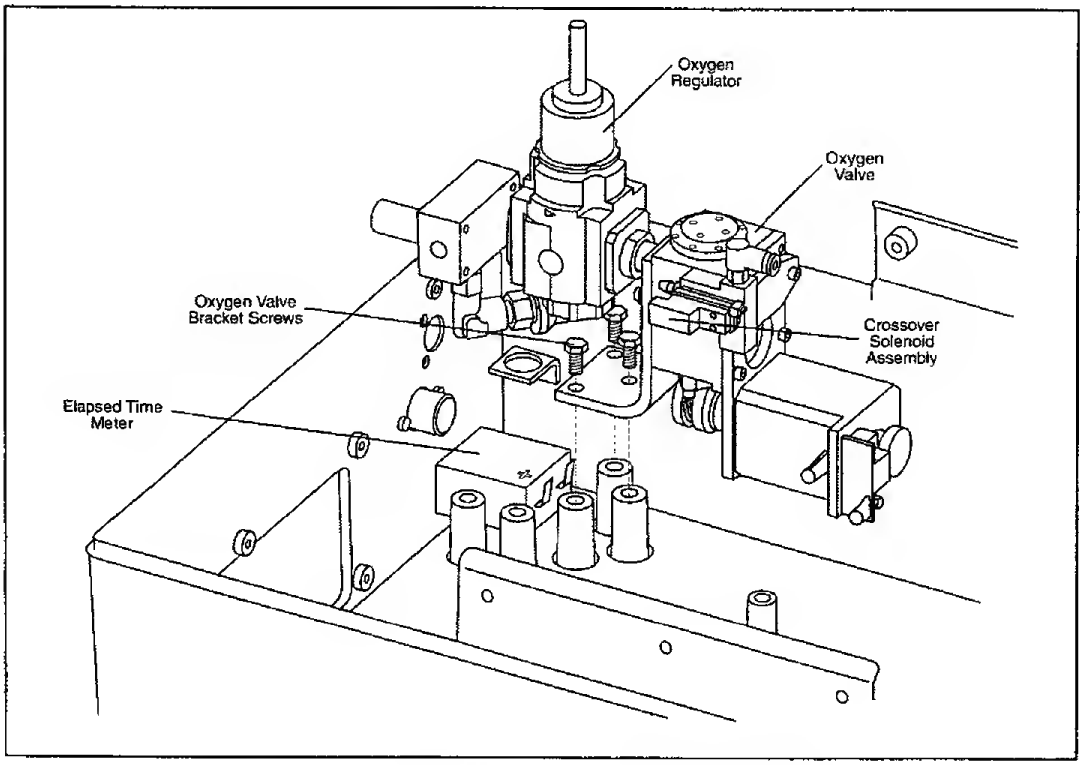


Figure 7-27: Oxygen Valve and Oxygen Regulator

7.58 Installation of Crossover Solenoid Assembly

1. Inspect the o-ring for cracks and deformation. Replace as necessary. Lightly lubricate the o-ring.
2. Reverse removal procedures.

7.59 Removal of Oxygen Regulator Assembly (includes Oxygen Pressure Switch)

(Refer to Figure 7-28 unless specified otherwise)

1. Remove the Top Enclosure (see Section 7.3).
2. Remove the Enclosure Brace.
3. Remove the Oxygen Flow Sensor (see Section 7.45), but do not cut the tie wrap or disconnect the cable labeled O2 F/S from the flow sensor.
4. Remove the Air Flow Sensor but do not cut the tie wrap or disconnect the cable labeled AIR F/S from the flow sensor (see Section 7.51).
5. Remove the Blower Valve Assembly (see Section 7.53).
6. Remove the Oxygen Valve Assembly (see Section 7.55).
7. Remove three screws holding the bracket to the Oxygen Water Trap/Inlet Filter Assembly and bottom enclosure, then remove the bracket.
8. Unscrew the bowl from the Oxygen Water Trap/Inlet Filter Assembly.
9. Remove the Oxygen Water Trap/Inlet Filter Assembly by unscrewing it from the inlet block.
10. Disconnect the two black wires from connectors J5 and J6 on the Sensor PCBA.
11. Carefully cut the tie wraps binding the two black wires near the Sensor PCBA.
12. Remove four screws holding the plate then remove the Oxygen Regulator Assembly.

7.60 Installation of Oxygen Regulator Assembly (includes Oxygen Pressure Switch)

(Refer to Figure 7-28)

1. Fasten the plate and the Oxygen Regulator Assembly to the bottom enclosure using four screws.
2. Remove any residual teflon tape from male and female threads
3. Apply 2 ½ turns of teflon tape to the thread of the inlet block.
4. Screw the Oxygen Water Trap/Inlet Filter Assembly onto the inlet block (clockwise) until one thread is showing and the assembly is perpendicular to the floor.
5. Screw the bowl onto the Oxygen Water Trap/Inlet Filter Assembly.
6. Fasten the bracket to the Oxygen Water Trap/Inlet Filter Assembly and bottom enclosure using three screws.
7. Connect the two black wires from the oxygen pressure switch to the J5 and J6 connectors on the Sensor PCBA. Polarity is not important.
8. Fasten the two black wires to the bundle of cables running across the top of the Sensor PCBA with two tie wraps.
9. Install the Oxygen Valve Assembly (see Section 7.56).
10. Install the Blower Valve Assembly (see Section 7.54).
13. Install the Air Flow Sensor (see Section 7.52).
14. Install the Oxygen Flow Sensor (see Section 7.46).
15. Install the Enclosure Brace.
16. Install the Top Enclosure (see Section 7.4).

7.61 Removal of Elapsed Time Meter

(Refer to Figure 7-28)

1. Disconnect all oxygen and power sources from the ventilator.
2. Unscrew the bowl from the Oxygen Water Trap/Inlet Filter Assembly.
3. Remove the two screws holding the Elapsed Time Meter to the bottom enclosure then slowly pull the meter from the enclosure to expose the attached wires.
4. Disconnect the red wire from the positive terminal and the black wire from the negative terminal, then remove the meter.

7.62 Installation of Elapsed Time Meter

1. Reverse removal procedures.

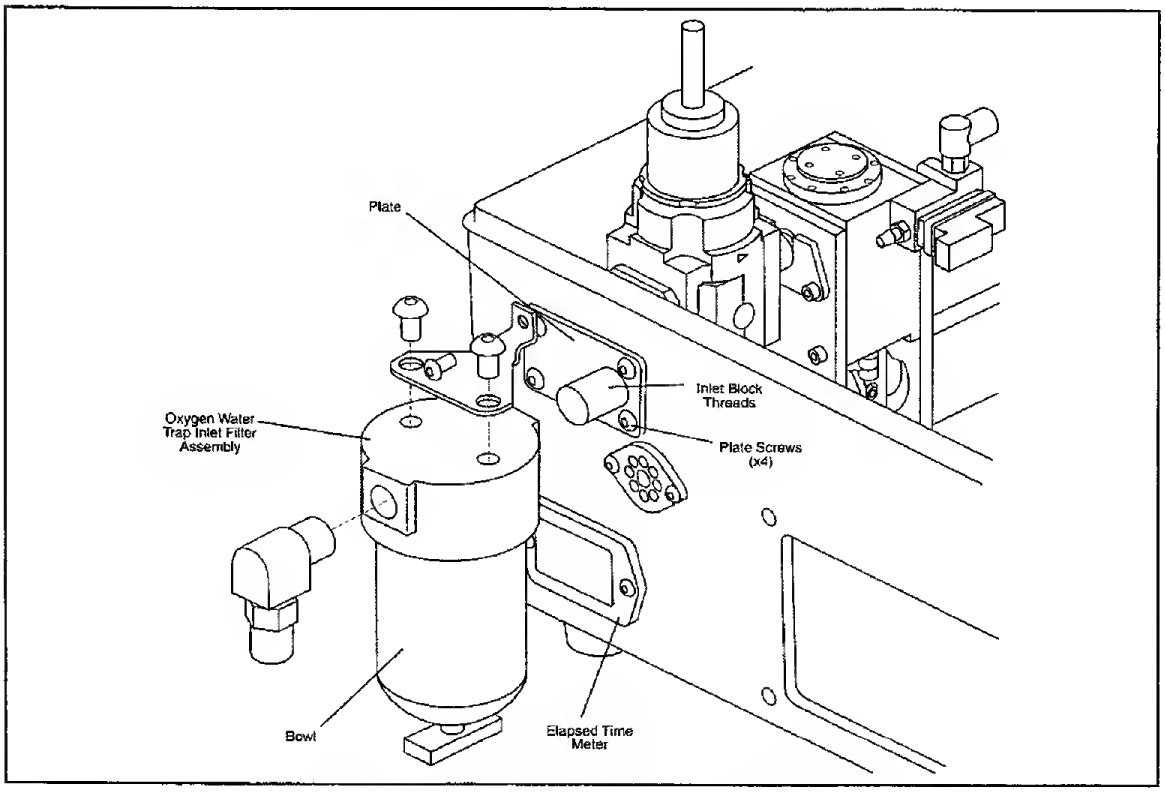


Figure 7-28: Oxygen Water Trap/Inlet Filter Assembly

7.63 Removal of Oxygen Water Trap/ Inlet Filter Assembly

(Refer to Figure 7-28)

1. Disconnect the oxygen hose from the ventilator.
2. Remove three screws holding the bracket to the Oxygen Water Trap/Inlet Filter Assembly and bottom enclosure, then remove the bracket.
3. Unscrew the bowl from the Oxygen Water Trap/Inlet Filter Assembly.
4. Remove the Oxygen Water Trap/Inlet Filter Assembly by unscrewing it (counterclockwise) from the inlet block.

7.64 Installation of Oxygen Water Trap/ Inlet Filter Assembly

(Refer to Figure 7-28)

1. Clean any residual teflon tape from the thread of the oxygen inlet block
2. Apply 2 ½ turns of teflon tape to the thread of the oxygen inlet block.
3. Screw the Oxygen Water Trap/Inlet Filter Assembly onto the oxygen inlet block until one thread is showing and the assembly is perpendicular to the floor.
4. Screw the bowl onto the Oxygen Water Trap/Inlet Filter Assembly.
5. Fasten the bracket to the Oxygen Water Trap/Inlet Filter Assembly and bottom enclosure using three screws.

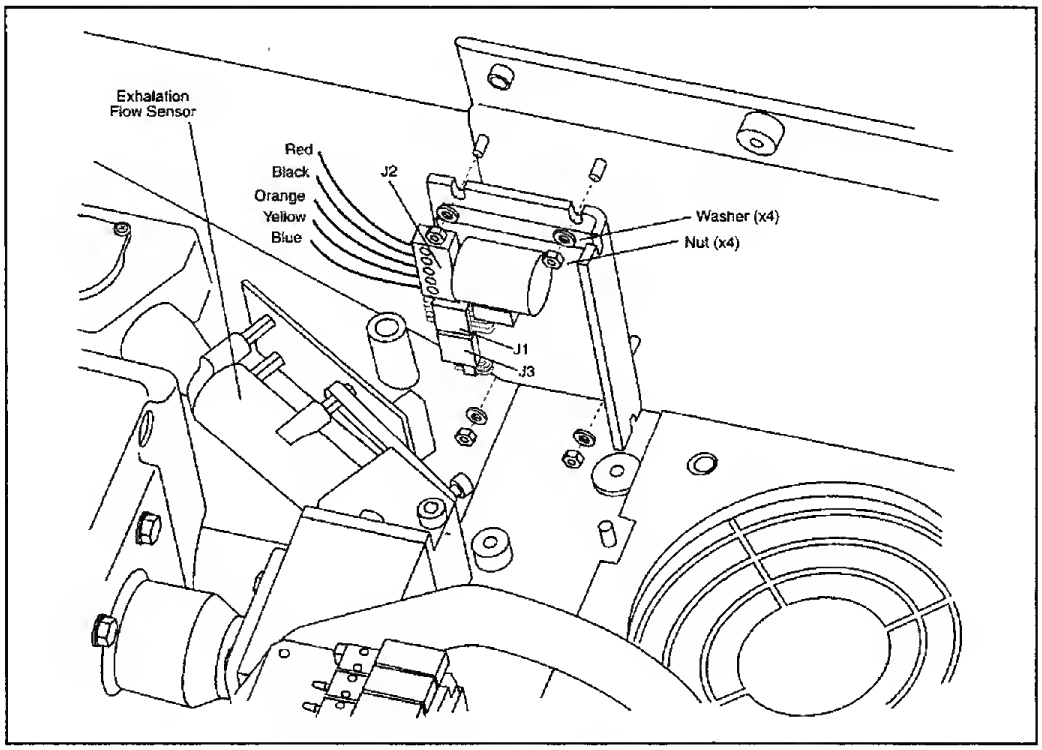


Figure 7-29: Blower Controller PCBA

7.65 Removal of Blower Controller PCBA

(Refer to Figure 7-29)

Note: The Blower Controller PCBA consists of a controller PCB, a smaller blower lock-up PCB and a bracket.

1. Remove the Top Enclosure (see Section 7.3).
2. Remove the Enclosure Brace.
3. Remove four nuts and washers holding the Blower Controller PCBA bracket, then partially remove the bracket.
4. Disconnect the green connector from connector J2 on the large PCB.
5. Disconnect the cables from connectors J2 and J3 on the small PCB (not shown), then remove the entire bracketed assembly.

7.66 Installation of Blower Controller PCBA

(Refer to Figure 7-29)

1. Install nuts and washers onto the two bottom threaded studs. Engage only a few threads at this time.
2. Install the Blower Controller PCBA onto the threaded studs then install the remaining two screws and washers. **Note the orientation of the PCBA. Tighten all four nuts until firm. Do not over-tighten.**
3. Connect the green connector to connector J2 on the large PCBA and cables to connectors J2 and J3 on the small PCBA.
4. Install the Enclosure Brace.
5. Install the Top Enclosure (see Section 7.4).

7.67 Removal of Blower Assembly

(Refer to Figure 7-30 unless specified otherwise)

1. Remove the Top Enclosure (see Section 7.3).
2. Remove the Enclosure Brace.
3. Disconnect the transfer tubes from the plastic tee and the top port of the Blower Valve.
4. Disconnect the silicon tube from the Crossover Solenoid Assembly (see Figure 7-31).
5. Pry the grommet from the Blower Shroud.
6. Remove four lock nuts holding the Blower Shroud.
7. Partially remove the shroud and pull the transfer tube into it, then completely remove the shroud.
8. Loosen the hose clamp holding the silicon tube to blower outlet then disconnect the tube.
9. Disconnect the transfer tube from the bottom of the Cooling Coil.
10. Disconnect the blue, yellow and orange wires from connector J2 on the Blower Controller PCBA by loosening the screws in the connector (see Figure 7-29).
11. Disconnect the cable (BLOWER J1) from connector J1 on the Blower Controller PCBA (see Figure 7-29).

12. Disconnect the cable (SENSOR BRD J3&J4) from the connectors J3 and J4 on the Sensor PCBA.
13. Remove four lock nuts and L-brackets holding the Blower, then remove the Blower (see Figure 7-31).

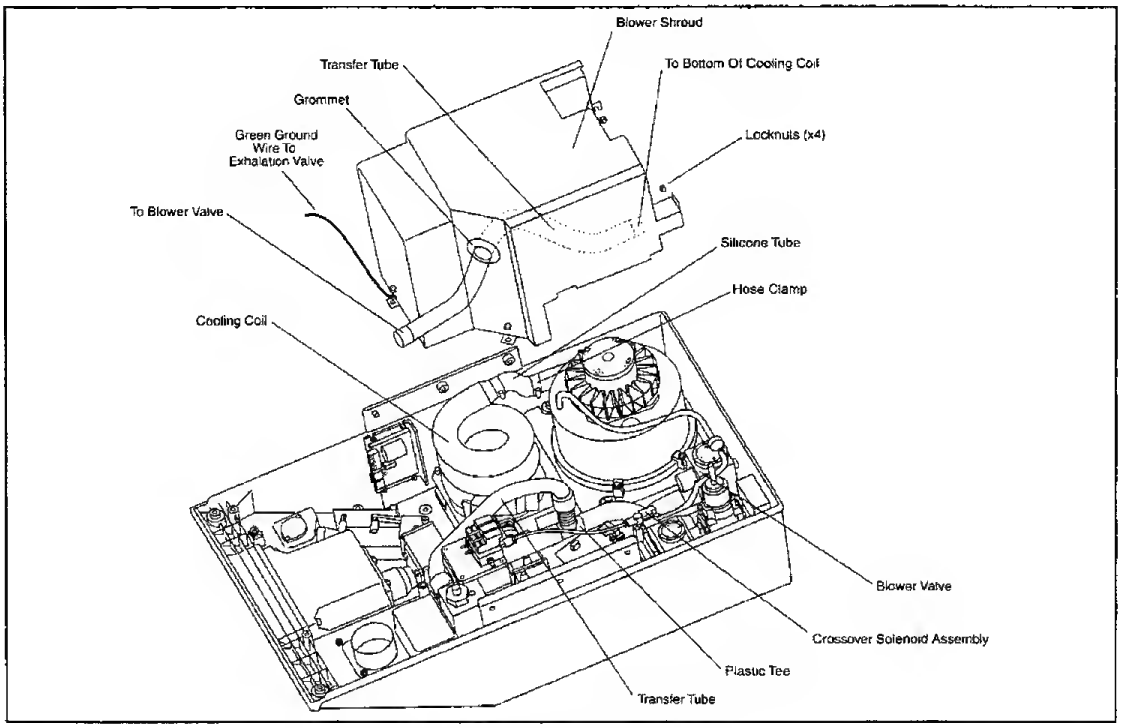


Figure 7-30: Blower Shroud

7.68 Installation of Blower Assembly

Note: The Muffler Assembly must be installed first.

(Refer to Figure 7-30 unless specified otherwise)

1. Install the transfer tube to the bottom of the Cooling Coil.
2. Place the Blower Assembly on the gasket. The blower outlet should be parallel to the enclosure wall. Fasten with four lock nuts and L-brackets (see Figure 7-31). **Note: The L-brackets should be perpendicular to the Blower after torquing. Torque until firm. Do not over-tighten.**
3. Route the blower cables between the Cooling Coil and the enclosure wall.
4. Connect the cable (BLOWER J1) to connector J1 on the Blower Controller PCBA (see Figure 7-29).
5. Connect the blue, yellow and orange wires to connector J2 on the Blower Controller PCBA (see Figure 7-29).
6. Connect the cable (SENSOR BRD J3&J4) to connectors J3 and J4 on the Sensor PCBA. Polarity is unimportant.
7. Connect the silicon tube from the top of the Cooling Coil to the Blower then fasten with the hose clamp.

8. Place the shroud over the Blower while pushing the transfer tube through the hole then install the grommet.
9. Fasten the shroud using four lock nuts. Connect the green ground wire from the Exhalation Valve to the shroud stud. Torque until firm. Do not over-tighten. **Note: Feed the cables from the blower and fan underneath the grommet at the bottom corner of the shroud.**
10. Connect the silicon tube from the Blower to the Crossover Solenoid Assembly (see Figure 7-31).
11. Connect the transfer tubes to the plastic tee and the top port of the Blower Valve.
12. Install the Enclosure Brace.
13. Install the Top Enclosure (see Section 7.4).

7.69 Removal of Blower Muffler Assembly

(Refer to Figure 7-31 unless specified otherwise)

1. Remove the Top Enclosure (see Section 7.3).
2. Remove the Enclosure Brace.
3. Remove the Blower Assembly (see Section 7.67).
4. Disconnect the transfer tube from the bottom of the Cooling Coil (see Figure 7-30).
5. Remove four bolts holding the Muffler Assembly.
6. Peel back the gasket then remove the Muffler Assembly.

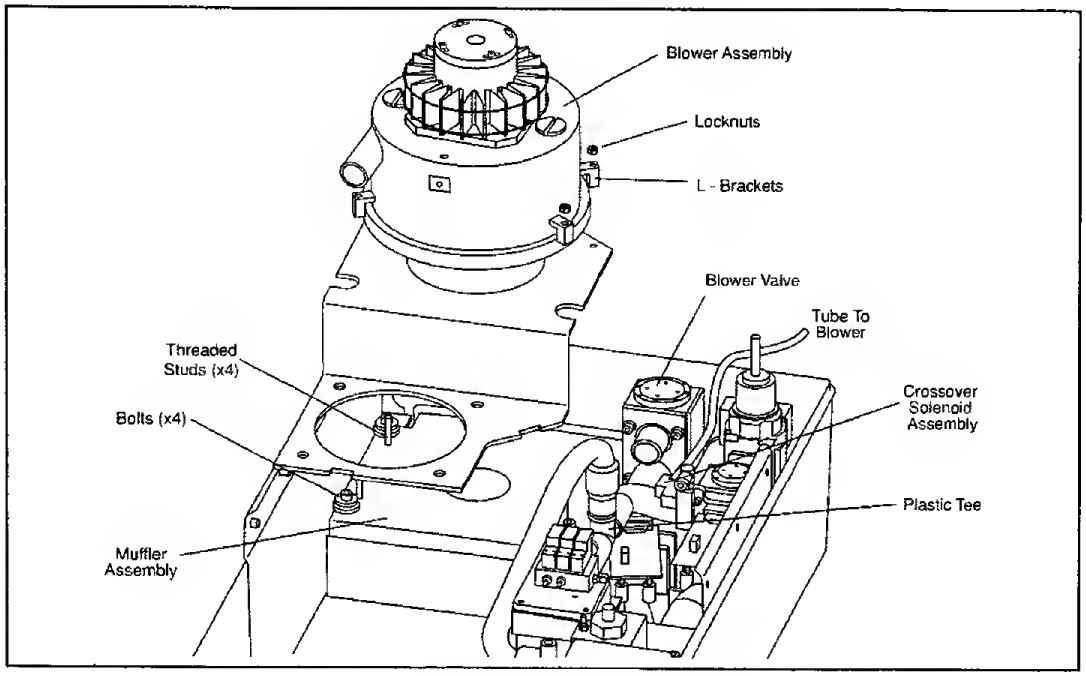


Figure 7-31: Blower Assembly

7.70 Installation of Blower Muffler Assembly

(Refer to Figure 7-31 unless specified otherwise)

1. Install the Muffler Assembly. Make sure the seal covers the blower inlet port.
2. Apply one drop of Loctite 222 to the threads of the four bolts.
3. Torque the bolts until they just touch the Muffler, then back-off 1 ½ turns.
4. Fold the gasket over the threaded studs.
5. Connect the transfer tube to the bottom of the Cooling Coil (see Figure 7-30).
6. Install the Blower Assembly (see Section 7.68).
7. Install the Enclosure Brace.
8. Install the Top Enclosure (see Section 7.4).

7.71 Removal of Cooling Fan/ Cooling Coil Assembly

(Refer to Figure 30 unless specified otherwise)

1. Remove the Top Enclosure (see Section 7.3).
2. Remove the Enclosure Brace.
3. Disconnect the transfer tubes from the plastic tee and the Blower Valve.
4. Disconnect the silicon tube from the Crossover Solenoid Assembly (see Figure 7-31).
5. Pry the grommet from the Blower Shroud.
6. Remove four lock nuts holding the Blower Shroud.
7. Partially remove the shroud and pull the transfer tube into it, then completely remove the shroud.
8. Loosen the hose clamp holding the silicon tube to the blower outlet then disconnect the tube.
9. Disconnect the transfer tube from the bottom of the Cooling Coil.
10. Disconnect three black and three red wires from connector J2 on the Blower Controller PCBA by loosening the screws in the connector (see Figure 7-29).
11. Remove four bolts holding the Cooling Fan then remove the Cooling Coil Assembly and the Fan (see Figure 7-32).

7.72 Installation of Cooling Fan/ Cooling Coil Assembly

(Refer to Figure 7-30 unless specified otherwise)

1. Place the fan on the gasket noting the orientation of the wires. **Note: The fan flow direction arrow must point down and the fan cable should be positioned nearest to the Blower Controller PCBA . Note: Make sure no wires are pinched under the fan (see Figure 7-32).**
2. Place the Cooling Coil Assembly on the fan noting the orientation of the Cooling Coil inlet, then fasten with four bolts (see Figure 7-32). Torque until firm. Do not over-tighten.
3. Connect the three red and three black wires to connector J2 on the Blower Controller PCBA (see Figure 7-29). Once fastened, gently tug on the wires to ensure a good connection.
4. Connect the transfer tube to the bottom of the Cooling Coil.
5. Connect the silicon tube to the top of the blower outlet and fasten with the hose clamp.
6. Push the transfer tube through the hole in the shroud then install the grommet.

7. Fasten the shroud using four lock nuts. Connect the green ground wires from the Exhalation Valve and Solenoid Assembly to the shroud stud. Tighten until firm. Do not over-tighten. **Note: Feed cables from blower and underneath the grommet at the bottom corner of the shroud.**
8. Connect the silicon tube from the Blower to the Crossover Solenoid Assembly (see Figure 7-31).
9. Connect the transfer tubes to the top port of the Blower Valve and plastic tee.
10. Install the Enclosure Brace.
11. Install Top Enclosure (see Section 7.4).

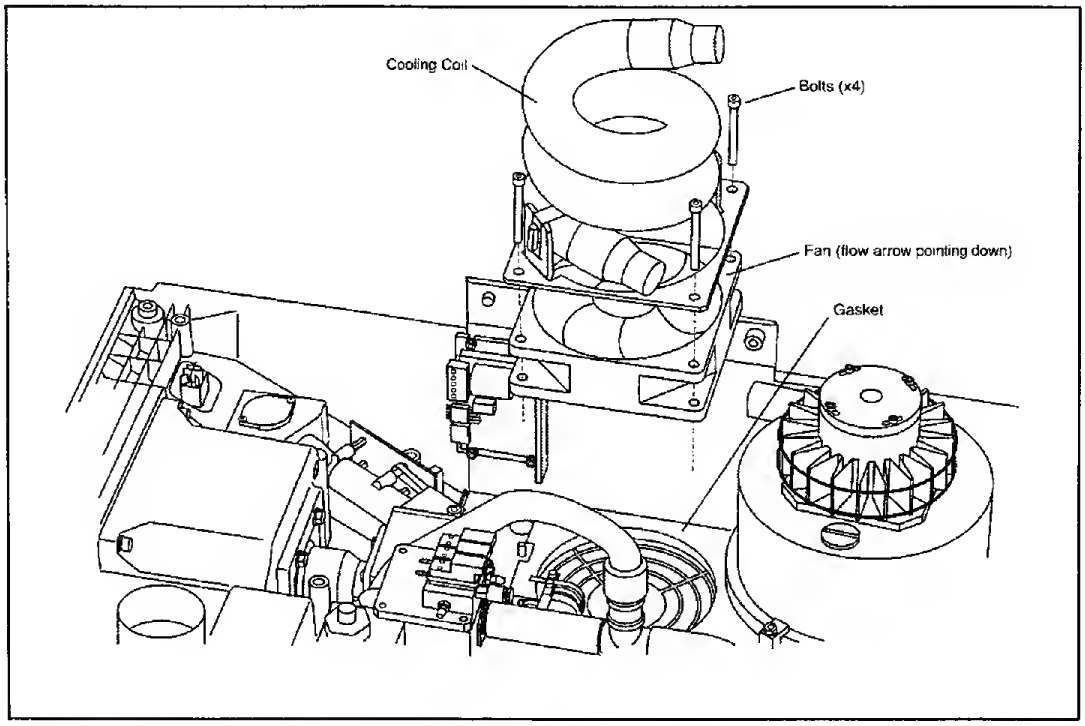


Figure 7-32: Cooling Coil and Fan

8 Where To Go For Help

For further information or technical assistance, contact the nearest Respironics Customer Satisfaction Center at 800-669-9234 in the U.S.

CANADA
51 A Caldari Rd., Unit 8
Concord, Onario
L4K4G3 CANADA
Telephone: 905-761-5490
Fax: 905-761-5499

EUROPE
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Telephone: 011-49-8-15-29-30-60

DEUTSCHLAND
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HONG KONG
Respironics Technologies
2/F Store Microtron Bldg.
Kwun, Tong, Kowloon
Telephone: 011-85-2-23-43-42-18
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9 Esprit Ventilator Replacement Parts List

This section will contain service subassembly/ component diagrams and part numbers